2017 iUTAH Annual Symposium

Celebrating Five Years of Research, Training, Education & Outreach for Utah's Water Future

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WATER FUTURE

EPSCoR iUTAH

iUTAH—Celebrating 5 Years of Research, Training, Education, and Outreach for Utah's Water Future

iUTAH 2017 Annual Symposium and Summer All-Hands Meeting
Utah State University, Logan, Utah

Agenda

Thursday, 13 July 2017

8:00 am to 12:30 pm
Eccles Conference Center Auditorium (ECC 216)

8:00 am **Registration**

8:00 am *Informal networking and light refreshments*

9:00 am **Welcome, Introduction and Announcements**

Dr. Michelle A. Baker, Project Director and Principal Investigator, iUTAH EPSCoR, Utah State University

9:15 am **Plenary Session "Critical Outcomes, Lasting Impact"**

- *Innovations and integration in social and engineering water science*
  Dr. Courtney Flint, Utah State University
- *Transcending system boundaries through integrative ecohydrologic research*
  Dr. Zachary T. Aanderud, Brigham Young University
- *Coupling the human-natural water system: five years of participatory modeling and innovative visualization*
  Dr. Courtenay Strong, University of Utah
- *Cyberinfrastructure to support large scale, collaborative water research in Utah: critical outcomes from the iUTAH project*
  Dr. Jeff Horsburgh, Utah State University
- *Advancing a water-literate workforce and citizenry for Utah*
  Dr. Mark W. Brunson, Utah State University

- *iUTAH research assessment: building a statewide collaboration network*
  Dr. Alan Porter, Georgia Institute of Technology

10:45 am *Break and liquid refreshments*

11:00 am **Plenary Session "Expanding Horizons, Diverse Journeys"**

- *iUTAH's mission, vision, and strategies for success*
  Andreas Leidolf, Assistant Director, iUTAH EPSCoR, Utah State University
- *Out of the museum and into the fire*
  Dr. Jacqualine Grant, Southern Utah University
  Introduction by Andreas Leidolf
- *Show up and say yes: two things that got me here*
  Dylan Dastrup, Brigham Young University
  Introduction by Dr. Zachary T. Aanderud
- *iUTAH: Shaping the future one scientist at a time*
  Simone Ka-Voka Jackson, University of Nevada
  Introduction by Dave Eiriksson, University of Utah
- *From PhD to tenure track: becoming a leader in hydrology through iUTAH experiences*
  Dr. Greg Carling, Brigham Young University
  Introduction by Dr. Paul Brooks, University of Utah
- *How do we answer questions scientists can't answer?*
  Julia Kelso, Utah State University
  Introduction by Dr. Michelle A. Baker

12:30 pm to 1:45 pm
Eccles Science Learning Center Atrium

12:30 pm **Poster Session and Lunch**

- 2017 undergraduate iUTAH iFellows
- iUTAH researchers and Education, Outreach and Diversity partners
- *Movie Screenings: Desert water: A new water ethic / Desert water: Climate change and the future of Great Salt Lake*
  Dr. Hal Crimmel, Weber State University

2:00 pm to 5:00 pm
Eccles Conference Center, Various Locations

2:00 pm **Concurrent Sessions**

- Water Quality along Mountain-to-Urban Transitions (ECC 205/207)

  Chair: Paul Brooks, University of Utah

  Persistent urban impacts on surface water quality via impacted groundwater in Red Butte Creek (Rachel Gabor, University of Utah)

  Utah Water Watch—Citizens monitoring for the future (Ellen Bailey, Utah State University)

  A microfluidic device for oxygen quantitation in anoxic water (Chris Monson, Southern Utah University)

  Bacteria and GAMUT: Urban infrastructure shapes bacterial communities (Erin Jones, Brigham Young University)

  Tracking urban water flow using stable isotopes of water (Yusuf Jameel, University of Utah)

  Investigating temporal and spatial variations of trace metal loading to Utah Lake, UT (USA) (Weihong Wang and Henintsoa Rakotoarisaona, Utah Valley University)

- Collaborative Approaches to Communicating Water Science: Cyberinfrastructure, Visualization and Broader Impacts (ECC 201/203)

  Chair: Stephanie Reeder, Utah State University

  Taking Learning Outdoors with the Natural History Museum of Utah (Laura Beck and Julie Koldewyn, NHMU)

  iFellows Undergraduate Research Program (Ellen Eiriksson, Utah State University)

  Weber State's iFellows: a model for workforce development through continued engagement (Carla Koons Trentelman, Weber State University)

  iUTAH Summer Research Institutes: Supporting the STEM pipeline through engagement of High School, undergraduate and graduate students, secondary teachers, and university faculty in authentic, joint research experiences (Louisa A. Stark, University of Utah)

  Social water science data in iUTAH: Dimensions, data management, and visualization (Amber Spackman Jones, Utah State University)

- Urban Water Systems (ECC 303/305)

  Chair: Taya Carothers, Utah State University

  Getting urban food production off the ground: Improvement of drought tolerance using native soil microbial communities (Bridget E. Hilbig, Weber State University)

  University-municipal collaborations lead to insights on drivers of water use in the Wasatch Front (Douglas Jackson-Smith, Ohio State University)

  Building an engaged-relationship with Utah's water systems: A 4th grade journey to water activism and sustainability (Joel Arvizo, University of Utah, and Rose Yazzie)

  Greenroof plant composition influences invertebrate biodiversity (Jacqualine Grant, Southern Utah University)

  What influences a person's propensity of engaging in water saving behavior? (Pratiti Tagore, University of Utah)

  Having your water and drinking it too: a method for visualizing sensitive, spatially explicit water-use data using synthetic geographies (Martin Buchert, University of Utah)

- Water Resources Planning and Management (ECC 307/309)

  Chair: Kay Parajuli, Utah State University

  The potential for markets to preserve water supply to the Great Salt Lake (Eric Edwards, Utah State University)

  Economic insights from Utah's water efficiency supply curve (Coleman Gerdes and Michelle Jones, Utah State University)

  Using survey data to determine a numeric criterion for nutrient pollution (Paul M. Jakus, Utah State University)

  Shifting water use patterns in response to the conversion of irrigated agricultural lands (Ennea Fairchild, Utah State University)

  Housing tenure as a driver of water use and conservation attitudes and decisions (Matthew Barnett, Ohio State University)

  Coupled modeling of the hydrological and socio-technical systems: Lessons learned from Utah's Water Resources analysis (Krishna B. Khatri, University of Utah)

3:30 pm *Break and light refreshments*

3:45 pm **Concurrent Sessions**

- Impacts of Dust on Water and Air Quality (ECC 205/207)

  Chair: Mark Brunson, Utah State University

  Wildfire ash and Great Salt Lake dust as sources of heavy metals to Utah's aquatic ecosystems (Frank Black, Westminster College)

  Composition of aeolian dust deposition to mountains in northern Utah and Nevada, USA (Dylan Dastrup, Brigham Young University)

  Modeling the impacts of a desiccating Great Salt Lake on future air quality along the Wasatch Front (Derek Mallia, University of Utah)

  Dust in airsheds and not pollution chemistry influence the bacteria dispersing in snow (Scott Collins, Brigham Young University)

  Tracing changes in water chemistry during spring runoff using 87Sr/86Sr in Upper Provo River (Colin Hale, Brigham Young University)

- Critical Zone Processes (ECC 201/203)

  Chair: Rachel Gabor, University of Utah

  Constraining physical controls on snow hydrology along the Wasatch Front (S. McKenzie Skiles, Utah Valley University/University of Utah)

  Classification scheme for reconstructed streamflow droughts in northern Utah (1430-present) (James Stagge, Utah State University)

  Initial assessments of the geomorphic impacts of two late Holocene, drainage-damming landslides within the City Creek and Little Cottonwood Creek watersheds (Nathan A. Toké, Utah Valley University)

  A Utah soil moisture monitoring and forecast network for improved water resource management and risk prediction (Scott B. Jones, Utah State University)

- Bioretention in Natural and Experimental Settings (ECC 303/305)

  Chair: Hilary Hungerford, Utah Valley University

  Green infrastructure optimization to achieve near natural hydrology in a semi-arid urban catchment (Hessam Tavakoldavani, University of Utah)

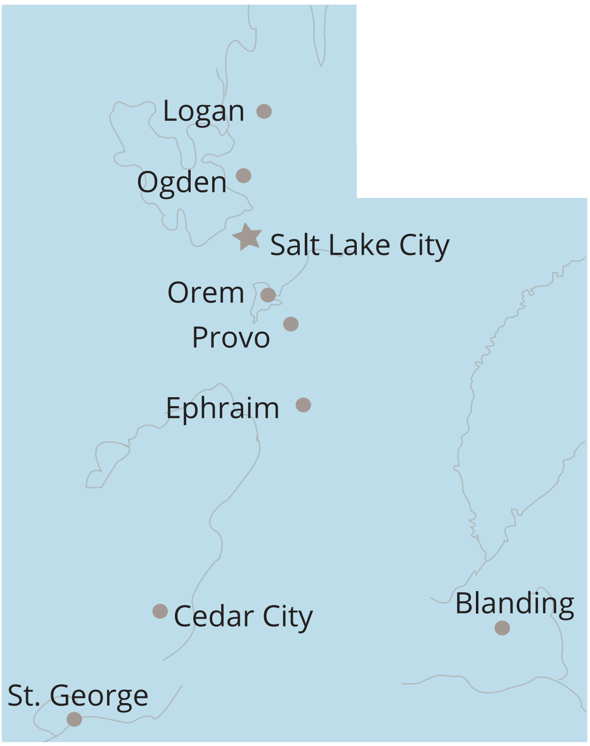
  Impact of Phragmites australis *control on Utah Lake water quality* (Eddy Cadet and Arthur Evensen, Utah Valley University)

  Evaluation of bioretention media performance at the Salt Lake City Public Utility Site (Trixie Rife, Utah State University)

5:00 pm **Conference ends**

Higher Ed Partners

Campus Collaboration Statewide



LOGAN

UtahState University

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UTAH VALLEY UVU UNIVERSITY

PROVO

BRIGHAM YOUNG UNIVERSITY FOUNDED BYU 1875 PROVO, UTAH

SALT LAKE CITY

THE UNIVERSITY OF UTAH

1875 WESTMINSTER SALT LAKE CITY

Salt Lake Community College

EPHRAIM

SNOW COLLEGE

BLANDING

UtahStateUniversity EASTERN - BLANDING

CEDAR CITY

SUU SOUTHERN UTAH UNIVERSITY

ST. GEORGE

DSU DIXIE STATE UNIVERSITY ST. GEORGE, UTAH

Presentation Abstracts

Abstracts of all concurrent session presentations are listed in alphabetic order by first presenting author last name.

Building an engaged-relationship with Utah's water systems: a 4th grade journey to water activism and sustainability

Joel Arvizo, *Rose Park Elementary School, Salt Lake City, UT, joel.arvizo@slcschools.org; and* **Rose Yazzie**, *Rose Park Elementary School, Salt Lake City, UT*.

This presentation will share data from our 4th grade research team and our journey to engaging youth in understanding, valuing, and protecting water and water systems in Utah. We will share our successes as well as lessons learned in developing youth water activists.

Utah Water Watch—citizens monitoring for the future

Ellen Bailey, *Department of Watershed Sciences and Water Quality Extension, Utah State University, Logan, UT, ellen.bailey@usu.edu*.

USU Water Quality Extension's Utah Water Watch (UWW) program has grown considerably thanks our partnership with iUTAH and other partners across the state. Water is not something that any group can manage on their own and often requires community and volunteer actions. Education and outreach is the link that takes the information to the public to encourage protection and management of water quality and quantity.

