2023 REPORT TO THE
GOVERNOR AND LEGISLATURE ON

Utah's LAND, WATER & AIR

Janet Quinney Lawson
Institute for Land, Water & Air
UtahStateUniversity®

COVER: *SPRING ON THE ISLAND | ANTELOPE ISLAND STATE PARK | DAVIS COUNTY*
THIS PAGE: *RED ROCK SILHOUETTES | ARCHES NATIONAL PARK | GRAND COUNTY*

Janet Quinney Lawson
Institute for Land, Water & Air
UtahStateUniversity

Utah State University and the Janet Quinney Lawson Institute for Land, Water, and Air will focus on convening the right stakeholders to research, to study, and to better understand daunting challenges facing Utah. We welcome the input and partnership with local government policymakers, state agencies, nonprofits, elected officials, and our colleagues at other institutions of higher education. Together, in a collaborative approach, Utah can position itself to best address these complicated problems.

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As Utah's land-grant institution, Utah State University (USU) has deep responsibility for serving the needs of Utah. I have very recently assumed the role of president of Utah State University, and I take very seriously USU's unique mission in solving Utah's problems. In a time marked by significant uncertainty, understanding and preparing for changes over the next two, three, or five decades is a central challenge.

Issues such as population growth, demographic changes, the effects of climate change and the overall need for Utah to be resilient into the future are among the critical concerns that we at USU feel compelled to address. To ensure continued prosperity, it is imperative that we arm Utah with the most reliable data and insights to inform decisions related to land, water, and air.

USU remains committed to our mission of service to the state and its communities. Collaboration with state leadership—including Utah legislators, policymakers, and community stakeholders—is integral to our approach. We are dedicated not only to addressing the most pressing issues of today but also to adapting to the evolving needs of our communities.

The Janet Quinney Lawson Institute for Land, Water, and Air exemplifies our land-grant mission. Our diverse team of researchers, drawn from every college within USU and across our statewide campuses, is deeply engaged in addressing the challenges associated with land, water, and air in Utah. In this report, we are pleased to share insights from 36 of these researchers, whose work spans a wide range of topics, from wildfire risk mitigation to residential water efficiency, and from the intricacies of Great Salt Lake dust to Uinta Basin ozone levels. By providing this knowledge, we aim to equip policymakers with the information necessary for making informed decisions that impact all Utahns.

Research plays a pivotal role in shaping the future of our land, water, and air. We seek your continued support for these vital efforts, with the hope of collaborating further to find innovative solutions and ensure a sustainable future for Utah.

Thank you for your dedication to Utah and its residents.

ELIZABETH CANTWELL

President
Utah State University

During the 1787 Constitutional Convention of the nascent United States, George Washington used an ornate wooden chair with a half sun carved in its back. Benjamin Franklin observed this chair during the signing of the Constitution. He said, "I have often... looked at that without being able to tell whether it was rising or setting: but now at length I have the happiness to know that it is rising and not a setting Sun."

The picture on the previous page showcases iconic shapes of Arches National Park. As I looked at the picture, I wondered out loud whether the photo was of the sun rising or setting over Utah's land, water, and air.

As anyone who is paying attention knows, we have challenges. Some may even say the sun is setting on our state's and nation's prosperity. Despite a historic snow year, water quantity and quality remain a top issue for many Utahns. Air quality raises concerns in many parts of the state. Disputes over land access and use serve as frequent sources of conflict statewide.

I've helmed natural resources at the national and state levels, and I've led the Janet Quinney Lawson Institute for Land, Water, and Air for a little over a year. I can tell you that the issues facing our shared resources are daunting, but they are also solvable. Our ability to collectively rise to address some of our greatest world challenges should hearten us all.

Over the past few years, Utahns have shown that they can adapt. Nowhere is this more apparent than the response Utahns have given to the drought in 2022. Utahns used less water in that year. They prioritized saving the Great Salt Lake and Colorado River. They, through the legislature and Governor, invested over a billion dollars in conservation efforts. These are not trivial actions. And so, while there is always cause for concern, there is also great cause for optimism.

The Janet Quinney Lawson Institute of Land, Water, and Air is based on the premise that when we know better, we can do better. This report is designed to help all of us "know better." By understanding more of the nuances of Utah's unique landscapes, geography, resources, and challenges, all of us, especially those of us who make decisions for our state, can make wiser choices.

In that spirit, I am pleased to present the *2023 Report to the Governor and Legislature on Utah's Land, Water, and Air*. After reading through the findings in this report, and the way our USU researchers, state agencies, and policymakers are working to meet these challenges, I can tell you—the sun is rising. (And, in the photo, it actually is.)

BRIAN STEED

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EXEC SUMMARY *of the research*

This report serves as a 2023 snapshot of key issues and concerns with Utah's shared resources. It highlights gathered data that is available to provide context to these issues, as well as identifies areas where more study is needed. Addressing these challenges will enable Utah policymakers to make informed decisions for the future. Under the authorship of 43 researchers and experts and the general guidance of 49 advisory committee members, the report outlines 32 issues and trends to pay attention to in the coming months and years. They include:

Introduction

How policymakers are addressing Utahns' environmental concerns
Utahns are very concerned about environmental issues such as drought and air quality but think policymakers could do more to address them.

Chapter 1: Land

1.A Protecting Utah's rangelands from adverse impacts of wildfire
Carefully selected fuels-reduction practices can lessen the impact of wildfire on Utah's rangelands.

