Cory Angeroth
Cory Angeroth is a Hydrologist and Associate Director of the USGS Utah Water Science Center and has led the water data collection activities for the Center since 2005. In this position he is responsible for the operation of over 150 streamgages, groundwater data collection from nearly 1,000 wells. He has been involved in research on Great Salt Lake since his arrival in Utah.

**USGS Great Salt Lake Salinity Activities—Past, Present, Future**

The United States Geological Survey (USGS) has been studying and monitoring Great Salt Lake (GSL) for over 100 years. Salinity has been a large part of the USGS work. In the early 1960’s, the USGS prepared a report on the dissolved mineral inflow to the lake and the chemical characteristics of the brine. In the early 1970’s, the USGS developed the first water and salt balance model of the lake that has been updated and modified several times since. More recently, an equation of state relating density and salinity was developed for GSL and is in use for current salinity monitoring. Currently, the USGS is doing a study of the redevelopment of the Deep Brine Layer after the opening of the new causeway breach. Focus areas for future study include extending the equation of state to higher salinities, monitoring dissolved solids/salts in surface water inflows, re-investigating groundwater inflows, refining nutrient mass balance estimates, and development of a lake wide hydrodynamic model.

Laura Ault
Laura Ault is the Sovereign Lands Program Manager for the Utah Division of Forestry, Fire and State Lands, which manages Utah’s sovereign lands or those lands found to be navigable at statehood.

**Partnering in the Salinity Process: Moving Forward With the GSL Salinity Advisory Committee**

A healthy Great Salt Lake provides a wide range of ecological, economical, and recreational benefits. Protecting these diverse benefits for current and future generations presents significant challenges to management agencies. Several federal, state, and local governmental entities have legal responsibilities for protecting these benefits and managing the Great Salt Lake ecosystem. Each of these entities also have unique authorities to implement protections. Therefore, management of the Great Salt Lake ecosystem requires a coordinated and collaborative effort among policy makers, government agencies, and stakeholders. The newly formed Great Salt Lake Salinity Advisory Council is an essential component of this collaborative management process. However, collaborative mechanisms for some aspects of managing the Great Salt Lake ecosystem still need to be implemented or existing mechanisms improved.
Bonnie Baxter
Bonnie Baxter is Professor and Chair of Biology and Director of Great Salt Lake Institute at Westminster College. Dr. Baxter and her undergraduate students study Great Salt Lake microbiology and the chemistry, geology, and genetics that influence microbial diversity. Current work with NASA is focused on the survival of microorganisms and their biological molecules inside minerals, especially salt, and how these are preserved over geologic time and perhaps on Mars.

Salinity and the Microbial Foundation of Great Salt Lake
Salinity gradients drive microbial diversity in Great Salt Lake, and the foundation of the food web is the community of microorganisms that inhabit the water, salt, and sediment of the lake. The species that make up this community may be overrepresented under some salinity conditions, and underrepresented under others. One way that the microorganisms respond to salinity changes by turning on and off genes that help them maintain their biology under challenging circumstances for life. Also, we have evidence that they also can survive in the fluid inclusions of salt crystals over time in salt-saturated brine. Finally, substances secreted by cyanobacteria may protect these critical phototrophs from desiccation and high salinity. All of these strategies are critical to maintaining a healthy ecosystem, especially to fuel the food web with nutrient turnover and primary production.

Thomas Bosteels
Thomas Bosteels is General Manager at Great Salt Lake Brine Shrimp Cooperative, Inc. He currently serves on the Technical Advisory Group for the Great Salt Lake Ecosystem Project, the Nutrient Technical Team for the Utah Division of Water Quality and the Great Salt Lake Salinity Advisory Committee for the Utah Division of Forestry Fire and State Lands.

Overview of Salinity Effects on Great Salt Lake Brine Shrimp
The brine shrimp *Artemia sp.* is known for its ability to function and survive over a broad range of environmental conditions. Live populations of brine shrimp thrive in hypersaline environments primarily as a result of a well-developed osmoregulatory system and the production of efficient heme pigments. There are however multiple factors that affect the health of a brine shrimp population in a hypersaline environment. Specifically with regard to *Artemia franciscana*, in Great Sale Lake, a combination of physiological, environmental and hydrological conditions will exert great influence on the viability and health of the brine shrimp resource. This presentation reviews important research and historic events to ascertain critical salinity thresholds that are likely to result in catastrophic population crashes and to identify optimal salinity conditions that should ensure a healthy brine shrimp population in Gilbert Bay, Great Salt Lake.

Sean Boyd
Sean Boyd is a Research Scientist in the Wildlife Research Division, Science and Technology Branch at Environment Canada.
**Eared Grebes: Changes in Affiliation Patterns Between British Columbia and Two Hypersaline Lakes in the USA**

Almost all N.A. Eared Grebes (*Podiceps nigricollis*) undertake a post-breeding migration to two hypersaline lakes, Mono Lake CA and Great Salt Lake UT. In 1996, grebes breeding in interior British Columbia were implanted with VHF transmitters to describe affiliation patterns with these lakes. Aerial telemetry surveys in the fall of 1996 indicated that ca. 50% of the tagged birds were on Mono Lake whereas only ca. 10% were on Great Salt Lake. Abundance patterns on these lakes appear to have changed in recent years, suggesting that some grebes may have switched affiliations from Mono Lake to Great Salt Lake. To assess this possibility, we captured grebes breeding on the same ponds in 2017 and implanted 30 birds with the same type of transmitter used in 1996 and attached light-level geolocators to their leg bands. Early fall telemetry surveys indicated that only 4 (15%) of the tagged birds were on Mono Lake whereas 12 (44%) were on Great Salt Lake. These findings suggest that the affiliation patterns of British Columbia grebes have changed over the last 20+ years. Interestingly, only 4 tagged birds were detected on the lakes during late fall surveys when more than 16 transmitters should have been present. The grebes accumulate a thick layer of body fat prior to migrating south and that is suspected to have reduced the signal strength of the internal transmitters. To circumvent this problem, we are planning to deploy backpack transmitters with external antennae on 30 breeding adults in 2018. Data from the 2017 VHF transmitters, the new 2018 tags, and retrieved geolocators will be used to determine the final proportional distribution of grebes on Mono Lake versus Great Salt Lake. They will also generate new information on migration patterns and overwintering areas.

**Virginia Catherall**

Virginia Catherall is a museum educator as well as a textile artist, knitter, and knitwear designer. She has been Curator of Education at the Utah Museum of Fine Arts for the past 23 years teaching families, children, and teachers about art and museums. In her art she is inspired by the incredible, rugged, and sublime landscape of Great Salt Lake. Virginia will discuss her origins as an artist and her inspiration from Great Salt Lake to create textile art and wearable landscapes. As a knitting and textile artist, Virginia’s work has a close affinity to the land and is inspired by the incredible, rugged and sublime landscape around the Lake. Many of her wearable landscapes and sculptures focus on interpreting the science, geography, and biology of an ecosystem within the traditional craft of knitting. Each work of art echoes something from the landscape. Whether it’s color, texture, or form, the uniqueness of each piece make the viewer or wearer more conscious of what the objects are and why they are wearing them; elevating Craft from a functional item to a conscious and deliberate work of art. The act of creating something so entwined with the land itself sparks a stewardship and urge to conserve that land. Through craft and art, Virginia hopes to engender an appreciation, love, and wonder of the ecology and history of the unique landscape around Utah and Great Salt Lake.
Rob Clay, Keynote
Rob Clay is the Director of the Executive Office of the Western Hemisphere Shorebird Reserve Network (WHSRN), which is housed by Manomet, a Massachusetts-based nonprofit that champions better practices in conservation, business sustainability, and science education.

Great Salt Lake: A Resource of Hemispheric Significance
Great Salt Lake is one of the most important sites in the USA for migratory shorebirds, ducks and other waterbirds, with several million birds using the lake annually. In 1991, the global significance of Great Salt Lake for shorebird conservation was recognized by its designation as a site of “Hemispheric Importance” within the Western Hemisphere Shorebird Reserve Network (WHSRN), due to the large numbers of shorebirds (more than 500,000) that use the lake each year.

The lake’s “Hemispheric Importance” designation goes beyond the sheer number of shorebirds that use its resources. Great Salt Lake is a cornerstone of a complex ecological network of key sites for shorebirds throughout the Western Hemisphere. The loss of any one threatens the survival of the whole system. The connectivity of Great Salt Lake was recognized early in the history of conservation efforts at the lake, when in June 1992, there was a "three-way twinning" with Laguna Mar Chiquita (Argentina) and Mono Lake (California). Both are WHSRN Sites, and share ecological similarities with Great Salt Lake, including large numbers of Wilson's Phalaropes. Further recognition of the important role of Great Salt Lake as part of a network came in 1998, when stakeholders from two additional WHSRN sites sharing species came together with Great Salt Lake to form the “Linking Communities, Wetlands and Migratory Birds Initiative”. These sites are the Chaplin Lake and associated lakes in Saskatchewan, Canada, and the Marismas Nacionales complex of Nayarit, Mexico. In more recent years, this network of conservation linkages has been expanded to sites in Argentina, Chile, Paraguay and Peru. However, Great Salt Lake’s connections with other WHSRN sites go beyond the birds themselves. Over one third of the world’s supply of bring shrimp cysts come from the lake. These are used in the shrimp aquaculture industry, including at WHSRN sites from Mexico and Nicaragua to Venezuela and Brazil.

My talk will illustrate the network of linkages that connect Great Salt Lake to the rest of the hemisphere through shared migratory birds and shared brine shrimps, underline the interdependence that exists between these networks of sites, and will report on the conservation successes throughout the hemisphere that have occurred thanks to the pioneering linking efforts from Great Salt Lake.

Michael Cohen, Keynote
Michael Cohen is a Senior Associate at the Pacific Institute, a non-profit organization based in Oakland, California. He has been a leading Salton Sea advocate for more than 20 years, developing revitalization proposals, promoting timely intervention, and writing articles, reports, and opinion pieces.
**Political and Environmental Challenges for the Salton Sea**

California’s Salton Sea recently passed a tipping point. The nation’s largest agriculture-to-urban water transfer, combined with several other factors, will reduce total inflows to the Sea by more than 20 percent in the next decade. As a result, the Sea’s already high salinity (>60 g/L TDS) will more than double as the lake’s surface drops by >14 feet, exposing >70 square miles of playa, in turn exacerbating already poor air-quality in the region. In November, 2017, California committed to the construction of 29,800 acres of habitat and dust-control projects in the next decade, but appears certain to miss this year’s acreage milestone, and likely will miss next year’s milestone as well, despite existing funding, permits, and water. After decades of research and more than fifty years of Salton Sea project proposals, California’s current program also lacks clear goals and objectives, suggesting that the lake does not rank highly on the state’s list of priorities.

