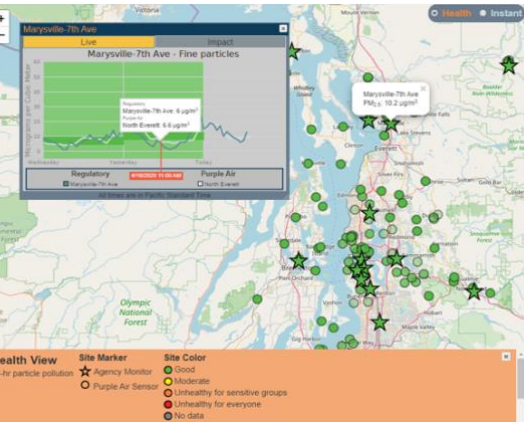
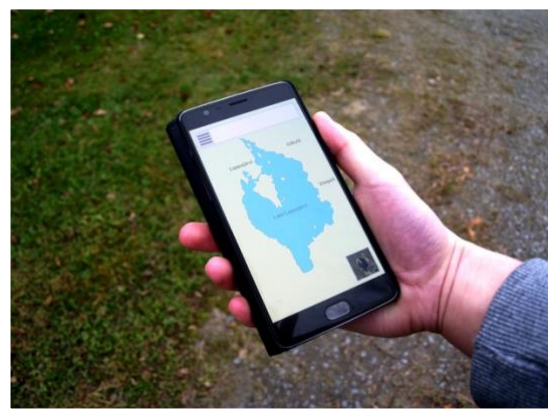




Citizen Science Programs at Environmental Agencies: Case Studies

October 2020



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INTRODUCTION

The involvement of volunteers in scientific monitoring or research is most commonly referred to as “citizen science”. However, this form of volunteerism is also known as community science, crowdsourcing and civic science to be more inclusive and emphasize that information can be gained by methods that are not scientific, such as traditional ecological knowledge. Recognizing the value of such views, the term "citizen science" is used here simply as a common shorthand which may include a wide range of participants.

The ability of the public to collect and report reliable data on local conditions has great potential for strengthening environmental protection and supporting the work of environmental agencies. Citizen science can be used to fill information gaps, define research agendas, monitor environmental changes, and define the concerns of environmental justice communities. Increasingly, environmental agencies at the state, tribal, and local level are developing new citizen science approaches. To record these efforts, two key resources have been developed, namely: **PART I** – Case Studies and **PART II** – Best Practices.

This report presents Part I, a compilation of 15 case studies of agency programs that actively involve the public to complement official action and to establish a collaborative role in protecting the environment. This compilation should not be viewed as a comprehensive survey of agency programs but rather as a representation of the variety of approaches currently undertaken. While ELI sought to highlight a wide range of citizen science examples, the emphasis is on citizen science at environmental agencies and its uses in environmental protection programs, particularly in air and water programs. The table below reflects the distribution of the 15 case studies across relevant program areas and levels of government.

	STATE	TRIBAL	LOCAL
AIR MONITORING PROGRAMS	1		5
WATER MONITORING PROGRAMS	4	2	1
ENFORCEMENT & COMPLIANCE PROGRAMS	1		1

The case studies reveal a diverse set of approaches to citizen science programs, particularly in terms of:

- **The types of environmental issues addressed**, such as monitoring for air and water pollutants;
- **The roles that environmental agencies play**, from leading a program to supporting an external citizen science initiative;
- **The ways in which environmental agencies make use of the data**, including public education, capacity building, research, monitoring and enforcement; and
- **The strategies used to engage and support citizen science**, including the use of technologies and hands-on interaction.

TYPES OF ENVIRONMENTAL PROGRAMS

While citizen science is used to address a variety of environmental problems, its use in pollution monitoring and enforcement programs has come into sharp focus in recent times. Described below are a few ways in which citizen science is contributing to environmental agency programs.

In water monitoring programs, citizen science is seen to be playing a role in four different aspects:

- Volunteers have been recruited by state environmental agencies to assist with surface water quality monitoring since the 1990's. Today, in the most advanced water programs, citizen-generated data are considered equivalent to agency data and are used to assess the impairment of rivers, lakes and streams.
- More recently, some state agencies have turned to the public for help in spotting dangerous cyanobacteria blooms – either by reporting events in the field or through continuous monitoring.
- State volunteers have also been trained to evaluate the ecological health of wetlands and their riparian areas.
- Groundwater is also a topic of interest, although not as widely monitored as surface water due to the extensive costs involved. Voluntary participation by private well owners can provide agencies with the data needed to identify pollutants of concern, their sources, and management actions needed to protect drinking water resources.

In air monitoring programs, recent advancements in low-cost sensor technologies and crowdsourcing platforms have prompted the use of citizen science. Air programs are gaining significant value from technology use and the data generated by volunteers, especially since this data can be used to fill gaps in the agency's monitoring network. Such information can help identify pollution hotspots and locations that bear a disproportionate share of pollution burdens. Other air programs are supporting the use of these low-cost sensing devices by providing volunteers with technical resources to enhance their knowledge and develop their skills in the field of air monitoring.

Compliance and enforcement programs are also finding ways to engage volunteers to help monitor compliance and provide the information needed for regulatory enforcement. Agencies are using online reporting and smartphone apps to equip the public with the ability to file a report when they see potential environmental regulatory violations, such as excessive vehicle idling or the misuse of pesticides.

ROLES PLAYED BY AGENCIES

The citizen science case studies reflect a few key roles that agencies can assume when engaging with citizen scientists. These roles largely depend on the agency's needs and capacity.

Agencies tend to establish and lead a citizen science program when there is a clear data gap or environmental issue that requires further investigation. Agencies also tend to take on a leadership role

to provide direction to citizen scientists and to facilitate an understanding of environmental concerns. The data generated by agency-led programs are used to achieve specific goals laid out by the agency, including identifying environmental and public health risks, answering research questions, and regulatory enforcement.

In other instances, agencies may choose to partner with and collaborate with other organizations. In these cases, the agency plays a significant role, but other organizations (including nongovernmental groups) co-lead the effort and undertake key responsibilities.

Agencies may also choose to support the efforts of citizen science groups or individuals by providing funding, equipment, educational resources, and other tools that may be needed to enhance the work of these groups. In this role, agencies are looking to empower citizen scientists by building their technical competency.

Finally, environmental agencies may also receive data gathered by stakeholders and, at their discretion, act on it. This is a common pattern in the enforcement context.

AGENCY USES OF DATA

Citizen science programs led by agencies actively involve the public in the process of assessing environmental conditions, both to complement official action and to establish a collaborative role in protecting the environment.

Citizen science data are used to inform regulatory or enforcement actions in the following ways:

- In air and water quality monitoring to determine the need for heightened regulatory requirements;
- Identifying pollution hot spots or emerging trends that may necessitate an agency investigation;
- Submission of evidence for possible violations that require enforcement action; and
- In research that informs agency program management and policy action.

In other cases, the data may be used by the agency for non-regulatory purposes, such data uses include:

- Informing state and local agencies on the health of economically valuable resources such as wetlands;
- Issuing public warnings of harmful conditions such as cyanobacteria blooms; and
- Public engagement and education programs.

AGENCY ENGAGEMENT STRATEGIES

A good working relationship with the public is essential to integrating their work into agency programs. Agencies use a variety of strategies to connect with volunteers, depending on the nature of the problem and the kind of information they are seeking. When agencies require data of a professional

standard, they partner with local organizations and create volunteer monitoring groups. These groups are supported financially and scientifically by the agency.

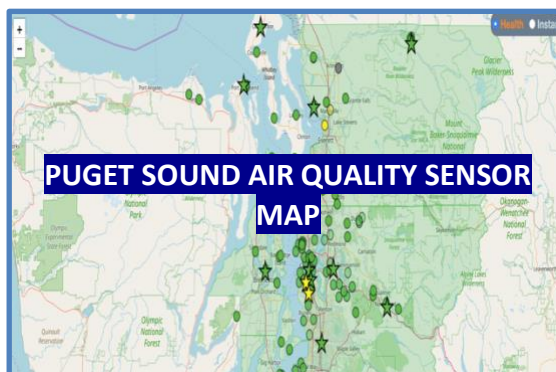
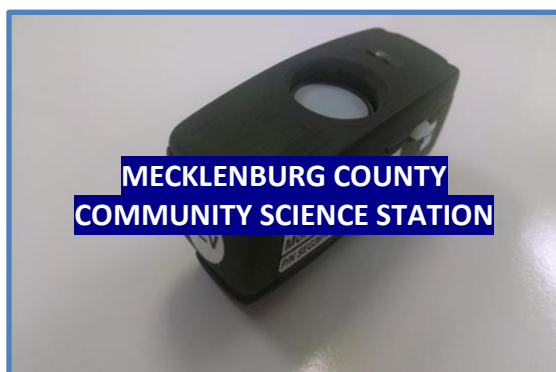
Where environmental issues cross over jurisdictional boundaries, interagency collaborations form. State, local, and tribal environmental agencies may contribute technical expertise, equipment, or financial and staffing resources to launch a citizen science monitoring or research effort.

Agencies may use data calls or create data submission platforms that invite volunteers to submit independently collected data. Agencies customize these platforms based on the level of detail required and the intended use of such data. These expectations are made clear to ensure data quality and use. Such platforms can be used in a variety of ways such as reporting harmful pollution events and regulatory violations.

To harness the full potential of citizen science, agencies must work to build the capacity of citizen science groups through technical training, access to informational materials and resources, and grant-making. The use of technology and equipment to facilitate engagement is considered to be an empowering tool, especially for marginalized communities. The provision of technical equipment, personal air sensor testing stations, and interactive data platforms are just a few ways to provide an opportunity for tangible contributions to environmental problems that cannot be seen.

AIR QUALITY

Measuring air quality is the foundation of efforts to reduce air pollution. Historically, monitoring air quality has been an exclusively governmental function as it required the use of expensive monitors. These monitors are deployed in networks, usually scattered across wide areas to measure air quality on a regional scale. However, in recent years developments in sensor technology have made it possible for private citizens to measure air quality particularly at the community level. Although the data from these devices is not equal in quality to monitors used by environmental agencies, state and local air agencies are supporting community monitoring efforts to understand and assess air quality on a neighborhood level. Click on the linked images below to read about these case studies.



IMPERIAL COUNTY COMMUNITY AIR MONITORING PROJECT

Community members helped gather data to establish an air-monitoring network. The air quality data are used by the local agency as an indicator for further investigation and by the community to manage their exposure.

Environmental Issue: Air Pollution [Particulate Matter (PM)]

Location: Imperial County, California

Agency: California Department of Public Health

Government Role: Agency-community partnership

For More Information: <https://trackingcalifornia.org/imperial-air-project/imperial-air-project-landing>

Contact: Michelle Wong | Tracking California | info@trackingcalifornia.org

BACKGROUND

Located along the US/Mexico border, the communities of Imperial County, California are exposed to air pollutants from cross border industrial, agricultural and transportation activities. The California standard for PM₁₀ has frequently been exceeded in Imperial County, for periods of more than 6 months. Exposure to high concentrations of PM₁₀ and PM_{2.5} is known to be linked to respiratory illnesses such as asthma and bronchitis. According to Tracking California (a program of the Public Health Institute and the California Department of Public Health), Imperial County has by far the highest rate of emergency visits and hospitalizations for asthma, in the state of California.

ABOUT THE PROJECT

Five regulatory monitors are located across in Imperial County. These are sufficient for regionwide air quality assessment but provide limited or no air quality data for most local communities. The Imperial County Community Air Monitoring Project began in 2013, when residents of the county called for location specific and real-time data. To address this need, Tracking California in partnership with the University of Washington (UW) and Comite Civico del Valle (CCV), a community-based organization, engaged affected communities through a five-year monitoring and research effort. The project set out to establish a network of community air monitors to generate localized data to reveal pollution trends for communities to act on, with the overall goal being to reduce air pollution and improve community health.

Community members were engaged using a tiered community participation structure, which provided various ways for community members to get involved. CCV, the community-based organization, played a key role in designing and implementing the monitoring network, and were involved in reaching out to communities, recruiting volunteers and disseminating information. The second tier involved a Community Steering Committee comprised of community leaders, advocates, and residents who guided project goals and activities. The third tier involved all other interested residents who participated in gathering data for monitor locations, hosting monitors, and using and sharing the available data. Community members were trained on air pollution, air-monitoring science, interpretation of air monitoring data and using data for community action.

Approximately 40 monitors make up the community air monitoring network. To ensure data accuracy and integrity, community members were trained to install and operate the monitors in accordance with UW's design specifications. The monitors were also co-located and calibrated against regulatory monitors operated by the California Air Resources Board (CARB). Real-time data from the monitoring network is uploaded to a database where it undergoes a quality review and further processing, prior to being published on the community-based environmental reporting website (IVAN AIR). This platform and data are managed by CCV.

The project was funded by the National Institutes of Environmental Health Sciences (NIEHS) through a 5-year, \$2 million grant. While funding was secured by Tracking California, UW and CCV, the project itself is considered a community led effort, with over 30% of the funding going to the community-based organization (CCV) to manage the network and compensate community volunteers. Tracking California managed the grant and ensured that the project received scientific and technical oversight through the formation of a technical advisory group. This group included state officials from CARB and CalEPA, local officials from Bay Area Air Quality Management District and Imperial County Air Pollution Control District and federal officials from EPA. These officials provided guidance on the air monitoring technologies employed, co-location and calibration of monitors and scientific interpretation of the data and research results. The technical advisory group had no decision-making power in the project; however, their insights helped identify opportunities to further the goals of the community.

PROJECT OUTCOMES

In July 2017, a few years after the project had been initiated; Assembly Bill (AB) 617 was signed into law. AB 617 requires CARB to deploy community air monitoring systems in communities with the highest exposure to toxic air pollutants and criteria air pollutants. An Assembly member, Eduardo Garcia, who is the Chair of the Joint Legislative Committee on Climate Change Policies, has said that "AB 617 was modeled on the highly successful Imperial County Community Air Monitoring Network, which has demonstrated that empowering communities with the ability to monitor local air pollution can lead to key policy victories and improve public health."

Due to the work of this project, these Imperial County communities were selected by CARB's Community Air Protection Program to develop a community emissions reduction plan. In October 2019, the community emissions reduction plan was approved by CARB and adopted by the Imperial County Air Pollution Control District. The selection of this community by CARB can be attributed to the early engagement of the community in air monitoring and the involvement of state, local and federal agencies on the technical advisory group. CARB is presently evaluating the data obtained from this project to assess the performance of sensor technology and has utilized the data for a spatial analysis.

The Imperial County Community Air Network is still operational. CCV has developed its organizational technical and scientific capability to now independently operate the monitors and use the results. On occasion, CCV does request assistance from Tracking California to analyze monitoring data. CCV currently provides technical assistance to other communities setting up their own community air

monitoring networks. The experience of this project has been recorded in a “Guidebook for Developing a Community Air Monitoring Network”, published in October 2018. The guidebook covers monitor siting criteria, stakeholder engagement strategies and technical advice on data storage and processing.

