The Institute for Water & Watersheds
Annual Technical Report
FY 2014

Introduction

Oregonians are witnessing the difficulties caused by water limitations. Water quantity and quality issues in the Willamette, Klamath, and Umatilla Basins are the Governor's top environmental and water allocation priorities. This situation is paralleled around the world, and points toward a strong emerging area for growth in research, education, and outreach. These challenges are particularly relevant given that Oregon continues to implement a statewide Integrated Water Resources Strategy released in 2012 – a first for the state.

Oregon State University is ideally positioned to assume a leadership role in addressing water problems, with about **125 faculty** in six colleges who teach and conduct research in areas related to water and watersheds. OSU is renowned for its landscape-scale ecosystems research and continues to grow five graduate degree programs in Water Resources. These research and education efforts have all occurred without the benefit of programmatic coordination or strategic vision.

Oregon's Water Resources Research Institute, called the **Institute for Water and Watersheds (IWW)**, coordinates interdisciplinary research, education, and technology transfer on issues related to water and environmental sustainability. The IWW program focuses on statewide water resources issues by assisting faculty within Oregon State University, as well as those located within neighboring Portland State University, University of Oregon, Western Oregon University, Oregon Institute of Technology, among many community colleges located across the state, to provide outreach and research related to water resources issues on an "as-requested" basis. Partners and constituents of include educational institutions, state and local governments, watershed councils, and the general public. While the IWW supports research through USGS funding, the model for IWW is to support grant preparation as opposed to providing grants to facilitate research.

The IWW is involved in promoting the effective and sustainable use of water resources in the State of Oregon. IWW serves as a hub for water resources activities, for example:

- IWW is part of the OSU's **Water Resources Graduate Program** (http://oregonstate.edu/gradwater/).
- IWW is part of OSU's **Natural Resources Leadership Academy** and **Transboundary Freshwater Dispute Database.**
- IWW staff serve as expert "volunteers" to state agency advisory committees, county water committees, and local watershed councils.
- IWW initiates and coordinates interdisciplinary water resource research projects and through the USGS water institutes program, it funds seed grants on critical water issues for the state.
- IWW sponsors a regional water resources seminar each spring term on topics such as drinking water, stream restoration, water quality, and water conflict. Speakers from Oregon, the United States, and abroad participate in the program which has a different focus topic each year.
- Staff at IWW assist faculty at the state's institutions of higher education in research and outreach efforts related to its mission.

Staff resources have been reduced to part-time status with the continued downturn in Oregon's economy. While the budget reductions have forced some re-defining of priorities within the IWW, it remains committed to the NIWR mission and providing research, education and outreach in water for the residents of Oregon. In many ways, these reductions have helped sharpen our knowledge of what is most critical in this regard and we are pursuing this with increased intensity with our world-class faculty in water within the Oregon higher educational system.

Research Program Introduction

At Oregon State University, over 125 faculty teach and conduct research in areas related to fresh water supply and quality. These faculty members are spread among six colleges and represent many different academic disciplines – including engineering, ecology, geosciences, social sciences, economics and the arts. OSU also hosts a vibrant Water Resources Graduate Program where students can earn specialized degrees in water resources engineering, science, and policy and management. Students and professionals desiring advanced training in water conflict transformation and natural resources negotiations participate in the one-week intensive training during the summer months in the Natural Resources Leadership Academy, now in the third year of operation.

The IWW is the hub for this diverse water research community. It seeks to solve complex water issues by facilitating integrative water research. The IWW’s functions are to:

- Assemble diverse research teams and lead interdisciplinary and transdisciplinary water research projects.
- Help policy makers and water managers collaborate with university faculty and students.
- Offer training and access to water quality and stable isotope analysis facilities through a shared laboratory called the IWW Collaboratory.
- Encourage community and collaboration among water faculty, students and water managers by sponsoring events and producing a monthly statewide water newsletter.
- Assist water faculty with project development and management.

Why Focus on Water?

Oregon's economic vitality is directly tied to water. Water is “virtually” embedded in all Oregon products, from timber and salmon to solar panels and semiconductors. But water supply and demand in the state is changing. There is now less snowpack in mountain regions and the snow is melting earlier in the spring and summer. These changes have implications for irrigation, human consumption, hydropower generation and ecosystems. Shifting population, land use patterns and environmental policies will also influence the future supply and demand for abundant clean water. And the state of Oregon continues to develop an Integrated Water Resources Strategy, one of two western states without a strategic water plan, to prepare for climate change and the wave of anticipated “climate change refugees” from drier and hotter regions of the United States.

In the academic community there is growing recognition that the solutions to future water challenges lie not within a single discipline or subject but through the connection of concepts between multiple academic fields and through successful collaboration between academics and water managers. For example, anticipating the effect of climate change on Oregon’s water resources requires not just the input of climatologists and hydrologists but also the perspective of many others from biologists and sociologists to water managers and policy experts.

Through an integrative research approach, the IWW seeks answers to questions important for Oregon, the nation and the world, such as:

- Where are climate change and human activity most likely to create conditions of water scarcity?

- Where is water scarcity most likely to exert the greatest impact on ecosystems and communities?

- What strategies would allow communities to prevent, mitigate, or adapt to scarcity most successfully?

Oregon State University hosts strong graduate degree programs in Water Resources and is located near state-of-the-art experimental watersheds and a suite of federal environmental laboratories. Below are short descriptions of some of the university's strengths in the areas of:

- water science
- water engineering
- water policy and management
- water outreach and community education

Water Science

The OSU community has one of the largest gatherings of hydrologists and ecologists in the USA. They include not only campus faculty but also courtesy faculty from the suite of federal research laboratories located adjacent to campus. This combination makes for a world-class grouping of people, mapped against one of the strongest hydrological gradients (from the super-humid Oregon Coast to arid Eastern Oregon) in the world. The campus is known for its cross-discipline collaborations -- for example faculty from the top-ranked forestry and conservation biology programs collaborating on salmon conservation studies. Many researchers take advantage of nearby field laboratories such as the NSF Long Term Ecological Research (LTER) facilities at the HJ Andrews Experimental Forest and industry timberland instrumented watersheds in the Oregon Coast range (Hinkle Creek, Alsea and Trask).

The OSU-Benton County Green Stormwater Infrastructure Research (OGSIR) Facility, a three-celled stormwater research facility for field-scale experiments and testing on green infrastructure (e.g., raingardens, bioswales, etc.), was completed in 2014. **Stormwater Solutions**, a film highlighting the creation of the OSGIR can be viewed at the following link (https://media.oregonstate.edu/media/t/0_03knf8eg).

Faculty from Oregon State University, the University of Oregon and Portland State University are completing the final year of work on a five-year project funded by the National Science Foundation titled "Willamette Water 2100," a study that will use Oregon's Willamette River basin as a test case for managing regional water supply. This project is evaluating how climate change, population growth, and economic growth will alter the availability and the use of water in the Willamette River Basin on a decadal to centennial timescale.

Water Engineering

Unlike other land-grant institutions, OSU's engineering connection gives it strengths in treatment technologies for surface water, groundwater, and wastewater systems. OSU Engineering now ranks in the top 50 programs in the US. Many OSU engineers specialize in biological treatment methods and OSU hosts a Subsurface Biosphere Initiative that emphasizes interdisciplinary research on soil and groundwater microbial ecology. Many engineering faculty are also connected to the Oregon Built Environment & Sustainable Technologies Center (Oregon BEST) that connects the state's businesses with its shared network of university labs to transform green building and renewable energy research. Partnering with the OSU College of Business places a “business face” on the sustainability of engineered solutions to water problems. Before graduating, many engineering students enroll in coursework leading to a business savvy Entrepreneurship Minor.

Water Policy And Management

Addressing water resource challenges and reducing conflict in the US and abroad requires that water professionals and decision-makers receive specialized resources and skills that go beyond the traditional physical systems approach to water resources management. OSU offers a post-graduate certificate as part of their Program in Water Conflict Management and Transformation. The program leverages personnel from the top-10 nationally-ranked Geosciences Department, the top-five nationally ranked College of Forestry, as well as specialists in water policy, social science, communication, and anthropology. The “softer side” of OSU water has close links with UNESCO, the World Bank, the US Bureau of Reclamation and the US Army Corps of Engineers.

Peace Corps Masters International – Water

OSU was awarded the first PCMI with an emphasis in water resources in 2014. OSU recognizes that a partnership with the Peace Corps is also an ideal possibility to enhance our international and diversity focus even more. Many of the WRGP faculty are Returned Peace Corps Volunteers (RPCV). A Humanitarian Engineering program is also under development given the international focus of many faculty on campus.

Joint Education Program in Water Cooperation and Peace

UNESCO-IHE Institute for Water Education in the Netherlands, the University for Peace (UPEACE) in Costa Rica, and Oregon State University (OSU) in the USA, have embarked on a joint education program in Water Coooperation and Peace. The goal of this new initiative is to broaden the scope of approach to conflict and peace, provide a more theoretical dimension to conflict, engage multi-level scales of conflict dimensions and strengthen skills through highly experiential learning opportunities. The program will provide tools and training in an international setting, with a unique opportunity to undertake coursework and hands-on experiences in Costa Rica, The Netherlands and the United States. Participants will be exposed to case studies involving diverse challenges and contexts at different scales.

Biological drivers of freshwater cyanobacterial harmful algal bloom extremes assessed via next-generation DNA sequencing technology

Basic Information

Title:	Biological drivers of freshwater cyanobacterial harmful algal bloom extremes assessed via next-generation DNA sequencing technology
Project Number:	2012OR127G
USGS Grant Number:	G12AP20157
Start Date:	9/1/2012
End Date:	8/30/2015
Funding Source:	104G
Congressional District:	OR-004
Research Category:	Not Applicable
Focus Category:	Water Quality, Water Supply, None
Descriptors:	
Principal Investigators:	Theo W. Dreher

Publications

1. No publications. Project is still in progress.
2. No publications. Project is still in progress.
3. We are still refining these analyses, planning to prepare data for publication in a journal such as **Remote Sensing**.

Progress report of activities under USGS award no. G12AP20157

Biological drivers for freshwater cyanobacterial harmful algal bloom extremes assessed via next-generation DNA sequencing technology.