The political and environmental challenges confronting California’s Salton Sea reflect broader challenges to water-dependent ecosystems throughout the West, including: ecosystem and public health impacts caused by agriculture-to-urban water transfers; direct and indirect climate change impacts; water quality issues associated with drainage-dependent ecosystems; ecosystem restoration versus rehabilitation; direct versus avoided costs of ecological rehabilitation; policy trade-offs associated with minimizing potential selenium toxicity, and ecological risks more generally; threats to avian species along migratory routes; public perception of “natural” versus “artificial” ecosystems; and prioritizing investment of public funds. The lessons learned from the Salton Sea could inform restoration efforts at the Great Salt Lake and other threatened ecosystems in the West.

**Robin Craig**
Robin Kundis Craig is the James I. Farr Presidential Endowed Professor of Law at the University of Utah S.J. Quinney College of Law in Salt Lake City, Utah.

**Resilience Thinking for Great Salt Lake in the Anthropocene**

The Anthropocene challenges our ability to manage natural resources based on past behavior or for sustainability goals. This talk examines the future of Great Salt Lake management from a resilience theory perspective, illustrating how resilience thinking can provide a different framework for discussing management goals and trade-offs in a changing climate and population base.

**Joan Degiorgio**
Joan Degiorgio is the Northern Mountains Regional Director for The Nature Conservancy. She works on identifying and managing projects in Northern Utah that preserve sensitive landscapes and species.

**Connecting Bear River to Great Salt Lake Health: Collaboration Concepts**

At last, there is growing recognition of the importance of the Bear River system to Great Salt Lake (GSL) health, including its contribution of approximately 60% of the inflow to the GSL. With concerns over a historically low GSL and the possibility of future withdrawals from proposed Bear River development – it really can seem like the sky is
falling (and the GSL will continue to shrink and blow away). But is there a way forward? While no promise of a silver bullet, there are opportunities to explore a new way of doing business on the Bear River.

Last year the Bear River Commission completed its second 20-year review. The first 20-year review resulted in the Commission establishing a tri-state water quality committee. In that spirit, and with new concerns emerging in the intervening 20 years, National Audubon Society and The Nature Conservancy together requested that the Commission create a stakeholder task force or a new committee to foster collaboration on watershed health; develop and implement contingency planning to address drought and the effects of a changing climate; and investigate the feasibility of water banking and other mutually acceptable ways of sharing water within the basin.

While not a complete answer to the many concerns that plague GSL, we think implementing these suggestions could represent progress towards more holistic basin management, including water management that accounts for: the potential impacts of climate change, water needs of the environment, increasing societal awareness about the importance of ecosystem services, and environmental impacts of development projects. This is an opportune time for all who are interested in ensuring a healthy Bear River watershed (that includes Great Salt Lake), to move forward together with better information and collaboration to develop solutions that will continue to provide water for people and nature. We hope that this panel can be a step in that direction.

Jeff DenBleyker
Jeff has been a project manager and water resources engineer at CH2M, now known as Jacobs, in Salt Lake City since 1996. He has led a wide variety of multidisciplinary scientific and engineering investigations with comprehensive stakeholder involvement and has extensive experience in ecosystem characterization and restoration—specifically in relation to the water quality and ecology of wetlands, tributary streams, and open waters of Great Salt Lake.

Panel: Understanding Great Salt Lake’s Salinity: Why Do We Care? What Are We Doing?

Becka Downard
Becka Downard has been the Wetland Coordinator for the Utah Division of Water Quality since 2016. Currently that work involves helping to develop water quality standards for the wetlands around Great Salt Lake. She received a PhD in Ecology from Utah State University, where she spent 5 years studying the impacts of impounded wetland management on wetland health around Great Salt Lake.

What Should the Water Quality Goals for Great Salt Lake Wetlands Be?
UDWQ has been working to develop water quality standards for wetlands of Great Salt Lake. To do this we need to define a beneficial use that captures the most important and sensitive parts of the wetland ecosystem and a narrative standard that effectively protects that use. Determining the appropriate water quality criteria for any wetland is
difficult because water quality changes naturally throughout the year, which makes it challenging to detect impairment caused by human activities. Great Salt Lake wetlands are even more challenging to protect because of complex environmental gradients, extensive management activities, and complicated water sources. UDWQ is conducting Conservation Action Planning (CAP) meetings to draw on the knowledge of a wide variety of experts that can help us understand the most important characteristics of our wetlands, the best indicators of wetland health, threats to wetlands, and strategies for protecting them. (In CAP terminology: Key Ecological Attributes, Indicators and Ratings, Stresses and Sources, and Strategies.) We hope we can use these meetings to build on previous research and local knowledge in order to effectively protect the water quality of these globally important wetlands and the health of the Great Salt Lake ecosystem.

Eric Duffin
Eric Duffin is experienced in the field of watershed science including hydrology, water quality, soil physics, fluvial geomorphology, and computer science. He has been employed at Cirrus Ecological Solutions since 2000.

Opportunities for Improving Water Quality Using Flow Management in the Lower Jordan River
Poor water quality is a concern in many segments of the Jordan River, a major tributary to the Great Salt Lake. These conditions are being actively addressed by Utah Division of Water Quality and the EPA. Conditions leading to poor water quality in the Jordan River are documented in a Phase I Total Maximum Daily Load study approved by the EPA in 2013. Long-term improvements in water quality will likely require pollutant load reductions from stakeholders at the municipal, county, and regional level. The Jordan River Commission (Commission) and other stakeholders are looking for opportunities to address acute and chronic dissolved oxygen (DO) concerns in the lower Jordan River (LJR) through flow management. This approach could be cost effective and provide additional ecosystem benefits compared to other water quality improvements that focus strictly on reducing pollutant loads.

In 2014, the Commission completed the first phase of a study investigating the use of flow manipulation as a potential mechanism for increasing DO during the late summer season in the LJR. On the basis of data review and model output, the study recommended field experiments that would manipulate flow at the 2100 South diversion and monitor the resulting downstream effects on DO in problematic reaches. Acquiring sufficient water rights has slowed implementation of the study, but significant progress has occurred during discussions with Utah Division of Water Rights. This experiment is unique in the history of Utah water quality remediation and if successful, could lay a foundation for similar work in other watersheds in the state. Flow and water quality are sometimes competing commodities in Utah and any long-term changes in LJR flow management must operate under these conditions. However, analysis of past data has shown that even minor flow changes at the right time, can produce positive improvements in DO. For many reasons, the need remains to identify flow management opportunities that will improve LJR water quality. Participants attending this presentation will gain an understanding of how flow management on the LJR has changed over time.
and the regulations and objectives that guide existing flow management. We will review existing data that identify the influence of flow on water quality in the LJR and describe the progress we have made to date in the LJR flow experiment. We will also identify short-term and long-term opportunities for changes in flow management.

Joanna Endter-Wada
Dr. Endter-Wada is a Professor of Natural Resource Policy and Social Science and Director of the National Environmental Policy Act (NEPA) Graduate Certificate Program. Her research focuses on conceptualizing and analyzing linkages between humans and biophysical aspects of ecosystems with emphasis on water, public land, forest resources, fisheries and urban landscapes.

Recognizing Water, Wet+Land, and Land Interconnections in Protecting Great Salt Lake
Great Salt Lake and its wetlands are world-renowned for their migratory bird habitat but reduced water availability threaten both the lake and its wetlands. Over recent decades, wetland managers have acquired water rights and used physical impoundments to keep wetlands wet through critical parts of the growing season. However, some people consider wetland impoundments to be a direct threat to the water supply of the lake. We contend that to maintain the integrity of the Great Salt Lake ecosystem into the future, it must be viewed holistically. Such a view requires analyzing the bio-physical and policy connections between the lake, its surrounding wetlands, and land use change in the rapidly urbanizing Wasatch Front Metropolitan Area. Policy, management, and conservation efforts need to incorporate this whole ecosystem focus in order to avoid pitting scientists and policy advocates focused on particular aspects of the system against each other. We address both policy and ecological management ideas for ensuring that the lake and its wetlands are viewed as highly connected parts of a healthy arid region aquatic ecosystem. Our goal is to contribute to conversations about how the Great Salt Lake ecosystem can be protected in a future with projected climate changes, continued population and economic growth, and adjacent land use transformations.

Erica Gaddis
Dr. Erica Gaddis is the Director of the Utah Division of Water Quality. Prior to joining UDEQ, Erica worked as a consultant with expertise in watershed modeling, limnology, water quality, Clean Water Act compliance, nutrient management, and restoration of aquatic systems.

Partnering in the Salinity Process: Moving Forward With the GSL Salinity Advisory Committee
A healthy Great Salt Lake provides a wide range of ecological, economical, and recreational benefits. Protecting these diverse benefits for current and future generations presents significant challenges to management agencies. Several federal, state, and local governmental entities have legal responsibilities for protecting these benefits and managing the Great Salt Lake ecosystem. Each of these entities also have unique authorities to implement protections. Therefore, management of the Great Salt
Lake ecosystem requires a coordinated and collaborative effort among policy makers, government agencies, and stakeholders. The newly formed Great Salt Lake Salinity Advisory Council is an essential component of this collaborative management process. However, collaborative mechanisms for some aspects of managing the Great Salt Lake ecosystem still need to be implemented or existing mechanisms improved.

**Joseph R. Havasi**
Joseph R. Havasi is the Director of Natural Resources for Compass Minerals International of Overland Park, Kansas. Joe is responsible for managing real estate, mineral reserves, water rights, and land-use planning. Joe is a geologist by training.

**Mineral Recovery in the North Arm: The Convergence of Place, Hydrology, Climate, and Salinity**
The Compass Minerals Ogden Site has been operating on the eastern shore of the Great Salt Lake at informal boundary Bear River Bay and Ogden Bay since 1970. Compass Minerals Ogden produces essential minerals that keep roadways safe in winter months, and Sulphate of Potash (SOP) that provides an essential plant nutrient to various orchard and nut crops, and turf grasses. Compass Minerals Ogden is the only domestic producer of SOP, and employs over 300 people, and is a valuable contributor to the $1.3B economic engine derived from Great Salt Lake (GSL). Joe will discuss the importance of GSL salinity and concentrations of key ions to mineral recovery in the Great Salt Lake and more specifically, Compass Minerals’ operations in the North Arm and between Bear River and Ogden Bays. The presentation will explore the unique circumstances that lead to the collection of ions found in the lake, and the Great Salt Lake’s place amongst other saline lakes in the world. Joe will also speak to the climatic, geographic, hydrologic, bathymetric, and salinity characteristics found in the North Arm, and how these factors contribute to a sustainable mineral recovery operation that yields the United States’ only source of SOP, a key source of chloride-free potassium to fruit and nut crops.