The data generated serves as an important indicator for local agencies and communities alike. One such use of the data is to influence behavior. In this case, local sensor data provided information to help community members manage their exposure, particularly at schools. The Air Pollution Flag Program alerts students and the wider community when pollutants are in high concentrations. A red flag is hoisted for poor air quality while orange, yellow and green flags are used to signal moderate to low pollutant concentrations. When a red flag is hoisted, schools implement a rainy-day schedule to reduce students’ exposure to harmful levels of air pollution.

SUCCESS FACTORS

- Equitable partnership and funding, the community-based organization had a lead role in the formulation and implementation of the project.
- Collaborative engagement between community members and technical advisors that led to a sustained understanding of scientific data and equipment operation and maintenance.
- Recognized and compensated the effort of community volunteers through stipends for travel, meals, child-care etc.

BARRIERS

- Distance between project collaborators, which made it hard to have an in-person presence (Seattle vs Bay Area vs Imperial County).
- Maintaining communication for transparency, relationship building, and continued participation in decision-making.
- Cultural/professional differences and navigating how to manage differences in organizational settings.
- Community engaged research requires much more time, funding, staff, and diverse skillsets.

KEY OPPORTUNITIES

Similar community air monitoring programs are currently being replicated in other counties of California and can be applied to any local community in the U.S. For long-term impact of such a program, there is a need for strong community ownership, especially when a project is borne from community concerns.

This community air monitoring program was initiated as part of a community based participatory research effort that involved long-term collaboration by academics, governmental officials and community members. During this five-year study, state and local agencies were given an opportunity to share their knowledge and technical expertise to support community goals. This approach has led to a robust community program, with all stakeholders equally invested in ensuring its success.

REFERENCES

- Project Website: <https://trackingcalifornia.org/imperial-air-project/imperial-air-project-landing>
- CARB Community Air Protection Program Staff Report (December 2019)
- Guidebook for Developing an Air Monitoring Network: Steps, Lessons and Recommendations from the Imperial County Community Air Monitoring Project (October 2018)

WEST OAKLAND COMMUNITY ACTION PLAN

A collaboration between agencies and community activists creates a long-term plan to reduce air pollution from large, small and mobile sources in an overburdened community.

Environmental Issue: Air Pollution [Environmental Justice]

Location: California

Agencies: Bay Area Air Quality Management District, California Air Resources Board, other state and local entities

Government Role: Agency-community partnership

For More Information: <https://www.baaqmd.gov/community-health/community-health-protection-program/west-oakland-community-action-plan>

Program Contact: Azibuike Akaba | Bay Area Air Quality Management District | aakaba@baaqmd.gov

BACKGROUND

In 2017, California adopted legislation, AB 617, aimed at addressing the environmental problems facing overburdened communities affected by high levels of pollution from many sources. The law directed the California Air Resources Board (CARB) to take a series of steps including:

- (1) creating a system for annual emissions reporting by certain types of large stationary air pollution sources;
- (2) establishing a community-level monitoring plan and identifying high priority locations in the state for deployment of community air monitoring systems;
- (3) preparing a strategy to reduce emissions in communities affected by a high cumulative exposure burden, and then selecting communities around the state for preparation of comprehensive emissions reductions programs.

The Bay Area Air Quality Management District (BAAQMD), based in San Francisco, selected West Oakland as the location for one of the emissions reduction programs. A major consideration in that choice was the presence of the West Oakland Environmental Indicators Project (WOEIP), which had been carrying out community-based air quality monitoring since 2002. BAAQMD and WOEIP co-led the development of the Community Action Plan, which was completed in September 2019 and received final approval from CARB in December 2019. The Plan identified 88 different actions to be taken by government agencies including not only CARB and BAAQMD but also the City of Oakland, the Port of Oakland, and others. The citizen science capabilities of WOEIP, and the data it provided, were essential to the development of the Plan.

ABOUT THE PROJECT

West Oakland sits on the eastern shore of San Francisco Bay. Although it is home to 26,000 people, it is heavily industrialized. Its air is polluted by emissions from the Port of Oakland, from truck and rail traffic to and from the Port, from freeways that surround it, from industrial sources (such as a major wastewater treatment plant and several recycling facilities), and smaller sources such as gas stations and body shops. It has some of the highest levels of diesel particulate emissions in the Bay Area.

West Oakland is also affected by many other challenges including poverty, unemployment, limited access to health care, and limited access to quality food options. Gentrification is raising average incomes in the area, but not benefiting its long-term residents.

The West Oakland Environmental Indicators Project began in 1999, founded by community residents Margaret Gordon and Brian Beveridge. Its mission encompasses air quality, climate change adaptation, and community influenced revitalization. It pursues these goals through a variety of strategies, one of which is community-based participatory research. This work began in 2002 and involves community members in measuring pollution and bringing about change through collaborative efforts with residents, businesses, and government agencies. It began training members on the use of hand-held air sensors in 2008, and since then has assembled an extensive body of data on air quality and air pollution sources. WOEIP sees value in training community members not just as a way of gathering data, but as a way of giving the community ownership of and confidence in its own data. Over this time WOEIP has carried out a number of different monitoring efforts, including one that involved partnering with Google on the use of cars equipped with sensors for mobile monitoring and creating a street-level grid of pollution levels. That project took nearly 3 million measurements over 14,000 total miles driven.

When BAAQMD selected West Oakland for action under AB 617, the availability of many years of data on local air quality was a major consideration. Another major factor was the presence of WOEIP as an expert and highly regarded community organization, with which BAAQMD had worked successfully in the past. The final plan states that “Decades of work by community activists, citizen scientists, and public and private sector workers have made this Plan possible. West Oakland is uniquely positioned to develop and implement this Plan because of this long-term work, spearheaded by the WOEIP, and because of the partnership between the WOEIP and the Air District.”

WOEIP also played an important role in organizing the effort, using their reputation and contacts to bring other community leaders and organizations to the process. The Plan states that “Because WOEIP is so experienced in community organizing, air quality issues, and partnering with government entities, the Co-leads were able to meet tight timelines.” Community organizations made a significant substantive contribution to the plan by identifying sensitive receptors to pollution, such as schools, playgrounds, day care facilities, senior centers, and office buildings.

The process of developing the plan was complex. Because there were many different kinds of air pollution sources to deal with, many different regulatory agencies had to be involved. Furthermore, many other, more narrowly focused planning efforts were already ongoing; the new project had to build on those activities, incorporating what was already underway and analyzing where gaps remained to be addressed. It did not address larger regional pollution sources such as highways and industry outside West Oakland.

PROJECT OUTCOMES

Ultimately, the plan identified 84 strategies for reducing pollution in West Oakland, and four Further Study Measures that add to or extend actions that are already underway. These strategies include steps such as:

- Port of Oakland: transition to zero-emission drayage truck operations by 2035, amend statewide at-berth regulation requiring more ocean-going vessels to plug in, fund cleaner tugboat engines;
- Truck management: increased enforcement of traffic laws, truck signage and driver education, improved truck routes;
- Relocation of two polluting facilities, and creation of incentives and subsidies to encourage other businesses to relocate that do not conform to zoning regulations;
- Increased compliance inspections and updating the District's complaint policy;
- City planning: Use land use controls to sunset industrial uses, facilitate relocation of major pollution sources, use filtration and other measures to mitigate indoor exposure;
- Improving public transit and improving street design for pedestrian and biker safety; and
- Permitting: Limit additional permits in residential areas and areas with high levels of pollution.

It is not within the capability of any single agency to carry out all these steps, so the plan requires a collaboration among multiple agencies to address all the many kinds of sources. BAAQMD, CARB, the City of Oakland, and the Port of Oakland all have major roles.

It will take years to see the benefits of the Plan. Its aim is to improve air quality in all parts of West Oakland so that it is at the average level for the community by 2025, and equal to the cleanest parts of the community by 2030.

SUCCESS FACTORS

- Enactment of legislation that mandated action and provided a vehicle for pulling together disparate parties into the development of a single unified plan.
- Presence of a community organization with a long history of work on these issues and experience working with the key regulators.
- Trust based relationship between researchers and community members, based on years of prior joint efforts.
- Long term commitment by both researchers and community, resulting in over 15 years of data on air quality in West Oakland (and the sources of pollution in the area).
- Knowledge by community members of locations with sensitive populations such as day care centers and senior centers.
- Effective communication of results.
- Participation by many different regulatory agencies, with jurisdiction over stationary pollution sources, mobile sources, land use controls, and port-related activities.

BARRIERS

- The AB 617 process convenes the necessary parties but does not guarantee that they will agree to all needed actions or will be able or willing to carry out commitments in the plan. Implementation remains an unknown and will require continued oversight.

KEY OPPORTUNITIES

- Other states or cities could adopt similar measures, targeting communities with the greatest need.
- The existence of active community groups, with citizen science capability and a track record of past success, would be a major factor in selecting those communities.
- Establishing a collaborative approach with academic institutions, government agencies and nonprofit organizations.

REFERENCES

- West Oakland Environmental Indicators Project; Margaret Gordon, Director.
- Community Action Plan, at <https://www.baaqmd.gov/community-health/community-health-protection-program/west-oakland-community-action-plan>
- The Beginning of Citizen Science for WOEIP, at <https://www.baaqmd.gov/~media/files/ab617-community-health/ab617-woeip-persepective.pdf?la=en>
- White House blog, “West Oakland Environmental Indicators Project: Citizen Engagement to Measure and Improve Air Quality,” at <https://obamawhitehouse.archives.gov/blog/2013/06/26/west-oakland-environmental-indicators-project-citizen-engagement-measure-and-improve>.

NEW YORK STATE COMMUNITY AIR SCREEN PROGRAM

The NYSDEC established a community-based program that requires volunteers to apply to participate. Selected volunteers sample the air in their local community. Samples are analyzed for toxic air pollutants and the data are shared with participants and are used by NYSDEC to address concerns and look for localized pollution hotspots for further investigation.

Environmental Issue: Air Pollution [Gaseous Toxic Air Pollutants]
Location: State of New York
Agency: New York State Department of Environmental Conservation (NYSDEC)
Government Role: Agency Led
For More Information: www.dec.ny.gov/public/81629.html
Contact: Ms. Randi Walker | NYSDEC | CAS@dec.ny.gov

BACKGROUND

In 2005, a group of concerned community members based in Western New York had suspected that industrial activities in the area affected their health. Due to limited air quality data at the community level, these residents collected their own air samples. The data revealed high levels of benzene, a known carcinogen. The data were submitted to the NYSDEC and subsequent air sampling by NYSDEC confirmed high benzene levels. NYSDEC applied to EPA for funding to conduct an air quality study, which found concentrations of benzene 75 times higher than the NYSDEC guideline. The Tonawanda Coke Plant was found to be a key contributor of the toxic air pollutant, among other sources and was responsible for the regulatory violations. The operation officially closed in October 2018. Since Tonawanda and other similar pollution cases, residents in New York have an increased awareness of local scale air pollution and are concerned by the potential health implications of poor air quality.

ABOUT THE PROGRAM

On the backdrop of the Tonawanda community efforts, there has been a steady increase in citizen science efforts in New York. While many of these efforts are focused on particulate matter, the NYSDEC identified the need for a community level program to monitor for gaseous toxic air pollutants. NYSDEC developed the Community Air Screen (CAS) program in 2012, replicating an earlier Citizen Air Sampling program by the Hamilton County Department of Environmental Services in Ohio. Both programs involve volunteers sampling and testing for toxic air pollutants (e.g. benzene, and perchloroethylene) released from industrial processes and fossil fuel burning. Given the potential risks of these pollutants to human and ecological health, these programs when active, attempt to address the concerns of community members while also providing these agencies with hyperlocal data that serves to identify air quality issues.

NYSDEC's CAS program is intermittent and has been offered twice, community sampling occurred between 2012 and 2014 and again in 2017 to 2018 with funding provided by the EPA. This program is not intended to be annual and is launched when the agency staff and laboratory have the capacity and resources to operate it.

When offered, the NYSDEC initiates the program with a 30-day application process, inviting community members to submit information on their pollutants of concern and the location and type of industrial sources in their community. Some communities were informed of the application process through direct notification while others were informed through an environmental justice news bulletin. The program selected 22 participants in 2012 and 11 participants in 2017. Participants can be individuals or community/interest groups. Approximately 40 % of past participants have been individuals with the remaining 60 % representing community or interest groups with varied levels of knowledge.

Applications are screened using criteria like the priority level of the pollutant, the severity of the community concern, known or pre-existing air quality issues, number of sensitive receptors and if the area includes an environmental justice community. Selected participants are chosen from various communities and are provided with SUMMA canisters (6 liter) to collect 1-hour samples. Canisters are generally provided during the warmer months with no more than six SUMMA canisters sent out for sampling, at any given time. Specific sampling tubes are available to collect air samples for formaldehyde analysis. Each participant receives between two to four canisters and up to eight sampling tubes. The number of samples collected in a community depends on the type of land use, pollutant of concern and the local air quality. Participants can obtain assistance from the NYSDEC staff to guide the sampling process; however, it is ultimately left to them to decide where and when to collect the sample. Participants are encouraged to sample at a time when they observe visible emissions or experience offensive odors.

Once samples are taken, participants send the canisters or sample tubes to the NYSDEC's laboratory for analysis, which involves screening for a suite of 43 air toxic pollutants (by EPA TO-15 analysis) or formaldehyde. The results are evaluated against data obtained from the state's network of monitors. If pollutant concentrations are found to be above the agency's threshold for the program, further sampling is conducted. These data are made available to participants and the public and the results are explained in a report for the community.

PROGRAM OUTCOMES

Since samples are collected over a short period of time and are limited in number, the data are not used for enforcement or compliance; however, it does help the agency determine its regulatory effectiveness in controlling sources that release these 43 toxic air pollutants or formaldehyde. Through the CAS program, the NYSDEC has identified several operations that could improve their operating procedures. The agency also learns about the nature of air quality concerns, associated public health issues across communities and how to improve community air quality information to the public. Sampling programs are the first step to achieving long-term air quality goals.

Participants learn about the ubiquitous nature of air toxic pollutants, common sources in their neighborhood and the regulatory measures taken to control these pollutants. This knowledge transfer empowers communities to be proactive in communicating and addressing their concerns. Through this

program, participants have also collaborated with schools, colleges and other community groups to engage the youth in air quality sampling.

SUCCESS FACTORS

- The NYSDEC pooled complaints from all their air quality offices to reach interested and concerned residents of New York to encourage them to participate in the CAS program. In 2018, 400 people reviewed online information relating to the application process for the program.
- The simple 4-question application process ensures an equitable process for potential participants. Some community groups are skilled at voicing their concern and have experience applying for grants while concerned individuals may not have the same knowledge or resources to complete a complicated application. Applicants are not judged on their skill level but rather their general understanding of the air quality issue.
- The provision of SUMMA canisters or sampling tubes has made community members feel empowered. The visual and written instructions were also done to be easily understood by participants with limited knowledge/skill.
- A great deal of decision-making power is given to participants who also are made aware that the agency is available to assist, if needed.
- NYSDEC staff invest significant time communicating with participants. Describing what is known about the air quality concern, other sources in the area, how NYSDEC regulates air pollution and what levels are found throughout the State.