1.B Canal trails for irrigation and active transportation
Trails associated with canals can be a win-win solution by promoting healthy transportation and conserving water.

1.C Understanding the potential costs of buy-and-dry
Examining the limitations of water markets in adapting to changing water availability can help us understand their potential role in addressing growth and climate variability.

1.D Balancing healthy ecosystems in Utah drilling areas
A new strategy offers a way to reduce potential conflict between conservation and development priorities on the Colorado Plateau by helping managers optimize decisions on the placement of infrastructure to minimize impacts on rare plants.

1.E Biochar offers a low-tech tool to aid in Utah's waste wood dilemma
The simple process of biochar production has significant potential toward managing waste wood on Utah lands, benefiting soils, and reducing the amount of carbon added to the atmosphere from wildfire and natural decay.

1.F Utah's agricultural future reflected from heritage
Utah's agricultural legacy, rooted in the diligence of pioneers, continues to thrive through modern sustainability practices, emphasizing the enduring importance of local food production while balancing environmental stewardship and economic stability.

LEFT: SPRING IN ASHLEY NATIONAL FOREST | UINTA COUNTY

EXECUTIVE SUMMARY (CONTINUED)

Chapter 2: Water

2.A Water shepherding: delivering saved water to Great Salt Lake
Water conservation could benefit the Great Salt Lake if the water is carefully measured and tracked through rivers, canals, and other water pathways within the basin—a practice that will require adequate measurement and real-time information sharing.

2.B Variability in Utah's residential water use
Residential water use is highly variable both across households and across time. Our assumptions about and focus on per capita water use do not account for this.

2.C A changing summertime climate-Implications for Utah's water
An expanding and increasingly hotter warm season, coupled with a more variable monsoon seasonality, is stressing Utah's water supply.

2.D Managing Utah's diverse groundwater basins
Understanding groundwater is key to managing Utah's limited water resource.

2.E Tracking Utah's "virtual water" trade
Traded products add new dimensions to Utah's water balance sheet. Understanding all water gains and losses can help manage the system more efficiently.

2.F Integrated water planning in the Great Salt Lake Basin
Ensuring a resilient water supply for Great Salt Lake and water users throughout the basin.

Chapter 3: Air

3.A Progress and problems with northern Utah's PM2.5
Even with inversion episodes in 2023, northern Utah appears to have reached EPA "attainment" status for its airsheds.

3.B How Great Salt Lake dust affects Utah's PM10 levels
Dust pollution could become a larger problem as the Great Salt Lake's playa gets drier.

3.C Uinta Basin ozone returns in a snowy winter
Winter ozone has declined over the past decade, but increased oil and gas activity, combined with unprecedented snow cover and inversions, led to a spike in high ozone this winter.

3.D Air quality advisories may not have the desired impact on reducing vehicle emissions
Issuing "yellow air day" advisories in northern Utah did not reduce vehicle trips or help reduce poor air quality during winter inversions.

3.E Seasonal temperature trends
While the 2022-2023 winter was colder than average, it was not enough to break the trend of rising winter temperatures in Utah.

3.F Reducing air toxins through smarter pesticide management
A new tool provides guidance for optimal application of insecticides and other chemicals.

3.G Determining the threat of halogens on the Wasatch Front
A new study will inventory halogen emissions and ambient concentrations.

Chapter 4: Colorado River

4.A Decisions that lie ahead for the Colorado River
Despite a very wet winter, the best option for sustainable use and management of the Colorado River, and for the stability of Utah's growing communities, is to focus on significant reductions in consumptive use.

4.B Can we rely on drought-busting "miracles" in the Colorado River Basin?
The frequency and intensity of drought-busting spring precipitation in the Colorado River Basin may decrease due to climate change, impacting water management strategies.

4.C Irrigation optimization and agriculture's future in the Colorado River Basin
The Colorado River is vital to Utah food production and can thrive through strategic water optimization, deficit irrigation, and fallowing.

4.D Drought and water access heavily impact tribal economies
Drought negatively impacts cattle and forage production on tribal lands, affecting economies and necessitating policies that support Native American communities' resilience.

4.E The future of outdoor recreation on the Colorado River
The trend toward an increasingly dry climate has practical and economic impacts for recreation hubs on the Colorado River.

4.F Managing Lake Powell's water level requires constant attention
The Drought Response Operations Agreement (DROA) released approximately 580 thousand acre-feet of water from Flaming Gorge to Lake Powell in 2021 and 2022. Water managers should be careful to ensure such transfers don't incentivize further releases from Lake Powell to the Lower Basin.

Chapter 5: Energy

5.A A team to chart Utah's energy future
The Energy Strike Team's collaborative efforts are shaping a sustainable and diverse energy future for Utah, addressing critical issues from resource diversification to workforce development.

5.B Charged perspectives on solar projects in Utah
Managing the political hot potato of expanding solar PV projects on Utah farms can be improved by understanding growers' opinions, particularly related to fair water policy.

5.C Benefits and barriers to moving toward net-100% renewable electricity
With a coalition of Utah communities committed to moving to net-100% renewable electricity by 2030, USU researchers are examining barriers and finding opportunities in the strategy.

5.D Creating a strategy for smart electrified transportation in Utah
Freight transport creates significant challenges to moving more fully to electrified vehicles. Advances in batteries and charging infrastructure can help address these problems.

