



EPA Tools and Resources Webinar

Citizen Science at EPA

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US EPA Office of Research and Development

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If you had 100,000 people to help you with your work, what would you do?

★ ★ ★ ★
FINAL

The **Minnesota Citizen** 3¢

DAILY 2¢, SUNDAY 10¢

MINNEAPOLIS, WEDNESDAY, JULY 23, 1962

VOL. CLXXXVH, NO. 129

VOLUNTEERS TO INVESTIGATE THE MIGRATION OF MONARCH BUTTERFLIES



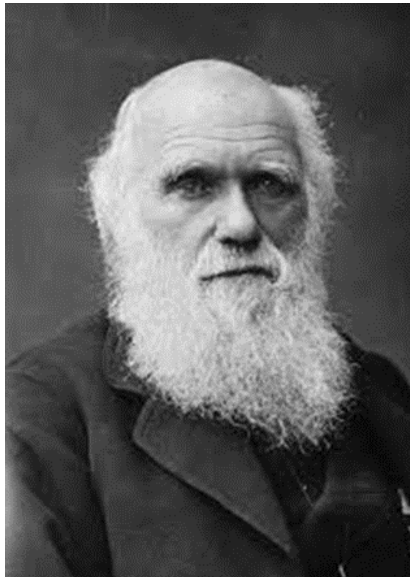
*University program relies on
cooperation of individuals*

Citizen Science is . . .

- The involvement of the public in scientific research often in collaboration with professional scientists and scientific institutions.
- A transformational approach to environmental protection that engages volunteers, allowing large numbers people to contribute to science.

Crowdsourcing and Citizen Science

In **crowdsourcing**, organizations submit an open call for voluntary assistance from a large group of individuals for online, distributed problem solving.



Charles Darwin

“The Original Crowd-Sourced Scientist”

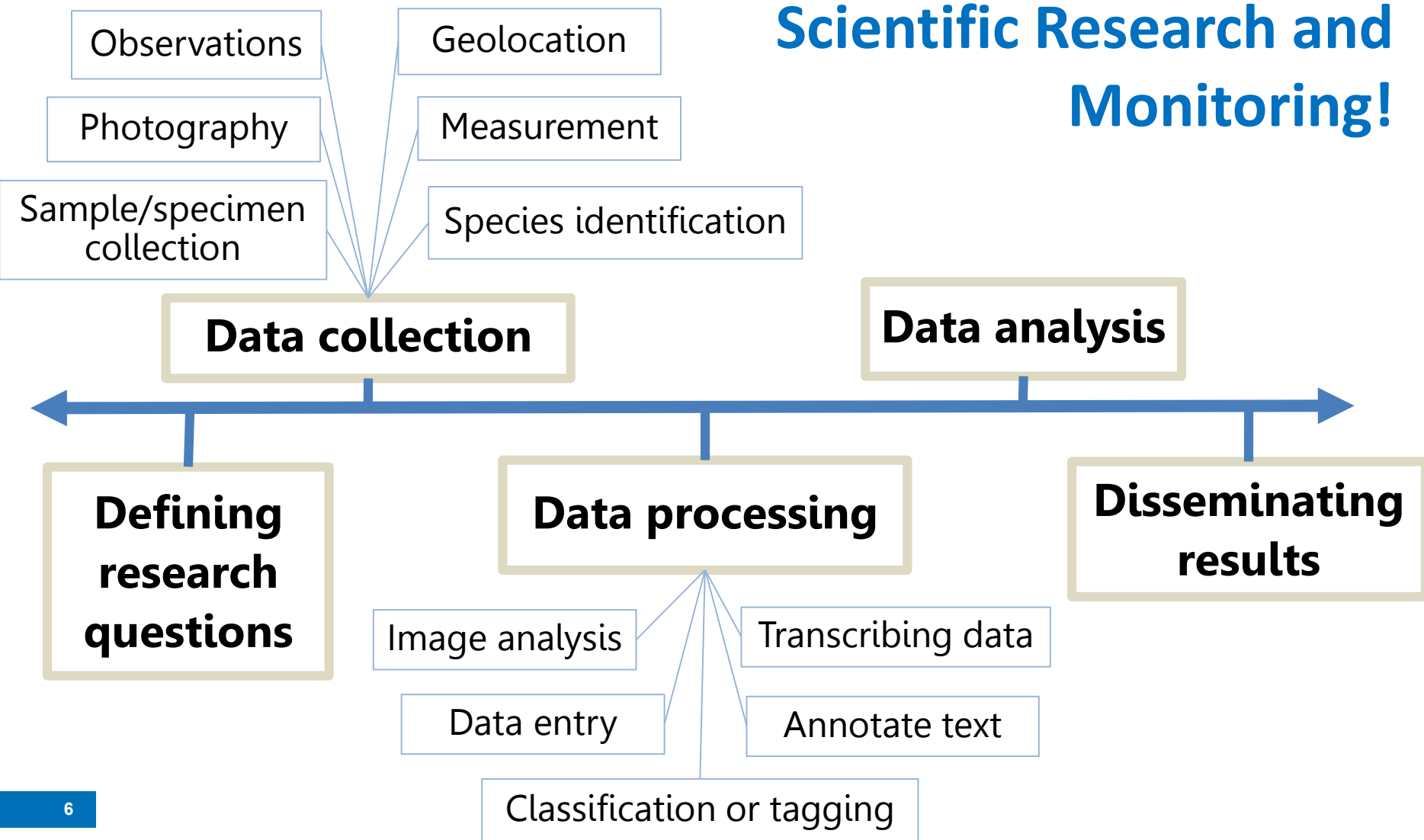
Crowdsourcing example:

“Can Smart Thermometers Track the Spread of the Coronavirus?”



- *Kinsa Health* thermometers (internet-connected) are in a million U.S. households.
- Real-time data from these thermometers can identify unusual patterns of fever clusters.
- For several years, the company’s maps have accurately predicted the spread of flu about two weeks before CDC’s surveillance tool.
- Crowdsourced fever data may be an early warning system for potential COVID-19 spread.

There are Many Ways to Involve Volunteers in Scientific Research and Monitoring!



Citizenscience.gov is an official government website designed to accelerate the use of crowdsourcing and citizen science across the U.S. government. The site provides a portal to three key assets for federal practitioners: a searchable **catalog** of federally supported citizen science projects, a **toolkit** to assist with designing and maintaining projects, and a gateway to a federal **community** of practice to share best practices.

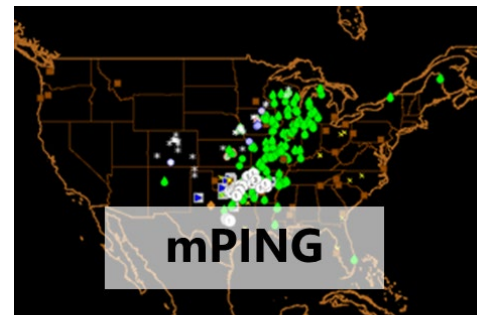
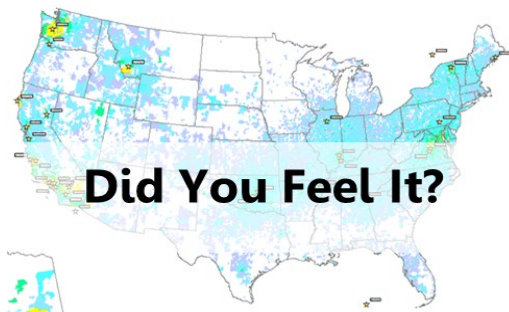
Explore Projects



Plan Your Projects



Join Our Community





Volunteer Water Monitoring

Thousands of groups across the US monitor the condition of their local streams, lakes, estuaries, wetlands, and groundwater resources.

States & Tribal Leadership in Water Citizen Science



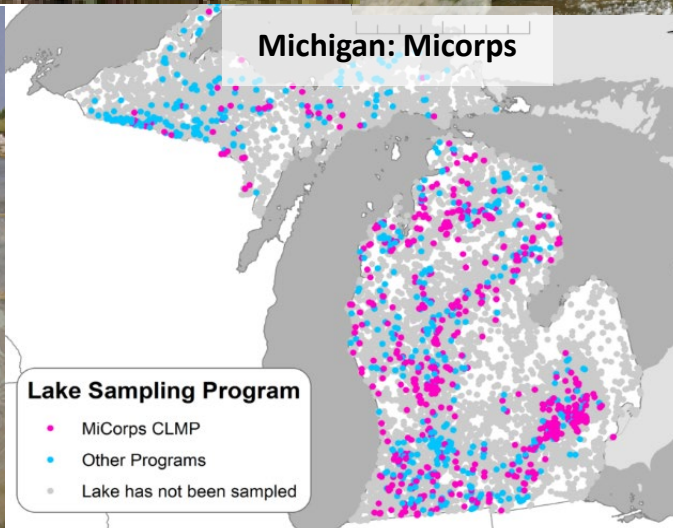
Georgia Adopt a Stream



Sitka Tribe in Alaska Shellfish and Toxins



Utah: Harmful Algal Bloom Response



Michigan: Micorps

Lake Sampling Program

- MiCorps CLMP
- Other Programs
- Lake has not been sampled



Colorado River Watch



Many Uses of Citizen Science at EPA

- Work with communities to understand local problems
- Monitor the environment for environmental protection
- Engage volunteers in research relevant to EPA's mission
- Educate the public about environmental issues





Why EPA Invests in Citizen Science

1. **Fill data gaps** and provide another means of identifying potential environmental problems.
2. **Improve public understanding** of environmental issues and actions that address them.
3. **Create inclusive, collaborative networks** of individuals and organizations dedicated to environmental problem solving.
4. **Yield cost savings and efficiency** in environmental monitoring and protection programs.