BARRIERS

- This program when active requires dedicated staff time, without the responsibilities of other programs that may impede on the assistance provided through this program.
- Funding was limited and only allowed for the purchase of the air sampling equipment and didn't include the cost of analyzing laboratory samples.
- Long term staffing is required to activate the program more often.

KEY OPPORTUNITIES

The CAS program has been replicated from the Hamilton County Department of Environmental Services citizen air sampling program which proves its potential for other counties and states. Furthermore, it is unique in that it engages the public on gaseous toxic air pollutants and not particulate matter like most other community air monitoring programs. This helps communities distinguish air pollutants and potential sources.

These programs have been designed to engage the most concerned or interested community members. It helps them address their concerns by empowering them with equipment and knowledge to sample their own neighborhood.

REFERENCES

- Program Website: <http://www.dec.ny.gov/public/81649.html>
- NYS DEC Community Air Screen Program Application Form
- Ohio Program Website:
[http://www.southwestohioair.org/residents/complaints/citizen air sampling](http://www.southwestohioair.org/residents/complaints/citizen_air_sampling)
- Citizen Science Community Resources Website: <https://csresources.org/>

SMELL PITTSBURGH

Smell Pittsburgh, a smartphone App crowdsources reports on offensive odors. The local health department utilizes this data from the public to identify pollution zones and track significant changes to local air quality.

Environmental Issue: Toxic Air Pollutants
Location: Allegheny County, Pennsylvania
Agency: Allegheny County Health Department
Government Role: Partnership with University
For More Information: <https://smellpgh.org/>
Contact: Jayme Graham | Jayme.graham@alleghenycounty.us

BACKGROUND

Odor is a common concern among communities located near industrial facilities, farmland, and waste operations. Odor complaints are frequently related to Volatile Organic Compounds (VOCs) and Sulphur compounds. While these compounds are regulated at the federal level, odor is controlled at a local level. Odors can be fleeting and considered a temporary nuisance; however, they can also be indicative of toxic air pollutants which can lead to harmful health effects. Pittsburgh is home to large coke and steel manufacturing facilities, including the Mon Valley Works to the southeast and foundries such as the McConway and Torley steel foundry to the northeast. Although the city's air is far cleaner than when it was the poster child for pollution, the emissions from these facilities combined with vehicle emissions and a changing climate contribute to poor air quality in some communities.

ABOUT THE PROJECT

Carnegie Mellon University, located in Pittsburgh, actively engages local communities through direct service and civic discourse to identify, deliberate, and address issues of public concern. Between 2016 and 2017, the CREATE Lab at the University met with local communities to learn about their concerns. During these discussions, it was found that local communities had an issue with odors emanating from industrial facilities and other sources. A community group raised the need to monitor odors, since foul odors may indicate the presence of toxic air pollutants. Furthermore, they felt that logging or documenting odors could potentially lead to identifying the source of emissions. This led the CREATE Lab at Carnegie Mellon University to co-design an App with interested stakeholders. The Smell Pittsburgh App was funded by Heinz Endowments and created in collaboration with several activist groups, including Allegheny County Clean Air Now, Clean Air Council, PennEnvironment, Group Against Smog and Pollution, Sierra Club, Blue Lens, ROCIS, PennFuture and Clean Water Action. These groups played a key role in promoting the Smell Pittsburgh App among local communities, which was critical since the App crowdsources smells, relying on human sensing.

While developing the App, the CREATE Lab sought input from the Allegheny County Health Department (ACHD) to ensure the data generated could be used to supplement local air quality monitoring efforts. The smell reports submitted through the App are sent to ACHD, this creates awareness and increases community engagement on odor issues.

To submit a smell report, users install and launch the App on their mobile devices. When odors are experienced, App users can rate the smell (1-5 scale), describe the odor (e.g. industrial or wood smoke) and are also given the option to list any symptoms attributed to the odor. Once submitted on the App, the smell report is submitted to the ACHD in an email format. Each smell report includes the location, date, time, rating and description of the smell, along with any personal notes and/or questions for ACHD. Once submitted, the smell reports are also added to a visual and interactive map. The map allows users to have access to real-time odor complaints across Pittsburgh, and they are able to compare this data to air quality data from federal air quality monitoring stations. The App and interactive map serve to provide local communities with access to information and the opportunity to contribute to improved governance of local air quality, particularly where communities are located in close proximity to heavy industry.

PROJECT OUTCOMES

Odor is a common complaint. In 2017, the ACHD received 8,570 reports through the Smell Pittsburgh App, and by 2019 the number increased to 18,337. (Approximately 1,700 reports in each year were for “good” air; the rest reported some odor.) Some individuals use the app frequently; a study found that 10% of those reporting accounted for 53% of the filings. These reports are too numerous to be handled in the normal complaint response procedures by ACHD’s complaints department. Due to the sheer volume of complaints received and its qualitative nature, the ACHD has been using statistical analysis and data mining techniques to identify pollution zones and track significant changes to local air quality. The data can result in useful visual tools that provide an understanding of possible causes and effects of these odors. ACHD is presently planning for a more effective process to analyze the data and determine its potential for other impactful uses, as part of the local air-monitoring program.

SUCCESS FACTORS

- Smell Pittsburgh was co-designed with affected communities and advocacy groups. There was early buy in, hence the significant number of reports received by ACHD.
- Data transparency is a priority, and the public can view all submitted reports and are able to download the data, if needed.

BARRIERS

- Information received is sometimes incomplete; e.g. there is no GPS location of the smell.
- Some of the information is qualitative and doesn’t lend itself to automated interpretation, requiring staff to review and analyze the reports. As a result, the potential for crowdsourcing and responding promptly to data has not been fully realized.
- ACHD has no internal funding or resources to manage the high volume of reports received.

KEY OPPORTUNITIES

- The piloting and success of the Smell Pittsburgh App has attracted the attention of other local governments. The source code is open and can be adapted for other areas; this has led to the

creation of the Smell My City App, currently being piloted in Louisville, Kentucky and Portland, Oregon.

- The App also serves as an important tool to build a connection between local governments and their constituents.
- The App has significant potential to complement the work of local regulatory air monitoring programs, particularly in compliance and/or enforcement.

REFERENCES

- Smell Pittsburgh website: <https://smellpgh.org/>
- Agency for Toxic Substances and Disease Registry: https://www.atsdr.cdc.gov/odors/general_info.html

MECKLENBURG COUNTY COMMUNITY SCIENCE STATION

The community science station allows members of the public to test the accuracy of personal air sensors. The data collected is provided to the local air agency to increase agency and community understanding of personal air sensor equipment and the data generated.

Environmental Issue: Air Pollution [Sensor Technologies]

Location: Mecklenburg County, North Carolina

Agency: Mecklenburg County Air Quality

Government Role: Agency support by providing a technical resource

For More Information:

<https://www.mecknc.gov/LUESA/AirQuality/EducationandOutreach/Pages/PersonalAirSensors.aspx>

Contact: Megan Green | MCAQ | Megan.Green@MecklenburgCountyNC.gov

BACKGROUND

Personal air sensors are an emerging technology that are designed to provide short-term air quality measurements of an individual's immediate environment. These portable sensor devices may not meet the stringent standards established for regulated monitors operated by state, tribal, local, or federal government agencies. Neither do they generate the quality of data needed to inform compliance with National Ambient Air Quality Standards (NAAQS) but can be considered as the first step in a series of steps to identify pollutant sources. Recent evaluations reveal that there is a high variability between different sensor technologies and the resulting data. The low cost of these devices has however created a burgeoning market. The information gathered from the use of these personal air sensors is increasingly generating public interest in community level air quality. This interest translates into an increased level of engagement between the public, state, tribal and local air agencies.

ABOUT THE INITIATIVE

In May 2019, Mecklenburg County Air Quality (MCAQ) installed a Community Science Station (CSS). The CSS provides a platform for students, advocates, interested community members, and scientists to experiment with personal air sensors and gives them the ability to evaluate sensor technology by comparing data from quality-assured regulatory monitors. This initiative was supported under a pre-existing state grant and a grant from North Carolina Air Awareness to fund construction.

The CSS is an aluminum monitoring shelter that includes multiple shelves. The design allows for air flow throughout the shelter and protects devices from rain and other weather elements. The shelter is equipped with electric power for sensors that require a local power connection. Access to a guest account on a local wireless network is provided for data acquisition. The CSS is located at Garinger High School in Mecklenburg County, NC in an area with unobstructed air circulation (i.e. no buildings, trees). It is situated ≤ 10 meters from MCAQ's regulated monitors and at the same height, so individuals can compare measurements from their personal air sensors with data from the regulatory instruments. The site is accessible 7 days a week from 7AM-7PM. Access is granted by performing a background check and through the use of Bluetooth Locks that log access events and restrict timing of access to appropriate hours.

Interested individuals or groups are required to submit an application to MCAQ for use of the CSS. The application requests information on the sensor technologies being tested, study design (i.e. research questions and methodology), and a study timeline with proposed access times to the CSS. Participants are required to share all data gathered from the use of the CSS with MCAQ, within 30 days of the conclusion of the study.

OUTCOMES

As of Spring 2020, MCAQ has received one application, which has been approved for use of the CSS. The user is testing two Particulate Matter (PM) sensors and one Volatile Organic Compound (VOC) sensor. This sensor testing is a joint effort between the University of North Carolina-Charlotte and Clean Air Carolina, a state-wide non-profit advocacy group. The results of the CSS work are intended to provide information on the performance of the tested personal air sensors as well as serve as a collocation site for understanding sensor output in the greater Mecklenburg County area. The CSS has capacity for additional sensors.

SUCCESS FACTORS

- There was adequate funding to support the construction of the CSS.
- Active use of the CSS is slowly developing. MCAQ is developing interest through previously established relationships local researchers and statewide advocacy groups.

BARRIERS

- Access to the site can be a challenge as the CSS is located on public school property and adjacent to a National Core Multipollutant Network station.
- Continual maintenance of the structure is required to ensure effective use, such as ensuring unobstructed air flow and a power source.
- Disadvantaged communities may not have the resources to purchase their own low-cost devices and may thus be excluded from the use and benefits of the CSS as a technical resource.

KEY OPPORTUNITIES

The CSS was based on a similar structure developed by the EPA. Since the development of MCAQ's CSS, EPA Region 4 has committed funding to deploy similar structures across the region. Sharing detailed plans and modifications of similar effective structures as well as associated costs may help other agencies plan for this type of initiative.

Local environmental agencies can use this type of initiative to guide community scientists in the use and understanding of personal air sensor devices. It also encourages conversations regarding community air quality interests and concerns with agencies representing the area. The CSS helps make air pollution and air monitoring more visible and relevant to the public, especially as an education tool.

REFERENCES

- Program website:
<https://www.mecknc.gov/LUESA/AirQuality/EducationandOutreach/Pages/PersonalAirSensors.aspx>
- Association of Air Pollution Control Agencies, Preparing for Personal Air Sensors: Definition, Opportunities, and Data Limitations, May 2019
- MCAQ Community Science Station Application Form

PUGET SOUND AIR QUALITY SENSOR MAP

The sensor map reveals data from all purple air sensors located in and around the Puget Sound area. The map adjusts personal air sensor data to more closely match the standard of agency monitors.

Environmental Issue: Air Pollution [Data Integration]

Location: Puget Sound, Washington

Agency: Puget Sound Clean Air Agency

Government Role: Agency support by providing a technical resource

For More Information: <http://map.pscleanair.org>

Contact: Graeme Carvlin | Puget Sound Clean Air Agency | graemec@psccleanair.gov

BACKGROUND

As interest grows in community level air quality, local air agencies are tasked with fielding questions about local pollution events. In the Puget Sound region, the effects of wildfire smoke are a common concern and have been one driver prompting the general public to purchase low-cost air sensor technologies to monitor personal exposure. The use of these devices and the resulting data comes with its own set of challenges, particularly relating to the validity of the data. While this data cannot be used for enforcement or compliance purposes, it can be developed into a useful communication and education tool to address the concerns of local communities and individuals.

ABOUT THE INITIATIVE

Due to the heightened use of sensor technologies, the Puget Sound Clean Air Agency recognized the need to adjust and visualize sensor data to effectively communicate air quality information more accurately. In 2019, the agency developed the [Puget Sound Sensor Map](#). This tool combines air quality data collected by the public and regulatory monitors in a single interface. Sensor Map pulls in data from every publicly-available PurpleAir monitor from the four-county region. This platform calibrates this crowd sourced data relative to the nearest regulatory monitor, or a regional background calibration, to improve the sensor accuracy, and displays the data from both the regulatory and PurpleAir monitors on the same map. The Agency and others¹ have shown that PurpleAir sensors are known to consistently read roughly twice the actual levels. The Agency chose to display PurpleAir Monitors for Sensor Map because they are relatively consistent, have been thoroughly evaluated², and there are a significant number of these reporting public data in this region. If other new sensors become more popular and consistent enough to calibrate, the tool could host other types of sensors in the future.

Before calibration, the data are also put through a quality control (QC) process, whereby data that are generated during a sensor malfunction are removed from the interface. Sensor Map also assigns confidence values to every PurpleAir monitor that is connected to the interface. If the readings of a PurpleAir monitor track closely to all nearby sensors and the two internal sensors read similarly, the sensor is assigned a high confidence value. The higher the confidence, the higher quality the data are.

¹ https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=539777&Lab=CEMM and <https://www.lrapa.org/DocumentCenter/View/4147/PurpleAir-Correction-Summary>

² <https://www.agmd.gov/qa-spec/product/purpleair-pa-ii>

The Sensor Map shares health-based (based on the EPA's NowCast formula³ for fine particulate matter) and instantaneous particle pollution for the Puget Sound region. Any time a new PurpleAir monitor comes online within the agency's jurisdiction, it's automatically added.

The Sensor Map is currently in beta testing to evaluate user experience and determine any technical difficulties. The development of this tool has been undertaken in consultation with interested stakeholders to ensure community information needs are addressed through this tool. This tool was conceptualized and developed by staff of the Puget Sound Clean Air Agency, thus internal funds were utilized for this initiative.

Since development, the agency views the Sensor Map as an important education and outreach tool, which serves to share and communicate consistent air quality information across the region. In addition, the agency has worked with local communities to help install PurpleAir monitors in areas of concern or in gaps in the regulatory monitoring network.

OUTCOMES

This public information tool allows individuals to contribute to a regional monitoring network, with the support of the local air agency to ensure data accuracy and an improved understanding of the data. There are at least 100 PurpleAir monitors connected to Sensor Map.

