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Agency

EPA Tools and Resources Webinar: EPA's Air Sensor Loan Pilot Programs – *Successes, New Resources, and Lessons Learned*

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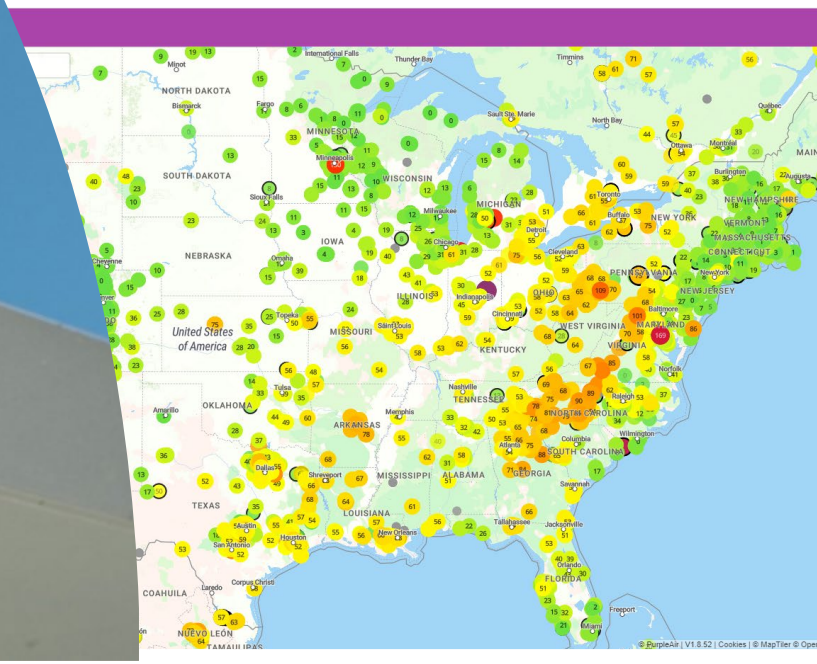
July 13, 2022

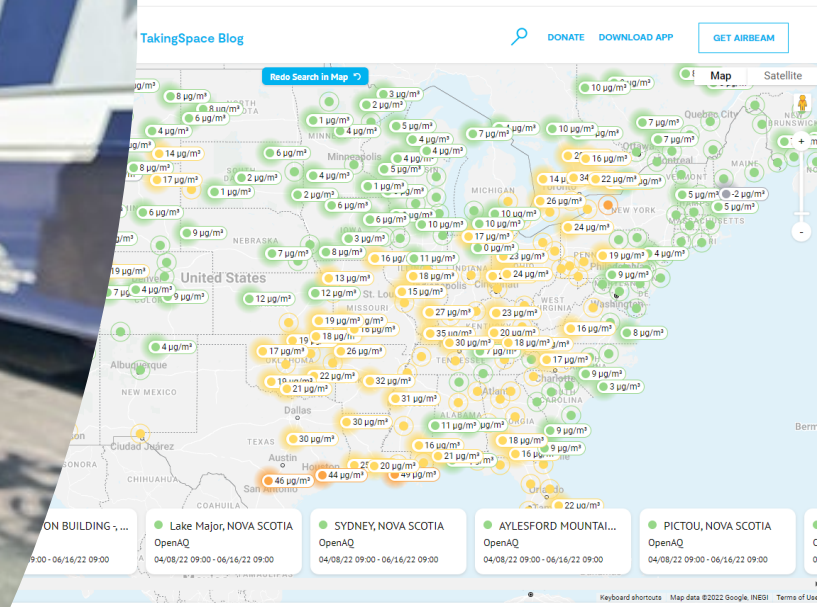
Presentation Outline

- Background
- Problem
- Benefits
- Goals
- Approach
- Results
- Outcomes
- Impact
- Take home messages
- Resources
- Contacts

Background

- Air sensors are non-regulatory technologies that measure air quality
- Sensors are often smaller, lower in cost, more portable, and easier to operate than regulatory air quality monitors
- Sensors may feature digital displays, data visualization, and crowdsourced maps
- The availability, demand for, and use of sensors continues to grow rapidly





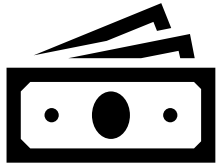
Problem – *Why is there a need for air sensor loan programs?*

- **Air quality education and supplemental monitoring are popular applications for air sensors**
- **Air sensors are not always accessible to potential users**
  - Initial purchase cost typically ranges from $100 to $5,000 (USD)
  - Additional costs are often needed (*e.g., maintenance, replacement, data storage and access, data analysis and visualization*)
- **Potential sensor users need guidance and resources such as…**
  - Background information on air pollution, air quality, sensors, etc.
  - How to select, purchase, and use sensors
  - How to plan and conduct a study
  - How to evaluate and interpret data
  - Educational materials to facilitate classroom or individual instruction

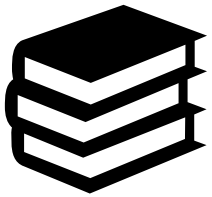
How can air sensor loan programs benefit or support state/local/tribal (SLT) governments?

- **Help build public trust in government**
  - Public may engage with a trusted partner to obtain resources/education needed
  - SLTs may partner with trusted groups allowing them to build relationships and trust

- **Develop SLTs expertise or knowledge on**
  - What applications sensors can/cannot be used for
  - How to set up and operate a loan program
  - How to find and direct the public to existing loan programs



- **Reduce SLTs resources (staff time, money, etc.) to**
  - Respond to interest in collecting air quality measurements
  - Respond to equipment loan requests
  - Manage all air quality complaints



- **Empower the public to collect data to demonstrate an actual or potential problem by providing**
  - Access to equipment or resources
  - Educating the public about air quality, sensors, and how sensors can/can't be used
  - Educating the public about how to collect high quality data