EPA Leadership in Citizen Science

Environmental Protection Belongs to the Public

A Vision for Citizen Science at EPA



National Advisory
and Technology (NACEPT)
December 2016

Information to Action

Strengthening EPA Citizen Science
Partnerships for Environmental Protection



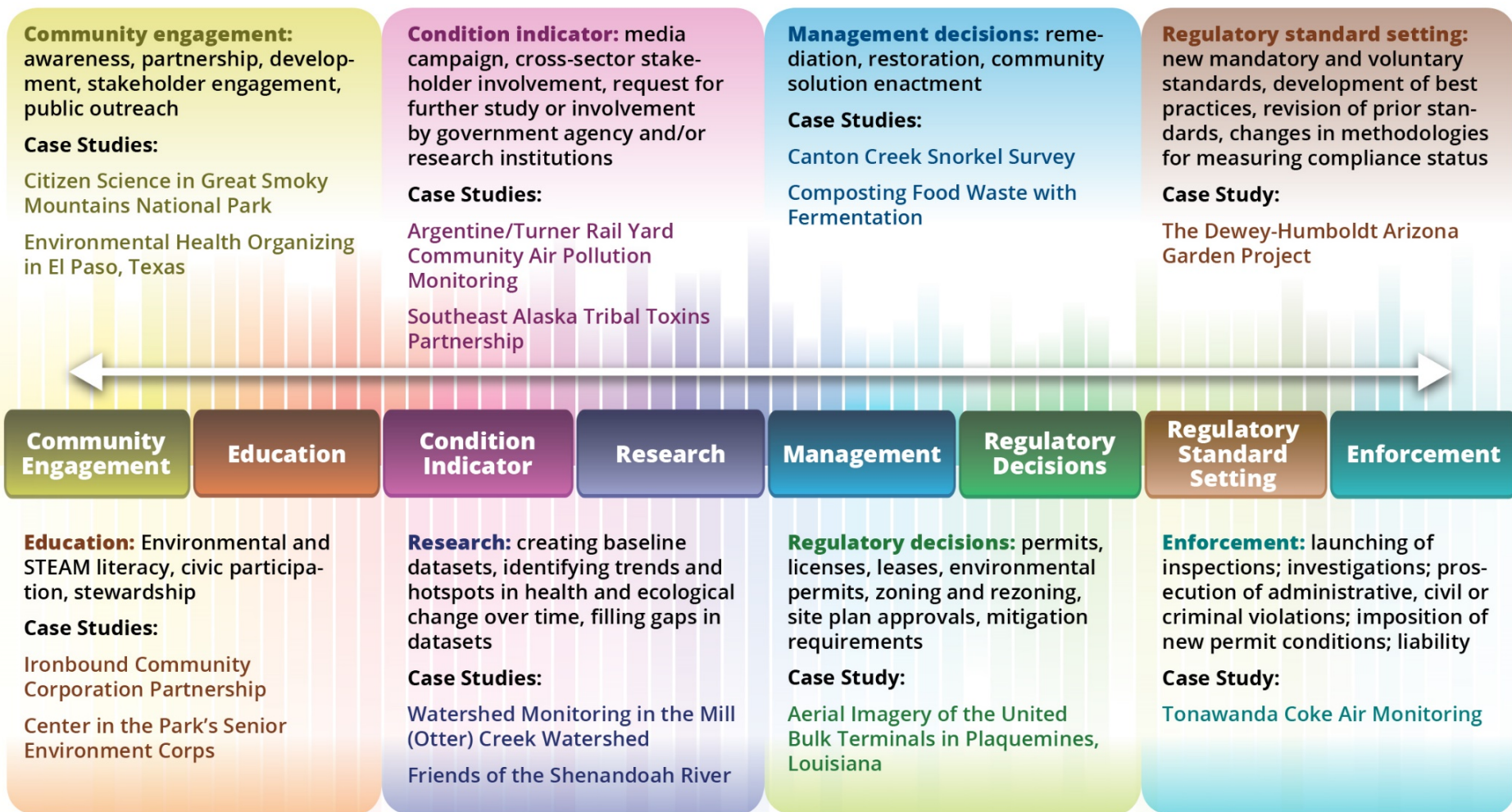
National Advisory Council for Environmental Policy
and Technology (NACEPT)
April 2018

EPA 220-R-18-001

Current Priorities

- A more comprehensive EPA vision and strategy for citizen science
- Increased institutional capacity for using citizen science in environmental programs
- Strengthening data management
- Technical support to build capacity on planning and documentation of data quality

Citizen Science Can Contribute to all EPA Work



EPA QA Handbook

Purpose is to help citizen science organizations select the appropriate level of QA and documentation to fit the intended use of the data.

Encourages preparation of a *Quality Assurance Project Plan (QAPP)* that provides information for data users to evaluate the quality of data collected by citizen scientists.

Recommends contacting federal, state, local, tribal or other organizations for more assistance or guidance.

CITIZEN SCIENCE

Quality Assurance & Documentation

"Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it is the only thing that ever has."

—Margaret Mead



 EPA United States
Environmental Protection
Agency

EPA 206-B-18-001

<https://go.usa.gov/xEw43>

HANDBOOK

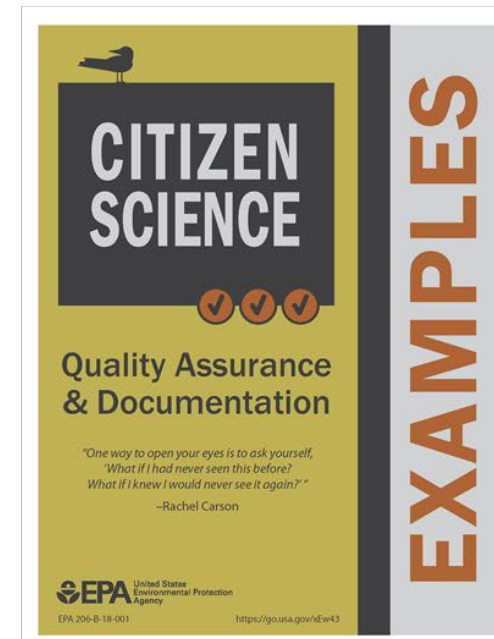
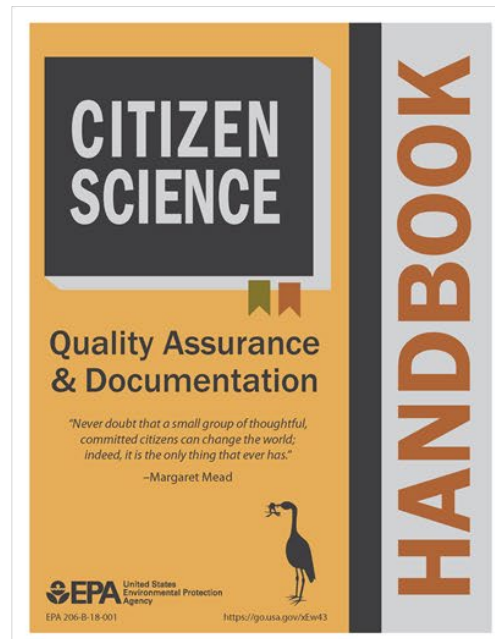
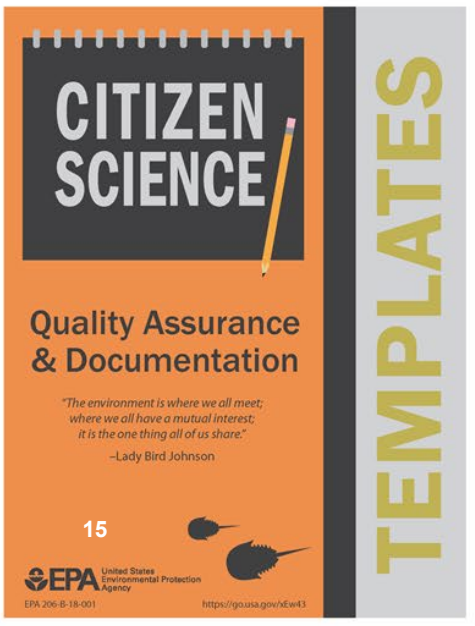
How to Use the QA Handbook

Three parts

Handbook – Explains the purpose of each template

Template – Provides instructions, tables and questions

Examples – Specific examples of QA documentation



Key Idea: Plan for Intended Data Uses

Categories of Data Use	Intended Project Purpose
Increasing public understanding	Community engagement
	Education
Scientific studies and research	Environmental condition indicators (screening, exposure)
	Studies and research
Legal and policy action	Regulatory decisions

Increasing levels of QA and documentation



QA Templates

EPA QAPP elements and QA templates recommended for citizen science projects.

