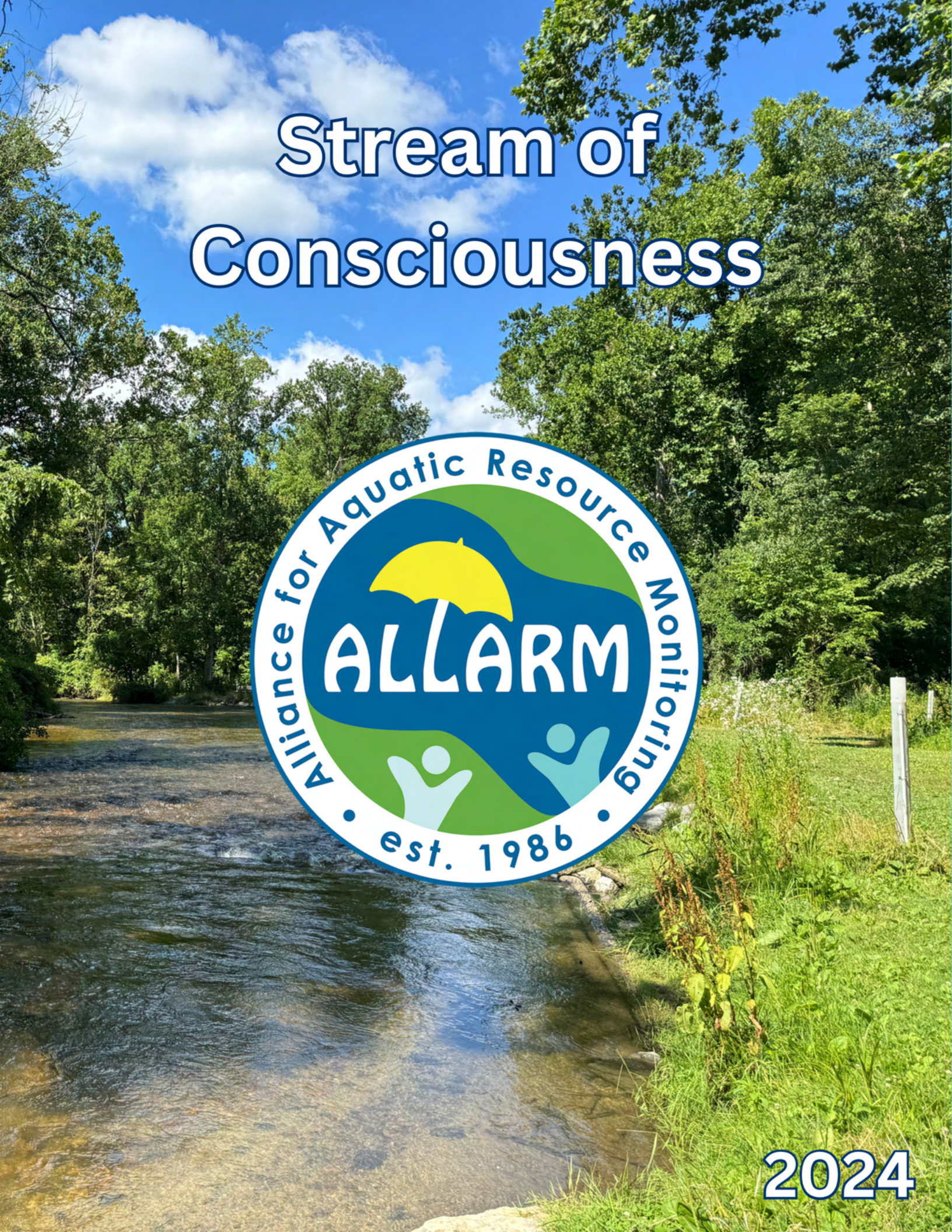
Stream of Consciousness



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Alliance for Aquatic Resource Monitoring

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The Intersection of Monitoring Efforts & Progress Towards Upcoming Bay Goals: The Concept of Shared Responsibility

By: Emma Spinelli '25

With 2024 well on its way, it is hard to miss the upcoming deadlines to try to meet Chesapeake Bay Goals. Pennsylvania, Virginia, West Virginia, Maryland, Delaware, New York, and the District of Columbia (D.C.), make up the Chesapeake Bay Watershed, creating a wide geographic region for ALLARM and other communities and actors in the area to try to make progress in reducing pollution levels and restoring watersheds. The Chesapeake Bay region has long been in the process of trying to meet goals of pollution reductions and watershed restoration efforts through different agreements between states and the Environmental Protection Agency (EPA) dating back to 1983 and efforts to set different pollution load caps.

Past efforts had fallen short, resulting in the current structure in place created by Executive Order 13508 and corresponding with the Chesapeake Bay total maximum daily load (TMDL). This executive order was put into place during Barack Obama's presidency and focuses on Chesapeake Bay protection and restoration alongside enforcement by the EPA with the expectation of full implementation of these goals by 2025 and milestones to be met in two-year increments. Capping pollutants had been targeted as an area of concern because of the high levels of phosphorous, nitrogen, and sediment pollution found throughout the region impairing the Bay's health. The executive order created a necessary foundation for the Bay-wide TMDL which specifies the maximum amount of pollution that will allow the waterbodies to still function healthily and support their designated uses. This 'pollution diet,' as it is also known, can then be used to see what measures need to be taken to reduce pollution loads to these levels.

Involvement of Diverse Stakeholders

The strategies for achieving the key outcomes of the Bay Goals were very intentional. Not only did they emphasize the implementation of efforts, but also the diversification of efforts, increasing community engagement, educating stakeholders, and encouraging advocacy for restoration efforts. The structure of many different actors interacting at all different levels to try to monitor and foster progress collaboratively is a key asset that the Chesapeake Bay region has utilized. Because of the shortcomings of past efforts, this strategy sets out to capture new expertise and practices through collaboration that might have been falling through the cracks before. Incorporation of local government plans, diverse partners,

non-profit organizations and EPA input and oversight makes the network between stakeholders much stronger with much more potential for change.

ALLARM's connection to larger efforts of tracking progress and reaching 2025 Chesapeake Bay Goals has positioned the non-profit as a significant contributor to efforts at compiling data and embracing more community engagement in data collection, interpretation and action based on volunteers' findings on the health of waters. As part of the Chesapeake Monitoring Cooperative (CMC), ALLARM's volunteers provide and upload critical data to the cooperative's database which then goes to the Chesapeake Bay Program (CBP). Their ChesapeakeStat data then is used as a tracking tool by the EPA to uncover patterns in data points and help assess how to best accomplish upcoming goals. This along with BayTAS (tracking and accounting visualization system), assessments via milestones, Watershed Implementation Plans (WIPs), County Action Plans (CAPs), and federal agency progress paint the fuller picture of our watershed system's health and progress being made.

Shared Responsibility as an Ideal & Goal

Checkpoints, milestones and other assessments have indicated that we still have substantial progress to make in achieving some of our goals, especially in Pennsylvania. The work being done to reduce pollution loads encompasses efforts by multiple sectors and entities through both remediating harms already caused, and through the prevention of further harm.

Key to rhetoric in meeting Bay Goals has been the concept of 'shared responsibility': the idea that the work to clean up our waters falls not just on the EPA or any specific individual or entity, but rather the community of the larger watershed as a whole. This concept has fostered a space for many partnerships as demonstrated at a large level via CBP Partnerships and at the smaller scale with the more locally centered partnerships that ALLARM has within its domain.

The CMC meets frequently to ensure the continuation of data collection and use.

Key outcomes for Bay Goals encompass this idea of relying on a united front to restore and clean watersheds with implementation of measures to meet Chesapeake Bay TMDLs. Having a diverse, eager and innovative effort base facilitates idea creation for Best Management Practices (BMPs) and by creating a community-based approach, there is more room for collaboration on efforts in WIPs and CAPs that are crucial to progress being made. This is why the work that volunteers do is so important. Without our volunteers, important data points, stories, and ideas would be missing from the overall picture of the Bay's health. Not only is shared responsibility about non-governmental organizations and government coming together, it also gives communities a platform to address issues that they are concerned about.

2025 is quickly approaching and with the data collection and interpretation that volunteer monitors do and the work that our partners and colleagues take on to compile findings, we can better see overall trends present within our shared watershed. While we will likely fall short of the 2025 goals initially set, the progress made is not insignificant, and all of these different actors are contributing to assessing what strategies have been working well and in what areas we need more attention or more local knowledge-based solutions to better improve conditions. The incorporation of communities is critical to furthering progress and our volunteers are at the heart of this. Your contributions make all the difference.

EPA's Equity Action Plans and the Role of Participatory Science as a Strategy towards Equity

By: Michelle Hom '24

On January 21, 2021, Executive Order 13985, released under President Biden, emphasized its goal to help undeserved groups overcome environmental barriers by improving the framework of federal agencies to better achieve equity (Biden 2021). Equity is defined as all community members having equal access to resources including public policy and environmental benefits (U.S. EPA 2022, pp. 3). Actions for federal government workers included increasing engagement with historically underrepresented groups and creating an Equitable Data Working Group to have more data representative of underserved groups. Each federal agency, including the Environmental Protection Agency (EPA), began publishing equity action plans annually starting in 2022 in response to this order (Biden, 2023). While progress has been made since the 2022 Equity Action Plan, one priority action that remained in

the 2022 and 2023 action plans was the importance of community-based participatory science as a strategy toward achieving equity. Once termed citizen science by the EPA, community-based participatory science is defined as "scientific research designed, implemented, and used by the community, often in collaboration with scientists" (U.S. EPA 2024). Participatory science provides underserved community members the platform to collaborate with federal agencies and tackle the environmental challenges that have most impacted their area. By participating in community-based science, community members strengthen their sense of place while also increasing their scientific literacy and access to data. Members can use these tools for future programs and to empower their community to reshape local to federal policies. All communities should have access to community science resources and tools. However, following the release of the 2023 Equity Action Plan and the creation of future equity plans, underserved communities should be the top priority for EPA projects and be given additional support to enable them to fully participate in society economically and socially. This is how equity will be better achieved.

Progress from the 2022-2023 Equity Action Plans

In the 2022 EPA Equity Action Plan, community science was listed under priority action #5. This equity plan creates a solid foundation and shows the developing stages of participatory science projects. Under strategies for improvements, an emphasis was placed on the need to provide more resources including grant funding, staff training, and other tools such as maps and tutorials. In addition, under limitations and barriers, the EPA focuses on the challenges of not having adequate community data and cultural concerns about Indigenous groups, including sacred parts of the culture being spread publicly by the federal agencies (U.S. EPA, 2022, pp. 16-17).

The 2023 EPA Equity Action Plan showed major progress in comparison to the 2022 plan. A new fourth principle of "advancing justice and equity" was incorporated in addition to "follow the science, follow the law, and be transparent" (U.S. EPA, 2024, pp. 1). Community-based participatory science was listed as priority action #7 and emphasized the importance of place-based connections for the communities in relation to their projects. Barriers listed included the need to create hubs or centers for participatory science along with more technical and financial tools. In addition, a new section on examples of current successful community science programs across the country was included. One example included the Chesapeake Monitoring Cooperative (CMC), which ALLARM is a member of, as a group that has prioritized diversity, equity, inclusion, and justice (DEIJ) in their protocols. Another example provided was the Pleasantville Community Air Monitoring

program based in Houston, Texas which is entirely community led and designed to allow members to decide where to place monitoring equipment (U.S. EPA, 2024, pp. 30-31).

The Importance of Environmental Justice and Sense of Place within Participatory Science

Community members have a unique, localized perspective about the environmental conditions they are most impacted by. However, to overcome the environmental barriers and allow communities to engage with local policy , federal agencies need to provide underserved community members with the proper tools and resources to enable them to deconstruct the existing power structures and to motivate action. The increased collaboration between federal agencies and historically underrepresented members puts scientists and community members on an equal playing field (Pederson et al. 2022). This also pinpoints the exact locations from where scientists should base their projects and avoids being too small or too large of a monitoring scale (Wyeth et al. 2019). It is essential to include community members during all stages of a project from developing the research question to the implementation of the protocol and handing the project over for community members' involvement (Pandya 2012). By following these steps and looking at the following study examples below, equity outcomes can be better incorporated into other communities, especially those that are underserved.

A good example of environmental justice, or the fair treatment and equal involvement of all people regardless of their background for improved legislation, being a core piece of a participatory science project is the community-engaged research that took place in Proctor Creek in Atlanta, Georgia (Johnson & Jelks 2023, pp. 8). Atlanta is a prime example of a city with a large portion of low-income and minority community members that do not have access to urban ecosystem research.