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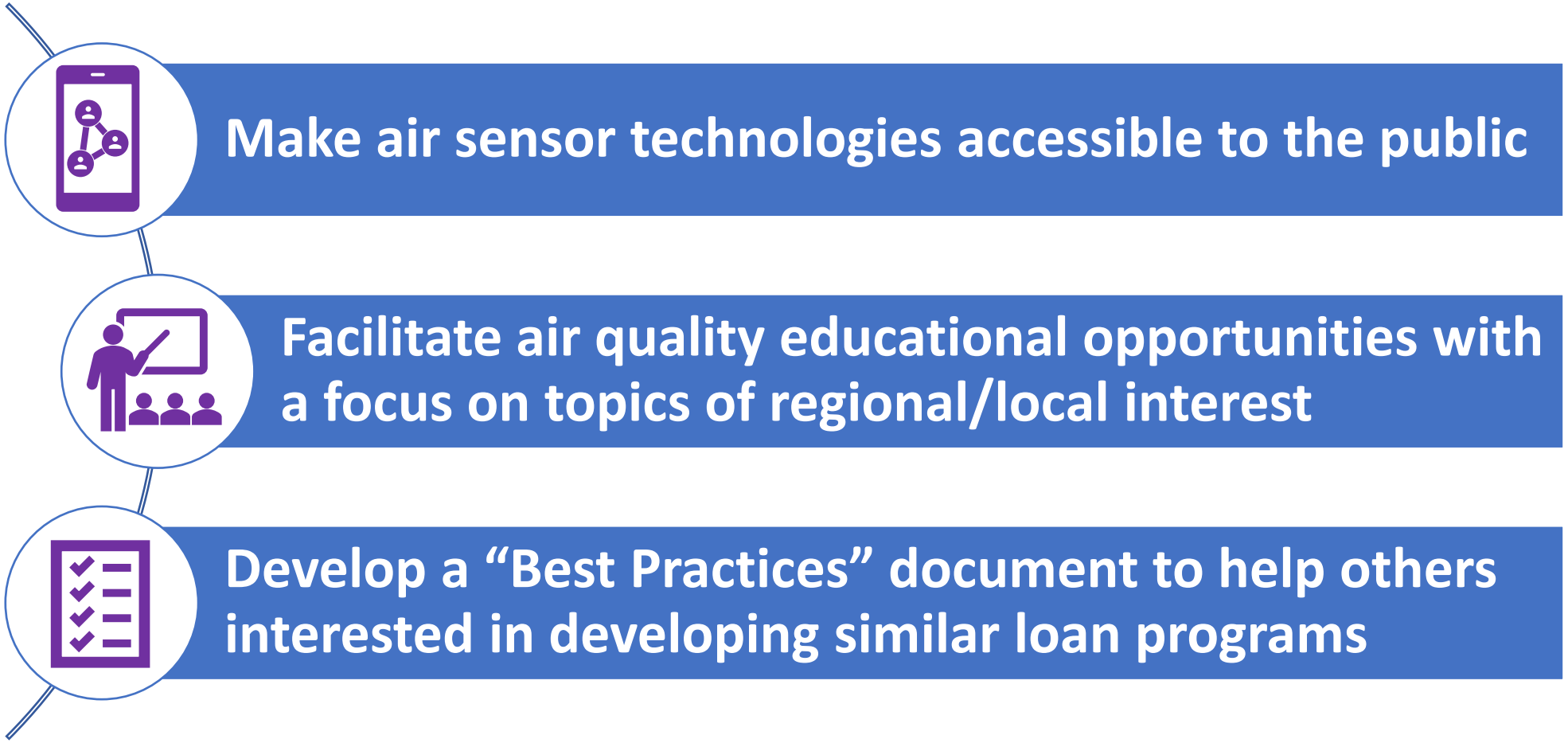
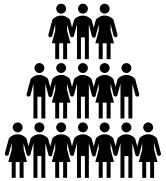
Goals of the Pilot Air Sensor Loan Programs



Approach

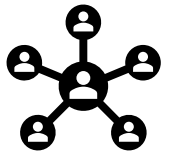
Start

- The Los Angeles Public Library (LAPL) contacted EPA Region 9 (R9) to discuss the idea of starting an air sensor loan program
- R9 applied for and received EPA internal RSTIP* funding to develop a pilot sensor loan program with LAPL



Expand

- EPA Region 5 (R5) and EPA Region 10 (R10) were interested in establishing similar sensor loan programs after learning about the LAPL program
- EPA Regions applied for and received RSTIP* funding to expand sensor loan programs to rural and remote libraries (R5) and Tribal communities (R10)

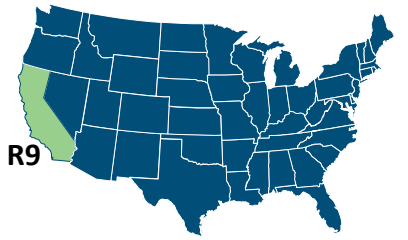


Summarize

- All partners collaborated on summarizing the lessons learned from the pilot projects
- Summary includes recommendations for others considering starting new programs

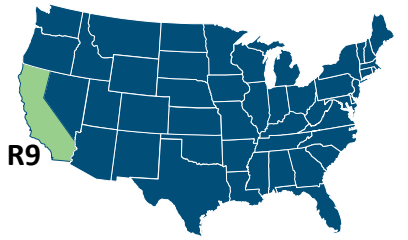
**RSTIP = Regional-State-Tribal Innovation Project*

EPA Region 9 (R9) – Los Angeles Public Library Air Sensor Loan Program



- **Air quality in the Los Angeles (LA) area has improved over the last four decades, but the area still struggles with air pollution**
  - Fine particulate matter ($PM_{2.5}$) is a concern due to health impacts
- **LA Public Library (LAPL) expressed an interest to R9 in**
  - Starting an air sensor loan program and community workshops to increase environmental literacy in the communities they serve
  - Adding sensors to their existing neighborhood science program allowing patrons to check out a sensor like they check out a book
  - Training neighborhood science librarians who would train other branch librarians
- **Sensor loan kits were placed at 21 of the 72 total branches within the LAPL system**

R9 – LAPL
Loan Program Design Considerations



R9 and LAPL expressed an interest in measuring many different types of air pollutants

- User-friendly and reliable sensors were not available for some of the pollutants of interest
- Funds for sensor purchase and replacement were limited so an affordable sensor with reasonable performance, a long lifetime, and no or minimal data costs was preferred

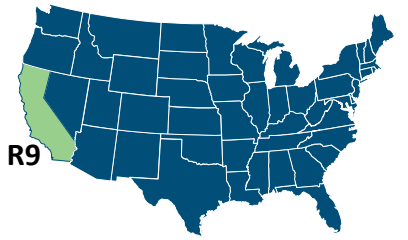
LAPL staff had limited knowledge about air quality and air sensors

- Background information and resource guides were needed to help librarians prepare
- Focusing on one pollutant helped keep the volume of background material manageable

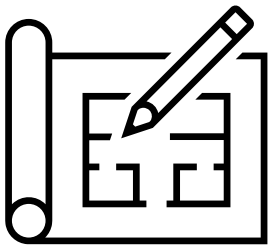
LAPL staff were interested in conducting educational programs at the library

- Hands-on activities were preferred that took 90 minutes or less and facilitated movement
- Handheld sensors allowed for movement, however available options required a cell phone
- Sensors need to be supplied with a cell phone, however privacy concerns needed to be considered since personal and location information could be collected

R9 – LAPL
Loan Program Final Design

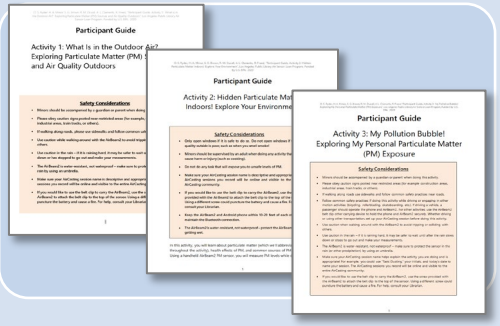


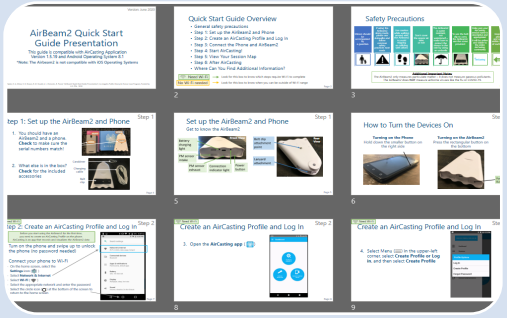
- Focus on measuring $PM_{2.5}$
- Offer a single hand-held sensor type
- Pair the sensor with an Android phone and public WiFi
- Library user accounts would be associated with each sensor/phone pair so that personal information would not be collected
- Educational support resources including lesson plans would be created
- Training would be provided to librarians



