



FRIENDS of *Great Salt Lake*

150 S. 600 E. Suite 2B, Salt Lake City UT 84102

www.fogsl.org

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In our Element

FRIENDS of Great Salt Lake Board and Staff on Antelope Island, February 4, 2017

The mission of FRIENDS of Great Salt Lake is to preserve and protect the Great Salt Lake Ecosystem and to increase public awareness and appreciation of the Lake through education, research, advocacy, and the arts.

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EXECUTIVE DIRECTOR'S MESSAGE

GREAT SALT LAKE – A BODY OF WORK THAT MUST BE INCLUDED IN OUR VISION FOR UTAH'S WATER FUTURE

“SHOW UP. DIVE IN. STAY AT IT!”

THE 44TH PRESIDENT OF THE UNITED STATES - BARACK OBAMA IN HIS FINAL ADDRESS TO THE AMERICAN PEOPLE

-JANUARY 10, 2017.

Nice snow. Nice rain too. As of February 1, 2017, snowpack in most of the 15 watershed basins around the state has exceeded what would normally constitute early April peak accumulations. According to the *Utah Water Supply Outlook Report* that's published each month by the National Weather and Climate Center, the succession of snowstorms from Christmas through early January translated into these impressive results. Currently, many of these watersheds are running “between 160% - 220% of normal - an increase of 25% - 65% over what was already a good situation.” When compared with last year, conditions look promising for soil moisture levels, reservoir storage, and stream-flow. However, based on the status quo, if this trend continues it's likely that spring runoff conditions could be dicey.

Using data generated by SNOTEL (Snow Telemetry), the *Utah Water Supply Outlook* reports provide timely updates on snow and precipitation levels around the state so that we can have a sense of how the second most arid state in the nation is doing as far as water that's falling from the sky.

But what's disappointing about the report is that Great Salt Lake is not accounted for in this important picture. In fact, on the maps of *Statewide Precipitation*, and *Statewide Snow Water Equivalent* our Lake isn't even labeled on the landscape. For a terminal lake that's located at the bottom of a 22, 000 sq. mi hydrologic drainage basin and relies heavily on precipitation and inflows from upstream water sources – the Bear, Weber/Ogden and Jordan Rivers – surely it's an oversight that nothing is mentioned about it in the context of Utah's water picture. This doesn't bode well for a system that generates \$1.3B annually for the state and regional economies. And it doesn't bode well for this unique hemispheric oasis for resident populations of wildlife and for millions of migratory birds that rely on its diversity of habitats and protein rich food sources for resting, staging, and nesting.

As you know, Great Salt Lake hit record low lake elevations in 2016. This is because climate change (also known as the climate regime) continues to create drought cycles and higher temperatures that hasten snowpack meltdown,

changes snow to rain, and increases evaporation. Exacerbated by upstream diversions that prevent critical inflows into the system, as the Lake's surface area begins to shrink, the lakebed is exposed to winds that create dust events. This dust contributes to already problematic air quality conditions along the Wasatch Front. That's why in the revision of the *September 2016 Draft of the Governor's 50-Year State Water Strategy* (draft strategy) that's currently underway - it's imperative that responsible recommendations that address Great Salt Lake's water future are incorporated.

Draft strategy? What draft strategy?

With an eye on the projected doubling of Utah's population by 2060 and how to reconcile this with managing the state's water resources, in 2013 Governor Herbert initiated a *50-Year State Water Strategy*. The strategy is supposed to “define priorities, inform water policy, and chart a path to maintaining and constructing needed infrastructure without breaking the bank or drying up our streams.” And it's supposed to include “extensive public input to guide the process.” Kudos to the Governor for providing us with continuing opportunities to reckon with Utah's water future and to exercise our commitment to effectively plan for it.

Using the momentum from former Governor Leavitt's water conservation goal to reduce municipal and industrial (M&I) use by 25% by 2050, Herbert upped the ante to achieve the reduction by 2025. Right now, we've reached 18% reduction. That's commendable but we can't stop at 2025. When you think about it, in-home water use constitutes only 4% of all the water we use. So if we continue to be judicious in our water conservation practices – and that should include industrial uses too - we should be able to provide water to twice as many people with our existing supplies and without developing new sources – climate change aside. Holding to this standard continues to make room for our natural systems that need protection and have a direct effect on our quality of life.

Just as education has changed our behavior about littering and wearing seatbelts, we've got to continue practicing



good water conservation measures because we simply can't afford to be profligate with this precious resource. If we're going to be honest about Utah's water future, we have to begin by shaking up the basic assumptions we have about our relationship with water and its utility, and perhaps even our assumptions about growth.