T. Dreher, J. Graham, PI's, $243,835, 9/1/2012 - 8/31/2015.

28 May, 2015: prepared by Dr. T. Dreher, Department of Microbiology, Oregon State University

Regular sampling continued during 2014, comprising monthly samples from the three study sites, Dexter Reservoir (Oregon), Cheney Reservoir (Kansas) and Lake Houston (Texas), with weekly collections from Dexter Reservoir throughout the bloom season (June through September). We have samples archived for the years 2013 and 2014, and some from 2012. During 2014, we implemented an improved sample processing scheme for weekly samples from Dexter Reservoir that includes sequential filtration onto 1.2 μm filters to collect large material including colonial cyanobacteria, 0.2 μm filters to collect free-living bacteria and archaea, and 0.02 μm filters to collect viruses and phage. The final flow-through has also been kept as a possible source of free DNA indicative of cell lysis. This scheme is intended (a) to collect all biological components in the system to allow DNA analysis and identification, (b) to separate the colonial cyanobacteria from free-living bacteria in order to assess bacterial communities associated with the cyanobacteria, (c) collect free viruses/phage that could be the progeny of an infection affecting the cyanobacterial population, and (d) free DNA indicative of cell death. We also filtered and preserved some samples on-site for mRNA (gene expression) analysis (analysis is not supported by this project and will be conducted as possible in the future). Together with a corresponding comprehensive dataset of chemical and physical parameters as well as phytoplankton and zooplankton enumeration, the weekly sampling represents an unprecedented collection made with high frequency throughout a bloom season. We believe it represents the best chance of uncovering the precise drivers of the growth and decline of particular genetic lineages of cyanobacteria, a prerequisite to constructing models for predicting HAB population dynamics.

We have analyzed samples by DNA sequencing in the form of Illumina 2000 100-nucleotide paired end reads) metagenomes and *cpcBA* (phycocyanin), 16S and 18S rDNA amplicons as proposed under ***Specific Objectives A and B***. Shotgun metagenomes, which aim to sequence a representative subset of all the DNA present in a sample, have proven to be highly informative, and have been the primary way we have been able to approach the question posed by ***Specific Objective B:*** which organisms are producers of taste-and-odor compounds or toxins? We have typically obtained about 30 million sequencing reads per sample/time-point from NexteraXT library preparations sequenced on the Illumina HiSeq 2000 instrument. We have developed a pipeline for analysis, in which IDBA_UD (Peng et al., 2012, Bioinformatics, 28:120-28) is used to assemble reads into contigs that are clustered by nucleotide sequence composition and read coverage using mmgenome (Albertsen et al., 2013, Nature Biotechnology, 31:533-8). Taxonomic assignments are made using a support vector machine algorithm implemented in Phylopythia S+ (Gregor et al., 2014, arXiv1406.7123). Gene identifications can then be made among the taxonomic bins in order to answer the questions regarding specific genes, such as toxin or taste-and-odor genes (***Specific Objective B***), metabolic genes that might establish fitness for particular conditions and provide a clue to the niche adaptations of cyanobacterial ecotypes/species, and viral genes indicative of the presence of viruses that may include cyanophages (***Specific Objective C***).

Our DNA analyses involve large amounts of data and have not yet been completed. We have already made some important findings, however, as indicated below.

Anabaena is the geosmin producer in Cheney Reservoir

A major objective of long-term studies in Cheney Reservoir has been to understand the circumstances that lead to geosmin production, so that the occurrence of this important compound that taints drinking water can be predicted and perhaps prevented. This clearly necessitates identifying the producing organism, which to date has been uncertain. We analyzed samples from 8/30/2013 representing a transect of 6 stations from the northern inflow to near the dam wall. The metagenome analysis corroborated phytoplankton analysis indicating the presence of distinct *Anabaena* and *Microcystis* blooms at the inflow and dam wall, respectively. The only genes for geosmin synthesis (e.g., *geoA*) were associated with the *Anabaena* genome (i.e., resided on contigs that clustered with other *Anabaena*-specific contigs), indicating that *Anabaena* is the principal, perhaps only, geosmin producer present. This has been true for all metagenomes prepared from Cheney Reservoir samples, and suggests that *Actinobacteria* bacteria (including *Streptomyces*), which are capable of geosmin synthesis, are not significant factors in Cheney Reservoir. A similar analysis shows that *Anabaena* is also the geosmin producer in Dexter Reservoir.

By firmly identifying the geosmin producer, this work has added substantial knowledge to the long-term USGS study of Cheney Reservoir water quality. After significant efforts to identify the causative organsim(s) producing geosmin, previous results had been inconclusive, because there were often poor correlations between cell counts of the suspected producer, *Anabaena,* and geosmin levels. Further analyses will address whether or not there is evidence for more than one strain of *Anabaena* (e.g., geosmin+ and geosmin- strains) as an explanation of the poor correlations observed between *Anabaena* and geosmin in previous years.

Using quantitative PCR (QPCR), which allows a more sensitive quantitative analysis of a single gene target, we observed a strong correlation between geosmin concentration assayed in water samples and *Anabaena geoA* gene copy number, across >20 samples collected during 2013 (Fig. 1B), consistent with *Anabaena* being the predominant producer. A close correspondence between *Anabaena* geoA copy number and geosmin concentration was seen over a range of two orders of magnitude (Fig. 1C).

Genes needed for microcystin biosynthesis (e.g., *mcyE*) were exclusively associated with *Microcystis*, although some strains/species of *Anabaena* are able to produce this toxin. Total microcystin levels in Cheney Reservoir samples taken during 2013 were tightly correlated to *mcyE* gene copies, indicating that *Microcystis* was the predominant source of microcystin toxins throughout 2013 (Fig. 2). This was true over a wide range of sequencing coverage depths of the *mcy* operon (Fig. 2), indicating that our metagenome analysis is robust and quantitative both when genes are abundant or rare; we have also verified this important point concerning the performance of metagenome analysis by deliberate undersampling of a metagenome dataset by up to 50-fold.

We have also analyzed the Cheney Reservoir *Anabaena* and *Microcystis* genome pools for the presence of gene clusters for secondary metabolites (Table 1). This has confirmed the presence of the geosmin and microcystin biosynthetic genes discussed above, but no other genes for known cyanotoxins.

We are preparing these results for journal publication in either *Environmental Science and Technology* or *Environmental Microbiology*.

Genetic analysis of bloom successions in Dexter Reservoir

The long-term understanding of the population dynamics of harmful algal bloom requires detailed identification of the bloom-producing strains/species and their gene content, as well as the external biological (top down) factors that can influence those cyanobacteria. Table 1 (discussed above) represents part of the annotation of the specific gene composition that identifies the particular cyanobacteria present in Cheney Reservoir. In Dexter Reservoir, we are applying that approach to the rather complex succession of distinct sub-blooms that occurs across a season. Fig. 3 shows phytoplankton analysis across 2013 and 2014, revealing the succession of two distinct *Anabaena* morphotypes (*Anabaena flos-aquae* and *A. crassa*-like morphologies), followed by *Gloeotrichia*, and overlapping with *Aphanizomenon flos-aquae* (especially abundant in 2014) and small amounts of a third *Anabaena* morphotype (*A. planktonica*).

Fig. 4 presents the metagenomic analysis of samples from the earliest component of the 2014 bloom, that occurring during June and consisted of one morphotype. The genetic analysis suggests that two *Anabaena* populations of substantial abundance are present, emphasizing an important attribute of genetic analysis, as well as the well-known problem that morphological traits provide limited discrimination that may underestimate the number of distinct population components present. Another important conclusion from this analysis, supported by several other metagenomes, is that cyanobacterial genome count (which we take to be correlated with cell numbers) is similar to that of the most abundant bacteria present in the lake. However, there are no obvious or specific associations of prokaryotic genomes with the cyanobacteria (analysis of colonies and colony-associated cells caught on GF/C filters), calling into question the significance of the phycosphere concept. This relates to the possibility that cyanobacterial colonies serve as host for a community that includes free-living bacteria or archaea that exist in a mutually beneficial association. It is an attractive concept in view of the difficulty in culturing cyanobacteria free of other bacteria, and is potentially relevant in bloom ecology in terms of the availability of appropriate commensal bacteria potentially limiting bloom development.

Fig. 4 does indicate that some specific bacteria were especially abundant, although it is uncertain at present whether this indicates any co-dependence on the presence of cyanobacteria. It may be part of a signature population that seems to be a strong hallmark of many lakes. Fig. 5 shows an analysis of bacterial genus representation in 45 metagenomes from five water bodies, indicating strong individual lake signatures in the bacterial communities present. The presence of particular cyanobacterial blooms evidently does not override the strong lake-specific influence, since samples do not cluster by whether they are dominated by a *Microcystis* or *Anabaena* bloom. This is an important finding with relevance to lake microbiology in general, and may indicate that cyanobacterial population dynamics are largely independent of other prokaryotes present in a lake. Information from 16S rDNA amplicon analyses is being added to this data; this analysis provides a deeper and second quasi-quantitative analysis of the prokaryotic taxa present.

The NMDS analysis depicted in Fig. 5 is an example of the advanced statistical analyses we are conducting on our entire genetic dataset, as well as analyses of that data in combination with metadata obtained from other sources representing chemical, physical, microscopic enumeration, etc. data. This is the goal of ***Specific Objective E***, reflecting the likelihood that bloom populations are under complex controls; possible scenarios include no single factor being a dominant driver, and different combinations of factors exerting major influence at different times or in different lakes.

Looking for viruses as potential top-down population-culling factors (Specific Objective C)

We have been able to assemble large fragments of multiple phages from metagenomes made from filters containing bloom cellular material, which we take to represent a source of ongoing infections. Although we are not necessarily able to physically identify the phages or be sure of their hosts, their genetic signals can be tracked and explored as possible top-down regulators of cyanobacterial populations. During 2014, as part of the comprehensive sampling scheme described above, we made collections of viral fractions (0.2 μm filter flow-through) in addition to collection of cellular material. DNA metagenome sequencing of some of those samples have just been completed and are ready for analysis. These are the various approaches we have used to assess the possible role of cyanophages as regulators of cyanobacterial populations. A serious impediment to this goal remains the existence of very few complete genome sequences for phages infecting *Microcystis* and the *Anabaena* strains relevant to the lakes in this study. We do not know the hosts of phages whose genomes we find in our metagenomes, except for phages closely related to Ma-LMM01, a *Microcystis*-infecting phage first isolated in Japan. This phage is present in Cheney Reservoir, and is quite closely related to the Japanese isolate.