5.E A clean, secure energy transition needs Utah's critical minerals
Mineral extraction and clean energy development require striking a delicate balance.

5.F Extractive industries and Utah's economy
Utah's extractive industries encompass a wide range of raw material extraction processes, presenting challenges in quantifying their overall economic impact, but they play a significant role in the state's economy.

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LAZY MORNING CATTLE | CACHE COUNTY

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RIGHT: *YUCCA IN WHITE ROCKS | SNOW CANYON STATE PARK*

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LOW CLOUDS ON FARMLAND | CACHE COUNTY

LAND, WATER & AIR *in the news*

This year, the Janet Quinney Lawson Institute for Land, Water, and Air worked to share a broader picture of land, water, and air in Utah, which included efforts to track and share news and media. We've included a 2023 summary page at the end of each chapter, and here are some of our most-viewed stories from each week:

January

01/09 New renewable energy project in Utah to benefit the entire world. (Utah Stories)

01/17 Multiple legal battles and concerns about the ecological impact surround the proposed Utah Lake islands. (The Salt Lake Tribune)

01/24 What do the data say about thinning trees to increase water supply? (Journal of Forestry)

01/31 Opinion: Chopping trees won't save the Great Salt Lake—but it may cause larger problems. (Deseret News)

February

02/07 Opinion: The Great Salt Lake can be saved. This is how we do it. (Deseret News)

02/14 Utah Division of Wildlife Resources Valentines. (UDWR)

02/21 How does a drying Great Salt Lake affect carbon cycling? (Phys.org)

02/28 Bear Lake is a well-loved Utah tourist gem. A state lawmaker wants to know if the lake is being loved to death. (The Salt Lake Tribune)

March

03/07 2023 Utah Legislative General Session natural resource bills passed. (USU ILWA)

03/14 Utah farmers gain more flexibility with water rights under proposed bill. (KSL News Radio)

03/21 State of Utah snow water equivalent chart (USDA.gov).

03/28 Utah Legislature gave $1 million to implement "roller felling" in some areas. (The Salt Lake Tribune)

April

04/04 Opinion: We need to love the Great Salt Lake to save it. (The New York Times)

04/12 Idaho legislature has taken initiative to preserve Bear Lake for future generations with a new protective bill. (Cache Valley Daily)

04/19 Officials from the Utah Department of Agriculture discussed their goals for the future and the state programs that can provide funding to farmers. (Herald Journal)

04/25 A bipartisan bill has been introduced to provide funding for farmers in drought-prone areas of the US West to implement water-saving technologies and practices. (The Hill)

May

05/02 Video: Cache Valley residents, along with Utah State students and professors, discuss land, water, and air concerns in the valley. (Aggie TV News)

05/09 Water in the Great Salt Lake spills over the emergency berm. (FOX 13)

05/16 Satellite photos show the Colorado River before and after the Bureau of Reclamation released a huge outflow of water from the Glen Canyon dam. (Newsweek)

05/24 Interactive: See how the Colorado River water is being used. (The New York Times)

05/31 California emerges as big winner in Colorado River water deal. (The Los Angeles Times)

June

06/07 Opinion: Speaker Wilson shares his perspectives on the relationship between Utah's farmers and the state's water needs. (Deseret News)

06/13 Opponents of a proposed mine in Parleys Canyon worry about air quality and potential health impacts. (The Salt Lake Tribune)

06/21 Video: 2022 was the dustiest year on record, with nearly 25% of that dust coming from the Great Salt Lake. (ABC 4)

06/27 Because of overuse of water and climate change, the Great Salt Lake is drying up—and the Church of Jesus Christ of Latter-day Saints is taking on an unusually public role to help save it. (The Washington Post)

July

07/05 The Great Salt Lake commissioner intends to seek input from all stakeholders, including environmental and tribal groups, agriculture producers and industries. (FOX 13)

07/12 A quiet piece of legislation has made it so cities cannot make rules about the design elements of new housing developments. (St. George News)

07/18 A small group of experienced climbers in southern Utah found a burning wildfire and helped prevent a potential major disaster. (St. George News)

07/26 Tribal leaders request Biden create a new monument near Grand Canyon, to the dismay of some Southern Utah towns. (St. George News)

August

08/01 Above-average snowpack and strong spring rains have led to a rise in river deaths on Colorado's waterways. (The Durango Herald)

08/08 Video: Satellite images captured the dramatic 43-foot rise of Lake Powell's water level this summer. (ABC 4)

08/15 The Spiral Jetty rock art formation is a representation of the Great Salt Lake's struggling ecosystem. (The Atlantic)

08/22 The severe drought conditions around Lake Mead have revealed the Latter-day Saint ghost town of St. Thomas. (Deseret News)

08/29 The BLM recently adapted its definition of non-motorized vehicles to allow e-bikes on more trails. (St. George News)

September

09/06 As summer turns to fall, southern Utah reservoir levels are expected to be lower. (St. George News)

09/12 A coalition of environmental organizations have filed suit against the state of Utah regarding the Great Salt Lake. (FOX 13)

09/21 The Colorado River isn't just managed to accommodate people—endangered wildlife species are being considered as well. (8 News Las Vegas)

09/27 Utah clarifies the difference between e-bikes and e-motorcycles on public lands amid 'confusion.' (KSL.com)

What's going on in Utah's land, water and air?