Through websites, handouts, training, hands-on activities, signage and other means, we do our best to convey useful information to the public and partners. UWW supports a volunteer network of 100 volunteers monitoring 150 sites around the state. These volunteers regularly monitor a site, record and share their data and notify us of any changes or concerns. Our program also provides teacher education so educators feel comfortable with the information about watersheds and water quality they provide their students. Many of these educators combine their lessons with Utah Water Watch as a citizen science connection to monitoring. This presentation is a highlight of what we have accomplished with iUTAH's support and hope to continue to accomplish in the future.

Housing tenure as a driver of water use and conservation attitudes and decisions

Matthew J. Barnett, *School of Environment and Natural Resources, The Ohio State University, Athens, OH, barnett.580@osu.edu;* and Douglas Jackson-Smith, *School of Environment and Natural Resources, The Ohio State University, Athens, OH, jackson-smith.1@osu.edu*.

There is very little literature regarding the impacts of different tenure arrangements and building structures on household water use attitudes and behaviors. While renters and multiunit dwellers comprise a significant and growing portion of the overall housing stock in the United States, most scientific literature regarding water use focuses on single family dwellings. Beyond representing different sociodemographic segments of society than single family dwellers, residents of unconventional housing types also face different water use and conservation incentives and constraints. The relationships people have with their homes and properties are often mediated by landlords, and further complicated by homeowner and condo owner associations (HOA/COAs). Additionally, renters may also lack knowledge about water use costs as water and other utilities are often included in their monthly rent payments. Using a 2014 survey of 2,400 households in Northern Utah, this paper uses multivariate logistic regression models to explore the extent to which tenure status and building structure affect a range of water use beliefs, attitudes, and behaviors. Preliminary results suggest that renters, multiunit dwellers, and HOA/COA members are less likely to have control of lawn watering and landscaping decisions, are less aware of water costs, and are less familiar with the volume of water that they use. Among residents of unconventional housing types who do have control over lawn watering and landscaping decisions, there is a range of differences between renters, multiunit residents, HOA/COA members, and single family dwellers regarding landscaping and lawn care decisions. Finally, housing tenure is associated with preferences for several water-related public policies such as charging more for large water users and subsidizing the purchase of low use appliances, with the directionality of many of these associations diverging between renters, multiunit residents, and HOA/COA members.

Taking Learning Outdoors with the Natural History Museum of Utah

Laura Beck, *Natural History Museum of Utah, Salt Lake City, UT, lbeck@nhmu.utah.edu*; and **Julie Koldewyn,** *Natural History Museum of Utah, Salt Lake City UT, jkoldewyn@nhmu.utah.edu.*

Local watersheds are right outside classroom windows, yet they can be so hard to access as an educational resource. Since 2009, Taking Learning Outdoors has provided K-12 teachers statewide with resources and training that bring the work of iUTAH into their classrooms. We will discuss the impacts of the program and brainstorm ways to continue facilitating authentic outdoor watershed lessons.

Wildfire ash and Great Salt Lake dust as sources of heavy metals to Utah's aquatic ecosystems

Frank Black, *Department of Chemistry, Westminster College, Salt Lake City, UT, fblack@westminstercollege.edu;* Greg Carling, *Department of Geological Sciences, Brigham Young University, Provo, UT, greg.carling@byu.edu;* Adele Reynolds, *Westminster College, Salt Lake City, UT, air0416@westminstercollege.edu;* and Anna Robert, *Westminster College, Salt Lake City, UT, afr1003@westminstercollege.edu.*

Climate models for Utah vary, but largely predict that future climate change in the region will result in an increase in the frequency and severity of wildfires. Ash from these forest fires and rangeland fires common in the region will, therefore, represent an increasingly important, but poorly studied, source of heavy metals to downwind environments, including Utah's lakes, rivers and streams. Previous research has shown that wildfires can remobilize lead, mercury, cadmium, and other heavy metals previously sequestered in surface soils. Most regional climate models also predict an increase in the frequency and duration of droughts for the Mountain West. Until 2016 Utah was in a five year drought that resulted in a 7 foot decrease in the elevation of the Great Salt Lake and a 30% decrease in the lake's volume. Future droughts or the effects of proposed water withdrawals from the Bear River for human water consumption could result in even greater declines. The shallow bathometry of the GSL results in the exposure of a large surface area of lake bed for even a small decrease in lake elevation. GSL lake sediments are elevated in mercury, selenium, arsenic, lead, copper, chromium, and other toxic trace elements, and newly exposed lake sediment is highly amenable to dust generation. As a result, the generation of dust from recently exposed GSL lake bed could result in substantial atmospheric deposition of heavy metals to downwind aquatic ecosystems that are important sources of human drinking water and wildlife habitat. We conducted studies to assess the impact of wildfires and the exposure of newly dried GSL lake sediment on the mobilization of heavy metals and the role of each of these in the atmospheric deposition of bioavailable metals to downwind aquatic ecosystems. This interdisciplinary project will combined field studies with lab experiments to characterize not only the magnitude of each of these two as a source of atmospherically deposited metals, but also differences in the lability and bioavailability of the metals associated with each.

Having your water and drinking it too: a method for visualizing sensitive, spatially explicit water-use data using synthetic geographies

Martin Buchert, *Global Change and Sustainability Center and Department of City and Metropolitan Planning, University of Utah, Salt Lake City, UT, martin.buchert@utah.edu;* Douglas Jackson-Smith, *School of Environment and Natural Resources, The Ohio State University, Athens, OH, jackson-smith.1@osu.edu*; and Melissa Haeffner, *iUTAH EPSCoR, Utah State University, Logan, UT, melissahaeffner@hotmail.com.*

Data on individual household water use can highlight the wide range of per capita and per acre water demand patterns found among Utah's residents. Yet access to water use data requires sensitivity to concerns by water system managers about the potential for accidental release of private information. Over the last two years, iUTAH researchers have developed formal memoranda of understanding to allow the confidential sharing of municipal water use data for individuals who participated in a large household survey in 2014. The aggregated dataset has been used to explore household, neighborhood, and city-level drivers of variation in water use. At the same time, researchers have been challenged to devise ways of presenting visualizations of these data that simultaneously illustrate important spatial patterns across neighborhoods and between cities, while not revealing the identity of individual water users.

In this presentation, we share examples of innovative dynamic spatial visualizations of monthly indoor and outdoor water use among households living in neighborhoods that were part of the iUTAH study. We use synthetic parcel geometries that are area-proportionate to the actual parcels for which we've collected water-use, but are laid out in an abstract space using a tree-map algorithm that clusters pseudo-parcels by area. Pseudo-parcel footprints are extruded proportional to monthly water use, while indoor- and outdoor-use can be represented as stacked prisms of differing colors. The method renders visible the following informational variables in a single visualization: between- and within- unit differences at spatial units of parcels, neighborhoods, and iUTAH valleys, and temporal units of months and years; for land area, indoor-, outdoor-, and combined water use. The visualizations provide a powerful and intuitive means to share information about spatial patterns in what would otherwise be a sensitive and potentially invasive data set, that can inform water management decision-making.

Impact of *Phragmites australis* control on Utah Lake water quality

Eddy Cadet, *Department of Earth Sciences, Utah Valley University, Orem, UT, cadeted@uvu.edu*; and **Arthur Evensen**, *Utah Valley University, Orem, UT, evensen.arthur@gmail.com.*

The introduction of the invasive perennial grass *Phragmites australis* in the 1980s has dramatically impacted the ecosystem of Utah Lake. This invasive species has choked out native plants, reducing biodiversity and decreasing the aesthetic value of the lake. State legislators have thus allocated significant funding for its elimination. The current method of removal involves aerial application of glyphosate-based herbicides followed by mowing, leaving the roots in the sediment. However, studies have shown that *P. australis* plants sequester trace metals in their roots. Thus, management in this fashion only recycles the contaminants into the lake, even potentially worsening the water quality by introducing herbicides to the system. While it is important to control proliferation of *P. australis* for ecosystem stability, its removal must be done holistically and thoughtfully. We hypothesize that trace metal concentration in sediments and water in locations where herbicide has been applied will be increasingly higher with time due to the slow decomposition of plant biomass relative to locations where Aqua Neat has not been applied, thereby reducing water quality.

P. australis, sediment and water samples will be collected from eight sites selected at random surrounding Utah Lake, including both treated and untreated areas for a period of 5 months. Sediment core samples (0-90cm) taken from each location will be divided into 15 cm increments and each increment composited for their respective location. Five replicate samples will be taken at each site. All samples will be prepped for acid microwave digestion, filtered and analyzed for trace metal content using the ICP-OES. Samples will be sent to the Utility Testing Lab in Salt Lake City for herbicide concentration determination. To understand the behavior of trace elements in each respective site, parameters such as temperature, pH, organic matter (OM), electrical conductivity, redox potential, dissolved oxygen, particle size distribution, total nitrogen, and total phosphate will be determined.

Rapid proliferation of the invasive *P. australis* is not only a local issue in Utah Lake, it is a continent-wide environmental concern as this species has invaded wetlands and most disturbed habitats across North America. Its aggressive distribution has been attributed to its ability to grow in soils with a wide range of pH, salinity, soil textures and in extreme environmental conditions. Although various approaches have been used to address the threats produced by this invasive plant, the manner in which the unintended consequences of *P. australis* control is addressed in Utah may also have implications for its management in other regions of North America. The proposed work will also advance the science of understanding geochemistry-ecological feedbacks in ecosystems, particularly involving exotic invasions. Many of these feedbacks are unknown and underappreciated. By demonstrating the potentially far-reaching consequences of invasive plant control efforts to geochemical cycling, this research will provide a template for other research efforts poised to address such relationships in other systems.

Dust in airsheds and not pollution chemistry influence the bacteria dispersing in snow

Scott Collins, *Brigham Young University, Provo, UT, scottcollins333@gmail.com;* Dylan D. Dastrup, *iUTAH EPSCoR and Department of Geological Sciences, Brigham Young University, Provo, UT, dylandastrup@gmail.com*; Greg Carling, *Department of Geological Sciences, Brigham Young University, Provo, UT, greg.carling@byu.edu*; and Zachary T. Aanderud, *Department of Plant and Wildlife Sciences, Brigham Young University, Provo, UT, zachary_aanderud@byu.edu.*

Global dust emissions doubled during the 20th century with dramatic effects on ecosystems. Dust entrainment radically changes the timing of snow melt and deposits trace metals into montane ecosystems. Dust deposition contributes substantial loading of salts, metals, and metalloids to snowpack but it also contributes bacteria. Bacteria transported in snow may travel attached to colloid fine-earth particles, be influenced by atmospheric chemistry, and pollution, and ultimately act as seeding sources for new bacterial species. However, little is known concerning the importance of dust source or heavy metal chemistry in determining bacterial dispersal. We evaluated the bacterial community composition and dust chemistry at peak snowpack in three airsheds in northern Utah, USA. We sampled snowpack before any melting occurs because liquid water may facilitate the movement of bacteria from snow and alter the snowpack chemistry and dust composition. We filtered the bacteria from snow, extracted genomic DNA and sequenced the v4 region of the 16s DNA using an Illumina HiSeq 2500 sequencer. Dust chemistry and heavy metals were evaluated with inductively coupled plasma-mass spectrometry including elements: Li, Na, Mg, Al, K, Ca, Ti, V, Mn, Fe, Co, Ni, Cu, Zn, Rb, Sr,Sb, Cs, Ba, Ce, and Pb.

