THE OVERLAP OF CITIZEN SCIENCE AND PLACE-BASED LEARNING

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Everybody lives in a place. We often organize ourselves around each other in towns and cities. But towns and cities do not exist by themselves; they are inherently tied to the ground they are built on and the water that flows through them. The concept of place "is defined by its human scale: a household, neighborhood, community, forty acres, one thousand acres" (Orr, 2013, p. 184). No matter how disconnected they may seem, our places have a direct connection to the natural environment. It then follows that whatever happens in our backyards, cities, and towns affects their respective natural environment, both on local and global scales.

Consider the raindrops that fall onto your roof and property. Clearly, that water does not stay confined to your property lines. The natural world does not recognize the boundaries we have created for ourselves. Some of that water will eventually find its way to a close by waterway after travelling through a stormwater system. Stormwater is the water from precipitation events that does not soak into the ground due to impervious surfaces like compacted soil and asphalt. It carries whatever pollutants it picks up from our lawns, streets, and other surfaces to the waterway it drains into, if untreated. Therefore, everyone has an intrinsic connection to their respective watersheds through their use of the land and water. The term watershed, like our concept of place, is also flexible in its scale. The watershed of your local stream lies within the watershed of the big river it eventually flows into, which then empties into the ocean.

However, downstream impacts often lie out of sight of a place's inhabitants until the consequences reach a drastic level. In general, individuals living in the developed world no longer depend on their immediate places for "food, water, livelihood, energy, materials, friends, recreation, or sacred inspiration" (Orr, 2013, p. 184). This phenomenon has fostered a mental disconnect between ourselves and our places of inhabitance, as we lose sight of the importance of protecting our local environment. The local landscape no longer provides direct resources in the eyes of its inhabitant, who buys food from a supermarket and turns a faucet for seemingly endless potable water. This blurs what should be a clear picture, which is the importance of local environmental quality for its people and how it plays into the global environment. Until our natural resources are in jeopardy and our economies and livelihoods are at stake, we tend not to notice much of our effect on nature.

Here in Carlisle, the home of Dickinson College, our stormwater runs into the LeTort Spring Run, which flows into the Conodoguinet Creek, which empties into the mighty Susquehanna River and finally the Atlantic Ocean through the Chesapeake Bay. This may be conjecture, but you would be hard-pressed to find people in Carlisle discussing how their lawn fertilizer might be affecting the Susquehanna, let alone the Bay. The Chesapeake Bay's poor

health has been acted upon for only as long as it has noticeably affected its communities and economies (Davison et al., 1997). The Bay's waters used to seem to offer endless supplies of fish, crabs, and oysters, at least until fishing vessels began to return to shore with less in their nets and traps. It takes time and effort, especially in the faraway communities, to notice and internalize our relationship to the Bay and what it provides humans. Nevertheless, there are now many praiseworthy efforts at the community and governmental levels across the Bay watershed aimed at curtailing the pollution going into the Bay. These efforts have increased and will continue to do so as people in the Bay watershed states become more aware of how their actions impact the Bay and its natural resources (Davison et al., 1997). The adoption of a place-based philosophy in our thinking and education is one strategy that can reconnect us to our places, like the Chesapeake Bay, and invigorate our passion for protecting them.

1. Untitled [c] pixabay.net CCO

Among many other things, "place-based consciousness means learning how to reinhabit our communities and regions in ways that allow for more sustainable relationships now and in the long run" (Smith, 2007, p. VIII). We can approach any number of problems with place-based education, a branch of place-based consciousness. David Sobel writes that placed-based education emphasizes "hands-on, real-world learning experiences, […] helps students develop stronger ties to their community, enhances students' appreciation for the natural world, and creates a heightened commitment to serving as active, contributing citizens" (2004, p. 4). Place-based education can be utilized in many different contexts, such as education in schools and other programs. For the purposes of this article, we will examine place-based learning, citizen science, and what they can do for each other.

Citizen science goes by a number of other names (community science, public participation in scientific research, etc.). Its goal is to involve community members/citizens/"non-professionals" in a scientific process. Of particular note is the use of citizen science as a means of environmental monitoring, which includes water and air quality, bird migrations, and a great deal of other exciting projects. Community members' involvement in environmental monitoring projects provides the prospect of expanding our capacity to learn about environmental quality at new spatial and temporal scales. As the movement continues to grow, participating communities become more conscious of environmental quality and develop

social capital (Conrad and Hilchey, 2010, p. 280). Perhaps more importantly, citizen science initiatives help cultivate a strong, informed community of people who can advocate for their natural resources. The EPA's National Advisory Council for Environmental Policy and Technology recommends that the EPA work on "emphasizing the power of place" while integrating citizen science efforts into its environmental monitoring work (NACEPT, 2016). Our collective, large-scale knowledge has much to gain from the place-specific knowledge that only inhabitants hold. The experiential knowledge that citizen scientists have and develop feeds into their collective place-based consciousness at the same time that place-based consciousness informs and directs citizen science.