SUCCESS FACTORS

- While the project is still in its developmental stage, it is noted that the key factor for effective use of this tool is continual community outreach and sensor deployment, where needed.

BARRIERS

- Public information tools such as this could be considered contentious, as the quality and use of the data comes into question especially since it is a tool developed and maintained by the local air agency.
- The Sensor Map is a pilot project and may require modifications to ensure the data are reflected appropriately.

KEY OPPORTUNITIES

The code used to develop this platform could be shared among local agencies to expand its use. It also encourages dialogue and engagement between local agencies and the general public on air pollution concerns.

REFERENCES

Program website: <https://pscleanair.gov/570/Air-Quality-Sensor-Map>

³ https://www3.epa.gov/airnow/ani/pm25_aqi_reporting_nowcast_overview.pdf

WATER QUALITY

In contrast to air quality monitoring, private citizens have played a role in gathering data on water quality for many years. The examples identified under this category have been further categorized, as follows. Click on the linked images below to read about these examples.

SURFACE WATER MONITORING

Under the Clean Water Act, states are required to assess and report on the extent of waters meeting CWA goals and identify those water bodies that do not meet water quality standards. However, monitoring is resource intensive. Therefore, EPA's regulations require states to consider all readily available data when developing these reports, including data from outside sources. While a precise count is not available, at least half of the states appear to use the work of citizen scientists to a significant extent in water quality monitoring. In addition, citizen science groups also play an important role in transboundary water monitoring.



ASSESSING WETLAND HEALTH

Wetlands play a critical ecological role. Assessing wetland health involves different techniques than are used for general surface water monitoring -- focused on plant and animal species. Wetland monitoring programs are less common; the following example may be a model for others.



REPORTING HARMFUL CYANOBACTERIA BLOOMS and FISHKILLS

Toxic cyanobacteria are increasingly a concern as it can render surface waters unusable for drinking, recreation and for wildlife. These bacteria form dense mats that are often referred to as “harmful algal blooms” but are not actually made up of algae; this report will primarily use the term “cyanobacteria” instead. Algal blooms are a particular challenge for environmental agencies because they are intermittent, unpredictable, and widely scattered. Since agencies cannot observe all water bodies on a regular basis, private citizens play an important role in spotting and reporting these events. Fishkills can occur as a result of toxic blooms or due to other factors such as oxygen depletion caused by high concentrations of nutrients. Again, since these events are scattered and unpredictable, agencies rely heavily on reports from private citizens.



The Cyanobacteria Monitoring Collaborative

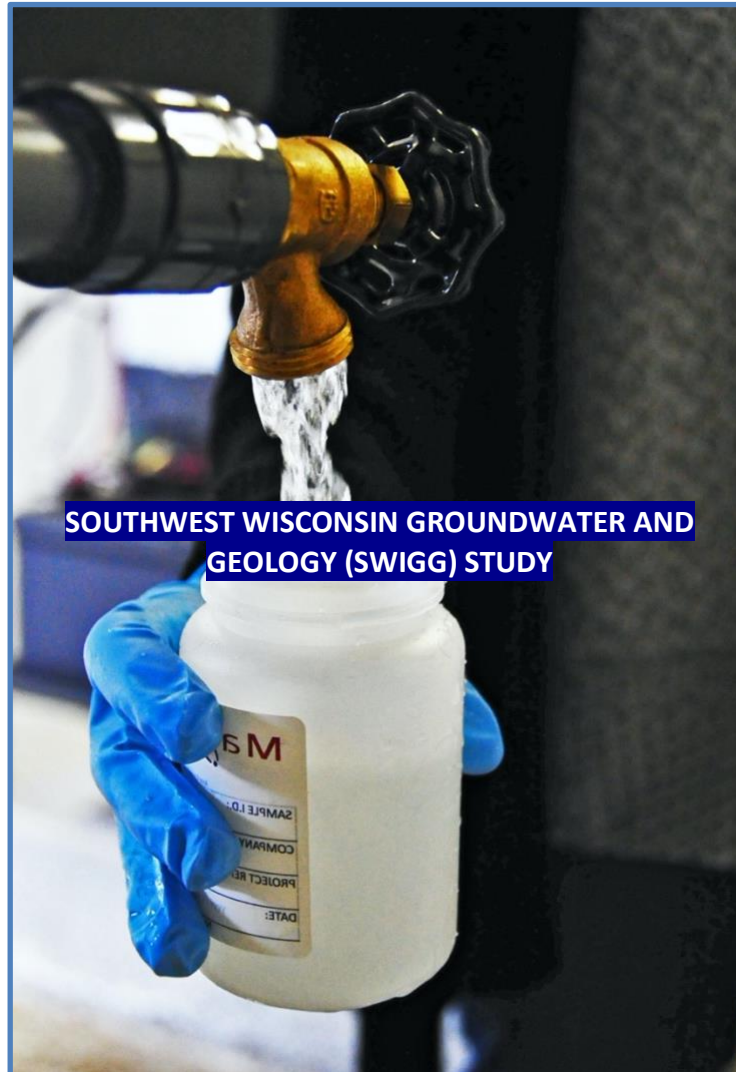
A collaborative program led by EPA Region 1 includes states, nonprofit organizations and others serves as a resource for citizen scientists across the country. It develops and shares monitoring protocols, provides equipment and support, and offers information on monitoring and tracking cyanobacteria blooms. It has an EPA phone App for identifying and tracking bloom occurrences, and an EPA approved Quality Assurance Project Plan (QAPP) which can be used by private citizens as well as agencies.

For more information: <https://cyanos.org>

Program contact: Hilary Snook | U.S. EPA Region 1 | snook.hilary@epa.gov

GROUNDWATER QUALITY SAMPLING

Groundwater can become contaminated even in rural areas where it is a primary source of drinking water for residents who are not connected to public water supply systems. Since there is no central water testing, monitoring water well water quality is essential for public health. Private home owners can play an important role in this process.



STATE WATER MONITORING: PATTERNS AND TRENDS

Many states turn to private citizens and local environmental groups for help in gathering data on surface water quality, using a variety of strategies to support their efforts and ensure good data quality.

WATER MONITORING PROGRAMS

Because so many states use volunteers in water quality monitoring, the following analysis summarizes patterns, trends and best practices observed in a broad survey of state programs. While it was not possible to look at every state, this summary reflects the range of practices used by states, particularly in the stronger programs, as well as innovations that have been adopted in recent years. The examples below provide a sense of the diversity of these programs.

Virginia Citizen Water Quality Monitoring Program

Virginia has one of the nation's leading volunteer monitoring programs, which dates to the late 1990's.⁴ The program, which is created by statute,⁵ provides a variety of assistance to watershed groups and similar organizations, such as offering small grants, approving research plans (called Quality Assurance Project Plans, or QAPPs), providing a detailed manual, and setting out detailed guidance on the ways in which data may be used and the quality of data required for each use.

As of 2018, Virginia estimated that almost 1300 volunteers, from approximately 140 different organizations, were involved in water monitoring activities, logging 81,000 hours of volunteer time.⁶ These groups provided data on over 3,600 stream miles, 41 square miles of estuaries, and 29,800 acres of lakes. The state estimates that the services provided by these volunteers had a monetary value of \$ 3.25 million per year. For its contribution, the Department of Environmental Quality (DEQ) provides \$ 88,000 per annum in grants to approximately 20 organizations, along with 1.5 staff equivalents to provide training, technical support and inspect field and laboratory operations. Approximately 27 outreach activities (training or field audits) were carried out in 2018.

Virginia uses this data in a variety of ways. Some is included in the state's Integrated Report; in recent years over 20 % of the data in that report came from citizen volunteers. The state also uses the data to help set its own monitoring priorities. Finally, data that is not of adequate quality for these purposes can be used for educational purposes -- for example, to inform landowners of the water quality impacts of their land use activities.

An uncommon feature of Virginia's program is that it formally invites members of the public to nominate water bodies for monitoring by Agency staff. In 2018, eight water bodies were nominated for monitoring, of which the state picked three based on citizen-generated data.

⁴See

<https://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/CitizenMonitoring.aspx>

⁵ See Virginia Code s. 62.1-44.19.11. See *Citizen Monitoring Guidance*, VIRGINIA DEP'T OF ENV'T'L QUALITY, <http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/CitizenMonitoring/Guidance.aspx>.

⁶ Data on 2018 are taken from Virginia DEQ's "2018 Citizen and Non-Agency Monitoring Activity Report."

Georgia's Adopt-a-Stream

Georgia's Adopt-A-Stream program is one of the oldest in the nation, stated in 1992. Early on, the program created a Quality Assurance Project Plan for chemical, bacterial and macroinvertebrate monitoring, developed how to manuals, created a 20 member board, and established a train-the-trainer program using regional training centers. It now partners with local governments, regional entities and watershed groups including 9 Riverkeepers.

The program relies very heavily on local coordinators, who are trained intensively and then given a high degree of responsibility to work with their local monitoring groups to select sampling locations, and organize and carry out monitoring activities. This allows a small central staff to support an extensive statewide program. Coordinators generally come from partners -- local governments or watershed groups.

Local governments are also a primary audience for capturing and acting on the results of monitoring activities. When monitors enter sampling data through the online database and document events such as sewer line breaks, septic tank leaks, or sewage spills, a report is autogenerated and sent via email in real time to the local coordinators who work with local authorities for the appropriate response. Water quality data is also provided to the state, which uses it for screening purposes to inform its own monitoring and identify new sites needing attention.

A central pillar of the program is its real time capture of sampling results through an interactive online database, which was created in 2008, and has been updated over the years. Program officials believe the database has helped attract volunteers because it enhances the program's credibility and that the work of volunteers is put to real use; program participation and the volume of data capture increased dramatically after the database was created. Data is submitted by volunteers who maintain QA/QC certification in the program, using an online form that can flag potential errors and provide immediate automated feedback.

Michigan MiCorps

The Michigan Clean Water Corps, or MiCorps, has been engaged in monitoring the quality of rivers and streams since 2003. The state also has a Cooperative Lakes Monitoring Program (CLMP); over 300 lakes were studied in 2018. These programs work with watershed councils, local governments, and citizen or community groups to gather data on water quality in lakes and streams. MiCorps carries out activities similar to Virginia: it trains volunteers in monitoring methods (primarily for macroinvertebrates for streams, and other indicators for lakes), offers grants, and works with groups to develop QAPPs. Data collected under a MiCorps QAPP is considered acceptable for inclusion in the state's Integrated Report.

Michigan also makes its data publicly available, and it is used by a variety of other audiences. State natural resource officials use the data in stocking fish (to identify which fish species might survive). Realtors and potential purchasers of lakeshore property use the program's public database to evaluate the desirability of lakes for recreation. Similarly, lakeshore property owners and local governments in areas with a large number of lakes, support the program because they have an interest in keeping lakes healthy and free of invasive vegetation. At a more general level, state officials see the program as building public interest in water quality issues and a growing body of individuals actively engaged on water quality issues.

MiCorps has also expanded beyond water quality monitoring. Starting in 2015, MiCorps began assessing the quality of shoreline on lakes, giving each lake a rating reflecting the degree to which its shores are naturalized (rather than developed). This information is of interest to lake associations as well as to other agencies.

MiCorps is administered primarily through a contract with the Great Lakes Commission, with one state employee overseeing the program. The program has had funding challenges in recent years, which limited its ability to provide grants. While lake monitoring will not occur in 2020, a new funding source has been created by the legislature which will allow the program to operate fully again in 2021.

Arizona Water Watch

Arizona's Water Watch program is a more recent program than those in Virginia and Michigan. Established in 2017, it relies less heavily on independent groups, and invites individual citizens to volunteer. Volunteers may be assigned to monitoring teams or may be assigned to perform other duties in support of the program (such as downloading data from remote cameras). There are about 25 teams, some assigned to specific streams and others traveling to locations around the state. Volunteers are given training, equipment and materials; all monitoring is done pursuant to the state's QAPP.

A distinctive feature of Arizona's program is its use of apps. One app is used by volunteers in the field to upload their data directly to the program's database. Other apps are available for wet/dry mapping and for trash reporting.

AWW also includes an app-based program for reporting basic information by the public, including residents and even tourists, without the need for specialized training. The app asks users to answer simple questions about water bodies, and to submit photos. Although the data collected is not sophisticated, the app can be used to report on stream conditions, such as fishkills and algal blooms, or to report whether particular streams are flowing. This provides a growing body of information over time on which streams are permanent, intermittent or ephemeral -- an important factor under the Clean Water Act in an arid state.

CITIZEN SCIENCE APPROACHES BY STATES: A TYPOLOGY

As these examples show, volunteer water monitoring programs can take a variety of forms. Most states use variations on the following models; some use more than one.

Partnership with watershed groups or individuals

Most programs, as seen above in Virginia and Michigan, partner with independent citizen organizations such as watershed and lakeshore groups, to identify and train volunteers and carry out monitoring. In this model, the state provides training, and typically helps the groups develop and implement QAPPs. States usually leverage their small program staff by delegating a high degree of responsibility to these groups, and to a core group of well-trained volunteers who then oversee the work of others. Some states also recruit individual volunteers (as seen in Arizona's program above).

It is common for states to delegate direct program management to an outside party, funded through a grant or contract. This reduces the need for state staff, and external organizations may be able to raise additional funds privately. Michigan's MiCorps program uses this approach; the Iowa DNR is moving to this model in response to staff reductions.

Use of intermediary nongovernmental organizations

In some states, nongovernmental organizations exist to provide assistance to watershed groups, complementing and filling gaps in state support. In the Chesapeake Bay Watershed, two groups fill that

need. The Chesapeake Monitoring Cooperative, based in Richmond, and the Alliance for Aquatic Resource Monitoring (ALLARM) at Dickinson College in Pennsylvania are examples of such intermediary organizations, working in multiple states. These groups build capacity in local organizations, train them and certify them as qualifying to submit data for regulatory use. In some cases, such external organizations actually manage the state program in lieu of state employees.

The Water Data Collaborative is building a support system on a national scale, which connects non-governmental monitoring groups across the country with the goal of building a community of trained and qualified data generators. Its aim is to create systems that streamline the processes of collecting, uploading and sharing data. It intends to provide a central source for resources and a public data platform that facilitates data sharing, as well as delivering training for citizen monitors. By scaling the diverse current set of tools and platforms for visualizing and analyzing data, it hopes to link that data to greater action. While the Collaborative is not formally linked to state programs, it works extensively with states and its efforts should help build capacity in the volunteer groups that states rely on.