Airsheds had a robust effect on the composition of snow bacterial communities. Based on our PCoA results, snow communities from the three airsheds separated in ordination space along axis 1, which explained 28.7% of community variation. The PERMANOVA results supported the ordination, with airshed location driving compositional difference among communities (F = 2.72, R^2 = 0.34, P < 0.0001). Bacterial species richness and diversity were lowest in the airshed with high levels of heavy metals which potentially originate off of dry Lake Bonneville sediments surrounding the Great Salt Lake (Red Butte, Salt Lake City, OTU number mean = 90.2 ± 21.1, Shannon diversity index mean = 3.0 ± 0.3). For example, heavy metal Sb (ANOVA, F = 27.9, P < 0.0001), As (ANOVA, F = 13.5, P < 0.0001), Sr (ANOVA, F = 10.1, P < 0.0001), which are often used as geological tracers, were higher in Red Butte snow than snow from the Provo and Logan airsheds. Conversely, elements, Pb and Cs, indicators of industrial pollution, did not differ between Red Butte and the Logan airsheds. Our findings suggest that bacteria dispersing through airsheds are chiefly dictated by mineral sources and not air pollution chemistry.

Composition of aeolian dust deposition to mountains in northern Utah and Nevada, USA

Dylan D. Dastrup, *iUTAH EPSCoR and Department of Geological Sciences, Brigham Young University, Provo, UT, dylandastrup@gmail.com*; Greg Carling, *Department of Geological Sciences, Brigham Young University, Provo, UT, greg.carling@byu.edu*; Stephen Nelson, *Brigham Young University, Provo, UT, oxygen.isotope@gmail.com*; Zachary T. Aanderud, *Department of Plant and Wildlife Sciences, Brigham Young University, Provo, UT, zachary_aanderud@byu.edu*; Diego Fernandez, *Department of Geology & Geophysics, University of Utah, Salt Lake City, UT, diego.fernandez@utah.edu*; and Maura Hahnenberger*, Department of Geosciences, Salt Lake Community College, Taylorsville, UT, maura.hahnenberger@slcc.edu.*

Wind-blown dust is an important source of trace metals and nutrients to mountain environments worldwide. Mountain ranges in Nevada and northern Utah are located downwind of dust sources in the Great Basin Desert with potential for trace metal loading from dust deposition. We sampled spring dust from snowpack (“snow dust samples”) and summer dust in buckets (“dust bucket samples”) across multiple locations in the Snake Range, Wasatch Mountains, and Uinta Mountains from 2013 to 2015. The objective of the study was to examine temporal and spatial variability in dust composition, with implications for identifying dust sources, and to evaluate form and availability of major and trace elements in dust. The snow dust samples were subjected to a three-step sequential leach procedure of 1 M acetic acid, 0.8 M nitric acid, and aqua regia and analyzed for $^{87}Sr/^{86}Sr$ ratios and concentrations of 40+ trace and major elements. The dust buckets were analyzed for bulk chemistry after an aqua regia leach. All samples were analyzed for mineralogy. The samples showed spatial variability in chemistry, with the central Wasatch dust containing the highest concentrations of playa-associated elements (U, Mg, Li, Ca, Sr, As) and anthropogenic elements (Sb, Mn, Zn, Cu, Pb, Se, Cd) and lowest concentrations of these elements in the northern Wasatch. Multivariate statistical analysis showed that over the course of the study samples had unique geochemical signatures within each sample area. These findings suggest that spatial variability is more important than temporal variability in terms of the chemistry of dust deposition. A major dust event on 17 March 2014 that was sampled across the study area showed spatially variable trace element concentrations and $^{87}Sr/^{86}Sr$ ratios, indicating that dust deposited to mountain snowpack originated from multiple upwind desert dust source areas. Backward trajectories calculated using the NOAA HYSPLIT model showed that dust sources to the Wasatch Mountains include wide areas of the Great Basin desert. Leachate results showed that nearly 60% Ca, Sr, and Cd mass is potentially available for transport during snowmelt and that the rare earth elements could be mobilized under lower pH conditions in the soil zone. With increasing populations and land use change in the western US, the short and long term effects of aeolian dust deposition to mountain environments need to continual monitored and constrained.

The potential for markets to preserve water supply to the Great Salt Lake

Eric Edwards, *Department of Applied Economics, Utah State University, Logan, UT, eric.edwards@usu.edu.*

Water in the Great Salt Lake (GSL) provides myriad services including economic production, dust control, ecosystem maintenance, and recreation. Diversions from the three main tributaries to the lake, the Jordan, Weber, and Bear rivers, have caused the lake level to decline during the last century (Wurtsbaugh et al., 2016). While declines have threatened ecosystem service production from the GSL, the culpable diversions are also valuable, providing water for municipal, industry, agriculture throughout much of northern Utah. With large anticipated increases in northern Utah's population, declines in the water level of the GSL are likely to continue. Markets offer a potential solution that can address the problems of the reduced GSL lake level at a relatively low cost. This study, conducted by undergraduate students at Utah State University as well as faculty members in the Department of Applied Economics, examines the feasibility and economic benefits of allowing the trading of water to preserve the elevation of the Great Salt Lake. To protect lake's current level, reductions in extraction are needed. These cutbacks could be applied uniformly, i.e., each user reduces use by the same percentage or quantity, or via the appropriative rights doctrine, i.e., cutbacks are implemented in the reverse order of the priority date on each water right. Both these measures are economically inefficient because the marginal cost of abatement is not equalized across all water users. Edwards et al. (2017) find that Utah has tremendous potential to increase the supply of water through investment in water-efficiency measures, with the cheapest actions available in agriculture. This means that when urban or highly-efficient agricultural users are asked to conserve, they could enter into win-win agreements to pay for water conservation by lower-value agricultural users. This study estimates the potential benefits of allowing these sorts of transactions, either within or between watersheds. It also explores the legal levers available for constructing such a market and the potential legal barriers to implementation.

iUTAH Undergraduate Research Fellows (iFellows) Program

Ellen Eiriksson, *iUTAH EPSCoR, Utah State University, Logan, UT, ellen.eiriksson@usu.edu;* and Mark W. Brunson*, iUTAH EPSCoR and Department of Environment and Society, Utah State University, Logan, UT, mark.brunson@usu.edu.*

For the past 5 summers, the iUTAH Undergraduate Research Fellows (iFellows) Program has provided an opportunity for undergraduate students from institutions across the state to gain first-hand research experience in the labs of iUTAH project scientists. During the program, iFellows participate in an 11-week paid research experience, being placed at either the University of Utah (UU), Utah State University (USU), or Brigham Young University (BYU). The program emphasizes science communication, community building and mentorship. Throughout the experience, iFellows train side-by-side with iUTAH researchers and graduate students, participate in professional skill development sessions, expand science communication skills, and engage with STEM professionals.

Shifting water use patterns in response to the conversion of irrigated agricultural lands

Ennea Fairchild, *Utah State University, efairchild@aggiemail.usu.edu;* and Douglas Jackson-Smith, *School of Environment and Natural Resources, The Ohio State University, Athens, OH, jackson-smith.1@osu.edu*.

The overwhelming majority (85%) of water withdrawals in the semi-arid Intermountain West (IW) are used for agricultural irrigation. However, the region is rapidly changing. Population doubled between 1970-2010 and is expected to double again by mid-century. Most urban growth has occurred on formerly irrigated farmland. While the pace and scale of change in the IW is almost unparalleled in the U.S., the impacts of urbanization and economic diversification on water use patterns is less clear. We used county- and state-level data to assess trends in water by use across different economic sectors over the last 20-30 years. Population in the IW region grew by 3.6 million people (over 50%) between 1985-2010. During this time, total withdrawals for public water supplies grew by 25%, with per capita water use rates declining 14% (from 211 to 182 gallons/per capita/day). Meanwhile, use of water for agricultural irrigation in the IW region declined by nearly 15% over this time period. Total irrigated acres declined by 1.4 million acres (about 11%) between the mid-1980s and late 2000s. Per acre application rates declined by 7%, from 4.15 Mgal/acre in 1985/90 to 3.86 Mgal/acre in 2005/10. Overall, it is clear that increases in water use for public water systems can account for only a small fraction of the net drop in water use in agriculture. Rather, internal dynamics within the farm sector (changes in commodity prices and technology) and competition from nonfarm commercial activities in rural areas (e.g. aquaculture and self-supplied industrial development) account for most of the changes in water withdrawals for irrigation. These findings suggest that despite rapid population growth and economic diversification, overall water withdrawals actually decreased in the Intermountain West by 15% over the past twenty years. This pattern is driven mainly by significant declines in water use on irrigated agricultural fields, and is accounted for more by a drop in irrigated acres than by improvements in the efficiency of irrigation systems. Moreover, declines in agricultural water use have not been associated with a decrease in the gross value of agricultural output or farm numbers. Meanwhile, urban water use does not appear to be the main driver of changes in agricultural water use. Partly because of improvements in per capita water use, overall regional increases in withdrawals for public water systems is much smaller than the size of the net decline in irrigation water use. In addition, the vast majority of the declines in agricultural water use occurred in counties that are not experiencing significant population increases.

Persistent urban impacts on surface water quality via impacted groundwater in Red Butte Creek

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Growing population centers along mountain watersheds put added stress on sensitive hydrologic systems and create water quality impacts downstream. We examined the mountain-to-urban transition in watersheds on Utah’s Wasatch Front to identify mechanisms by which urbanization impacts water resources. Rivers in the Wasatch flow from the mountains directly into an urban landscape, where they are subject to channelization, stormwater runoff systems, and urban inputs to water quality from sources such as road salt and fertilizer. As part of an interdisciplinary effort within the iUTAH project, multiple synoptic surveys were performed and a variety of measurements were made, including basic water chemistry along with discharge, water isotopes, and nutrients.

Red Butte Creek, a stream in Salt Lake City, does not show significant urban impact to water quality until several kilometers after it enters the city where concentrations of solutes such as chloride and nitrate more than triple in a gaining reach. Groundwater springs discharging to this gaining section demonstrate urban-impacted water chemistry, suggesting that during baseflow a contaminated alluvial aquifer significantly controls stream chemistry. By combining hydrometric and hydrochemical observations we were able to estimate that these groundwater springs were 17-20% urban runoff. We were then able to predict the chemistry of urban runoff that feeds into the alluvial aquifer. Samples collected from storm culverts, roofs, and asphalt during storms had chemistry values within the range of those predicted by the mixing model.

This evidence that urbanization affects the water quality of baseflow through impacted groundwater suggests that stormwater mitigation may not be sufficient for protecting urban watersheds, and quantifying these persistent groundwater mediated impacts is necessary to evaluate the success of restoration efforts. Further work involves using fluorescence analysis of dissolved organic matter chemistry and microbial genomics to identify "fingerprints" of urban impacts to water quality.

Economic insight from Utah's water efficiency supply curve

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Across the western US, growing populations and urbanization along with environmental demands and a changing climate have strained water allocation mechanisms originally designed to provide water to agriculture. This paper provides a methodology, using Utah as an example, for examining the options for new water supply via conservation, interpretable by policymakers, water agencies, and water users. Findings indicate that the largest potential water savings, at the lowest cost, are in agriculture and outdoor residential water use, where more efficient applications can maintain the acreage of crops and lawns at current levels while dramatically reducing use.

