



SoundCitizen: Students and Citizens Conducting Environmental Science Together

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ABSTRACT

SoundCitizen (www.soundcitizen.org) is a community-based water sampling network focused on scientific investigation and knowledge discovery of the chemical links between urban settings and aquatic systems. It is staffed by undergraduate students, whose individual research topics help define the overall scientific aims of the program. SoundCitizen encourages involvement with citizen volunteers and school groups, who voluntarily collect water samples from aquatic systems, perform a series of simple chemical tests, and then mail samples to the lab to be analyzed for cooking spices and emerging pollutants. Since the program's inception in fall 2008, more than 200 volunteers and 500 K-12 students have participated in the program. Nearly 1000 kits have been distributed and the sample return rate is 60%. More than 95% of the returned samples pass initial quality control screening and are fully processed for emerging pollutants and cooking spices. Our scientific findings, which are described more fully elsewhere, show strong seasonal links between household activities (cooking, cleaning etc.) and the subsequent release of chemical "fingerprints" of these activities in aquatic and marine environments. This short communication describes the community volunteer network SoundCitizen has established in its first year of operation.

INTRODUCTION

"Citizen Science" is an increasingly popular means of conducting research or creating community awareness of scientific issues (Silvertown, 2009). "Citizen scientists" are loosely defined as persons who assist in the collection of, or analysis of, data as part of a scientific study. Citizen Science is a form of 'crowdsourcing' (Brabham, 2008), or the use of a volunteer community to conduct a task traditionally performed by an employee. Successful citizen science programs provide scientific opportunity to an interested public and allow for public involvement in scientific inquiry, interpretation and use of data. The use of citizen science networks often allows scientists to

accomplish research objectives more feasibly than would otherwise be possible. Thus, citizen science is both an opportunity for scientific discovery as well as a hands-on approach to informal science education.

Citizen science is not a new concept (Cohen, 1997, Brossard et al., 2005), but it has rarely been applied to aquatic geochemical research because of the inherent high costs of sampling and sample processing. Typical examples of citizen science involve low investments in infrastructure and sampling equipment. Exemplary programs include Cornell University's Lab of Ornithology (Brossard et al., 2005), which enlists volunteers to study birds using guidebooks and binoculars. Generally



Figure 1. SoundCitizen logo depicting urban and natural environments integrated by stream networks and volunteers.

speaking, there are three types of citizen science programs found in the earth sciences; 1) those that are long-term and aim to broadly assemble large data sets (e.g. bird counts), 2) those that are driven by a specific question and are typically of short-term duration (e.g. the project ends, the program ends), or 3) those that enlist citizens to help analyze data using web programs (e.g. galaxyzoo.org).

SoundCitizen (<http://soundcitizen.org>) was formed in fall 2008 with the purpose of sustaining a long-term community sampling and science network focused on investigating geochemical links between urban settings and aquatic systems. The program is run by undergraduate students in the School of Oceanography at the University of Washington with the help of a program coordinator and a faculty mentor. SoundCitizen is designed to be a flexible network that can accommodate multiple research questions. The independence of the SoundCitizen network from a single research question allows volunteers to potentially participate in numerous scientific studies, some of which may only last a short period of time or may require specialized volunteer training and specific samplings. In this sense, SoundCitizen is like the numerous ‘bird count’ or other ‘monitoring’ programs which aim to assemble large data sets that can be used to answer many questions. This potentially makes the program a viable long-term local ‘brand’ for aquatic citizen science. Multiple researchers, teachers, students and volunteers can potentially use SoundCitizen as a reliable tool to enhance their research and education. Current questions being addressed by SoundCitizen scientists and volunteers range in scale and scope, and include a) regional-scale questions about the processes that bring urban pollutants to marine

waters, b) watershed-scale questions of the impact of storms and runoff on nutrient and chemical release to streams, and c) molecular-scale questions about how subtle differences in chemical composition affect the environmental fate of emerging pollutants.

PROGRAM DESCRIPTION AND GOALS

Mission Statement

SoundCitizen is committed to involving citizens and undergraduate students in high-quality research about the connections between land and sea. SoundCitizen encourages volunteers at all age levels and helps its members understand the scientific findings through education and outreach programs.

Structure of SoundCitizen

SoundCitizen has grown in its first year and currently focuses on two efforts; research and curriculum development. Three faculty mentors provide guidance (Keil – environmental sciences, Phil Bell and Andy Shouse – education). During our first year, our goals were to establish lab protocols for student training and data analysis, recruit a minimum of one hundred citizen participants and four partner K-12 schools, create a web site that could serve as a portal for sample requests and data dissemination, and distribute two



Figure 2. A typical SoundCitizen sampling kit sent by mail to volunteers. Kits contain an instruction sheet and pencil, a pre-cleaned sample bottle with barcode, gloves, chemical test strip for evaluating water prior to mailing, and a pre-paid mailing label to assist in returning the sample to the university.

hundred kits in the Puget Sound region. Our long-term goals included securing long-term funding for the project, establishing a core group of citizen participants for repeated data collection, publishing articles (peer-reviewed and informal) about our research, and broadening our research topics.