Templates organized into 4 major QAPP elements listed in EPA guidance documents.

- A. Managing the Project
- B. Collecting the Data
- C. Assessing the Data
- D. Reviewing the Data

Template	Increase Public Understanding	Science/Research	Legal/Policy
A. Managing the Project			
1. Title and Preparer Page	X	X	X
2. Table of Contents		X	X
3. Problem Definition, Background and Project Description	X	X	X
4. Data Quality Objectives and Indicators	X	X	X
5. Project Schedule		X	X
6. Training and Specialized Experience	X	X	X
7. Documents and Records	X	X	X
B. Collecting the Data			
8. Existing Data		X	X
9. Sampling Design and Data Collection Methods	X	X	X
10. Sample Handling and Custody		X	X
11. Equipment/Instrument Maintenance, Testing Inspection and Calibration		X	X
12. Analytical Methods	X	X	X
13. Field and Laboratory Quality Control	X	X	X
14. Data Management		X	X
C. Assessing the Data			
15. Reporting, Oversight and Assessments	X	X	X
D. Reviewing the Data			
16. Data Review and Usability	X	X	X
Managing the Project (continued)			
17. Organization Chart		X	X
18. Project/Task Organization		X	X
19. Project Distribution List		X	X

EPA Citizen Science Activities

Some Examples



CyanoScope



Air Sensor Toolbox



Air Sensor Loan Program



Real-time Water Quality Monitoring



Video Image Analysis



Radon Crowd-Mapping

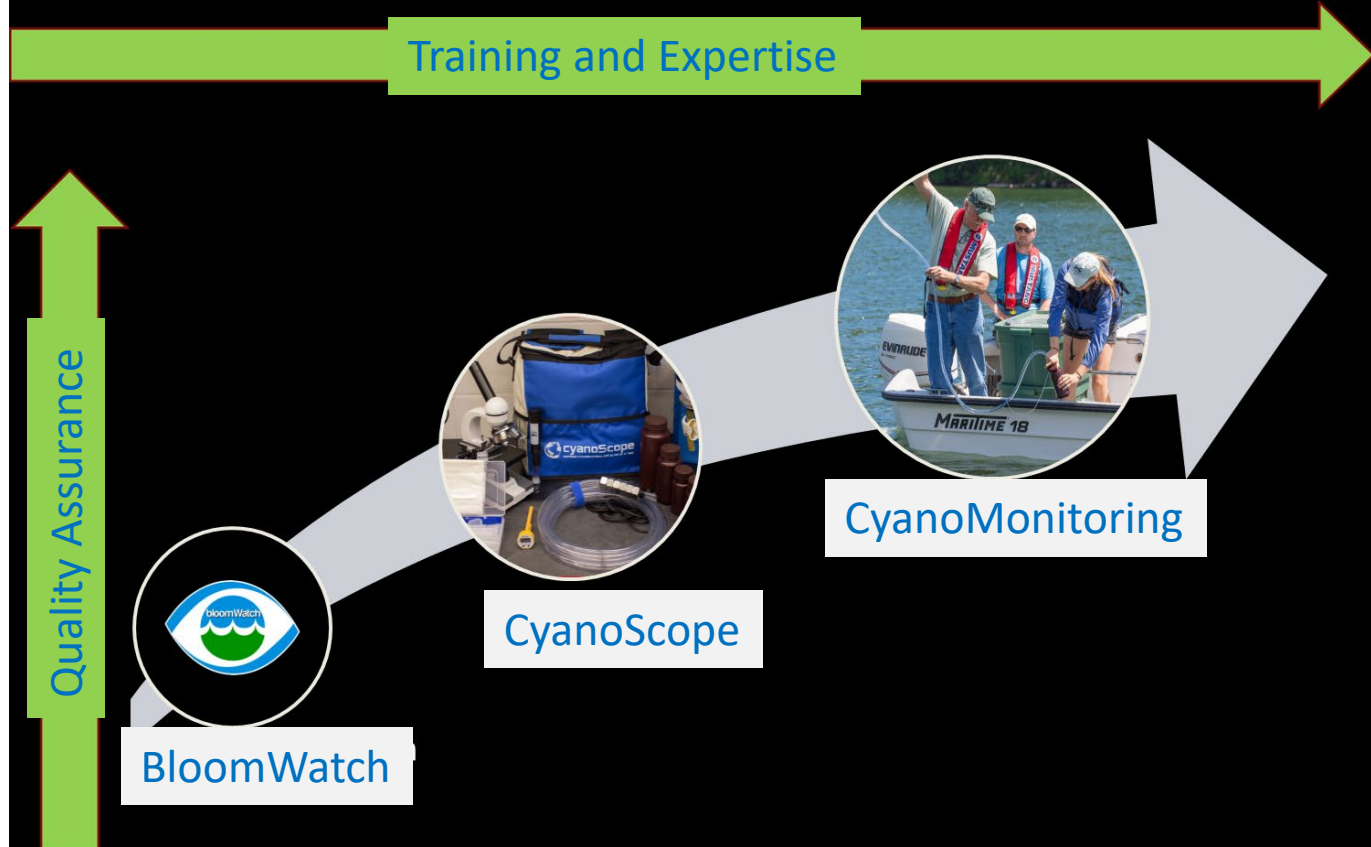
Smoke Sense

Cyanobacteria Monitoring Collaborative

An Approach for Education, Monitoring and Management of Harmful Cyanobacteria



Locating and Understanding Harmful Cyanobacteria



Three Coordinated Monitoring Projects

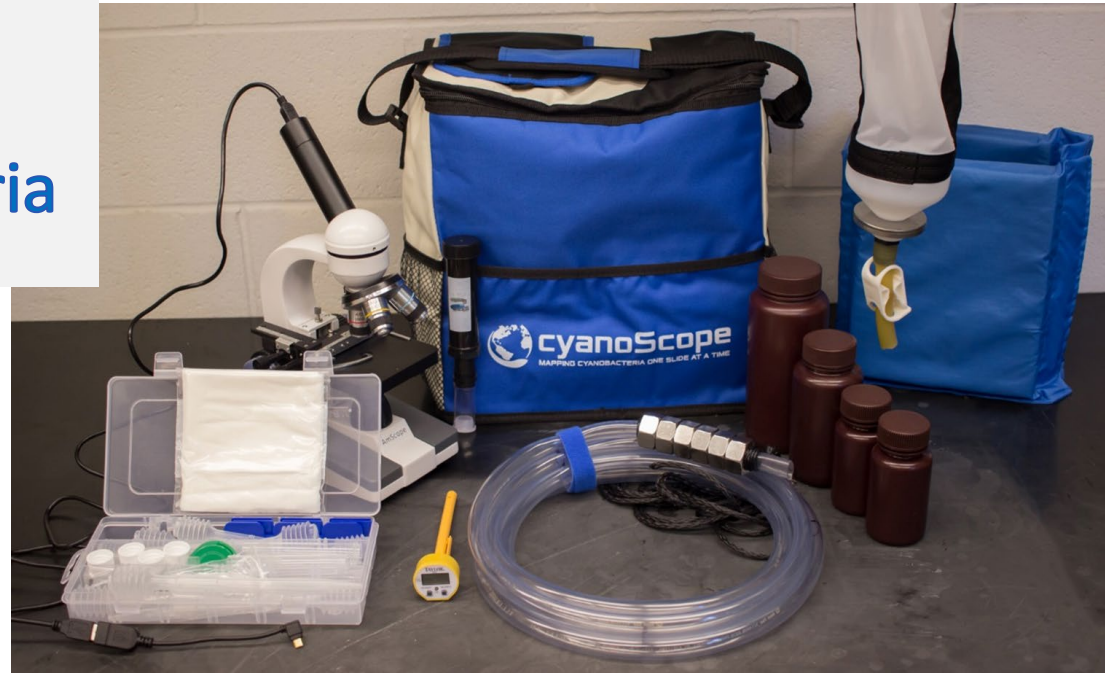
1. **BloomWatch App** – Crowdsourcing to find and report potential cyanobacteria blooms
2. **CyanoScope** – Mapping cyanobacteria one slide at a time
3. **Cyano Monitoring** – Professionals and trained citizen scientists monitor freshwater for cyanobacteria to determine environmental factors that cause blooms