Although it is unlikely that a convincing case for a phage-induced population collapse can be made by looking only at infected cells, such a case can be made when parallel analysis tracks specific cell numbers and phage numbers, and when sampling has high temporal resolution. Such an event would be indicated by a sharp decline in a cyanobacterial population accompanied (with a delay of a short time, such as a few days) by a peak in a phage population. We are looking for such evidence in the multiple population transitions that occurred during 2014 in Dexter Reservoir (Fig. 3). However, the lack of knowledge concerning phages infecting *Microcystis* and *Anabaena* remains an impediment, and it is possible that the greatest value of the current studies will be to lay the groundwork for future work examining the influence of cyanophage.

Use of remote sensing in quantifying cyanobacterial bloom biomass (Specific Objective D)

We have been able to collect data from the satellite-resident spectrometers MERIS during 2011 and HICO during 2012 and 2013. The spatial resolution of MERIS (300 m) proved to be too coarse for useful observation of Dexter Reservoir (Fig. 6B), and MERIS expired in March, 2012. Weather and scheduling limitations prevented any useful observations with HICO during 2014. In situ water samples, used for pigment analysis, were collected when possible to coincide with scheduled HICO observations. HICO also expired (in late 2014).

An important finding has been that the 100 m spatial resolution of HICO is adequate for small lakes such as Dexter Reservoir (Fig. 6C), which is about 0.5-0.8 km wide. The high spectral resolution allows extraction of signals specific for chlorophyll-a and phycocyanin (Fig. 7) to allow estimates of relative bloom abundances through correlations between the satellite signal and chlorophyll-a determinations on samples taken at the same time. Dexter Reservoir has a simple phytoplankton population that is dominated in summer by cyanobacteria, while Cheney Reservoir and Lake Houston support large populations of other phytoplankton (esp. diatoms) alongside cyanobacteria. We are still refining these analyses, planning to prepare data for publication in a journal such as *Remote Sensing*.

Fig. 1. Quantitative PCR indicates that *Anabaena* was the predominant geosmin-producer in Cheney Reservoir during 2013. **A.** Standard curve used for the QPCR assay. **B.** Comparison of geosmin concentrations measured by GC-MS for all sites during the study period in 2013 relative to QPCR estimates of *Anabaena* geosmin synthases (*geoA*). **C.** Application of the QPCR assay to samples collected during a transect of the lake that coincided with abnormally high concentrations of geosmin (Aug. 30, 2013).

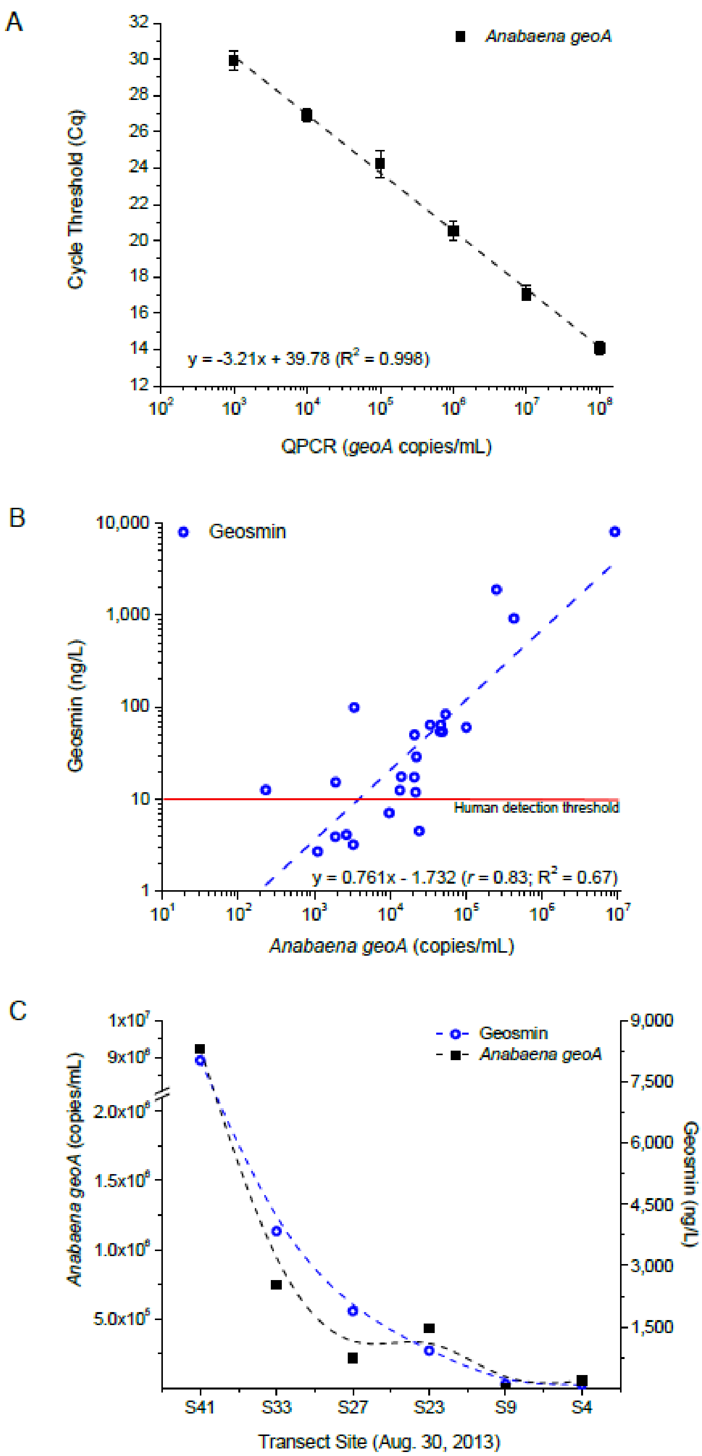

Fig. 2. Shotgun metagenomes provide quantitative evidence that *Microcystis* was the only producer of microcystin toxin in Cheney Reservoir during 2013. Presented here are data from the routine monitoring site (near dam wall) in 2013; total microcystin was estimated by ELISA, *Microcystis* sp. biovolume was estimated by microscope counting, *mcyE* gene copy number was determined by QPCR, and shotgun metagenomes were analyzed to determine the coverage depths for microcystin (*mcy*) genes found in contigs > 2 kb (n = 18 contigs). Close correspondence is seen between microcystin concentration, *Microcystis* biovolume, *mcy* operon coverage depth (determined from metagenomes) and *mcyE* gene copies (determined from QPCR) at each time point (**A**) and in regressions spanning all samples (**B-D**).

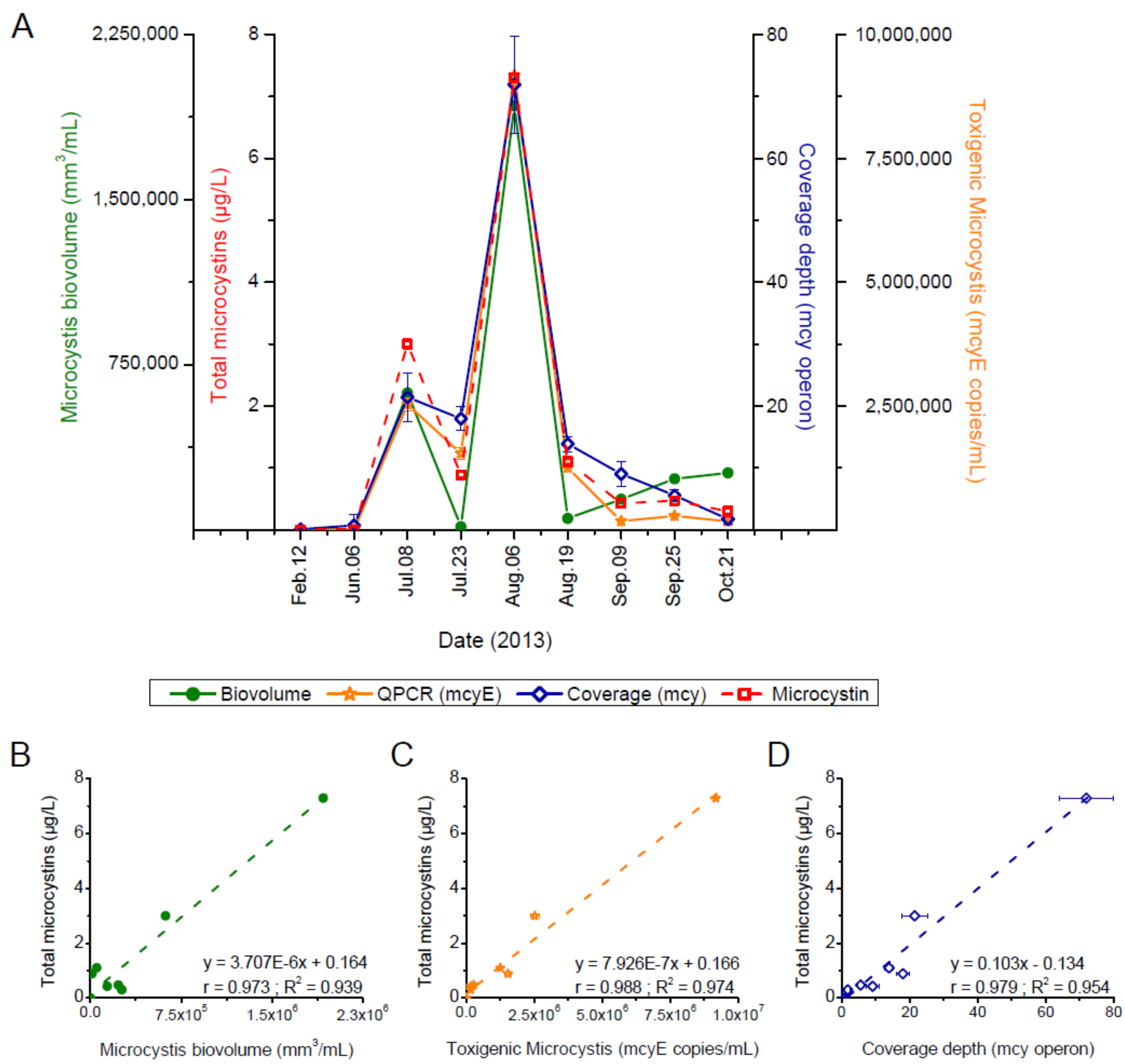

Fig. 3. Complex succession of cyanobacteria across the 2013 and 2014 bloom seasons in Dexter Reservoir. Phytoplankton enumeration indicated an overall similarity in the successions that occurred in the two seasons, but also differences, notably the much greater presence of *Aphanizomenon flos-aquae* and the near-complete bloom disappearances in early July and early August.