**Darren Hess**
Mr. Hess is currently an Assistant General Manager for Weber Basin Water Conservancy District. He is responsible for strategic initiatives, future water supplies and the water conservation program for the District.

**Conservation Projects that Help Postpone the Bear River Project**
Weber Basin Water Conservancy District continues to increase its water conservation efforts. The metering of secondary water is possibly the largest conservation program which is yielding significant results in water use reductions. The District has installed over 7,000 secondary water meters and is achieving water savings at an average of 35%. The District is also issuing rebates for the purchase of smart irrigation controllers both on the residential side and in commercial applications. In addition, the District recently created a rebate program for low flow toilet replacements on toilets installed prior to the year 2000. The District continues with public education by doing free residential water checks, water treatment and garden tours for school groups, and free landscape classes and garden events to promote the wise use of water. The District is
also increasing awareness through advertising on billboards, UTA buses and local ad mailers to promote the principles of water efficiency and proper irrigation. These ads target outdoor use and encourage less wasteful watering practices in the landscape.

**Randy Jefferies**
Randy Jefferies is the Project Manager for the West Davis Corridor Environmental Impact Statement. He has been with UDOT for 20 years and has led a number of environmental studies on major projects in northern Utah.

**West Davis Corridor Mitigation Plan**
In 2017, the Federal Highway Administration approved the Environmental Impact Statement (EIS) for the West Davis Corridor, a 19 mile highway in western Davis County. During the 8 year EIS process, hundreds of meetings were held and thousands of comments were received as UDOT evaluated 51 various alternatives to meet the transportation need while minimizing impacts. Of utmost concern was the effect the highway could have on the Great Salt Lake environment. UDOT worked closely with state and federal resource agencies and various non-governmental organizations to explore ways to avoid and minimize these impacts, and to prepare a comprehensive, 1,100 acre wildlife and wetland mitigation plan that will be a long term benefit to the Great Salt Lake. As UDOT moves into the implementation phase of the project over the next few years, UDOT will continue to collaborate with agencies and stakeholders to ensure the mitigation is successful.

**Paul Jewell**
Paul Jewell is a faculty member in the Department of Geology and Geophysics at the University of Utah. He is presently working on three surface environments: Pleistocene Lake Bonneville in the western United States, Great Salt Lake, and alluvial channels and erosion in the intermountain west.

**Historic Low Stand of Great Salt Lake, Utah: Mass Balance Models and Origin of the Deep Brine Layer**
The Great Salt Lake of northern Utah is among the largest and most ecologically important water bodies in North America. Since the 1950s, the lake has been divided into two hydrologically distinct water bodies by a gravel-fill railroad causeway. Flux through the causeway is driven by two forces: differential surface elevation and differential density between the north and south arms. Precise quantification of water flux through the causeway has been problematic due to the highly heterogeneous and slowly compacting nature of the causeway fill. Between 2008 and 2015, the Great Salt Lake shrank to near historic low water levels. During this same time, enhanced gauging of various surface inflows and outflows and density measurements made throughout the lake permit detailed water mass calculations of both the north and south arms. Results suggest that during wet periods, density-driven flow through the causeway predominates due to freshening of water in the south arm. At other times the dominant drivers of causeway flow are south-to-north head gradients across the causeway. These head-driven causeway fluxes have a seasonal signal. The primary driver of deep brine
layer in the southern arm of the lake over the past 20 years could flow through the culverts or causeway although the latter is favored by this study.

**Bill Johnson**
William Johnson is a Professor in the Geology & Geophysics Department and an Adjunct Professor in the Civil & Environmental Engineering Department at the University of Utah. His research group research examines fate and transport in water of contaminants ranging from particles and pathogens to trace elements such as mercury as well as organic compounds.

**Total Mercury and Methylmercury Response in Water and Sediment to De-Stratification and Re-Stratification of Great Salt Lake**
The recent closing and re-opening of culverts in the railroad causeway separating the north and south arms of Great Salt Lake constitute a large scale experiment for which we monitored the response of total mercury and methylmercury in water and underlying unconsolidated sediment. Related aquatic chemical parameters demonstrated that de-stratification of the lake occurred in response to elimination of flow from the higher salinity north arm into the south arm in December 2013. Specifically, prior to elimination of flow, oxic and anoxic conditions characterized the shallow and deep brine layers, respectively. After elimination of flow, the south arm became vertically homogenous and oxic, with consequent loss of sulfide (99.7%). Concurrently, reduction of total mercury (81%) and methyl mercury (86%) in the water column, and reduction of methyl mercury (77%) in underlying unconsolidated sediment occurred, suggesting that the deep brine layer promoted the accumulation of methyl mercury in both phases. In the period prior to re-establishment of north-to-south flow, periodic anoxia at depth under quiescent conditions indicated respiration of underlying sediment organic matter, with consequent increase in sulfide, methyl mercury, and total mercury. Following re-establishment of north-to-south flow in July 2017, density stratification progressed from north to south with consequent stable increases in sulfide, methylmercury and total mercury. Our results confirm that the denser deep brine layer promotes methylmercury accumulation in bottom waters and underlying unconsolidated sediment.

**Karin M. Kettenring**
Dr. Karin Kettenring is a faculty member in the Department of Watershed Sciences, Quinney College of Natural Resources, Utah State University in Logan, Utah.

**Recognizing Water, Wet+Land, and Land Interconnections in Protecting Great Salt Lake**
Great Salt Lake and its wetlands are world-renowned for their migratory bird habitat but reduced water availability threaten both the lake and its wetlands. Over recent decades, wetland managers have acquired water rights and used physical impoundments to keep wetlands wet through critical parts of the growing season. However, some people consider wetland impoundments to be a direct threat to the water supply of the lake. We contend that to maintain the integrity of the Great Salt Lake ecosystem into the future, it must be viewed holistically. Such a view requires analyzing the bio-physical and policy connections between the lake, its surrounding wetlands, and land use change in the
rapidly urbanizing Wasatch Front Metropolitan Area. Policy, management, and conservation efforts need to incorporate this whole ecosystem focus in order to avoid pitting scientists and policy advocates focused on particular aspects of the system against each other. We address both policy and ecological management ideas for ensuring that the lake and its wetlands are viewed as highly connected parts of a healthy arid region aquatic ecosystem. Our goal is to contribute to conversations about how the Great Salt Lake ecosystem can be protected in a future with projected climate changes, continued population and economic growth, and adjacent land use transformations.

**Stefan Kirby**
Stefan Kirby is a licensed Professional Geologist working with the Groundwater and Paleontology group of the Utah Geological Survey. He is currently a Senior Geologist with active projects that include state funded hydrogeologic framework and water budget studies of groundwater basins, and federally funded projects focused on assessment of strategic and critical metals in industrial geothermal, and oil and gas produced waters.

**Mapping Groundwater Quality and Chemistry Adjacent to Great Salt Lake, Utah**
Groundwater chemistry influences the ecology of wetlands and groundwater dependent ecosystems in areas near Great Salt Lake (GSL). The chemical character and salinity of the groundwater system near GSL also control water usage for a variety of industrial, agricultural, and domestic sources and likely play an important role in the total salt budget of GSL. Despite this, previous work has not focused specifically on groundwater quality and chemistry surrounding the entire GSL. The goal of this project is to characterize groundwater and its potential input to GSL wetlands, by compiling existing chemistry data and collecting new samples in areas that immediately adjoin GSL. These data (including major ion chemistry, stable isotope composition, and site location) were combined into a geodatabase to create GIS-based maps of groundwater quality and chemistry. We compared the data with existing wetland water quality data, available from the Utah Geological Survey, Utah Department of Environmental Quality, and other organizations. This work is the first systematic basin-wide assessment of groundwater chemistry in areas near the lake that potentially feed the lake system, and the data can form a basis for future work to better delineate the interplay of groundwater and surface water supplying important wetlands adjoining GSL. The data may also lend insight into salinity contributions to GSL from groundwater.

**Don Leonard**
Don Leonard works as Chairman and CEO of the Great Salt Lake Brine Shrimp Cooperative, Inc., a fully integrated cooperative that harvests, processes and markets Artemia cysts on behalf of its member companies. Leonard currently serves as Chair of the State’s GSL Advisory Council.
Water for Great Salt Lake—Strategies to Maintain or Increase the Surface Elevation

Great Salt Lake (GSL or lake) water levels are in a long-term decline. The Great Salt Lake Advisory Council (GSLAC or Council) commissioned a report to compile possible strategies to preserve or provide water for GSL. The strategies include submissions from a wide range of individuals and organizations, including water suppliers, water users, conservation interests, state and local governments, industry and commercial interests, non-governmental organizations, and members of the general public. The report describes seventy-two (72) strategies with potential to maintain and/or increase the surface elevation of GSL. The strategies consist of coordination, environmental, legal, operational, policy and structural practices that, if implemented, could deliver greater quantities of water to GSL or conserve water within GSL itself. Since its publication, the Council has used the report as a tool to inform the debate. GSLAC is also seeking to rank and prioritize the strategies to facilitate consensus and action. This presentation will discuss lake elevation, the GSLAC report, possible strategies to address lake elevation, the Council’s role in this debate, and the on-going effort to address the long-term decline.

Melody Lindsay

Melody Lindsay is a 5\textsuperscript{th} year Ph. D. candidate and a NASA Earth and Space Science Fellow in Dr. Eric Boyd’s geobiology lab in the Department of Microbiology and Immunology at Montana State University. Her thesis work focuses on studying the distribution and activities of extremophiles in order to understand the adaptations that facilitate life under extreme conditions.