Facilitating submission of data

Some states have arrangements that facilitate the submission of data by outside parties, independent of any organized volunteer program. For example, some issue a “data call” for information to be used in an upcoming Integrated Report. In Maryland data solicitations are conducted prior to each two-year listing cycle.⁷

A more advanced approach is to create a portal for data submission by independently operating citizen organizations. In this model, the state provides objective data quality standards for alternative uses and invites citizen groups to submit data (relying on the groups to initiate monitoring and providing less direct assistance than in the previous models). The prime example of this is Indiana’s new “External Data Framework,” a website through which outside parties can submit data in a structured format. (Indiana also operates a more traditional Riverwatch program.) The Framework is recent and is currently used primarily by academic and other governmental researchers but could be used in the future by watershed groups and other nongovernmental organizations. Program staff review the submissions and group the data into three tiers based on the quality of the data; data in the highest tier may be used for regulatory purposes such as listing impaired waters (this is currently uncommon but is expected to grow over time). Lower quality data can be used for general informational purposes or to inform the state’s own planning. The Framework is also a vehicle for providing some assistance, such as articulating data quality requirements and some direct support for submitters whose data falls slightly short of the highest tier. The state is currently working on a QAPP tool that will also help outside groups meet the most rigorous quality requirements.

Consideration of independently-submitted data

⁷ <https://mde.state.md.us/programs/water/TMDL/Integrated303dReports/Pages/index.aspx>

Finally, in some cases, the state has no organized program or formal procedure for using data from citizen scientists. However, even in these states an informal partnership may exist with independent groups that conduct monitoring efforts and submit data for consideration by the state.

STATE PROGRAM GOALS

It is important to understand that volunteer monitoring programs help serve important goals beyond providing data for Integrated Reports. Demand for data also comes from local constituents, such as lake or watershed groups who want to know about the quality of their local water bodies, from local governments concerned about protecting resources for tourism, or even realtors evaluating the attractiveness of lakeshore properties.

Some programs study matters other than water quality. For example, Michigan's Micorps program also monitors invasive vegetation because of its potential harm to recreational enjoyment of lakes. In response to growing interest in the quality of shorelines, Michigan also has a program that assesses and rates lakes on shoreline health.

Finally, volunteer monitoring programs build public interest, awareness and understanding of water quality issues. For many, this community-building aspect is as important a goal as the formal programmatic functions. States also support monitoring efforts that do not generate data for agency purposes, but educate the public on water quality issues, and train members of the public in how to evaluate water quality. Indiana's Riverwatch is designed for that purpose. Another approach is New York DEC's "Day in the Life of the Hudson", when thousands of students collect scientific information at points along the Hudson River, and upload the data to the web.

STATE SUPPORT OF CITIZEN SCIENCE

States can provide various kinds of assistance to citizen scientists, especially in those programs that work with independent external groups. These include:

Training

Training is an essential part of any state program that makes active use of volunteer monitoring. Data are most valuable when accompanied by documentation that it was collected in a scientifically rigorous way. Almost all programs involve some training component.

Technical Assistance

Another essential component to a program intended to generate scientifically valid data is a QAPP. States can assist volunteer groups in developing a QAPP, and typically require that the final be

submitted to them for approval before monitoring begins. If data is being used for federal regulatory purposes, EPA may also approve the QAPP.⁸

Sampling equipment

State programs typically help groups obtain necessary equipment such as sampling kits, waders, and nets. In some cases, this is done through grants to the groups or to intermediaries; in others the equipment is provided directly where the state directly oversees the monitoring activity. Some EPA regional offices also have equipment loan programs.

Field audits

When monitoring begins, states may provide direct oversight. In programs where volunteers work directly for the state, this oversight is inherent in the program. Where the monitoring is done by independent outside groups, the state may conduct field audits to make sure that sampling is being consistent with the QAPP. This is one of the services offered, for example, by the Virginia program described above.

Access to state-certified laboratories

The final step in the data gathering process is typically for samples to be submitted to a laboratory for analysis. States can assist citizen scientists by giving them access to state-certified labs or paying the cost of the analysis.

Tools for data submission

States are increasingly using automated data submission systems for use by volunteers. In addition to improving efficiency, well-designed, user-friendly data entry systems can enhance volunteer enthusiasm; systems can also be designed to highlight omissions or catch likely errors in data entry to improve the quality of information in the resulting database. Just a few examples of such tools include those used by the California Water Boards,⁹ Georgia's Adopt-a-Stream program,¹⁰ and the Maryland Department of the Environment.¹¹ Arizona offers a smartphone app that allows citizens or visitors to submit photos and answer basic information on what they observe.

Funding

Some states provide grants to local watershed groups that do water quality monitoring. Such grants are usually small but make it possible for small groups to obtain necessary equipment and defray other expenses. As described above, Virginia offers small grants for equipment, preparation of a QAPP, and

⁸ EPA provides assistance for designing QAPPs in its *Handbook for Citizen Science Quality Assurance and Documentation*, available at <https://www.epa.gov/citizen-science/quality-assurance-handbook-and-guidance-documents-citizen-science-projects>

⁹ www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/data_solicitation.html#who_can_submit

¹⁰ adoptastream.georgia.gov

¹¹ <https://mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/Data-Solicitation.aspx>

other basic expenses. Somewhat larger grants are available to organizations that coordinate other groups across at least three different municipalities.¹²

USE OF CITIZEN-GENERATED DATA

Data from citizen scientists is used by water programs in a variety of ways, such as:

For regulatory purposes, equivalent to state monitoring data

Some states consider the highest quality citizen data acceptable for inclusion in the Integrated Reports that are submitted to EPA and form the basis for determinations of which water bodies are considered impaired under the Clean Water Act. Citizen-generated data used in these reports is treated as equivalent to data collected by state agency staff. Such programs can add significantly to the state's knowledge of water quality; as noted above, in Virginia, over 20 % of the data in the state's report came from community groups.¹³

To identify areas of concern and prioritize state monitoring efforts

States may also use information from the public for screening purposes (e.g., to identify waters that will be given priority for the state's monitoring efforts). In Michigan, stream monitoring volunteers do not collect data on chemical parameters, but their data on macroinvertebrates helps the state select streams for monitoring by state biologists.

To identify non-compliances and possible enforcement

Ambient water quality monitoring programs often identify problems that may lead to more focused compliance monitoring and enforcement by the regulatory agency. Volunteer-generated data is rarely used for enforcement purposes because of the strict methodological and chain of custody expectations for legal action, and watershed volunteers may not want to become involved in enforcement themselves, but, it is not uncommon for volunteers in the field to discover indications of local problems such as sewer line breaks, agricultural spills or construction-related spills. These can be reported to agencies who can conduct a closer investigation.

To inform program planning and management

States may also rely on data generated by private citizens for broader planning and program management. For example, In Texas monitoring data is collected by the Stream Team, a project of the Meadows Center for Water and the Environment at Texas State University. That data can be used by agency and river authority monitoring staff (among many others) for purposes such as watershed characterization, problem identification, understanding background conditions, and watershed-based plan development.

¹²www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/CitizenMonitoring/GrantOpportunities.aspx

¹³ Virginia Department of Environmental Quality, *2017 Citizen and Non-Agency Monitoring Activity Report* (2018). An additional 12 % came from other non-agency sources including businesses and academics.

Similarly, the Chesapeake Monitoring Cooperative identifies a variety of ways data that do not qualify for regulatory purposes can be used for management purposes. Such information is used in the Chesapeake Bay Program's Report Cards, which are a driver of planning by the federal and state partnership engaged in restoring the bay. It can also be used for targeting stream segments for assessment and selection of agency priority sites.¹⁴

Water quality data can also be used by other agencies or units of government. For example, in Michigan, data on lake water quality is used by the state's Department of Natural Resources to plan its fish stocking. Lake quality is also of great interest to local governments in Michigan, for whom having healthy lakes is important to tourism.

To inform the public

Many states place volunteer-generated information in a public database, available on the web. This allows the data to be used for purposes beyond the agency's own needs, as well as raising public awareness of water quality issues and providing information that is valuable for educational purposes. For example, in Michigan, the public centralized database that is a key part of the MiCorps program¹⁵ is commonly used by the public; for example, lakeside homeowners, and potential property buyers, use the database to check on the health of their lakes. Graphic displays of monitoring activities and results are also maintained by Georgia,¹⁶ Indiana,¹⁷ and the Chesapeake Monitoring Cooperative,¹⁸ to list just a few.

A strong database has benefits beyond sharing information. A database helps attract volunteers, because it tells them that their work will reach a broader public and be used by researchers far beyond their immediate communities.

ENSURING DATA QUALITY

An important factor in all water monitoring programs is ensuring that data is adequate for the way in which it is used. Data quality requirements are most basic for uses such as public education. Somewhat higher quality data is needed for the state to use the information for management decisions, such as to prioritize and target its own monitoring. The highest tier is for use of data for regulatory purposes, such as listing or delisting waters as 'impaired' under 303(d) as well as TMDL development. Many states establish data quality tiers for data submitted by outside parties, including Indiana, Michigan, Maryland¹⁹ and Virginia.

¹⁴ <https://www.chesapeakemonitoringcoop.org/wp-content/uploads/2018/11/Tiered-Framework.pdf>

¹⁵ <https://micorps.net/about-data-exchange/>

¹⁶ <https://adoptastream.georgia.gov/https%3A/aas.gaepd.org/Region.aspx/view-data-region>

¹⁷ <https://www.hoosieriverwatch.com/search/>

¹⁸ <https://www.chesapeakemonitoringcoop.org/services/chesapeake-data-explorer/>

¹⁹ <https://mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/Data-Solicitation.aspx>

Some states have published guidelines that set out expectations regarding the way in which data can be used, and the nature of data required for each use. Clear data quality guidelines are an important tool, providing an open and transparent road map for citizen groups wishing to influence government action. They offer guidance on the steps and procedures citizen scientists must use to have data accepted by the state.²⁰ They help to ensure that citizen scientists understand what they need to do for their work to be used by the state, and to help them establish appropriate goals for their efforts. This gives citizen groups a clear target to shoot for and reduces the risk that they will go to a great deal of work collecting data but not have it accepted by the agency. Indiana’s External Data Framework provides guidance on data quality being submitted to the portal; Indiana is developing a “QAPP tool” for further assistance.

Some states have enacted data quality laws that govern data used for regulatory purposes. For example, Iowa’s law specifies that for data to be accepted volunteers must be “qualified” pursuant to agency regulations. Volunteers must use a site-specific plan with quality assurance procedures and must provide proof that the plan was followed. All data must be reviewed and approved by the agency before being used for official purposes.²¹ Although these steps are commonly used by monitoring programs, their codification makes it even more essential that data meets the legislated standards.

SUCCESS FACTORS

Water monitoring may be the area in which agencies have had the greatest success using the work of citizen scientists. This may stem from a variety of factors. First, there is a tangibility to the protection of rivers, lakes and streams that makes it possible to attract strong public support and participation. As a result, there has been a long history of engaged volunteers gathering data and making other observations, which has built trust and confidence as well as the ability to demonstrate that such programs avoid significant monitoring costs. The existence of regulations explicitly calling on states to consider data from outside sources gives such data legitimacy that it may lack in other programs. Perhaps most fundamentally, the technology and procedures used to assess basic water quality characteristics are within the technical capabilities of volunteer groups, so they are able to gather data that is effectively equivalent to what state staff might otherwise generate. (In contrast, official air quality monitoring is done using very expensive high-quality devices; the devices available to private citizens, while of good quality, are not equivalent and do not meet agency expectations.)

Among programs, features that help contribute to success include:

- Good oversight, including assistance in development of QAPPs, and field audits;
- Training programs and access to basic equipment;
- Funding for external organizations; and
- Clear expectations regarding data requirements.

²⁰ For example, California has detailed guidance on data submission at https://www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/data_requirements.html#instructions_n_n_ceden_submissions

²¹ <https://programs.iowadnr.gov/adbnnet/Docs/Codex/Credible%20Data%20Law>

BARRIERS

- The greatest threat faced by these programs is funding uncertainty (even though they provide the state with valuable services at a very low cost). Monitoring is a relatively invisible agency function that may lack support in spite of the fundamental role it serves supporting sound decision making. Budget pressures sometimes force states to scale back and redesign their volunteer efforts; Iowa, for example, has shifted from a state-run program with a sizable staff supporting volunteers, to one that contracts out much of its program management.
- Programs face other operating challenges, such as high rates of volunteer turnover. However, none of the programs we observed seemed to find it difficult to generate and sustain public interest.

KEY OPPORTUNITIES

- The long history of using volunteers to assist in water quality monitoring demonstrates that citizen scientists can contribute meaningfully to monitoring, at a level justifying the investment required.
- Independent citizen groups can provide data that is of sufficient quality to be used in a variety of ways. With support and guidance, data from outside groups can be good enough to use in official regulatory reporting. Extensive experience has been gained in developing QAPPs that provide confidence in the data.
- Setting out clear guidelines on how data can be used, the quality of data required for each use, and the documentation needed to demonstrate its quality, is helpful for citizen scientists who want to be confident that their work will be utilized.
- Intermediary organizations can provide assistance across multiple states.

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- Marcy Knoll Wilmes, Michigan Dept. of Environment, Great Lakes and Energy

ALASKA-YUKON INDIGENOUS OBSERVATION NETWORK

Community-based monitoring tracks water quality across a vast area in Alaska and Canada, providing information that is used by tribal governments, states, and federal agencies.

Environmental Issue: Water Quality [Toxic Releases & Climate Change]

Location: Alaska and Yukon, Canada

Agencies: Yukon River Inter-tribal Watershed Council

Government Role: Led by multi-tribal collaborative

For More Information: <https://www.yritwc.org>

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BACKGROUND

The Yukon River watershed (YRW) is the fourth largest drainage basin in North America, spreading across a vast area in Alaska, the Yukon Territory, and British Columbia. The river flows through 20 different ecosystems with unique geological features and is mostly underlain by permafrost. The watershed is populated largely by indigenous communities, which have a close relationship to the river and landscape -- as a source of food and water as well as a cultural and economic resource due to their traditional way of life. In addition to the usual problems of impacts from resource development, the YRW faces profound environmental changes resulting from climate change.

Environmental monitoring across the entire stretch of 2,300 mile river system exceeds the capability of individual tribal governments, First Nations and other governmental agencies. To fill this environmental monitoring gap, the Indigenous Observation Network (ION) coordinates trained community members to gather water quality and permafrost data that can be used by Tribal and First Nations governments, as well as other federal, state, and local agencies.

ABOUT THE PROGRAM

ION is led by the Yukon River Inter-Tribal Watershed Council (YRITWC), an Indigenous grassroots non-profit organization formed in 1997. Its mission is to protect and improve water quality in the Yukon River. The YRITWC consists of 57 Alaska Tribes and 17 Canadian First Nations. The YRITWC staff is directed by an Executive board made up of elected indigenous leaders from the signatory Tribes and First Nations, who identify research questions based on community concerns, interests and priorities. The YRITWC environmental monitoring program is coordinated by Tribes and First Nations, who provide input into the selection of the sites for sampling and conduct field monitoring activities.

The YRITWC's first water quality monitoring program began in 2001. In 2006, a collaborative effort between the YRITWC and U.S. Geological Survey (USGS) formed ION as a community-based research program that combines Indigenous Knowledge and modern science. ION subsequently developed two projects: the water quality monitoring program was launched in 2006, and a cooperative, community-based permafrost monitoring project known as the Active Layer Network (ALN) started in 2009.