CyanoScope

Mapping Cyanobacteria

First Steps

1. Join cyanoScope project at iNaturalist.org
2. Obtain sample collection and microscopy kit
3. Get training



How Volunteers contribute observations

1. **Collect Cyanobacteria** – Take a water sample with a net tow, prepare a microscope slide, and identify cyanobacteria in the sample.
2. **Submit the Images** – Take a photo of the Cyanobacteria found in the sample, and upload images and info on iNaturalist platform.
3. **Interact Online** – iNaturalist community can confirm type of cyanobacteria, you can view images from other volunteers, and everyone can explore the geospatial patterns of cyanobacteria.

iNaturalist Website Helps Identify the Type (Genus) of Cyanobacteria

cyanoScope

Print

The inaturalist cyanoscope project <https://www.inaturalist.org/projects/cyanoscope> is a citizen science based program to photograph and identify cyanobacteria and other phytoplankton. This guide is a work in progress. ...more ↓

All 16

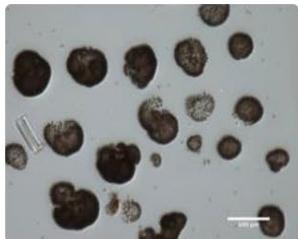
Search Search

Sort Grid Card

- TAGS
- BMAA 1
 - Cyanobacteria 1
 - Microcystin 1
 - toxin 1
- TAXONOMY
- Class Cyanophyceae 15
 - Order Synechococcales 1



*Microcystis*¹



*Woronichinia*¹



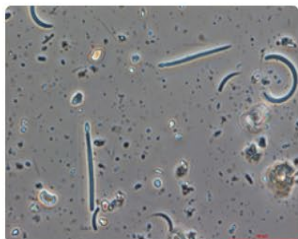
*Anabaena*¹



*Dolichospermum*¹



*Aphanizomenon*¹



*Cylindrospermopsis*²



*Planktothrix*¹



*Nostoc*¹



AIR SENSOR TOOLBOX

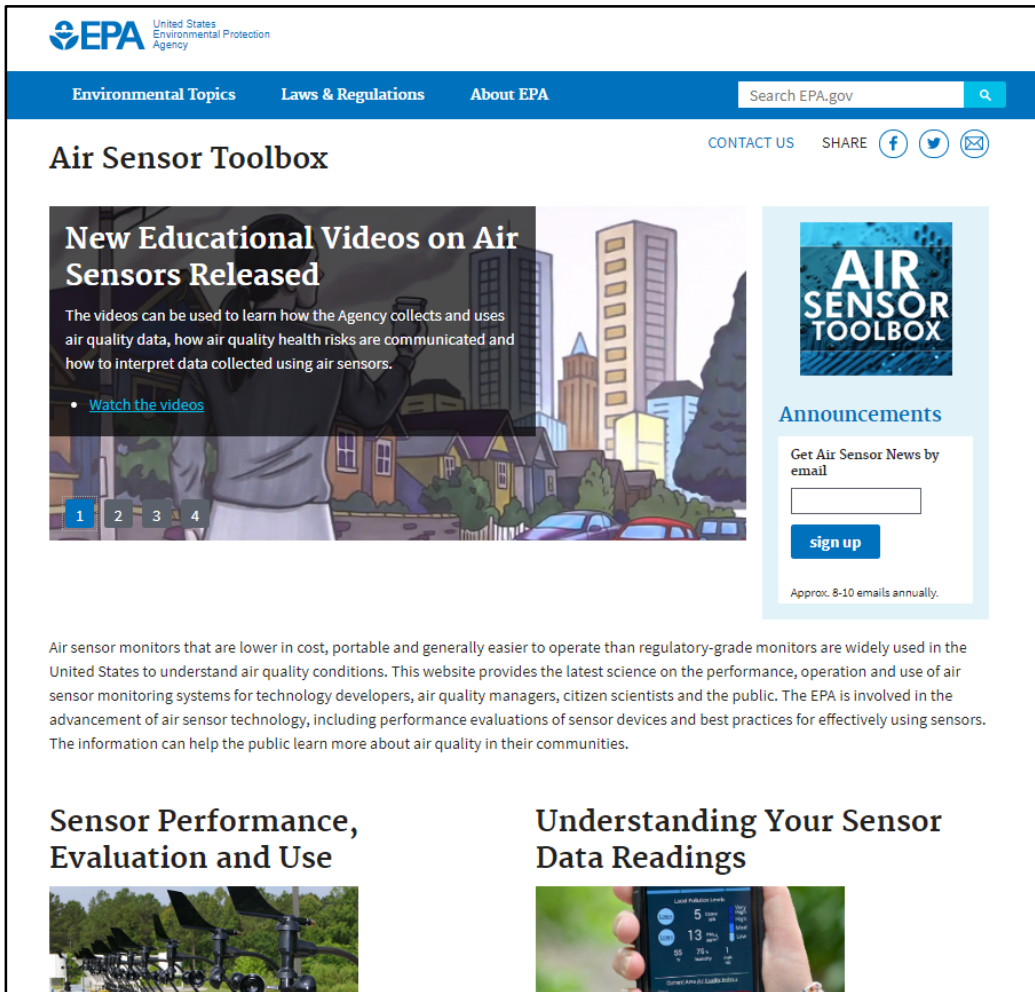
Audience:

- Citizen scientists
- Technology developers
- Researchers
- State/local/tribal agencies
- General public



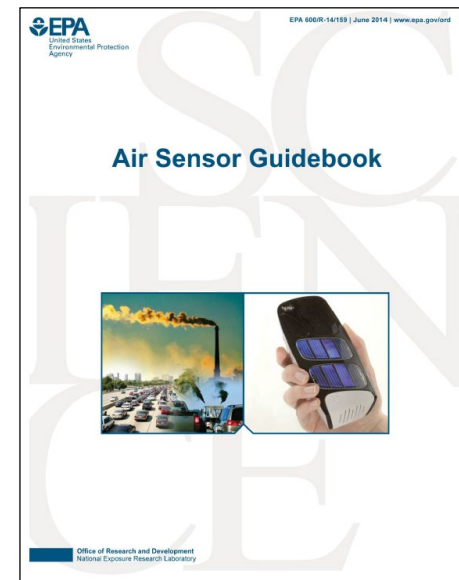
<http://www.epa.gov/heasd/airsensortoolbox>

Information on Performance, Operation and Use of Air Sensors



The screenshot shows the EPA website's 'Air Sensor Toolbox' page. At the top, there is a navigation bar with 'Environmental Topics', 'Laws & Regulations', and 'About EPA', along with a search bar and social media icons. The main heading is 'Air Sensor Toolbox'. Below it, a featured section titled 'New Educational Videos on Air Sensors Released' includes a video player with a cityscape background and a 'Watch the videos' link. To the right, there is an 'Announcements' section with a 'Get Air Sensor News by email' sign-up form and a 'sign up' button. Below the main content, there are two article teasers: 'Sensor Performance, Evaluation and Use' and 'Understanding Your Sensor Data Readings', each with a small image of air sensor equipment.

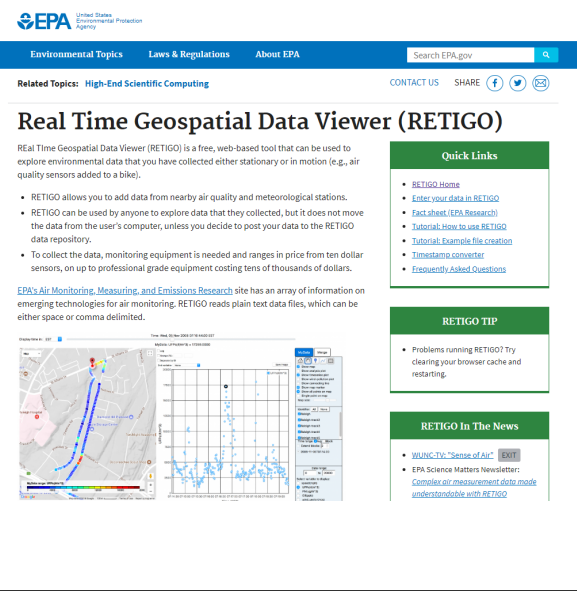
Air Sensor Guidebook (2014) – guide for using air sensors to collect air quality measurements



**The Air Sensor Guidebook is
currently being updated!**

Helpful Tools for Data Analysis, Visualization and Communication

RETIGO – Free web-based tool to explore environmental data



Real Time Geospatial Data Viewer (RETIGO)

Real Time Geospatial Data Viewer (RETIGO) is a free, web-based tool that can be used to explore environmental data that you have collected either stationary or in motion (e.g., air quality sensors added to a bike).