R9 – LAPL Air Sensor Loan Program

Program Components





Sensors Technologies

AirBeam2 Sensors (paired with Android phones)

3 Lesson Plans

- Outdoor Air
- Indoor Air
- Personal Exposure

Support Materials

- Slides: Air Quality 101, Advanced Topics on Sensors
- AirBeam2 Quick Start Guide
- Resource Guide
- FAQs

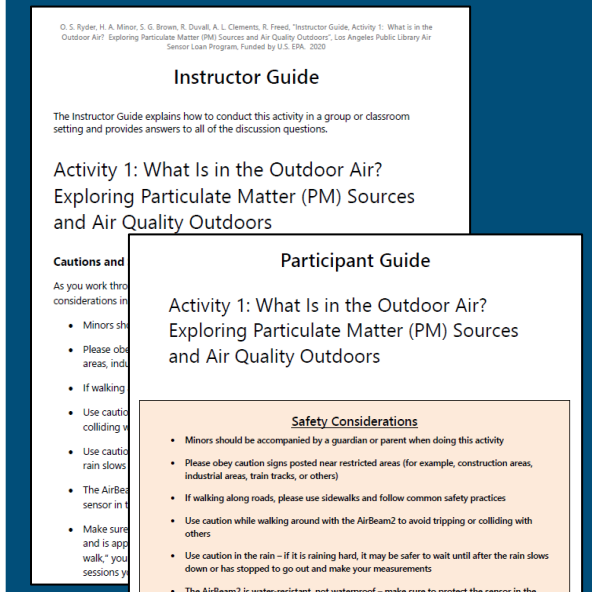
Partner Training

8 hours of virtual training over 3 days for neighborhood science librarians

Contents of Lesson Plans

Activity-centered and adaptable for different audiences and age groups

Instructor & Participant Guide


O. S. Ryder, H. A. Minor, S. G. Brown, R. Duvall, A. L. Clements, R. Freed, "Instructor Guide, Activity 1: What is in the Outdoor Air? Exploring Particulate Matter (PM) Sources and Air Quality Outdoors", Los Angeles Public Library Air Sensor Loan Program, Funded by U.S. EPA. 2020

Instructor Guide

The Instructor Guide explains how to conduct this activity in a group or classroom setting and provides answers to all of the discussion questions.

Activity 1: What Is in the Outdoor Air? Exploring Particulate Matter (PM) Sources and Air Quality Outdoors

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Participant Guide

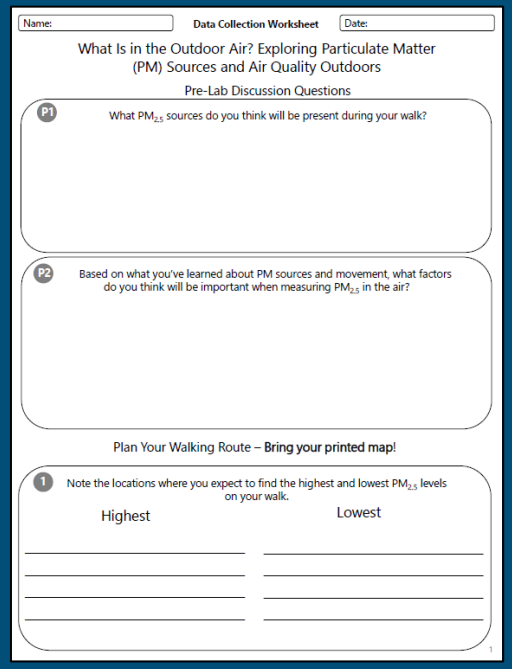
Activity 1: What Is in the Outdoor Air? Exploring Particulate Matter (PM) Sources and Air Quality Outdoors

Safety Considerations

- Minors should be accompanied by a guardian or parent when doing this activity
- Please obey caution signs posted near restricted areas (for example, construction areas, industrial areas, train tracks, or others)
- If walking along roads, please use sidewalks and follow common safety practices
- Use caution while walking around with the AirBeam2 to avoid tripping or colliding with others
- Use caution in the rain – if it is raining hard, it may be safe to wait until after the rain slows down or has stopped to go out and make your measurements
- The AirBeam2 is water-resistant, not waterproof – make sure to protect the sensor in the rain by using an umbrella
- Make sure your AirCasting session name is descriptive and appropriate! The AirCasting sessions you record will be online and visible to the entire AirCasting community.
- If you would like to use the belt clip to carry the AirBeam2, use the screw provided with the AirBeam2 to attach the belt clip to the top of the sensor. Using a different screw could puncture the battery and cause a fire. For help, consult your Librarian.

Introductory Slides

Participant Worksheet


Name: Data Collection Worksheet Date:

What Is in the Outdoor Air? Exploring Particulate Matter (PM) Sources and Air Quality Outdoors

Pre-Lab Discussion Questions

P1 What $PM_{2.5}$ sources do you think will be present during your walk?

P2 Based on what you've learned about PM sources and movement, what factors do you think will be important when measuring $PM_{2.5}$ in the air?

Plan Your Walking Route – **Bring your printed map!**

1 Note the locations where you expect to find the highest and lowest $PM_{2.5}$ levels on your walk.

Highest Lowest

- Worksheet answer key
- Extension activity
- NGSS alignment

NGSS = Next Generation Science Standards

Contents of Support Materials

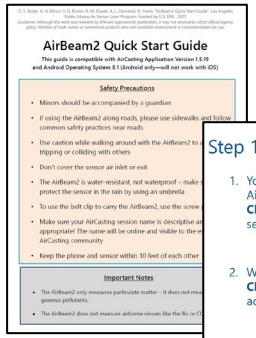
Background information on air pollution, air quality, and air sensors

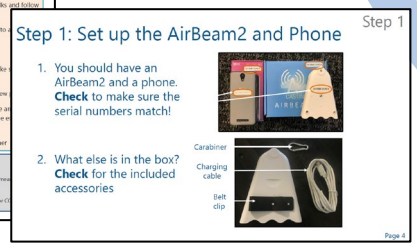
Background Slides

Covers topics such as interpreting evaluation results, collocation, data quality control, and data analysis

Step-by-step instructions on how to set up and run a borrowed sensor. Also includes presentation slides.