We began publishing a weekly email newsletter, containing a roundup of stories in the media related to Utah's land, water, and air. We shared nearly 2,000 stories, mostly from local media, but we included stories from national outlets as well. Read our report and subscribe to our weekly email news roundup at: **usu.edu/ilwa/newsletter**.

SUMMER BLOOMS | WHITE PINE LAKE | CACHE COUNTY

UTAH'S ENVIRONMENT *by JENNIFER GIVENS and JESSICA SCHAD*

Introduction
How policymakers are addressing Utahns' environmental concerns

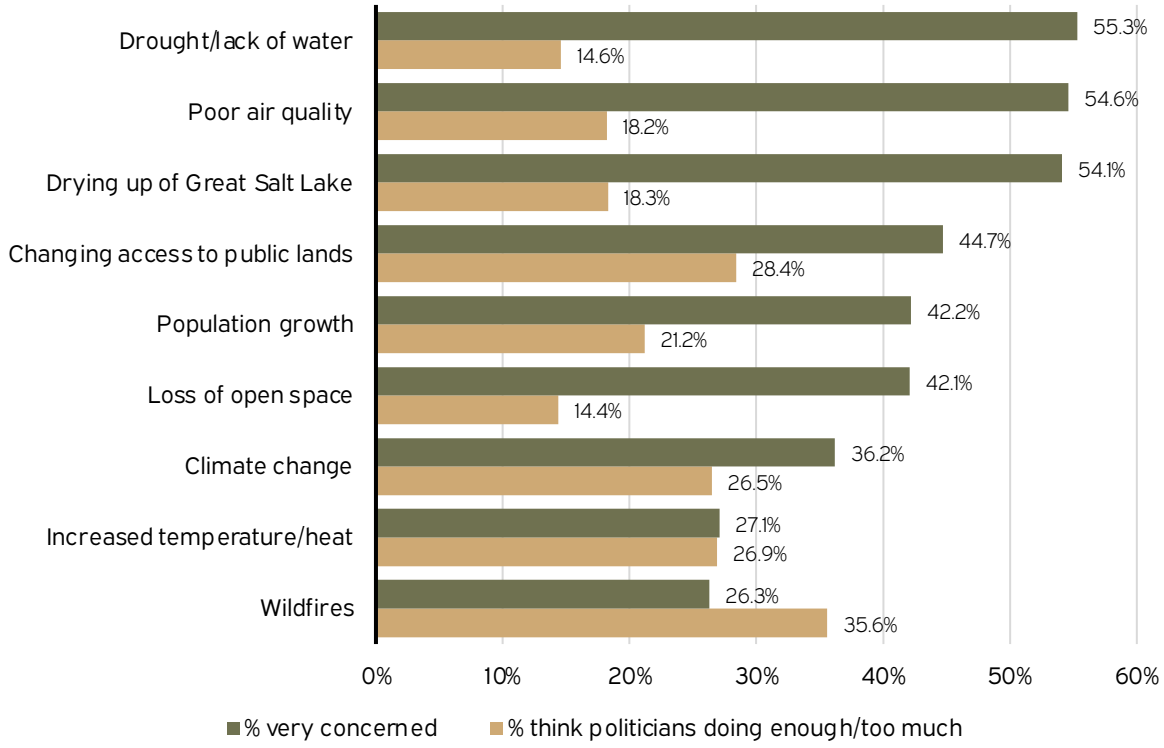
TAKEAWAY» **Utahns are very concerned about environmental issues such as drought and air quality but think policymakers could do more to address them.**

In the spring of 2023, an interdisciplinary group of USU faculty and graduate students started the Utah People and Environment Poll, or UPEP, to gather representative infomation on Utahns' perceptions of environmental issues to help inform policy.

Residents from across the state were randomly selected to participate in the survey, conducted by mail and online, with nearly 450 sharing their thoughts.

The survey asked respondents their thoughts on nine environmental issues in the state. More than half of the respondents are very concerned about drought/lack of water, poor air quality, and the drying of Great Salt Lake. About four in 10 are also very concerned about changing access to public lands, population growth, loss of open space, and climate change. Approximately three in 10 are very concerned about increased temperature/heat and wildfires. Only a small

Figure I.1 Utahns' perception of environmental issues in Utah (2023)



In spring 2023, a random sample of Utahns (450 respondents) shared their level of concern on nine environmental issues in the state. ***Source****: Utah People and Environment Poll*

percentage said they are not concerned at all about these issues.

We also asked if respondents think politicians and policymakers in Utah are doing enough to address these issues—few did. The biggest gap between concern and policy is with drought/lack of water—55% are very concerned about this issue, yet only 15% think politicians are doing enough or too much. This data clearly indicates that many Utah residents would like to see their leaders enact additional policies to address environmental issues..

MORE THAN HALF OF THE RESPONDENTS ARE VERY CONCERNED ABOUT DROUGHT/LACK OF WATER, POOR AIR QUALITY, AND THE DRYING OF GREAT SALT LAKE.