Greenroof plant composition influences invertebrate biodiversity

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Green roofs were designed by civil engineers to insulate buildings, protect buildings from ultraviolet light, and slow stormwater runoff. However, from a biologist's perspective they are an untapped resource for growing crops and native plants that support pollinators. Two basic assumptions about green roofs are (1) that they provide more habitat for invertebrates than normal roofs, and (2) that they approach the same level of biodiversity as ground level sites. The first assumption is so basic that it has rarely been tested. We compared biodiversity on a green roof composed of plants from a commonly used genus in the green roof industry, sedums, with biodiversity on an asphalt tile roof. To test the second assumption we compared biodiversity on a green roof of plants that contained a mix of native and nonnative plants to ground level sites in the immediate vicinity. Surprisingly, invertebrate biodiversity on a sedum roof was not different from that of an asphalt tile roof containing no vegetation. Biodiversity on the mixed native plant green roof did, however, approach similar levels of biodiversity to nearby ground level sites. We conclude that for green roofs to be functional from both engineering and biological perspectives, they must include a diverse array of plants. We are now testing a variety of native plants from Utah to determine their suitability for green roof installations.

Tracing changes in water chemistry during spring runoff using $^{87}Sr/^{86}Sr$ in Upper Provo River

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Windblown dust deposits on snowpack causes changes in solute and trace element chemistry. Thus, snow and subsequent melt water chemistry is dependent on the influx of dust. The Wasatch Front and surrounding area dust flux is expected to increase from changes in climate. These changes may affect the water supply supporting much of the population along the Wasatch Front. Preliminary sampling occurred between 2014-2016 samples of snow, river, and surface runoff have been collected in the upper Provo River watershed. During 2016, more intensive sampling of the upper Provo River took place with river, snow, and surface runoff samples. Preliminary $^{87}Sr/^{86}Sr$ results show promise as a tracer to understand changes in water chemistry in the Provo River from impacts of dust in the Uinta Mountain snowpack. However, mixing curves with end members as base flow and snow samples do not explain $^{87}Sr/^{86}Sr$ ratios of samples taken during spring runoff. This suggests that there is an alternate source of elemental Sr to the system. Future work will consider lake water, soil water, groundwater, and vegetation as alternate end members effecting upper Provo River water chemistry.

Getting urban food production off the ground: improvement of drought tolerance using native soil microbial communities

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Efforts to enhance global food security promote the inclusion of local urban food systems, which are often more limited by the cost and availability of water than conventional agricultural systems. Areas of the Wasatch Front are currently experiencing moderate to severe drought, which can have profound effects on the viability of sustainable urban food systems. Soil microorganism, in particular arbuscular mycorrhizal fungi (AMF), have been shown to greatly influence drought tolerance of plants, so that viable crops can be produced with less water. We investigated how to effectively introduce soil biological complexity found in natural systems into the highly artificial soils of community gardens and green roof gardens, so that crops might be better able to contend with drought-stress or less irrigation. Green peppers (*Capsicum annuum*) were grown in community garden plots and green roof units with commercial AMF that consists of a single species *Glomus intraradices*, locally sourced AMF that consist of all species found in the rhizosphere of *Artemisia tridentata*, and sterile soils, and under continual or pulsed water treatments. Plants will be grown until fruit production, at which point they will be harvested and measured for aboveground biomass, belowground biomass, percent root infection by AMF, and nutrient concentrations of N, Ca, P, Mg, K, Na, Fe, Mn, Cu, Zn, and B.

University-municipal collaborations lead to insights on drivers of water use in the Wasatch Front

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Managing competing water needs among limited water resources in the Western United States is a complex issue that demands the attention of multiple actors. This paper presents results of an innovative collaboration between university researchers and local municipal water system managers to combine data from a household survey with billing records of household-level water use. Results illustrate the wide diversity of water use patterns among households in this region, and highlights how these patterns reflect both individual and municipal scale factors. Rather than assuming that there is an 'average' household water use rate, we argue that important lessons can be learned by comparing both (a) broad patterns of aggregate water use differences among diverse cities, but also (b) the distinguishing characteristics of outlier household behaviors (both high and low water use).

Using survey data to determine a numeric criterion for nutrient pollution

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We present a scientific replication of a nuisance algae study originally conducted in Montana, but we do so using a different sampling methodology in a different state. We then extend the analysis to examine the effects of respondent inconsistency in rating the desirability of different levels of nuisance algae as depicted in photographs. While preference inconsistency has the potential to change the numeric criterion, in this case it did not. We also estimate a statistical model linking desirable densities of chlorophyll *a* (Chl *a*) to respondents' water quality concerns, recreation use, and demographic characteristics. Our analysis suggests Chl *a* levels in excess of 150 mg Chl a/m^2 are undesirable.

Tracking urban water flow using stable isotopes of water

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Stable isotopes of water have extensively been used to understand hydrological cycle in natural environment, however their application in highly managed urban water systems have been limited. Recent research has shown that water isotopes reflect urban water management practices and have potential application in understanding urban water supply network dynamics, evaluating effect of climate variability on water resources, geolocation and water monitoring and regulation.

Previous work has highlighted strong and structured spatiotemporal variation in tap water isotope ratios of Salt Lake Valley (SLV) which has been attributed to complex distribution systems, varying water management practices and multiple sources used across the valley. Building on these observations, we collaborated with the largest water supply company in SLV, Jordan Valley Water Conservancy District (JVWCD) and expanded our project which now includes predicting the source (or sources) contributing to a given supply area. The different sources supplying JVWCD (such as Provo River system, Wasatch Creeks and groundwater wells) have similar yet distinct isotope ratios, providing an excellent opportunity to test the robustness of water isotopes in monitoring distribution pattern of the sources in the supply system. For this project, we collected more than 100 samples/month (between April 2015-May 2016), from different water sources (creeks, streams and groundwater wells), water treatment plants (WTP), storage reservoirs and delivery locations along the supply lines across the water distribution area, measured their isotopic ratio and developed isotopic mixing models using Hierarchical Bayesian (HB) framework to connect the different sources in the system to their supply area.

In this study, we have used water isotopes to quantify the proportion of water supplied by different sources at various locations within the supply system. We have explicitly incorporated volumetric and spatial effects to constrain the contribution of each source, thus addressing identifiability issues associated with partitioning multiple sources with only two isotopes (∂^2H and ∂^{18}O).

Our initial results are in close agreement with those obtained by physical models used by JVWCD and suggests that isotopes open a new line of investigative technique to analyze urban water systems which does not require details of the supply system information. HB isotopic models can be extremely useful in systems where the supply information is missing, or are proprietary. In general, comparing the results from the isotope model can help improve the robustness of the existing physical models. Considering the fact that isotopic measurements have become fairly easy and cheap, coupling the physical supply models with isotope data in future can make urban water supply systems analysis more robust and accurate. The only requirement for robust estimates from isotopic models is the presence of sufficient isotopic variations between the different sources in the system. In systems with sources having comparable or similar isotope values, the robustness of the estimates will be questionable.

Social water science data in iUTAH: dimensions, data management, and visualization

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Water systems are increasingly conceptualized as coupled human-natural systems, with emphasis on representing the human element in hydrology. Monitoring social aspects of water systems involves expanding the range of data types typically used in hydrology and appreciating nuances in datasets that are well known to social scientists, but less understood by hydrologists. A collaborative and interdisciplinary project focused on water sustainability, iUTAH (innovative Urban Transitions and Arid-region Hydrosustainability) aims to capture and integrate information about the human and natural aspects of water resources within Utah. As we developed policy and practices for iUTAH research products, we needed methods to better understand types of social science datasets and implications for data management. Furthermore, we deployed cyberinfrastructure for baseline biophysical data, and we sought tools and interfaces for analogous social science data. In this presentation, we define social water science data as any information representing human aspects of a water system. We present a scheme for classifying these data, highlight an array of data types, and illustrate data management considerations and challenges unique to social science data in the context of datasets generated as part of iUTAH. As a particular case of social water science data, we focus on social science surveys, which are important datasets for iUTAH. Survey results are typically interpreted through the lens of the original researcher and communicated in static figures or reports. To provide exploratory and dynamic communication of these data, we developed a web-based, interactive viewer, which we applied to the results of several iUTAH surveys. This interface is applicable for examining survey results that show human motivations and actions related to environmental systems and as a useful tool for participatory decision-making. It also serves as an example of how new data sharing and visualization tools can be developed once the classification and characteristics of social water science data are well understood. The methodology developed to classify social water science data to better understand implications for data management and new, interactive tools to provide broad access to survey data are important outcomes of the iUTAH project that contribute to improving understanding of and access to data collected in studies of human-natural systems.

Bacteria and GAMUT: urban infrastructure shapes bacterial communities

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Urban infrastructure affects stream biota in a variety of ways, but the impacts to the smallest organisms has been largely uncharacterized. Within the three iUTAH watersheds, there are a variety of types and size of urban impacts along elevations gradients that allow us to compare a wide range of hydrologic and chemical factors and the resulting stream bacterial communities. Because bacteria rely on less common metabolic pathways, minor nutrients and trace metals play larger roles in driving the structure of communities. Networks of species that share compatible pathways may switch between active and dormant depending on water conditions. We sampled at GAMUT aquatic stations in all three iUTAH watersheds (Logan, Red Butte, and Provo) five times between September 2014 and October 2015. In addition to sensor data, we collected samples to measure major nutrients, anions, cations, and trace metals. We collected water and filtered to collect and extract bacterial DNA. We used Illumina Hi-Seq to sequence 16S rDNA, and then processed and analyzed the sequences using MOTHUR and R. Shannon diversity, richness, and evenness, which represent ecologic function, was higher at high elevation sites, and decreased at sites measured directly below reservoirs. There was no significant difference in diversity indices between watersheds and seasons, although the communities had unique compositions at each of the sites. In a PCOA, high elevations clustered by watershed, with below reservoir sites clustering separately. Further analysis will provide insight to which variables are most likely driving the changes in bacterial communities observed along these urban and elevational gradients.

A Utah soil moisture monitoring and forecast network for improved water resource management and risk prediction

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Soil water is the lifeblood of Planet Earth and it affects virtually every process occurring in soil, including plant growth and crop production, microbial and root respiration, infiltration and groundwater recharge, carbon sequestration and loss, as well as security issues of runoff and flooding, drought and fire. Utah's landscape is littered with what could be the most dense soil moisture monitoring network system on Planet Earth, made up of iUTAH, Snotel, SCAN, UDOT, Agrimet, and other networks located across Utah and the Western US. More than half of which include soil water content sensors for recording soil moisture at one or more depths. These records can provide valuable information for understanding the network's current or historical soil moisture situation. However, for planning and management purposes, it would be even more beneficial to have access to soil moisture forecasts. For both soil- and weather-forecasts, computer-based numerical simulations of future conditions are required, which rely on current conditions as well as on future "boundary" conditions such as atmospheric temperature and precipitation. Unlike weather forecasts with their high degree of uncertainty, hydrologic processes in soil (e.g., infiltration, ET and drainage) are associated with less variability and are thus more predictable. Funding from the Utah Agricultural Experiment Station will initiate a pilot study of the proposed soil moisture forecast using both iUTAH and other weather station data. The long-term goal is to develop a high-resolution statewide network and kriged map of soil moisture leading to a statewide 7-10 day soil moisture forecast. We anticipate this product would improve management and prediction of flood-, fire- and drought-conditions throughout the State of Utah.