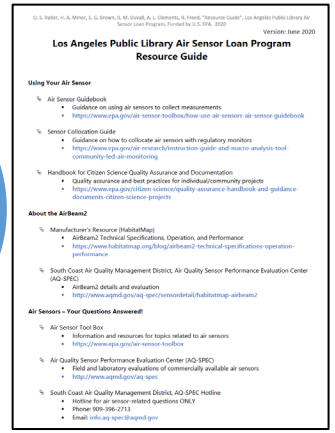
Quick Start Guide





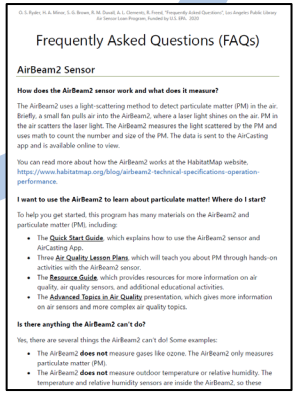
Support Materials

Resource Guide



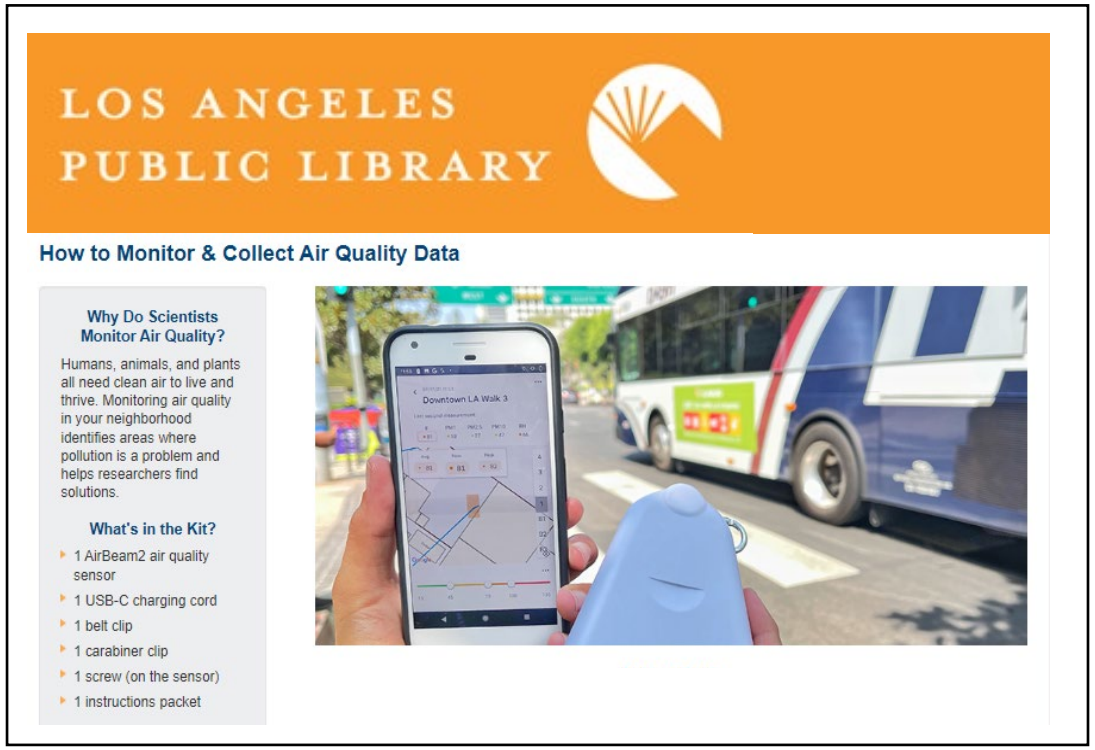
Supplemental information on air sensors, air quality, and air pollution; other educational materials are included

FAQs



Supplemental information with answers to common questions related to air sensors, data collection, and air quality

Case Study: R9 – LAPL Air Sensor Loan Program



Program Website: https://lapl.org/neisci/kits/air-quality

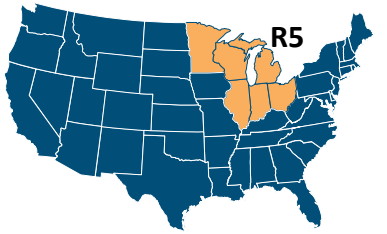
Program implementation

- LAPL integrated air sensor loans as part of their Neighborhood Science (NeiSci) DIY science kits program
- The kit includes an AirBeam2 sensor, necessary sensor accessories, and an instruction guide to help community members measure $PM_{2.5}$

Program expansion

- LAPL also incorporated the Air Quality Flag Program in some branches
- The Library Foundation of Los Angeles agreed to fund the purchase of additional sensors to expand the program to other branches
- Local educators expressed interest in incorporating air sensors into their classrooms and programs prompting LAPL to create a kit for longer-term loans

EPA Region 5 (R5) – Air Sensor Loan Programs for Remote and Rural Locations and an Arboretum



- Remote and rural locations may not have easy access to sensors and educational materials focusing on air quality
- Bayliss Public Library (*Sault Ste. Marie, Michigan*) which serves rural and remote communities, initially expressed interest in air quality education and sensor loans
- Program expanded to include other libraries and an arboretum

Superior Library District
Rural/remote libraries that serve the Eastern Upper Peninsula region of Michigan

L'Anse Area School/ Public Library
Small library in Michigan's Upper Peninsula serving residents in rural and remote communities; program is partnering with the Keweenaw Bay Indian community

Evansville Vanderburgh Public Library
Large public library system in Indiana with multiple locations throughout Vanderburgh County serving urban and rural locations

Morton Arboretum
Provides education for teachers, families, and community members about the importance of trees and other plants; serves the greater Chicago region

R5 – Air Sensor Loan Programs for Remote and Rural Locations and an Arboretum

Program Components

Sensor Technologies

- AirBeam2 Sensors (paired with Android phones)
- PurpleAir Sensors

1 Lesson Plan*

The Power of Plants! How Vegetation can Help Protect Us from Air Pollution

Support Materials

- Slides: Air Quality 101, Advanced Topics on Sensors
- AirBeam2 video*
- AirBeam2 and PurpleAir Quick Start Guide*
- Resource Guide
- FAQs

Partner Training

4 hours of virtual training over 2-days (repeated once to accommodate all partners)

**New material developed for this program*

Case Study: R5 – Bayliss Public Library

Program implementation

- The project initially engaged Bayliss Public Library and the Superior District library, but they quickly recruited other district libraries onto their team
- The program launched at some libraries in the fall of 2021 and others around Earth Day in 2022
- Librarians will lead activities and sensors will be available for check-out
- Libraries have placed special emphasis on programming for children and teens

Program expansion

- The Friends of the Library funded the purchase of additional sensors to expand access

Case Study: R5 – Morton Arboretum

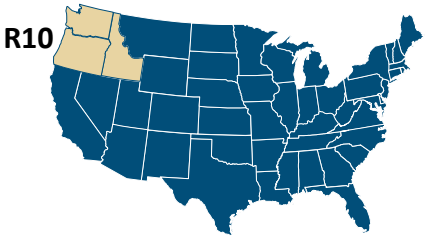
Program implementation

- The Morton Arboretum incorporated their air sensor loans into an existing program that trains educators and lends kits to teachers for classroom use

Program expansion

- The Arboretum created the Vegetative Barrier Toolkit for Schools and Communities by adapting EPA's vegetative barrier lesson plan and created additional curriculum incorporating more information about the types of vegetation that can be used for effective barriers and soil science
- In March 2022, the Arboretum offered a teacher workshop and filled the program to capacity with ~40 educators

EPA Region 10 (R10) – Air Sensor Loan Program in Tribal Communities



- Air quality can be impacted by smoke events such as wildfires, outdoor burning, and residential wood heating
- The public within and near tribal reservations need
  - Access to air sensors to increase spatial coverage and real-time air quality data during periods of smoke
  - Education about air quality and the health impacts of smoke
- Partners include:

Heritage University
Private university located on the Yakama Indian reservation in Washington serving approximately 1,000 students and surrounding community

Institute for Tribal Environmental Professionals (ITEP)
Established in 1992 at Northern Arizona University to strengthen tribal capacity and sovereignty in environmental and natural resource management

Nez Perce Tribe
Federally recognized tribal nation located in north-central Idaho with more than 3,500 members