LEFT*: SPRING ON THE ISLAND / ANTELOPE ISLAND STATE PARK / DAVIS COUNTY*

Chapter 1

LAND

Key issues facing Utah's land

1.A PROTECTING UTAH'S RANGELANDS FROM ADVERSE IMPACTS OF WILDFIRE

1.B CANAL TRAILS FOR IRRIGATION AND ACTIVE TRANSPORTATION

1.C UNDERSTANDING THE POTENTIAL COSTS OF BUY-AND-DRY

1.D BALANCING HEALTHY ECOSYSTEMS IN UTAH DRILLING AREAS

1.E BIOCHAR OFFERS A LOW-TECH TOOL TO AID IN UTAH'S WASTE WOOD DILEMMA

1.F UTAH'S AGRICULTURAL FUTURE REFLECTED FROM HERITAGE

Chapter Summary by BRIAN STEED

Over past decades, our relationship with the land has been changing. As Utah has become increasingly urbanized, with demographic trends indicating a sustained move away from rural/agricultural life, our attitudes and opinions about management of Utah's lands have become more diverse.

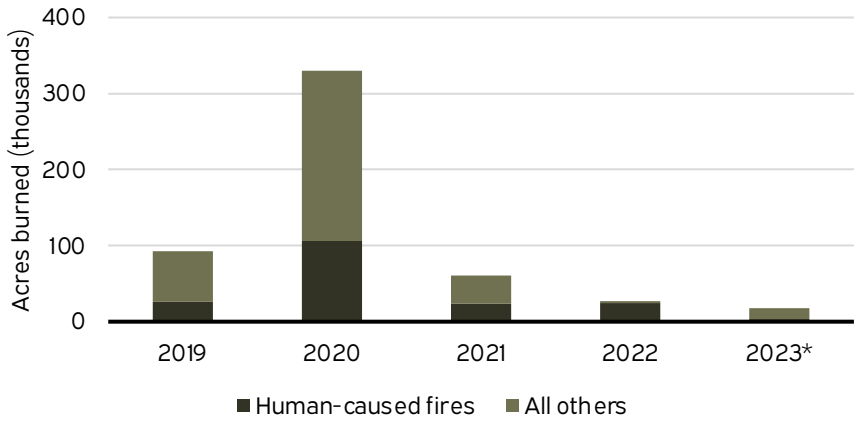
Many in our state treasure landscapes more for their ecological and recreational amenities than for their raw natural resource benefits. Agriculture is still highly valued but is often praised equally as a source of open space, as well as its economic importance. These changes create interesting management challenges.

One example of of a land management challenge is our efforts in wildfire mitigation. Over the last five years, we've been largely spared from disaster fires, but it could take significant mangagement of our open spaces to maintain that trend.

Local populations away from the urban centers often feel like they do not have sufficient influence over the decisions made by the state or federal government impacting the landscapes in their regions. Similarly, local economic needs are often much more reliant on actively using the land, rather than recreating on or occasionally visiting it.

As we make land-use decisions, we must understand these differing viewpoints and trade-offs. When it comes to wildfire, extractive industry, and urban community management, among other issues, we can work to create solutions that maximize benefits from the things we value most. In the following sections, we explore some of the recent insights on how we can improve landscape conditions, increase recreational opportunities, and allow continued, yet wiser, resource use across Utah.

Figure 1.1.1 Acres burned by wildfire in Utah (2019-2023)



Source: *National Interagency Coordination Center, Utah Fire Info *2023 provisional numbers*

SNOW CANYON STATE PARK | WASHINGTON COUNTY

RANGELAND

by MARK BRUNSON and EUGENE SCHUPP

1.A Protecting Utah's rangelands from adverse impacts of wildfire

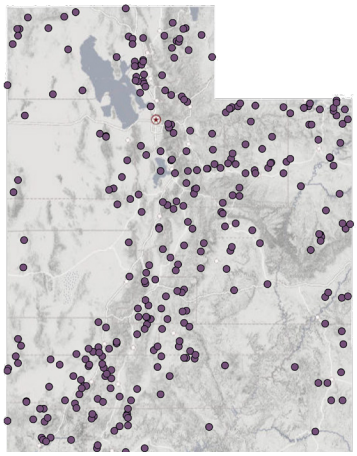
TAKEAWAY» **Carefully selected fuels-reduction practices can lessen the impact of wildfire on Utah's rangelands.**

In Utah's west desert, weedy Eurasian grasses such as cheatgrass and expanding pinyon-juniper woodlands are displacing native sagebrush, bunchgrasses, and wildflowers. As a result, wildfires are much more common, sometimes burning thousands of acres, threatening ranching livelihoods, rural communities, water and air quality, and recreational opportunities.

Fires are inevitable in an arid landscape with summer lightning storms and growing recreation use. As part of the Sagebrush Steppe Treatment Evaluation Project (SageSTEP), Utah State University is helping land managers find tools to protect rangelands and people from wildfire's worst impacts with the fewest unintended negative consequences. Student crews from USU and the U.S. Geological Survey gather data annually from a network of 21 experimental sites across the Great Basin region from Beaver, Millard, and Tooele counties to eastern Oregon and Washington. At each site, experiments were created to understand both positive and negative effects over time of proactive practices such as herbicide spraying, mowing, tree removal, and prescribed burning to reduce the fuels that feed rangeland fires.

NATIVE SAGEBRUSH | RICH COUNTY

Figure 1.A.1 Current terrestrial treatment areas with Utah's Watershed Restoration Initiative



Source: *wri.utah.gov*

Table 1.A.1 Remedies for pinyon and juniper tree expansion in the Great Basin

In the past 100 years, pinyon and juniper trees have expanded their historic range, partly because wildfires have been suppressed, and partly because there are fewer grasses to carry fire between trees because of grazing. These trees are using more water, out-competing other plants, and changing the ecosystem, leading to some fairly serious consequences. The following table outlines the impacts of three management remedies.