Work on developing the *50-Year State Water Strategy* began in the summer of 2013 with a series of 8 statewide scoping meetings. The "listening sessions" provided an opportunity for citizens to express their ideas about Utah's water future and ways to address water challenges. The meetings were hosted by a task force of six people involved in Utah's water world. Discussions included recreation and the environment, climate change, population growth, water law, water for agriculture, delivery and efficiency, competing interests, and funding water infrastructure. With the addition of online comments an impressive amount of input was gathered and summarized in a series of white papers presented to the Governor that fall. You can review the comments and hear recordings of the sessions by visiting www.utahswater.org

At the same time, a State Water Strategy Advisory Team representing a range of interests and expertise from around the state that included water conservancy districts, academics, conservationists, attorneys, planners, government agencies, politicians and FRIENDS was appointed by Governor Herbert. The Advisory Team would work through an Envision Utah (EU) modeling process to "identify Utah's choices related to water, create 5 water scenarios for the EU 2050 *Your Utah Your Future* visioning process scheduled for roll out in April 2015, participate in the process, and provide the Governor with a *Draft 50-Year State Water Strategy* on which he and other policymakers could build a vision and framework for water issues going forward."

From 2013 - 2015+ under the direction of Envision Utah facilitators assisted by 3 co-chairs involved in the statewide listening sessions, the Advisory Team was "guided" through discussions intended to shape the water scenarios. Unfortunately, this facilitated exercise limited our ability to delve fully and more objectively into provocative and pithy aspects of the future of our water resources such as questioning baseline assumptions with a bias toward structural supply enhanced solutions. And it also limited the scope of the scenarios on offer for the public to consider as a water vision for the future. As a result, we weren't able to address important matters such as-

- Currency of data on projected water use
- Water pricing and secondary metering
- The prior appropriation doctrine, the public

welfare and conservation incentives

- Modernizing Utah water law to improve transparency and public involvement
- Costly and controversial new infrastructure projects with significant environmental externalities
- Climate change impacts on flows from the Colorado River
- Best practices and tools that are working in other states
- The future of Great Salt Lake

None of these things were adequately discussed which is very frustrating for those of us working for a sea change in our usual water ethic. Alas.

Fast forward to September 13, 2016 when the Advisory Team was called back together after a hiatus of almost 20 months to review the *September 2016 Draft of the Governor's 50-Year State Water Strategy* <http://envisionutah.org/projects/utah-water-strategy>. A draft strategy that would ONLY invite comments from the Advisory Team and who would ONLY have 3 weeks to provide them. It wasn't pretty. The public protested as did many members of the Advisory Team. The deadline for comments was extended and the public was invited to participate. Fast forward to February 2017.

Although the work continues on revising the draft strategy, the process has changed. We have a long rein to "create a worthwhile outcome from this long undertaking and write the ending to this story as you see fit." And we've taken this to heart. Without facilitation, we've self-selected to work in small groups that meet at different times and at different venues. As we focus on the 12 key policy questions that comprise the draft strategy, our discussions are more open, engaging and energetic as we address the task before us. Our collective goal is to produce a meaningful tool that's durable and has integrity. Perhaps we can be the first step in a new era in water policy. We'll have to see.

"We're talking about the need to be nimble and adaptive, practical and proactive in our approach. We need to evaluate the future of water planning and its relevance to land use and economic planning so that it's cohesive and resilient in the scheme of sustainability thinking for Utah's population and our precious natural systems that includes Great Salt Lake." Joanna Endter-Wada, USU and Advisory Team cohort.

I'm inspired.

In saline,

Lynn



FRIENDS' ORGANIZATIONAL STATEMENT

FRIENDS of Great Salt Lake is a membership-based non-profit 501c3 organization founded in 1994. The mission of FRIENDS is to preserve and protect the Great Salt Lake Ecosystem and to increase public awareness and appreciation of the Lake through education, research, advocacy, and the arts. The long-term vision of FRIENDS is to achieve comprehensive watershed-based restoration and protection for the Great Salt Lake Ecosystem.

FRIENDS has a very active Board of Directors and Advisory Board consisting of professionals in the scientific, academic, planning, legal, arts, and education communities.

The organization sponsors an array of programs, activities, and materials in pursuit of its mission.

Every two years, FRIENDS hosts the Great Salt Lake Issues Forum to provide a focused discussion about the Lake for policy makers, researchers, planners, industry and other stakeholders. The goal of each Forum is to encourage constructive dialogue about the future of the Lake's ecosystem and its resources, and to illuminate the complexities involved in research, management and planning for the lake.

The Friend of the Lake award was established in 2002 and is given at each GSL Issues Forum. It acknowledges a citizen, business or organization working to promote Great Salt Lake awareness in the community.

In 1998, the Utah Chapter of the Wildlife Society awarded FRIENDS the Conservation Achievement Award.

In 2002, the Doyle W. Stephens Scholarship Award was established. The scholarship provides support to undergraduate and graduate students engaged in new or on-going research that focuses on Great Salt Lake.

In 2002, Lynn de Freitas was awarded the outstanding vol-

unteer educator award by the Utah Society for Environmental Education

In 2006, FRIENDS was the recipient of the Calvin K. Sudweeks Award from the Utah Water Quality Board for outstanding contributions in the water quality field.

Janessa Edwards, hired in 2014 as Education & Outreach Director, is working to strengthen the Lakeside Learning Field Trip Program and FRIENDS community outreach.

In 2014, FRIENDS established the Annual Alfred Lambourne Prize to celebrate creative expressions inspired by the Lake.

In 2016 our Lakeside Learning Field Trip Program was recognized as the Environmental Education Program of the Year by the Utah Society for Environmental Education.

In 2016 FRIENDS hired Holly Simonsen as our new Membership Coordinator.