- RETIGO allows you to add data from nearby air quality and meteorological stations.
- RETIGO can be used by anyone to explore data that they collected, but it does not move the data from the user's computer, unless you decide to post your data to the RETIGO data repository.
- To collect the data, monitoring equipment is needed and ranges in price from ten dollar sensors, on up to professional grade equipment costing tens of thousands of dollars.

Quick Links

- RETIGO Home
- Enter your data in RETIGO
- Find a site (EPA Research)
- Tutorial: how to use RETIGO
- Tutorial: Example file creation
- Time series converter
- Frequently Asked Questions

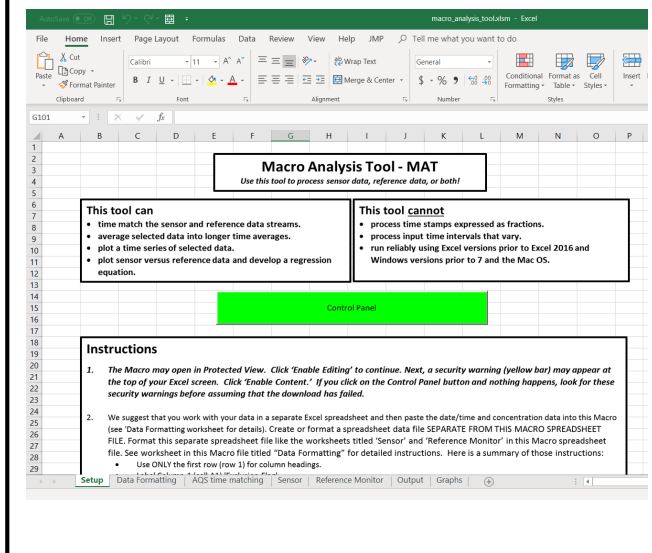
RETIGO TIP

- Problems running RETIGO? Try clearing your browser cache and restarting.

RETIGO In The News

- WUNC-TV: "Sense of Air" [EXIT](#)
- EPA Science Matters Newsletter: [Compare air measurement data made understandable with RETIGO](#)

Macro Analysis Tool – Free excel-based tool to compare air sensor and reference monitor data



Macro Analysis Tool - MAT
Use this tool to process sensor data, reference data, or both!

This tool can

- time match the sensor and reference data streams.
- average selected data into longer time averages.
- plot a time series of selected data.
- plot sensor versus reference data and develop a regression equation.

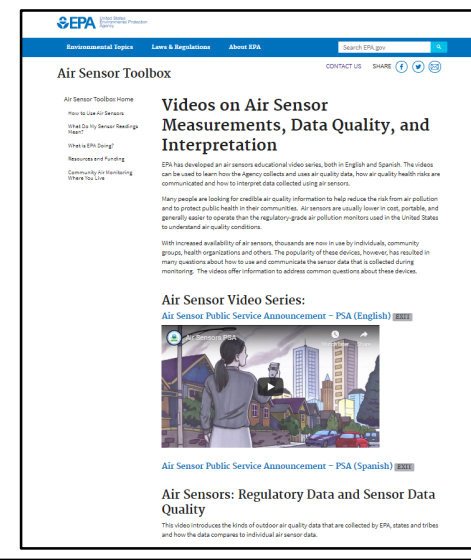
This tool cannot

- process time stamps expressed as fractions.
- process input time intervals that vary.
- run reliably using Excel versions prior to Excel 2016 and Windows versions prior to 7 and the Mac OS.

Instructions

- The Macro may open in Protected View. Click 'Enable Editing' to continue. Next, a security warning (yellow bar) may appear at the top of your Excel screen. Click 'Enable Content.' If you click on the Control Panel button and nothing happens, look for these security warnings before assuming that the download has failed.
- We suggest that you work with your data in a separate Excel spreadsheet and then paste the date/time and concentration data into this Macro (see 'Data Formatting worksheet for details). Create or format a spreadsheet data file SEPARATE FROM THIS MACRO SPREADSHEET FILE. Format this separate spreadsheet file like the worksheets titled 'Sensor' and 'Reference Monitor' in this Macro spreadsheet file. See worksheet in this Macro file titled "Data Formatting" for detailed instructions. Here is a summary of those instructions:
 - Use ONLY the first row (row 1) for column headings.

Educational Videos – Address how to use and communicate data from air sensors



Air Sensor Toolbox

Videos on Air Sensor Measurements, Data Quality, and Interpretation

EPA has developed an air sensors educational video series, both in English and Spanish. The videos can be used to learn how the Agency collects and uses air quality data, how air quality health risks are communicated and how to interpret data collected using air sensors.

Many people are looking for credible air quality information to help reduce the risk from air pollution and to protect public health in their communities. Air sensors are usually lower in cost, portable, and generally easier to operate than the regulatory-grade air pollution monitors used in the United States to understand air quality conditions.

With increased availability of air sensors, thousands are now in use by individuals, community groups, health organizations and others. The popularity of these devices, however, has resulted in many questions about how to use and communicate the sensor data that is collected during monitoring. The videos offer information to address common questions about these devices.

Air Sensor Video Series:

- [Air Sensor Public Service Announcement - PSA \(English\)](#)
- [Air Sensor Public Service Announcement - PSA \(Spanish\)](#)

Air Sensors: Regulatory Data and Sensor Data Quality

This video introduces the kinds of outdoor air quality data that are collected by EPA, states and tribes and how the data compares to individual air sensor data.

Just released on Feb 18th!

Understanding Sensor Data Readings

Potential for improved environmental awareness about local pollution levels through citizen-based monitoring

Data Collection

Analysis and Interpretation

Communication



Los Angeles Public Library Air Sensor Loan Program



- Air quality in the Los Angeles area has improved over the last 4 decades, but the area still struggles with air pollution.
- To meet requirements of the Clean Air Act, criteria air pollutants are monitored at a limited number of stations.
- **New, lower cost air sensor technologies allow** the public to measure air quality in more locations at the neighborhood or street level.

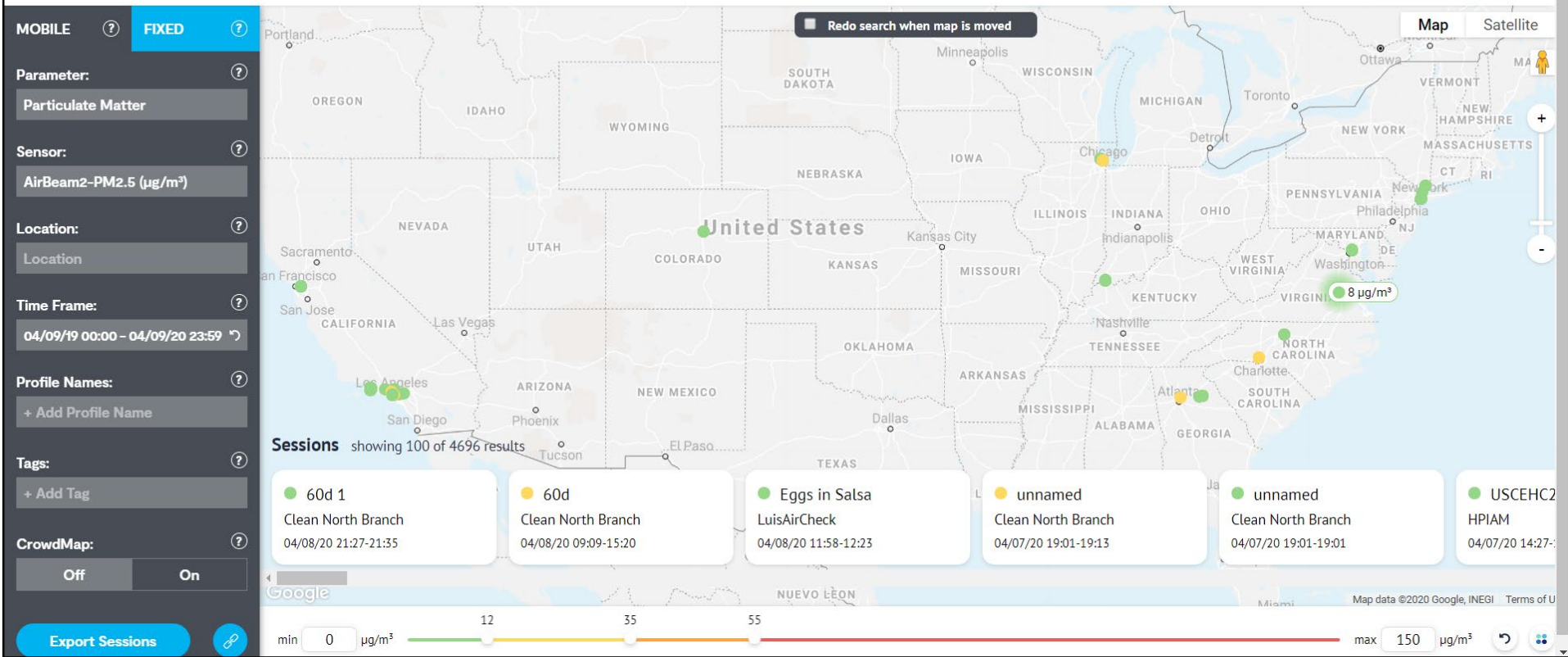
Collaborative Project

Approach:

- Air sensors that measure fine particles (PM_{2.5}) will be available for checkout at select branches of the Los Angeles Public Library system.
- Three lesson plans with hands-on activities based on the sensor will be used.
- Libraries will host workshops on how to use the sensor using the lesson plan.
- Loan program will use the *AirBeam2 Sensor* which measures PM2.5, humidity & temperature.