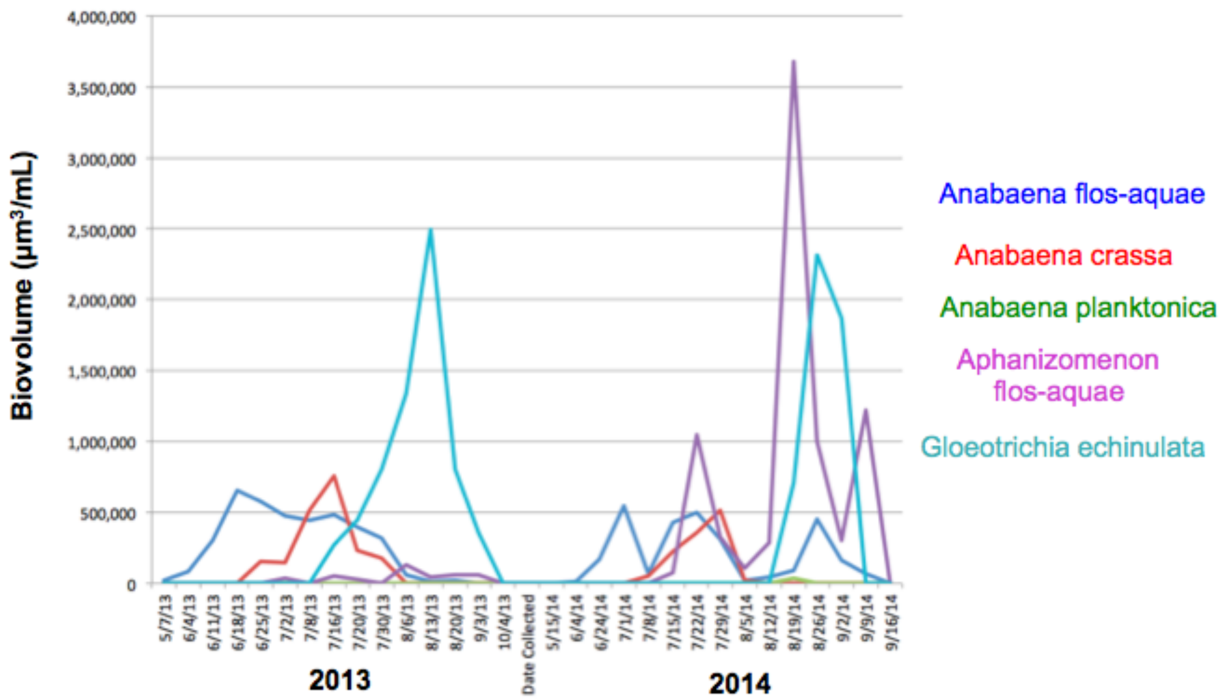

Fig. 4. Shotgun metagenome analysis of the first bloom event during June, 2014, in Dexter Reservoir. The upper panels show assembled prokaryotic contigs clustered and displayed according to taxonomic identification. For each indicated date, the X-axes represent read depth (number of times a nucleotide has been sequenced) in the metagenomes prepared from cells caught on 1.2 µm (GF/C) filters, while the Y-axes represent analysis of cells that passed the 1.2 µm filter but were caught on the 0.2 µm filter. The X-axis thus represents colonial cyanobacteria and other bacteria or archaea associated with those colonies or other larger particles, while the Y-axis represents free-living bacteria and archaea.

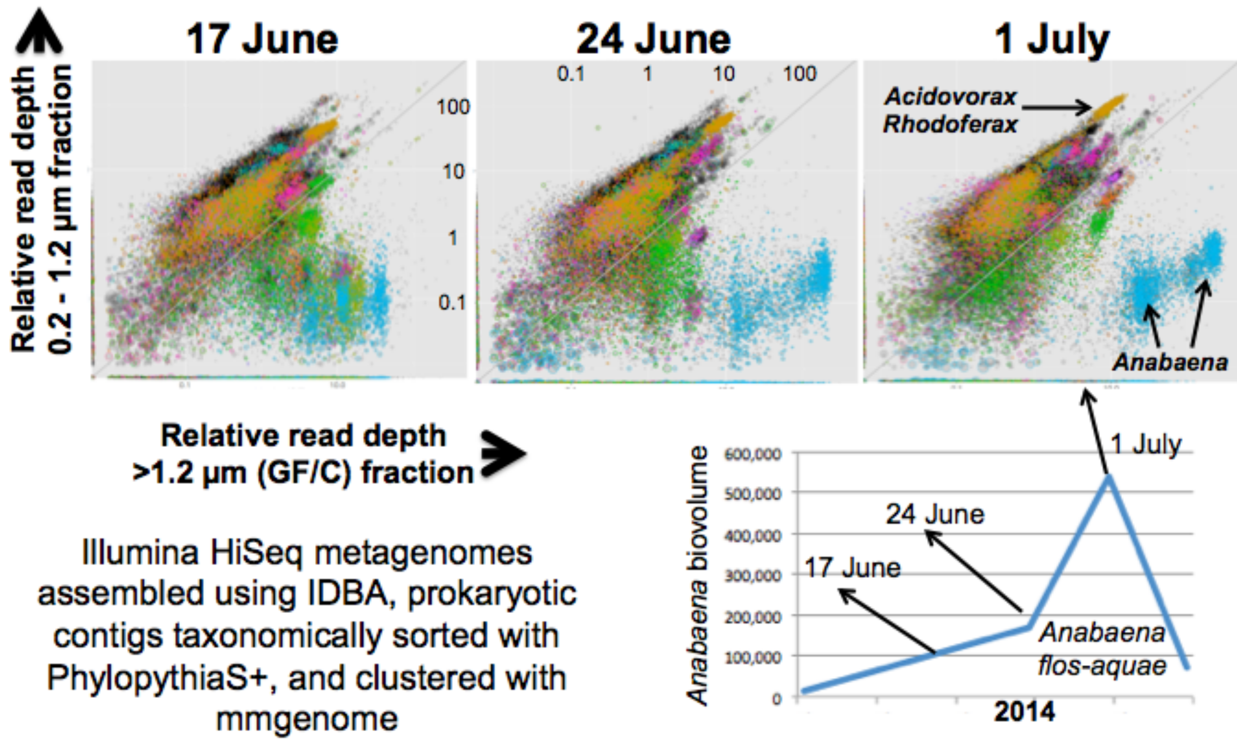

Fig. 5. Non-metric multidimensional scaling analysis of bacterial genus representation in 45 metagenomes from five water bodies, including Dexter and Cheney Reservoirs and Lake Houston. The strong clustering by lake indicates strong individual lake signatures in the bacterial communities present. The presence of particular cyanobacterial blooms evidently does not override the strong lake-specific influence, since samples do not cluster by whether they are dominated by a *Microcystis* or *Anabaena* bloom. For instance, The Cheney dataset includes samples with dominant *Microcystis* or *Anabaena* blooms, and Iron Gate and SF Estuary are also systems with dominant *Microcystis* blooms.

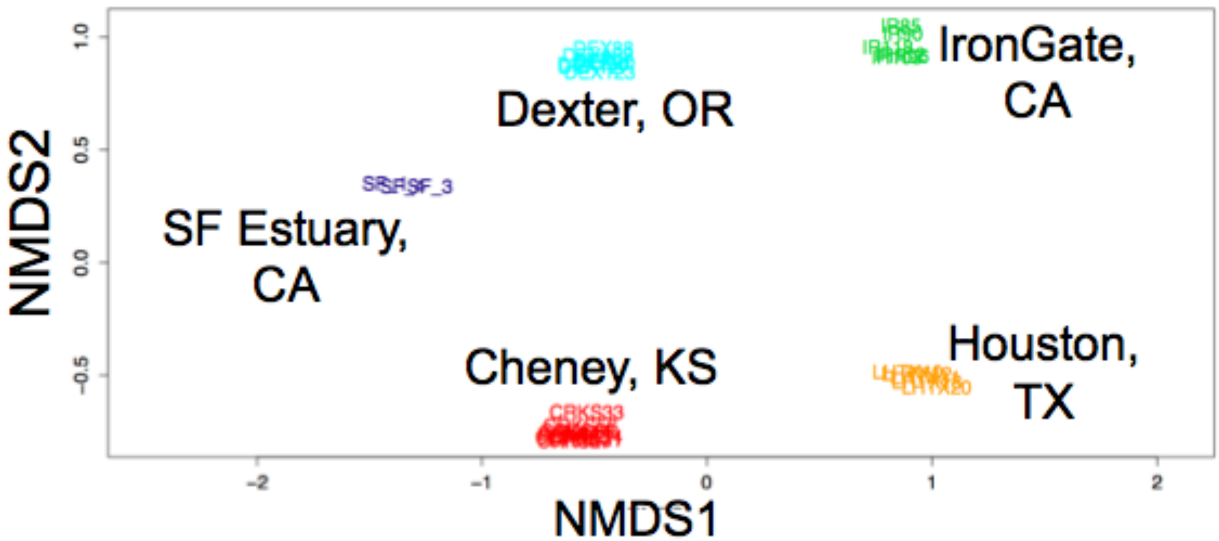

Fig. 6. Importance of adequate spatial resolution for remote sensing in small lakes. **A.** Dexter Reservoir (0.5-0.8 km wide) is adjacent to the small town of Lowell, and is bisected by a bridge and causeway. **B.** MERIS, with 300 m spatial resolution, allows only a small number of pixels to be analyzed, and provides inadequate resolution. **C.** HICO, with 100 m spatial resolution, provides good resolution that minimizes data losses to shoreline edge effects and is able to distinguish the presence of the causeway and the spatial patchiness of the cyanobacterial bloom.