Girl, the Spiral Jetty and the Great Salt Lake by Susan Kirby, submitted for the 2015 Alfred Lambourne Prize

On the Cover

Renewing our commitment to the Lake and its sustainability, FRIENDS Board of Directors and Staff gathered together for our annual retreat on Antelope Island. The Lake is always the right place to be to talk about the science, the issues and the work that needs to be done on its behalf. Big briny thanks to Wendy Wilson, Assistant Manager at Antelope Island State Park and the friendly staff who make the Visitors Center the perfect place for us to meet. And in our usual fashion, we toasted the Lake and its future for generations to come.

Left to right back row - Juan Arce-Larreta, Lynn de Freitas, Katie Pearce, Melissa Barbenell, Janessa Edwards, Holly Simonsen, Rob Dubuc

Left to right front row - Janice Gardner, Frank Feldman, Emily Gaines, Cindy Lund, Heidi Nedreberg, Hikmet Loe



CREATIVE EXPRESSION INSPIRED BY OUR INLAND SEA



Pink Brine

22 x 30

acrylic and salt on paper

Clinton Whiting

Submitted for the 2016 Alfred Lambourne Prize

You can see more of Clinton's work at clintonwhiting.com, and on Instagram at [clint_whiting](https://www.instagram.com/clint_whiting)



TIME PAST, TIME PRESENT AND TIME FUTURE FOR THE GREAT SALT LAKE

Time present and time past
Are both perhaps present in time future,
And time future contained in time past.
If all time is eternally present
All time is unredeemable.
What might have been is an abstraction
Remaining a perpetual possibility

Excerpted from Burnt Norton by T. S. Eliot

Utah's inland sea, the Great Salt Lake is a paradox. To its East is a significant urban population called the Wasatch Front and further East is a true wilderness mountainous area known as the Central Wasatch. To the West is high country desert which has a mining/refining operation – US Magnesium– which is among the heaviest air polluters in North America. Put another way, wilderness and solitude, urban population and crowding, wilderness and solitude and finally industrialization and pollution.

For the Native populations of the area, before the Pioneers, the Lake was mostly circumnavigated. There were the hot springs of North Salt Lake and the important tributaries that fed the Lake and provided the Native population with food and fresh water, but little which were immediately productive to their indigenous way of life.

From the founding days of the Pioneers the Lake was a source of recreation, entertainment and commerce. The Saltair Resort from its founding through the early 1960's was comparable to present-day amusement parks like Lagoon or Liberty Park, in earlier times. The Lake itself through the early part of the 20th century had steamships that transited the Lake carrying raw materials from North to South and manufactured materials from South to North. It was a hub of social and commercial activities.

As a child growing up in Utah, my visits to the Lake were limited to when my grandmother from New York came to Salt Lake. Most of her visit was a collage of pleasant child spoiling activities. However, she would always insist that we visit the Great Salt Lake. If you had any type of cut the salty water created excruciating pain and the constant buzzing of the midges, gnats and brine flies were a bother equal to, or greater than, the unpleasant whiffs of repugnant and undetermined odors found in and around the Lake. Put another way, the Lake was to be avoided.

With help and leadership of FRIENDS of Great Salt Lake

and other conservation groups, my childhood resistance has been replaced by a growing appreciation of the natural ecosystem the Lake and its drainage areas and their environs represents. Where else in the world do you find a major metropolitan area, remarkable, global class research universities and colleges and a growing population wanting to protect its shared legacy? It was truly prescient for the Pioneers to have named the river between Utah Lake and Great Salt Lake, Jordan. Brigham Young was by several historic accounts an ardent environmentalist. When Parley Pratt and other earlier settlers desecrated Parley's Canyon and Emigration Canyon, Brigham Young took the ownership of City Creek Canyon. Under his stewardship no one was allowed into City Creek Canyon unless they had Brigham Young's personal, written permission.

Col. Conor, an early commander of Ft. Douglas, attempted to circumvent Young's edict by establishing two mining camps in the upper portion of City Creek. When Brigham Young discovered this transgression, he dispatched Porter Rockwell to the mining camps and they were disbanded in two days. The same early environmental protection cannot be found for the Lake. Indeed, any and all pollution which could be dumped into the tributaries feeding the Lake were, with predictable consequences of residual environmental problems we are having to face in our time.

Since the 500-year flood of 1983 and its historic high shoreline elevation to the present near record low elevation, the Lake's future is in a quandary. Remember the Great Salt Lake Marina which provided many Utah citizens with wonderful sailing excursions on the Lake to gain a remarkable degree of solitude has all but ceased to function because of the Lake's shrinkage. Scientists warn that if the Lake continues to diminish many of the heavy metals and other health threatening pollutants that have found their way into the Lake will be blown back into our cities and towns by the prevailing southwesterly wind. Will these serious health consequences particularly for the young and



the old be our generation's legacy?

There are really only two choices for the Lake. Either we can continue down the pathway of "anything goes". That is, yes, let's dam the Bear River, continue to pollute the Jordan River and extract as much water as possible before it is "wasted" on the Great Salt Lake. One can think of innumerable variations of this unchecked urge to develop for immediate profit without regard to the long-term consequences for the present or future generations.