PRESCRIBED FIRE	CUTTING	SHREDDING
Prescribed fire reduces both trees and shrubs. Areas treated with prescribed fire have lower shrub cover than those treated with cutting or shredding even six years after treatment.	Clearcutting uses chainsaws to cut trees taller than half meter, and leaves them where they fall. It can reduce tree cover to less than one percent of what it was before treatment.	During mastication, live trees are shredded with a spiked, rotating drum attached to a tractor. It can be done any time the soil is dry enough to avoid excessive compaction.
Prescribed fire, and mechanical treatments like cutting and shredding, reduce the number of encroached trees. This increases the time that soil water is available to other plants in the spring, which increases grass and shrub growth and cover. Water and available nutrients become available to both desirable native grasses and unwanted weeds like cheatgrass.		
Prescribed fire removes live trees and consumes much of the wood on the ground, allowing later wildfires to be less intense and less severe.	Cutting and shredding are more flexible, more controlled, and less risky than prescribed fire. They reduce canopy fuels and allow easier wildfire suppression, and can be done any time of year, as long as the ground is not too wet.	
Prescribed fire causes short-term increases in runoff and soil erosion. But this should be evaluated in the context of the big picture–avoiding more serious consequences of encroachment and wildfire.	Mechanical treatments like cutting typically double or triple the amount of small down wood that could burn during a wildfire, particularly in older woodland stands.	Shredding produces mulch that can increase water infiltration rates and reduces erosion. Shredding also aids in wildfire suppression by bringing the fire from tree tops to the ground.
Warm and dry sites are not well-suited to prescribed fire, especially if native grasses are missing from the understory	The burnable mulch left after shredding and the downed wood from cutting can increase the risk of high-temperature ground fires, which may damage desirable plants and seeds by causing the fire on the ground to burn hotter and longer.	
Treatment of any kind increases burnable grass fuels, especially in older stands, probably because the removal of woody vegetation results in an increase in soil water during the growing season, which can be captured by grasses and flowering plants like forbs as they grow to re-claim the site.		
To best maintain and increase cover, sites should be treated before the encroaching tree cover approaches 20% (to maintain shrubs) or 45% (to maintain grasses and forbs). These sites will have more surviving native plants at the onset, which will help prevent a cheatgrass invasion later.		

Source: sagestep.org

The emerging results are complex, and the best management for a site depends on the current make-up of the vegetation, elevation, and other factors. By applying study findings to their specific circumstances, land managers can create a landscape more resistant to weed invasion and more resilient after a wildfire. Since 2006, SageSTEP scientists have informed management strategies used by the U.S. Forest Service and Bureau of Land Management in sagebrush rangelands. Research has also helped to set guidelines for selecting the right treatment at a given site and is used regularly to guide the work of organizations such as Utah's groundbreaking Watershed Restoration Initiative.

RESIDENTIAL LAND

by PATRICK SINGLETON and ALFONSO TORRES-RUA

1.B Canal trails for irrigation and active transportation

TAKEAWAY» **Trails associated with canals can be a win-win solution by promoting healthy transportation and conserving water.**

Community planners have increasingly been asked to provide additional active transportation options. Siting trails is often very complicated. Irrigation canals offer unique opportunities for connecting communities with walking and bicycling trails. Canal trails encourage physically-active transportation and outdoor recreation and are especially relevant given the 2023 passage of S.B. 185, a transportation amendments bill that established the Active Transportation Investment Fund and authorized a statewide trail network for walking and bicycling between communities.

Some trails are next to an open channel, and others are above an enclosed canal. Covering a canal conserves water by reducing seepage and evaporation. It also improves water quality and lowers maintenance costs. Although enclosure is expensive, several state and federal funding programs are available. Some funding sources prioritize projects with recreational trails.

Trails offer many co-benefits for canal operators. They may help with maintenance (trash and weeds), community policing, and documenting/preserving the right-of-way. Of course, there are challenges to overcome, including gaining approval from landowners, limiting legal liability, ensuring canal maintenance can occur, designing safe street crossings, and addressing privacy concerns. Luckily, there are many case studies on how canal trails can be successfully built and operated in Utah.

Utah's nearly two-dozen canal trails come in all shapes and sizes, from the hugely popular Murdock Canal Trail covering 17 miles through Utah County, to the quarter-mile trail along the "Kids Canal" in Vernal.

Table 1.B.1 Canal trails in Utah (June 2021)

CANAL TRAIL	TRAIL SPONSOR	CANAL
Smithfield Canal Trail	Smithfield City	Logan, Hyde Park, Smithfield Canal (Cache Highline)
Lundstrom Park and Highline Canal Trails	Logan City	Logan, Hyde Park, Smithfield Canal (Cache Highline)
North Ogden Parkway	North Ogden City	Ogden-Brigham Canal
West Haven Canal Trail	West Haven City	Wilson Canal (South Branch)
Clearfield Canal Trail	Clearfield City	Davis and Weber Canal
200 South Trail	Clearfield/Syracuse	Clearfield Irrigation Company
Clinton Canal Trail	Clinton City	Clinton Creek (Drain)
Onion Parkway Trail	West Bountiful	DSB Canal Drain
Redwood Trail	Salt Lake County	Brighton North Point Canal
Utah & Salt Lake Canal Trail	Salt Lake County	Utah & Salt Lake Canal
Phebe Brown Trail	Draper City	East Jordan Canal
Oquirrh Mountain Trail	South Jordan City	Welby Jacob Canal
Draper - Sandy Canal Trail	Draper/Sandy	Former Draper-Sandy Canal
Canal Trail	Sandy City	East Jordan Canal
Murray Canal Trail	Murray City	Jordan and Salt Lake Canal
Jacob Canal Trail	Saratoga Springs	Welby Jacob Canal (South)
Murdock Canal Trail	Utah County	Murdock Canal
Mapleton Lateral Canal Trail	Mapleton City	Mapleton Lateral Canal
Kids Canal Trail	Vernal City	Ashley Central Canal