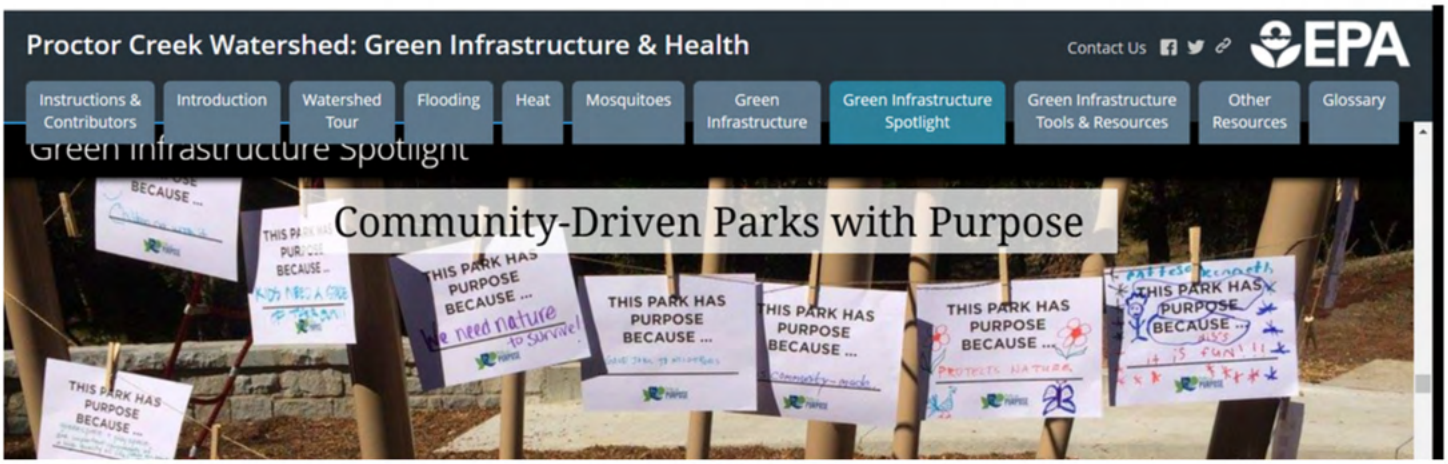


Image credit: Screenshot taken from the EPA's Proctor Creek Story Map: https://epa.maps.arcgis.com/

To resolve this issue, multiple stakeholders including residents, college students, and members of the Urban Waters Federal Partnership (UFWP) collaborated with the United States Fish and Wildlife Service (USFWS) to monitor the ecological health of Proctor Creek at 11 sites (Johnson & Jelks 2023, pp. 1). Environmental justice-focused efforts included participant recruitment which was open to all community members via advertisements and word of mouth. Community members were paired with a scientist during equipment training and each group went at the pace that best suited the community member. The greatest effort towards environmental justice included the UWFP protecting the data collected from the research study to prevent gentrification of the area from real estate agencies. Protection avoided ecological damage to the site as well. After the project, USFWS passed down the equipment to the Georgia Institute of Technology to continue the monitoring efforts without federal assistance (Johnson & Jelks 2023, pp. 9). Trainings and courses for students and community members have since been hosted by Georgia Tech and the West Atlanta Watershed Alliance.

An example focusing on place-based participatory science, a form of education that increases the connection between the person and the location being studied, is the interviews conducted with the volunteer scientists of the Coastal Observation and Seabird Survey Team (COASST) based in Washington state (Haywood 2014). Each member of the team is assigned their own beach and is tasked with identifying and cleaning up marine bird carcasses. Gathering data allows the marine ecosystem to be maintained and protected. The interview questions, which were centered around place-based learning, quickly showed that three quarters of the volunteers, or 53 out of the 79 interviewees, developed a strong sense of place after repeatedly monitoring and collecting data for their site. This was further seen as 46% of the interviewees felt that contributing to the program data was a form of protecting their place and the ecosystem at large (Haywood et al. 2016, pp. 480-481). Additional outcomes included personal investment or time spent on their site along with site-specific knowledge or seeing detailed changes over time.

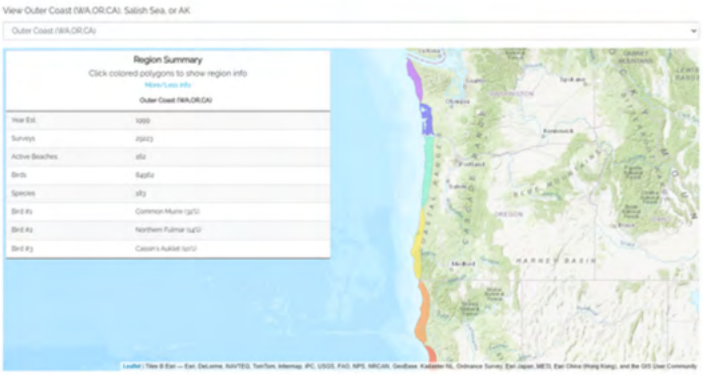


Image credit: modified from COASST: Explore Data

To learn more about COASST and the data being collected, find them at https://coasst.org/

Conclusion

The Proctor Creek example demonstrates how the EPA can assist and uplift underserved communities through an environmental justice lens while the COASST interviews emphasize the importance of integrating a sense of place within community science. Combining these two perspectives is critical in creating future EPA Equity Plans and improving and establishing more participatory science projects throughout the country. However, future projects and studies should integrate and assess the equity outcomes for a community to measure the impacts over a long period of time. Both examples and the need for long-term equity assessments can play a role in advancing the other priority actions listed within the 2023 Equity Action Plan. This includes re-allocating the budget for more participatory science projects. Overall, community members can build their scientific literacy and data skills and become stewards of their local land if the EPA continues to increase the amount of funding and assistance provided to community science projects.

Works Cited:

Biden, Joseph R JR. (2021). *Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government*. The White House. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government/

Biden, Joseph R JR. (2023).*Executive Order on Further Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (2).* The White House. https://www.whitehouse.gov/briefing-room/presidential-actions/2023/02/16/executive-order-on-further-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government/

Haywood, B.K. A "Sense of Place" in Public Participation in Scientific Research. (2014). *Science Education: Wiley Online Library*. 98(1). 64-83. DOI 10.1002/sce.21087

Haywood, B.K., Parrish, J.K, & Dolliver, J. (2016). Place-based and data-rich citizen science as a precursor for conservation action. *Conservation Biology.* 30(3). 476-486. DOI:10.11/cobi.12702

Johnson, T. & Jelks, N.O. (2023). Implementing community-engaged ecological research in Proctor Creek, an urban watershed in Atlanta, Georgia, USA. *Ecological Applications.* 33(5). 1-11. https://doi.org/10.1002/eap.2792

Pandya, R.E. (2012). A framework for engaging diverse communities in citizen science in the US. The Ecological Society of America. 10(6). 314-317, doi:10.1890/120007

Pederson, M., Wood, G.E.R., Fernes, P.K., Rosas, L.G., Banchoff, A., & King, A.C. (2022). The "Our Voice Method": Participatory Action Citizen Science Research to Advance Behavioral Health and health Equity Outcomes. *International Journal of Environmental Research and Public Health*. 19 (14733). 1-16. https://doi.org/10.3390/ijerph192214773

U.S. Environmental Protection Agency. (2022). *E.O. 13985 Equity Action Plan: U.S. Environmental Protection Agency April 2022*. Washington, D.C. https://www.epa.gov/system/files/documents/2022-04/epa_equityactionplan_april2022_508.pdf

U.S. Environmental Protection Agency. (2024). *Equity Action Plan: U.S. Environmental Protection Agency February 14th, 2024*. Washington, D.C. https://www.epa.gov/system/files/documents/2024-02/epa-2023-equity-action-plan.pdf

Wyeth, G. Paddock, L.C., Parker, A., Glicksman, R.L., & Williams, J. (2019). The Impact of Citizen Science in the United States. *Environmental Law Institute*. 10237-10263.

Data Ethics in Participatory Science

By: Prerana Patil '24

As data collection has increased over the past decade, data management has become a ubiquitous need for companies and organizations. Simply put, more data is being collected all the time and understanding how to deal with that enormous amount of information is a focus of many institutions. Still, fewer institutions are thinking about data ethics, the moral considerations for how to keep data safe, use it responsibly and ensure access to data (Atenas et al. 2023). Data ethics is a wide-ranging topic with a lot of factors: What is the structure of data collection? Who oversees data governance? Who has access to data? How do we credit data collectors while respecting their privacy? Should data collectors be paid? Rasmussen et al. 2019 asks the cutting: "is it ethical to sustain participatory science on volunteer labor?" These aren't easy questions. But thinking about them and being proactive about data ethics helps build a culture of ethical decision-making and in turn can help ensure safe data practices.

The Alliance for Aquatic Resource Monitoring (ALLARM) is one such organization thinking about data ethics. ALLARM is a participatory science organization, or an organization that "engages the public in advancing scientific knowledge" (EPA 2024). As ALLARM collects data in a decentralized way, through volunteers, it has a unique relationship with data ethics, one we will explore in this article.

Data Ethics Overview

Within traditional scientific contexts, data ethics has been a topic of discussion for many years. In 2002, Pimple developed a framework for thinking about ethical decision making in science. He outlined the responsibilities that scientists have:

1. Responsibility to the scientific work
2. Responsibility to the subjects of research
3. Responsibility to peers
4. Responsibility to the institution which one is working within
5. Responsibility to society
6. Responsibility to the environment
7. Responsibility to the self

(Pimple 2002).

Responsibility to scientific work is a commitment to scientific integrity throughout the research and development process (Pimple 2002). Responsibility to research subjects includes protecting human and animal subject interests (Pimple 2002). Responsibility to peers acknowledges that scientific work is inherently collaborative which includes considerations for authorship in publication but also the researcher's responsibility to

mentor and review the work of other researchers (Pimple 2002). Responsibility to the institution would include managing resources effectively and ensuring fiscal responsibility (Pimple 2002). Responsibility to society would include considerations for how scientific work will affect the broader community (Pimple 2002). Responsibility to the environment considers how research practices affect environmental health and safety (Pimple 2002). And lastly, responsibility to self-ensures that the researcher is not coming to harm in the pursuit of scientific work (Pimple 2002). This framework is an accessible way to think about how holistic ethical considerations in science are. Decisions about data management must answer to all the responsibilities listed above.

In the participatory science context, there has recently been the development of a Data Ethics toolkit by Caren Cooper, Lisa Rasmussen and Elizabeth Jones. Cooper et al. found that it was imperative to embed ethical decision-making for participatory science specifically because "the data is assembled by many and held centrally" (Cooper et al. 2022). This, they explain, leads to "unique obligations for stewarding and disseminating data" (Cooper et al. 2022). As a participatory science organization, this means that ALLARM has a unique responsibility to ensure ethical data practices that protect our volunteer monitoring base and their work. But also, it shifts how we understand Pimple's heuristic model for data ethics considering that the model was developed for a fundamentally different data collection power structure/method. Cooper et al. continue to outline a useful framework for establishing a data ethics culture in a participatory science organization with focus on data governance and data integrity (Cooper et al. 2022). The question then becomes, how do we ensure commitment to the responsibilities that Pimple outlined with the knowledge put forth in the Data Ethics toolkit by Cooper et al. and develop a culture of ethical decision making, trust and access within ALLARM?

Data Accessibility

Data accessibility is a central tenant to data ethics. In 2010, the Panton Principles, a guide for open data practices, recommended the use of open data domain licenses and the waiving of copyright (Cooper et al. 2021). While open data accessibility can be critical to removing barriers to who can use the data, Cooper et al. 2021 argues that groups who have historically experience data inequities/intimidation by traditional scientists may have reason to ensure higher levels of data protection (Cooper et al. 2021). Having open conversations about the data collectors and their needs is crucial at this junction to understand the level of "open-ness" an institution and volunteers want their data to have. Currently, all volunteer data from ALLARM is largely accessible to volunteers and the public. Volunteer data uploaded into the Chesapeake Data Explorer is publicly

available, and queries can be expanded to include data about the group but not necessarily the volunteers who collected the data. This prevents accreditation to a degree but also protects volunteer safety to a degree as discussed above. All data sheets remain with volunteers so they can reference data they collected at any time and collated data is presented to volunteers in the form of data packets biannually.

Data Ethics in Organizational Culture

Internally, ALLARM has al ready undertaken several key actions to the goal of integrating data ethics principles into its organizational culture. ALLARM focuses on fostering an open dialogue and creating engagement with the volunteer monitoring base and broader community to ensure that the work that ALLARM is doing aligns with community values and priorities. Shirk et al. 2012's framework for ensuring ethical data practices suggests that the first questions for any project be "who's interests are being served?" -- a concept integral to ALLARM's project development process. Furthermore, we want the volunteers to feel as though they have a sense of autonomy during the entire data process. ALLARM attempts to build feelings of autonomy within volunteers through capacity building work . This includes verbally uplifting volunteers, building their confidence during Quality Control (QC) workshops and endowing volunteers with a sense of legitimacy through data packets and data packet workshops where volunteers develop their own analyses of data. To use the data packets as a more specific example, volunteers are given their sampling data in graphical and table form and guided to notice patterns in data and then extrapolate data stories for their personal use. If volunteers notice, for example, elevated conductivity levels during winter months, they may extrapolate (as many volunteers have) that road salts play a role in water conductivity levels. They may use and share this data as they see fit. Moreover, the organization works to ensure transparent documentation of data management processes, clear communication with stakeholders about data use from use in GIS classes to use in the Chesapeake Data Explorer and foster a culture of transparency and accountability. ALLARM wants to credit the amount of work that volunteers put into their stream monitoring. A simple step includes noting the amount of time volunteers put into their monthly monitoring function to track their contributions and sharing volunteer contributions.