Effects of Changing Salinity on Microbialite-Associated Primary Producers and Secondary Consumers in Great Salt Lake

Primary producers serve as the base of all ecosystems. In Great Salt Lake (GSL), photosynthetic cyanobacteria and algae associated with microbialite structures, which cover ~20\% of the lake bottom, contribute a significant amount of the primary production to the ecosystem. However, these phototrophs are subject to the changing conditions of the lake, including varying levels of salinity. We investigated the effects of changing salinity on the primary productivity and community composition of microbialites of GSL, as well as how these changes affect the fecundity of the secondary consumer species, *Artemia franciscana* (brine shrimp). Using a microcosm approach, we incubated microbialite samples at salinities ranging from 8.0\% to 30\%. Microcosms were inoculated with a known number of *Artemia* cysts and were incubated, and rates of primary production (CO\textsubscript{2}-fixation) were measured after letting the microcosms incubate for 8 weeks. Microbial community composition and abundance and hatch and survival rates of *Artemia* were assessed weekly. Rates of primary productivity in microbialite communities were significantly lower at salinities over 20\%, with the highest rate of CO\textsubscript{2}-fixation measured at 10\% salinity. The hatch rate of *Artemia* individuals was significantly decreased at salinities greater than 15\%, but adult *Artemia* persisted at salinities of up to 20\%. These results reveal a significant negative impact of salinities over 20\% on the productivity of the microbialite communities, and also on the hatch and survival rates of *Artemia franciscana*. Shifts in the composition and abundance of
microbialite microbial communities that may be responsible for the overall decrease in the productivity of microbialites will be presented.

**John Luft**

John Luft is the Program Manager for the Great Salt Lake Ecosystem Program. The Great Salt Lake Ecosystem Program monitors, manages and performs research on or around the lake in order to preserve the lakes resources. The project focuses primarily on the brine shrimp industry and coordinated avian monitoring around the Great Salt Lake.

**The Importance of Salinity to the Great Salt Lake Ecosystem**

Great Salt Lake is separated into four distinct bays with unique ecologies. At the forefront of these distinctions is salinity, essentially determining the ecology of each bay. The Great Salt Lake Ecosystem Program (GSLEP) has been monitoring salinity, as well as other limnological parameters, for over 20 years. This research studies the impact of salinity to determine how it affects brine shrimp and brine flies in the lake. Long-term monitoring of the lake and its biota provides a basis for GSLEP to manage the brine shrimp fishery on Great Salt Lake in order to maintain a productive fishery and ensure the forage base for many avian species. This approach has succeeded in developing a cooperative relationship with the brine shrimp harvest industry and conservation efforts in order to preserve this unique ecosystem.

**Chris Mansfield**

Chris Mansfield is a recent graduate from Westminster College where he completed a double-major in music and biology.

**Savage Poem Around Me**

My composition includes lyrics from Alfred Lambourne's "Our Inland Sea" (public domain). As such, it is based on Lambourne's and my experiences at the lake. Lambourne provides descriptive imagery of the lake in winter, but also details his emotional response to being alone in the immense wilderness—a response that is similar to my own. I lose my sense of time and place along the shore. The scenery mirrors scenery that came before, and yet there is always something new and beautiful! I go no where, despite walking miles, or the opposite: I travel miles without moving my feet. There is an all-encompassing sense of eternity by the water that is both inviting and isolating. It is this paradox I am attempting to convey through sound. In music, meter and harmony keep time and movement. Thus, I use irregular meter and harmony to maintain stasis. Large block chords echo the expansive surroundings, while the singer voices Lamborne's solitude. The music converges on glissandi with the lyrics "waters." Thus, the rippling piano symbolizes the rippling water. The inner section reduces to a more intimate texture with an anxious chromatic bass line, serving to shift focus from the surroundings to the internal conflicts Lambourne describes in the corresponding text. Gradually the music expands, returning to block chords and the ultimate grandeur of the lake.
Geoff McQuilkin
Geoffrey McQuilkin became a Mono Lake Committee member in fifth grade and his enthusiasm for Mono Lake has never waned. He has worked for the nonprofit Mono Lake Committee for over twenty years, including the past decade as Executive Director, giving him the chance to be involved with all aspects of the citizen group’s protection, restoration, education, and science programs.

**Keeping Mono Lake Protected: Vigilance Through Public Policy and Science**
Mono Lake is well known for its scenic tufa towers, a legendary water battle over excessive water exports to Los Angeles, and a notable set of protections achieved over the past 40 years. Mono Lake and its tributary streams are now healing after decades of excessive water diversions, providing real world proof of our ability to balance human water needs with ecological protection. Continued protection and successful restoration require constant vigilance and continuing engagement. Science, advocacy, and sound public policy continue to play critical, complimentary roles in advancing tributary stream and lake ecosystem restoration. New issues constantly arise that require engagement from lake advocates, from climate change impacts to recent attempts to undermine the Public Trust Doctrine. The successes and lessons at Mono Lake offer hope for other threatened saline lake systems and suggest strategies to achieve their long term sustainable management.

Craig W. Miller
Craig Miller earned a BS in civil engineering from Brigham Young University in 1975 and a master’s degree in irrigation and agricultural engineering from Utah State University in 1979. Craig currently is the manager of the Hydrology and Computer Modeling section at the Utah Division of Water Resources where he has worked for 38 years in design, performing hydrologic studies and writing computer models.

**Current State of the Art in Modeling the Mineral Resources of Great Salt Lake and Planned Future Improvements**
One of the future missions planned for the recently developed Great Salt Lake Integrated Water Resources Model is to help the Utah Division of Forestry Fire and State Lands understand and manage the mineral resources of the lake. To accomplish that task, accounting for the total salt and its mineral components is necessary. Brine shrimpers also need to be able to predict harvests requiring a knowledge of the surface salinity of the south arm. Progress in improving our ability to accomplish these tasks will be discussed.

**Understanding How the Bear River Compact and Future Depletion Could Affect Great Salt Lake**
The Bear River Compact was a complicated agreement forged over the course of several decades setting down rules for the use of Bear River water in Utah, Idaho and Wyoming. It divides up future depletion of the Bear River waters to the tune of hundreds of thousands of acre feet between Utah, Idaho and Wyoming establishing rules and priorities. One issue that the Compact does not tackle is how those future depletions might affect the Great Salt Lake. Tools for evaluating those impacts have been
developed in the last couple of decades and will be used to examine the amounts of depletion outlined in the latest Compact agreement.

**Armin Munévar**
Armin Munévar is the CH2M (now Jacobs) global technology leader for Integrated Water Resource Management and firm lead for water resources planning and climate change adaptation.

**Can We Avoid the Tipping Point?**
Terminal lake basins present a unique challenge and accentuate the importance of proactive, integrated, and collaborative planning. Terminal lakes such as the Great Salt Lake are part of large, interconnected watersheds and their trajectories reflect the integration of upstream anthropogenic and natural changes. Changes in climate, land and water use, vegetation, infrastructure, and resource management all significantly impact the future state of these lakes, making it impossible to manage the Great Salt Lake independent from the watershed. Experiences from the Salton Sea, Owens Lake, and other terminal lakes provide examples of decades of lake decline followed by billions of dollars in restoration to prevent the worst outcomes. This presentation will highlight some of the major factors that could influence the future trajectory of the Great Salt Lake and illustrate that proactive, integrated resource management can provide a framework for a long-term sustainable Great Salt Lake and watershed.

**John Neill**
John Neill works with the Utah Division of Wildlife Resources as an Avian Biologist for the Great Salt Lake Ecosystem Program, which manages the sustainable harvest of brine shrimp from the lake through research and monitoring.

**Gunnison Island, Pelicans, and Satellites**
Gunnison Island in the northwest arm of Great Salt Lake is home to one of the largest breeding colonies of American white pelicans within its North American range. Regular surveys of the pelican population on the island, beginning in 1972, now include 42 years of information. Regional pelican populations appear to be doing well with the establishment and growth of nearby colonies leading to problems associated with the consumption of protected fish species and the danger of potential bird-airplane collisions; however, recent drought in Utah threatens the Gunnison Island pelican colony by turning it into a peninsula accessible by land-based disturbances. Pelican population and productivity data from Gunnison Island will be shared along with the results of other pelican research including diet analyses, West Nile Virus and heavy metals testing in pelicans, and tracking efforts at Great Salt Lake and Strawberry Reservoir with the aid of leg bands, wing tags, and GPS satellite transmitters.

**Jeff Nichols**
Jeff Nichols is Professor of History at Westminster College in Salt Lake City, where he co-directs the Institute for Mountain Research.
Revisiting Great Salt Lake Histories
Great Salt Lake is an essential feeding and breeding ground for waterfowl. For Native Americans, the wetlands where fresh water meets saline provided vital food products. But with the settlement by Euroamericans in the nineteenth century, the lake seemed mostly a natural curiosity or recreation grounds. Thereafter, as its centrality to the identity of Utah diminished, it gradually became an overlooked and abused water body. The saline lake as a subject of historical inquiry has also been somewhat neglected. Some good histories place the lake in the regional context of the fur trade, overland migration, and government exploration. Dale L. Morgan’s The Great Salt Lake, published in 1946, brings the lake’s history into the twentieth century but is sorely dated. Gary Topping excerpted some of the best historical and literary writing about the lake in Great Salt Lake: An Anthology, published in 2002. New approaches and perspectives are beginning to build on previous narratives to reveal the environmental and cultural significance of the lake in the twentieth and twenty-first centuries. In particular, a special issue of the Utah Historical Quarterly dedicated to the lake’s “edges”—where water meets the land—combines the methods and tools of the humanities, social sciences, and natural sciences to yield insights into an old theme: natural-human interaction in the saline environment.

Brian Nicholson
Mr. Nicholson is a senior project manager and regulatory specialist at Martin & Nicholson Environmental Consultants. He has more than 20 years of experience working in rivers, streams, and wetlands in the Intermountain West.

Panel: Bear River Compact: Then and Now

Amelia Nuding
Amelia Nuding joined Western Resource Advocates in 2010, where she is the Senior Water Resources Analyst. She works with utilities, municipalities, and state agencies to advance innovative water management strategies, and to improve the integration of water and land use planning.

The Future of Secondary Water Metering
Improved water conservation efforts are necessary to improve water management throughout Utah. Western Resource Advocates (WRA) conducted a study in 2017-2018 to determine which conservation measures would be most effective at saving substantial amounts of water over the next 5-10 years. While water conservation necessarily requires a multi-pronged strategy, secondary water metering rose to the top, based on a series of interviews conducted with experts across the state. WRA then conducted a Lead User workshop, bringing together experts in secondary water metering, finance and communications, which resulted in the articulation of a three-pronged pathway to accelerate metering of secondary water systems. The results of that workshop, as well as its implication for water conservation and the Great Salt Lake, will be discussed.
Kevin Perry
Dr. Perry is an Associate Professor in the Department of Atmospheric Sciences at the University of Utah and has served as Chair of the Department since 2011. He holds a B.S. degree in meteorology from Iowa State University and a Ph.D. degree in Atmospheric Sciences from the University of Washington.