Or, we can use the remarkable community of scientist, health experts, planners and regular citizens to plan for a sustainable future for the Lake. Working through the cities, towns and counties surrounding the Lake we need to create a unified, enforceable plan that maintains steady commercial opportunities while at the same time does the necessary scientific and health research to maintain the health and viability of the system. Instead of having divided communities and arguments over jurisdictional boundaries, why not have a unified plan that looks at the entire drainage areas of the Great Salt Lake? Only with this type of integrated planning process will we be able to ensure future generations will have a GREAT Salt Lake.

So, what can you do?

1. Support FRIENDS of Great Salt Lake both financially and by participating in their many well thought out activities.
2. Take your family, your neighbors and friends to Great Salt Lake for a visit. Antelope Island is a remarkable place to visit with its historic farm, its bison herds and numerous hiking trails.
3. Sponsor visits by elementary, middle school and high school classes to Great Salt Lake. Check with FRIENDS for information that can be used to enhance that learning experience.
4. Get involved with the innumerable government entities that have some jurisdiction over the Lake. Your thoughtful involvement will be an insurance policy against special interest groups guiding the policy decisions for short-term gains, and not taking the necessary long view.

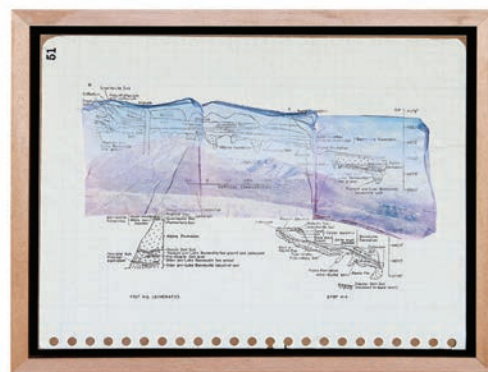
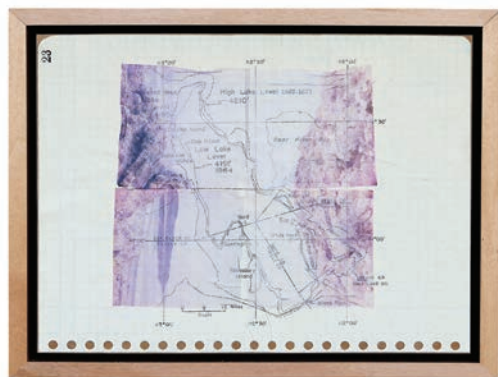
Patrick Shea, Attorney, and Research Professor of Biology,
University of Utah



Lake with a View by Charles Uibel

EPHEMERAL NONSITES OF LAKE BONNEVILLE AND GREAT SALT LAKE

Polaroid Emulsion Lifts, Xylene Transfers, Graph Paper



I dedicated the second half of my senior year (2015) in the University of Utah's photography program focused on combining the use of analog instant film photography* and land art as my senior thesis and the jumping off photographic series towards my career as a visual artist. As a passionate witness of land art and a lifelong resident of Salt Lake City I was naturally attracted to the earthworks of Robert Smithson and his usage of the Great Salt Lake in possibly the most famous land art masterpiece, the Spiral Jetty.

Smithson's Spiral Jetty is a physical art reality that all of us can experience, but after further research of his life I became intrigued in what he deemed a "Non-Site" and how it relates to art history and the exploration of land art. Alternatively I become devoted towards furthering the idea of The Great Salt Lake as metaphorical construct between ephemeral art and the deconstructive power of nature that Smithson's Jetty was created in mind of.

"The Non-Site is a three dimensional logical picture that is abstract, yet it represents an actual site. It is by this dimensional metaphor that one site can represent another site which does not resemble it - this The Non-Site. To understand this language of sites is to appreciate the metaphor between the syntactical construct and the complex of ideas, letting the former function as a three dimensional picture which doesn't look like a picture. The Non-Site itself exists a space of metaphoric significance. It could be that "travel" in this space is a vast metaphor. Everything between the two sites could become physical metaphorical material devoid of natural meanings and realistic assumptions." - Robert Smithson, 1966

This series of images I produced entitled "Ephemeral Non-Sites of Lake Bonneville and the Great Salt Lake" incorporates integrated diagrammatic and cartographic representations of space with counterpointing, two-dimensional, photographic perspectives. These artistic works investigate

the Great Salt Lake, a slivered apparition of water to the west, an ethereal, saline landscape. The lake is a fluctuating micro-climate of water, salt, mud, rocks, crystals and wildlife has an elusive ability to detract itself from being captured completely by any singular artistic medium.

"In terms of abstraction, there seems to be one urge, and that is toward the development of a purely mental construct that is then transferred into a physical object. And the notion that surrounds the Non-Site has to do with the dialect that exists between interior and exterior space. So that the open limits of the site enter the closed limits of the Non-Site, and there's no attempt to foster an idea of freedom within the confines of a room." - Robert Smithson, 1971

These emulsion lifts are created by submerging the film in water after the exposure. Water bleeds into the film and the emulsion separates itself from the chemical backing and protective plastic window of the film. The emulsion floats in the water separated entirely from its protective casings, waiting to be absorbed onto another surface. The use of topographical maps and geological statistics were used as the transferred imagery onto the graph paper. The series was a wonderful gateway for me to really explore the shores of the lake and learn about it's precious eco-system in a first hand and educational formula.