Data Ethics and Equity

Ethical data intersects with ALLARM's focus on equity. Specifically, how ALLARM can push to create more equity through its role as a participatory science organization as Michelle Hom outlined in her article (page 7) about the EPA Equity Action Plan. Data ethics is one part of that puzzle. By focusing on transparency,

accountability and integrity, ALLARM will be creating an environment that is just as open to equitable action as it is to ethical data management. Internally, ALLARM looks ahead to developing more ethical data conversations with our watershed coordinators. This would look like conversations during staff meetings and during onboarding about ethical data decisions, responsible data collection and consent processes for volunteer collaboration.

Works Cited:

Atenas, J., Havemann, L. & Timmermann, C. Reframing data ethics in research methods education: a pathway to critical data literacy. *Int J Educ Technol High Educ* 20, 11 (2023). https://doi.org/10.1186/s41239-023-00380-y

Cooper, C. B., Rasmussen, L. M., and Jones, E. D. (2022) A Toolkit for Data Ethics in the Participatory Sciences. Citizen Science Association.

Cooper, C. B., Rasmussen, L. M., & Jones, E. D. (2021). Perspective: The Power (Dynamics) of open data in citizen science. *Frontiers in Climate, 3*. https://doi.org/10.3389/fclim.2021.637037

EPA. (2024) Participatory Science for Environmental Protection. US EPA. https://www.epa.gov/participatory-science

Pimple, K.D. (2002) Six Domains of Research Ethics: A Heuristic Framework for the Responsible Conduct of Research, Science and Engineering Ethics 8(2): 191-205.

Rasmussen, L. M., & Cooper, C. B. (2019). Citizen Science Ethics. *Citizen Science*, 4(1). https://doi.org/10.5334/cstp.235

Shirk, JL, Ballard, HL, Wilderman, CC, Phillips, T, Wiggins, A, Jordan, R, McCallie, E, Minarchek, M, Lewenstein, BV, Krasny, ME and Bonney, R. 2012. Public Participation in Scientific Research: A Framework for Deliberate Design. *Ecology and Society*, 17(2): art. 29. DOI:https://doi.org/10.5751/ES-04705-170229

Bringing C-Science Excitement to D.C.! Our Director's Time with the EPA

By: Charlotte Kratovil-Lavelle '24

As of 2020, over of quarter of people living in the United States were estimated to have been engaged in a participatory science program (Thigpen and Funk 2020). Known by many names, including community, science, citizen science, or just c-science, participatory science is defined as the collaboration between professional scientists and members of the public. In recent years, there has been an effort within the federal government to expand the scope of participatory science in the United States. In 2015, the Federal Citizen Science and Crowdsourcing Act was signed into law, requiring federal scientific agencies to leverage community collected data as applicable to support their missions. As a result of this legislation, there became a need within the U.S. Environmental Protection Agency (EPA) for a community science subject matter expert to help develop protocols for building credibility, managing data, and ensuring data quality.

Who better to fill this role than our very own Jules Vastine? For sixteen years, Jules has served as the Executive Director of the

Alliance for Aquatic Resource Monitoring (ALLARM) where they have worked to promote the importance of community science on the local, state, and national levels. In 2021, Jules was contacted by personnel at the EPA and invited to work within the Office of Research and Development as an Intergovernmental Personnel Detail. Jules accepted, taking a step back from their role as ALLARM director to help the EPA develop a strategic vision for the implementation of volunteer-collected data within the agency. After their return to ALLARM in January of 2024, I had the opportunity to speak with Jules about their time with the EPA.

Having spent two decades in the non-profit sector, Jules was excited by the opportunity to "engage the field from a different point of view." When asked about their experience getting started with the EPA, Jules recounted that "there was an expectation that I was going to dive in at a high level and make it happen." Guided by the goal of developing a protocol for the use of volunteer-collected data, Jules worked alongside colleagues both inside and outside the EPA. Their work included one-on-one and group interviews, collaboration with consultants to develop focus groups, and scads of research into the realms of volunteer collected air, land, water, and soil data.

Among their federal colleagues, Jules sought to promote diversity, accessibility, and excitement around the field of participatory science, noting "I wanted to make sure that I was bringing diverse voices from the field to the table as examples as much as possible." Jules was asked to provide the EPA with examples of community science projects and used the opportunity to bring attention to successful programs across the country while also giving a special nod to the work being done here in Pennsylvania. When I asked Jules about the role of ALLARM in their work at the EPA, they responded, "the work I was doing

Volunteers participate in an accessible Restoration Monitoring protocol that Jules helped develop while working at ALLARM. Image credit: Dickinson College, Dan Loh

was not about me, it was about the field." As such, they focused not on their work with ALLARM specifically, but rather on the array of diverse and unique programs happening across the country. Examples they highlighted include Missouri Stream Team, the original creators of a "stream team" program, and the Blue Thumb Stream Protection Program of Oklahoma. Of course, stream monitoring is only one facet of participatory science (though perhaps our favorite). Jules made sure to emphasize that a great strength of participatory science is that it stretches across diverse communities and scientific disciplines and includes programs ranging from butterfly monitoring to human health studies.

During our conversation, Jules emphasized that they considered one of the most important aspects of their role at EPA to be generating excitement around the field of community science within the federal sphere. Jules wanted to convey the incredible opportunity that volunteer-collected science presents to advancing both scientific research and environmental equity. Speaking to this point, Jules reiterated, "I wanted to make sure that they [EPA] weren't just talking about the field as a whole, I wanted them to be thinking about our individual volunteers and their motivations and why they wanted to be collecting science in the first place." When asked about the outcomes of their detail, Jules shared that they were "very successful in making people feel excited about this as an opportunity," something they considered a significant win.

Jules Vastine, Director of ALLARM - Image Credit: Dickinson College, Dan Loh

While reflecting on their experience, Jules shared their gratitude for having met "so many wonderful people" and getting a look inside the inner workings of the EPA. They shared that it was an "incredible privilege to have had the opportunity to represent my field and bring diverse voices and experiences to the table." The culmination of their work at the EPA is a summary document on participatory science implementation that will eventually be released to the public, a deliverable Jules described as a "participatory science love letter." On the theme of love, on February 14 of this year, a few weeks after my discussion with Jules, the EPA released its Equity Action Plan. The seventh strategy of this plan was listed as "Strengthening Community-Based Participatory Science to Achieve Environmental Equity in Communities with Environmental Justice

Concerns." While we missed having Jules around last year in the ALLARM office, we are proud to have had our director representing the field of community science on the national scale.

To our volunteers who have collected data as a part of Stream Team, we say thank you for being a part of a larger movement to amplify the voices of passionate community members across the country. The work you do matters. And the federal government is taking note.

Work Cited:
Thigpen, C. L., & Funk, C. (2020). Younger, more educated US adults are more likely to take part in citizen science research. Policy Commons.

The Chemistry of Nitrate and Why It Matters

By: Amelia Harper '25

Nitrate, or nitrate-nitrogen, is an important parameter in water quality monitoring, but how does it work, and how do we quantify it? It's important to think about what nitrate actually is, because nitrogen can exist in several forms. Earth's atmosphere is composed primarily of nitrogen gas, but atmospheric nitrogen is completely unusable to plants and animals because it is in the gaseous N_2 form consisting of two nitrogen atoms bonded together with no electric charge. Nitrate, the form of nitrogen that is most important in water quality monitoring, consists of a central nitrogen atom bonded to three oxygen atoms, and has an overall negative charge. Since plants and animals cannot metabolize the N_2 that is abundant in the atmosphere, we need to rely on the organisms that can: nitrogen-fixing bacteria! Certain groups of bacterial species have evolved the ability to take in N and convert it into ammonium (NH_4^+); bacteria and fungi that break down organic matter as decomposers also produce ammonium as a waste product. Different bacterial species known as nitrifying bacteria can then take up ammonium and convert it into nitrite (NO_2^-) and nitrate (NO_3^-). Nitrate, nitrite, and ammonium are the forms of nitrogen that plants and animals can use. The microbial conversion of atmospheric nitrogen into ammonium, nitrites, and nitrates is absolutely necessary for all other life forms on this planet, because of the "central dogma" of modern biology. The central dogma states that all the information needed to build an organism is encoded in DNA, DNA genes are then transcribed into mRNA molecules that act as "messengers" for specific pieces of genetic information, and those mRNA messages are translated into a protein that carries out the "instructions" in the message. All living organisms that we have found on this planet use DNA, RNA, and protein as their biological foundation. This is important because the building blocks of all

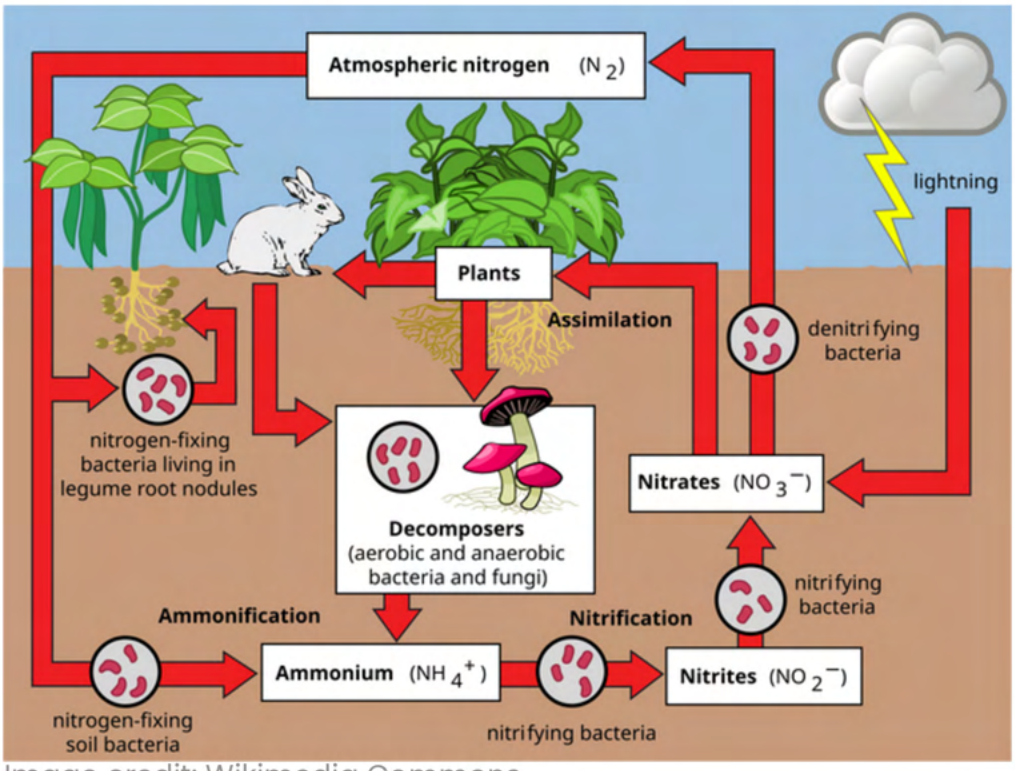


Image credit: Wikimedia Commons

three fundamental biomolecules (DNA bases, RNA bases, and amino acids that make up proteins) all have nitrogen in their chemical structures. Therefore, nitrogen in a usable form must be available in order for life to continue to exist!

In nature, the pool of usable nitrogen is generated almost completely from the actions of bacteria and fungi in the nitrogen cycle. Since these bacteria often live in the soil, and plants remove nitrogen from the soil for their own use (Miller et al, 2008), it stands to reason that in some ecosystems there might not be enough nitrogen to go around. This is an issue for agriculture, especially because common crops like corn are particularly nitrogen-depleting. Although crop rotation can help replenish usable nitrogen in the soil, the development of the Haber-Bosch process in the early 20th century revolutionized agriculture by providing a means to take N_2 from the atmosphere and industrially convert it into ammonia that can be added to fertilizer—in other words, it is an industrially scalable method of nitrogen fixation! The use of nitrogen fertilizer has significantly increased crop yields, allowing agriculture to scale up enough to feed everyone on the planet. Large-scale agriculture as it exists today would not be possible without the development of an industrial means to fix nitrogen (Louchheim, 2014). Of course, this is a double-edged sword— pollution from nitrogen fertilizer is a significant environmental issue. Because of the ubiquitous use of nitrogen fertilizer, runoff from agricultural fields is very high in nitrates, nitrites and ammonia. When these polluting compounds enter waterways in

much higher concentrations than would naturally exist, they can create a eutrophic system (state of nutrient excess and overgrowth of aquatic vegetation) that leads to dangerously low levels of dissolved oxygen, which is obviously harmful to many forms of aquatic life. In addition to agricultural runoff, nitrate/nitrite/ammonium pollution in waterways can come from sewage or animal waste (US EPA, 2012). In either case, nitrites and ammonium will tend to be converted to nitrate when in a freshwater environment; this means that nitrates are the primary form of nitrogen in stream water, making nitrate levels a good measure of the overall level of nitrogen compounds in a stream (Schullehner et al, 2017).