R10 – Air Sensor Loan Program in Tribal Communities

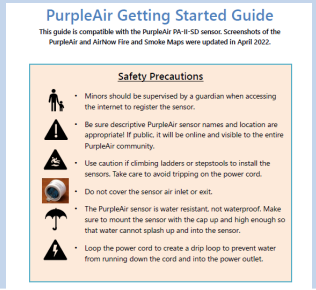
Program Components

Sensor Technologies

PurpleAir Sensors

1 Lesson Plan*

Is that Smoke Affecting Me? Using crowdsourced public data to explore air quality during smoke events



Support Materials

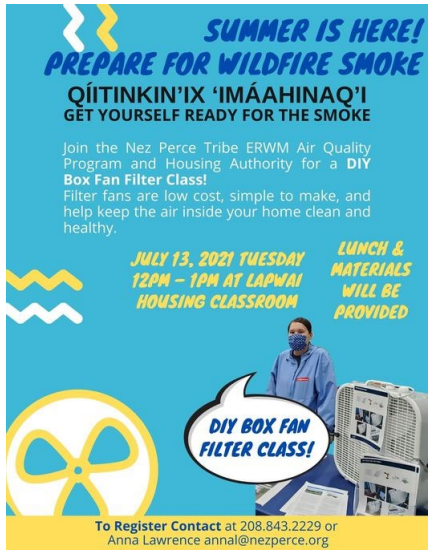
- Slides: Air Quality 101, Advanced Topics on Sensors
- PurpleAir Quick Start Guide*
- Resource Guide
- FAQs

Partner Training

4 hours of virtual training over 2-days

**New material developed for this program*

Case Study: R10 – Libraries on the Nez Perce Reservation



Program implementation

- PurpleAir sensors were installed at 10 libraries on the Nez Perce Reservation
- Librarians were trained as air sensor and air quality educators for their local communities

Program expansion

- Librarians also voluntarily incorporated the Air Quality Flag Program, do-it-yourself box fan air filter demonstrations and kits, and a moisture meter loan program for firewood testing
- The Tribe plans to expand their program by incorporating portable $PM_{2.5}$, and possibly radon, sensor loans for more hands-on outreach
- The Tribe produced smoke ready guidance tailored to the community in Nimipuutimt, the Nez Perce language

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Challenges

Pivots

Challenges	Pivots
Launch of the programs began during COVID making in-person training impossible	Training plans were changed and conducted virtually, spaced out over several days
Difficult to virtually show people how to use a sensor and troubleshoot problems	Sensors were shipped before training and a data collection walk was added to the schedule
Some equipment failed (e.g., did not respond or just reported zeros) out of the box	Failures were covered under manufacturers warranty and were replaced
The budget for the LAPL program did not include accessories (e.g., screen protectors)	LAPL purchased some supplies and similar expenses were added to future budgets
Patron surveys required several layers of approval which took a long time	Feedback and user stories were informally collected (e.g., conversations, focus groups)

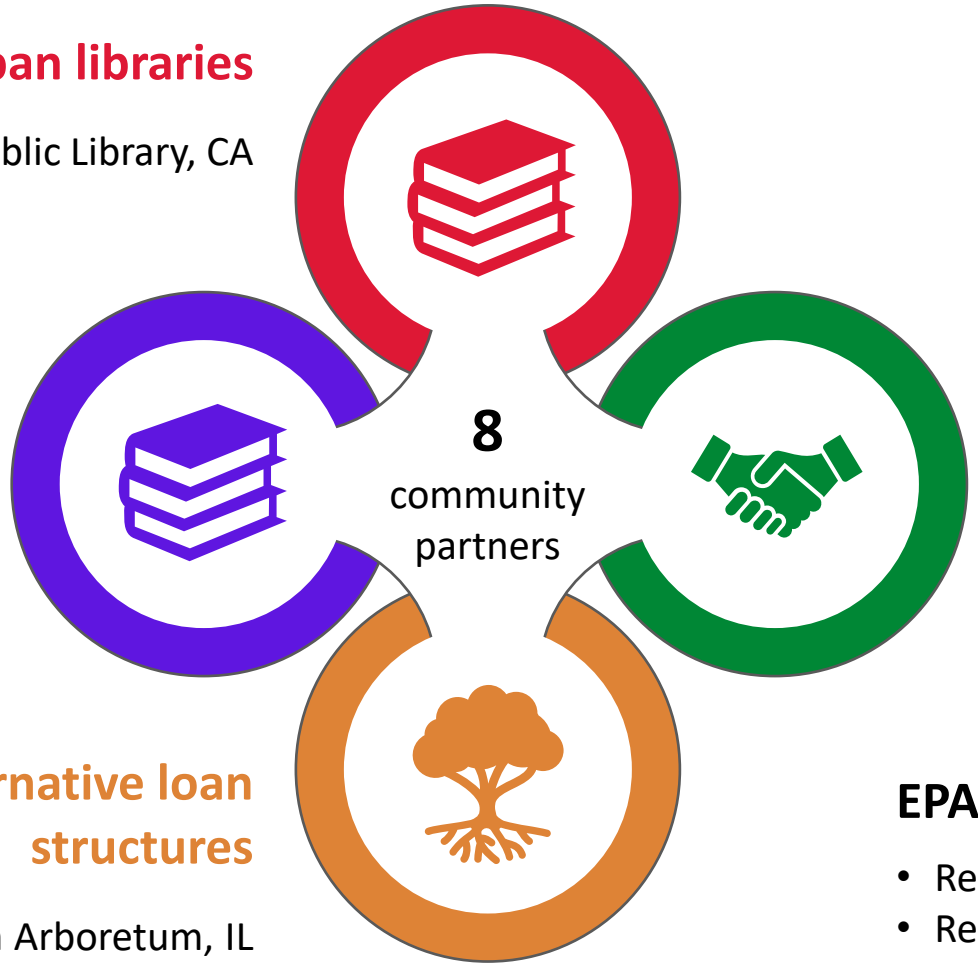
Results: Summary of Partnerships

Urban libraries

- Los Angeles Public Library, CA

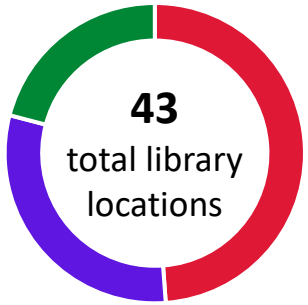
Rural & remote libraries

- Bayliss Public Library & Superior District Library System, MI
- Evansville Vanderburgh Public Library, IN
- L'Anse Area School/Public Library, MI



Tribal communities

- Nez Perce Tribe, ID
- Heritage University on Yakama Reservation, WA
- Institute for Tribal Environmental Professionals (ITEP), AZ



Alternative loan structures

- The Morton Arboretum, IL

EPA participants

- Region 5
- Region 9
- Region 10
- Office of Research and Development

Results: Benefits

All programs have either launched are in the process of launching soon*

User Benefits

- Increased access to
  - Sensor technologies
  - Educational materials to learn and teach about air quality and air sensors

Partner Benefits

- Established loan programs in urban, rural, and tribal communities
- Built capacity to be community resource about air quality and air sensors

EPA Benefits

- Advanced understanding of air sensors for public engagement
- Fostered positive connections within EPA and with partners and their wider communities