AGRICULTURAL LAND *by SHERZOD B. AKHUNDJANOV*

1.C Understanding the potential costs of buy-and-dry

TAKEAWAY» **Examining the limitations of water markets in adapting to changing water availability can help us understand their potential role in addressing growth and climate variability.**

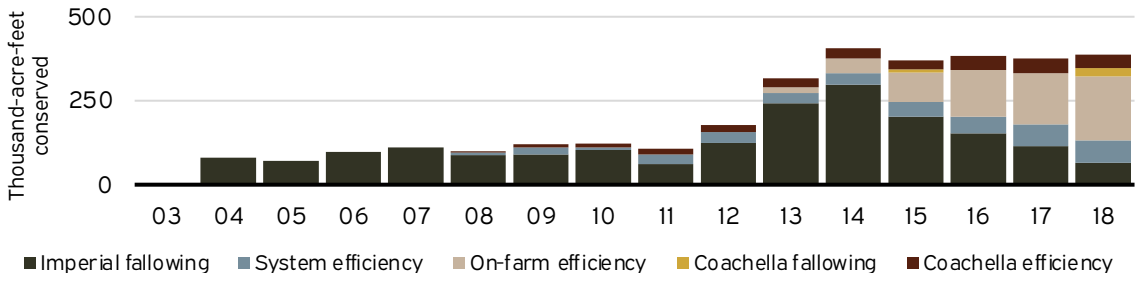
Growing urban populations and shifting climatic patterns drive the need for flexible use of markets to reallocate water in arid regions. In the American West, like many arid regions, irrigated agriculture accounts for up to 80% of water consumption. Water trading between agriculture, urban, and commercial uses offers large potential gains to both buyers and sellers.

However, local impacts on water-exporting areas are often neglected in economic analyses of water markets. Local opposition to water markets has historically been strong, focusing on potential job losses and limits on future economic development in the originating region. Water transfers have been derisively referred to as "buy-and-dry" due to their perceived fiscal and environmental depletion of the selling regions. These concerns have been expressed as Utah discusses water transfers from agriculture to urban areas or other needs.

Analysis of such water transfers in other areas in the U.S. provide insight to help Utah avoid pitfalls. In looking at the transfer of agricultural irrigation water from Imperial County to urban uses in San Diego County, California, we see immediate loss of harvested acres, declines in agricultural employment, a widening skilled/unskilled work wage gap, and a significant rise in air pollutants (PM_{10} and $PM_{2.5}$) caused by reduced inflows into the Salton Sea—a large terminal saline lake once maintained by return flows from irrigated agriculture. A back-of-the-envelope calculation suggests health costs due to dust are of the same magnitude as the annual revenue of the water sale in some years.

Smoothly operating markets offer significant efficiency advantages over other means of allocation. Our work emphasizes the importance of assessing costs and impacts of environmental and financial externalities associated with market-based resource allocation. Water markets can be designed to maintain ecosystem services and generate gains from trade. Doing so in this case appears to be a more cost-effective approach than a moratorium on transfers.

Figure 1.C.1 Water conservation in the Imperial Irrigation District in California



AGRICULTURE TO URBAN WATER TRANSFER RESULTED IN IMMEDIATE LOSS OF HARVESTED ACRES, DECLINES IN AGRICULTURAL EMPLOYMENT, A WIDENING SKILLED/UNSKILLED WORK WAGE GAP, AND A SIGNIFICANT RISE IN AIR POLLUTANTS.

SOIL TILLING | BOX ELDER COUNTY

Table 1.D.1 Rare plants studied in the Colorado Plateau

Rabbit Valley gilia
Horseshoe milkvetch
Hamilton's milkvetch
Isely's milkvetch
Heliotrope milkvetch
Cisco milkvetch
Oilshale cryptantha
Fragrant cryptantha
Jone's waxydogbane
Maguire's fleabane
Flat-top buckwheat
Uinta Basin waxfruit
Barneby's pepperwood
Trotter's alpineparsley
Despain's pincushion
Winkler's pincushion
White River beardtongue
Flowers' beardtongue
Gibben's beardtongue
Uinta Basin beardtongue

EXTRACTION & LAND

by EDD HAMMILL and THOMAS EDWARDS

1.D Balancing healthy ecosystems in Utah drilling areas

TAKEAWAY» **A new strategy offers a way to reduce potential conflict between conservation and development priorities on the Colorado Plateau by helping managers optimize decisions on the placement of infrastructure to minimize impacts on rare plants.**

The Colorado Plateau hosts unique and valuable resources—a diverse set of extensive oil and gas deposits and rare plant species. As a high-value resource, deposits have spurred significant investment in the region by extractive industries—including 99,000 oil and gas well pads. This infrastructure can create significant impacts on the biodiversity of the area, especially for the 20% of endemic Colorado Plateau species classified as rare.