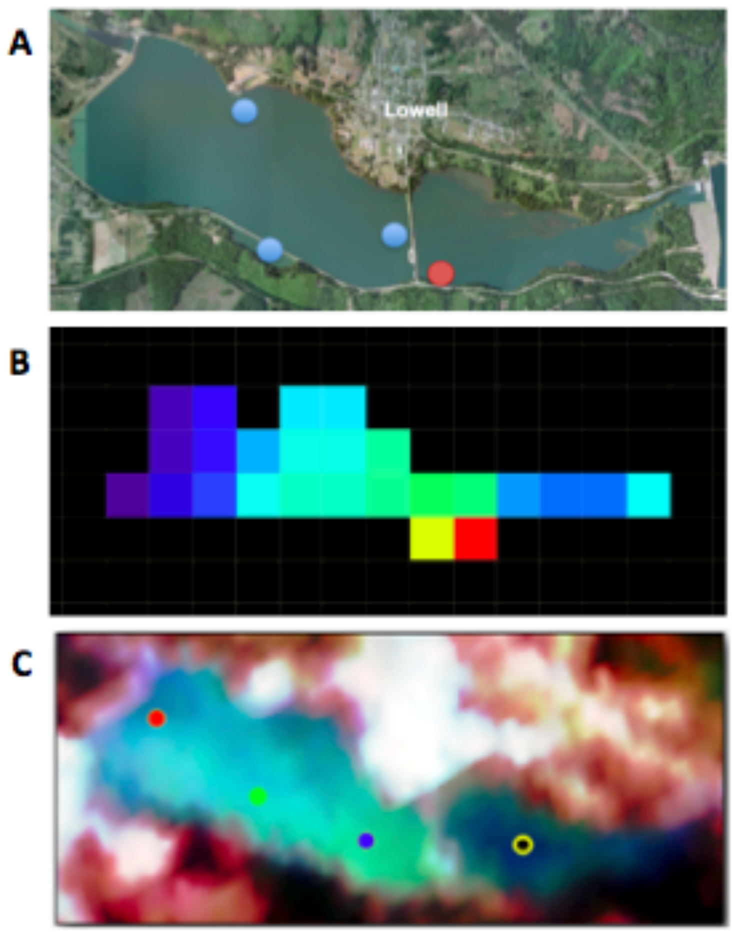

Fig. 7. HICO remote sensing of cyanobacterial bloom in Dexter Reservoir, 4 September, 2012. **A.** Image of bloom distribution and location of transect (NW to SE) along which 6 samples were taken for chlorophyll-a analysis. **B.** Spectra extracted from points along the transect with the high spectral resolution of HICO reveals distinct absorption peaks for chlorophyll-a and phycocyanin.

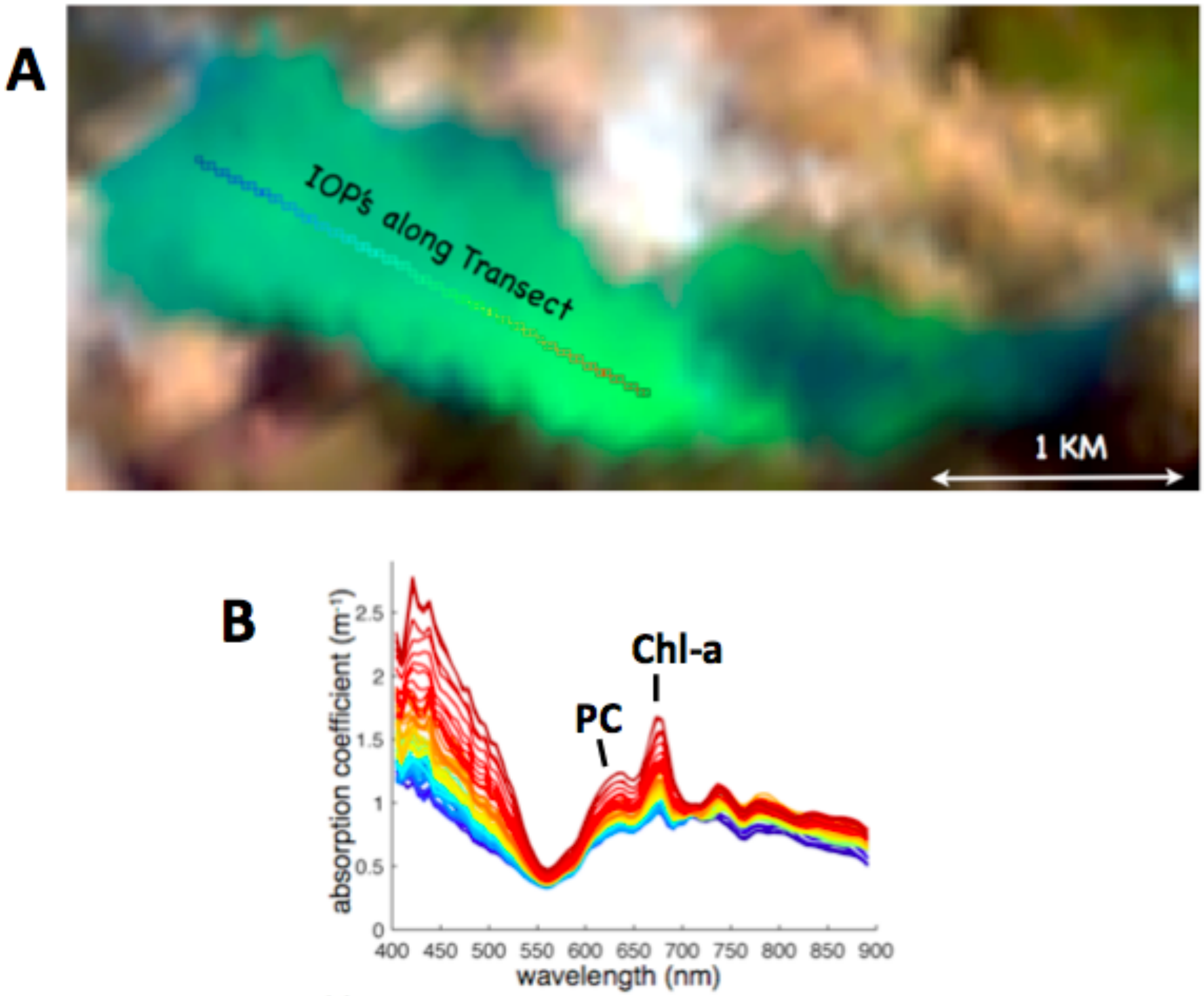

Table 1: *Anabaena* and *Microcystin* present in Cheney Reservoir are producers of geosmin and microcystin, respectively. The secondary metabolite screening platform antiSMASH 2.0 was used to identify known and putative NRPS/PKS or terpene biosynthetic pathways in the two main CyanoHAB genera identified in Cheney Reservoir. The *Anabaena* metagenome revealed four distinct terpene biosynthesis pathways, these included: geosmin synthase, squalene cyclase (producing hopene) and two phytoene synthases. No 2-methylisoborneol synthases were detected. The *Microcystis* metagenome contained the NRPS/PKS cluster for microcystin synthesis, as well as additional unidentified PKS gene clusters.

Organism	Contig ID	Product/Operon	Type	Contig length (nt)
Anabaena	1655	Geosmin	Terpene	19,758
Anabaena	72677	Squalene-hopene cyclase	Terpene	1,978
Anabaena	5790	Squalene cyclase	Terpene	9,992
Anabaena	18376	Phytoene synthase	Terpene	4,966
Anabaena	6770	Phytoene synthase	Terpene	9,107
Anabaena	168	Uncharacterized peptide synthetase	NRPS	54,430
Anabaena	5526	Uncharacterized peptide synthetase	NRPS	10,269
Anabaena	2288	Uncharacterized polyketide synthase	T1PKS	16,906
Anabaena	233	Uncharacterized polyketide synthase	T1PKS-OtherKS	35,849
Anabaena	669	Chloramphenicol acetyltransferase	Fatty Acid	31,012
Anabaena	2309	Putative quinolone response pathway	Bacteriocin	10,965
Microcystis	23363	Unidentified terpene cyclase	Terpene	4,249
Microcystis	79451	Phytoene synthase	Terpene	1,860
Microcystis	127272	Phytoene synthase	Terpene	1,335
Microcystis	77182	Putative cyanopeptolin (partial operon)	NRPS	1,833
Microcystis	*Numerous	Microcystin synthetase	NRPS/PKS	51,919
Microcystis	8250	Uncharacterized polyketide synthase	T1PKS	8,067
Microcystis	6449	Uncharacterized polyketide synthase	T1PKS	9,385
Microcystis	2409	Uncharacterized polyketide synthase	T1PKS	16,443
Microcystis	1489	Uncharacterized polyketide synthase	T1PKS	21,487
Microcystis	1920	Putative cylindrocyclophane synthase	T1PKS-T3PKS	18,685
Microcystis	7318	Uncharacterized polyketide synthase	T3PKS	8,683
Microcystis	99530	Uncharacterized protein	Bacteriocin	1,589

*Microcystin contigs - 7665, 11915, 18254, 20865, 32094, 32773, 37098, 38507, 42651, 46543, 52049, 72050, 109888, 126418, 150897, 166486, 170391, 225972

Information Transfer Program Introduction

OSU's reputation for providing vital environmental information to students and the public is beyond reproach. A few of OSU's water-related outreach programs include:

- The **Master Watershed Steward Program** - An OSU Extension program offering educational sessions and materials to help watershed groups and individuals understand how their watersheds work and apply this knowledge to watershed stewardship on their own land or in their community.

- The **Oregon Well Water Program** - An OSU Extension program designed to help Oregonians protect the groundwater that supplies their drinking water through education.

- The **Hydroville Curriculum Project**- A program proving water-themed educational materials and exercises to K-12 teachers. It is operated by OSU's Environmental Health Sciences Center.

- The **Oregon Explorer Program** - An online digital library that provides natural resources information to decision makers through a growing series of Web portals.