**COVID restrictions, staffing shortages and other reasons have contributed to delays*

Impact: Partner Quotes

R9 Program: "Serving the largest city in a state threatened by more and more intense wildfires, Los Angeles Public Library is grateful for this important partnership with EPA. This critical and timely collaboration not only empowered our librarians with the knowledge needed to develop effective air quality educational programs, but also provided the library system with low-cost air quality sensor loaning kits for patrons to check out for free. By combining information learned at library programs with firsthand experience of monitoring and interpreting air quality in and outside of their homes, **Angelenos will be able to make informed decisions for their health and well-being**." – *Los Angeles Public Library, Neighborhood Science Program Lead Vivienne Byrd*

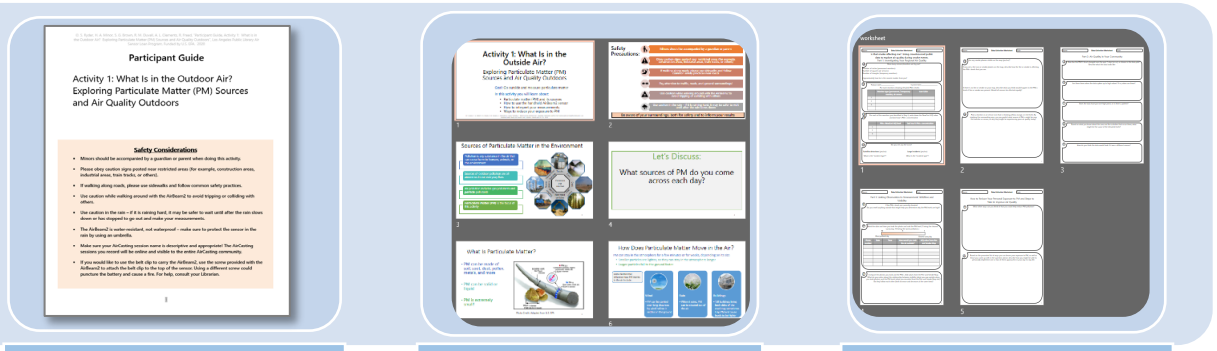
R5 Program: "We launched the Airbeam2 sensors on April 22nd at Howell Wetlands' Earth Day celebration. I did a session along the wetland paths prior to the event so that I could show individuals what the finished product looked like and what the current quality of air ratings were. This was very helpful and **people found the readings fascinating**. Some expressed worry about damaging the sensors or not being able to work them correctly. I directed them to the information that comes with the kits. Four of the five sensors I took with me to the event got checked out." – *Evansville Vandenburg Public Library Katie Reineke*

R10 Program: "We are really honored and so thankful that you all reached out to us last fall. Synergy! This project has allowed us to take our library partnership deeper and really **support communities across the Reservation to increase awareness and action around smoke**. It's one of the best things to come from 2020 in my book." – *Nez Perce Tribe Air Quality Program, Environmental Outreach Specialist Johna Boulafentis*

Outcome: New Resources

Five Hands-On Lesson Plans

1. What is in the Outdoor Air?
2. Hidden Particulate Matter Indoors!
3. My Pollution Bubble!
4. The Power of Plants! (*coming soon*)
5. Is that Smoke Affecting Me? (*coming soon*)



Instructor & Participant Guide
- Information to help instructors lead the lesson
- Answers to questions
- Additional tips for participants

Introductory Slides
- Slides instructors can use to introduce the lesson and key concepts
- Useful for independent learners to review prior to the lesson

Participant Worksheet
Printable pages with space for participants to fill in their answers to questions

Technology Resources

Quick Start Guide
Step-by-step instructions on how to set up and run a borrowed AirBeam2 or PurpleAir sensor

Quick Start Guide Presentation
- Slides on how to set up and run a borrowed AirBeam2 or PurpleAir sensor
- A video on the AirBeam2

FAQ Document
Supplemental information with answers to common questions related to air sensors, data collection, and air quality

Additional Resources

Resource Guide
Supplemental information on air sensors, air quality, and air pollution; other educational materials are included

Air Quality 101 Presentation
Background information on air pollution, air quality, and air sensors

Advanced Topics in Air Sensor Use
Slides on interpreting evaluation results, collocation, data quality control, and data analysis

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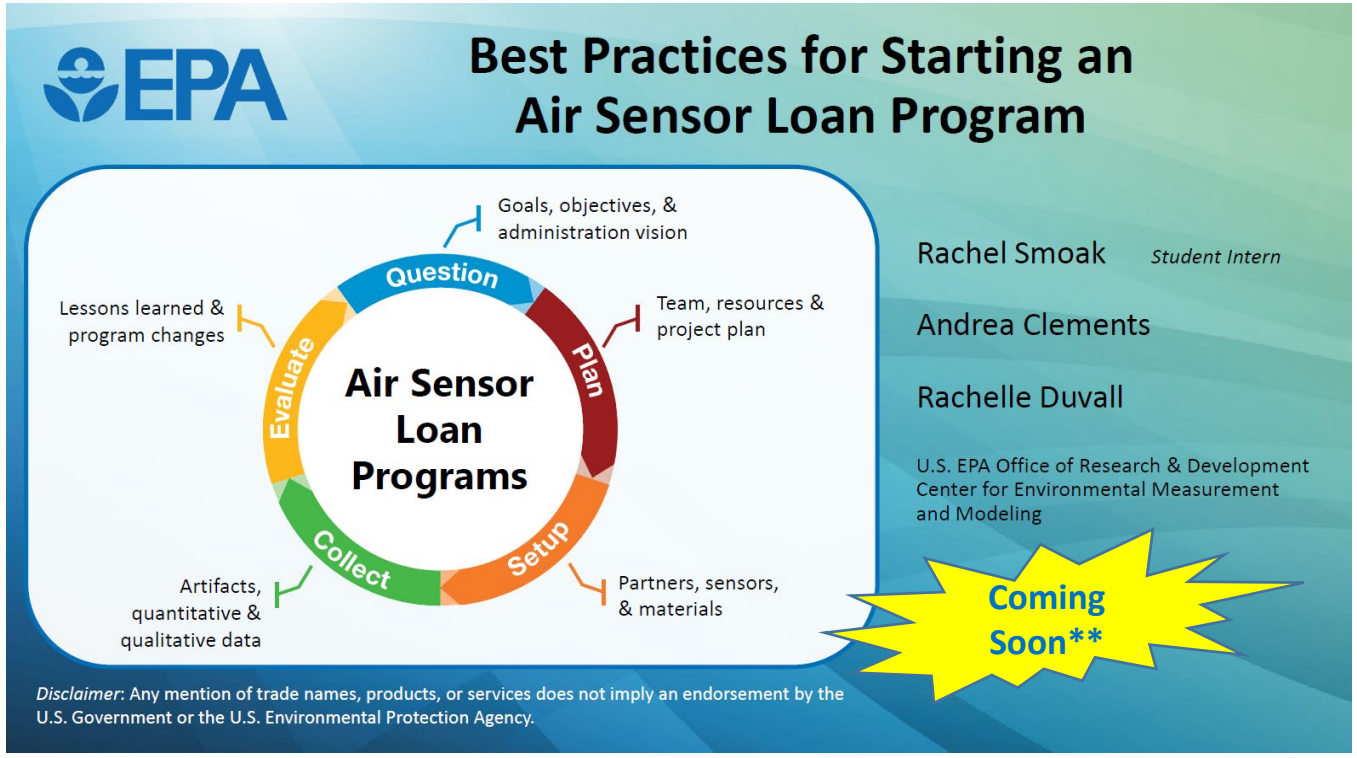
Outcome: Best Practices for Starting an Air Sensor Loan Program

