What is your project?

Public Lab Open Water: Mystic River project has two main components: 1) the development of a low-cost, open source water quality monitoring device, the 'Riffle', that will allow everyday citizens to collect and easily share local water quality data; and 2) a local community support structure (a 'civic water monitoring node') which will provide technical assistance, training, workshops, as well as a local interface with advocacy groups, academics, and journalist, to communities that would like to engage in assessing water quality issues in their local area. Based on our experience, we believe that both components -- accessible monitoring technologies, as well as the support systems for collecting, interpreting, and sharing the resultant data and narratives -- are equally important components of a successful community monitoring effort.

Part 1: The Riffle. The Riffle is an 'open hardware' water monitoring prototype, developed collaboratively within the Public Lab community, that will cost around $100 to produce, and will rely on a recycled plastic water bottle as a housing. Like many of the sensors commonly used today in hydrology research, the Riffle is intended to be placed in a river, lake, private well, or house water supply (e.g. the toilet water tank), and record, over time, some of the most commonly-measured water quality parameters: temperature, conductivity, turbidity, depth -- assessing, for example, road salt contamination of river networks, or the impingement of hydraulic fracturing fluid chemicals into local drinking water supplies. But unlike most water quality sensors used today, the Riffle is a completely 'open source' design, allowing the community to quickly and easily make improvements and add new capabilities. While most water quality sensors require an expensive software license, additional hardware to retrieve the data, and generate a proprietary data format, the Riffle is designed to record its data directly to a microSD card in a plain text format, making sharing the data very easy. In true open source fashion, the Riffle is a close cousin of the Arduino UNO, so that the thousands of UNO tutorials, video trainings, and educational websites are also relevant to the Riffle. In its current form the Riffle will last approximately five months on three AAA batteries, and its sensors fit inside the cap of a recycled water bottle. We believe that this design (or some open source variant of it that we hope to encourage) will be uniquely accessible for participants in community watering monitoring efforts, allowing citizens to become stewards of their local water resources; so, the first main component of our project is to continue to co-design, test, and refine this prototype with our partners in the Mystic River Watershed Association. Our specific goals for this part of our project during the initial 6 month timeframe are to ensure that we have a basic sensor that can measure temperature, conductivity, and turbidity -- basic, but very informative water quality parameters -- in a robust fashion.

Part 2: A Civic Water Node. Because water quality issues can be quite complex, the second part of our project is vital to ensure that citizens who wish to use DIY environmental monitoring technologies (like the Riffle, and others) are able to effectively collect, interpret, and share their data. Our aim is to pilot the first in a series of 'Civic Water Nodes', self-supporting, sustainable, local social 'support structures' that will provide a meeting space for environmental education, technical support, and an interface with representative members of the various stakeholder groups in a watershed -- including citizens, water resource managers, advocacy groups, policy makers, scientists, and educators. We hope in this process to develop a framework for a replicable structure that will provide workshops, trainings, and meetings around DIY, open source environmental monitoring, and which can be implemented in several other communities after this 6 month period is over. The basic plan for our Civic Water Node pilot in the next six months is to gather a cohort of stakeholders -- as well as journalism students from Catherine d'Ignazio's Emerson College course -- to participate in all of three, four-hour water quality weekend workshops that will take place over the course of Spring 2015, focused on issues that pertain to the

Mystic River Watershed and its River Herring population. The workshops -- held at an alternative education center, Parts & Crafts, which will be the site for our pilot node -- will be the following:

Workshop #1: Water Quality Issues in the Mystic River Watershed In this meeting, we will first learn about the basics of water quality (similar to a recent meetup we had at the Center for Civic Media -- see RESEARCH NOTE). We will learn how measuring temperature and conductivity can contribute to a picture of the overall health of the Mystic River Watershed, and we will develop ideas for how we might use any data we collect to create meaningful narratives that speak to the interests of other community members, watershed managers, journalists, policy makers, and academics. We will then learn how to use a Riffle, and participants will choose a location of the Mystic for which they agree to become a 'water quality steward', deploying a Riffle there, to be retrieved later.

Workshop #2: Reports from the Field; Visualizing River Herring Habitat Data. The water quality stewards bring the raw data they've collected with their Riffle, along with pictures they'd taken of the monitoring site, unforeseen problems they'd faced, and what they hope the data will tell them. To make the water quality issues more grounded, we'll talk about historical challenges for the River Herring population in the Mystic River, and how the River Herring has become a signal and a symbol of water quality in the watershed. We'll brainstorm around ways of making this emerging story more public, and how we might engage other members of the community / stakeholders. The goal will be to emerge with some data visualizations about local water contamination and River Herring habitats.

(After Workshop #2, participants return their sensor to the field, correcting any errors they'd made, adjust the position of the sensor, redesign any identifying sign they'd made, and etc. Meanwhile, journalism students associated with the project will engage in historical and contextual research into the Mystic and the effect of its water quality on local drinking water and wildlife.)

