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Filling the information gaps with citizen-supplied water resources data on the Boyne River

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Black Boxes

Small metal black boxes are conveniently hidden underneath many highway bridges that pass over our rivers and streams. Inside are gauges that gather a variety of water resource data. These gauges are installed by the United States Geological Survey (USGS), the non-regulatory research-only agency responsible for understanding the water, geology, and biology of the United States. There are approximately 7,600 gauges gathering data essential for forecasting floods, characterizing water quality conditions, monitoring quantity of power production, recreation, culvert design, and wildlife habitat, among others.

As Earth's systems change, these unbiased and long-term data are critically important to understand, predict, and manage the health of our watersheds for all who depend upon these resources.

Maintaining the quality of long-term data has its costs. One box of gauges requires about \$18,000 to install and \$16,000 to \$21,000 annually for the USGS to service the box and house the data.

While the State of Michigan has almost 200 of these real-time USGS gauges, there are no gauges on the Boyne River. Yet, the Boyne River is an important stream to fish that live in it, to those who float and fish it, and depend upon its water. Many streams like the Boyne lack this information. The research project described below addresses this problem of a lack of data.

From Road Kill to Rivers: Citizen-Supplied Scientific Data

In the early 2000s, a researcher in California wanted to better understand the wildlife population. He asked citizens to report observations about wildlife-vehicle collisions, also known as, roadkill. People passing through would report what animals were struck and where. This information was input into a computer model of wildlife movement and used to improve understanding of wildlife populations, migration, and habitat.

Could the same be done for streams where there are no USGS stream gauges; could citizens supply necessary stream-flow data? Chris Lowry from the University at Buffalo and Mike Fienen from the USGS wanted to know if they could solicit citizen scientists to collect water-level data. In 2010, they put a water-level height gauge, basically a large ruler (Figure 1), at the Buffalo Audubon Society nature center in North Java New York and asked people who passed by the gauge to use their phones to text message the readings (data) to the researchers. These data were then use to model the hydrology of a stream and wetland. People provided information where there were none. This "crowd-sourced" data and the

network of gauges was dubbed CrowdHydrology and given a website (www.crowdhydrology.com). Within seven years, CrowdHydrology had installed over 100 gauges in 11 US states.

Super Friends meet Super Computers

In 2014, in an effort to learn more about their river, the Friends of the Boyne River (FoBR) installed five CrowdHydrology gauges. Over two years, these five gauges were receiving a high number of readings suggesting that people were actively visiting these gauges. These readings were impressive because, like USGS gauges, readings were also being taken during crummy weather conditions. Readings in inclement weather are essential for understanding the overall water system. Because of the community of river users' commitment to delivering consistent high-quality data, the Boyne River merits further study.

A team of water researchers including a hydrologist, a hydrological modeler, a fisheries biologist, and social scientist was pulled together to use the citizen-generated data to develop a hydrological model of the Boyne River that uses real-time data input into a super-computer. The model uses citizen readings of stream height and water temperature (temperature gauges to be added in October 2017), enabling the prediction of high and low-water events as well as fishing and boating conditions three to seven days in advance. With the citizen-supplied data, the model will be able to improve itself in real time.

A National Science Foundation Study

To construct this model, we are conducting field research to develop and calibrate the model with citizen readings. Our biologist is working with local organizations to assess the aquatic life in the Boyne.

For the social science, we are interested in who is texting information to the super computer. We are particularly interested in why people participate? How could we increase participation? And what can we make this model do that is of interest to those persons texting readings to the super computer?

We are carrying out this work in the Lake Charlevoix watershed for the next two years. Through the simple task of Boyne River users texting information to the server, this crowdsourced data supplies information that otherwise is unavailable. The Boyne River model will serve as an example to the nation that the quality of local streams and natural systems as well as the ability to protect these resources does not have to fluctuate as state and federal funding and priorities change. For those persons who care about the health of their waterways, lakes, and oceans, small collaborations can have large impacts. We have seen this with the Boyne River and its many friends including the FoBR, Michigan Department of Natural Resources, Michigan Trout Unlimited, Boyne Area Chamber of Commerce, Boyne Outfitters, Boyne City, Boyne USA, Little Traverse Bay Bands of Odawa Indians, Tip of the Mitt Watershed Council, the Lake Charlevoix Association, and others.

For individuals who wish to help, please text us your readings from any and all of the stations in the rain, snow, or sunshine.



Figure 1. Stream-flow (water height) gauge.



Figure 2. Downtown Boyme City gauge.