**Polaroid film is a form of analog instant photographic film that allows for an almost immediate development of an image. The negative consists of three emulsion layers sensitive to the primary colors (red, green, and blue) each with a layer of developing dye beneath it of the complementary colors (cyan, magenta, and yellow). Once light exposes the film, the reagent material, which is pooled within the border of the plastic film sheet to keep it separate from the light sensitive layers, passes through a set of rollers that squeeze the reagent material into the sheet, causing chemical reactions in the film's layers. Emulsion layers which were exposed to their respective color block the complementary dye below it, reproducing the original color.*



See the full 12 image series at <http://www.maxrosenzweig.com/work/#/non-sites/>



CREATIVE EXPRESSIONS INSPIRED BY OUR INLAND SEA

Lake of Tears

Many suns and moons before strangers “discovered” the lake, the Great Spirit’s fingers molded and baked the Bowl of the Mountains. The rivers poured their floods and fish into this pot and the sky painted the watery surface sapphire-blue. Sweet wavelets lapped the beaches of this desert paradise. The Spirit traveled lightly over it and saw that it was good. He scattered diamonds of sun to mark the boundary between sky and water.

One day six hundred generations ago, after many long icy winters, Bear awoke in a bad mood. He grew angry with his neighbor, Snake, and withheld his cool streams from her. He poured them instead into the great bowl. The Snake grew thirsty but the Bear just laughed. His churning waters filled the bowl, until the waves overflowed and washed away the soft edge at Red Rock Pass. In just two moons the bowl was drained of all that it held in a flood big enough to fill an ocean. It cut the Snake deep into the bedrock of its valley and only stopped after all the angry water reached the Western Sea. All the fish were flushed out and banished, leaving behind only their salty tears in the Bowl. Today their descendants still live in rivers and lakes and oceans downstream, trying in vain to return.

Now strangers have built cities of skyscrapers around the shallow lake at the bottom of the Bowl, where once a thousand feet of water stood and a million fish swam. But on a sunny day, the Great Spirit’s sparkling diamonds can still be seen floating on the surface of the fishes’ tears.

Jon Sebba

Submitted for the 2016 Alfred Lambourne Prize



Aristole’s Dream (Earth - Air - Fire - Water) by Thomas Horton 2016

Submitted for the 2016 Alfred Lambourne Prize

See more of Thomas’s work at www.furtherthetofly.com



GREAT SALT LAKE EDUCATION

TELLING THE STORY OF GREAT SALT LAKE

JULES JIMREIVAT, PRODUCER AND HOST OF GREAT SALT LAKE PODCAST, TELLS THE WHO, WHAT, WHERE, WHEN AND WHY OF THE PODCAST

I have always loved podcasts. My first introduction to the podcast world was with *This American Life*. I was hooked to this audio because of its journalistic yet personal look into stories. Later, I became heavily influenced by Radiolabs for their increasingly personal conversation style of storytelling paired with complex scientific communication. Growing up, a DC local, I was too often confined to the claustrophobia of concrete city life. When I was 18, my love for rock climbing, and the outdoors brought me to Salt Lake City, where I enrolled as a Biology major at Westminster College. On the drive from the airport to school, I remember being taken away by the view of the Wasatch. I immediately began to fall in love with this city for its close connection to the outstanding outdoors.

Not long after the start of Freshman year, I met Syd Sattler, a fellow Biology major, who shared my love for podcasts. We'd meet in the cafeteria for breakfast and greet each other with a casual "did you hear that episode of Radiolabs that came out last night?" which was generally followed by an enthusiastic "yes!" along with a discussion of topics in the podcast that often paralleled scientific concepts we were learning in class. These conversations also lead to fantasies of the creation of our own podcast. How hard could it be?

In our sophomore year, thanks to a genetics course taught by Bonnie Baxter, Syd and I directly studied Great Salt Lake, and the salt-loving organisms that live there (extremophiles, as Bonnie would call them). As I sequenced DNA extracted from these extremophiles, I was submerged in a world of questions; how could these organisms tolerate so much salt in such a unique environment? This led to more questions about the lake itself; why had I heard so little about it after living an entire year at its shores? It was after this course that Syd and I got the idea to make a podcast about Great Salt Lake. With the help of Bonnie, Great Salt Lake Institute, and the seemingly limitless resources at Westminster, we got to see our creative idea blossom into something real: Great Salt Lake Podcast.

Podcasts are an emerging media form. Unlike traditional radio, podcasts can be downloaded, and played whenever and wherever is convenient for the listener. 21% of Americans listen to podcasts monthly, which is the same percentage of Americans who use Twitter, according to Edison Research. Since 2013, podcast listenership has grown 75%. I want to harness this growth, and use it to bring attention to environmental issues at our backdoor. In this case, it's water, which

is a reoccurring theme for environmental issues in the West. Through this ongoing podcast journey, Syd and I have been faced with many hard facts of this world. In an interview with Rob Dubuc, an attorney for Western Resource Advocates, my jaw dropped as the backwards water law practiced in the state of Utah was explained to me. Is water something that should be commercialized, or is it a right? If it is a right, I believe the realization of that right must include the right to the places that connect and house that water.