Source Regions and Elemental Composition of PM10 Mineral Dust Originating from the Exposed Lakebed of the Great Salt Lake
As the water level of the Great Salt Lake (GSL) has decreased to historic lows, it has exposed more than 550 mi² of lakebed. Similar to other receding lakes in arid regions (e.g., the Salton Sea and Owens (dry) Lake), the exposed GSL lakebed has begun to generate dust plumes during high-wind events. These dust plumes significantly reduce local visibility and elevate the PM10 and PM2.5 concentrations in communities along the Wasatch Front. A two-year study is currently underway to learn more about how these dust plumes are generated and to what extent they might impact local air quality. Previous studies of the GSL dust have deployed active or passive air samplers at strategic locations and waited for plumes to arrive. This study takes an alternative approach by collecting soil samples directly from the exposed lakebed and returning them the lab for processing.

Warren Peterson, Keynote
Warren Peterson is vice president of a multinational farm and ranch investment and management company. Previously, he practiced agricultural and water law for 29 years. He has four decades of involvement in water policy development. Peterson served as the State Water Strategy Advisory Team Co-chair.

41 Resolute Members, Four Years, 93 Recommendations—One State Water Strategy Report
Utah faces daunting challenges as one of the driest states and one of the fastest growing. At the convergence of these two realities lies the challenge of providing water for a population projected to nearly double by 2060, while maintaining strong farms and industries as well as healthy rivers, lakes, wetlands, and aquifers. At the same time, climate projections predict warming temperatures that will significantly decrease Utah’s snowpack, which provides more water storage capacity than all of Utah’s human-made reservoirs combined, and increased evapotranspiration rates.
In 2013, Utah Governor Gary R. Herbert launched a water strategy initiative to address these concerns. The initiative became a three-phase process:

- The first phase involved six water professionals who participated in eight facilitated public comment and discussion sessions, then prepared white papers on six topics.
- For the second phase, Gov. Herbert appointed a 41-member team of diverse water experts who served as the water issues advisory team to the Envision Utah team Your Utah, Your Future project and the resulting report from Envision Utah.
- In the third phase, the diverse 41-member team, with staff support from Envision Utah and other organizations, generated a 201-page final report presenting 93 recommendations.
The team delivered its report to Gov. Herbert on July 19, 2017. This presentation:

- Describes interplay among the team members and their constituencies in developing consensus on the form of the final report.
- Some of the key findings.
- How the team reached key decisions.
- Prospects for implementation of major recommendations.

It also includes lessons learned as the team navigated the “human factor” among the realities of water supply challenges, terminal river systems, political polarity, and pressing demands amidst the high deserts and powdery peaks of Utah.

Jedediah Rogers
Jedediah Rogers is co-managing editor of Utah Historical Quarterly and a senior state historian, Utah Division of State History.

Revisiting Great Salt Lake Histories
The Great Salt Lake is an essential feeding and breeding ground for waterfowl. For Native Americans, the wetlands where fresh water meets saline provided vital food products. But with the settlement by Euroamericans in the nineteenth century, the lake seemed mostly a natural curiosity or recreation grounds. Thereafter, as its centrality to the identity of Utah diminished, it gradually became an overlooked and abused water body. The saline lake as a subject of historical inquiry has also been somewhat neglected. Some good histories place the lake in the regional context of the fur trade, overland migration, and government exploration. Dale L. Morgan’s The Great Salt Lake, published in 1946, brings the lake’s history into the twentieth century but is sorely dated. Gary Topping excerpted some of the best historical and literary writing about the lake in Great Salt Lake: An Anthology, published in 2002. New approaches and perspectives are beginning to build on previous narratives to reveal the environmental and cultural significance of the lake in the twentieth and twenty-first centuries. In particular, a special issue of the Utah Historical Quarterly dedicated to the lake’s “edges”—where water meets the land—combines the methods and tools of the humanities, social sciences, and natural sciences to yield insights into an old theme: natural-human interaction in the saline environment.

Ryan Rowland
Ryan Rowland is a Hydrologist with the U.S. Geological Survey Utah Water Science Center (UTWSC) in West Valley City, Utah. During his 15+ year career, he has participated in and lead numerous ground and surface water studies.

Assessment of Deep Brine Layer Extent and Geochemistry Prior To and After Opening of a New Causeway Bridge, Great Salt Lake, Utah
Closure of the east and west culverts and recent (Dec. 1, 2016) opening of a new bridge on the Great Salt Lake causeway presents a unique opportunity to study deep brine layer (DBL) dynamics and its impact on south arm (Carrington and Gilbert Bays) biological and geochemical processes. The USGS, in cooperation with the Utah Department of Natural Resources, Division of Forestry, Fire, and State Lands, and the
University of Utah, Department of Geology and Geophysics, is working on a project to 1) quantify the timing of initiation and evolution of anoxia in the DBL after opening of the new bridge; 2) characterize vertical development of the DBL in the water column at fine time scale resolution; and 3) determine the timing of initiation and evolution of sulfate reduction and mercury methylation in the DBL. Preliminary results of the study confirmed 1) the absence of the DBL prior to opening the new bridge; 2) persistent anoxia in deep water in Carrington Bay prior to and after re-establishment of the DBL; 3) short-term development of anoxic conditions at sites south of Carrington Bay before DBL re-establishment; and 4) re-establishment of the DBL in much of the south arm by December 2017. The loss and subsequent return of the DBL had direct impact on the concentrations of total and methyl mercury in water samples collected in the south arm for the project that will be discussed by Dr. Bill Johnson, University of Utah.

Andrew Rupke
Andrew Rupke joined the Utah Geological Survey as an industrial minerals geologist in 2010. Andrew is also involved in research at Great Salt Lake including continuing UGS’s long-standing brine sampling program and study of the north arm's salt crust.

Utah Geological Survey Great Salt Lake Monitoring—Salinity, Chemistry, Salt Crust
The Utah Geological Survey (UGS) has monitored Great Salt Lake’s salinity and chemistry since 1966. We have typically collected vertical profile samples of the lake’s brine from specified locations in the north and south arms of the lake. The samples are analyzed for density and major ions, including Na+, Mg+2, K+, Ca+2, Cl-, and SO4-2, and these data are compiled into a database that is regularly updated on the UGS website. More recently, we compiled available data on the lake’s north arm salt crust and began monitoring the thickness of the crust on the margins of the lake.

Søren Simonsen
Søren Simonsen is Executive Director of the Jordan River Commission. He is an urban planner, architect, educator, community-builder and social entrepreneur.

Opportunities for Improving Water Quality Using Flow Management in the Lower Jordan River
Poor water quality is a concern in many segments of the Jordan River, a major tributary to the Great Salt Lake. These conditions are being actively addressed by Utah Division of Water Quality and the EPA. Conditions leading to poor water quality in the Jordan River are documented in a Phase I Total Maximum Daily Load study approved by the EPA in 2013. Long-term improvements in water quality will likely require pollutant load reductions from stakeholders at the municipal, county, and regional level. The Jordan River Commission (Commission) and other stakeholders are looking for opportunities to address acute and chronic dissolved oxygen (DO) concerns in the lower Jordan River (LJR) through flow management. This approach could be cost effective and provide additional ecosystem benefits compared to other water quality improvements that focus strictly on reducing pollutant loads. In 2014, the Commission completed the first phase of a study investigating the use of flow manipulation as a potential mechanism for
increasing DO during the late summer season in the LJR. On the basis of data review and model output, the study recommended field experiments that would manipulate flow at the 2100 South diversion and monitor the resulting downstream effects on DO in problematic reaches. Acquiring sufficient water rights has slowed implementation of the study, but significant progress has occurred during discussions with Utah Division of Water Rights.

This experiment is unique in the history of Utah water quality remediation and if successful, could lay a foundation for similar work in other watersheds in the state. Flow and water quality are sometimes competing commodities in Utah and any long-term changes in LJR flow management must operate under these conditions. However, analysis of past data has shown that even minor flow changes at the right time, can produce positive improvements in DO. For many reasons, the need remains to identify flow management opportunities that will improve LJR water quality. Participants attending this presentation will gain an understanding of how flow management on the LJR has changed over time and the regulations and objectives that guide existing flow management. We will review existing data that identify the influence of flow on water quality in the LJR and describe the progress we have made to date in the LJR flow experiment. We will also identify short-term and long-term opportunities for changes in flow management.

Steve Slater
Steve joined HawkWatch International in June 2006 as the organization’s Conservation Scientist and has since become the Conservation Science Director. Much of Steve’s recent work has focused on Golden Eagles, including monitoring, transmitter deployment and tracking, and risk assessments.

The Importance of Great Salt Lake and Promontory Peninsula to Raptor Populations
The Great Salt Lake ecosystem encompasses a unique landscape of wetlands, grasslands, shrublands, and agricultural habitats that provide critical breeding, wintering, and migratory habitat for hundreds of bird species. Birds of prey are located at the apex of most avian food chains, and can thus reflect the health of ecosystems such as the Great Salt Lake. The Promontory Peninsula-area of the Great Salt Lake ecosystem is one such important region for raptor populations that utilize the area year-round. Golden Eagles, Red-tailed Hawks, Swainson’s Hawks, American Kestrels, Peregrine Falcons, Great Horned Owls, Short-eared Owls, and Burrowing Owls breed along the peninsula. Three of these species – Golden Eagle, Peregrine Falcon, and Burrowing Owl – are Species of Greatest Conservation Need in Utah. Two other Species of Greatest Conservation Need – Bald Eagle and Ferruginous Hawk – utilize the peninsula during migration and winter. The east Promontory Road and 7200 N are also known hotspots for raptor-vehicle collisions, a mortality risk that could become significantly exacerbated with increased vehicle traffic. Road strikes from at least five raptor species have been documented along these two roads with very little survey effort; including Short-eared Owl (n = 5), Burrowing Owl (n = 3), Golden Eagle (n = 1), Turkey Vulture (n = 1), and Red-tailed Hawk (unknown number). HawkWatch has
conducted migration surveys near Promontory Point and Antelope Island that confirm the importance of the area to spring and fall raptor passage. Finally, recent Golden Eagle tracking data from multiple individuals also highlights the importance of the general area and traffic route for foraging eagles.

**Casey Snider**

Casey Snider is the Executive Director of the Bear River Land Conservancy. He has been actively involved in natural resource policy in both the non-profit and government sectors.