The foundation of the network is a community-based program to monitor climate change sensitive parameters along the Yukon River and its tributaries. The goal is to develop long-term datasets that provide critical information on environmental impacts at the community, watershed, and globe scale. The data from the network helps to fill the large gap in knowledge of water and permafrost conditions, covering areas that are difficult for state or government agencies to monitor.

Since the establishment of the YRITWC science program, over 300 community members have received technical training on collecting water quality and permafrost data. The ION has established 54 water quality monitoring sites and 20 permafrost monitoring sites, from the Yukon's headwaters to its mouth on the Bering Sea. Over a thousand water quality samples have been collected and analyzed for 41 climate indicator parameters. At each ALN site, temperature and moisture of the active layer soil is continuously monitored as is air temperature. Each year, trained community members assist USGS and YRITWC staff to measure the thickness of the "active layer" (i.e., the top layer of soil that thaws during the summer and freezes in the fall) at all sites.

The ION members, referred to as "environmental technicians." are members of Alaska Tribes and First Nations. As such, they give their communities an active role -- along with formal governmental entities - in the protection of the resource. In 2015 a study conducted to assess the ION program found that these community members value ownership of information and data collected through the program, in part because information from government or other sources is not entirely trusted.

YRITWC provides training and oversight to ensure that the data generated is of high quality, using USGS protocols and quality assurance project plans (QAPPs) approved by EPA. It also provides environmental sampling equipment. YRITWC makes it a priority to use a holistic approach that is guided by Indigenous Knowledge, in which environmental observations made by the local technicians are paired with monitoring that follows rigorous scientific protocols.

Water quality data collection is done on a biweekly basis during open water season (roughly June through October). Physical parameters such as pH and dissolved oxygen are measured on-site, while surface water samples for chemical parameters such as nutrients are shipped to YRITWC before ultimately being sent for analysis to the USGS and University of Alaska Fairbanks (UAF). The YRITWC disseminate the monitoring results via community reports and made them publicly available through USGS ScienceBase (<https://www.sciencebase.gov/catalog/item/573f3b8de4b04a3a6a24ae28>), and Biological Science Curriculum Study (BSCS) FieldScope (<https://yukon.fieldscope.org/v3>).

In addition to measuring typical water quality parameters, ION gathers data on the effects of climate change on hydrology, water quality, and the landscape. Arctic river ecosystems are more fragile than those in warmer climates, and warmer air temperature causes permafrost thawing, which destabilizes the landscape, threatens infrastructure, and increases river and coastal erosion, which YRITWC and community technicians assess using drones.

For example, landfills in rural areas were designed without liners or leachate catchment on the assumption that permafrost would act as a barrier, preventing infiltration into groundwater. However, warmer air temperatures contribute to permafrost thawing, creating small pathways that allow the release of heavy metals and other dangerous chemicals such as mercury that have been trapped in the permafrost for over a century. Warmer temperatures can also result in infestations of invasive plant species and algal blooms, as well as depletion of dissolved oxygen which results in large fish die-offs.

Data from ION is used in a variety of ways. First, the data is shared with Tribal and First Nation governments. Second, YRITWC compares water quality parameter data with regulatory standards and advises Tribal and First Nation communities on whether water quality meets federal and state standards. The collected water quality data gives an indication of trends in local water quality. Communities are also able to leverage the data to gain assistance from agencies.

Data from ION is also used in implementing the Yukon River Watershed Plan, which sets out the long-term vision and objectives of the organization for the protection and preservation of the Yukon River. Community-generated data from ION are used to track progress toward those objectives and identify where degradation has occurred.

Beyond these agency applications, YRITWC itself works in the communities to provide training, education and awareness programs about concerns relating to the Yukon River. It provides non-technical community reports, designed for purposes of the general public. Data is also made available to the public via the USGS ScienceBase, Yukon Government Water Data Catalogue, and is uploaded into the National Water Quality Monitoring Council's Water Quality Portal. The ION active layer monitoring program is a contributing member of the Circumpolar Active Layer Monitoring (CALM) network, an international Arctic effort to understand changes in permafrost.

PROGRAM OUTCOMES

- Through more than a decade of monitoring, ION has created a long-term dataset that will lead to a better understanding of the linkage between the terrestrial and aquatic systems in the YRW.
- ION provides a number of valuable parameters to the remote sensing and modeling community for Arctic and Subarctic region for climate change prediction. ION's water quality monitoring program can provide a baseline against which to assess changing hydrological processes and water quality conditions in the Yukon River and its tributaries.
- ION's active layer network contributes to advance the knowledge of seasonal active layer dynamics to assess landscape changes affected by climate change.
- ION empowers community members with the knowledge and tools to monitor their environment, contributing to good stewardship of the river.

SUCCESS FACTORS

- As a ‘bridging organization’, YRITWC plays a key role in facilitating collaboration and connections between different actors including communities, governments and other partners. Strong collaborative relationships built over the long term were important in ensuring that technical and financial capacities are fairly distributed within the network.
- The sustained training of local residents over many years has created a pool of technicians who can generate high quality data.
- Efforts to link ION datasets with decision-making processes such as the Yukon River Watershed Plan are focused on prioritizing Indigenous water rights and governance. Linkages such as these are crucial to building trust in evidence that drives the decision-making affecting water quality at the community, watershed, and even global scale.

BARRIERS

- The greatest challenge for ION has been ensuring sustainable long-term funding across the entire watershed, including Alaska, USA and Canada. ION has only limited funding availability to address local contaminant concerns such as heavy metals and sediment loads from mining or leachate from local sewage lagoons or landfills.
- Because of these resource limitations, ION has not had the capacity to monitor all of the contaminants identified as priorities in the Yukon River Watershed Plan.

KEY OPPORTUNITIES

- YRITWC is particularly valuable as a model in coordinating large scale citizen science environmental monitoring with Indigenous people dependent on lakes and rivers for food as well as drinking water. It also shows that standardized monitoring can be coordinated effectively across a very large geographic area across state and national boundaries.
- It demonstrates that indigenous leadership in citizen science monitoring within the YRW has been essential developing a program that is designed to meet desired outcomes for Indigenous water rights and co-governance.

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EVALUATING WETLAND HEALTH IN MINNESOTA

Minnesota state and county agencies provide local residents tools and expertise to assess their local wetlands. The data they generate are used by local municipalities and watershed groups, to ensure that the wetlands stay vital and provide an important community amenity.

Environmental Issue: Wetland Protection

Location: Minnesota

Agencies: Hennepin and Dakota Counties, Minnesota; Minnesota Pollution Control Agency

Government Role: Partnership of State and County agencies with municipalities and watershed organizations

For More Information: <http://www.mnwhep.org/>; <https://www.hennepin.us/your-government/get-involved/wetland-health-evaluation-program>;

<https://www.co.dakota.mn.us/Environment/CommunityInvolvement/WHEP/Pages/default.aspx>

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BACKGROUND

Protecting and preserving wetlands is an important part of the system for water quality protection, and a matter of great concern to residents of Hennepin and Dakota Counties in the Twin Cities metropolitan area of Minnesota. Municipalities and watershed groups within those counties want to keep track of the health of their wetlands, for a variety of reasons ranging from local interest to compliance with Clean Water Act. To help them, these two counties, supported by the Minnesota Pollution Control Agency (PCA), have operated the Wetlands Health Evaluation Program (WHEP) for over 20 years. The program trains volunteers to gather data on macroinvertebrates and vegetation, as indicators of whether wetlands are thriving.

ABOUT THE PROGRAM

In contrast to other cases we studied, WHEP is not driven by state or federal needs, but rather responds to requests from sponsors -- usually local governments and environmental groups. The program, which has been in existence for over 20 years, is a partnership between Hennepin and Dakota Counties, and their respective sponsors. The counties, with assistance from the state, provide technical guidance and expertise, while the work of doing the evaluation is carried out by volunteers provided by the sponsors. Sponsors of the Hennepin County program have included the cities of Bloomington, Eden Prairie and Minnetonka; three Watershed Management Commissions, the Shingle Creek/West Mississippi watershed organization, and the Minneapolis Park and Recreation Board.

Sponsors may have a variety of reasons for wanting to know the health of a wetland, such as:

- Wetlands are an important amenity for cities and their residents, so municipalities need data on their general condition.
- A city may be required to engage communities under the Clean Water Act TMDL program (total maximum daily load) and may use the wetlands evaluation process for that purpose.
- Community watershed groups have an avid interest in their local water bodies and want to have a scientifically valid measure of how those water bodies are doing.

The city of Minnetonka, for example, has participated in the program for many years. It has over 600 wetlands within the city limits, and through WHEP has monitored a representative sample of 34. The city has had a longstanding policy of protecting wetlands, with strict regulations limiting direct impacts from development. Therefore, it wants data to keep track of those areas, and to respond to inquiries from local residents. WHEP makes assessment affordable; in turn, the active involvement of local residents raises awareness of wetlands and makes community members more aware that these are vital natural areas hosting a wide variety of plant and animal species.

Assessing the health of wetlands is a scientific process that involves a combination of technical knowledge, proper equipment, and research design. To determine whether a wetland is healthy, researchers take samples to test the presence of macroinvertebrates (such as insects, leeches, small crustaceans, and snails), and inventory the plant community in representative plots within the wetland. The inventory is an indicator because some species of macroinvertebrates and plants will only survive in healthy wetlands.

The sponsors designate the depressional type wetlands that they want to have evaluated. The evaluation process is led by county coordinators, who organize volunteer recruitment and training events. For each wetland being studied, there is a team of 8 to 15 volunteers (generally recruited by a sponsor), most of whom live in the vicinity of the wetland being studied. Volunteers with some formal training in biological sciences serve as team leaders; they are responsible for equipment, team monitoring logistics, assuring data quality in accordance with written protocols. Team Leaders received small stipends. The county agency trains the team leaders, who then train and lead the other volunteers. In addition, the county provides equipment such as waders and nets.

The WHEP assessment is done using protocols developed by scientists at the Minnesota PCA. PCA provides annual training field methods and respective invertebrate and plant taxonomic identification. Its scientists generally do not work with volunteers in the field but are occasionally asked to help on difficult questions about identification (at the family/genus level for invertebrates, and genus/species level for plants). The evaluations generate data that are used by municipalities and watershed groups.

The evaluation teams go into the field twice during the summer. In late May or June, the teams collect dipnet samples to determine the presence of macroinvertebrates (and identify the macroinvertebrate species based on their training, assisted by the county staff when necessary). This involves taking samples using a net following a prescribed procedure. Samples are then preserved and analyzed to identify the macroinvertebrates. In July, they return to do an onsite vegetation survey, which involves designating a 100 square meter plot and then carefully examining all of the plants within the plot to determine what plants are present. Wetland sampling data is transferred by the county staff to electronic and paper data sheets, which generates an assessment, which is then shared with the sponsor.

Although the county leads the effort, volunteers take a high degree of responsibility for carrying it out, including initial species identification. Volunteers are not required to have prior scientific experience but are trained to ensure that the evaluation is rigorous and reliable. The county reports that volunteers are motivated by the commitment to sound science, and the knowledge that the data will be used. Some volunteers have returned for several years.

PROGRAM OUTCOMES

The value of the program is shown by its ongoing support from sponsors, and its long duration -- over 20 years in operation. In 2019, it collected data on 30 locations in Hennepin County, working with eight different governmental and non-governmental sponsors. 84 volunteers participated in these evaluations, contributing 637 hours of their time. In Dakota County, ten cities participated in 2019 as well as the county parks and a watershed association.

Data from the 2019 wetland evaluations was used in a variety of ways, including:

- The City of Eden Prairie gathered data on an invasive plant species, which it is trying to control. In another location, the data collected will form a baseline for purposes of a comparison required by the TMDL program.
- The Minneapolis Park and Recreation board obtained data that it will use in its management plan, and to track trends over time. These wetlands within the city boundaries attract a high degree of interest from local residents.
- The Pioneer/Sarah Watershed Commission will use the data in planning to target goal project areas.
- The Shingle Creek Watershed Association will use the data to track the health of a wetland that is affected by extensive development.

In addition, Hennepin County compiles the data from all its locations to create interactive maps, posted on its website, that show wetland health ratings across all of the sites that were evaluated.

SUCCESS FACTORS

- Sustained demand from sponsors (municipalities or watershed groups) who want the data and appreciate the support that makes the data scientifically valid.
- External factors such as TMDL requirements.
- Expertise of county staff (and state agency), which guarantees data quality and helps overcome natural skepticism about the validity of citizen science.
- Extensive training by county staff, which also ensures validity.

BARRIERS

- WHEP program contacts did not identify any major barriers.

KEY OPPORTUNITIES

Hennepin County staff does not believe that any other program like this exists in the country. This is consistent with ELI's research, which found very few wetland-oriented programs. Given the sustained success of the effort, which indicates a need exists, the WHEP program could be used as a model elsewhere in states, tribes or local governments.

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TRACKING CYANOBACTERIA IN LAKE CHAMPLAIN

Volunteers at Lake Champlain monitor for toxic cyanobacteria blooms, reporting to a multi-agency collaboration that uses data to alert the public to risks and identify which areas are safe to use.

Environmental Issue: Cyanobacteria
Location: New York and Vermont
Agencies: New York DEC, Vermont DEC, Vermont Department of Health, Lake Champlain Basin Program, Lake Champlain Committee
Government Role: Partnership with several governmental and non-governmental organizations
For More Information: <https://www.healthvermont.gov/tracking/cyanobacteria-tracker>;
<https://www.lcbp.org/water-environment/human-health/cyanobacteria/>;
<https://www.lakechamplaincommittee.org/lcc-at-work/cyanobacteria-in-lake/>
Program Contacts: Matt Vaughan | Lake Champlain Basin Program | mvaughan@lcbp.org
Angela Shambaugh | Vermont Dept. of Environmental Conservation | Angela.Shambaugh@vermont.gov

BACKGROUND

In response to growing public concern about cyanobacteria around Lake Champlain, a multiparty effort has been established to test for the presence of toxins; report findings centrally, share that information, and respond when appropriate by closing beaches and notifying the public. Volunteers play an important role, checking weekly for dangerous blooms and reporting those findings, as well as reporting at other times if they see blooms in the Lake. The network of private volunteers makes it possible to keep track of when and where blooms are occurring so that agencies can act. This information also allows agencies to reassure the public that most of the lake is safe, which benefits the tourism industry.

ABOUT THE PROGRAM

Lake Champlain, located between Vermont, upstate New York and Quebec, is a major attraction for recreation, tourism and fishing. The problem of cyanobacteria first came to public attention in the area in 1990 when two dogs died after being exposed to the toxins. Since then, blooms have become more frequent and receive a great deal of media coverage. The various organizations that work to protect and enhance the Lake have developed a sophisticated effort to track and act on the problem.