Citizen scientists have diverse backgrounds and bring invaluable experience and knowledge into projects. These individuals have ties to their locality and place that make them excellent and unique candidates for monitoring their environment. The term place attachment "broadly encompasses aspects of identity, physical or social dependence, and emotional connection to specific aspects of the physical environment or other creatures that share such space" (Haywood, 2014, p. 70-71). This concept provides words for the special knowledge that only inhabitants have, which can then be shared through those inhabitants' involvement in citizen science initiatives (Newman et al., 2017, p. 56). Who, aside from its inhabitants, could have intimate knowledge of the seasonal patterns and ecology of a specific place? Depending on the project, participants may even visit their study site on a regular basis. Repeated visits escalate their understanding of their sites and respective ecosystem, which is then compounded by the explicitly observant and scientific lens citizen scientists look through (Haywood, 2014, p. 71).

2. Citizen scientists train for macroinvertebrate monitoring in the upper reaches of the Bay watershed

Community members who involve themselves in citizen science projects can be generalized as being conservation literate, especially when it comes to their local environment. Additionally, these projects are typically place-specific and local because they need to meet community members where they are geographically. This creates a promising formula for addressing place-specific, scientific questions and spreading the information generated by the project. Connections between the local environment, its inhabitants, and the overall community may be strengthened through citizen science, as it offers an avenue for motivated

community members to actively observe their landscape and share their findings with the rest of the community. By organizing around a local scientific question, citizens can empower themselves and others and activate their specialized knowledge. Participation in citizen science projects has also been demonstrated to increase peoples' conservation action, which includes changing personal behavior and contacting government officials according to conservation goals (Haywood, Parrish, and Dolliver, 2016, p. 483). Citizens who are already motivated to participate in environmental monitoring are a force to be reckoned with in the political arena because they actively seek the protection of their environment through citizen science. Their involvement gives them new information and increased confidence that allows them to advocate for their natural resources and spread the word to their peers.

ALLARM works to assist community science projects centered on water quality monitoring. We have the privilege of working with the amazing citizens who involve themselves in protecting their local waterways, and our work would mean very little without their dedication and knowledge. Students are typically drawn to ALLARM because it marries both environmental science and community work. The multi-faceted work of ALLARM lends itself to giving students opportunities to interact closely with community members. ALLARM staff had the opportunity to share their stories about their experiences at community events and ALLARM's work in general through responding to a survey. This survey was geared towards learning about how the place-based knowledge of community members contributes to that of the ALLARM staff through their interactions. Many of the quotations throughout the rest of this article are taken from their survey responses.

A recurring event called the Conodoguinet Snapshot brings around thirty volunteers to the ALLARM workspace each season to test water samples they have collected from the Condoguinet Creek and some of its tributaries. Repeated interactions with these participants led to some ALLARM students realizing "how many members of the community are aware of the factors affecting their stream health." The Snapshot gives its participants a chance to share their local knowledge of the area and how weather, land use, and time of year

3. **Watershed Coordinator Allison Curley looks over maps and data from previous Snapshots with some of the participants.**

might affect water quality. ALLARM students have also noticed that “many of the volunteers grew up in the Carlisle area and therefore have a lifetime of knowledge about the local environment and how it has changed overtime.” Beyond water quality, one staff member even “learned about an invasive moth that affects trees in PA.” Place-based learning effortlessly reveals itself through citizen science and community events.