**Allies All: The Power of Collaborative Partnerships in the Debate Over the Great Salt Lake Watershed**

As increased demands for water and land are placed on the Great Salt Lake Watershed it becomes more and more vital to expand collaborative working partnerships among an ever increasing array of diverse stakeholders. Founded in 2008, the Bear River Land Conservancy (BRLC) was established to ensure that valuable lands for wildlife, birdwatching, farming, ranching, hunting, and fishing are conserved for future generations and for the health of our ecosystem as a whole. BRLC's first project was a wildlife conservation easement in partnership with PacifiCorp Power along the Bear River in northern Cache County. On this single piece of property BRLC has been able to partner with sportsmen on migratory bird habitat improvements, educated high school classes on the value of riparian landscapes, utilized livestock to manage invasive weeds and invasive grasses, worked with UDOT to mitigate wetland losses, and recruited thousands of hours of volunteer work with a wide range of interests. This one project has yielding incredible benefits for wetlands, wildlife, neighboring land owners, industry, and the local community. As BRLC expands its footprint, and as pressures on the Great Salt Lake and its tributaries increase, the need for strategic partnerships becomes even more apparent. Hunters and anglers, agricultural producers, mineral and mining interests, municipal waste water plants, legislators, environmentalists, tourists, and many others, should all be viewed first as allies in an ever changing dialogue about the future of this important regional and global asset.

**Jim Steenburgh**

Jim Steenburgh is professor of atmospheric sciences at the University of Utah. An avid "three sport" skier (nordic, alpine, backcountry), he is the creator of the popular blog Wasatch Weather Weenies, author of *Secrets of the Greatest Snow on Earth*, and a leading authority on mountain weather and lake-effect snowstorms.

**The Great Salt Lake Effect: Mechanisms and Contributions to Wasatch Snow**

Conventional wisdom often suggests that the lake effect is due to cold air picking up moisture from the lake and that it is of great importance for snowfall in the Wasatch Mountains. In reality, the mechanisms driving lake-effect are multifaceted, vary from case to case, and can include a mixture of lake- and terrain-related processes. In addition, recent studies suggest that lake-effect periods contribute less than 10% of the average cool-season precipitation in the Wasatch and Oquirrh Ranges, although there is considerable variability from year to year and large lake-effect storms during October
and November can be important for building a low-elevation snowpack. This presentation provides a review of these results and their implications, including perspectives on what a shrinking Great Salt Lake may mean for the Greatest Snow on Earth in a warming climate.

**Blair Stringham**
Blair Stringham is the Migratory Game Bird Coordinator for Utah Division of Wildlife Resources. He has worked for the Division for over 10 years, and he oversees the management of waterfowl, cranes, doves and band-tailed pigeons.

**Boom or Bust: How Waterfowl Respond to Varying Water Levels of Great Salt Lake**
The Great Salt Lake ecosystem is a critical area for a variety of North America's waterfowl species. An estimated three to five million birds use the lake and its adjacent marshes for breeding, staging and wintering habitat each year. The most significant variable in determining waterfowl use on the lake are annual water levels. Fewer waterfowl use days occur on the lake in years of extremely high and low water levels, which is largely driven by the amount of accessible feed available to birds. Maintaining water in the Great Salt Lake ecosystem is critical in maintaining a link between breeding and wintering areas for many waterfowl species.

**Karyn Stockdale, Keynote**
Karyn Stockdale has spent the past 17 years working to protect and restore freshwater ecosystems across the American West. As Western Water Director for the National Audubon Society, Karyn leads strategic conservation, public policy, and engagement efforts to improve water management and water policy for nature and bird habitats in the West with a wide range of public and private partners.

**Water and Birds in the Arid West—Saline Lake Habitats in Decline**
Great Salt Lake and the Salton Sea, along with other less well-known landlocked saline lakes that dot the West, are the unsung heroes that birds like the American Avocet and Eared Grebe depend on for survival. Collectively, saline lakes in the West support global populations of birds, including over 99% of the North American population of Eared Grebes, up to 90% of Wilson’s Phalaropes, and over 50% of American Avocets. Importantly, these saline lakes function as a network of critical habitats. Each is a vital link on migratory pathways from winter to breeding grounds and back again — and because shorebirds and waterbirds congregate in large numbers at major lakes, they are particularly vulnerable to habitat loss. But these saline lakes are drying up at an alarming rate, and not only eliminating bird habitat but, in some places, exposing toxic dust that threatens neighboring communities. More than half of the major saline lakes in the West have shrunk by 50 to 95% over the past 150 years. If current western water trends continue and are compounded by climate change, many bird species face diminished and degraded habitat in the future. Audubon’s Water and Birds in the Arid West: Habitats in Decline report released in 2017 highlights these major findings for saline lakes in a comprehensive assessment of the relationships that exist among birds, water, and climate change in the region. Without action, the decline of water resources
threatens birds [and people] that rely on these habitats. This problem demands short-term solutions to address the habitat issues of the present while working to address longer-term solutions for reliable water supplies, even in the face of climate change impacts.

**Tom Tripp**
Tom is currently employed by US Magnesium as the Director of Technical Services and Development. Since 2004 he has been a member of the United Nation’s International Project on Climatic Change (IPCC) that deals with topics related global warming and other environmental issues.

**How the Changing Great Salt Lake Salinity Affects Magnesium Production**
US Magnesium (and predecessors) have produced magnesium metal and other commodity chemicals from the salts contained in the Great Salt Lake water since 1972. Over that that period, the salinity on the Great Salt Lake has varied with the lake elevation, but the data show that there has been a significant decline in the salt inventory in the South Arm of the Lake as minerals have migrated to the North Arm through the openings in the railroad causeway. This decrease in salinity has affected the production capacity and economic vitality of mineral extraction industries located on the South Arm of the Lake.

**Jake Vander Laan**
Jake coordinates the Utah Division of Water Quality’s Great Salt Lake water quality and freshwater lake assessment programs.

**Great Salt Lake: Salinity, Beneficial Uses, and Water Quality Standards**
One of the unique aspects of the Great Salt Lake ecosystem is the relatively abrupt juxtaposition of fresh, brackish, saline, and hypersaline aquatic habitats. These differences are driven in part by a series of causeways that have subdivided GSL into four main parts. Variations in salinity among different portions of GSL have resulted in the occurrence of distinct sets of chemical and biological conditions which necessitates a unique approach to the development and implementation of water quality standards to protect GSL’s beneficial uses.

In December 2016, flow between two major portions of GSL, Gilbert Bay and Gunnison Bay, was restored through the construction of a new bridge in the causeway that separates them. Flow rates of water, salt, and other constituents between these two bays have potentially important implications for GSL’s beneficial uses. The GSL Salinity Advisory Committee is an essential component in considering these implications and providing recommendations to the state agencies responsible for evaluating and implementing management actions on the new causeway opening.

**Jody Williams**
Jody Williams is a partner in Holland & Hart’s Energy, Environment and Natural Resources practice in the Salt Lake City office. She serves as Federal Commissioner and Chair of the Bear River Commission.
**Bear River Commission: 20 Year Compact Review**

The Bear River originates high in the Uinta Mountains in Utah, flows north past (but not into) Bear Lake before taking a sharp turn south, then flows through Idaho and back into Utah, eventually terminating in the Bear River Migratory Bird Refuge and Great Salt Lake. It is the largest river in North America that does not flow to an ocean. Although it is 500 miles long, it ends up only 90 miles from its headwaters, after crossing state lines between Utah, Wyoming and Idaho five times.

The twenty year annual average of water discharging into Great Salt Lake is 850,000 acre feet. With Congressional consent, the U.S. Constitution allows states to enter into agreements and interstate compacts. Utah, Idaho and Wyoming, which all contribute water to the Bear River, were developing at different rates, and the three states recognized the need to equitably apportion the Bear River among them. They requested permission from Congress to negotiate a compact, which was granted in 1946. Negotiations continued until the three states signed the original Bear River Compact in 1955. President Eisenhower signed the Compact in 1958.

The purpose of the Compact is to “remove the causes of present and future controversy over the distribution and use of the waters of the Bear River; to provide for efficient use of water for multiple purposes; to permit additional development of the water resources of Bear River; and to promote interstate comity.” Early irrigation appropriations in the three states left little water available for new uses and lead to conflicts. The Bear River Compact provides a solution by grandfathering existing water rights, dividing the remaining water among the states, and authorizing new storage above Bear Lake. It is important to note that although the Compact divides water among the three states, administration of water is directed by the individual states. The Compact also created the Bear River Commission, composed of nine Commissioners, three representing each signatory state, and an additional Commissioner appointed by the President representing the United States, to serve without vote.

The three states soon recognized that changes to the Compact were needed. Issues such as unrestricted groundwater development, no limit on depletion of appropriated water, the need for additional storage development above Bear Lake and a potential race between Idaho and Utah to develop water below Bear Lake again caused conflict among the basin states. In 1970, the states formally began amendment negotiations, and in 1976, they ratified an Amended Compact. Congress approved the Amended Bear River Compact, and President Carter signed it in February of 1980. The Amended Compact granted Idaho the first right to develop and deplete an additional 125,000 acre feet and Utah the second right to develop and deplete 275,000 acre feet below Bear Lake. It authorized additional storage above Bear Lake under certain conditions. Unlike many interstate compacts, Article XIV of the Bear River Compact requires the Commission to undertake a public review of the Compact every twenty years to see if changes are needed. In 1997, the Commission undertook a 20 year review of the Compact. After compiling written and oral comments, it found that there was no need to amend the Compact at that time but created a Water Quality Committee and added
public involvement to the function of the existing Records Committee. During its April 2017 meeting, the Commission formally initiated the present 20 year review, after which the Commission held a public hearing (November 2017) and took public comments from November 2, 2017 through December 2, 2017.

Wayne Wurtsbaugh
Dr. Wayne Wurtsbaugh is an emeritus professor in the Watershed Sciences Department and the Ecology Center at Utah State University. His research and teaching interests are in the areas of limnology, water pollution and fisheries.

Lessons from the Desiccation of the World’s Saline Lakes: Is It Too Lake for Great Salt Lake?
Saline lakes are not common, representing 44% of the volume and 23% of the area of all lakes on Earth. These systems are being lost at an alarming rate as overpopulation increases the demand for irrigated agriculture and water for urban centers. Central Asia’s Aral Sea, the Dead Sea in Jordan and Israel, Bolivia’s Lake Poopó, Iran’s Lake Urmia, and California’s Salton Sea are prominent examples of the startling trend of human impacts on these ecosystems.

Water development for agricultural, industrial and municipal applications increases economic productivity and stability. In contrast, the ecological, sociological and economic benefits of saline lakes are diverse, but not as easily monetized. Terminal saline accumulate and recycle nutrients more than freshwater systems, so they are highly productive. This makes them extremely important for avian communities, and consequently, saline lakes around the world have been designated as Ramsar Wetlands of International Importance or as Western Hemispheric Shorebird Reserve sites.