Coupled modeling of the hydrological and socio-technical systems: lessons learned from the Utah's Water Resources analysis

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Sustainable water resources planning and management requires detailed understanding and estimation of multiple components of the hydrological system and its interactions with human and socio-technical systems in a basin level. This study investigates current and future water stress levels in eleven river basins in the state of Utah, USA. The water stress level is quantified by the "water criticality index" calculated as a ratio of future water resources availability and water withdrawals. The water stress level is classified into four types based on the criticality index: (1) "very high water stress" when less than 1.25, (2) "high water stress" when ranging between 1.25 and 2.5, (3) "moderate water stress" when ranging between 2.5 and 10, and (4) "no water stress" when greater than 10. The study framework uses a steady state water balance model driven by future precipitation and evapotranspiration, external basin supply, and potential groundwater resources to estimate the average annual water availability in a basin. The water withdrawals modeling considers the population-driven municipal & industrial water demand and agricultural water demand. The Weather Research and Forecasting (WRF) regional climate model was used to dynamically downscale climate drivers (P and ET) to 4-km horizontal resolution covering Utah for 1989 to 2010, 2035 to 2044, and 2085 to 2094. A k-NN algorithm and bootstrapping techniques were applied to generate confidence limits on future population, water demand, and water supply. Uncertainty in basin criticality was analyzed considering the statistically downscaled ensemble if climate projections from the Coupled Model Intercomparison Project Phase 5 (CMIP5). Five basins out of eleven achieve high water stress by 2040s, and four river basins achieve very high water stress by the 2090s. This study concludes that the criticality of Utah's water resources will be driven mainly by population growth eclipsing modest increases in gross effective precipitation from climate change. The presentation will also summarize lessons learned from the coupled modeling research currently underway to assess the impacts of climate and land use change on future water quantity and quality in Jordan River valley Utah.

Modeling the impacts of a desiccating Great Salt Lake on future air quality along the Wasatch Front

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Human exposure to adverse air quality is expected to continue into the foreseeable future along the Wasatch Front due to rapid population growth combined with an increase in dust production as a result of shifting climate and heightened anthropogenic activities (e.g., agriculture, energy exploration/development, recreation). In addition, the mean lake elevation for the Great Salt Lake (GSL) has been declining as a result of increased water consumption

along the Wasatch Front, resulting in an increase of dust-prone land-surfaces. Wind-blown dust events often lead to elevated levels of particulate matter (PM10 and PM2.5), which are regulated by the U.S. Environmental Protection Agency (EPA) through the National Ambient Air Quality Standards (NAAQS). Research has shown that prolonged exposure to elevated PM2.5 and PM10 concentrations can cause significant health issues in the form of cardiovascular and respiratory diseases as well as premature death, with the young and elderly being the most sensitive to exposure. In order to estimate the impacts of a shrinking GSL on future air quality, we have developed a dust modeling framework that can quantify the impacts of wind-blown dust on PM2.5 concentrations at major population centers. To assess the dust modeling framework's fidelity under normal conditions, we ran model simulations for two separate wind-blown dust events along the Wasatch Front during the spring of 2010, both of which had PM2.5 concentrations that exceeded 200 µg/m3 and resulted in violations in EPA's NAAQS. Initial model results showed that the model was able to replicate PM2.5 concentration at 6 study locations along the Wasatch Front for each event (R = 0.5). Next, simulations were carried out for two different GSL level scenarios: (1) the GSL after the proposed Bear River Dam Project is completed, and (2) complete desiccation of the GSL. For the Bear River Dam scenario, results showed that despite a minimal decrease in lake levels by 23 cm, PM2.5 concentrations along the Wasatch Front during wind-blown dust events increased by ~70%, on average. For the desiccated lake scenario, PM2.5 increased by ~110%. These results suggest that further reducing GSL water levels could significantly increase the risk of significant enhancements in PM2.5 levels during wind-blown dust events, which will worsen air quality along the Wasatch Front and potentially jeopardize Utah's State Implementation Plan for reducing PM2.5.

A microfluidic device for oxygen quantitation in anoxic water

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Anoxic waters, or water containing very low levels of oxygen (<1% of oxygen saturation), are important and relatively common, occurring in both natural waters (such as ocean basins and deeper waters in lakes such as the Great Salt Lake) and managed waters (such as waste lagoons). We have created a microfluidic device to measure low oxygen levels that we hope will be less expensive and more sensitive than current STOX techniques. Our microfluidic device is loosely based on the STOX electrode, but it employs active (magnetohydrodynamic) transport and microfluidic flow control. Progress toward a field-ready sensor will be discussed.

Evaluation of bioretention media performance at the Salt Lake City Public Utility Site

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Bioretention is a Green Infrastructure (GI) site design feature that allows stormwater runoff to be captured and treated before release into groundwater or nearby surface water. Different system components allow for different functions of the bioretention area. Various vegetation types provide metal uptake and nitrogen and phosphorus removal from the runoff. Different media depths and bioretention system configurations such as inclusion of an underdrain allow for additional leachate control and improved pollutant removal. Bioretention is considered a best management practice by the EPA and is preferred for green buildings and leadership in energy and environmental design (LEED) certification.

A full-scale bioretention system designed to treat runoff from a 1 ac. parking lot at the Salt Lake City Public Utilities building has been instrumented to determine the pollutant removal performance of two types of retention media: pea gravel and Utelite expanded shale that have been installed in two separate treatment cells at the site. Isco autosamplers have been used to collect stormwater samples from parking lot runoff and exfiltrate from wells installed below the two retention media filter layers, and a datalogging rain gauge has been used to collect rainfall data at the site since September 2016.

A summary of rainfall data and pollutant loading from the parking area will be presented along with initial results of pollutant removal performance for each of the two retention area media types, and recommendations regarding future implementation of bioretention systems in Northern Utah.

Constraining physical controls on snow hydrology along the Wasatch Front

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The mountain snowpack is a critical component of the water budget in the Western US; the timing and magnitude of snowmelt controls the timing, rate, and volume of river runoff, which in turn influences water availability, flood potential, hydroelectric generation, and water quality. Salt Lake City, UT is an example of a relatively large metropolitan area in the Western US that relies on the mountain snow water reservoir. The contribution of snowmelt from the Wasatch Mountains to surface water supplies for the Salt Lake City Department of Public Utilities is up to 80% or more. The majority of this comes from four streams, along which there is limited storage to buffer water supplies in low snow years. Given this dependence on snowmelt and the general trend in declining midlatitude snow cover, it is of interest to better constrain patterns and physical controls on snow hydrology along the Wasatch Front. This project is using a multi-method approach to better understand snow melt dynamics, including 1) remotely sensed fractional snow covered area to assess snow cover interannual variability, 2) field spectroscopy to quantify spatial and temporal variability in snow albedo, 3) laboratory analysis to establish physical, chemical, and optical properties of deposited aerosols, and 4) physically based radiative transfer modeling to determine aerosol radiative forcing and melt contribution by aerosols in snow. Here I will present an overview of fieldwork efforts and initial results from Water Year 2017.

Classification scheme for reconstructed streamflow droughts in northern Utah (1430-present)

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New advances in reconstructing streamflows from tree rings permit reconstructing streamflows back to the 1400s and earlier at a monthly, rather than annual, time scale. This is a critical step for incorporating centuries of streamflow reconstructions into water resources planning and allows for greater detail to characterize both recent and more distant droughts. This study uses these newly developed monthly reconstructions to characterize and categorize drought events since 1430 CE and develop a drought categorization scheme for three northern Utah rivers (Bear, Logan, and Weber). We also determine whether drought characteristics have changed in the region over the past 600 years and how the most recent 100-year period of the instrumented record compares to the longer history. Drought was defined as flows less than the 50th percentile and characteristics for each drought event were then derived using the Theory of Runs. Example characteristics include drought duration, severity, cumulative loss, onset month, seasonality, recession rate, and recovery rate. Using these characteristics, drought events were clustered by k-means and hierarchical clustering to determine distinct drought “types.” Results for the Weber river show that the historical record contains several drought events that are longer (starting in 1658 and 1705, both greater than 13.5 years) than the observed drought of record (1930, 7 years). Despite this, the 1930 drought event remains the most severe drought event in the reconstruction with regards to minimum flow percentile. These results help scientists, water resources managers, and stakeholders to place recent drought events into a larger historical context. This is particularly important for extreme events where the observed record contains only a few of these rare, but potentially disastrous events. Further, by clustering droughts into “types,” water managers can plan to manage different types of drought and to reduce their impacts.

iUTAH Summer Research Institutes: Supporting the STEM pipeline through engagement of high school, undergraduate and graduate students, secondary teachers, and university faculty in authentic, joint research experiences

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Multiple types of programs are needed to support the STEM workforce pipeline from pre-college through graduate school and beyond. Short-term, intensive programs provide opportunities to participate in authentic scientific research for students who may not be sure of their interest in science and for teachers who may be unable to devote an entire summer to a research experience. The iUTAH Summer Research Institute utilized an innovative approach for a 5-day program that engaged high school and undergraduate students as well as middle and high school teachers in conducting research projects led by graduate students and faculty members. Each Institute involved 3-4 half to full-day research projects. Participants collected and analyzed data related to, or for use in, on-going iUTAH projects. They then worked in groups with the graduate students to create posters, which they presented at the summer iUTAH All-Hands meeting. In addition to introducing participants to research, one of the Institute's goals was to provide opportunities for meaningful near-peer interactions with students along the STEM pipeline from high school to undergraduate to graduate school.

On the end-of-Institute evaluations, almost all students reported that their discussions with other participants and with graduate students and faculty were a "Highly effective" or "Effective" part of the Institute. In response to a question about how the Institute would impact their course choices or their plans to pursue a career in science, many high school and undergraduate students noted that they planned to take more science courses. Each year several undergraduates who were previously unsure about a career in science indicated that they now intended to pursue a science career. When asked how the Institute would impact their classroom practice, teachers most frequently reported that they intended to purchase equipment that would enable them to carry out some of the Institute research projects with their students, and that they planned to provide more opportunities for students to collect and analyze data.

The influence of the Summer Institute will continue past the iUTAH project and impact a broader audience through curriculum materials that will be available on the Learn.Genetics and Teach.Genetics websites. These sites, which constitute the most highly-used life science education resource in the world, are widely used by teachers and include other materials on ecology and water. During the Institutes, the participating teachers identified which research projects would lend themselves to adaptation for the typical secondary-level classroom and what support materials teachers would need to implement the projects. The Science Learning Center curriculum development team narrowed the list to those that directly address Utah Science Standards and the Next Generation Science Standards, ensuring usability for teachers in Utah and nationally. In addition to producing these curriculum materials, an Interactive, online Watershed was developed to illustrate many of the water availability, quality and use issues that were explored during the Institutes.

What influences a person's propensity of engaging in water saving behavior?

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Ensuring availability of sufficient water for urban areas in the present and in the future is an extensively researched topic. The US EPA estimates that nationally, about one-third of all residential water is used for landscape irrigation, totaling to 9 billion gallons per day. In Utah, single family households use about 65% of their total water outdoors. Often, yards are watered more than required. This may be due to timed and faulty sprinklers, and lack of knowledge about how much water is actually required. Water conserving behavior such as testing sprinklers, estimating the amount of required landscape water and installing an efficient lawn watering system may reduce outdoor water use, which contributes to the larger goal of water conservation.

In this research, we are interested to know how and why households adopt water saving behavior. There are two research questions which we want to answer. First, does adoption of water saving behavior vary by city? Second, what influences a household to engage in water saving behavior?

Previous research has indicated that demographics and other parcel-level factors such as lot size and age of house are strong predictors of household water conservation. A survey was conducted in three cities in Utah—Salt Lake City, Logan and Heber, to understand people's motivations in adopting water saving behavior. In Utah, Salt Lake City is the largest city in terms of population, Logan is a medium sized city, and Heber is a small city. A study across different city sizes would help generalize results, which was why these three were chosen. Information on demographics, home ownership status, perceptions of water availability, and watering habits and behavior were collected.

Survey data was analyzed by binomial regression. Results suggest that renters and non-white families self-report as poor adopters of water saving behavior. Results also suggest that families with low income and no college education need incentive and help to engage in water saving behavior and other environmental actions.

Results indicate that water conservation and water demand reduction strategies must be built around target groups, as different residential user groups think of, and use water differently. Results may have greater implications in policy making in cities for water use.