ALLARM students’ sense of place may be focused on the Greater Carlisle community and the LeTort Spring Run and Conodoguinet Creek, but it also extends to whichever communities they work with. We may only spend a day or two with each community, but we learn a lot about each place through our conversations with community members. Our shale gas program brings us to communities in Pennsylvania, New York, and West Virginia, but state borders aren’t the only lines we cross. We also cross major watershed boundaries, from the Chesapeake Bay watershed to the Mississippi River watershed and back again. Community members, as we have already established, have specialized knowledge of their respective places. Water quality monitoring workshops and other community events frame the conversation for us and open the floodgates of the participants’ brains. There exists a special, mutually beneficial exchange of information, as ALLARM provides technical assistance and training for community members while they share their local experience with us. This give-and-take bolsters each party’s capacity to fulfill their role in the community science project. The community scientists learn water quality monitoring techniques and how to work towards achieving their goals, while ALLARM staff may better understand the environmental issues, politics, and cultures unique to different parts of the program’s geographic reach. One member of the ALLARM staff explained that she feels “geographically connected to most of our shale gas volunteers in PA” because she has interacted closely with most of them in-person or on the phone. She said, “that has given me the opportunity to hear about what is going on in their areas and has helped me feel as connected to that place as possible.” Another ALLARM staff-member mentioned that the “emotional and intellectual investment of our volunteers in their local water quality” consistently stands out to her during community events. She went on to say that “the knowledge and investment of community members is one of [our] most indispensable and irreplaceable resources.” Another staff-member demonstrated how, “most times I go into workshops or events thinking I will be an expert, but the true experts are the people who live in the location.”

These workshops and community events also serve as a meeting ground for likeminded citizens. An ALLARM student shared that "it often happens that when a community member asks a question during a workshop presentation, another community member supplements our response with an additional piece of local knowledge that we would not have otherwise had." Orr's writing corroborates this observation, as he describes how studying the local environment together acts as "the basis for rational coordination and planning and as a vehicle for widespread public participation" (2013, p. 185). Haywood also writes that "the basic procedures involved in monitoring and analyzing natural phenomenon are used as platforms to unite scientists, communities, and stakeholders across scales, help frame socially legitimate indicators of environmental problems, and advance locally relevant and practical conservation goals and strategies" (2013, p. 65). Community members participating in the workshops must coordinate and cooperate with each other to a certain extent for their monitoring program to be successful. Together, they can address environmental questions and present their results to the rest of the community. Ideally, solutions will follow from those results.

4. **Outreach Manager Natalie McNeill assists community members with ALLARM's shale gas monitoring protocol.**

Each water quality monitoring workshop requires special attention that is specific to the region of focus. Through our shale gas program, ALLARM students create and work with maps detailing the unconventional well (otherwise known as hydraulic fracturing or fracking) activity and waterways in a given area as well as conduct chemical analysis for quality control on the water samples flowing in from those areas. One student who works in the lab noted that "it is interesting to see the relationship between the areas where more shale gas is being extracted and where pollution levels are highest." As these components of the shale gas program coalesce and members of the ALLARM staff collaborate and share information, we can form a more complete picture of how shale gas extraction impacts waterways in different areas. Beyond their knowledge, community members' passion for environmental issues feeds the fire of the ALLARM staff's passion because they realize "that people from all different walks of life are drawn to water quality monitoring." Coupled with the data-driven parts of the shale gas program, the energy and devotion of volunteer monitors nourishes the ALLARM staff's

consciousness of the environmental justice issues presented by hydraulic fracturing in Pennsylvania communities. We gain unique insight into both the scientific and social aspects of this issue from the stories and data that citizens share with us.

Oftentimes, the most ecologically-versed locals are longtime anglers, hunters, and other outdoor recreationalists. By immersing themselves in an environment, especially in the context of hunting and fishing, these people must 'tune into the landscape' to some extent. Paul Errington, a distinguished wildlife ecologist, spent much of his early life in the outdoors. Kohler (2011) notes that "in his hunting and trapping he developed habits of close observation and analysis of what he saw that were also those of a naturalist" (p. 224). Errington also grew to be a close associate of Aldo Leopold, the father of the famous land ethic. Leopold, "like Errington, developed an early and passionate attachment to outdoor life. He too became an avid hunter and outdoorsman" (Kohler, 2011, p.226). In *A Sand County Almanac*, Leopold wrote that "we abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect" (Leopold, 1949, p. viii). In many ways, Leopold's land ethic embodies our idea of place-based consciousness. Throughout its 33-year history, ALLARM has engaged with the outdoor enthusiast community and its conservation organizations. Anglers and hunters comprise a considerable portion of conservation efforts, partly because they have some stock in the wellbeing of the environment. Their many outdoor experiences lend themselves to developing a deep sense of place and ecological literacy. Orr quotes John Dewey's statement that, "we cannot overlook the importance for educational purposes of the close and intimate acquaintance got with nature at first hand" (Orr, 2013, p. 186). The most ardent conservationists typically have closely held memories within nature and a remarkable sense of place.