A few months ago, I scheduled an on-campus interview with Brent Olsen, a professor of environmental Studies at Westminster, as well as a director for the Institute for Mountain Research. He told me that water becomes a useful lens, through which we can evaluate a whole set of social challenges and questions. Looking at Salt Lake City through the lens of water unveils an ugly truth that I believe is all too common globally; lack of interest and public pressures on local government results in an economy structured such that costs are externalized to environmental factors. How do we renew a public connection with the lake to save the air we breathe as well as a landmark ecosystem that deserves respect? Can we? I believe, through education, we can. There lies the mission of Great Salt Lake Podcast.



Jules Jimreivat, Producer and Host of Great Salt Lake Podcast untangles mic cables while capturing audio of the Lake. Photo by Jeri Gravlin.



Diving into this project has made me realize that I can As I dive into this project, I have come to realize that I can create meaning using stories. My goal is to do this in the same manner that I came to love podcast: first intrigued by the real-life pictures painted in audio clips of *This American Life*, and later captivated by the conversation style used to communicate scientific concepts, in *Radiolabs*. I want to tell stories that let people connect with the lake, understand it, and find reason to protect it. The importance of telling the story of the lake has become very personal. I love Salt Lake City, but I question if it can become my long-term hometown, when it sometimes seems that we are destined for increased water usage, decreased lake levels, and increased particulate

matter in our air shed. Helping people understand the lake is quintessential for my peace of mind living here. Now a senior in college, my path after graduation is unclear and scary, but I know that being a voice for places that I love is something that will always be woven into that path.

The three-part pilot series of *Great Salt Lake Podcast* is currently available on greatsaltlakepodcast.com, as well as on iTunes. Syd and Jules are currently working on a full series, which will be released when the story is complete.

Jules Jimreivat, Producer and Host of *Great Salt Lake Podcast*



Jules Jimreivat and Syd Sattler, creators of *Great Salt Lake Podcast* record sounds of the Lake. Photo by Jeri Gravlin.



GREAT SALT LAKE AT A GLANCE

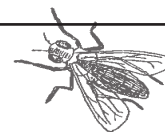


Courtesy U.S. Geological Survey





E • phy' • dra, a noun; a genus of two species of brine flies that live on the bottom of the Great Salt Lake as larvae and pupae, and along the shores of the Lake as adults.



The Water Climate Nexus of Utah

Introduction

As many of you may know, as State Climatologist, I am often asked to give talks on climate change and how it pertains to or will affect Utah. Most often my talks use powerpoint as a way of delivering information and, in order to ward-off a “death by powerpoint” experience, I often “Jazz”-up (excuse the pun!) the presentation with animations and the like. Recently, to garner my audiences’ attention I start by showing a clip of the riveting car chase from the beginning of *Quantum of Solace* – that truly gets my audience’s attention! Apart from the rush of adrenaline my modus operandi lies in the theme of the film i.e. James Bond goes after corrupt General Medrano, who plans with *Quantum* to stage a military coup in Bolivia and hijack “one of the world’s most precious natural resources” and that precious resources is of course WATER.

Let’s NOT Shy Away From Climate Change

In the coarsest of terms, a warming planet dictates that more water vapor can co-exist in the atmosphere. However, while such a principle holds true, the distribution of that water vapor in the form of precipitation does not, i.e. everywhere receives more – other factors are at play in our complex climate system. So, what does global warming mean for Utah’s precipitation regime and subsequently its hydrological regime? In making any kind of assessment we have to consider precipitation as follows:

1. Annual Precipitation – How Much?
2. Seasonal Precipitation – When?
3. Precipitation Intensity – How Intense?
4. Precipitation Form – What Kind?

In the most general terms precipitation within Utah is changing in all four categories but especially so in categories 3 and 4 where storms are fewer in number but their intensity has increased. However, of particular significance is that fact that we are transitioning from a predominance of wintertime snow to a mixed regime of snow and rain. A detailed account of Utah’s climate change can be found in [1].

Utah’s future water resources lie extensively in climate change and the risks associated with it, as we are transitioning towards a very different hydrological regime. In fact, the

supply of water is almost entirely about climate change and will fundamentally drive those water challenges that will face Utah in the future and so, climate change should be a baseline consideration while at the same time compounded by Utah’s increasing population base (i.e. demand for water will increase). So, we have to recognize the problems we anticipate along with possible solutions and not shy away from them.

Just to confuse – Enter Variability

Another factor that is often misconstrued is that of climate variability – they are not the same thing as climate change. Variability is an inherent part of climate especially in the Western U.S. and while the climate models are suggesting that the climate may become even more variable it is often easy to fall into the trap that the issue is increased variability rather than more relevant point that it is a transition to a new climate regime. Furthermore, the transition is happening all over the planet. As my colleague Rob Davis notes “This fact carries with it considerations that do not come with a simple case of regional climate variability.” Climate change over the intermountain west has the potential to be major stressor for the region as States face shortages or shortfalls in water resources.