Here at ALLARM, we measure "nitrate-nitrogen," which is the amount of nitrogen in the form of nitrate that is present in a water sample, in milligrams per liter. In other words, for a one-liter water sample, measuring nitrate-nitrogen in mg/L using an ALLARM protocol would give you the total weight, in mg, of the nitrogen atoms that are in nitrate ions in that sample. This measurement does not include the weight of the three oxygens present in each nitrate ion. Importantly, a nitrate-nitrogen measurement does not provide information about the levels of other forms of nitrogen—nitrite, ammonia, and N_2 — in a water sample, but since nitrogen in streams tends to be quickly converted to nitrate, we can usually ignore these other forms.

We have a few different methods of measuring nitrate-nitrogen at ALLARM. The testing kits that Stream Team volunteers use for monitoring, and the nitrate test strips that some of our partners use, utilize the zinc reduction method. When we process samples from our monthly monitoring of the LeTort Spring Run in the ALLARM lab, we measure nitrate-nitrogen with the cadmium reduction method. Zinc reduction and cadmium reduction are common ways to measure nitrate-nitrogen, and their chemistry is essentially identical. Both methods use a metal catalyst, either cadmium or zinc, to convert nitrate ions in the sample to nitrite. Cadmium and zinc are in the same column of the periodic table, meaning that they have very similar chemical properties, and both can easily catalyze the reduction reaction that converts nitrate (NO_3^-) to nitrite (NO_2^-) by ripping off electrons. In our Stream Team testing kits, the

Michelle Hom (back) and Michelle Cao (front) prepare samples using the cadmium reduction method.

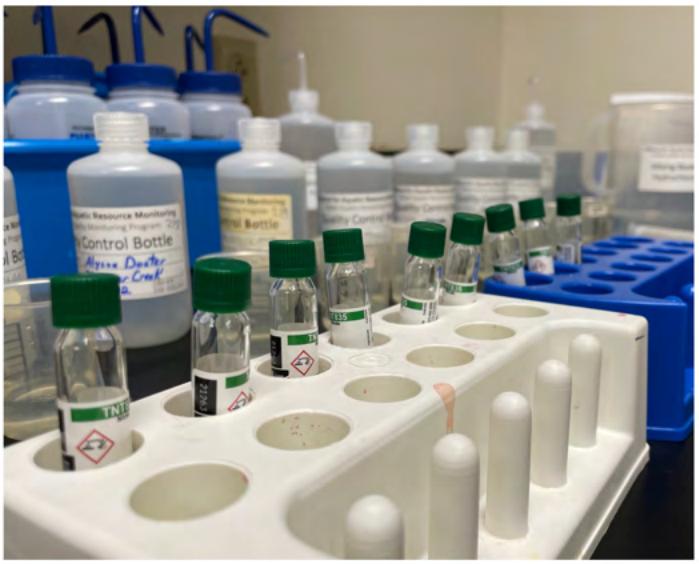
Nitrate #2/CTA reagent that is added to the sample water contains zinc to accomplish this conversion, and sulfanilic acid [cta SDS]. Sulfanilic acid reacts with the nitrite (which was formerly nitrate) in the sample to form a new chemical compound that is red-brown in color—this is the color that develops during the 5-minute waiting period in our Stream Team testing kits, and similarly in the cadmium reduction protocols that we use in the ALLARM lab! The intensity of color is proportional to the amount of nitrite that reacted with sulfanilic acid, representing the amount of nitrate present in the original sample. Naturally, if there is any nitrite present in the initial water sample, one would expect the cadmium/zinc reduction methods to give an inaccurately high value for nitrate-nitrogen, since the red-brown color actually comes from a chemical reaction with nitrite. Although this generally isn't an issue for free-flowing streams since nitrite levels are typically negligible, Stream Team nitrate testing kits are designed to give accurate results even if nitrite levels are non-negligible. The nitrite problem is overcome by sulfamic acid (not to be confused with sulfanilic acid!) in the Nitrate #1 reagent tablets that are added to the sample first in the Stream Team protocol [N1 sds]. Sulfamic acid converts nitrite back into gaseous nitrogen (N_2), effectively removing it from the sample, before the addition of zinc in the Nitrate #2/CTA reagent converts any nitrate to nitrite. This means that the final color of the solution in the test tube truly represents the amount of *nitrate* in the initial water sample, without any interference from nitrite.

The chemistry of the cadmium reduction method that we use in the ALLARM lab to measure nitrate-nitrogen is nearly identical to the zinc reduction method that Stream Team volunteers use. The key difference, of course, is the use of cadmium instead of zinc. Cadmium is toxic and carcinogenic, and nitrate-nitrogen testing by cadmium reduction generates hazardous waste that must be disposed of specially [nitraver5 sds]. When we measure nitrate-nitrogen by cadmium reduction in the lab, instead of visually comparing the color of the solution to a standard like in the Stream Team zinc reduction protocol, we use a benchtop machine called a spectrophotometer. Our spectrophotometer shoots light through the sample in a glass vial, precisely measures the amount of light that is absorbed and doesn't pass through

This Nitrate kit utilizes the aforementioned Nitrate #1 and Nitrate #2/CTA tablets to create a chemical reaction

the sample (a visually darker sample means that more light is being absorbed), and uses that light absorption value to calculate the nitrate-nitrogen measurement in mg/L. The spectrophotometer provides a more accurate nitrate-nitrogen measurement than a visual color comparison would.

For Stream Team quality control, instead of cadmium reduction, we use a testing method called TNT to measure nitrate-nitrogen. TNT, also called the dimethylphenol method, uses a completely different chemical reaction than the zinc and cadmium reduction methods. In the presence of sulfuric acid, nitrate in the water sample reacts with a chemical called 2,6-dimethylphenol to form p-nitro-dimethylphenol, which absorbs light at a specific wavelength (Hach Company, 2013). For organic chemistry nerds, this is an electrophilic aromatic substitution reaction! The color is nearly impossible to see visually unless the nitrate concentration is very high, but our spectrophotometer can precisely measure the amount of light absorbed by p-nitro-dimethylphenol and convert that number into a nitrate-nitrogen measurement. TNT is my favorite test to perform in the lab. The chemical reaction is exothermic, meaning that it releases energy in the form of heat; when we do TNT nitrate testing in the ALLARM lab, the glass vials that the reactions are performed in turn hot to the touch when a solution containing 2,6-dimethylphenol is added!



TNT samples need to sit before being processed.

Nitrate testing is an essential part of water quality monitoring , since excess nitrate in streams is a hallmark of pollution . Additionally, we all depend on nitrogen for our fundamental biology, so we all ought to understand how it flows through ecosystems in the normal nitrogen cycle. We run nitrate tests so often here at ALLARM that it's easy to take them for granted, but understanding and appreciating the actual chemistry of the different types of nitrate testing makes it a much more rewarding activity.

Works Cited:

Hach Company. (2013, Jan 10). Spectrophotometric Measurement of Nitrate in Water and Wastewater. https://cdn.bfldr.com/7FYZVWYB/at/wv5rq9452s3bkwxh28xbwjm/EPA_Method_10206_Hach_Nitrate_TNTplus_835_836_for_Water___WW.pdf

Miller, A. J., Fan, X., Shen, Q., Smith. S. J. (2008). Amino acids and nitrate as signals for the regulation of nitrogen acquisition. Journal of Experimental Botany, 59(1), 11-119. https://doi.org/10.1093/jxb/erm208

Works Cited:
Nitrate #1 Tablets; MSDS No. 2799A [Online]; LaMotte Company: Chestertown, MD, May 21, 2015. https://lamotte.thewercs.com/MyDocuments/DownloadSingleFile?content=E4E1F9FC-9968-4D33-9F24-400ECB0919DF_PDF (accessed 02/22/24).
Nitrate #2 CTA Tablets; MSDS No. NN-3703A [Online]; LaMotte Company: Chestertown, MD, May 26, 2015. https://lamotte.thewercs.com/MyDocuments/DownloadSingleFile?content=81C0A23F-1BB8-4937-891B-DDAD5970E25A_PDF (accessed 02/22/24).
NitraVer 5 Nitrate Reagent; MSDS No. M00049 [Online]; Hach Company: Loveland, CO, Mar 8, 2021. https://www.hach.com/p-nitraver-5-nitrate-reagent-powder-pillows-10-ml-pk100/2106169#resources (accessed 02/22/24).
Schullehner, J., Stayner, L., Hansen, B. (2017). Nitrate, Nitrite, and Ammonium Variability in Drinking Water Distribution Systems. Int. J. Environ. Res. Public Health, 14(3), 276. https://doi.org/10.3390/ijerph14030276
United States Environmental Protection Agency. (2012, Mar 6). 5.7 Nitrates. https://archive.epa.gov/water/archive/web/html/vms57.html

Meet the Conewango Creek Watershed Association

By: Marja Barrett '26

The Conewango Creek Watershed Association (CCWA) is a grassroots organization founded in 1999 whose goal is to promote stewardship of the watershed to improve its health (About Us, n.d.). It is a partnership between two states (Pennsylvania and New York), three counties, numerous municipalities, and several county, state, and federal agencies (About Us, n.d.). CCWA began working with ALLARM in 2018 in partnership with our Shale Gas Monitoring Program, but as tides turned, CCWA became interested in transitioning from monitoring shale gas to monitoring the baseline water quality of local waterways. Baseline stream monitoring, or identifying parameters for a particular stream and measuring these over time, allows a monitor to determine the "norms" for a waterway, and thus to identify when these data deviate from that baseline. At ALLARM, this generally involves monitoring water temperature, stage, water clarity, conductivity, pH and nitrate-nitrogen, although parameters are often determined by the interests of the monitoring group. In 2023, CCWA teamed up with ALLARM to launch a monthly volunteer Water Quality Monitoring Program funded by the Consortium for Scientific Assistance to Watersheds (CSAW) in order to help inform baseline stream health. I was fortunate enough to be given the opportunity to interview three directors on the board of CCWA, Elizabeth Dropp, Jane Conroe, and Judy Haller. In doing so, I got to learn more about CCWA as an organization, as well as each of their specific insights and experiences.

Introductions

Elizabeth Dropp (Liz), Chair of CCWA's Board of Directors, has had a lifelong love of the outdoors. She distinctly remembers her

first Earth Day, describing it as the moment where things clicked for her, and she couldn't understand why people were destroying the environment. She has an associate and bachelor's degrees in Agronomy, worked for the USDA NRCS, two different Conservation Districts, the US Forest Service, and the PA Dept of Agriculture (About Us, n.d.). She has been director for CCWA for nearly 11 years and served as treasurer for most of that time (About Us, n.d.).

Jane Conroe, Vice Chairperson, became hooked on water monitoring after she started taking water samples of Lake Erie for New York's Department of Environmental Conservation program. She compares taking water samples to taking the temperature of a sick child or an elderly parent, an act of care and interdependence. She is a retired secondary school science educator whose specialty was the physical sciences, so coming to CCWA meant learning new skillsets. She has been self-taught in this regard and believes that you learn the most when you're learning it yourself.

Judy Haller, Secretary, got involved with CCWA after a kayak fun day hosted by the organization. She had never interacted with the watershed before, but after kayaking down it she became dedicated towards its preservation, inspiring her to volunteer for the organization.

From Shale Gas to Baseline Monitoring

I wanted to better understand what exactly inspired CCWA's switch from monitoring shale gas to monitoring baseline water quality. Liz said that CCWA switched from the Shale Gas program to baseline monitoring after being recommended to do so by the ALLARM staff. She thought that baseline stream data would be helpful for reference to know what normal stream health is, especially if oil wells are developed in the future, so CCWA can be aware of what effect these wells have. Judy added that people were dumping brine on country roads, so CCWA was interested in finding out how this was impacting stream health. When CCWA was looking into further water monitoring, ALLARM helped them decide to start at baseline water quality monitoring, and to go from there as interests piqued.

Aspirations for Data Usage

I also wanted to find out CCWA's aspirations for data usage, and the ultimate goal for their monitoring program. Jane emphasized that CCWA's first and foremost goal is protection of the watershed. She described the Conewango as a forgotten and somewhat abused creek and expressed hope that because they have switched to baseline parameters, CCWA will be able to better read the general health of the watershed. She then noted that further goals will be derived from future data patterns, and CCWA will go from there.

Favorite Memories

I then asked each of them to share a favorite memory they have from volunteering with CCWA. Liz's was the first time she went down the Conewango in a kayak. She described a serene area of the creek, right in the middle of NY and PA, where there's no development nearby and you can't hear any traffic. It was a special experience to her that made her feel connected to a part of nature less obviously touched by human influence.