5. "Fly Fishing on the South Santiam" [c] Peter Forsyth for commons.wikimedia.org CCO 1.0

The many community partners we work with inhabit all sorts of places, but they share important qualities. For one reason or another, they have the motivation to care for their local waterways. The place-specific work of community watershed associations alongside that of other groups sums up to a large scale collective of effective environmental stewardship. Part of

ALLARM's mission is to show community members that they have the knowledge and skills necessary for effective environmental monitoring. One student wrote that "if a person is equipped with the tools and knowhow to conduct monitoring, they can make environmentalism a personal and location-specific practice." We embrace the ideal of thinking and acting globally and locally, which we satisfy through citizen science. Armed with results and confidence, empowered communities can better protect their natural resources.

ALLARM works as part of the Chesapeake Monitoring Cooperative (CMC), whose mission it is to integrate volunteer water quality monitoring data into the Chesapeake Bay Program. As part of our work through CMC, ALLARM forms partnerships with community groups interested in doing citizen science in Pennsylvania and New York's share of the Bay watershed. The Otsego County Conservation Association (OCCA) of New York is one such community partner. ALLARM takes each community partner through a well-defined study design process to best address their needs and concerns. To establish a successful and meaningful monitoring program, we ask our partner to first define their group's mission. After that, we ask them why they are monitoring, which touches upon the watershed's history, land use, environmental concerns, how they will address these concerns, and how their overall monitoring goals align with the group's mission. We then identify what water quality indicators the group wants to monitor, along with the specifics of how they will monitor them.

This process is, by necessity, heavily based in the specific place the group operates in. For Otsego County, much of the land use in their watershed is devoted to agriculture. OCCA therefore identified high nutrient levels in their water as a key concern of theirs, which they address through monitoring levels of nitrate and orthophosphate in the water. ALLARM staff met with OCCA staff and leadership to go over the study design. Part of the meeting also included talking to scientists from labs in the area and a representative from the local Soil and Water Conservation District. ALLARM was able to advocate for the credibility of volunteer-collected data when it was called into question by people in the meeting. After completing the study design process, ALLARM and OCCA moved on to the quality assurance/quality control process, which ensures that the data collected will be credible and of known quality. This process includes training the volunteer monitors as well as analyzing their samples either in our lab or elsewhere to make sure that they are collecting data properly and according to procedure. In OCCA's case, they send their samples to the close by SUNY Oneonta Biological Field Station. Volunteer monitors working on OCCA's project contribute to our collective understanding of the Chesapeake Bay watershed, which, when summed with other monitoring

initiatives, paints a more complete picture for resource managers, government officials, and communities.

Monitoring the water quality of local waterways is an excellent way for people to become more attached to their places. Streams and rivers carry with them the story of the surrounding and upstream land. Should there be a forest cut down upstream, the water quality will reflect that, albeit to varying degrees. Pennsylvania is an especially strong example of how waterways inform us about human impacts on an environment. With the greatest mileage of waterways of the lower 48 states, second only to Alaska, our waters make up a network of pathways reminiscent to our circulatory system. Just like we might test our blood for impurities, we can test our waters for the same purpose. In the context of water quality monitoring, the hard part is diagnosing how humans disturb their local natural environment. To use the Harrisburg-area as an example, we can point to our agricultural practices as the source of much of our high levels of nutrients and sediment.

Although this melding of place-based philosophy and citizen science sounds great on paper, there is more investigation to be done. Haywood (2013) notes that "expanding the PPSR [public participation in scientific research] research agenda to include inquiry on sense of place is particularly pertinent and timely given the extensive socioecological challenges of the twenty-first century" (p. 77). ALLARM, as an organization primarily focused on citizen science, has a role to play in this investigation. We can work towards this goal by collaborating with other citizen science groups and environmental protection entities. Identifying the benefits and dynamics of place-based learning in concert with citizen science lends itself to harnessing the two more effectively.

As our government officials call into question funding for environmental monitoring projects, citizen science increasingly becomes a source of hope. Let us keep the ball rolling and perpetuate the growth of citizen science. Each town is home to people with deep knowledge of their place, and their full potential to channel that knowledge towards citizen science, civic engagement, and conservation has yet to be realized. Now more than ever is the time to feed into our desire to learn more about our environment and how it is changing, both on local and global scales.

6. Members of OCCA and ALLARM celebrate after a productive study design meeting.

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Photo 1: [crab pots offshore] 2018 https://pixabay.com/en/westport-crab-pots-crab-crabbing-3428426/