Green infrastructure optimization to achieve near natural hydrology in a semi-arid urban catchment

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One of the challenges facing a sustainable city, is managing stormwater in urban catchments and subcatchments, and mitigating the probable negative impacts of urbanization and development on hydrologic variables to a sustainable level. Such a level could be defined as approaching the near natural hydrology condition of an urban catchment, which implies the predevelopment state. Therefore, a stormwater management plan could be set to approach the predevelopment condition of a catchment. However, conventional stormwater management approaches are costly and not necessarily contribute to maintain natural hydrology of a region against the urbanization and development. Green infrastructure (GI) techniques on the other hand, are able to control the runoff followed by a storm event in an environmentally friendly manner, and may be used as a tool to manage stormwater related issues in a catchment scale. However, a wide variety of GI plans can be used for a stormwater reduction plan. In this study, a combination of bioretention swales and Rainwater Harvesting (RWH) systems is considered for a control scenario. This imposes this question that which configuration of these scenarios are more effective and less costly. In this study, considering the Life Cycle Cost (LCC), the quantity of runoff, and the Water Budget Restoration Coefficient (WBRC), which reflects the closeness to the natural hydrology, a systematic multi-objective optimization framework is developed to build the foundation of the analysis. Specifically, by comparing the results of different GI configurations, the optimum plans with respect to the objective functions will be determined and discussed in terms of performance and cost. A 0.11 km^2 subcatchment in stormwater drainage network of Salt Lake City, is the focus of this study, and stormwater characteristics and GI performance are modeled using the United States Environmental Protection Agency Storm Water Management Model (EPA SWMM5).

Initial assessments of the geomorphic impacts from two late Holocene, drainage-damming landslides within the City Creek and Little Cottonwood Creek watersheds

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Landslides are important geomorphic processes in tectonically-active mountain ranges. Drainage-damming landslides (DDLs) can result in increased flood risk, alter stream discharge, form niche ecological environments such as landslide-dammed floodplains (LDFs), and completely alter the sediment budgets of affected streams. The Salt Lake Valley watershed has been impacted by at least two such DDLs during the late Holocene: The Grandview Peak landslide along City Creek canyon and the White Pine landslide in Little Cottonwood canyon. To assess the timing and of these DDLs we have collected xx samples from the glide planes and deposits of these landslides for cosmogenic radio-nuclide dating. To assess the geomorphic impact we have used lidar-derived digital elevation models (DEM) to quantify the impoundment of sediment within LDFs and determine how these DDLs have altered stream profiles, terrace formation, and sediment supply within these drainage basins.

The White Pine landslide dam consisted of at least ~1.2 x 106 m^3 of quartz monzonite broken into meter-scale boulders. A 7.3 x 104 m^2 LDF formed behind the landslide, above which sediment was sourced from a 26.5 x 106 m^2 catchment. Seismic refraction and tile probe penetration tests suggest the LDF is underlain by up to 7.7 meters of impounded sediment. Using DEM analyses we estimate that 2.4 x 105 m^3 of sediment is currently impounded within the LDF, however the landslide dam has been breached by fluvial incision. Using long-term denudation rates along the Wasatch we estimate that the creek was likely dammed to surface flow for between 50-130 years. Since that time very little of the landslide deposit has been transported downstream.

The Grandview Peak landslide dam is composed of limestone and quartzite and extends ~2.5 km down City Creek canyon. The morphology of the deposit indicates that the landslide fluidized during emplacement. The top of the DDL coincides with the confluence of City Creek and one of its tributaries, forming two separate LDFs with a combined area of more than 7.6 x 104 m2. Lidar-produced DEM analyses indicate that 5.8 x 105 m3 of sediment, sourced from a 6.9 x 106 m^2 catchment area, has been impounded within the LDFs. Because the Grandview

Peak landslide dam has not been breached, we use long-term denudation rates to estimate the time required to fill these LDFs, which indicates the landslide occurred between 500 and 1200 years before present. While geochronology results will help refine these analyses, initial results show that such DDLs can prevent upstream sediments from being transported past the landslide for decades to millennia. Furthermore, after fluvial incision of DDLs, the deposit can be a source of enhanced sediment supply to the drainage for even longer periods of time.

Weber State's iFellows: a model for workforce development through continued engagement

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At Weber State University, the iUTAH professionals have successfully integrated the "workforce development" aspects of iUTAH with Weber's focus on undergraduate research and engaged learning. This integration has resulted in a model for keeping iFellows from WSU engaged on an ongoing basis once they have been selected for the program. In this presentation, we demonstrate how we incorporate these students into the WSU iUTAH team in ways that encourage them to stay involved throughout the remainder of their time at WSU, allowing us to continue encouraging their professional development. A suite of events where their participation is treated as both opportunity and expectation keeps them engaged at several key points through the year following their iFellow summer and beyond. The model we have developed includes an initiation to the WSU team before their work with the iFellows begins; a fall semester mini-symposium where they present their iUTAH research to WSU administration, faculty and staff; a January recruiting event where they get to share their iFellow stories with students who have some interest in applying to the program; and at the close of spring semester, being part of the initiation of the next cohort.

This degree of involvement with our iFellows has resulted in several positive outcomes. First, recruitment and preparation of iFellows has been strengthened. WSU was fortunate to have a relatively large number of iFellows, and we believe our active recruiting efforts, of which returning iFellows were a key element, played a role in this. Second, being this involved in iFellow recruitment has led to improved attempts at recruiting a more diverse pool of applicants, work that has resulted in the WSU iUTAH team being more mindful and proactive about working with diverse students, as well as increased network building for us. Third, the iFellows mini-symposium represents an active (and successful) effort to place iUTAH squarely into the consciousness of senior administrators, notably the university president, and other members of the WSU community. Finally, the high profile of iUTAH at WSU, achieved through this model of iFellow engagement, has been an excellent way to showcase the strength of WSU's programs and students to those who interact with them through iUTAH.

Investigating temporal and spatial variations of trace metal loading to Utah Lake, UT (USA)

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Utah Lake has long been considered severely polluted and undesirable for recreation due to the heavy loadings of various pollutants related to anthropogenic activities. In this project, we collected floc layer sediment samples as well as monthly water samples from Utah Lake's four major inlets, from the Jordan River outlet, and from the lake itself for trace metal analysis. In addition, to examine the lake's vertical mixing condition we collected depth profile samples at an interval of 0.5 m in the water column at the deepest site of the lake. We integrated geochemical data with GIS spatial mapping techniques to (1) investigate the temporal and spatial variations of trace metals in Utah Lake, its four inlets, and the outlet, and (2) assess the spatial variation of trace metal concentrations across the lake using GIS modeling. Elevated trace metal concentrations in river and lake water samples have been detected, especially in June. Arsenic in both lake and river sediment samples exceeded its respective background concentrations and was particularly high in the Jordan River outlet in November. The concentration of trace metals at the lake locations tends to be higher than that at the river locations. The GIS modeling revealed that the highest trace metal concentration was located at the deepest part of the lake, and the trace metal concentration in lake water showed large seasonal variations across the lake. In contrast, water samples taken from the depth profile site imply relatively uniform concentrations of trace metals. These results indicate that Utah Lake is not well mixed horizontally but it is well mixed vertically. In addition, trace metals from non-point pollution sources are suspected to be a significant contributor of trace metals to the lake, which indicates that the lake acts as a sink for trace metals. Elevated levels of arsenic and lead in water samples during the summer months could be due to the application of manure as fertilizers in the agricultural practice and the runoff from mine tailings.

Poster Abstracts

Abstracts of all poster presentations are listed by poster number.

1. Using a WEAP model to predict unmet municipal & industrial water demand due to population growth and drought duration in Cache County

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The Governor's office is estimating the population in Cache County to double by 2050. Utah is a desert and experiences long and severe droughts. Which combinations of severe drought duration and population growth in Cache County will cause the existing Bear River system to not meet municipal and industrial delivery needs within Cache County: and if the delivery is unmet, at what percent is it unmet? A Water Evaluation and Planning model is used to predict unmet water demand when population increases and droughts are experienced. Research results show that unmet municipal and industrial water demand is more sensitive to population growth than drought duration or severity. Recommendations for advancement include more research in population projection and forming a county drought management plan.

2. Urbanization influences soil respiration in evaluating the seasonal sensitivity of soil carbon

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Almost 10% of atmospheric CO_2 is respired through the immense stores of C in soils annually. Seasonal fluctuations are regulated to a large extent by soil organic C quality and quantity, bacterial and fungal populations, moisture, and temperature. Under urbanization, all of the key drivers regulating soil respiration may change. For example, urbanization introduces built infrastructure and impervious surfaces potentially altering soil temperature and moisture, and fertilizer additions and native vegetation removal may influence C sources and microbial diversity. To evaluate the effects of urbanization on microbial population dynamics and soil respiration, we measured CO_2 concentrations and soil moisture and temperature in real-time, and used target metagenomics of 16s rDNA and 16s rRNA, in urban and montane ecosystems at two depths (5cm and 20cm) in three watersheds across northern Utah, USA. Soil CO_2 was monitored with Vaisala CO_2 GMP220 sensors. We also evaluated soil C availability as dissolved organic C using a Schimadzu-TOC analyzer, and C quality using fluorescence Excitation-Emission Matrices with a Horiba Aqualog.

Urbanization rather than montane systems demonstrated more variable soil respiration. In winter months, the often snow-bare soils in urban systems experienced freeze-thaw cycles that created pulses of CO_2. However, CO_2 levels in montane soils remained relatively constant under

a permanent snowpack. For example, urban soil CO_2 concentrations in the three watersheds varied as much as 1000ppm while soil temperatures dipped multiple times below subzero temperature. The gradient in CO_2 concentrations between the two depths, which reflects the magnitude of CO_2 efflux, was always higher in the montane sites, suggesting that soil efflux was consistently higher in the more constant soil moisture and temperature conditions. Sequencing results have not been determined, but we expect microbial populations to remain steady in both montane and urban systems, while the activity within each system will vary between seasons. 5cm microbial populations are expected to have more diversity, particularly in the montane systems. The increased nitrogen in urban systems could lead to lower population diversity. DOC tended to decrease from montane to urban ecosystems (RMANOVA, $F = 0.52$, $P = 0.62$) with the availability of organic substrates potentially leading to higher soil respiration. Also, we did find a potential link with urbanization and nitrogen fertilization where total nitrogen availability increased 62% from montane to urban systems (RMANOVA, $F = 8.5$, $P = .03$). Our findings suggest that urbanization may alter soil temperature and moisture enough to drive microbial processes in the winter.

3. Impacts of salinity on photo-reactive fluorescent tracer dyes

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The Bonneville Salt Flats (BSF) is a large saline evaporite playa located in the most western part of the Great Salt Lake Desert of Utah. BSF changes over annual, seasonal, and climate cycles in response to changes in the water and solute balance. The north half of the playa includes the historic Bonneville Speedway and is public land managed by the U.S. Bureau of Land Management (BLM). Its south half is mainly private and is used by for commercial potash production. The public land has been a prominent site for Hollywood films, land speed records, and is often cited as a must-see destination to visitors of Utah. Over the last few decades, concerns about possible changes in salt content and the character have called into question the best land use management and mining mitigation practices to promote long-term sustainability of this ephemeral landscape.

Despite numerous studies on salt crust thickness change within the BSF, little is understood about the geohydrology of the playa. Fluorescent tracer dyes are commonly used for the accurate characterization of water movement within both surface and groundwater systems and could potentially be very useful in quantifying water movement at BSF. However, these photoreactive dyes have yet to be used in a highly saline environment. This research tests the effects of BSF level salinity (~30% salinity brine) on two particular dyes of interest, Eosin (EOS) and Rhodamine WT (RWT). Using concentrated and diluted brine from the BSF, an experiment was conducted to test the impact of salinity on the photo-degrading capacity of the dyes. Changes in the amount of dye degradation over time were quantified through the experiment using visible to near infrared reflectance spectroscopy.