Acknowledging that academics need to communicate research in different ways with policymakers, IWW has experimented with new ways to diversify our outputs. Gone are the days of simply sending academic journal articles to policy makers and staff. IWW now completes what is termed **"just-in-time"** white papers or short You-Tube videos on topics of interest. For example, a white paper and video have been developed on **pico-hydro powerHumanitarian Engineers and Hydrophilanthropists** in Oregon are growing in number given the recent addition of the Water Resources Graduate Program to the Peace Corps Masters International program. A summary white paper was developed listing these individuals, organizations, and their locations of work. New white papers are under development summarizing the role of serious gaming in water resources conflict transformation and negotiations.

Other Collaborative Activities

- The IWW Collaboratory use numbers keep climbing from a sample count of 2,250 in 2008 to 16,086. Number of users (departments, entities) totals 52.
- The **4th Annual OSU Student Water Research Symposium** put on by the Hydrophiles and the Water Resources Graduate Program and sponsored by IWW had over 130 attendees from 10 universities with 77 student presenters over a three day period.
- The **IWW Film Library** has become famous and is used as a resource for the Environmental Conflict Resolution courses at the University of Oregon Law School located in Eugene, OR.
- Students use the the IWW Water Video Equipment purchased through the USGS 104(b) grants to make "Stormwater Solutions", a documentary video of constructing the **OSU-Benton County Green Stormwater Infrastructure Facility (OSGIR)**, an Oregon BEST lab, a research facility designed to study the effectiveness of bioswales in regulating flow patterns and improving water quality.
- IWW Director Todd Jarvis, in concert with the Water Resources Graduate Program and the Natural Resources Leadership Academy, has been working with the Falls City, OR since January 2013 to convene public meetings, listening sessions, and community mapping of potential solutions to **surface and groundwater flooding** associated with urban development and deforestation. The project is used by a graduate student for their research project.

Technology Transfer

Basic Information

Title:	Technology Transfer
Project Number:	2014OR137B
Start Date:	3/1/2014
End Date:	2/28/2015
Funding Source:	104B
Congressional District:	0004
Research Category:	Not Applicable
Focus Category:	Education, Law, Institutions, and Policy, Management and Planning
Descriptors:	None
Principal Investigators:	Todd Jarvis

Publication

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PicoHydro Electric Generator

Why and where it is useful as an alternative power source

The steep incised rivers and streams in The Oregon Coast Range make it challenging to get materials, supplies, and frankly people to various field locations. Because of the difficulties involved with traveling to our research site, an attempt was made to find ways to make data collection more self-sufficient.   The first thought was solar power, but the long gloomy winters and steep relief make it challenging to receive enough light to make solar a viable option. Instead, we chose to use a first order perennial stream that feeds into our study reach, as a power source.

We began by building a “5 gallon bucket generator” seen here (https://www.youtube.com/watch?v=1tXgvoo6v10), which worked okay but not great. After exploring some options and looking into how we could make a more efficient generator we came up with the design seen above. Some things that make the design slightly better than the bucket style are adjustable jets (these allow for the control of the water flow so we can increase or decrease the flow based on the available supply, also we can better calibrate the jet velocity to better fit the turbine curve which is optimal at jet velocities twice the turbine velocity(Cobb, 2012)), next we limited the restrictions in the pipe (this is done a few ways, first we replaced the pipe reducers with tapered reducers (see examples on the next page), second instead of multiple bends to connect to the jet, like the 5 gallon bucket style, instead we used a poly pipe called Pex and made one long sweep to each jet), third we made it possible to adjust the jet position (this is nice because you can calibrate them on site with the flow your site is using), last we went with a machined turbine (this is more efficient in dissipating water and generating energy then the handmade one).

With the new design we went from 0.7 amps at 12 volts to 1.5 amps at 12 volts, doubling our power. We could have made more power by running a higher voltage (we approached ~45 watts when we stacked batteries to 48 volts), and we could have opened up the jets, but running the jets wide open at our site put too much strain on our stilling pond causing the pond to eventually drain which resulted in air coming of the jets.

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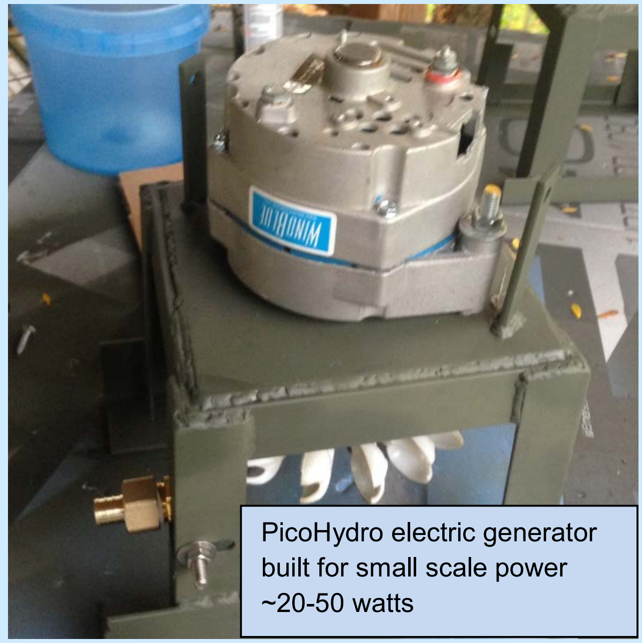

PicoHydro electric generator built for small scale power ~20-50 watts

Parts List with Vendors

Parts used include:

• Turbine, for this application I used the larger turbine (http://peltonwaterturbine.com/tema1/produts11.asp)

• Alternator (http://www.windbluepower.com/Permanent_Magnet_Alternator_Wind_Blue_Low_Wind_p/dc-440.htm)

• Adjustable Jets
SBCG — for 0.17 to 0.47 inch (4.3 to 12 mm) cord diameters, Type 4X (IP66) rated, ½-inch (15-mm) NPT threads (http://www.orenco.com/)

• Pipe Fittings (purchased from Home Depot)

1. (2)3/4 in. x 1/2 in. Brass Barb x Male Threaded Adapter
2. (2) 3/4 in. Brass Barb x Female Swivel Adapter
3. (2) 3/4 in. x 1/2 in. Lead-Free Brass MIP x FIP Hex Bushing

• Extension shaft and Jet holder (fabricated at OSU by Ben Russel email brussell@coas.oregonstate.edu)

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Item Images, Examples, and Notes

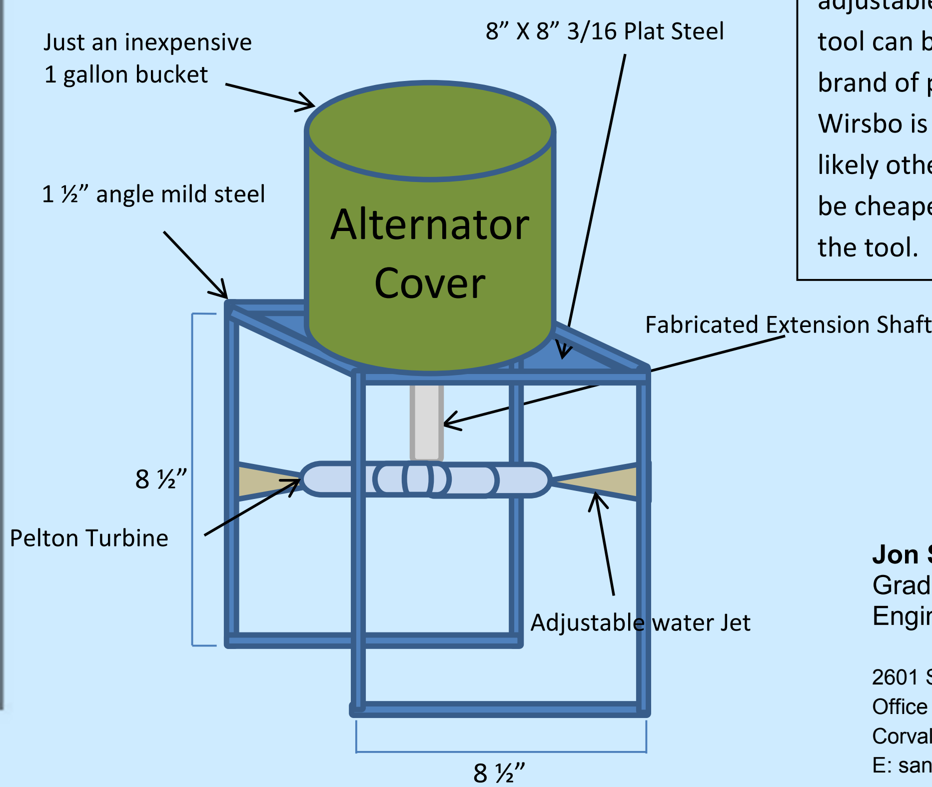
http://www.sears.com

Adjustable Jets

http://www.orenco.com

http://www.thefind.com

http://www.redlinepex.com



Conceptual design of PicoHyro generator

Notes:

The Wind Blue Alternator is a permanent magnet alternator that is remanufactured from an ACDelco alternator; ACDelco uses a propitiatory thread pattern for the output shaft (this means you can't find a nut for the main shaft at your local hardware store). I went to a local auto wrecking yard and found deeper main shaft nuts that could be machined and pressed into an extension tube to make my extension.

The Jets were a lucky find at a local Ferguson's Plumbing Store, before I found them I intended to use a bulkhead fitting, but they also have a propitiatory thread pattern. The jets from Orenco are half inch pipe thread so they will screw into any half inch pipe fitting (this makes hooking it to the Pex pipe as easy as getting a female ½" Pex fitting)

Pex Poly Pipe uses a special crimp tool to compress rings over the pipe that connect it to the barbed fitting which then connects to the adjustable jet and tapered pipe fitting. The Pex tool can be as much as $70. There is another brand of poly pipe called Wirsbo, but the tool for Wirsbo is usually more expensive. There are likely other options for this connection that may be cheaper or you may be able to borrow or rent the tool.