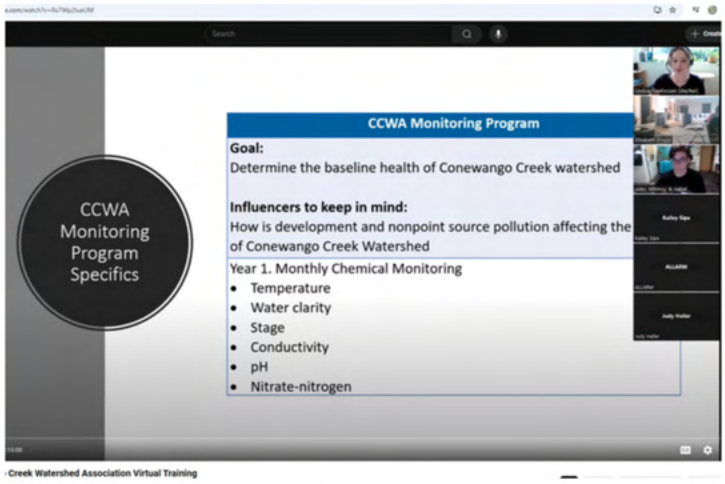
One of Jane's favorite memories is when she ran into someone who told her about how happy and abundant the spiny softshell turtles are at the upper reaches of the Conewango. The spiny softshell turtle is CCWA's mascot. Jane said that these kinds of places work to inspire people; by knowing they are there, and that's what we are protecting, maybe communities can come together to protect the environment and restore waterways.

Judy really enjoys CCWA's watershed cleanup events because they foster a sense of community through hard work and giving back to the environment. Also, the kayak event that first inspired her to volunteer for CCWA got people interested in the river who had never interacted with it before. She noted that the fun events are what really help educate people, get them enthused about the environment, and motivate them to be dedicated towards its preservation.

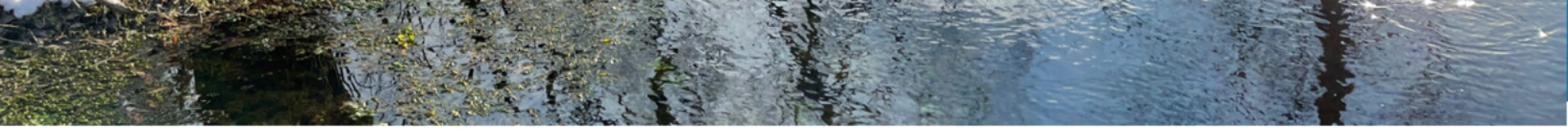
Partnerships

The value of ALLARM's partnership with CCWA is that we get to make valuable

Whimsy Mark-Ockerbloom '24 demonstrates how to clean test tubes during a CCWA virtual equipment training.



During the CCWA virtual equipment training, the ALLARM team went over the goals of monitoring and the specifics outlined by CCWA when the partnership began.
Screenshot modified from training video



connections with volunteers and community leaders, and as a result, better understand the ways that different organizations need support. To conclude the interview, I asked each of the interviewees to share what has surprised them the most throughout their experience with CCWA. They all largely echoed the same sentiment, ALLARM's support system. When CCWA and ALLARM first began collaborating, Jane thought the support ALLARM offered was almost too good to be true. She emphasized that this process has been a team effort, and ALLARM has been an itegral part of that. Liz expressed her thanks to ALLARM for supporting CCWA and being there to keep them moving, especially as a small group. Judy stressed that it has been nice to have a support system, as well as to have data and results to take to community and government leaders. Hearing these sentiments warmed my heart, as ALLARM's mission is exactly that, to empower communities through citizen science and back them each step of the way. Our partnerships and volunteers make ALLARM who we are, they are the backbone of this organization, and we could not do it without them.

Photo taken at the end of a 2024 CCWA Check-in meeting!

Thank you to Elizabeth Dropp, Judy Haller, and Jane Conroe for your willingness to be intereviewed! It was great to hear about your experiences and work alongside ALLARM!

Work Cited:
About Us. Conewango Creek Watershed Association. (n.d.). https://www.conewangocreek.org/about/

York County Stream Team - 5 Years Later!

By: Max Carfrey '26

Introduction

York County Stream Team was ALLARM's first, and since its establishment in December of 2018, most successful Stream Team. Made up of diligent, hard-working volunteers who have dedicated countless hours to ensure their waterways are healthy, it's clear to see why York Stream Team has yielded so much data - but what makes them so successful? To answer this question, I decided to interview two volunteer monitors, Lettice Brown and Mark Lentz, as well as the Master Watershed Steward Coordinator of York Country, Jodi Sulpizio. Talking with all of them, I was able to get some insight into their program, glimpsing what goes on behind the scenes and how they interact with ALLARM.

Meeting some York County Volunteers

Speaking with Lettice Brown, a Penn State alum and avid volunteer monitor, I was able to get an inside look at some of the incredible work being done in York and especially in Mill Creek, Lettice's monitoring location. Lettice is the stormwater coordinator for the City of York's Public Works Department; she engages in public education, investigations, and trainings of city staff. Born and raised in York, one of her favorite memories is travelling to York College and doing her first macro survey on a cold late fall day. "I enjoy [volunteer monitoring] because [water] is a renewable commodity that we can't take for granted. We need clean water to survive," she expressed to me. "I have a real

Two photos from the December 2018 York County Stream Team equipment training - Some of these volunteers still monitor to this day!

fear of not having clean water at some point. If we don't take care of it, who's going to do it?" This statement really resonated with me because it helped me to see the passion behind the work both Lettice and York County Stream Team are doing. Local waterways are extremely important to aquatic life but also incredibly important to humans. Lettice is a firm believer that the public community should know about what is happening in their local waterways even if they don't care. She told me that it is good information for people to know about since we can start to pinpoint where problems are occurring and deal with those issues from there. "The perfect time to plant a tree is 20 years ago, and the second perfect time is now," is a quote that she likes to refer to often since although she wishes we could have acted sooner, Lettice hopes that our actions in the present will help to prevent future issues down the line.

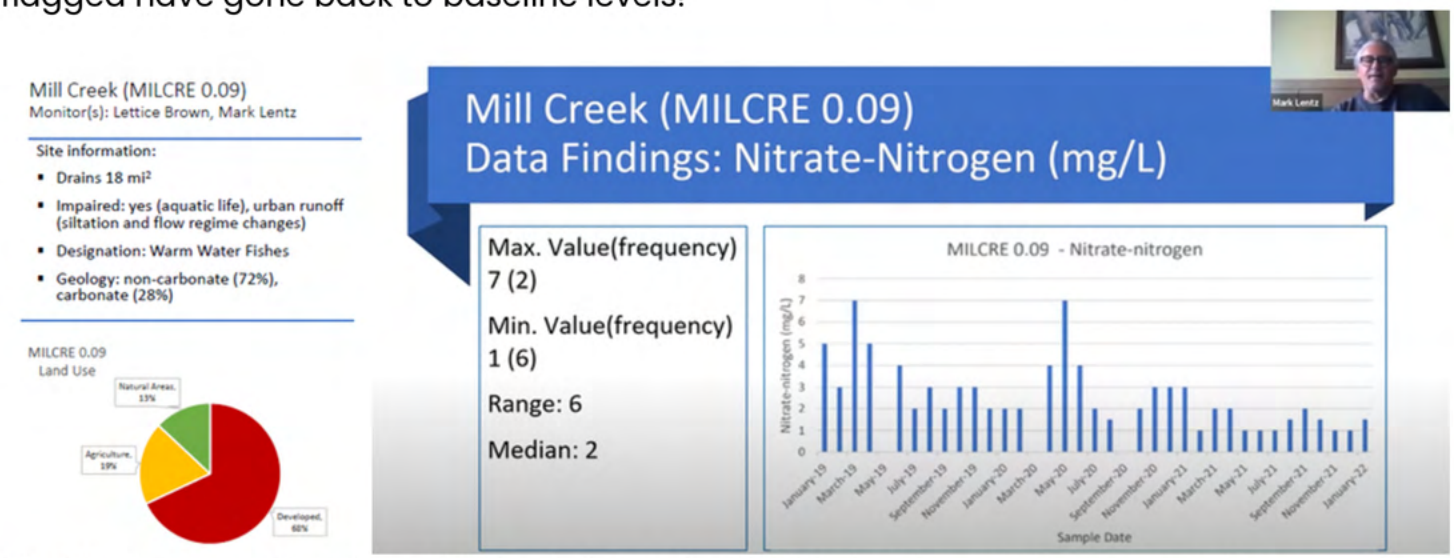
Mark Lentz, who retired from teaching high school environmental science and biology last June, is an enthusiastic and passionate volunteer. Besides being a part of Stream Team, Mark loves to fish catch-and-release style for trout . He got involved with Stream Team through the Master Watershed Stewards Program of York County because of his interest in environmental science from his time in elementary school. Outside of Stream Team, Mark takes his expertise into the classroom and, through his work with his students and some volunteers in the Master Watershed Stewards, has built 23 acres of riparian buffer zone on school district property that Mark still tends to. Since retiring, he has become the assistant coordinator for Master Watershed Stewards of York County, organizing events such as trash pickups and tours of property owned by the Lancaster Conservancy to understand the work they have been doing, including riparian buffer maintenance. Overall, Mark speaks very highly of his experiences with Stream Team and his monitoring partner, Lettice. He told me, "The data on the streams is important, but the relationships we form with other people are probably more important." When I asked him for some advice for someone interested in volunteer monitoring, he said, " Don't be afraid to fly your tree hugger flag. It's nothing to be ashamed of! It's not a political thing, it's not a social thing, it's a science thing."

York County volunteers learn how to test nitrate-nitrogen using a kit. Photo from the 2019 York equipment training.

Together, Mark and Lettice monitor Mill creek, a waterway situated right on the cusp of highway interstate 83, where they were doing a huge construction project the previous year. During data interpretation, they realized that there were two spikes in nitrate-nitrogen due to sediments and nutrients getting into the creek from the road work being done. Mark and Lettice realized this, and decided to implement riparian buffers along the side of the creek so that they could catch these sediments and nutrients before they got into the water. Another thing they realized is that in January and February, Lettice and Mark saw excess amounts of road salt being applied during the winter months and it seemed to be impacting conductivity readings. Together, they came to the realization that high salinity and high conductivity readings could correlate at this site due to the abnormal levels they saw while monitoring. After another look at their data, it does appear that the areas of concern that they flagged have gone back to baseline levels!

Interviewing the Master Watershed Steward Coordinator of York County

Jodi Sulpizio, the Master Watershed Steward Coordinator of York County and a natural resource educator, oversees the stewards who participate in Stream Team. The York program launched in 2016 with about 80-90 volunteers participating in on the ground restoration projects to help with water quality such as riparian buffers, rain gardens, and lawn to meadow conversions. Jodi told me that education through extension is the goal of the master watersheds, and she has found that Stream Team is a great citizen science program for stewards. "Partnerships have really been the key to our success," Jodi told me. "Although there are other watershed steward programs, we [York] are able to get more done and leverage more resources if we can work together." ALLARM has been partnered with the York Master Watershed Stewards since 2018, providing



Mark Lentz presenting about Mill Creek during the 2022 Data Interpretation Presentation

a mutualistic relationship where there is excellent communication with the volunteers through trainings, QC pick-ups and check-in meetings. "I feel like every day I learn something new and the volunteers, I feel, really enjoy learning and they love to learn new stuff." She continued further and told me about the importance of the work that is being done. Even though stewards and monitors don't necessarily have the title of "scientist," they are doing real science and are a part of the bigger whole. All volunteers of these programs are putting in their effort to contribute to a cause that is larger than themselves and they have a huge passion for the work that they are conducting. For example, volunteers have alerted counties like York to major pollution events because monitors have recognized when their sites are abnormal. They can then report it and have another determine the cause of the pollution or contamination.

York Country Volunteers met in 2023 to check in about monitoring.

Conclusion and Takeaways

Talking to Jodi, Lettice, and Mark, I started to understand that communication is the key to success and volunteer monitors must be wary of the times when data findings do not line up with what they know as baseline. We are still learning the best monitoring practices as we go. Jodi and I talked a lot about the pandemic and how it affected the Master Watershed Stewards as well as Stream Team. It placed a new type of strain on the work being done, but it didn't deter the monitors. We turned to virtual meetings, from trainings to check-ins, which ultimately brought in a new avenue of connection, one that bridges volunteers working in different counties.

After hearing all the volunteer monitors stories, I was amazed at the hard work that is consistently put into efforts to keep our freshwater bodies heathy and clean. The amount of time and patience it takes to monitor is no easy task, but the volunteer monitors stick through it! They truly deserve all the praise, thank you to all who volunteer monitor! A special thank you to Lettice, Mark, and Jodi for sharing their stories—the work that you all do is inspiring.

Thank you to Lettice Brown, Mark Lentz and Jodi Sulpizio for your contributions to monitoring in York and to this article!

Getting to Know the Northern Tier Stream Team

By: David Marsh '26

This semester, I had the pleasure of interviewing one of ALLARM's regional Stream Team coordinators and Penn State Master Watershed Steward Coordinator, Jeremy Leaidicker. Jeremy has been one of the driving factors in the Northern Tier Stream Team's expansion over recent years. Ever since becoming a Master Watershed Coordinator for Susquehanna County two years ago, and becoming involved with Stream Team shortly thereafter, Jeremy Leaidicker has been making waves in the Northern Tier region of Pennsylvania. As Jeremy has expanded the reach of the Master Watershed Steward Program, he has built strong relationships across the region with watershed associations, county conservation districts, and soil and water conservation districts in both Pennsylvania and New York! Over the past 3 years, Jeremy has expanded the Master Watershed Steward program in Susquehanna County into seven more counties including Bradford, Lycoming, Sullivan, Tioga, Wayne, and Wyoming County.