Initially, cyanobacteria monitoring was done only by state agency employees, who collected water samples for laboratory analysis. However, research has shown that a simple visual observation can suffice to determine whether there is a possibility of toxins being present. Non-toxic blooms are not visible; those that are visible may (but do not necessarily) produce toxins. This discovery made it possible to use non-specialists as the first line of detection, and a volunteer monitoring program was launched in 2012.

The program has several leading parties, each of which plays a distinct role. The Lake Champlain Basin Program receives funding from the U.S. EPA. It contracts with the Lake Champlain Committee (LCC), a nonprofit organization, to carry out the program in the field. The LCC recruits volunteers and trains them to collect data using a protocol that is common to both New York and Vermont (and Quebec). Data collected by volunteers are reported electronically to a database maintained by the Vermont Health

Departments. The Vermont Department also hosts an online cyanotracker map that the public can use to check on local conditions and see recent reports.²² The New York DEC, Vermont DEC and the New York and Vermont Departments of Health analyze data, take action when needed to close beaches or warn the public, and prepare an annual report on cyanobacteria blooms.

Volunteers are recruited and trained by the Lake Champlain Committee in both Vermont and New York; about 150 were active in 2019. Volunteers are trained on a Quality Assurance Project Plan or QAPP, which spells out protocols for monitoring. Each volunteer is responsible for visually checking a particular location once a week during warmer months. The agencies can also accept reports at any time; most of these reports come from trained program volunteers but the public can also report blooms to the Department of Health by phone or email.

Reports (both detection and non-detection) are submitted to the Department of Health using an online form. Reports indicating that a bloom may be present are checked by agency staff who can review photos and request more information. Volunteers may also be asked to collect samples to confirm that a toxic bloom is present. If a bloom is confirmed, alerts are sent to public agencies in both New York and Vermont, as well as to local governments who have the primary responsibility for beach closings.

The event is also posted on the Department of Health website. The online “cyanotracker” map serves as a primary public resource and is used frequently by residents in areas where blooms are common.

Volunteers report weekly, even if they do not find a bloom. Reporting the absence of blooms can be as important as finding one, because the information can be released to assure the public that an area is safe. One benefit of the program lies in reducing fears resulting from highly publicized toxic bloom events.

While the Department of Health is primarily responsible for the immediate response, the Vermont DEC and Lake Champlain Basin Program carry out programs to make residents aware of what causes blooms, and what can be done to prevent them -- especially controlling the use of phosphorus and other nutrients. DEC also issues a report each year providing the data from all the volunteer reports, which shows when, where and how often dangerous blooms occur.

PROGRAM OUTCOMES

- Through the integrated collaboration of volunteers, state agencies and the Lake Champlain Basin program, residents and tourists have timely information and avoid dangerous beach locations.
- Information on what areas are safe is as important as those that are not. The assurance that lake waters are safe almost all the time is valuable in an area heavily dependent on tourism.

²² <https://apps.health.vermont.gov/vttracking/cyanobacteria/2019/d/index.html>

- Interest in the program has been so strong that it is beginning to extend beyond Lake Champlain to other lake communities in Vermont.

SUCCESS FACTORS

- Strong public interest in the problem, which benefits an important resource.
- Well-established working relationships among the agencies and other organizations dealing with the problem, with clear roles and effective coordination.
- Systematic monitoring that provides data on a weekly basis, allowing agencies to identify healthy areas as well as those that should be avoided.

BARRIERS

- The program operates across state lines, which makes coordination a priority.

KEY OPPORTUNITIES

- Cyanobacteria are a risk in many states. Where locations of concern are predictable, the model used at Lake Champlain could be replicated without a disproportionate investment of resources.

REFERENCES

- Vermont Dept. of Health Cyanotracker website: <https://www.healthvermont.gov/tracking/cyanobacteria-tracker>
- New York DEC website: <https://www.dec.ny.gov/chemical/83310.html>
- Lake Champlain Committee website: <https://www.lakechamplaincommittee.org/lcc-at-work/cyanobacteria-in-lake>
- Lake Champlain Basin Program website: <https://www.lcbp.org/water-environment/human-health/cyanobacteria/>
- New York Dept. of Environmental Conservation website: <https://www.dec.ny.gov/chemical/77118.html>
- Vermont Dept. of Environmental Conservation website: <https://dec.vermont.gov/watershed/lakes-ponds/learn-more/cyanobacteria>
- U.S. EPA list of state programs: <https://www.epa.gov/cyanoabs/state-habs-monitoring-programs-and-resources>

REPORTING HARMFUL CYANOBACTERIA BLOOMS IN IDAHO

In Idaho, reporting by private citizens is the first line of defense in identifying and responding to toxic cyanobacteria blooms. The Idaho DEQ depends on these reports to spot problems and provide information that allows state staff to alert the public and provide dangerous exposures.

Environmental Issue: Cyanobacteria

Location: Idaho

Agencies: Idaho Department of Environmental Quality

Government Role: Agency-led

For More Information: <https://www.deq.idaho.gov/water-quality/surface-water/recreation-health-advisories/cyanobacteria-harmful-algal-blooms/>

Program Contact: Brian Reese | Idaho Dept. of Environmental Quality | Brian.Reese@deq.idaho.gov

BACKGROUND

Harmful blooms of cyanobacteria are a significant concern in Idaho, a state famous for its outdoor recreation. Monitoring algal blooms is a challenge for the Department of Environmental Quality (DEQ), which is a relatively small agency; each of its six regional offices has at most one or two staff who respond to reported blooms across an area half the size of the state of Maryland. It can take an 8 hour day for staff to look at and sample one water body. Therefore, the agency relies on the public and other innovative strategies to play a significant role in identifying and reporting toxic blooms.

ABOUT THE PROGRAM

The Idaho program invites fishermen and other recreational users, as well as the general public, to report potentially harmful blooms via a phone hotline, and by email to a dedicated address, algae@deq.idaho.gov. The majority of reports come from individuals; some come in through other agencies such as state park staff and Idaho Fish and Wildlife staff. DEQ also publicizes the importance of reporting to recreational groups. The state experimented with using a publicly available app but found that very few reports were made in that way.

After receiving reports, DEQ staff follow up to obtain more information that will help them assess whether the event is a cyanobacteria bloom and whether it is hazardous. The staff try to obtain photos for purposes of offsite screening and have criteria for photos to help ensure data quality. After getting a report, DEQ determines whether to issue an advisory against fishing or swimming. Signs are posted at the site, and advisories are publicized on social media.

More formal citizen science efforts are emerging with support from the Phytoplankton Monitoring Network, a NOAA program that provides microscopy and identification training to a non-technical audience. At Lake Cascade north of Boise, a group of concerned citizens have formed a citizen science program to collect and report data on a weekly basis; data is reported to DEQ, EPA and NOAA. Their data gathering includes microscopic images that DEQ can use to identify the species of cyanobacteria in water, and their abundance. This regular reporting allows the local residents, and DEQ, to track trends and severity so that DEQ can determine whether it is a priority for response. In another location, an individual volunteer monitors a reservoir that is heavily used for recreation and irrigation.

A threshold challenge for the program is educational: making residents aware of how dangerous the blooms can be. People using the rivers and streams have seen them in the past (and perceive these as harmless algae). Therefore, DEQ has a regular program to raise awareness of the problem and the hazards the blooms present. From spring through late summer, it has an outreach campaign and uses social media to get that message out.

Idaho also participates in the Cyanobacteria Assessment Network (CyAN), a joint effort among EPA, NASA, NOAA and USGS that uses data from satellites to detect and quantify cyanobacteria blooms. Although not a form of citizen science, it is worth noting because it complements the efforts described above as part of Idaho's overall strategy. Idaho uses remote sensing data extensively and is planning to provide the information to the public in a map on its website. The remote sensing data is not used to issue or lift health advisories but serves as a monitoring tool to anticipate a toxic bloom and continue monitoring remotely when a bloom is confirmed.

PROGRAM OUTCOMES

The program allows Idaho DEQ to respond effectively to a growing problem, which is difficult for agency staff to monitor. Involving the public also raises awareness of the risks associated with algal blooms.

SUCCESS FACTORS

- Publicity about the environmental problem, so the public is aware of the risks and their role in addressing it.
- The state also uses satellite remote sensing extensively to anticipate bloom formation and monitor confirmed blooms.
- New technology, such use of email and transmitting photos, makes reporting more effective.

BARRIERS

- Need for greater public understanding of the problem and ability to identify potentially harmful blooms accurately.

KEY OPPORTUNITIES

- States are able to use public input to make responses to algal blooms timely and cost-effective.
- Evolving technology may improve reporting. In addition to reporting by email, the state has a web portal for reporting potential environmental concerns.

REFERENCES

- Program website: <https://www.deq.idaho.gov/water-quality/surface-water/recreation-health-advisories/cyanobacteria-harmful-algal-blooms/>

OKLAHOMA KILL RESPONSE MANAGEMENT PROGRAM

Users of Oklahoma’s rivers, lakes and streams use a telephone hotline to report fishkills as part of a multiagency partnership for identifying and responding to these events.

Environmental Issue: Cyanobacteria

Location: Oklahoma

Agencies: Oklahoma DEQ, Cherokee Nation, many others

Government Role: Agency-led

For More Information: https://www.deq.ok.gov/wp-content/uploads/deqmainresources/OKRMT_02-2019.pdf

Program Contact: Ferrella March | Oklahoma Dept. of Environmental Quality | Ferrella.March@deq.ok.gov

Jason White | Cherokee Nation | Jason-White@cherokee.org

BACKGROUND

Oklahoma has experienced a growing number of fish kills in its rivers and streams, a result of oxygen depletion and events such as cyanobacteria blooms. To act effectively in response to such events, federal, state and tribal agencies have formed the Oklahoma Kill Response Management Team (OKRMT). Private citizens play an essential role in the response, as they are the primary source of reports and can take other steps to assist in determining the likely causes of fish kills.

ABOUT THE PROGRAM

Fishing is important in Oklahoma both for recreational and subsistence purposes, especially on tribal lands. Fish and other marine life such as freshwater mussels are important cultural resources for tribal members. Therefore, fish kills are a significant concern in Oklahoma, occurring in water bodies across the state. The risk is greatest in the summer when heat and low flows impact the quality of rivers and streams. Between April and September of 2018 there were 32 fish kills, across lakes, rivers, streams and ponds. The primary causes are depletion of oxygen in the water (a result of excessive nutrients from wastewater and agricultural runoff) and toxins (from sources such as cyanobacteria blooms, and biological blooms or discrete events such as chemical releases).

Information about fish kills usually originates with private citizens, who may be residents or recreational users. Some reports come in from volunteers doing water quality monitoring. Reports are made primarily by phone calls to an Oklahoma DEQ hotline. Those calling the hotline are then asked for key information such as the time, date and location of the fishkill; the size of the fishkill; the color of the water body; etc. With this information, the state or tribal staff are better prepared to respond. Local residents such as tribal members may also have other knowledge about the water body that helps responders assess the situation. Citizens calling the hotline may be asked to preserve samples of the water, or of the dead fish, for investigators to use.

The function of OKRMT is to coordinate the response among multiple agencies who may have jurisdiction over the stream or may have relevant technical expertise. These are primarily state agencies and tribal governments; federal agencies may also play a role. Through the Team, the agencies have established roles and responsibilities for receiving citizen complaints, forwarding them for response, and carrying out the response. The OKRMT includes:

State: Department of Environmental Quality, Department of Wildlife Conservation, Water Resources Board, Department of Agriculture, Food and Forestry, Corporation Commission.

Tribes: Cherokee Nation, Chickasaw Nation, Cheyenne-Arapaho Nation, Delaware Nation, Iowa Nation, Muscogee Creek Nation, Osage Nation, Ponca Nation, Sac and Fox Nation.

Federal: U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and the Natural Resources Conservation Service of the U.S. Department of Agriculture.

The agencies may respond in a number of ways. A detailed assessment of the fish kill will go into a database that is used to track trends and causes of the events. In serious cases, local communities and the public are notified to discourage fishing in the area. Where the cause of the event can be traced to a specific source, the agencies may take enforcement action or seek to recover natural resource damages.

PROGRAM OUTCOMES

Over time, the agencies in OKRMT hope to build a better understanding of the causes of fish kills and take measures to address problems at the source. They also hope to raise public awareness of the issue both to increase reporting and gain support for the response.

SUCCESS FACTORS

- Publicity about the importance of fish kills and of the need to report them as soon as possible.
- Structured working relationship among response agencies, which helps expedite responses and ensure shared access to key information.

BARRIERS

- The primary barrier is the continuing need to increase public awareness of the hotline and the importance of reporting fishkill events.

KEY OPPORTUNITIES

- OKRMT may be a model for other types of emergency response needs, where effective action depends upon a combination of prompt citizen reporting and a well-coordinated response.

REFERENCES

- OKRMT Fact Sheet: https://www.deq.ok.gov/wp-content/uploads/deqmainresources/OKRMT_02-2019.pdf
- Presentation by Ferrella March, Oklahoma DEQ, at Tribal Environmental Coalition in Oklahoma, January 21, 2020.

SOUTHWEST WISCONSIN GROUNDWATER AND GEOLOGY (SWIGG) STUDY

Private well owners are contributing water samples on their land to inform a local study on groundwater contamination in the southwest region of Wisconsin. The study, funded by three local counties, is designed to assess the geographic extent of well contamination, identify sources of pollution and analyze risk factors associated with well contamination.

Environmental Issue: Groundwater Quality

Location: Southwest Wisconsin

Agencies: Land Conservation Departments of Grant, Iowa and Lafayette Counties

Government Role: Funding a collaborative study

For More Information: <https://iowa.extension.wisc.edu/community-development/swigg/>

Contact: Mr. Joel Stokdyk | USGS | jstokdyk@usgs.gov

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BACKGROUND

Forty-four percent of residents in the southwest Wisconsin counties of Grant, Iowa, and Lafayette get their drinking water from private wells. This area is characterized by fractured bedrock, allowing surface pollutants like wastewater and manure to easily enter groundwater aquifers. Drinking water contamination across the state is a concern for local health and environmental agencies. Wells sampled in Grant, Iowa and Lafayette counties reveal a higher than average occurrence of contamination when compared to other counties in Wisconsin. Contaminants of concern include nitrate and microorganisms such as E. coli which can lead to infectious diseases. High levels of nitrates can pose serious health risk to pregnant women and infants.

ABOUT THE STUDY

The Southwest Wisconsin Groundwater and Geology (SWIGG) study was prompted by a need for up-to-date information on groundwater quality and the pathways and extent of contamination in this area. In 2018, the land conservation departments of Grant, Iowa, and Lafayette counties banded together to fund this multi-year study. The SWIGG study is a collaborative research effort between researchers at the University of Wisconsin Division of Extension, Wisconsin Geological and Natural History Survey, US Geological Survey, and US Department of Agriculture.