Decreases in lake size and the simultaneous increase in salinity decreases bird habitat and the production of their prey organisms. At Lake Urmia, for example, increasing salinities have eradicated brine shrimp, flamingos and most other birds. Additionally, when saline lakes are desiccated, they become sources of dust that harm human health and agriculture. The city of Los Angeles, which diverted water from the Owens Lake watershed in California, will spend US$ 3.6 billion to reduce dust emissions from the relatively small dry bed of Owen’s Lake in an effort to mitigate these effects. Effective controls of dust emissions from larger desiccated lakes become logistically and economically unfeasible.

Once water development occurs in a basin and a saline lake is desiccated, it becomes extremely difficult to reverse the trend because humans become habituated to high water use. Abundant and inexpensive water leads urban users to landscape their homes without regard to the environmental and human health costs. Another example is the Iranian government that built dams and irrigation systems in the Lake Urmia basin over the past 25 years that has caused a precipitous decline in the lake. Iranians are now struggling to recover the lake, but the establishment of water-hungry crops has made the agricultural community dependent on intensive irrigation, and it seems unlikely that the lake can be saved in the foreseeable future. Dust storms, impacts on
human health, and the loss of avian communities will likely persist for decades. Great Salt Lake has lost approximately 50% of its area and volume and proposed water development would cause additional loss. Nevertheless, much of the lake is still functional, and we can, and should, learn lessons from the ecological disasters that have occurred elsewhere. Water conservation, reduced population growth and changes in water distribution laws can preclude the need for further water development, and even provide additional water to the lake to reverse the decline seen over the past 150 years. Unlike many developing nations, we have the economic means and the knowledge to save the lake—now is the time to act before it is too late.

Katherine Barrett
Katherine Barrett is a researcher at the University of Notre Dame. She is the 2018 recipient of the Doyle W. Stephens Scholarship from FRIENDS of Great Salt Lake for her project, Linking Artemia To the Benthos: Do Microbialites Support Brine Shrimp Production in Great Salt Lake?, which explores the connections within the Great Salt Lake food chain.

Steven E. Clyde
Steven E. Clyde is an attorney with ClydeSnow. He is the recipient of the 2018 Friend of the Lake Award in recognition for initiating a timely and important conversation about how we can bring water to Great Salt Lake. In a room filled with attorneys and water-purveyors at the October 2016 Utah Water Law Conference in Salt Lake City, Clyde delivered his white paper, Water Rights for Great Salt Lake—Is it the Impossible Dream? He argued that the Lake has a range of ecosystem services and values that must be honored; and that in the context of Utah water law, there are viable tools for bringing water to the Lake to sustain these values and to fulfill our stewardship responsibility for this unique and complex system.
Quantifying Minimum Banding Size and Survival in fledgling American White Pelicans from Gunnison Island

Claire Prasad, Jaimi Butler, David Kimberly, Ashley Kijowski

Every year, nearly 20,000 American White Pelicans (Pelecanus erythrorhynchos) raise young on Gunnison Island in the North arm of Great Salt Lake. The Gunnison Island pelican colony is the second largest in the Western United States, and is crucial to the viability of the species. Serious concerns have been raised about pelican resource use, including eating game fish from reservoirs and colliding with airplanes. To specifically address these concerns and to understand the population ecology, The Utah Division of Wildlife Resources (UDWR) studies pelican migration through wing tags on pelicans. In general, only large-bodied birds, which are chosen based on sight alone, are selected to be banded. The primary goal of this research project was to correlate and make recommendations for reliable morphometrics that could quickly and quantitatively be used to select pelicans for banding. To do so we collected morphometric data from pelicans during the annual UDWR event. Our findings suggested that beak length correlated most strongly with pelican weight, and would therefore be the most reliable morphometric to use. Increasing our understanding of population dynamics will help conservation managers construct plans that ease tensions between the natural resource (pelicans) and other land-use shareholders.

The Biogeography of Great Salt Lake Haloarchaea: Testing the Hypothesis of Avian Mechanical Carriers

Erin Tabish and Bonnie Baxter

To explain the vast diversity of microorganisms and their overlapping geographic distributions, Baas Becking famously postulated that “everything is everywhere, but the environment selects.” Recent studies have disputed this idea and suggest other mechanisms of distribution. Halophilic archaea inhabit hypersaline ecosystems all around our planet, and they are highly adapted to desiccating conditions, surviving in salt crystals over long time periods. Genetically similar strains have been found in locales that are geographically isolated from one another. We sought to test the hypothesis that small salt crystals could be carried on bird feathers and that birds were the driving force of these distributions through their migration patterns. We collected salt from the shores of the north arm of Great Salt Lake (GSL), then isolated microorganisms from the salt. Subsequently, microorganisms were isolated from salt crystals located on pelican feathers from Gunnison Island in the north arm of GSL. Archaea isolated from the shore crystals were primarily Halorubrum genus, with a small
portion being *Haloarcula* genus. Archaea from the feathers showed to be strictly *Haloarcula*. These species were identified through PCR amplification and sequencing of the 16S RNA gene and compared to similar strains in the GeneBank database. We found there to be five geographical locations that *Halorubrum* and *Haloarcula* had in common as well as GSL. To evaluate the hypothesis that nearly identical *Halorubrum* strains exist in salty sites around the globe due to “hitchhiking” on the exterior of birds, we compared these sites against different bird migration patterns that included GSL as a stop-over.

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**An Overview of the US Magnesium Superfund Site**

Anna Rasmuson, Logan Frederick, and Shu Yang  
Advised by Dr. William P. Johnson  
University of Utah, Geology and Geophysics

The Superfund process at US Magnesium has been a long and complex road. In order to involve community members, a Technical Assistant Grant (TAG) was awarded to Friends of Great Salt Lake and subcontracted to technical advisors at the University of Utah. The role of the TAG group is to explain technical site report, site conditions, and the EPA's proposed cleanup plan to the public so that the public can ask informed questions. US Mag is currently in preliminary stages of the Superfund process with efforts aimed at identifying toxic chemicals at the Site and their associated human and ecological risk. So far, several chemicals have been identified, including chlorine gas, HCl, dioxins, PCBs, and VOCs. These measurements will be used to create a remediation plan with the goal of returning concentrations to background levels. We are currently in the eighth year of the Superfund process, which promises to be lengthy. Because US Mag is currently operational and is the largest producer of magnesium in North America, the Site poses many unique and interesting challenges.

![US Magnesium Superfund Site Map](image)
Effects of surfactant seed coating and water level on alkali bulrush germination and biomass

Anders Hart and Emily Martin, Utah State University; Matthew Madsen, Brigham Young University; Karin Kettenring, Utah State University

Great Salt Lake (GSL) wetlands provide vital ecosystem services, including habitat for migratory birds. Alkali bulrush (*Bolboschoenus maritimus*) plays an important role in providing these services, but invasion by *Phragmites australis* has reduced the extent of alkali bulrush stands in GSL wetlands. Restoring alkali bulrush is a primary goal for GSL managers following *Phragmites* removal. However, climate change and human water demands may lead to lower soil moisture availability in GSL wetlands, potentially inhibiting alkali bulrush germination and establishment. Surfactant seed coatings have been effective in aiding the germination of seeds in upland restoration sites by reducing soil water repellency, but have not been tested in wetlands. We tested whether the addition of a surfactant seed coating to alkali bulrush seeds improved germination at four water levels in a greenhouse. Water level and seed coating were significantly associated with improved germination. In a second experiment, we tested the effect of the seed coating at a low and high dose and staggered water level drawdowns on seedling height and biomass over six weeks. Seed coating and time of water level drop were not significantly associated with differences in seedling height. The water level decrease may not have been extreme enough to negatively affect seedlings. More research is needed to determine if this surfactant seed coating enhances alkali bulrush germination and growth under unfavorable water availability conditions.

Response of invertebrate assemblages to *Phragmites australis* invasion and native plant revegetation in Great Salt Lake wetlands

Emily Leonard, Dr. Karin Kettenring, Dr. Charles Hawkins
Utah State University

An invasive grass, *Phragmites australis* (common reed), is rapidly invading Great Salt Lake wetlands, outcompeting native vegetation, and substantially altering critical habitat for migratory birds and waterfowl. Although the removal of *Phragmites* can help restore native vegetation, additional factors, such as food resource availability, contribute to bird habitat quality. Specifically, invertebrates provide an important food source for many bird species, yet how *Phragmites* may be altering invertebrate assemblages is unclear. This project addresses three primary objectives to help fill these knowledge gaps: 1) Examine how invertebrate assemblages respond to *Phragmites* invasion 2) Identify if *Phragmites* removal and the reestablishment of native vegetation can restore invertebrate species composition, biomass, and diversity within previously invaded wetlands and 3) Estimate the role of different restoration techniques in determining invertebrate recovery success. To accomplish these objectives, invertebrate assemblages will be examined within three dominant native wetland vegetation types, invaded *Phragmites* areas, and two active restoration sites. Recognizing how
invertebrates interact with *Phragmites* as well as with native vegetation is a critical component of understanding how to restore these wetland habitats. By gaining a better understanding of these relationships, invertebrate assemblage composition could serve as a potential assessment metric for determining wetland restoration success.

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**Seed-based Restoration of Native Plant Communities Following *Phragmites* Control in Great Salt Lake Wetlands**

**Emily Martin; Karin M. Kettenring**

Research has highlighted effective control techniques for *Phragmites australis* on the Great Salt Lake; however, recolonization of native vegetation is limited. While many strategies exist to reestablish native vegetation, seeding offers the advantage of being cheaper and less labor intensive to install. Four potential factors that may limit revegetation are: 1) dense *Phragmites* litter, 2) displacement of buoyant seeds, and 3/4) unfavorable moisture and temperature conditions. Therefore, we evaluated the effects of tackifier (to address seed buoyancy), mulch addition (to retain spring moisture), litter removal, and sowing timing on native plant establishment. We conducted a field experiment with two litter treatments: ‘mow and remove’ and ‘roll and crush’ and five seed treatments: untreated control (no seeds), and combinations of mulch (+/-), and sowing times (early/late spring). Tackifier was applied in each of the seeding treatments. Percent cover and stem density data were collected. We found that tackifier was successful at keeping seeds in place, while the mulch did not enhance native cover or density. The most important treatment driving plant recovery was the litter treatment—there was higher seedling recruitment in the mow and remove plots. Our findings provide strategies that land managers can use to enhance seedling recruitment.