Jeremy participated in the Train-the-Trainer process in order to better support his volunteers

In addition to expanding the Master Watershed Steward program, Jeremy has been integral to the expansion of the Northern Tier Stream Team. After the initial training for Susquehanna Stream Team in 2022, monitors in Bradford and Wyoming Counties were onboarded the following year, and even more are planned for Summer 2024. As a Stream Team regional coordinator, Jeremy helps facilitate communication between ALLARM and volunteers, helps manage monitoring activities, and supports in-person events. He has also taken on additional responsibility by piloting the Stream Team Train-the-Trainer process so he can support individual onboarding in the Northern Tier region.

In my interview with Jeremy, we discussed some of the challenges associated with coordinating so many new counties across such a broad geographic area. Since he covers such a large area and has other partners even farther away, he needs to do much of his work digitally, or find ways to meet halfway, such as when he helps coordinate Stream Team Quality

Control for his region. Jeremy has found that communication is most effective when you "step foot on the farm," and one of the most rewarding parts of his job is traveling around to different counties and experiencing more of the countryside.

As Jeremy has been building partnerships and expanding the Master Watershed Stewards program in the region, the disappearance or dissolution of watershed associations in the area has also been a challenge. Within his region of coordination, he works to support still-existent watershed associations, while having conversations with conservation districts and other individuals in areas without regional watershed associations. Jeremy has found that county partners are usually excited to hear about ALLARMs involvement. He enjoys sharing resources and connecting with others when he can, which has helped him develop a network of connections with over thirty organizations throughout the area.

When I asked Jeremy about the future of the Northern Tier Stream Team, he said that it looks bright. He is looking forward to the chance to meet and collaborate with other Stream Teams in the area. Of the services that ALLARM provides, Jeremy found the refresher meetings to be most helpful to ensure that monitoring skills are reviewed and tricky techniques are reinforced over time. He is also looking forward to upcoming trainings with ALLARM, introducing the Stream Team protocol to new groups of volunteers. Jeremy has no intention to stop expanding anytime soon. Jeremy monitors with the Susquehanna and Wyoming Stream Teams and told me that the most rewarding part of monitoring for him has been the connections that he has made with his team. I learned a lot about Jeremy Leaidicker in our interview, but what stuck out to me the most was his passion for his community and the environment.

After the Train-the-Trainer, ALLARM hosted a Stream Team training for the Northern Tier volunteer group!

Thank you Jeremy for your dedicated work and for interviewing for this article!

Community Science and Cyanobacterial Blooms

By: Crosby Wilkin '26

Of the numerous environmental issues that affect waterways, one of the most dangerous and fastest-growing issues is the occurrence of harmful algal blooms or HABs for short. Algal Blooms form when certain environmental factors make it so that algae, which is naturally found in waterways, rapidly grow to abnormally high amounts. In recent years, the scientific community has a consensus that algal blooms are becoming more common worldwide (EPA 2023a). HABs have various harmful effects on local communities, impacting the health of the environment and humans.

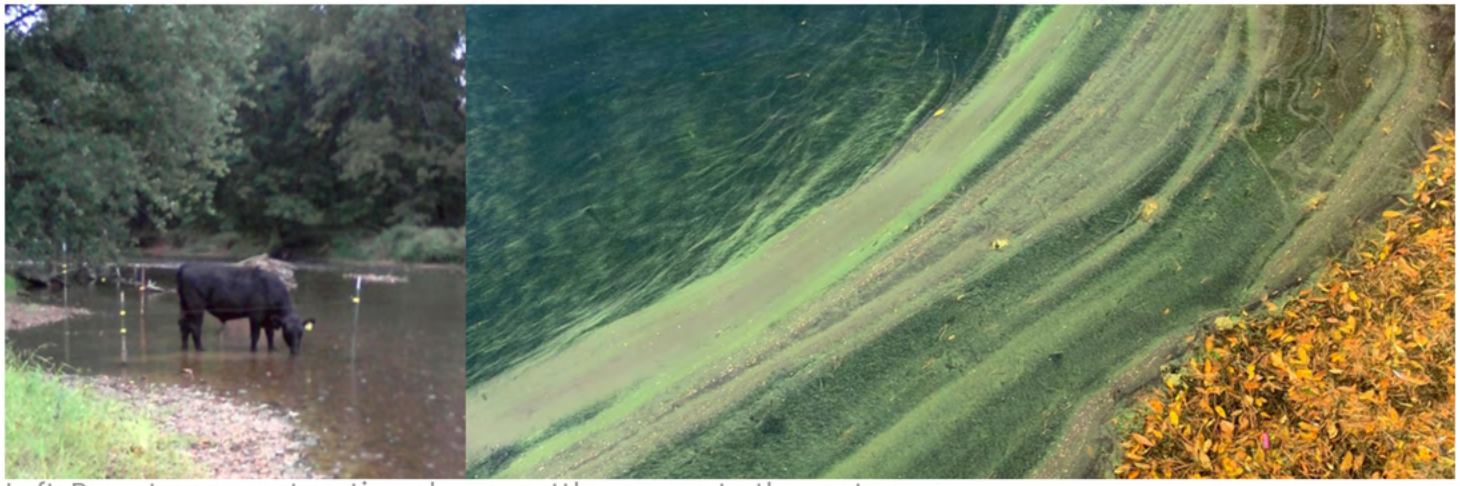
There are many factors which lead to the formation of algal blooms. Water temperature, pH changes, and increased amounts of nitrogen or phosphorus all contribute to a bloom forming (EPA 2023a). Human activities have a major effect on the previously mentioned factors through excessive fertilizer application and climate change. Fertilizers frequently applied to agricultural land often contain nutrients like nitrogen or phosphorus which can flow into waterways after it rains. Algae needs nutrients to grow, so an excess of nutrients allows algal populations to boom. These nutrients, along with general warmer temperatures from climate change are speculated to be causing the increase in HABs.

Algal blooms have a variety of negative effects on aquatic ecosystems. For one, they are known to cause hypoxia, which refers to areas in the water with no oxygen, causing the deaths of numerous organisms dependent on oxygen, primarily fish. Hypoxia occurs because after the algal bloom takes place, the excess nutrients that caused the bloom are consumed, leading to the death of the new algae. When algae dies, bacterial decomposition of that algae consumes oxygen. Although any algal bloom has the potential to harm aquatic life and disrupt ecosystems, there is an alga which is particularly dangerous for wildlife and for humans: cyanobacteria.

Also called blue-green algae, cyanobacteria are tiny organisms that can be found in diverse environments ranging from deserts to oceans. Cyanobacteria is often confused with green algae due to their similar appearance, though cyanobacterial blooms are far more dangerous. Cyanobacterial cells can release a variety of different toxins (EPA 2023b). Microcystins are the most widespread cyanobacterial toxins found in the U.S (EPA 2023b). They have negative effects on the liver and can also affect the kidneys and reproductive systems (EPA 2023b). Besides microcystins, there are several other toxins which can be released, such as cylindrospermopsin, anatoxins and saxitoxins (EPA 2023b). Some negative

effects of these toxins include skin irritation, liver illness, and in some cases, death (EPA 2023b). Because of the danger these toxins pose to the health of both the environment and people, it is of the utmost importance to monitor and control the spread of Cyanobacterial blooms. Many larger organizations, such as the Environmental Protection Agency and Department of Environmental Protection, monitor algal blooms, but what is the community science sphere up to?

While ALLARM does not monitor algal blooms directly, we do have someone quite familiar with cyanobacteria and harmful algal blooms on our team. One of our incredible watershed coordinators, Prerana Patil, has done extensive research on cyanobacteria in the recent past. Prerana is a strong advocate of community science, saying that "community science, beyond what it can do for research [with] the number of observations coming in, from the volunteers' perspective it is a great way to form a connection with the land you live on." When I asked Prerana how she thought community science can help monitor and mitigate the effects of HABs she had a lot to say. She made a point to say just how useful community members can be in monitoring conditions which cause algal blooms, saying "nutrient monitoring [by volunteers] in streams or rivers which flow into other waterbodies is very important." Prerana isn't the only one who thinks there's strong potential for monitoring algal blooms with community scientists. In an article published in LAKELINE about how community science can help monitor HABs it was said that "traditional water monitoring programs are not designed to capture these short-term, small-scale dynamics, which may result in cyanoHABS going undetected. As a result, datasets that can support large scale comprehensive studies of cyanoHABs are rare" (June et al. 2021). This is where community science can really shine. Volunteers can take samples on a regular basis, and they can take samples whenever they observe changes in



Left: Pre-stream restoration shows cattle access to the waterway.
Right: Evidence of an algal bloom. Modified from photo taken by Lindsay VanFossen

the waterways which they know so well. As Prerana said, "There is so much expertise coming from volunteers who live near their sites" But are people invested enough in this issue to participate? Yes! CyanoHABs are a major issue which can affect many aspects of a community, so of course people want to participate. Prerana told me in her time monitoring HABs, during major events like fish kills, several people approached her to ask what was going on and how they could help.

If community members can be helpful in monitoring HABs and have the motivation to do so, what avenues are there for community members to help? There are several ways for community members to contribute. If you visit cyanos.org, you can find initiatives which allow community members to help monitor HABs. One such initiative is Bloomwatch. Bloomwatch is, in their own words, a "collaborative workgroup of citizen scientists, state and federal water quality managers, public health officials, water supply managers, university researchers, and waterbody association members." Moreover, Bloomwatch is an app you can download on your phone. On the Bloomwatch app, you can learn what HABs are and how to identify one. After you create an acount, you can begin to submit information on a waterway of your choice. As Bloomwatch says, "submissions on the app provide important information on when and where potentially harmful bloom events are happening" Bloomwatch also provides a link showing a map of all algal blooms reported to them. Bloomwatch is one of the easiest ways for someone to get involved in monitoring cyanoHABs. If you're interested in helping out, I couldn't recommend any better way to start.

Data collected using community science isn't just collected for the sake of data collection, it can be applied to scientific studies. As mentioned earlier, traditional water monitoring methods are less suited to collect data on HABs given the unpredictability of when HABs occur. Volunteers have the advantage of living closer to sites where HABs occur and having more intimate knowledge of the sites. In a study done in 2021 to determine if cyanoHABs had a connection to invasive dreissenid mussels in New York lakes, the Citizens Statewide Lake Assessment Program (CSLAP) collected tons of data on over 100 different lakes. This data was used effectively to study the causes of HABs while community members became more involved in keeping their local waterways healthy - "CSLAP volunteers not only collected useful environmental data, but also became engaged and educated regarding the causes of cyanoHAbs" (June et al. 2021). Using the data, they were able to determine that dreissenid mussels do seem to promote HABs and create several very well-made figures. This would've been impossible to do without the massive amounts of data collected by CSLAP volunteers. CyanoHABs are a widespread issue which can be significantly different depending on the location and context, making it difficult for traditional science to effectively handle the issue, especially as it

becomes more widespread. Community science is uniquely equipped to study and mitigate HABs as volunteers are uniquely equipped with knowledge and investment in their local environments.

Works Cited:

Bloomwatch. Cyanobacteria Monitoring Collaborative. (2024, January 26). https://cyanos.org/bloomwatch/#bloomwatch_whatis

Environmental Protection Agency. (2023a, March). Causes of Cyanobacterial Blooms. EPA. https://www.epa.gov/cyanohabs/causes-cyanohabs

Environmental Protection Agency. (2023b, July). Learn about Cyanobacteria and Cyanotoxins. EPA. https://www.epa.gov/cyanohabs/learn-about-cyanobacteria-and-cyanotoxins

Environmental Protection Agency. (2023c, July). Health Effects from Cyanotoxins. EPA. https://www.epa.gov/cyanohabs/health-effects-cyanotoxins

Matthews, D., Matt, M., Mueller, N., & June, S. (2021). Citizen science advances understanding of cyanohabs in new york lakes. LakeLine, 41(2), 32–36. LakeLine-Summer-2021-CyanoHABs-in-NY-State-Lakes.pdf (nysfola.org)

Macroinvertebrates and the RiverWatch Approach

By: Whimsy Mark-Ockerbloom '24

Aquatic macroinvertebrates are water-dwelling (aquatic) organisms without a backbone (-invertebrate) that are visible to the naked eye (macro-). You may even be familiar with some of the larger ones: crayfish, clams, snails, maybe the bigger bugs. Many of the smaller, lesser-seen species are the larval stages of familiar terrestrial insects like dragonflies, beetles, and flies. The world of aquatic macroinvertebrates is vast and filled with thousands of species of varying size, shape, and biology.

Dragonfly larvae found during a lake-side collection.

Common stonefly found during ALLARM student orientation.