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[June 2014]

HE@OSU

by Gareth Baldrica-Franklin

Funding for this paper from the Institute for Water and Watersheds using funds granted through WRRA Section 104(b)

[Introduction]

Technology today is rapidly progressing. It seems as if each new week brings forth achievement worthy of publicity. From advancements in computation, to medicine, to energy, we live in an age of continual innovation. However, vast populations throughout the world lack access to these technological resources, many of which have become so common and interweaved so closely with life in and around the developed world. To these communities, lack of cell phones or Internet availability is commonplace, but not in the forefront of global views or importance. Instead, resources perceived as necessity are often either absent, difficult to obtain, or tainted altogether.

Today, over 783 million people don't have access to safe drinking water, and 3.4 million die annually from water related illnesses. 842 million lack adequate food supplies, leading to malnutrition, stunted growth, and more death than malaria, aids and tuberculosis combined. 1.3 billion people are deprived of electricity. And 37% of the world's urban population is subjected to inadequate sanitation facilities, fostering the spread of disease. While this list could be far longer, there is something that each of these associated issues has in common: all can benefit by our recent technical achievements, and can be solved at the local level rather simply. Pumping a well, paving a road, providing modern agricultural techniques. By combining the technicality of engineering with the value and motive of humanitarianism, we can work together to create a brighter outlook for struggling populations worldwide. Enter, humanitarian engineering.

[What is Humanitarian Engineering?]

Put simply, humanitarian engineering is an attempt to better the world; or, more specifically, to improve the lives of disadvantaged communities through engineering strategies and techniques. Conceptually, it has existed for decades, perpetuated by groups of do-gooders striving for improvement. Today, however, individuals are working to organize humanitarian engineering into a legitimized field of study. Already, two institutions in the United States have adopted HE programs, and both have been lauded considerably. Oregon State looks to be the third.

[Humanitarian Engineering in Oregon]

Oregon has been on the forefront of the humanitarian engineering effort for many years, and our state contains various organizations that have dedicated themselves to the improvement of the world around them.

[Organization Profiles]

Puralytics | Beaverton, Oregon

Founded by OSU mechanical engineering alumni, Mark Owen, Puralytics has been a major innovator in water purification initiatives. Driven by their main product, the SolarBag, Puralytics has been able to provide clean drinking water to communities in Africa and Southeast Asia. The company has received numerous honors for their work, including the National Grandprize in the 2010 Cleantech Open.

Right: A village in Malawi poses with their SolarBags.
Left: A SolarBag, Harnessing photochemical reactions triggered by sunlight, the SolarBag can provide purified drinking water efficiently and effectively.

Engineers Without Borders (EWB) | Various Oregon Campuses

Left: Locals watch as an EWB-OIT faculty member uses a newly built well.

A nationwide non-profit with 3 branches in Oregon (Oregon State University, Portland State University and Oregon Tech), EWB promotes worldwide humanitarian engineering projects through student engagement.

Green Empowerment | Portland, Oregon

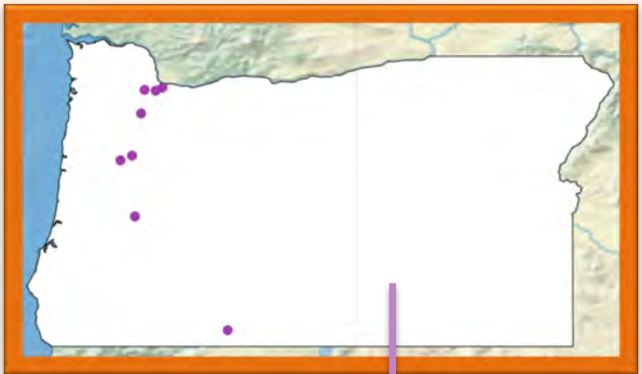
A non-profit based in Portland, Green Empowerment looks to promote social and environmental change through small scale engineering projects, largely dealing with access to water and electricity at the village level. Green Empowerment has partnered with local nonprofits in 8 countries to enable projects and oversee their completion.

Right: Locals assist engineers to install solar panels in Sabah, Malaysia.

[Organization List]

Name :	Location in Oregon :
SunBridge Solar	Portland, Oregon
Solar World	Hillsboro, Oregon
Agilyx	Beaverton, Oregon
SWEETSense	Portland, Oregon
Puralytics	Beaverton, Oregon
Schneider Water Services	St. Paul, Oregon
Hydration Technology Innovations	Albany, Oregon (HQ in Arizona)
Mercy Corps	Portland, Oregon
Ecotrust	Portland, Oregon
Green Empowerment	Portland, Oregon
CH2M-Hill	Portland, Oregon (HQ in Colorado)
REACH Community Development	Portland, Oregon
Habitat For Humanity	Offices throughout Oregon
Engineers Without Borders – OSU	Corvallis, Oregon
Engineers Without Borders - OIT	Klamath Falls, Oregon
Engineers Without Borders - PSU	Portland, Oregon
Ann Campana Judge Foundation	Corvallis, Oregon
Global Wells	Portland, Oregon
WaterAfrica	Portland, Oregon
Portland Global Initiatives	Portland, Oregon
Aprovecho	Cottage Grove, Oregon

[Humanitarian Engineering Across the World]



Left: A map displaying locations of humanitarian engineering organizations in Oregon.
Below: A series of maps highlighting areas throughout the world where Oregon humanitarian engineering organizations operate.

About the author | Gareth Baldrica-Franklin is an undergraduate intern with the Institute for Water and Watersheds.

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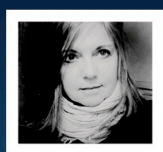
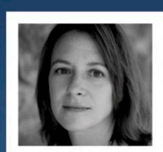


OCT 29 Joni Kabana, Visual Storyteller

Humanity Before Us: Crossing the Cultural Divide

7 PM lecture, Construction and Engineering Hall, LaSells Stewart Center

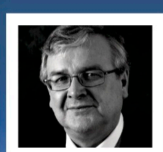


NOV 4 Jamie Bechtel, Social Entrepreneur

The Art of Listening

4:30 PM lecture, Kearney Hall 112

AFFILIATED WITH A NEW COURSE



NOV 13 David Manz, Environmental Engineer

Future of the BioSand Filter

4:30 PM lecture, Rogers Hall 226

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PHOTO CREDIT, JONI KABANA

Fall 2014 Water Resources Graduate Program Seminar Series

Watershed-based Partnerships for a Resilient World

Wednesdays, October 1—December 3, 4 –5 p.m. in KEAR 305
Free and open to the public!

OSU Graduate Water Resources Program

Oct 1 *The Role of Regional Scale Water Management in Natural Systems: Connections, Interactions and Feedbacks*
Laura Condon, Colorado School of Mines

Oct 8 *Sustainable Rural Communities and the Urban-Rural Divide in Oregon*
Brent Steel, Oregon State University: Political Science Department

Oct 15 *Watershed Based Partnerships in Public/Private Managed Landscapes*
Ken Bierly, Oregon Watershed Enhancement Board (Retired)

Oct 22 *Documenting Public Values for River Ecosystem Services*
Matthew Weber, US Environmental Protection Agency: Western Ecology Division

Oct 29 *Knowledge Networks for Sustainable Water Management*
Kathy Jacobs, University of Arizona: Center for Climate Adaptation Science and Solutions

Nov 5 *Stream and Watershed Restoration: The Implementation Quandary*
Jon Souder, Coos Watershed Association

Nov 12 *Addressing Water Issues in Private Land Conservation Planning*
Sarah Bates, National Wildlife Federation & Center for Natural Resources and Environmental Policy, Montana

Nov 19 *Resilient People and Places: The Role of Community Partnerships in Preparing for Coastal Disasters*
Lori Cramer, Oregon State University: Department of Sociology

Dec 3 *Watershed Restoration Planning and Partnership*
Dan Bell, The Nature Conservancy and Tara Davis, Calapooia Watershed Council

Special thanks to our Sponsor:

OSU Oregon State University Institute for Water and Watersheds **through the USGS 104(b) program**

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Journal Club WRP 505 (CRN 15364)

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http://oregonstate.edu/gradwater/

2014-15 Water Resource Graduate Program Seminar Series

OSU Graduate Water Resources Program

Winter 2015: Research & Careers in Water Resource Engineering

Jan 7 — *Contesting Hidden Waters: Engineering Resolutions to Groundwater Conflict*
Todd Jarvis , IWW Oregon State

Jan 14 — *A GIS Approach to Estimating Continuous Hydraulic Conductivity*
Tracy Arras, Oregon State University: College of Civil Engineering

Jan 21 — *The Challenges and Opportunities of Engineering Careers in Water Resources*
Kim Anderson, CH2M-Hill (Retired)

Jan 28 — *Forest HydroEcoPedoPyrology: Trans-disciplinary Research for Integrated Source Water Management*
Kevin Bladon, Oregon State University: Department of Forest Engineering, Resources, and Management

Feb 4 — *Optimizing Capillary Trapping of CO_2 for Safe Storage and Prevention of Groundwater Acidification*
Dorthe Wildenschild, Oregon State University: School of Chemical, Biological, and Environmental Engineering

Feb 11 — *New Technologies in Water Resource Engineering*
Jack Herron, Hydration Technology Inc

Feb 18 — *Microbial Fuel Cells for Sustainable Energy Generation and Wastewater Treatment*
Hong Liu, Oregon State University: Department of Biological and Ecological Engineering

Feb 25 — *Reservoir Storage Feasibility as Part of Oregon's Integrated Water Resource Strategy*
Keith Mills, Oregon Water Resources Department

Mar 4 — *Fracture/Fault Characterization in Crystalline Rocks: Implications for Groundwater Fluxes and Resources*
Clément Roques, Oregon State University: Department of Biological and Ecological Engineering

Mar 11 — *Sediment Transport Prediction in Ungagged Basins and Implications to Stream Ecology*
Catalina Segura, Oregon State University: Department of Forest Engineering, Resources, and Management

Peavy 242

Free and open to the public

Students can enroll for credit:

- Seminar WRE 507 (CRN 35648)
- Journal Club WRE 505 (CRN 33713)

Wednesdays 4-5 PM

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CALLING ALL WATER ENTHUSIASTS

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SUNDAY APRIL 26

9:30 am	**GROUP HIKE to ABIQUA FALLS** Check symposium website for updates

MONDAY APRIL 27

9 am – Noon	**STUDENT ORAL PRESENTATIONS** Glacial hydrology, climate change, stream ecology
1 pm – 3 pm	**STUDENT POSTER SESSION** Water availability and geomorphology
3 pm – 5 pm	**NETWORKING RECEPTION**
6 pm – 8:15 pm	***Who Owns Water* FILM & PANEL**