The study has two distinct phases. Phase one involves sampling hundreds of private wells to assess the extent of contamination. Phase two will include further sampling of contaminated wells to identify the source of pollutants and factors influencing movement of contaminants, including geology and well construction. Phase one of the study, now complete, invited voluntary participation of private well owners across all three counties. These wells were selected at random and owners were sent a letter requesting participation. About 25% of those contacted, replied confirming their participation (3,350 homeowners were contacted). Well owners who opted to participate were provided with a bottle and instructions for how to submit it for laboratory testing. Homeowners were instructed to 1) use a tap that was not softened or subject to treatment, preferably one near the house's pressure tank, 2) wash hands, 3) sterilize the tap with a flame, 4) run the water for at least 5-10 minutes, and 5) prevent anything from

touching the inside of the bottle or cap. The Water and Environmental Analysis Lab (WEAL) at University of Wisconsin-Stevens Point analyzed samples for phase one. Samples were tested for indicator bacteria (total coliform and E. coli) and nitrate.

Researchers at the US Geological Survey and US Department of Agriculture designed the study, solicited and enrolled participants, and coordinated sample collection. A total of 840 samples were taken during two sampling events (November 2018 and April 2019) to account for seasonal variations. In November 2018, 301 samples were taken, 539 samples were taken in April 2019. All samples were collected over two days to limit the effect of changing weather over the sample period. The synoptic event is a strength of the study but also added logistical challenges. The participation of well owners was subject to anonymity. Therefore, the location of sampled wells will not be shared as part of the study.

Phase 2 study objectives involve additional sampling events to identify microorganisms that indicate contamination from human wastewater and livestock manure. Once sampling is complete, study researchers plan to undertake statistical modelling to determine the contamination of private wells in the region based on land-use, geology and well construction. The results of the SWIGG study are expected to be released in 2021.

STUDY OUTCOMES

The study results will help inform county residents and state and local agencies about the quality of private well water in the region and relationships between water quality, land use practices, and water well design and condition.

SUCCESS FACTORS

- The research organizations served as a valuable intermediary in this technical study between the land owners and local government organizations. Private well owners were more receptive to participating because the well contamination data would be confidential and anonymized when presented in a public data set.
- Participation in the sampling process was voluntary and well owners were provided with the equipment to take the necessary samples and were given their test results.
- This project was designed to meet the information needs of the local counties, and thus, received the appropriate funding and support.
- This project illustrates a multi-organization partnership between local, state and federal agencies and academic institutions.

BARRIERS

- The cost of groundwater monitoring studies can be significant (estimated total project cost of this study is \$200,000) with funding coming from a variety of organizations.
- Monitoring groundwater quality is often done less frequently than surface water monitoring due to higher sampling costs and restricted access to private wells.

- Complexity of understanding and solving groundwater pollution problems, including geology, land use, well construction and other factors.

KEY OPPORTUNITIES

Fifteen percent of the U.S population rely on private wells as a source of drinking water. The quality of drinking water from private wells are not federally regulated and may also not be regulated by some states. The relationship between local or state governments and private well owners may in some instances be strained – but this study indicates a willingness of well owners to contribute well water samples to allow local understanding of potential sources of groundwater contamination. Local environmental agencies with the assistance of research groups have a unique opportunity to gather data at a local level to inform regional policies and management actions to ensure the health and safety of groundwater resources. The SWIGG study was further supported by federal agencies who provided study guidance. Although EPA and state agencies don't regulate private drinking water wells, this collaborative study can help local residents and government agencies work together to better understand how to protect groundwater as a source of drinking water.

REFERENCES

- Program website: <https://iowa.extension.wisc.edu/community-development/swigg/>
- <https://wgnhs.wisc.edu/southwest-wisconsin-groundwater-and-geology-study-swigg/>
- <https://www.wpr.org/southwest-wisconsin-water-study-finds-human-waste-contaminating-private-wells>

ENFORCEMENT AND COMPLIANCE

Agencies have always relied on citizen complaints to identify potential violations. Some of the citizen science activities described above can play that role; for example, volunteers taking water samples may report events they have observed that could warrant enforcement action. The following examples show how agencies have used new technology to enhance the ability of the public to report otherwise elusive violations and to provide the kind of information necessary to support legal action.



CALIFORNIA PESTICIDE INCIDENT REPORTING PROGRAM

Using a smartphone app, workers and the public in California can report detailed information on problems with pesticide application, helping state and county agencies respond quickly.

Environmental Issue: Pesticide Exposure / Compliance

Location: California

Agencies: California EPA / Department of Pesticide Regulation, county pesticide programs

Government Role: Agency-led

For More Information: <https://www.cdpr.ca.gov/docs/dept/quicklinks/caspir.htm>

Program Contact: Okla Hensley | California Dept. of Pesticide Regulation | Okla.Hensley@cdpr.ca.gov

BACKGROUND

Agriculture is a large part of California's economy. Pesticides are used widely in the state, subject to federal and state regulations that protect human health (e.g., farmworkers) and the environment. Enforcing these regulations is difficult because pesticide application is widely dispersed and intermittent. To support enforcement, California EPA's Department of Pesticide Regulation (DPR) has procedures through which workers or members of the public can report concerns. In 2019, DPR launched a smartphone app for reporting such events, which takes citizen reporting to a new level. The app is called CASPIR, for California's System for Pesticide Incident Reporting.

ABOUT THE PROGRAM

Pesticide regulation involves agencies at the federal, state and local level. Federally, the U.S. EPA registers pesticides to permit their use under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), and issues regulations for safe application. The application regulations are intended to prevent environmental harm, protect workers, and guard against exposures to members of the public.

At the state level in California, the DPR issues rules while pesticide use inspection and enforcement is done by county agricultural commissioners (CACs). To ensure consistency in enforcement, DPR issues guidance to the CACs, and oversees and evaluates the county programs. State and county pesticide programs therefore work together closely.

The CACs have an extensive inspection program (over 25,000 inspections were conducted in the last year). However, monitoring compliance is still difficult for a widely dispersed activity that occurs intermittently. Therefore, to complement agency inspections, DPR and counties in California rely in part on reports of problems by those in the field – workers, or members of the public. The types of incidents that can be reported include:

- Complaints about pesticides blowing beyond field boundaries, especially where there is human exposure such as at a school.
- Harmful effects on neighboring properties, such as damage to plants or gardens.
- An unpleasant odor coming from an agricultural operation.

- Complaints from persons onsite about inappropriate activity such as improper or excessive application.

DPR has a hotline for reporting such concerns, and in 2019 it launched CASPIR to provide another reporting option. The app, which is easily available, allows users to file reports electronically to their local CAC. Reports can be submitted any time and from any location, during the incident or at some later point. The user can provide a narrative description, upload photos or videos, and identify the location of the event using the GPS function or by referring to another location. The user elects whether to provide identifying information, or report anonymously. The app is available in English and Spanish; funding to develop the app was provided in part by a U.S. EPA grant.

When a report comes in through the app, it is routed to the county automatically when a user selects the location using the map function. The user also has the option of providing a written location description; in those instances, DPR either identifies the location and route to the appropriate county or requests that the app user to submit additional information to help determine the correct county. The county then responds, which may include contacting the grower, taking samples, conducting interviews and other investigative steps. If the user provided contact information, the county would directly contact the app user for additional information. The county would determine whether there were any violations and can issue a Cease and Desist order if there is an immediate and imminent hazard or the equipment is unsuitable. Also, the county would take additional enforcement when violations are found. If the person filing the report included their name, the county would receive that information and could contact them.

The app also provides Information back to the reporter, notifying them of what agency is investigating, the status of the case, and whether it has been closed.

When DPR was first planning the app, it was focused on reporting by farmworkers. Based on advice received through an extensive stakeholder consultation process, it expanded the scope to include other members of the public as well. Although the app was primarily designed with agricultural cases in mind, it may be valuable in non-agricultural settings as well. Nearly two-thirds of all pesticide illnesses investigated in California occur in such places as homes, institutions, factories, restaurants and swimming pools.

PROGRAM OUTCOMES

CASPIR has been in use since April 2019. As of January 2020, the app had been downloaded almost 900 times and approximately 40 reports have come in through the app. DPR expects this number to grow, as the app went online late in the growing season and with limited publicity.

In the outreach process conducted when the app was being designed, counties and the agricultural sector expressed concern that the app might lead to excessive or inaccurate reporting that would impose burdens and waste time for responders. To date, that has not occurred.

SUCCESS FACTORS

CASPIR has only been operational for a short time, so it is early to assess success. However, some factors contributing to its successful development and launch include:

- Established predecessor program for handling reports; well established relationships among the relevant agencies to make good use of reports.
- Stakeholder outreach helped design app that would work for the public.

BARRIERS

- Awareness is still limited; DPR plans to publicize the app widely in the new growing system.
- Farmworkers may be reluctant to report concerns involving their employer.

KEY OPPORTUNITIES

CASPIR could be a useful tool for other states with significant pesticide application concerns. In addition to the app itself it shows how technology can be integrated into agency operations.

REFERENCES

- Program website: <https://www.cdpr.ca.gov/docs/dept/quicklinks/caspir.htm>
- Press release: <https://www.cdpr.ca.gov/docs/pressrls/2019/062619.htm>
- App Store link: <https://apps.apple.com/us/app/caspir/id1448929133>
- Video: <https://www.youtube.com/watch?v=JsRloEu9e4c&feature=youtu.be>

D.C. & NEW YORK CITY ANTI-IDLING ENFORCEMENT PROGRAMS

New York City and Washington D.C. invite the public to report illegal idling of commercial vehicles, with photos and data that provide the information for agencies to take action against violators.

Environmental Issue: Air Pollution [Enforcement]

Location: New York City / Washington D.C.

Agencies: NYC Dept. of Environmental Protection / D.C Dept. of Energy & Environment

Government Role: Agency-led

For More Information: - <https://www1.nyc.gov/site/dep/environment/idling-citizens-air-complaint-program.page>
- <https://doee.dc.gov/service/engine-anti-idling-law>

Contact: New York City: Geraldine Kelpin | Department of Environmental Protection | citizencom@dep.nyc.gov
Washington: Kelly Crawford | Department of Energy and Environment | kelly.crawford@dc.gov

BACKGROUND

Vehicle idling -- especially from buses and trucks with diesel engines -- is a significant source of air pollution in urban areas. Idling releases carbon dioxide (CO₂) and other greenhouse gases into the atmosphere which contribute to climate change. Idling also emits carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter, and nitrogen oxides (NO_x) -- all causes of various health risks including asthma, heart attacks, strokes, and lung cancer. Moreover, these releases occur where people are present, and exposures are the most immediate, and often in neighborhoods that are already overburdened by pollution sources. Idling is especially problematic in cities where vehicle emissions like NO_x and VOCs mix with sunlight to form asthma-inducing ground-level ozone commonly known as smog.

This issue can be important in State Implementation Plans under the Clean Air Act, and many states and cities have taken steps to reduce idling either through regulation or voluntary measures (for an example of a state voluntary program in Utah, see <https://deq.utah.gov/air-quality/health-effects-be-idle-free>). However, compliance is still a problem, due to lack of awareness about the law, and the difficulty of enforcement.

ABOUT THE PROGRAMS

To improve compliance with local anti-idling ordinances, New York City and Washington, D.C. have adopted innovative strategies that involve the public in the enforcement effort.

Although New York has had anti-idling laws in place since 1971, pollution emissions from idling remains a serious problem. To address the issue, the city adopted new legislation in 2017 and its Department of Environmental Protection (DEP) launched the Citizen Air Complaint Program in 2018. This program allows members of the public to report idling vehicles. As an incentive for citizens to report, anyone who submits a report receives 25% of any fine collected by the DEP (which can vary between \$300 to \$2,000 for repeat offenders).

In May 2019, the city launched an online system for reporting idling violations. To be reported, a vehicle must have its engine on while not in motion for at least three minutes in the city (just one minute in

front of a school). In the online system, witnesses submit a form with a time-stamped video of the offending vehicle, and photos of the license plate and other identifying information. The report is reviewed to determine whether it provides the evidence necessary to support an enforcement action, and if it does, a summons is issued. Respondents may request an in-person hearing, but most either pay the penalty or simply default (in which case the city can collect the fine).

The online system has dramatically increased the number of citizen reports; in 2019 approximately 7,800 reports were received from approximately 200 witnesses, with reports received from all five boroughs. Some residents make many reports; one person gained public attention for the number of reports he filed and the amount he received as his share of the resulting fines. Most reports have proven adequate for purposes of enforcement. If they are not, city staff may return reports to witnesses for more information. Over time the quality of reporting has improved, and the city has provided clarifying guidance to reduce the number of reports that cannot be prosecuted.

Motor vehicles are the largest source of air pollution emissions in Washington D.C. The District's Department of Energy & Environment (DOEE) created the Engine Idling Citizen Enforcement Pilot Program in 2019, building on New York's experience. DOEE added an idling element to the city's general app for citizen reporting, called DC311. Citizens reporting an idling violation must submit two time-stamped photographs (using a camera in the app) to record the start and stop time of the observation period, which should be at least 5 minutes long. The report also requires a photo of the idling vehicle's license plate and a photo showing identifying information or a company logo, as well as information on the location of the report. Reports are reviewed by an agency inspector, who then contacts the reporting person. If the complaint appears sufficient to support an enforcement action, the DOEE will ask the reporting person to fill out and sign an affidavit and possibly testify in an administrative hearing. Notification is then sent to the alleged violator. About a third typically pay the fine; the remainder are referred to the Office of Administrative Hearings, of which about half are contested.

PROGRAM OUTCOMES

The use of citizen incentives is notable and effective in the New York City case. Since implementing the bounty policy in January 2018, the number of reports increased exponentially from 24 in 2017 to 1,038 in 2018. It is difficult to measure the impact on compliance rates, but there is anecdotal evidence that companies with repeated violations have improved their behavior.

The D.C. App was launched in September 2019 and information on usage so far is limited. DOEE did report that one bus company changed its practices after being fined multiple times, to avoid idling while passengers are boarding.

SUCCESS FACTORS

- Online reporting has enhanced the city's ability to enforce the anti-idling regulations.
- Members of the public appear motivated to report, in part due to the reward and in part because of their desire to reduce bothersome idling.

- The proof required to document idling violations is simple and clear, so that private citizens can assemble the evidence necessary to support enforcement.
- Mobile communication technology is key to D.C.'s program as it relies on the app to submit complaints.

BARRIERS

- In both New York and D.C., reporting requires some expertise in using the system, and some reports submitted have been deficient or erroneous. Both cities have worked to train users and provide guidance to reduce the number of inadequate reports.
- Additional agency staff were required in New York to respond to the large number of reports.

KEY OPPORTUNITIES

Programs utilizing the power of citizen enforcement for anti-idling laws can be replicated in cities across the country – for both illegal idling and potentially other environmental issues. Providing a financial incentive, like the NYC bounty, increases reported infractions and spreads awareness for the laws and program. Cities have the most to benefit by reducing vehicle emissions and providing citizens the opportunity to get involved in protecting their environment, and consequentially, their health.

REFERENCES

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