Curriculum

The educational branch of SoundCitizen has developed two curricular units. They are: 1) a small add-in component to a local 5th grade teaching unit on microorganisms called “Microbes and Me”, and 2) a 4-week high school level environmental sciences unit called “My Place in Puget Sound”. In the microbes unit, SoundCitizen provides place-based content pertinent to the discussion of ‘good’ and ‘bad’ (disease-causing) microorganisms in homes and the environment. In the high school units, SoundCitizen data and research themes act as frameworks for student-lead learning, discussion and research. Students in both curricula are encouraged to participate in SoundCitizen sampling and data collection. By joining the scholastic and research missions, a two-way data share is created where students are given the opportunity to gather data that serves a larger purpose than that of their specific classroom learning, while also being able to draw from a larger (and expanding) database of information that they can use for their individual studies.

Citizen Participation

Individuals and groups are encouraged to apply on-line for one or more science sampling kits. Kits are sent out by mail. Citizen scientists are encouraged to collect samples of interest to them, but kits are selectively distributed in order to best answer the scientific questions at hand. Samples sought after include street runoff, rain water from gutters, local streams and beaches, and samples from Puget Sound and Lake Washington, etc. In addition to providing water samples to the lab, citizen scientists collect information on water quality (pH, temperature, weather conditions, etc.).

Lab Operations

Day-to-day operations of SoundCitizen consists of various jobs including retrieving samples from the mail and immediately processing them, web site maintenance and creation of new

kits to be mailed the next day (Figure 2). SoundCitizen uses a bar code system to track kits. When water samples are received, they are filtered and acidified within 24 hours and then stored for solid phase extraction and analysis by Gas Chromatography - Mass Spectrometry (Keil and Neibauer 2009).

COMPOSITION OF FIRST YEAR PARTICIPANTS

During its first year, demand for sampling kits exceeded initial projections by nearly a factor of 5 (920 / 200) and SoundCitizen could not meet all requests. Of the ~500 kits returned, 95% were from western Washington, with additional samples scattered across the contiguous United States, Canada and Alaska. Every major watershed releasing water into Puget Sound was sampled at least once (Figure 3), and nearly 23% of the watersheds had multiple samples taken over the course of the year.

Nearly 40 other organizations (non-profits, state agencies) have voluntarily collected samples through their established networks. Collectively, these organizations account for 39% of the samples we received in 2009 (Figure 4). The second most abundant type of sampler (34%



Figure 3. Google map of SoundCitizen samples collected in the Puget Sound watershed between November 2008-2009. This map is generated from the on-line results page of the SoundCitizen website.

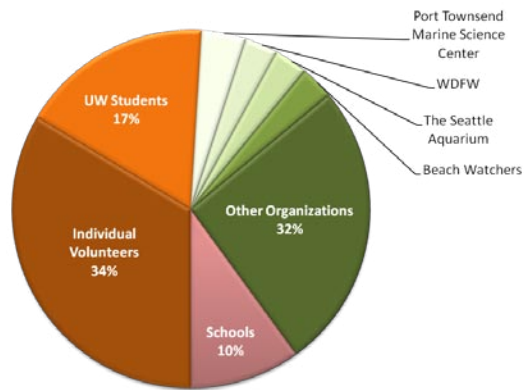


Figure 4. Pie chart illustrating the percentage of samples returned to SoundCitizen from various sources. The four largest sampling partners contribute 76% of the samples. WDFW is the Washington State Department of Fish and Wildlife.

of returned kits) was individual volunteers. University and K-12 students contributed 17 and 10% of the returned kits, respectively. Although the relative proportion of K-12 samples is low, the number is attenuated by the observation that many students request kits after participating in SoundCitizen curricular units, but do not identify themselves in our questionnaire as acting on behalf of their class. In 2010, this misalignment in counting will be corrected.

ACKNOWLEDGEMENTS

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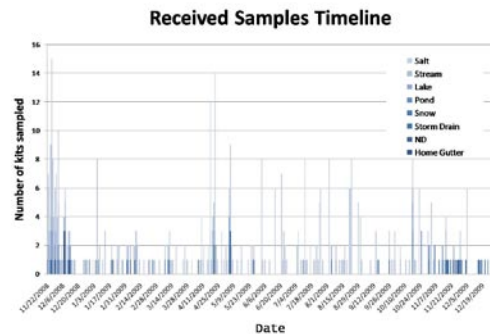


Figure 5. Frequency diagram of sample return to the laboratory. Two intentional periods of strong (more than 5 samples/week) sampling occurred over Thanksgiving 2008 and EarthDay 2009.

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