What Is and Isn’t Uncertain

Climate uncertainty is often quoted but it should be realized that more uncertainty equals more risk (not less). There is no doubt that we climate scientists don’t know all aspects of the change but we do know other factors that are not uncertain: We do know with high confidence that the climate of Utah will be warmer; this means increased evaporation and evapotranspiration, and that the hydrological regime will be driven less by snow and more by rain.

Articulation of Climate Change Projections Should Underlie Future Water Management

Climate change projections should be a critical part of risk assessment and associated management plans. The climate models have projections of low-carbon to high-carbon scenarios and we should develop scenarios of water use based upon them. Moreover, a number of recent papers suggest future hazards like megadroughts in the American South-



west; these are defined as “periods of aridity as severe as the worst multiyear droughts of the 20th century and persist for decades.” [2] Current studies advocate the risk of significant droughts of the extreme variety reminiscent of those in Utah’s ancient past [2, 3]. One study [2], does in fact project a rather dismal scenario saying “We find that regional temperature increases alone push megadrought risk above 70, 90, or 99% by the end of the century, even if precipitation increases moderately, does not change, or decreases, respectively.”

Perhaps the greatest but yet unrealized risk for Utah lies in population migration into and within the State. The adage often used in science courses like physiology is where one learns “Where sodium goes water follows” might be more aptly be coined in the context of climate change: “Where water goes people follow.” So, if northern Utah is becoming wetter while other areas like the southwest are becoming drier, then it is likely that there will be judicious movements of population coupled to and with other economic factors. While such a scenario has not yet been realized Utah population is already increasing through other dynamics with the concomitant demands for water resources.

The “U.N. is warning the world could suffer a 40% shortfall in water by 2030 unless countries dramatically change their use of the resource. Many underground water reserves are already running low, while rainfall patterns are predicted to become more erratic with climate change.” While Utah may

be more resilient compared to other parts of the world it is still beholden of us that we have every reason to expect and prepare for shifting supply (climate change) and demand (population increase).

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Dr. Robert R. Gillies, State Climatologist, Utah Climate Center, Utah State University



Salt Lake City Sunset by Charles Uibel



DISCOVERING OUR LAKE

STRIKING A BALANCE ON THE GREAT SALT LAKE

INFRASTRUCTURE AND ECOLOGICAL CONSIDERATIONS



Removal of the southern access road to open the bridge, December 1, 2016 – photo courtesy of HDR Engineering

For more than 100 years, Union Pacific's 22-mile causeway across the Great Salt Lake has influenced one of the world's most ecologically unique bodies of water. Built in 1902 and modified in 1957-59 to replace the wooden trestle portion, the rock-filled causeway originally had two 15-foot wide concrete culverts that allowed water, salt and boats to pass between the North and South Arms of the lake. In 1984, the causeway was modified in coordination with the State of Utah to construct a 300-foot bridge opening on the west side of the lake, near Lakeside, UT, to facilitate the exchange of water between the North and South Arms during the historic flooding cycle. In 2016, the causeway was modified again; this time to address changes in the lake bed which caused the culverts to fail.

Diving inspectors reported cracks in the side walls of both culverts directly under the tracks in 2011. "We determined in 2012 that it was not safe to operate trains across the west culvert, because it could collapse and take the track out of service," said Mark McCune, retired Union Pacific Railroad structures engineer, who worked on engineering aspects of the causeway project for several years. The cracks were caused by uneven sinking of the causeway fill, which settled 15 feet below its original construction level. Because the causeway is situated between two faults in the earth's crust, the layer of earth just below the bottom of the lake had fallen away, leaving a gap filled with a primordial pudding made of loose silt, ooze and biological deposits from dead

brine shrimp. "The culverts were slowly sinking and bending into the gap," McCune said. "Imagine taking a stick and bending it in your hands. Eventually it will snap." These safety concerns regarding the integrity of the two concrete culverts required Union Pacific and regulating authorities to seek an infrastructure and ecological solution. Union Pacific proposed to construct a new bridge that would duplicate the water and salt transfer function of the culverts, and allow the failing culverts to be stabilized, ensuring safe rail passage across the lake.

As Union Pacific began to evaluate the process of determining the optimal bridge span size to duplicate the water and salt transfer function of the culverts (and accommodate varying lake levels), a team of water quality and lake experts came together. Union Pacific looked to Kidd Waddell, retired U.S. Geological Survey (USGS) hydrologic modeler, and Dr. Wally Gwynn, retired Utah State Mineralogist. The team and regulating agencies determined what models to use in order to compare the water and salt exchange between arms under existing culvert conditions to lake conditions with the proposed bridge conditions. The USGS 1998 Great Salt Lake and Salt Balance Model fit the bill. "When Union Pacific was ready to do computer modeling for a new causeway bridge, they asked if I would help update the model," Waddell said. The computer model replicates the Great Salt Lake's bi-directional flow – the water flowing from both directions (more saline from the north, less saline from the south). "The computer model describes these bi-directional flows, along with the lake's physical properties," Waddell said. "The model allowed us to determine what bridge width and depth would duplicate the amount of water and salt transfer the culverts provided."