<https://www.habitatmap.org/airbeam>

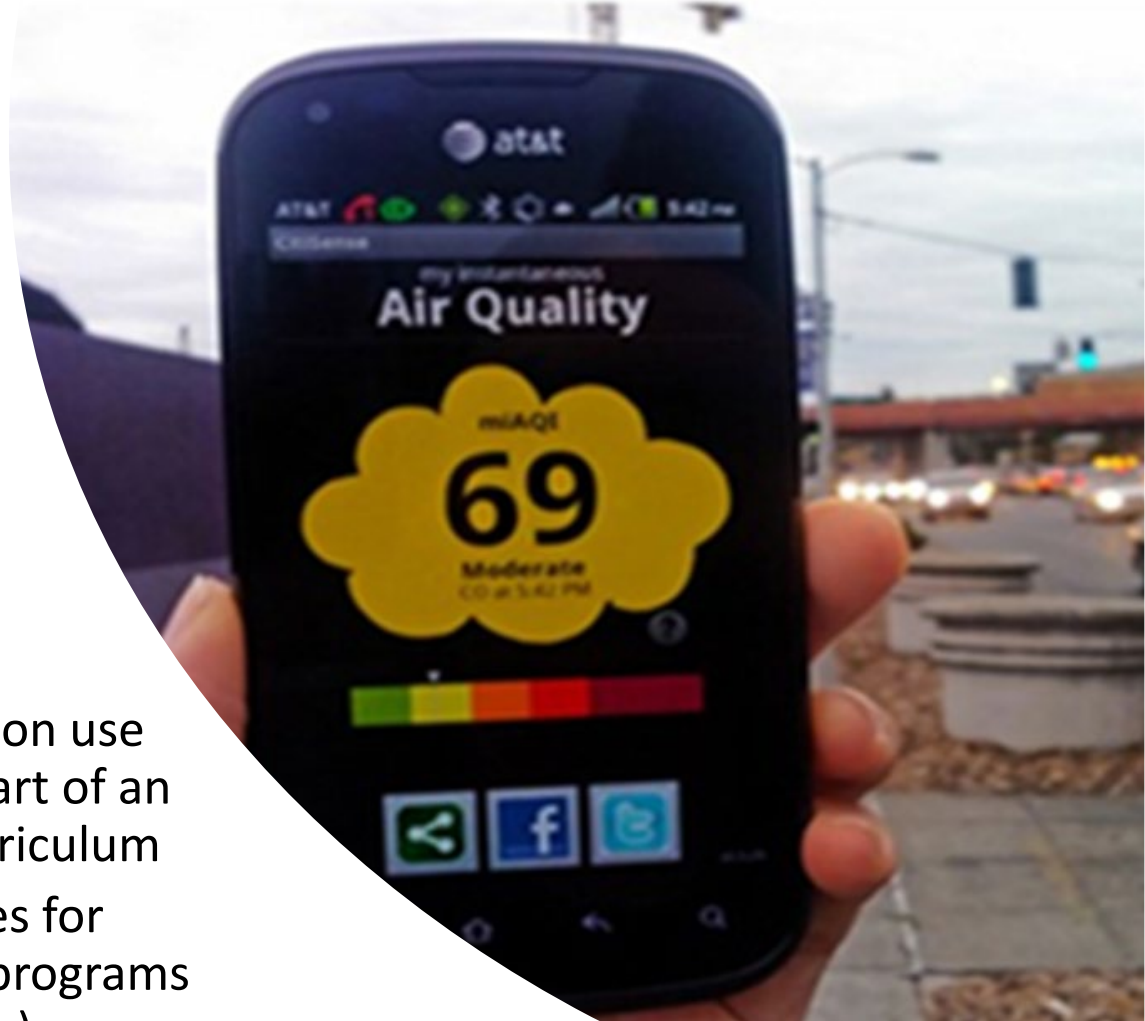


Anticipated Impacts

- Increase air quality awareness
- Educate and engage the community
- Help the public take actions to protect their health
- Develop transferable resources including air quality lesson plans for classroom instruction

Goal of LA Library Loan Program: Demonstration and Replication

- **Learning** – How to train staff on use of air sensor equipment as part of an environmental education curriculum
- **Practical logistics** – Challenges for community equipment loan programs (maintenance, calibration etc.)
- **Knowledge Transfer** – “Best Practices” guide with lessons learned for implementing similar programs in other parts of the country



New Technology for Water Quality Monitoring

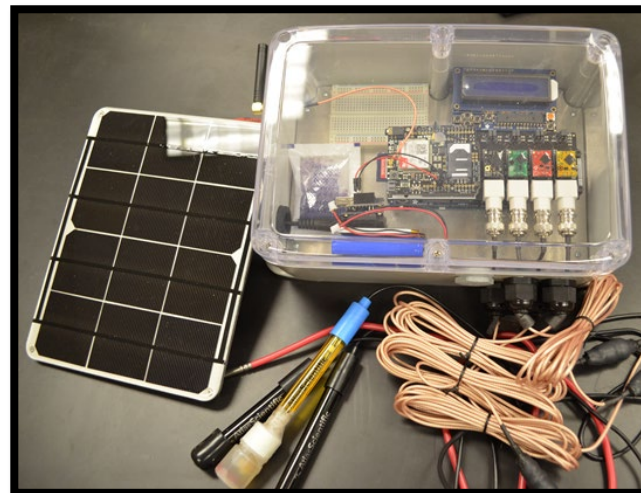


Demonstration Project in Georgia
Low Cost Sensors for Real-Time
Continuous Monitoring

Cooperative Project with Georgia's Adopt-A-Stream Program

- Two day workshop trained 15 volunteer organizations to build and operate low-cost water quality sensors
- Built, programmed, and deployed 20 open source/low-cost sensor units
- Used publicly available sensors for key parameters (temperature, pH, dissolved oxygen, and specific conductance)
- 3-month field evaluation completed in June 2018 (collected 90 days of data)

<https://www.epa.gov/innovation/low-cost-sensors-real-time-continuous-water-quality-monitoring>



Results from Evaluation Study

Findings inform shift to advanced water quality monitoring

Low-cost sensors compared well to industry standard equipment under controlled laboratory conditions

Challenges with sensor systems deployed at field sites

- Frequent calibration drift
- Decreased life expectancy (pH probe)
- High power demand
- Susceptibility to damage