- ✓ **Walks through how to establish an air sensor loan program using EPA's Air Sensor Guidebook planning wheel**
- ✓ **Includes important topics such as identifying the project purpose, building a team, developing a project plan, selecting equipment, collecting data, sharing findings and resources, and more!**



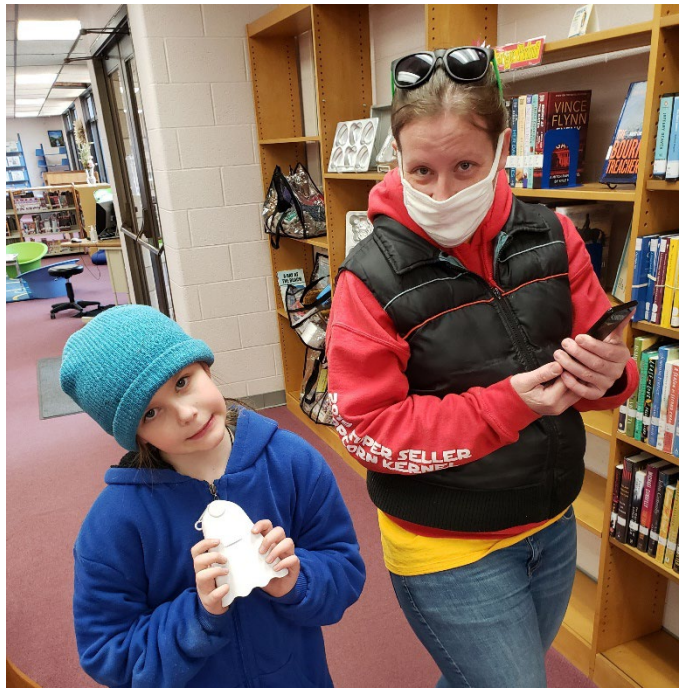
Target Audience

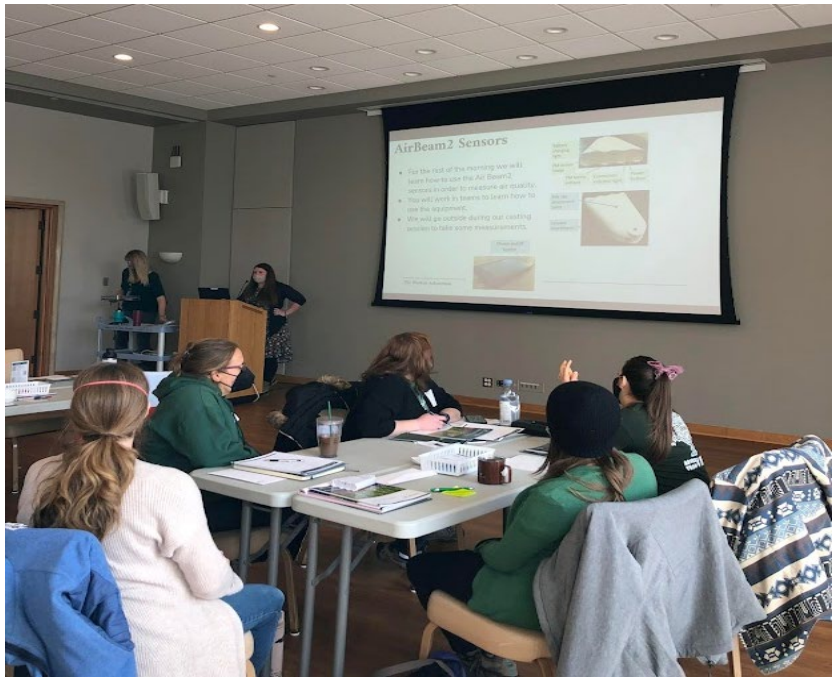
- Educators – schools, libraries, after-school programs, community organizations, etc.
- State/local/tribal air quality agencies
- Government agencies
- Academia
- Any group interested in starting an air sensor loan program

***Slides will be shared on the Air Sensor Toolbox Webpage*

Impact: General

- Loan programs **put sensors in the hands of individuals** who might not know about or otherwise have the opportunity to access this technology
- The resources developed to support these programs have **improved the environmental literacy** of our partners helping them to offer education and programing within their communities





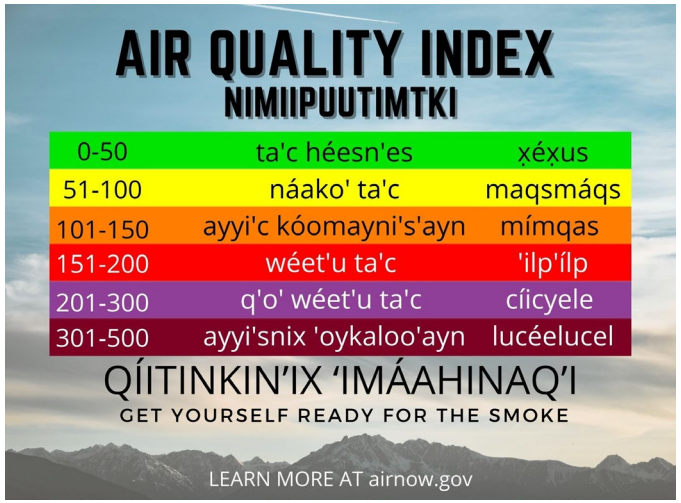
Impact: General

- Programs allow groups or individuals to
  - **Learn** about air quality and sensors
  - **Explore pollution sources** within their communities or homes
  - Explore ways in which they can **reduce exposure to air pollution**
- The **lesson plans are publicly available** and can be used and adapted by educators
- The lessons learned and resources will **make it easier for others to develop similar programs**

https://www.epa.gov/air-sensor-toolbox/educational-resources-related-air-sensor-technology

Impact: Partners

- The positive connections developed with partners will ensure the **programs are sustainable** over time
- **Partners have tailored resources** for their own needs (e.g., translations into native languages, supplementing with more in-depth information)
- Partners have **implemented additional programming** (e.g., educator training sessions, air quality flag program) where they saw opportunity and need



Translation of Air Quality Index (AQI) chart by the Nez Perce Tribe

New curriculum by the Morton Arboretum

Impact: EPA

- Programs have **informed the development and design** of ARP* funded loan programs currently being established by EPA regions
- Efforts have **advanced EPA's research priorities** in the areas of air quality, environmental justice, and participatory science