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**Mapping and Modeling Ecological Functions for Ecosystem Service Management in Great Salt Lake Wetlands**

**Aubin Douglas, Maya Pendleton, Dr. Trisha Atwood, Dr. Edd Hammill, and Dr. Karin Kettenring**

*Department of Watershed Sciences and The Ecology Center – Utah State University*

Managers of Great Salt Lake (GSL) wetlands are responsible for maintaining ecosystem services provided within their complexes. Unfortunately, GSL wetland managers have limited data on the synergies and trade-offs between services across the landscape. Ecosystem services are often measured via "proxies," which, for this research, are several ecological functions (i.e. sediment retention, carbon and nitrogen uptake, seed production, migratory bird habitat, heavy metal uptake) performed by particular wetland types. In this project, we are quantifying and determining the distributions of ecological functions performed at two GSL wetland complexes. To do so, we are using object-
based imagery analysis to map seven vegetation types across the study areas using high resolution, 2016 aerial imagery and LiDAR data. We will then model the distributions of each function per vegetation type across the study areas, linking the classified imagery with previously collected field measurements of the ecological functions. We then employ a systematic landscape planning approach to provide an unbiased, optimized management plan that meets set targets of functions while minimizing costs to managers. Through multiple iterations of varying conservation targets and costs, we will calculate the amount of each function that can be conserved on the landscape per dollar spent by management.

Linking Artemia to the benthos: understanding the contribution of microbialite resources to brine shrimp populations in Great Salt Lake

Katherine L. Barrett and Gary E. Belovsky

Great Salt Lake’s benthos contains the world’s largest distribution of microbialites, the primary habitat of brine fly larvae and pupae (Ephydra). While brine shrimp preferentially feed on phytoplankton, they deplete this food source over the summer months, which creates a bottleneck to fall cyst production. We hypothesize that during mid-summer, brine shrimp consume benthic resources contained on microbialites. To test this hypothesis, ongoing laboratory feeding trials, field studies, molecular analyses, and stable isotopes of $\delta^{13}$C/$\delta^{12}$C and $\delta^{15}$N/$\delta^{14}$N will determine the contribution of benthic resources. Feeding trials indicate that brine shrimp nauplii and juveniles survive and grow when provided benthic food sources, but survival and transition rate is significantly lower compared to shrimp feeding on phytoplankton. Field studies found higher densities of brine shrimp above microbialites in August compared to other seasons, and brine shrimp sampled during this time had a $\delta^{15}$N/$\delta^{14}$N signature suggesting the incorporation of benthic resources into their diet. Together, these results suggest biofilm contained on microbialites may be an important component to brine shrimp population persistence in Great Salt Lake. Ongoing field and laboratory studies in 2018 will further elucidate the role of benthos in sustaining brine shrimp populations.
Using $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of carbonate minerals to quantify dust fluxes from desert playas to the urban Wasatch Front, Utah, USA

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Dry lakebeds (playas) are significant dust sources globally. The Wasatch Front is located adjacent to multiple playas, including the Great Salt Lake (GSL). As water levels on GSL continue to decline, an increase in dust emissions from the lakebed is expected. Dust emissions were sampled at GSL and other playas, including Sevier Dry Lake, and dust deposition was sampled along the Wasatch Front at Provo, Salt Lake City, Ogden, and Logan. To quantify fluxes from GSL relative to other playas, fingerprints for dust sources were developed by analyzing samples for mineralogy, bulk chemistry, $^{87}\text{Sr}/^{86}\text{Sr}$ and other isotope ratios, which were then compared to dust deposition samples. Sr isotope ($^{87}\text{Sr}/^{86}\text{Sr}$) ratios in the carbonate mineral fraction varied at source sites, ranging from 0.7100 in Sevier Dry Lake to 0.7150 in GSL, and dust deposition samples fell between those values. We developed mixing equations using $^{87}\text{Sr}/^{86}\text{Sr}$ ratios and elemental concentrations to quantity fluxes from GSL and Sevier Dry Lake to the Wasatch Front. The mixing equations showed that GSL contributed ~10% to ~50% of the dust flux in Fall 2015, and ~0% to ~15% of the dust flux in Spring 2016. Sampling will continue to understand seasonal changes in dust composition.

Ecosystem Functioning of Great Salt Lake Wetlands

Maya Pendleton, Aubie Douglas, Karin Kettenring, Trisha Atwood

Research has suggested that increased species diversity also increases ecosystem functioning, including multifunctionality (support of multiple functions simultaneously). However, despite being species poor, wetlands have been identified as one of the most productive and highly functioning ecosystems on Earth. Studies have suggested that high levels of ecosystem functioning in wetlands may be the result of larger-scale diversity such as habitat diversity. In this study, we will investigate the contribution of different habitat types in Great Salt Lake’s wetlands to ecosystem functioning. To accomplish this objective, we will evaluate multiple functions (sediment accumulation, seed nutrition, avian diversity, heavy metal accumulation, biomass, and above and below ground carbon and nitrogen storage) across seven dominant habitats (Typha spp., Phragmites australis, Salicornia rubra, Bolboschoenus maritimus, Schoenoplectus americanus, S. acutus, and playa). These data will serve as a baseline by which managers can assess the importance of different habitat types to the provisioning of ecosystem functions. Furthermore, these baseline data will help us better understand how management practices, invasions, and development are likely to influence individual ecosystem functions and multifunctionality via changes to wetland habitats.
Total Mercury and Methylmercury Response in Water and Sediment to Destratification and Restratification of Great Salt Lake, Utah, USA

Shu Yang, William Johnson, Frank Black, Ryan Rowland, Carla Valdes

The recent closing and re-opening of culverts in the railroad causeway separating the north and south arms of Great Salt Lake constitute a large scale experiment for which we monitored the response of total mercury and methylmercury in water and underlying unconsolidated sediment. Related aquatic chemical parameters demonstrated that destratification of the lake occurred in response to elimination of flow from the higher salinity north arm into the south arm in December 2013. Specifically, prior to elimination of flow, oxic and anoxic conditions characterized the shallow and deep brine layers, respectively. After elimination of flow, the south arm became vertically homogenous and oxic, with consequent loss of sulfide (99.7%). Concurrently, reduction of total mercury (81%) and methyl mercury (86%) in the water column, and reduction of methyl mercury (77%) in underlying unconsolidated sediment occurred, suggesting that the deep brine layer promoted the accumulation of methyl mercury in both phases. In the period prior to re-establishment of north-to-south flow, periodic anoxia at depth under quiescent conditions indicated respiration of underlying sediment organic matter, with consequent increase in sulfide, methyl mercury, and total mercury. Following re-establishment of north-to-south flow in July 2017, density stratification progressed from north to south with consequent stable increases in sulfide, methylmercury and total mercury. Our results confirm that the denser deep brine layer promotes methylmercury accumulation in bottom waters and underlying unconsolidated sediment.

Changes in Surface Albedo of Desert Playas Caused by Short-Term Variations in Soil Moisture

Kevin M. Craft, John D. Horel

Land surface parameterizations are an important aspect for creating accurate weather and climate models. Quantifying these parameters for the Bonneville Salt Flats in Northern Utah and other salt playas around the Great Salt Lake provides a unique challenge due to their constantly evolving surface characteristics. Seasonal flooding of the Bonneville Salt Flats and other low lying salt playas can transform the landscape from a bright surface which reflects a large fraction of the incoming solar radiation to a shallow saline lake which reflects less incoming solar radiation. Furthermore, surface winds can change the distribution of water coverage making large scale parameterizations of this system even more difficult. To address these issues a combination of in-situ data collected by an automated weather station and satellite observations from MODIS will be used to create an improved understanding of land surface characteristics for the Bonneville Salt Flats and playas around the Great Salt Lake.
Predicting and Assessing Conflicts Between Future Development and Migratory Bird Habitat Around Farmington Bay, Utah

Aubin Douglas, Dr. Keith Christensen, Dr. Barty Warren-Kretzschmar, and Dr. Karin Kettenring

The Great Salt Lake and its wetlands provide essential habitat to over 250 migratory bird species from both the Pacific and Central Flyways every year. However, Utah’s most populous and economically expanding region, the Wasatch Front, lies just east and south of the Lake, specifically around Farmington Bay. According to the Wasatch Choices 2040 and 2050 planning documents, Davis and Salt Lake Counties are expecting to develop 22,000 new acres of land by 2050, likely impacting current migratory bird habitat. This research addresses development-related impacts to habitat for three migratory bird guilds that frequent the Farmington Bay area: waterfowl, waterbirds, and shorebirds. First, habitat maps will be generated for each guild by overlaying distribution data for five representative species from each guild. Models for residential, commercial, and industrial development will be generated according to Wasatch Choices 2040 to meet expected development demands. An overlay of the development models on each habitat map will identify conflict areas and assess the amount of habitat lost to development. This research will identify areas of significant conflict between future development and current migratory bird habitat, and provide recommendations to local planners and concerned organizations so they understand how to meet development trends while accommodating migratory bird habitat.

Quantifying Functional Trait Variation within Native Bulrush Species in the Intermountain West

Rachel Nia Hager and Dr. Karin M. Kettenring

To restore functioning wetlands, we need to understand how different plant sources may vary in functional traits and how that variation can be captured to best support the restoration of a multitude of functions. In a mesocosm study, we identified and quantified the variation of functional traits between and within populations of three native bulrush species (Schoenoplectus acutus, S. americanus, and Bolboschoenus maritimus), so we can better understand this intraspecific variation. Rhizomes of these three species were collected in the spring of 2016 and 2017 from six states in the Intermountain West (Montana, Idaho, Utah, Nevada, Arizona, and Wyoming) and from twenty-eight wetlands in these states (not all species are found at all sites due to species range limits and establishment). Preliminary analysis indicates differences in mean and variation of the different functional traits across the rhizome source locations including across geographic location and abiotic gradients. Variation of functional traits between and within sites provides a strong potential for more targeted restoration planning. Based on these findings we can make recommendations to land managers on restoration material best suited for their wetland restoration sites based on desired wetland function.
Ladies of the Lake

Emily G. Calhoun*, Chloe L. Fender*, Bonnie K. Baxter

Although women fill half the jobs in the U.S. economy, they hold less than 25 percent of those in the field of STEM. This has been the case for decades, even as college educated women continue to increase their presence in the overall workforce. Underrepresentation of women creates a disparity that impacts not only job opportunities and promotions, but also income and grant-funding. To bring this closer to home, we looked at participation of female-identifying researchers exploring the Great Salt Lake and how their work is represented and accepted in our community. Preliminary results show that female-identifying folk are not as widely represented in the fields of study and are not participating at the same level as men. We explored this issue by looking at papers with the key words “Great Salt Lake Utah” published in 2009, the year before the first Great Salt Lake Issues Forum up to 2017, the year before this year’s forum. Our poster will explore ideas and questions such as how can we be more inclusive and representative of women in STEM? And what can we do locally to make our lake research environment more accessible to female-identifying researchers?

*Authors contributed equally.