TUESDAY APRIL 28

9 am - 2 pm	**STUDENT ORAL PRESENTATIONS** Sediment transport, surface water, water quality, water management and infrastructure
2 pm – 4 pm	**STUDENT POSTER SESSION** Water quality and policy
4 pm – 4:30 pm	**AWARDS**

For more information visit: hydrophilesresearchsymposium.org

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Presents a LET'S TALK ABOUT WATER event

Monday April 27th 2015

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Oregon State University

Doors Open: 5:30 pm   Film & Discussion: 6:00 pm

Who Owns Water

An award-winning documentary film about our most valuable resource

featuring panelists

Filmmaker David Hanson
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Dr. Brenda Bateman
Administrator for Technical Services Division at the Oregon Water Resources Department

Dr. Aaron Wolf
Professor of geography at Oregon State University and an expert in transboundary water conflict and cooperation

Julie Keil
29 years of experience in hydro licensing with Portland General Electric and past president of the National Hydro

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Student Chapter of the American Water Resources Association and American Institute of Hydrology

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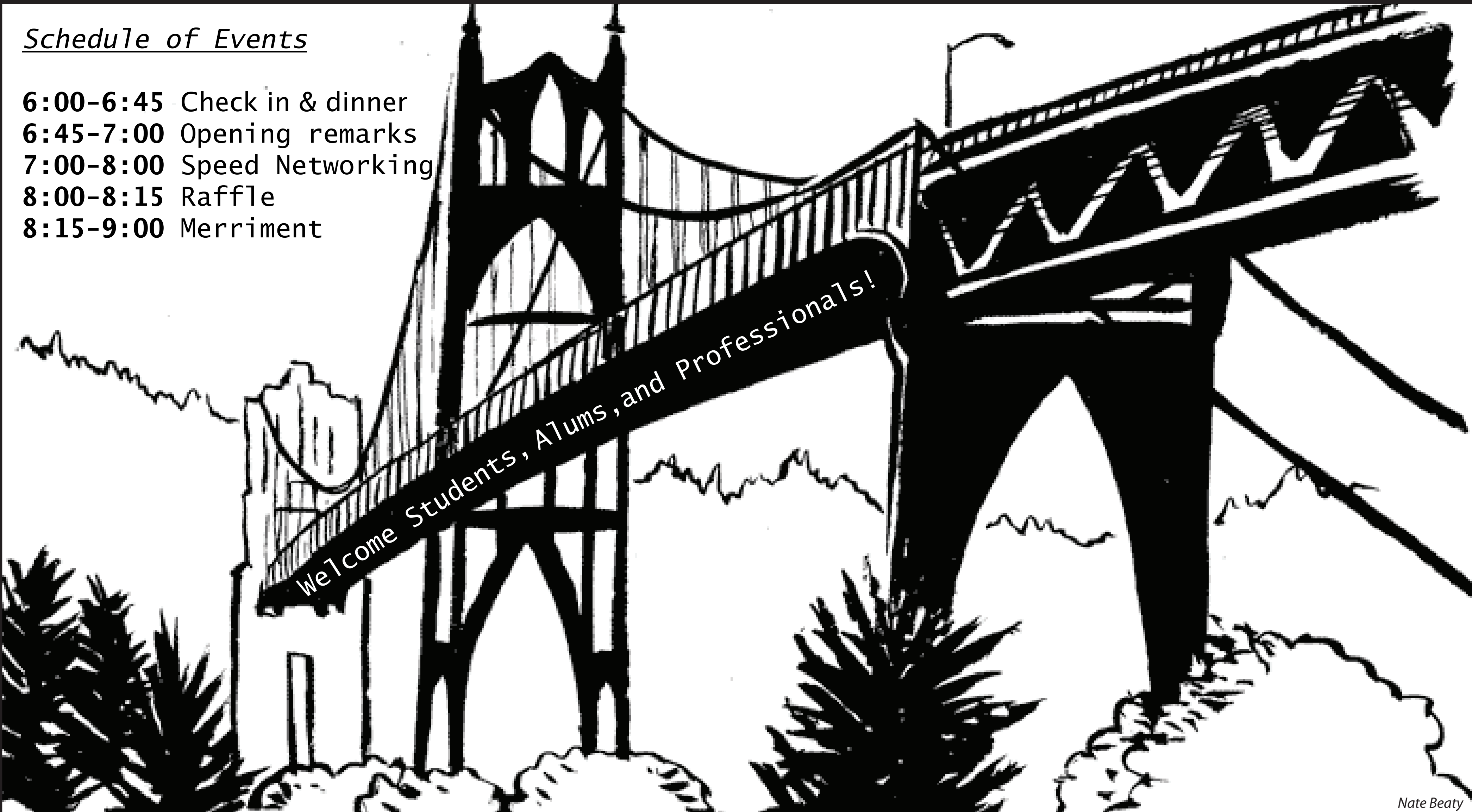
Schedule of Events

6:00-6:45 Check in & dinner
6:45-7:00 Opening remarks
7:00-8:00 Speed Networking
8:00-8:15 Raffle
8:15-9:00 Merriment



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Professional and non-Hydrophiles: $15 / Hydrophiles: $10

Many thanks to WEST Consultants, the OSU Water Resources Grad Program, and the Institute for Water and Watersheds for their generous support

The Hydrophiles Fall Rafting Educational Adventure

On Friday, October 17th, the Hydrophiles embarked across the Oregon/Washington state boarder on an educational adventure to the White Salmon River. The students heard about restoration efforts and fish progress from Jeanette Burkhardt and Joe Zendt from the Yakama Nations Fisheries. The group then camped at Trout Lake Creek Campground in Gifford Pinchot National Forest.

The coffee call came the next morning at 7 am, and the Hydrophiles crawled out of their sleeping bags and wet tents after a rainy night. At 8:45 am the two university vans, funded by the Institute for Water and Watersheds, were loaded up and driven to the former Condit Dam site for a tour led Pacifice Core's Condit Dam Director, Todd Olson.

Todd Olson leading a Hydrophiles tour at the former Condit Dam site.

The Condit Dam was a hydroelectric dam built in 1912 and breached in 2011. The cost of improving the dam to comply with new fish passage regulations was estimated to be around $100 million, while the decommissioning cost was estimated to be around $38 million. Therefore, Pacfic Core chose to remove the dam as the most economical option. Since the dam's removal, salmon and steelhead have migrated upstream to use the spawning grounds that they did not have access too for nearly 100 years. A short documentary of the dam removal project can be viewed at National Geographic's website, http://video.nationalgeographic.com/video/news/us-condit-dam-salmon.

After the dam tour, the Hydrophiles geared up and went rafting down the White Salmon River. A huge thank you to Noa Bruhis, Tom Mosier, Desiree Tullos, Susan Hollingsworth, Joe Kemper, and most of all to the Institute for Water and Watersheds for making this trip possible!

The Hypdrophiles rafting down the White Salmon River.

USGS Summer Intern Program

None.

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	1	1	0	0	2
Masters	4	0	0	0	4
Ph.D.	0	0	0	0	0
Post-Doc.	0	3	0	0	3
Total	5	4	0	0	9

Notable Awards and Achievements

Aaron Wolf, an internationally recognized expert on water conflict resolution, has been named a recipient of the **Heinz Award** in the category of public policy. Established to honor the memory of U.S. Sen. John Heinz, the awards recognize significant contributions in arts and humanities, environment, human condition, public policy, and technology, the economy and employment. Wolf's award, given by the Heinz Family Foundation, includes an unrestricted cash award of $250,000.

Jon Sanfilippo and Stephen Lancaster leverage bridge funds from USGS 104(b) funding for developing a **picohydro electric generator** used to power a remote data collection station located in the coastal range of western Oregon to secure NSF Award number 1452091 (EAR). Video: https://youtu.be/O-TAt6ekFck

Jordan Beamer, Ph.D. candidate in the Water Resources Graduate Program, was one of six students selected for the prestigious **2014 CUAHSI Pathfinder Fellowship**.

Jakob Wiley (JD/MS WRPM) awarded the **Oregon Small Woodlands Association (OSWA) Scholarship** (http://www.oswa.org/).

Gareth Baldrica-Franklin, undergraduate student and staff videographer for IWW awarded an **Ambassadorship with the College of Earth, Ocean, and Atmospheric Sciences**

Kim Ogren, a PhD Geography student, won the **Outstanding Student Oral Presentation Award** at the recent American Water Resources Association (AWRA) 2014 Annual Conference for her research on the Columbia River treaty.

Arturo Leon, Ph.D., P.E, Assistant Professor in the School of Civil and Construction Engineering at Oregon State University, has been named a **Diplomate, Water Resources Engineer (D.WRE)** of the American Academy of Water Resources Engineers (AAWRE), a subsidiary of the American Society of Civil Engineers (ASCE). The D.WRE certification is the highest post-license certification available in the water resources engineering profession and it is an accredited program by the Council of Engineering & Scientific Specialty Boards (CESB).

IWW Interim Director Todd Jarvis publishes **Contesting Hidden Waters: Conflict Resolution for Groundwater and Aquifers**. In this newly released book, Dr. Jarvis explores the unique challenges and issues surrounding the governance and management of groundwater. Through case studies and first-hand accounts, the book shares insights gained through his 30 years of experience as a consulting groundwater hydrologist, professional mediator, and academic researcher.

UNESCO-IHE Institute for Water Education in the Netherlands, the University for Peace (UPEACE) in Costa Rica, and Oregon State University (OSU) in the USA, have embarked on a **joint education programme in Water Coooperation and Peace**. The goal of this new initiative is to broaden the scope of approach to conflict and peace, provide a more theoretical dimension to conflict, engage multi-level scales of conflict dimensions and strengthen skills through highly experiential learning opportunities.

IWW hosts Mr. Jechul Yoo, Director General of the International Cooperation Bureau, Ministry of Environment with the Republic of Korea as a visiting researcher for one year. Mr. Yoo's visit is a result of a **Memorandum of Understanding** between OSU-IWW and the Han River Watershed Management Committee signed in March, 2014.