4. Pricing elasticity model for the Weber Basin Water Conservancy District

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This research is a collaborative effort between Weber State University students in the Political Science and Economics departments and the Weber Basin Water Conservancy District. This project was initiated by Utah's unique and difficult policy challenges associated with a very fast growing arid western state whose water pricing system is inconsistent with population trends and consumer pricing. We began this process by identifying 15 cities served by the Weber Basin Water Conservancy District. By comparing these 15 cities with other cities in the area we have established a pricing structure that is relative to other structures. Incentives include saving time, money, and most importantly - water. This research is a collaborative effort between Weber State University students in the Political Science and Economics departments and the Weber Basin Water Conservancy District. This project was initiated by Utah's unique and difficult policy challenges associated with a very fast growing arid western state whose water pricing system is inconsistent with population trends and consumer pricing. We began this process by identifying 15 cities served by the Weber Basin Water Conservancy District. By comparing these 15 cities with other cities in the area we have established a pricing structure that is relative to other structures. Incentives include saving time, money, and most importantly - water.

5. Quantifying spatial variation of habitat suitability in the Weber watershed

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The purpose of this study was to quantify the spatial variability of habitat parameters important for native fish in the Weber watershed and determine if they are correlated to elevation or stream order. The watershed is located in northern Utah and spans Weber, Morgan and Summit Counties. Sites were selected by using various layers in GIS and other spatial mapping tools to determine land ownership and potential access points. Data collected at selected sites include water quality parameters, such as stream temperature (°C), dissolved oxygen (mg/L), total dissolved solids (µs/cm), and salinity (ppt). Geomorphic conditions and a pebble count to quantify substrate were also recorded at each site. These data were averaged by Strahler stream order (1-5) and six elevation bands between 4000' and 8500'. The data show that there is no direct correlation between habitat parameters and elevation or stream order with one exception. The exception is that temperature is correlated with stream order, with an r^2 of 0.8. This means that as stream order increases, average temperature also increases in the Weber watershed. With regards to quantifying spatial variability, temperature is most and least variable in 2nd and 3rd order streams, respectively. Both dissolved oxygen and total dissolved solids were most and least variable in 4th and 5th order streams, respectively. This analysis can be applied to future projects in the Weber watershed. Further studies using these data and selected sites could include temporal variation, and variation due to land use.

6. Monitoring microbial loading in storm water runoff from various surface types

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The introduction of pollutants into storm water runoff can be rather concerning since it can be collected for personal use, infiltrate groundwater systems, or find its way into irrigation canals. This means that storm water can act as a vector for environmental pollution or even household contamination. Environmental factors such as roofing materials, ground surface type, or vegetation can affect the extent of runoff pollution. This study will assess the microbial contamination of storm water runoff from various sources including a metal roof, an irrigation canal, and dry collection wells in a parking lot and a planter box on the USU campus. The microbes being tested for are coliforms and E. coli, as they are indicators for fecal contamination and possible presence of other harmful microbes. ISCO auto samplers were used to gather storm water samples from dry collection wells and surface gutters located across the Utah State University campus. Collection sites included the parking lot of the Education building, a water sump adjacent to the Engineering building that collected water from the roof, and a planter box adjacent to the Distance Education building. Additional grab samples were collected from gutters attached to a pump house roof, one to collect from the metal roof and another to collect from a photovoltaic cell. Grab samples were also taken from the Hyde Park canal. The concentration of coliforms and E. coli in the samples was determined using the IDEXX Quanti-tray 2000/Coliert system.

7. Nitrogen and phosphorus uptake in plant biomass of experimental bioretention systems in Utah

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Nitrogen and phosphorus are prevalent in urban stormwater, and plants and soil in bioretention treat stormwater before they enter natural waterways. A limited number of studies have focused on quantifying nutrient accumulation in plants. Studies have shown that species differently affect N uptake processes (e.g. direct uptake, couple nitrification-denitrification, soil accretion). Many of these studies on nutrient uptake have been based on small-scale experiments and have been carried out in mesic environments, which means their findings are difficult to use in semi-arid bioretention. We quantified above-and belowground biomass and foliar N and P content annually for upland and wetland plant species. To determine if plant tissues was an important nutrient sink, above-ground plant biomass in the semi-arid was measured, and the plant was harvested.

To assess the nutrient removal capacity of bioretention, vegetated and unvegetated bioretention were established. The designed bioretention units housed at the University of Utah have three different vegetation types: Utah native plants (upland), no plants (control) and wetland plants (wetland grasses and reeds). The bioretention units are designed to capture 95% of the runoff from an impervious area of 220 m^2. The soil is composed of 63% sand, 23% silt,

and 14% clay. The bioretention units were regularly irrigated using synthetic stormwater. The synthetic stormwater was made from using the combination of tap water and soil containing in the soil.

We quantified total nitrogen (TN), Total carbon (TC), and Total phosphorus (TP) uptake in plants biomass of bioretention systems of semi-arid climate. We compared TN, TC, and TP accumulation in plant biomass of upland and wetland systems. Two sets of samples were taken for this study. For the first set, plants have been thoroughly destroyed in several upland and wetland bioretention units, TN, and TP were quantified in their overall biomass and roots. For the second set, TN uptake was quantified in non-destructed samples on a monthly basis. To determine biomass of non-destructed samples, and TN, TP uptake, allometric equations were developed using plant height, crown diameter, and stem diameter measured monthly from May 2015 to Dec 2015. Isotope ratio mass spectrometry (IRMS) was used to quantify TN, TC, and lachat colorimetry was used to quantify TP in plant samples. TN, TC, and TP results for the destructed showed similar trends in three upland and wetland systems. i.e. when one increased other also increased. TN, TC analysis on plant samples over a seven months period showed that TN and TC decreased in summer, but it was significantly higher during winter. TN and TC on non-destructed samples spiked towards late spring, and woody plants had lower but better-maintained biomasses, TN and TC than grasses. Overall, the results from this experiment showed which plants are more efficient in foraging nitrogen and phosphorus from the soil, and which plants performed best in nitrogen and phosphorous removal from bioretention in a semi-arid climate.

8. Evaluating model accuracy for fish habitat in the Weber watershed

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This study assessed accuracy of modeled predictions for fish habitat parameters in the Weber River watershed through collection and comparison of temperature and discharge data. Estimated parameters, including temperature and NHD discharge were input into a GIS based model to classify reach conditions as poor, fair, good, or excellent Bonneville cutthroat trout habitat. Measured field data was collected at 44 sites and statistically compared to validate estimated temperature and discharge values and conditions. Sites were selected for measurement through evaluation of accessibility and feasibility, with the goal of collecting measurements throughout the entire watershed. Using a YSI probe temperature (°C), dissolved oxygen (mg/L and %/L), salinity (ppt), and specific conductance (microsiemens/cm) were measured at stream sites. If wadable, streams discharge was measured using a handheld Marsh McBurney flowmeter. Geomorphic conditions were assessed visually and substrate composition was measured using the Wolman Pebble Count technique. Measured temperature and discharge data were compared to modeled data to statistically quantify, bias, percent bias, root mean square error, and Nash Sutcliffe Efficiency. Measured values that deviated significantly from expected values were spatially represented and compared to barrier locations to determine if barriers are responsible for high error values.

9. The impact of competition on plant water use efficiency

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Plants experience stress competing for water with neighboring plants, both with members of the same species (intraspecific competition) and different species (interspecific competition). As plants conduct photosynthesis, they open pores in their leaves called stomata to uptake carbon dioxide from the atmosphere. However, there is a tradeoff: as carbon is gained, water is lost through evaporation as stomata open during the transpiration process. This tradeoff—the carbon gain to water lost during photosynthesis—represents the plant's water use efficiency. Plant physiological stress due to external factors may affect stomatal regulation and water use efficiency. Through two experiments, one in a controlled growth chamber and the other in the natural area of Red Butte Garden, this study analyzes the differences in water use efficiency of native Utah plant species (*Populus tremuloides, Quercus gambelii, Acer grandidentatum* and *Acer negundo)* as they face differing levels of interspecific and intraspecific competition. I found that intraspecific competition negatively impacts plant water use efficiency, but, plants that face interspecific competition improve their water use efficiency as the interspecific competition increases. Understanding the correlation between competition and water use efficiency will help predict future plant and forest success not only to stressors such as competition, but also to changing water availability resulting from global climate change.

10. Geochemical and sociological study of backyard wells in Utah Valley, Utah

Janelle Gherasim, *Utah Valley University, Orem, UT;* and **Josh McNeff**, *Utah Valley University, Orem, UT, mcneffjs@gmail.com.*

Ferreira (2013) documented elevated concentrations of As and heavy metals in rivers that flow westward across the Wasatch Range and heavily-populated Utah Valley, Utah, to drain into Utah Lake, which is consistent with the history of unregulated mining in the watershed of Utah Lake. In Utah Valley, it is not uncommon for urban residents to dig and maintain shallow (< 10 m) wells in their backyards, although the practice is illegal in Utah and unusual in urban areas outside of developing countries. Since the rivers in Utah Valley are losing streams, the question arose as to the levels of As and heavy metals in these shallow wells. The objectives of this study are to determine (1) the concentrations of contaminants in backyard wells (2) the pathways for shallow groundwater flow (3) why the urban residents of Utah Valley dig backyard wells. The objectives are being addressed by collecting water samples from backyard wells in Utah Valley and interviewing the owners of the backyard wells. Water temperature, pH, electrical conductivity, and dissolved oxygen are being measured on-site and water samples are being analyzed for nitrate, phosphate, sulfate, As, 11 heavy metals, and stable isotopes of hydrogen and oxygen. Chemical analysis of 107 backyard wells thus far has shown that EPA Drinking Water Standards are not met for Mn, As, Cd, Fe, Cu, Pb, and nitrate in 18.7%, 15.9%, 6.5%, 6.5%, 0.9%, 0.9%, and 0.9% of wells. Wells with elevated As and heavy metals tend to occur not near streams, but along the boundary between the groundwater recharge and discharge zones. According to a preliminary analysis of 80 interviews carried out with backyard well owners thus far, backyard wells are dug and maintained for emergency planning and for watering lawns and livestock, but not for gardens. Backyard well owners are conservative in terms of their social, political and religious attitudes, but are not survivalists or adherents to conspiracy theories. In fact, owners of backyard wells are no different than the mainstream of Utah culture, which suggests that backyard wells may be very common throughout the state. These findings raise the possibility that a state water policy that is backed by the public ought to include the promotion and legalization of safe water supply at the household level. Further results and interpretation will be presented at the meeting.

11. Socio-environmental analysis of landscape tree choices in Cache Valley, Utah

Emily Jorgensen, *Brigham Young University, Provo, UT, ylime.33@gmail.com;* Mark W. Brunson, *Department of Environment and Society, Utah State University, Logan, UT, mark.brunson@usu.edu;* and Elisabeth York, *Department of Environment and Society, Utah State University, Logan, UT, eyork1229@gmail.com.*

Identifying tree species can be one method to measure and determine trends in Utah landscape water demand and use. The purpose of this research was to discern and determine which trends exist and if they are likely to influence the overall landscape water demand of a particular property and thereby affect water conservation efforts statewide. Data on species of trees used in front yards and park strips (between sidewalk and street) in Cache County cities of Logan, River Heights, and Providence, Utah was gathered and combined with selected information about the homes associated with those yards in order to draw conclusions on various trends. Understanding the existing trends between property ages, current property values, and tree species will allow better understanding of the water demand associated to each property. Such knowledge will lead to further research of the sociology behind why particular tree species are more favored than others in the decision-making process.