The RiverWatch Approach

Danelle Haake, the Director of Illinois RiverWatch from the National Great Rivers Research and Education Center, knows just how fantastic and important macroinvertebrates are. RiverWatch is a volunteer monitoring program that conducts habitat and biological surveys across Illinois ("About Riverwatch", n.d.). Unlike ALLARM's macroinvertebrate program, which identifies macroinvertebrates to order level, RiverWatch identifies macroinvertebrates to family level, which is one more layer of specificity (Chen, 2018). For comparison, RiverWatch's method of sample collection and organism identification is roughly equivalent to the Chesapeake Monitoring Cooperative's Tier 2 Benthic Monitoring ("Tier 2 Benthic Monitoring", 2024). In an interview with ALLARM Watershed Coordinator Whimsy Mark-Ockerbloom, Danelle shared insight into RiverWatch's monitoring process and preference of macroinvertebrate monitoring over other indicators of stream health.

RiverWatch's macroinvertebrate monitoring training is a long day of study for volunteers. Along with the history of the program and some basics about aquatic macroinvertebrates, RiverWatchers are led through the sample collection process in a variety of different habitat categories and shown how to evaluate habitat measurements like flow rate, sedimentation, and shade. To learn to identify macroinvertebrates, volunteers are walked through different groupings of organisms by taxonomic or visual similarity. For each group, instructors then go through slideshows breaking down the unique features to ID different families, and RiverWatchers are given the chance to observe live specimens in petri dishes and preserved ones in resin. This is repeated for the rest of the groupings, imitating a dichotomous key to make identification as straightforward as possible. To maintain data quality after trainings, RiverWatchers temporarily preserve their samples in ethanol and send them to RiverWatch for internal quality control. To maintain program quality, 30% of those samples are then sent for external verification, ensuring data reliability.

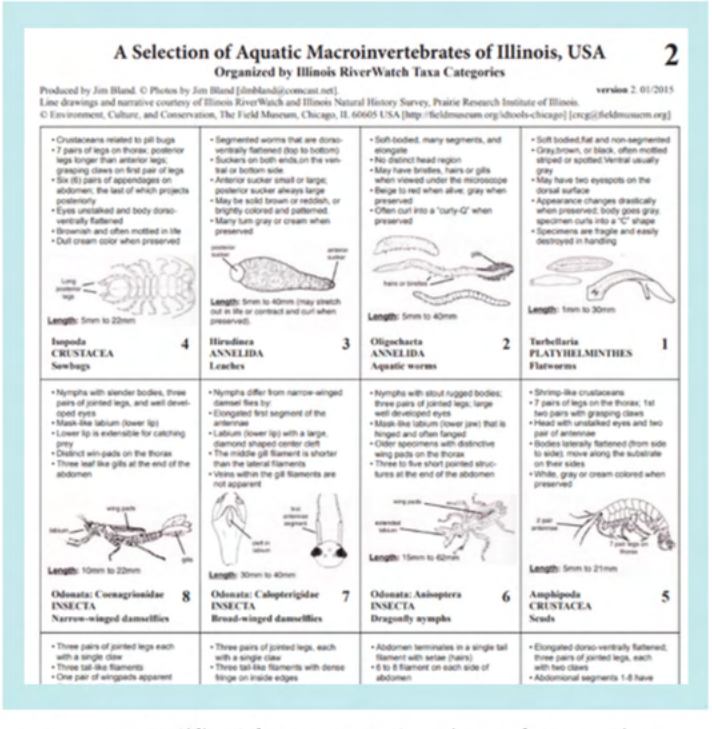


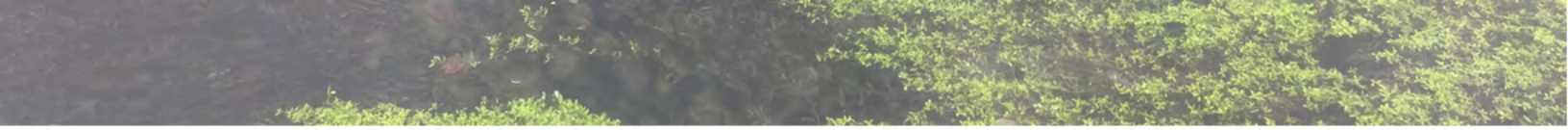
Image modified from "A Selection of Aquatic Macroinvertebrates of Illinois, USA" organized by Illinois RiverWatch.

Why does RiverWatch identify to a higher level of specificity? As Danelle says, even though order is generally indicative of the potential amount of pollution present in a body of water, there is still quite a range of tolerance within orders. Even among what are considered the most sensitive orders, Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), there are some species that ride the extremes of environmental variable ranges (Harris & Lawrence, 1978). By sorting individuals into more specific groups and weighing those groups depending on their internal variability, RiverWatch can more accurately use macroinvertebrates as stream health indicators. There is still variability within these smaller groups, introducing some inaccuracy to the data, but RiverWatch's protocol is designed to balance data quality with feasibility: identification to a species level, while even more accurate, would be intensely time consuming and more at risk of error. RiverWatch's categorization system is a compromise for the best volunteer program possible.

Why Care About Macroinvertebrates?

Why monitor macroinvertebrates at all? Other than the scientific benefit of a long-term indicator of stream conditions, Danelle says macroinvertebrate identification is a great active process. Sample collection is a physical activity , and specimen identification is often a group endeavor . The communal process of sampling is a great way for people to connect with each other, not just their stream. Additionally, any exciting data is likely to be positive— seeing a new insect or finding a lot of a species that aren't negative indicators of health - whereas finding unexpected extreme numbers in chemical testing is more likely to be an indicator of disaster. Finally, macroinvertebrate monitoring is simply more affordable than chemical testing. Macroinvertebrate collection materials need to be bought once and maintained , while chemicals need to be replenished and repurchased. For smaller or less financially equipped organizations, macroinvertebrate monitoring may be more accessible than other measurements of stream health.

Interested in learning more about Illinois RiverWatch?
Scan this QR code to be brought to their site!



Macroinvertebrates may be valuable for the purpose of water quality monitoring but studying them is important for other reasons as well. Macroinvertebrate ecology is an under-researched field—it's a big world, and they're tiny creatures. There are remarkably few taxonomic specialists, meaning species are lumped together all too frequently, and their nuance and uniqueness are missed. We simply don't know how many species there are, which are invasive, and the full geographic span of different species. The more people out there studying macroinvertebrates, the more we know. In that, the study of something creates value for it. The more people that volunteer to get to know these critters and care about them, the more macroinvertebrates will matter by virtue of being cared about. And you don't just have to love the bugs—macroinvertebrates are foundational to the food web. If there isn't a healthy macroinvertebrate community, there won't be healthy fish, waterbirds, amphibians, etc. If you want to take care of the biggest parts of the ecosystem, look to the base.

Look to the aquatic macroinvertebrates!

Thank you Danelle Haake for all that you do for your program and for contributing to this article!

Works Cited:

About RiverWatch. (n.d.). The National Great Rivers Research & Education Center. Retrieved February 7, 2024, from http://www.ngrrec.org/RiverWatch/about/.

Chen, P. (2018, September 22). Macroinvertebrate Biotic Index Calculator. http://peterchen.nicerweb.com/RiverWatch/MBI_calculator.html.

Harris, T. L., Lawrence, T. M. (1978). Environmental requirements and pollution tolerance of trichoptera. Environmental Protection Agency. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=91019ZU4.txt

Tier 2 Benthic Monitoring. (2024). Chesapeake Monitoring Cooperative. Retrieved February 7, 2024, from https://www.chesapeakemonitoringcoop.org/monitoring-programs/cbp-stream-health-assessment/.

ALLARM's use of Macroinvertebrates

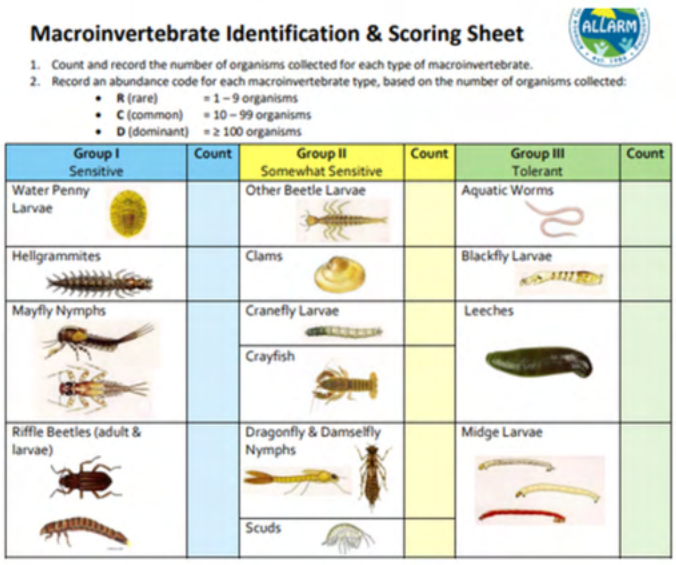
By: Amaya Hamilton '24

At ALLARM, we utilize different methods of assessing the health of our waterways – this includes macroinvertebrate counts in addition to the monthly chemical testing ALLARM's volunteer monitors participate in. Nitrate, pH, and orthophosphate measurements show the stream's condition at the moment data is collected, but these chemical tests do not provide a look into the overall or long-term condition of a stream. Since macroinvertebrates live in streams, the types of macroinvertebrates present and how many individuals make up these communities can give insight into how healthy a stream is. Differing macroinvertebrate species have a range of

tolerance to stream contamination, so having more species diversity present at a site suggests a stream that is healthy, compared to an unhealthy stream which would likely have low species diversity with a higher abundance of pollution-tolerant individuals.

In addition to the monthly stream monitoring that ALLARM's volunteer water monitors participate in, trained monitors may also complete macroinvertebrate counts each year at those same sites. ALLARM hosts workshops that teach volunteers how to identify macroinvertebrates down to order level so that volunteers can sample their sites. At these workshops, ALLARM walks attending volunteers through the macroinvertebrate collection protocol created by the organization. Attendees, with ALLARM mentorship, will go down to a local stream and participate in several practice "kicks" where stream substrate is disturbed to dislodge the macroinvertebrates from their habitats (rocks, sticks, leaves etc.) and into kick nets. We then sort the caught macroinvertebrates, following a dichotomous key, to determine which macroinvertebrate orders are present and how many individuals belong to each identified order. The goal of these workshops is to give volunteers the tools and knowledge to collect and identify macroinvertebrates independently with any collected data reported back to ALLARM yearly.

ALLARM encourages volunteers to utilize macroinvertebrates.org which provides identification suggestions for macroinvertebrates commonly found in Eastern North America. The site describes distinguishing characteristics of each order, has images of macroinvertebrates, and rates their pollution tolerance. For practice, users can also utilize flashcards and quizzes to build familiarity of these macroinvertebrates.



Macroinvertebrate Identification & Scoring Sheet

1. Count and record the number of organisms collected for each type of macroinvertebrate.
2. Record an abundance code for each macroinvertebrate type, based on the number of organisms collected:
   - **R** (rare) = 1 – 9 organisms
   - **C** (common) = 10 – 99 organisms
   - **D** (dominant) = ≥ 100 organisms

Group I Sensitive	Count	Group II Somewhat Sensitive	Count	Group III Tolerant	Count
Water Penny Larvae		Other Beetle Larvae		Aquatic Worms	
Hellgrammites		Clams		Blackfly Larvae	
Mayfly Nymphs		Cranefly Larvae		Leeches	
		Crayfish			
Riffle Beetles (adult & larvae)		Dragonfly & Damselfly Nymphs		Midge Larvae	
		Scuds			

Modified from ALLARM's Stream Team Macroinvertebrate Monitoring Manual.

While ALLARM has its own methods for identification and sample collection, there are other great resources out there! CreekCritters is a great app that teaches users how to collect and identify insects. The app provides a list of supplies needed and a step-by-step tutorial on how to collect macroinvertebrates, as well as an identification tool which walks users through a dichotomous key using drawings and images. Data collected by the user is

compiled to create a stream health report to assess the quality of the stream and the app uploads this information to the Clean Water Hub.

The app iNaturalist is also a useful source, as users can take photos of macroinvertebrates and upload them to the app for identification help. iNaturalist makes guesses about the macroinvertebrate based on the image, and other users can comment what they believe the species is. This resource is helpful for those who may struggle using dichotomous keys or who would like a second opinion about specific macroinvertebrates.

For in-office use, ALLARM is working on creating a preserved specimen collection of macroinvertebrates gathered from local streams. The project is in its beginning stages, but the end goal is to have many samples of macroinvertebrates preserved in resin. We have already tested various methods of preservation and are excited for when we can have a library available as references for the ALLARM team, campus collaborators, and volunteers who want to see real life samples of the macroinvertebrates found during stream sampling.

Opportunities for individuals to learn about macroinvertebrates are everywhere. Books, preserved specimens, internet resources, and apps can be obtained for practice purposes or for identifying during macroinvertebrate collections.

Amaya Hamilton '24 experimented with different methods of preserving macroinvertebrates for educational use. This method used an ice cube tray and resin.

Senior Reflections from the class of 2024!