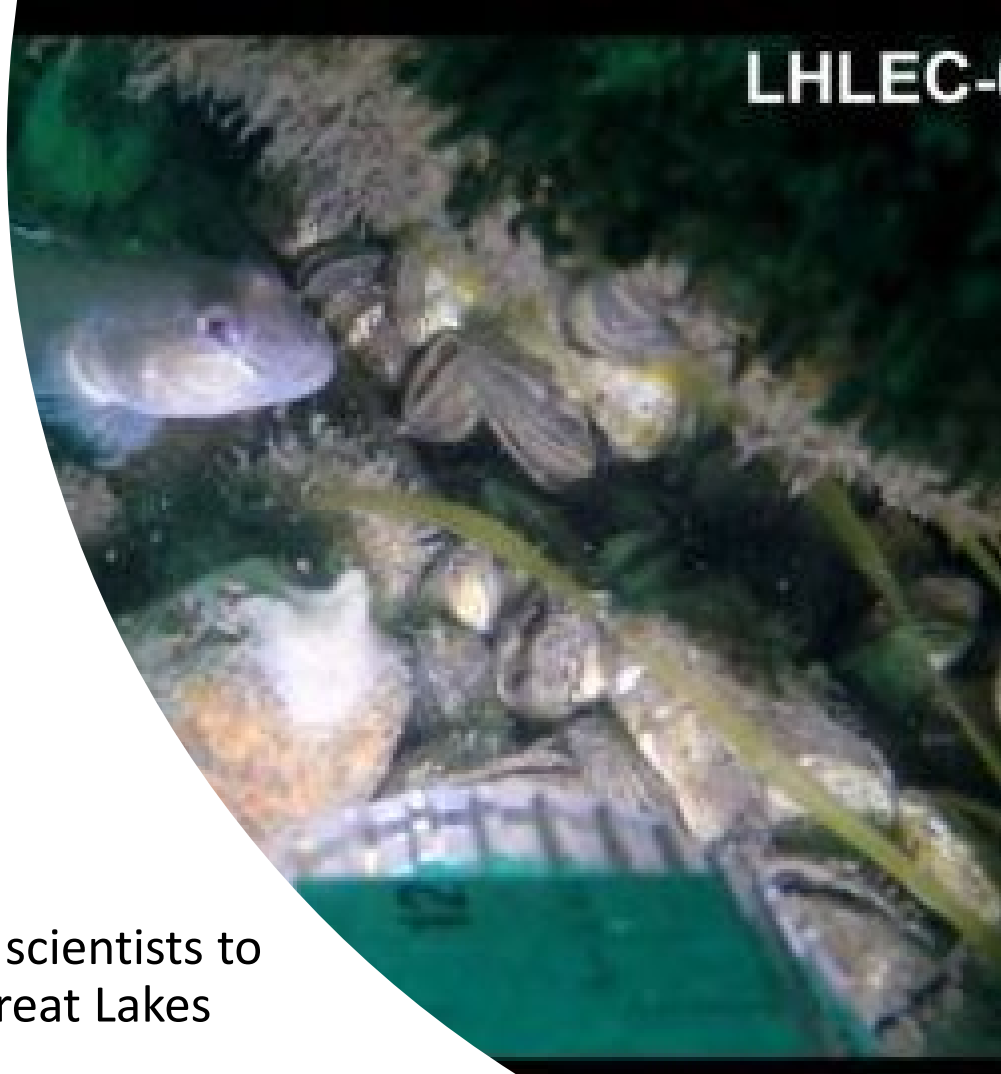
Lessons for future projects that utilize open source/low-cost sensor technology

- Field ruggedness
- Maintenance/calibration demand
- Technical learning curve
- Data quality objectives



Deep Lake Explorer: Using Citizen Science to Analyze Underwater Video in the Great Lakes

- Created a web application for citizen scientists to evaluate underwater videos of the Great Lakes
- 531 volunteers analyzed 746 video clips in 2 weeks for *habitat characteristics* and *invasive species*