12. Mapping the Upper Provo River watershed via soil and plant analysis

Andrew Luymes, Brigham Young University, Provo, UT, luymesandrew@gmail.com.

In conjunction with tracking mercury and strontium in the Upper Provo River watershed, mapping the physical and chemical characteristics of the soil, and plants are of vital importance to obtaining a complete picture of how the previous mentioned metals move throughout the watershed. It was sought to examine potential areas of reserves where these trace metals might be held in the biosphere. Samples were collected from 21 sites and analyzed in the Brigham Young University Environmental Analytical Lab. Plant species were selected based on the two most populous species at each site. Soil samples were taken using a standard soil T-probe. Analyses were chosen for their potential impact at increasing understanding of the relationship between the metals and their movement within the watershed.

13. Desert Water: The Future of Utah's Water Resources & Desert Water: Climate Change and the Great Salt Lake

Hal Crimmel, *Department of English Language and Literature, Weber State University, Ogden, UT, hcrimmel@weber.edu;* Issac Goeckeritz, *IG Films, Salt Lake City, UT, isssac@rcordtoinspire.com;* Daniel Bedford, *Department of Geography, Weber State University, Ogden, UT, dbedford@weber.edu;* and Daniel McCool, *Department of Political Science, University of Utah, Salt Lake City, UT, dan.mccool@poli-sci-utah.edu.*

No abstract submitted.

14. Measuring cyanobacteria growth response to changes in phosphorus

Agatha Roese, *Brigham Young University, Provo, UT, agatharoese@hotmail.com;* Erin Jones, *Department of Plant and Wildlife Sciences, Brigham Young University, Provo, UT, erinfjones3@gmail.com;* and Zachary T. Aanderud, *Department of Plant and Wildlife Sciences, Brigham Young University, Provo, UT, zach_aanderud@byu.edu.*

My research is on the algal blooms in Utah Lake and why they bloom. This affects us because the cyanobacteria that is in the algal blooms create toxins that, in large doses, can kill us. This also effects the fish in the water and all uses of the water because it becomes toxic after an algal bloom. I will be focusing on the isolation of certain cyanobacteria and how they grow when added to different concentrations of phosphorus. I believe that the results will correspond with how much phosphorus we add. The more phosphorus, the more cyanobacteria will be able to grow. This data will help us understand if the blooms are occurring when the lake is higher in phosphorus and help us control how much phosphorous we put into the lake to help contain the algal blooms to a minimum.

15. Effects of beaver dams on stream biogeochemistry

Arin Towns, *Utah State University, Logan, UT, arin.towns@yahoo.com;* and Janice Brahney, *Department of Watershed Science, Utah State University, Logan, UT, janice.brahney@usu.edu.*

The biogeochemical and ecological effects of beaver dams are expansive and at present not well understood. This study is designed to understand the physical and biogeochemical effects beaver dams may have on river water and stream bed composition. We tested potential beaver dam effects by comparing longitudinal stream profiles from two streams in Cache County Utah; Curtis Creek, a stream with deconstructing beaver dams, and Spawn Creek, a stream with active beaver dams. Data collected at each site included physical characteristics of the water column (pH, specific conductivity, temperature, dissolved oxygen, and turbidity), biogeochemical characteristics of the water column (total phosphorous and nitrogen, dissolved organic carbon), and periphyton and sediment analyses for ash-free dry mass (AFDM) and Chlorophyll-*a* as proxies for productivity. We sampled upstream, within, and downstream of several active or deconstructing beaver dams along each river, each week through the spring season therefore our data represents both longitudinal stream gradients and changes through time. Although some sample testing and data analysis are in preliminary stages, we have found interesting patterns based on the physical data. In general, Curtis creeks shows linear trends through the longitudinal sections while Spawn creek is more varied, likely due to the stream complexity attributable to beaver dams. One trend that is statistically significant is the percent dissolved oxygen in dam sites, which is higher than sites right below the dams ($p < 0.042$). We found many

noticeable trends (particularly in temperature and turbidity) that need more data sets in order to be statistically significant. These patterns could become the foundation for future, more expansive studies.

16. WaterGirls: field science for STEM outreach

Maura Hahnenberger, *Department of Geosciences, Salt Lake Community College, Taylorsville, UT, mhahnenb@bruinmail.slcc.edu.*

Water monitoring in the field with students engages and educates in a meaningful and long-lasting way. iUTAH WaterGirls is a field experience program for middle school students to monitor water quality in the canyons in the Salt Lake Valley. The program engages students in place-based learning and scientific field experiences with a goal of increasing interest of girls in STEM careers. Middle school ages have been determined to be a critical time when female students begin to lose interest in a career in STEM fields. An effective method to retain female students' interest in science and desire for a career in STEM is laboratory and field experiences. Further, by engaging in place-based outdoor education, students create a connection to their community and their environment that engages their emotions and values along with scientific skills and knowledge. Field experiences are critical to recruiting and retaining women and girls into STEM fields. Exposure to field research helps students experience the true nature of science and research, while nurturing a sense of curiosity about the world around them. iUTAH WaterGirls has successfully run for three years and engaged over 60 middle school participants and over 15 female science role models.

17. Bird species assemblages as an indicator of riparian quality

Margaret England, *Weber State University, Ogden, UT, menglandjohns@mail.weber.edu;* Andreas Leidolf, *iUTAH EPSCoR, Utah State University, Logan, UT, andreas.leidolf@usu.edu;* and Michelle A. Baker, *iUTAH EPSCoR and Department of Biology, Utah State University, Logan, UT, michelle.baker@usu.edu.*

Human disturbance can have a significant impact on the quality of watersheds and surrounding riparian areas. Avian species assemblages may be used as an indicator of these impacts. We counted riparian passerines, using point-count methodology, on 17 sites across three experimental watersheds instrumented with water quality monitoring stations as part of the iUTAH Gradients Along Mountain-to-Urban Transitions (GAMUT) observatory. We also assessed anthropogenic disturbance in 25 categories of human impact using methodology adapted from Bryce et al. (1999). We compared differences in select water quality parameters among sites, using data retrieved from data.iutahepscor.org, to observed differences in avifaunal composition, diversity, and conservation value, as well as human disturbance.

18. Harmful algal blooms on Utah Lake

Eric Shipp, *Brigham Young University, Provo, UT, shipp.eric44@gmail.com;* Dylan D. Dastrup*, iUTAH EPSCoR and Department of Geological Sciences, Brigham Young University, Provo, UT, dylandastrup@gmail.com;* and Scott Collins*, Department of Plant and Wildlife Sciences, Brigham Young University, Provo, UT, FMG333@gmail.com.*

The water that flows into Utah Lake comes from a variety of rivers and streams that originate high in the mountains. Along the way, these water bodies bring many different nutrients, and minerals with them that end up in Utah Lake. Cyanobacteria, microscopic photosynthetic organisms, feed on these nutrients and can grow into large communities of algae that can possibly have negative impacts. The quality of water in Utah Lake has impacts on public health, outdoor recreation, local revenue streams, and lake ecology. Water samples were collected weekly at 7 sites on Utah Lake, and biweekly at 5 sites on Farmington Bay and 3 sites on Deer Creek Reservoir. Data was collected using a handheld meter, TOC-L analyzer, and spectrophotometer. It is expected to see higher levels of phosphorus (P) in the Utah Lake than in Deer Creek Reservoir, and we already see higher turbidity in Utah Lake than in Farmington Bay and Deer Creek. Because Utah Lake is shallow, warm, and high in P we expect to see a bloom at some point in Utah Lake during our sampling period. As more data is collected we expect to better understand the conditions present before, during, and after an algal bloom.

19. Risk communication to Spanish-speaking populations

Jared Stewart, *University of Utah, Salt Lake City, UT, jstewartrome@gmail.com;* Peter Howe*, Department of Environment and Society, Utah State University, Logan, UT, peter.howe@usu.edu; and* Yajie Li*, Department of Environment and Society, Utah State University, Logan, UT, yajie.li.1991@aggiemail.usu.edu.*

While not specifically tied to Utah's hydrology, heat is the leading cause of weather related deaths in the United States. It is important that agencies and organizations understand heat and other extreme weather-related risks, especially as climate change exacerbates the frequency and severity of extreme weather events. Life threatening risks need to be communicated effectively to the public so that necessary precautions can be taken and lives saved. The United States is growing in cultural, ethnic, and linguistic diversity, potentially complicating efforts to communicate risk to the population at large. Areas currently facing such challenges are those with large Spanish-speaking populations, such as communities in the vicinity of the southwest border of the United States, which have a need for risk communication in the Spanish language. I analyzed Twitter data from local National Weather Service (NWS) accounts to determine how forecasting offices communicate to Spanish-speaking populations. I found that some offices automate selected warning types (flood and thunderstorm warnings). Automated tweets in these particular offices are similarly represented in both Spanish and English. Other warning types, such as heat and special marine warnings, were not communicated equivalently in English and Spanish from all forecasting offices. These findings indicate that the NWS could improve communication to Spanish-speaking populations by automating more tweets or by allocating greater resources to create Spanish translations of critical tweets. A potential limitation of this research is that communication through Twitter is assumed to be representative of how the NWS communicates across all mediums. This information should help iUTAH by providing perspectives on how to best communicate high risk situations to expanding minority populations.

20. Microbial contamination and die-off on plants irrigated with treated wastewater

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Wastewater treatment plants significantly reduce the microbial load in treated water. However, the remaining microbes may be able to regrow in the nutrient-rich wastewater effluent. Therefore, when this treated effluent is used as a secondary water source on crops, there is a potential for contamination. For this study, an agricultural field was irrigated using treated wastewater from the Hyrum Wastewater plant. All microbial tests were processed using IDEXX's Colilert and Enterolert. These tests enable MPN counts for coliforms, E. coli, and enterococcus, all found in high levels in wastewater influent. The water was tested before and after irrigation to determine the microbial loads applied to the crops. Plant samples were then taken daily to determine both the initial microbial contamination level and any die-off or regrowth that occurs after the irrigation event.

21. Greenhouse gas emissions from Utah wetlands

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Wetlands are landscape features that provide important ecological services including flood protection, wildlife habitat, and water purification. Despite such benefits, wetlands can serve as important contributors to local and global emissions of greenhouse gases (GHG). Human activities lead to alterations in hydrology, chemistry, and species composition that can drastically change wetland nutrient assimilative capacity, and their influence upon GHG budgets. Here, we use a mesocosm experiment to evaluate how these alterations influence wetland ecosystem function. Our experiment was conducted in Unit One of the Farmington Bay Waterfowl Management Area, a non-tidal wetland of Utah's Great Salt Lake. Experimental treatments included a control in which water from the bay was used in an unaltered form, phosphorous reduction to mimic improvements to waste water treatment, an increased salinity condition to mimic drought conditions, and submerged aquatic vegetation removal to examine the influence of plants on wetland biogeochemical processes. An acrylic dome from which gas samples could be collected was deployed onto the surface of each mesocosm to collect gases emitted from the water's surface. Using a gas chromatograph, the concentration of CO_2, CH_4, and N_2O gas measured in samples collected from the floating domes, as well as from ambient air and dissolved gases in the water within them. Ambient and dissolved gas concentrations were used to calculate the saturation ratio of gases in water compared to atmospheric equilibrium. Using the data collected from the domes, emission rate of each gas was used to calculate the transfer velocity. We hypothesize that gas emissions from the control will be highest due to high nutrient availability, but emissions from the increased salinity, phosphorus reduction, and plant removal conditions will decrease emissions.

Photo by Wyatt Traughber

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