Amaya Hamilton

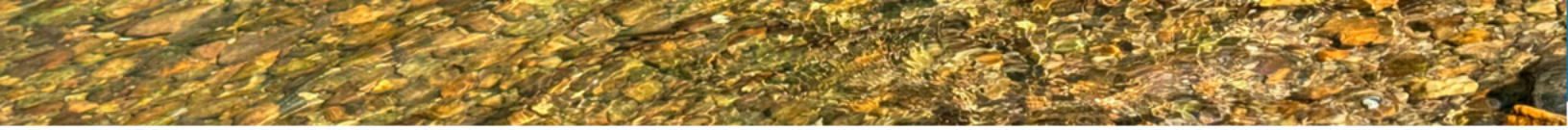
As my time with ALLARM wraps up, I am sentimental thinking about all the wonderful people I have worked with and all the new experiences I've had. When I applied to ALLARM, I had assumed the organization would utilize me for my laboratory knowledge I had garnered through my classes, but as I grew my skill set through my education at Dickinson, ALLARM has allowed me to apply these skills in unique and creative ways. I learned GIS software and specimen preservation at Dickinson and continued to build my knowledge in these areas at ALLARM. With each of my projects and involvements at ALLARM, there have been new things to learn and obstacles to overcome, and through these complications could have discouraged me, the organization has given me the tools to find solutions on my own, as well as taught me to embrace my mistakes as a learning opportunity. At ALLARM, I have learned to take pride in my own work and value how my efforts, along with others', contribute to goals bigger than ourselves. Through many volunteer meetings and workshops, I have met people of all backgrounds and experiences who had dedicated time and energy to monitoring their waterways. These volunteers have shown me how community science can empower people to participate in scientific discussions, gather data, and protect their environment. When I started college, I was focused on learning how to do science, yet it was my time at ALLARM which showed me what science can do for people. As I finish my final semester at Dickinson, I want to carry these experiences on to the next chapter of my life, continuing to do science with the focus on how science can be leveraged to better our world.

Michelle Hom

Every moment at ALLARM has been so valuable for me, and I am going to miss the amazing community I have gotten to work with over the past 3 years. Each year I have seen myself grow more confident and passionate in my role as a Watershed Coordinator by getting to work in all areas at ALLARM. I first started out in the lab measuring water samples my sophomore year. My time in the summer and into my junior year allowed me to dive more into training and working with volunteers. Finally, for my senior year, I got the opportunity to create the Stream Team newsletter that went out via email and conduct research on the role of local knowledge in participatory science. One of my favorite memories was during my junior year when I attended my first macroinvertebrate workshop. I enjoyed working with the volunteers and seeing how excited they were after they identified a macro correctly! I also loved spending quality time with my fellow ALLARMies and getting to know them more as individuals. Overall, I think this example is a testament to my time at ALLARM. Everyone at ALLARM is truly welcoming, kind, and supportive. Each person I have worked with has shaped me to become a better co-worker, student, and person, and I cannot thank the team enough for that. ALLARM has always been a constant during my time at Dickinson, and I am glad I always had a group to lean on. From my experiences and the skills I have developed at ALLARM, I am ready and excited for what lies ahead in my future. To my amazing ALLARM team: I love you all, and I know that you will continue to achieve and do amazing things at ALLARM. :)

Charlotte Kratovil-Lavelle

Spring of 2021 was an odd time to be a freshman in college. Sitting in my dorm room on Zoom (which is how I spent a not insignificant amount of time that semester), I remember learning about ALLARM for the first time during an introductory environmental science class. At the time, I was eager to learn more about environmental policy, particularly the Clean Water Act, with the intention of pursuing environmental law after college. Looking back at my ALLARM application from that spring, it's incredible to think about all that has happened and changed since I submitted that application. Now wrapping up my third year with ALLARM, I can say with certainty that this job has had an incredible impact on my life. Right off the bat, ALLARM challenged my preconceived ideas of professional norms (think Wall Street) by always providing a safe and comfortable working environment where I knew my human needs came first and where I was surrounded by colleagues who wanted to help me succeed. Through my work with ALLARM, I came to understand and gain an immense appreciation for community science. ALLARM has taught me that engaging with and learning from communities is an invaluable tool for increasing our knowledge of a scientific issue, promoting environmental stewardship, and working towards a more just and equitable future. I have had the wonderful privilege of participating in a variety of volunteer and community events, from my first in person Stream Team meeting in Susquehanna County to my most recent check in meeting with Dauphin and Lebanon Counties. As someone who began their ALLARM experience in our lab, it was wonderful meeting the individuals behind the quality control bottle labels. Perhaps the most meaningful aspect of my work with ALLARM has been engaging with our volunteers and helping to illustrate to others the importance of community-centered science and environmental action. I am incredibly grateful for the ALLARMies who came before me and helped to guide me my first year (Nick and Grace, you are missed), for the incredible senior staff (Stephanie, Phoebe, Lindsay, and Isabel, thank you), for my fellow ALLARMies who I have shared wonderful experiences with over the years, and of course, for Jules Vastine, my fellow Eastern Shore native who I couldn't be more grateful to have met. My days of Zoom class in a freshman dorm should be behind me, but I am confident that my experience with ALLARM will stay with me and guide my future endeavors as a scientist, community member, and life-long Stream Team enthusiast.

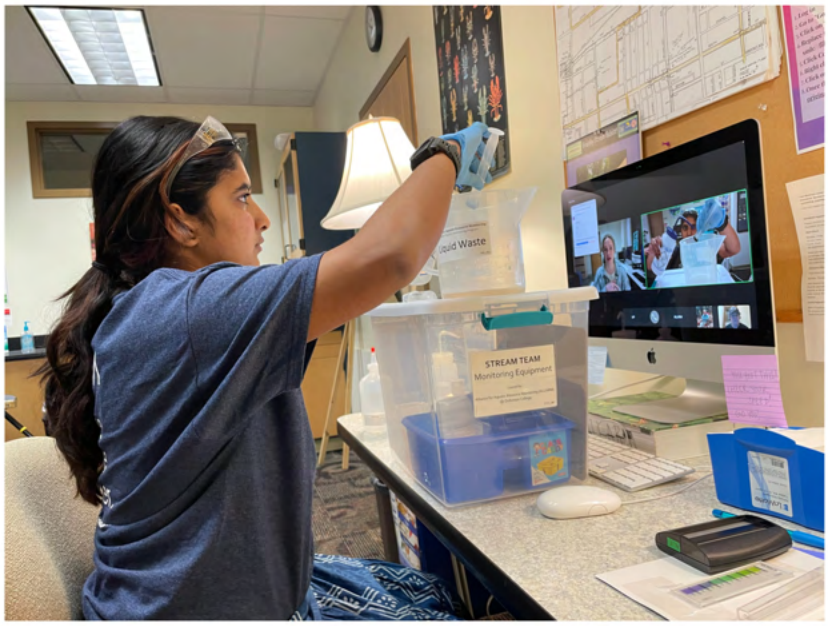


Whimsy Mark-Ockerbloom

I joined ALLARM the second semester of my sophomore year without a real sense of what I was doing. I was meandering my way through college at that point—I barely knew my major plans and wasn't thinking at all about life after Dickinson. ALLARM was something I might as well do, since it seemed cool. How far we've come since. ALLARM has given me immense purpose, helping me hone my interests and passions and being an incredible work environment where I was able to find my feet and direction. I found job opportunities, made friends, learned new skills, got to actually apply the things I was learning in classes, and developed a lifelong obsession with aquatic macroinvertebrates (woo scuds!). I went from not knowing where I was going academically or professionally to having a specialty at my job, professional contacts, a team of friends as peers, and a 5-year plan. I've worked at ALLARM during the school year and over the summer, and while both experiences were uniquely different, they worked in tandem to help me decide that I truly love community and field science not just as an academic supplement but a full-time job. I have at all steps been supported by an incredible team of full-time staff, who have curated the ALLARM environment into a second home. My main piece of advice to my younger self: join ALLARM sooner!

Prerana Patil

Working at ALLARM has been a journey in the best way possible. It began in the lab as a sophomore, doing analyses and QC, to the data and outreach worlds in my junior year and is ending in the world of research. All throughout, I've written, I've worked and met with volunteers, and I've been surrounded by the most welcoming and supportive work community. One of the themes I spent a lot of time thinking about at ALLARM is capacity building. In the way that ALLARM attempts to build capacity in their volunteers and how that's successful. I've been thinking a lot recently about how ALLARM has built my capacity. Sure, I've had a lot of practical experience and I've gained a lot of hard skills and insight into the non-profit/participatory science worlds, but I feel as though on a deeper level my time at ALLARM has built my personal confidence, my sense of connection to Carlisle and my confidence that out there, there are good people who care about their environments and want to help them. In the harder parts of my Dickinson experience, ALLARM has been there for me in a way that no other part of the community was. I owe a lot to ALLARM and the people who made working here so incredible! I want to take an opportunity to specifically thank Phoebe Galione, Stephanie Letourneau, Isabel Ruff, and Lindsay VanFossen for creating the most wonderful working environment and being such lovely role models. I want to thank Charlotte Kratovil-Lavelle and Michelle Hom for the best comradery during this 3-year stint at ALLARM (shoutout ENST 162!). I want to thank Jules Vastine for being an incredible mentor, rock and friend! And finally, I want to thank all of the ALLARMies that have been a part of my time working here – you're all exemplars of tenacity, passion, diligence and a good time!

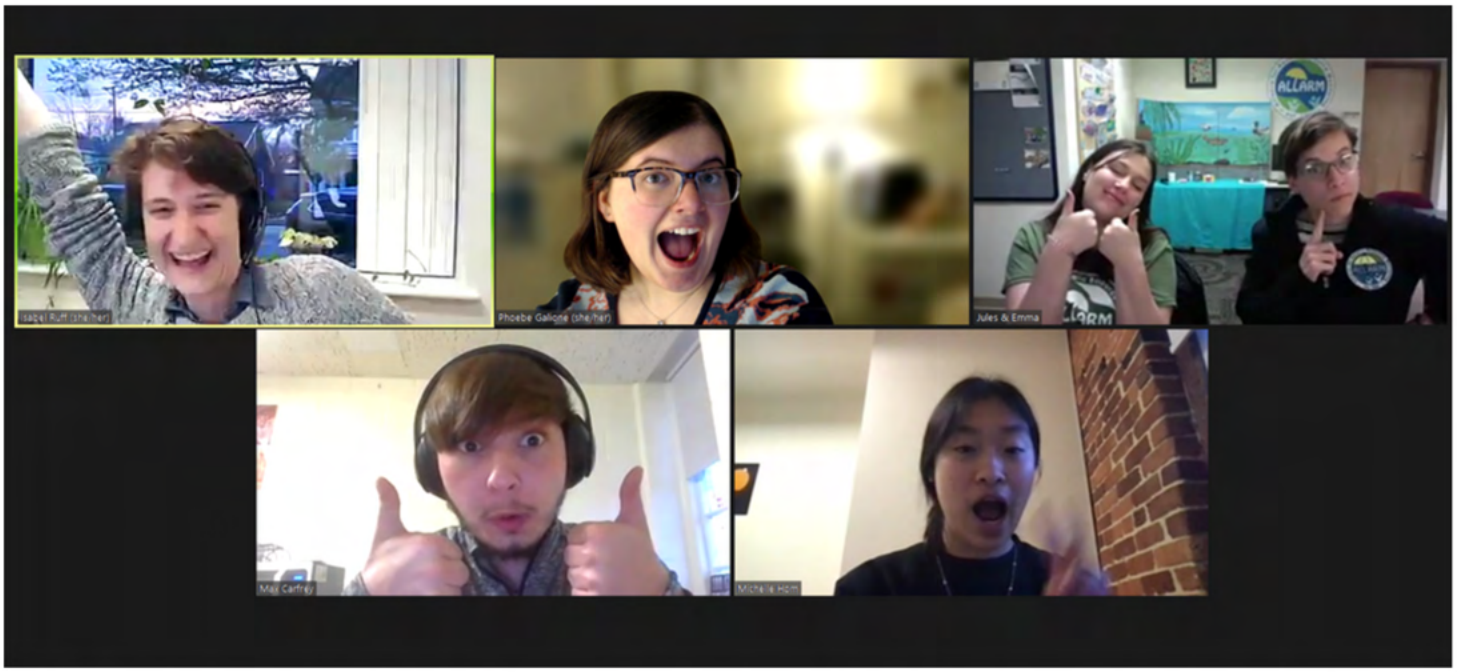


ALLARM in Photos!

ALLARM full-time staff pose with the seniors for an end of year photo! From left to right: Phoebe Galione, Lindsay VanFossen, Prerana Patil '24, Michelle Hom '24, Amaya Hamilton '24, Charlotte Kratovil-Lavelle '24, Whimsy Mark-Ockerbloom '24, Isabel Ruff and Jules Vastine.

Left: Michelle Hom '24 presents to an Environmental Studies class about volunteer collected data. Right: Whimsy Mark-Ockerbloom '24 helps full-time staff collect macroinvertebrates on a chilly November day.

Left: ALLARM attended the Chesapeake Watershed Forum in West Virginia and, after a long, engaging day of session attendance and networking, posed together for a group photo.
Right: Amelia Harper '25 walks volunteers from Lycoming County Stream Team through conductivity calibration at a Quality Control Check-In meeting.



The ALLARM team celebrates after a successful Stream Team Data Interpretation meeting where they primed volunteers on the influencers to water quality and how to go about interpreting data.