Video Camera set up



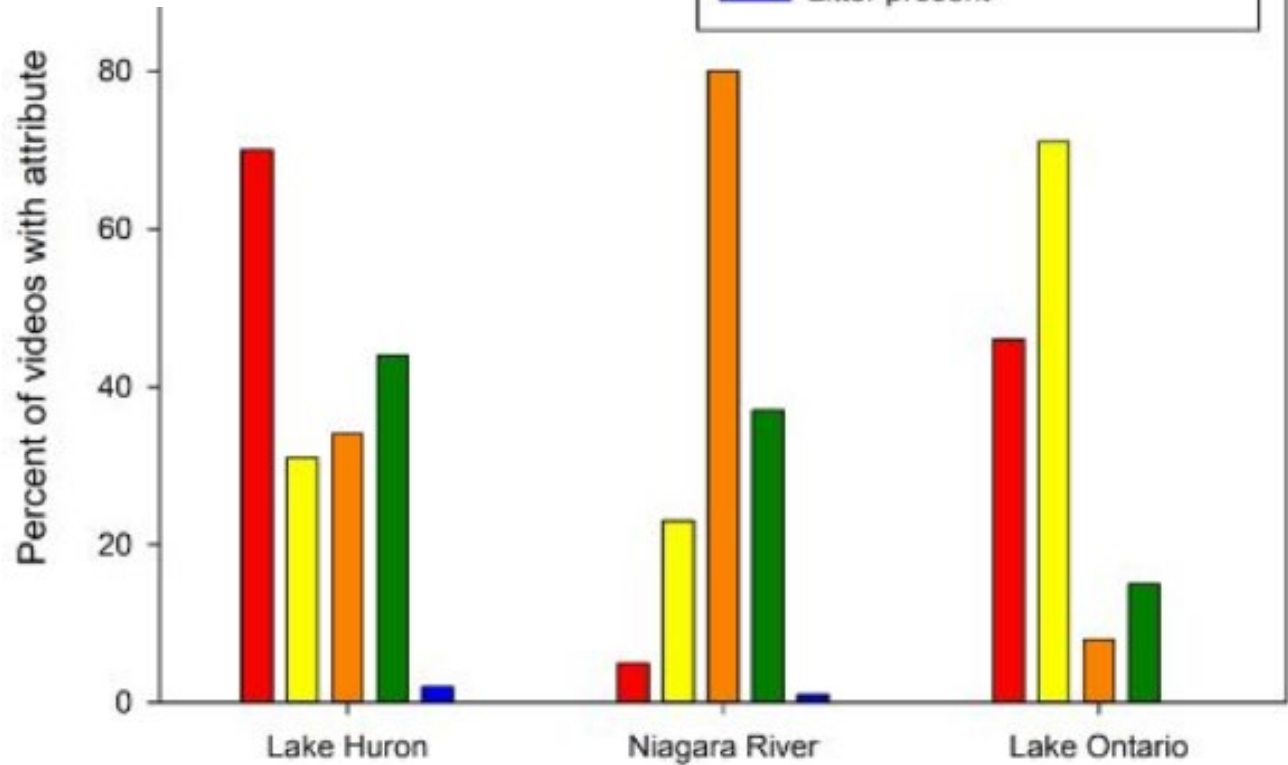
Underwater Image



Project Compared Classifications by Experts vs Crowdsourced Volunteers



Video Images

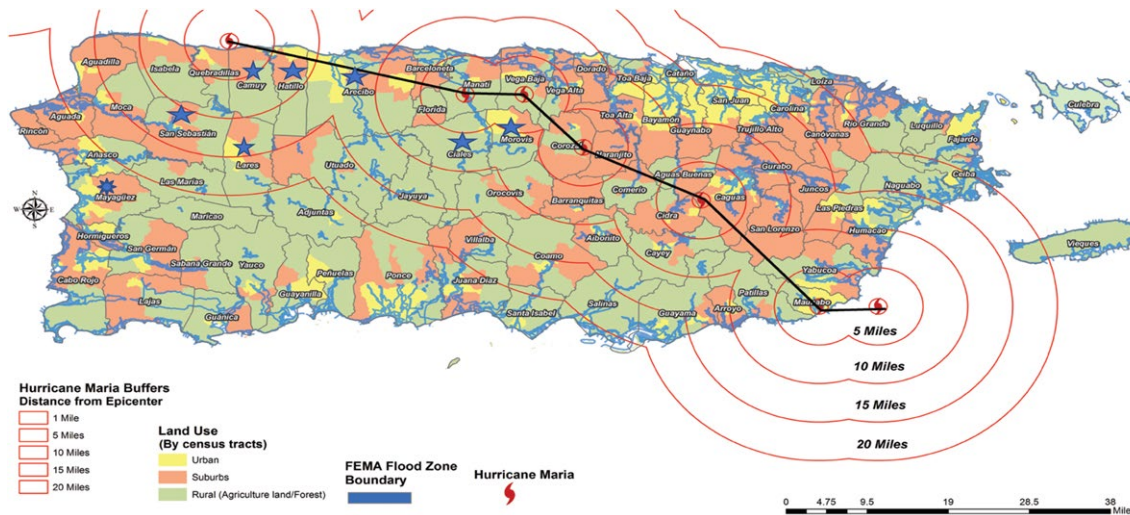


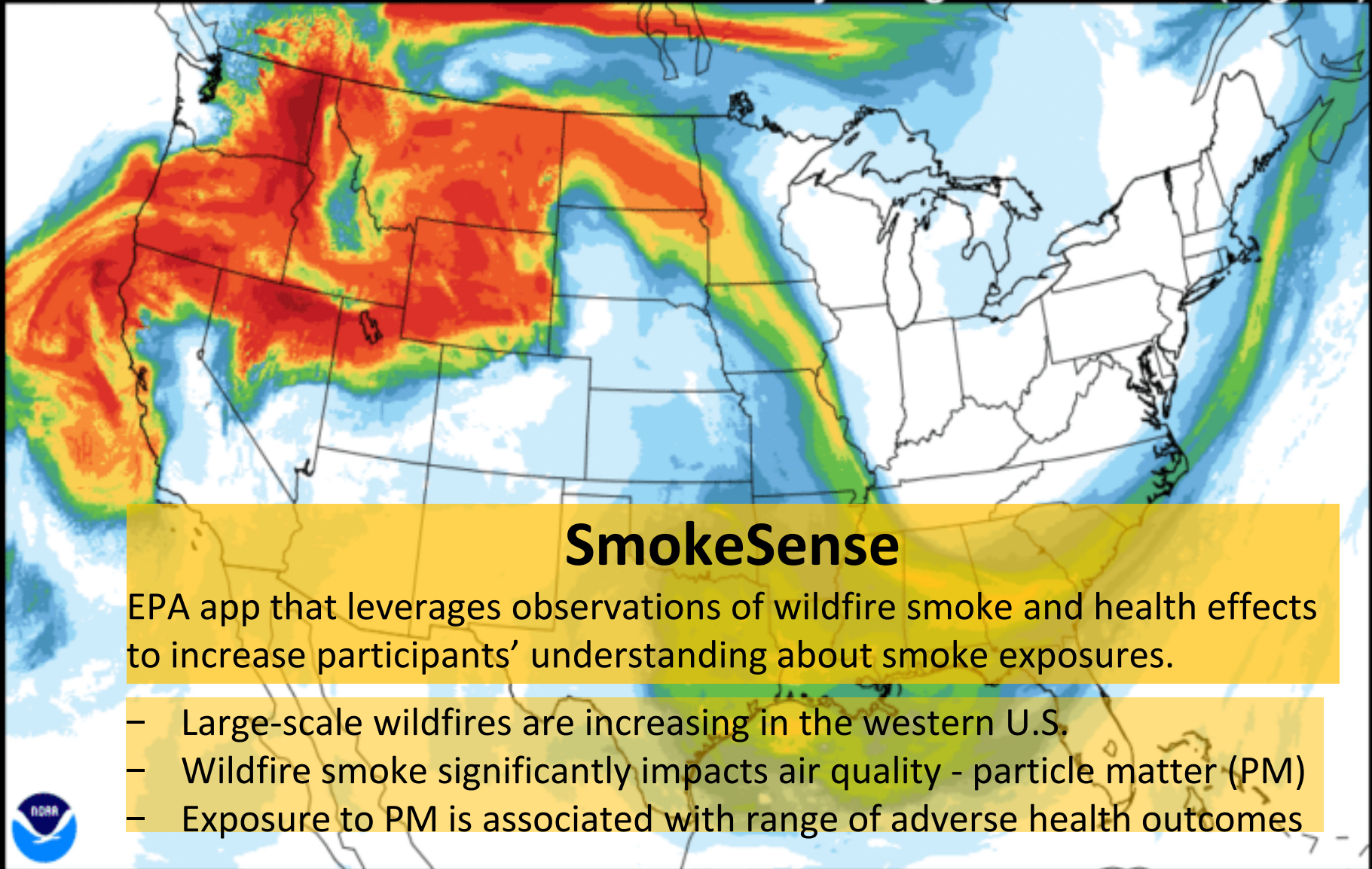
Types of Questions Asked

1. Is substrate mostly hard, soft, or mixed?
2. Is vegetation present?

1. Do you see fish?
2. If so, are they round gobies?
3. Do you see invasive mussels?

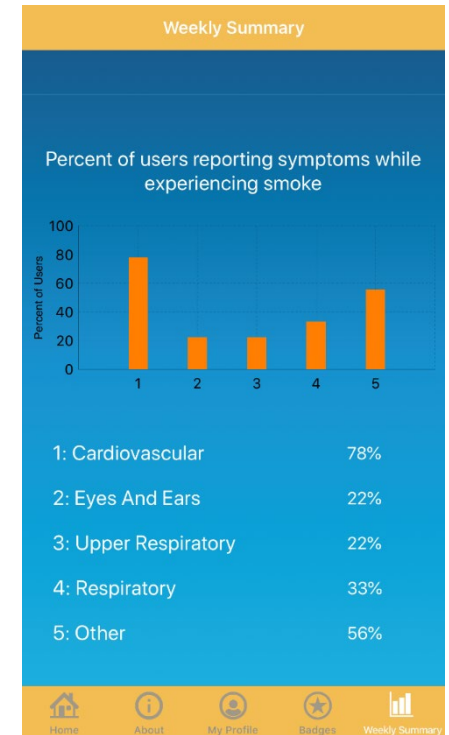
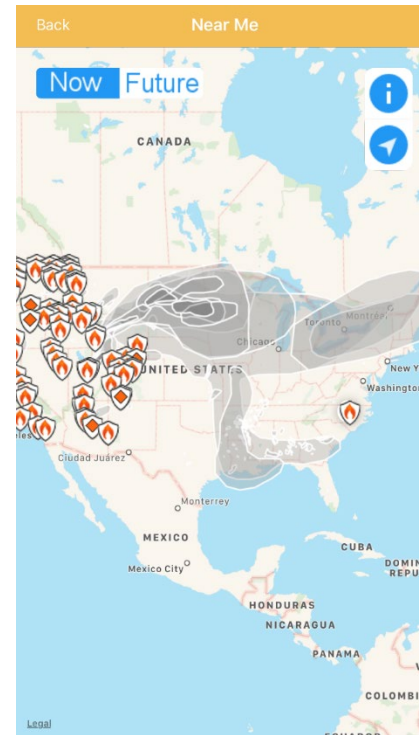
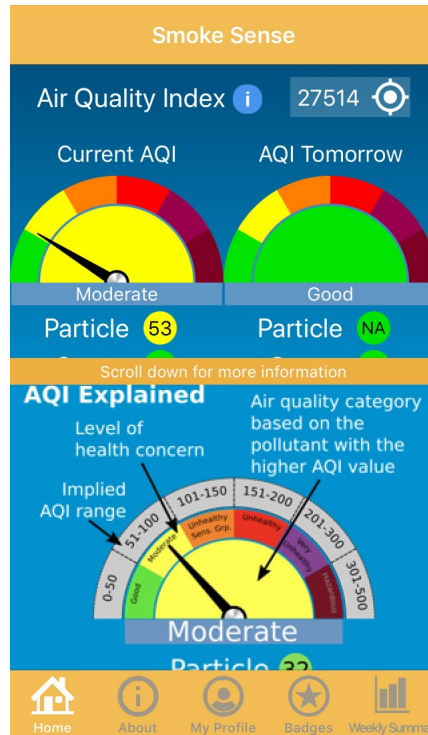
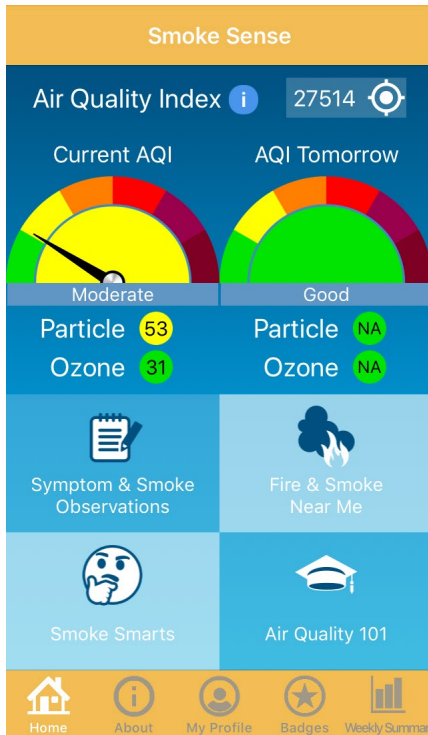
New Test Method for Community Mapping of Radon in Puerto Rico



Vertically Integrated Smoke (mg/m^2)

Smoke Sense App

Innovative method for communication and data collection



Smoke Sense App has over 30,000 users!



Citizen Science Contribution to EPA's mission

Enhanced scientific research and
environmental monitoring

STEM education

Community-scale problem solving

Stronger links to the public

Image: CROWD & CLOUD

Want to learn more?

Websites

- citizenscience.gov and epa.gov/citizen-science
- [Citizen Science Association](https://citizenscience.org)
- [SciStarter](https://scistarter.org) – to find projects

Helpful reports and documents

- [NACEPT reports](#) about EPA's citizen science
- [Recent article in Nature magazine](#)
- [NAS report](#) on Learning through Citizen Science
- [Report to Congress on Citizen Science](#)



Contacts

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For more information about specific EPA citizen science projects:

CyanoScope

Air Sensors Toolbox

Library Sensor Loan Program

Real-time Water Monitoring

Underwater Video Analysis

Community Radon Mapping

Smoke Sense

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