Workshop #3: Lessons Learned; Public Storytelling; Next Steps. In this meeting, we review what we've collectively learned about what is required for an effective, grassroots water monitoring effort. What questions emerged, and which one of thems did we feel we could address with this technology? How should the methods and technology be improved? Journalism students will present the research and interviews they have collected, and community members will work together to present their findings. We'll brainstorm around how this data might be used to support local advocacy goals, inform policy, and engage the rest of the community.

All of the planning, activities, and outcomes of these workshops will rely on Publiclab.org's online infrastructure -- research notes, wikis, and mailing lists -- so that by the end of the workshop series, we will have a collection of materials that will inform the design of a 'civic node infrastructure' and answer the core question: what is the most effective way of supporting local community in their monitoring efforts, and of helping them achieve their advocacy goals?

We will encourage community partners and individuals who participate in the civic node to enter the discussion with specific goals and ideas for desired outcomes. For example, myRWA is interested in gathering temperature data throughout the watershed in order to assess ideal habitats for river herring; they are also interested in engaging new audiences and volunteers; the optimal outlet for their work might take form of improved online content, or more local press. As a community learning space, Parts and Crafts is interested in developing curriculum for middle-school-aged kids and their families to engage in hands-on activities around water quality; this will result in more wiki-based tutorials and instructions on Public Lab's site. Academics like Mark Green and Catherine d'ignazio may wish to publish the outcomes

of their projects in academic journals focused on hydrology or civic technology design. We hope to structure this civic node collaborative space in such a way that all stakeholder's interests and methodologies are supported and enhanced in a collaborative environment.

Who is the audience/user of this project? How will they be impacted?

People of the Mystic River Watershed. We will be designing our pilot project to support people who live in and around the Mystic River Watershed of New England to explore and address issues around urban water contamination, and, specifically, the migration and health of the river herring, a fish species that plays an important role in the culture, ecology, and economies of communities in the watershed. In the past, millions of river herring swam through the Mystic, but their numbers have dropped considerably due to offshore fishing, pollution and dam construction. They have inadvertently become a local symbol for the effects of rampant contamination in the watershed, which recently received a 'D' grade from the EPA for water quality.

The Mystic River Watershed Association (MyRWA) has organized local residents around fish counts each spring for the last 16 years as part of an effort to evaluate the overall health of the watershed and raise local awareness of its problems. Our project will support these efforts through a mix of civic engagement through grassroots environmental monitoring, investigative journalism, academic hydrology research, environmental advocacy, and integration into middle school and college curriculum. Specifically, our audience includes:

- **Watershed community members, advocates, and volunteers** (Mystic River Watershed Association). MyRWA has a long history of advocacy and volunteer work in support of the Mystic. One of their goals is to raise awareness of issues faced by the Mystic, and to expand the scope of their volunteer water monitoring efforts. We'll be using the activities and individuals associated with this Civic node to assist MyRWA in learning to use lower-cost water monitoring technology, allowing them to deploy many more sensors than currently possible, and build up a far more detailed picture of water quality issues in the region; also, the civic engagement, investigate journalism, and community outreach components of our workshops will help MyRWA more effectively engage the public with stories of water quality issues that affect everyone in the watershed.

- Hydrologists. Mark Green, at Plymouth State University, has already developed an extensive citizen science volunteer network in order to better assess the impact of road salt on river networks in New England; specifically, he is examining the interplay between road salt levels and arsenic levels in river ecoloyg. This extensive network relies on proprietary sensors, costing thousands of dollars; and it is difficult for the indivdiuals in the network to retrieve the data from the sensors. By providing hydrologists like Mark with much lower-cost and accessible monitoring tools, the scope and robustness of his research program; and by using these open source tools in the college classroom, a a new generation of students is introduced to the 'open source ethos' in science.

- **College journalism students (Emerson College).** We will be building course curricula for Emerson College journalism students in which they will get hands-on training in sensor data collection and water science as well as experiment with new ways to tell environmental health stories using crowdsourced data collection. The curricula will focus on assessing the environmental and cultural issues in the Mystic, through investigative research, data gathering, a comprehensive evaluation of the impact of this 'civic

node' project. A goal for this audience is to help them find a way to broadcast these local environmental issues in a meaningful-way to other communities in New England.

- Professional journalists. A local public media station will work in tandem with the Emerson college journalism students to document and report on water quality monitoring efforts in the Mystic -- online and on-air -- to help amplify the students' message to a wider New England constituency. The larger storytelling goal is to use grassroots water quality data as a way of talking about the health impacts for animals and humans of the Mystic River, explore why the river is contaminated, and galvanize the local community around what we can do to clean up urban water systems.

- **Local middle school students and parents.** (Parts & Crafts). Parts and Crafts is an alternative education space devoted to facilitating hands-on, project-based learning for students and their families. Our project will provide a range of hands-on activities and water quality-related problems that will be folded into the Parts and Crafts curriculum. As Parts & Crafts moves towards an 'open hours shop' and 'tool lending library' model in its teaching, we hope to provide water monitoring tools to the community in an ongoing, accessible basis; community members can drop by informally, borrow a sensor, and ask questions about the data they've collected so far. This dynamic, in turn, enriches the Parts & Crafts learning community: students and parents are learning about environmental issues by focusing on real-world, local problems.