Updates and modifications to the model – including recalibrations to account for inflows, outflows and salinity between 1987 and 2012 – allowed Union Pacific to develop three long-term hydrologic scenarios for wet, mild and dry climate cycles. The use of the model provided Union Pacific, regulators and stakeholders a new understanding of the complex hydrodynamics of water and salt transfer through the causeway and made the updated model an innovative and irreplaceable tool. Union Pacific's modifications to the USGS hydrodynamic model and results were peer-reviewed by USGS and Utah Division of Water Quality.

After initial analysis, a proposal for a 150-foot bridge that was 28-feet deep was suggested. However, concern surfaced that once built within the causeway, the bridge could not



be modified, and that permitting requirements of adaptive management of flows through the causeway opening remained outstanding. Union Pacific and the state and federal regulators evaluated options to provide variable flows through the causeway opening. Their conclusion, a 180-foot bridge with a depth of about 35 feet would be constructed along with an earthen control berm to the north of the bridge, and an excavated south channel.

The earthen control berm would be built to constrict the larger bridge opening to the optimal bridge size of 150-foot wide and about 28-feet deep. During the adaptive management phase, the control berm can be increased or decreased in size and shape, effectively increasing or decreasing the water and salt transferred through the opening, thereby meeting the adaptive management intent of the regulations. Sarah Null, assistant professor of watershed sciences at Utah State University, thought the proposed bridge project was a perfect opportunity to conduct a study of her own. "A third party hadn't done any research on what the various bridges Union Pacific proposed would mean for the lake," Null said. Null also used the USGS model to conduct her independent study. "The berms are very progressive," Null said. "They can be built up or removed. This solution is adaptive. In 20 years, if we decide something's not quite right, or ecosystems are declining, there's something we can do to manage salt transfer. It's an innovative and elegant solution."

The project, consisting of a bridge, control berm and excavated channel, was permitted in September 2015 by the US Army Corps of Engineers and Utah Division of Water Quality. With permits issued, construction began in October 2015, the bridge was opened on December 1, 2016, and construction was complete by the end of 2016.

Rail traffic continued east and west across the causeway during construction. Construction activities were closely coordinated with Union Pacific operations to ensure the safety of all involved. To safely accommodate existing rail traffic, the bridge was constructed in phases that included building access roads, realigning rail, completing the bridge, and transferring the access road from the south side of the rail to the north side along the newly constructed bridge. The bridge consists of six 30-foot spans, supported on forty nine 24-inch piles. As with any project, there were construction delays. Among those delays, the piles had to be driven deeper than originally planned to reach adequate resistance, and rail cars that had been buried in the causeway had to be excavated.

The earthen control berm was constructed with quarried rock and protected from wave erosion with a layer of 4-foot diameter rip rap material. The southern excavated channel

extends 300 feet to the south, allowing the heavier Northern Arm brines to flow unrestricted into the South Arm. The final construction activity removed the access road and allows open water flow between the North and South Arms. Two track hoes, working over a 2-day period, removed about 180 dump truck loads of material to breach the causeway. The infrastructure project now moves into a 5-year monitoring phase, where lake salinities and flows through the causeway opening will be measured and compared to project performance standards. In addition, agreements are being developed to allow the designated lake management agency, Forestry, Fire and State Lands, to modify the control berm for lake management purposes, after the 5-year monitoring phase, if they choose.

Completion of the causeway opening marks a renewed cooperative effort among Union Pacific, regulatory authorities, and stakeholders in the Great Salt Lake's ecosystem to protect and preserve the extraordinary assets, while delivering continued safe intercontinental rail passage.

More information, videos and photos of the breach can be found at the following link: http://www.up.com/aboutup/community/inside_track/causeway-6-14-2016

Footnote:

As of January 7, 2017, about 5 weeks after the bridge was opened, the USGS lake monitoring gages report North Arm has risen about 1.8 feet (22 inches) and the South Arm has dropped about 0.3 feet (4 inches). The USGS measured the south to north flow through the opening one week after the opening and reported an average flow rate of about 4,700 cubic feet per second (https://waterdata.usgs.gov/nwis/measurements/?site_no=10010025).

At the time of measurement, there was no flow from the North Arm to the South Arm (https://waterdata.usgs.gov/nwis/measurements/?site_no=10010026).

Karen Nichols, HDR Engineering
Nathan Anderson, Union Pacific Railroad



Flow through the control berm, looking north.
December 2016 –photo courtesy of HDR Engineering





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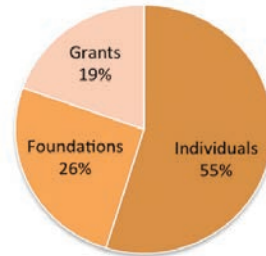
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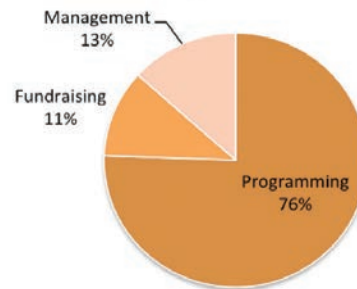
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The first recorded mention of Great Salt Lake was in what year?

Answer: 1776 when Dominguez & Escalante were told by the Timpianogoes Utes.



Lady of the Lake

Cory C. Dangerfield

Submitted for the 2015 Alfred Lambourne Prize





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