**ARP = American Rescue Plan*

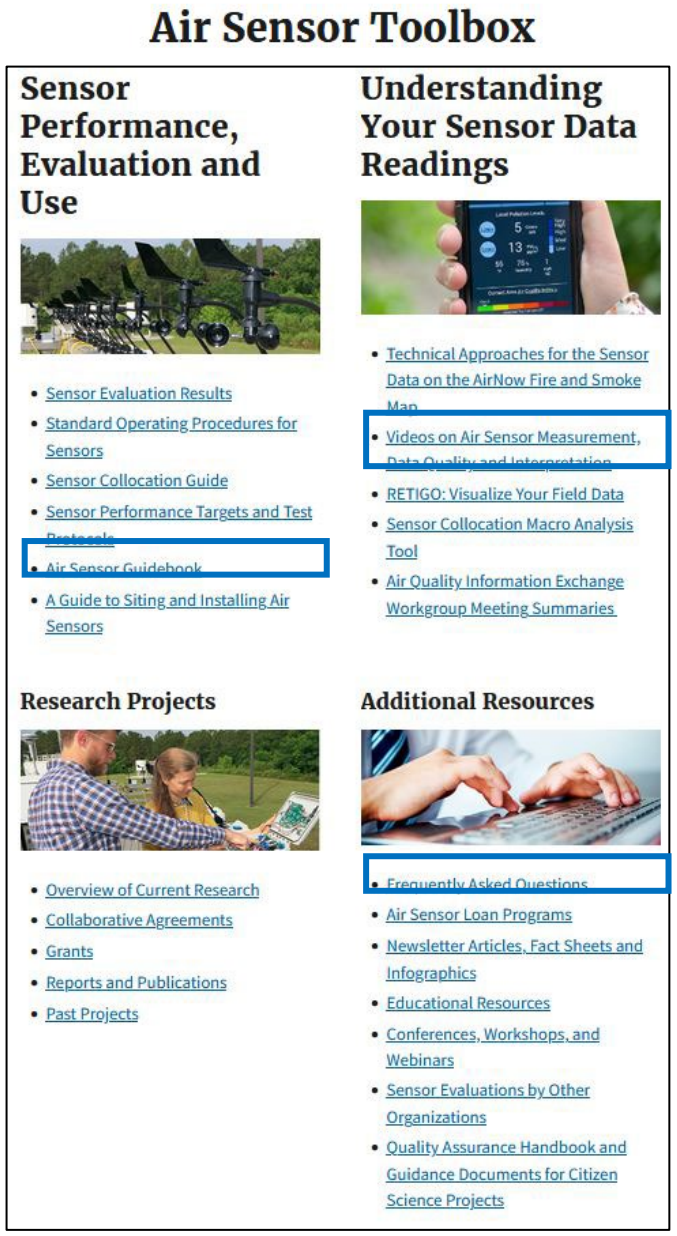
Take Home Messages

- ORD, in conjunction with EPA Regions 5, 9, and 10, and a variety of local partners, have established air sensor loan pilot programs which have
  - Facilitated access to sensor technologies
  - Increased environmental awareness and literacy
  - Generated numerous resources
  - Inspired program expansion and additional programing
  - Provided a model for similar programs to be established
- Air sensor loan programs are currently available in select locations around the U.S., and we anticipate new programs will be established in the future

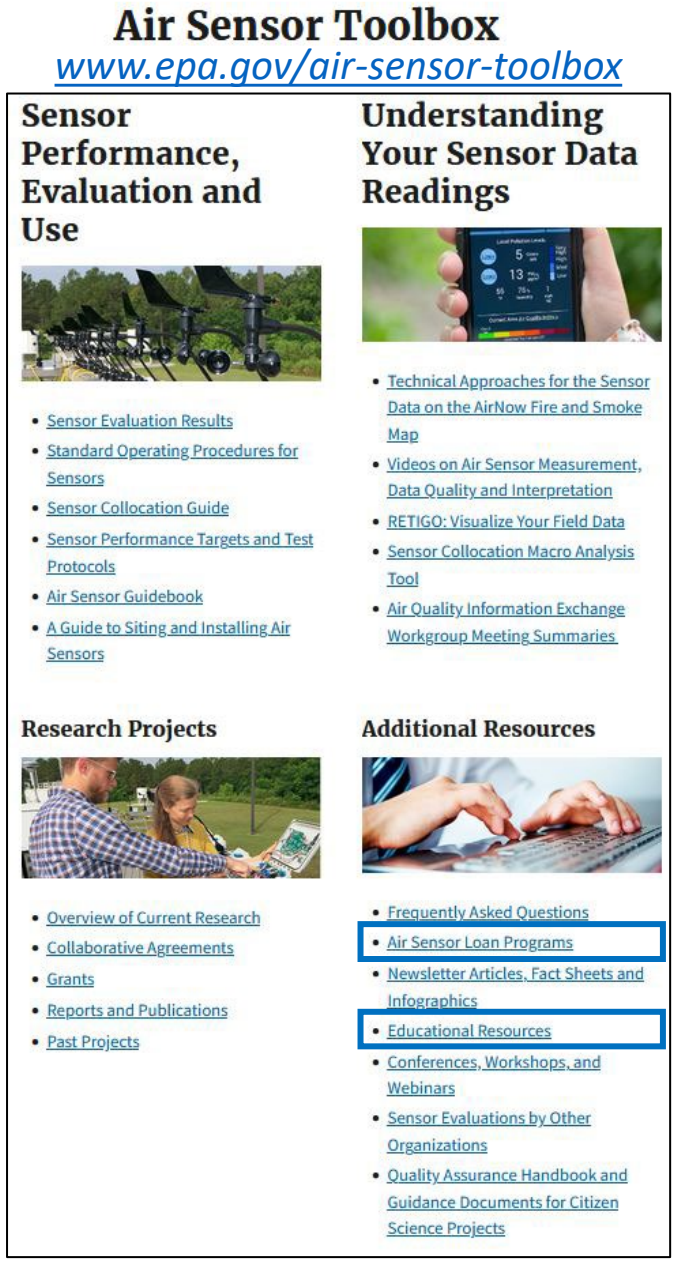
Resources: General Air Sensor Information

- Air Sensor Video Series
- Air Sensor Guidebook
- Frequently Asked Questions
- Introduction to Air Sensors Presentation

Air Sensor Toolbox: www.epa.gov/air-sensor-toolbox



Resources: Air Sensor Loan Programs



Air Sensor Loan Programs

Educational Resources

- Hands-On Lesson Plans
- Quick Start Guides
  - AirBeam2
  - PurpleAir (*posting soon*)
- AirBeam2 Video
- Air Quality 101 Presentation
- Air Sensor Advanced Topics Presentation
- Resource Guide (*posting soon*)
- FAQs (*posting soon*)

Acknowledgements

EPA

R5 – Sheila Batka, Megan Gavin, Ben Weiss
R9 – Ryder Freed, Katie Stewart, Ken Davidson
R10 – Christi Duboiski, India Young, Sarah Waldo
ORD – Rachel Smoak (*student intern*)

Contractor

Sonoma Technology – Olivia Ryder, Hilary Minor, Steve Brown

Urban Libraries

Los Angeles Public Library – Vivienne Byrd

Rural and Remote Libraries

Bayliss Public Library and Superior District Library System – Lisa Waskin (Superior District); Pam Flood, Sabrina Neveu (Bayliss); Emily Hyde (Pickford); Jane French (Les Cheneaux); Megan Stefanski (DeTour)
Evansville Vanderburgh Public Library – Charles Sutton, Andrea Kappler, Katie Reineke
L'Anse Area School/Public Library – Sonya Evans, Susan Tollefson (L'Anse); Jane Kahkonen (Keweenaw Bay Indian Community)

Alternative Loan Structures

The Morton Arboretum – Meghan Wiesbrock

Tribal Communities

Institute for Tribal Environmental Professionals at Northern Arizona University
Mansel A. Nelson, Josie Kamkoff

Heritage University
Jessica L. Black (Center for Indigenous Health, Culture & the Environment)
Dalia Wolftail, Darren Olney, Agnes Meninick, Lillie Wesley (Science Department)

Nez Perce Tribe Air Quality Program
Johna Boulafentis, Mary Fauci

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