Who's on your team?

Our core team is composed of:

Don Blair
Public Lab Open Water Fellow
http://publiclab.org/profile/donblair

Catherine D'Ignazio
Assistant Professor of Civic Media & Data Visualization Storytelling, Department of Journalism, Emerson College
Profile: http://civic.mit.edu/blog/kanarinka/

Lily Bui
MIT Comparative Media Studies M.S. candidate, 2016 (expected)
Profile: http://lilybui.info/

Mark Green
Assistant Professor of Hydrology
Center for the Environment, Plymouth State University
Profile: https://www.plymouth.edu/center-for-the-environment/people/faculty-staff/mark-green/

Patrick Herron
Water Quality Monitoring Director
Mystic River Watershed Association
Profile: https://www.linkedin.com/pub/patrick-herron/12/82b/bb1

Will MacFarlane
Co-director, Parts & Crafts (http://partsandcrafts.org)

Katie Gradowski
Co-director, Parts & Crafts (http://partsandcrafts.org)

What assumptions will you test?
Full question on application form: What assumptions will you test? How will you know if the project worked or not?

1. Accessible technology: Is it possible to make a robust, inexpensive, open source water quality monitoring device that is easy for non-technical individuals to use?

2. Sensor Journalism: Is it possible to collect and interpret basic water quality parameters -- temperature, conductivity, and turbidity -- in such a way that people without a background in hydrology can find the data meaningful, and use it to convey meaningful stories to others?

3. Civic Engagement: what is the right mix of stakeholders in a grassroots monitoring effort, and can we create a replicable, sustainable model for local technical, social, and advocacy support?

4. Community Education: can we connect college and middle school curricula -- using sensors, data, and narrative -- to local environmental issues while impacting those issues in a meaningful way?

We will work with Catherine D'Ignazio at Emerson College to design an assessment mechanism to answer these four questions. As this is preliminary, we will focus on qualitative measures such as interviews with participants in the civic node and survey questions at regular points during the process. We will also include quantitative measures such as online participation in the Public Lab community. We expect to learn a great deal from this initial process which can inform the design of future civic nodes, ideally leading towards a replicable social and technical structure that will make water quality monitoring by communities possible and sustainable. We hope to publish this assessment as a white paper or in an open access academic journal and as a series of 'research notes' and wiki materials on publiclab.org.

What have you made so far?

- Public Lab's community, and the Open Water Project. The Public Lab nonprofit community, of which we are a part, has already developed an extensive online community that supports just these sort of grassroots environmental monitoring projects. The Open Water Project has grown up within this community around the idea of making grassroots collection of water quality data more accessible, effective, and democratic. We've assembled a large team of water resource managers, advocacy groups, hydrologists, and journalists interested in moving this project forward. Partners include: the Mystic River Watershed Association, the MIT Center for Civic Media, the Emerson Civic Engagement Lab, the Center for the Environment at Plymouth State, the Institute for the Study of Earth, Oceans, Space at UNH, the City of Cambridge Water Department,

More details here:
http://openwaterproject.io
http://publiclab.org/wiki/open-water

- Open Water Workshops. We have already held several workshops and meet-ups focused on the Open Water project, including workshops on:
'A Water Quality Primer':
http://publiclab.org/notes/donblair/05-05-2014/monday-5-5-14-at-mit-water-quality-primer-data-visualization-sprint
and 'Introduction to Conductivity':
http://publiclab.org/notes/donblair/07-15-2014/recap-open-water-workshop-july-12-2014

The Riffle. The Riffle technology has been in development for the past eight months. Currently we have a working prototype that measures temperature and conductivity, and we are in the process of collecting data about the validity of those measurements against industry standard water data loggers. The current design will be about 10 times less expensive than current water monitoring technologies, and employs a non-proprietary data format. For more details on the device:

http://openwaterproject.io
https://github.com/p-v-o-s/riffle-ito
https://github.com/walkerjeffd/riffle-ito-apps

We have already deployed two initial Riffle prototypes, measuring temperature, conductivity, and light levels, for several days alongside a USGS sensor maintained by the City of Cambridge Water Department, and the trends in our ($100) sensor data appear to correspond nicely with those generated by the ($6000) sensor that they are using:
http://publiclab.org/notes/donblair/08-01-2014/first-riffle-deployment-city-of-cambridge-water-department
We are planning further deployments soon to refine our instrumentation and enclosure design.

Parts and Crafts as a Civic Environmental Node.

Parts and Crafts (http://partsandcrafts.org) is an alternative education space focused on offering hands-on, project-based classes to middle school-aged students. Public Lab has a long history of working together with Parts and Crafts on educational material around its open source tools, and recently Parts and Crafts has begun to expand their scope: in addition to regular classes, they are now aiming to become a 'family / civic hackerspace', allowing parents and children to come in and work on projects together during 'open shop time'. Part of this new vision includes the idea of becoming a node in our proposed 'civic water network' -- including such activities as offering water quality workshops to the community, hosting regular meet-ups and discussions, and curating an environmental tool 'lending library'.