A new strategy offers a way to reduce potential conflict between conservation and development priorities by helping managers optimize decisions on the placement of infrastructure to minimize impacts on rare plants. The model uses information about existing plant distributions and spatial optimization data to identify defined locations that conserve sufficient habitat for rare plants while still accounting for and minimizing disruption to oil and gas development. With such an approach, it is possible to maintain relatively high levels of plant conservation at a minimal cost to the industry. The model identifies 2% of the total area where effective management could protect 30% of the distribution of all 29 rare plant species. By prioritizing and protecting these ecologically important locations, restoration costs could be kept low while protecting a minimum population of genetically unique rare plants, impacting 522 oil and gas well pads of the 99,000 existing sites (less than 1%) on the Colorado Plateau. No solution can completely meet objectives for both plant conservation and energy extraction, but where there is direct conflict, this model can help land managers accommodate a level of balance.

LEFT: *HIGH-DENSITY DRILLING AREA | CARBON COUNTY ,* ***BELOW:*** *ACTIVE DRILL PAD | CARBON COUNTY*

FORESTED LAND *by DARREN MCAVOY*

1.E Biochar offers a low-tech tool to aid in Utah's waste wood dilemma

TAKEAWAY» **The simple process of biochar production has significant potential toward managing waste wood on Utah lands, benefiting soils, and reducing the amount of carbon added to the atmosphere from wildfire and natural decay.**

As society looks to reduce carbon output, one simple practice offers the dual benefit of capturing carbon and providing a tool for forest managers on Utah's landscapes. Biochar production is the relatively simple process of converting waste wood into a charcoal-like product through low-oxygen burning. If downed wood burns or decays in open air, the carbon contained in that material is added to the carbon load of the atmosphere. But through the biochar process, about one third of that carbon can be preserved and stored in soils for centuries—and can immediately benefit soil productivity and water retention.

Biochar materials are around 85% pure carbon, and can be added to soil to increase plant productivity (in most cases) and significantly increase water holding capacity.

The Utah Biomass Resources Group (UBRG) has taught biochar production through workshops and demonstrations in 10 Utah counties and in four surrounding states over the last decade. The low-tech process of biochar production is possible for anyone who manages Utah's lands—homeowners, farmers, ranchers, or forest managers—and training can help to inform on issues like air quality considerations, permissions, and risks. The entry cost is reasonable, and the process is easy to learn.

UBRG has focused on the on-site production of biochar, and has developed tools like the Big Box biochar kilns. These kilns are purpose-built metal boxes the size of dumpsters that can be used to burn forest waste in a controlled way, and then to completely extinguish the coals with water. While producing biochar is still more expensive than simply burning material in place, its widespread adoption could be a broadly accessible means of working toward a healthier climate and provide another marketable product from forest management.

THIS PROMISING LOW-TECH PRACTICE CAN ACTUALLY REMOVE EXISTING CARBON FROM THE ATMOSPHERE AND STORE IT IN SOILS FOR THE LONG TERM, WHILE ALSO MANAGING FUEL LOADS ON UTAH LANDS.

BIOCHAR PRODUCTION | TOOELE COUNTY (DARREN MCAVOY)

FARMLAND | CACHE COUNTY

AGRICULTURAL LAND

by SPENCER GIBBONS, Utah Farm Bureau

1.F Utah's agricultural future reflected from heritage

TAKEAWAY» **Utah's agricultural legacy, rooted in the diligence of pioneers, continues to thrive through modern sustainability practices, emphasizing the enduring importance of local food production while balancing environmental stewardship and economic stability.**

Utah's agricultural legacy traces its roots back to the pioneers who arrived in the Salt Lake Valley in 1847. These early settlers faced countless challenges, but their determination to till the soil, divert water, and cultivate crops laid the foundation for a robust agricultural industry and thriving Utah communities. Today, while society has evolved, the fundamental need for food production remains a constant, and Utahns recognize the significance of local food sources.

Beyond providing local food, Utah's farmers and ranchers play a multifaceted role in the state's landscape. They serve as stewards of the environment, working to preserve wildlife habitats, sequester carbon, and maintain water resources. Their efforts bolster rural communities, offering economic stability and alleviating the pressures of urbanization. Moreover, the agricultural sector instills vital values, emphasizing hard work, responsibility, and civic duty.

In this modern age, sustainability and innovation have become key tenets of Utah's agricultural practices. Farmers leverage cutting-edge technology, including advanced equipment, precision farming tools, and biotechnology, to optimize resource utilization. These innovations enable farmers and ranchers to produce more food while minimizing environmental impacts, including reducing water and fertilizer use. On the state level, the management of water resources remains a paramount concern. Initiatives such as the Ag Water Optimization grants and efforts to conserve the Great Salt Lake underscore the importance of responsible water management. Additionally, measures are in place to safeguard the agricultural industry, including preserving agricultural lands, promoting local food processing, and reinforcing property rights.

At the national level, broader concerns come into play. These encompass risk management, transparency in beef pricing, and addressing food insecurity. There's a push to modernize the farm bill, enhance transparency in milk pricing, and expand nutrition programs. Trade-related issues, water regulation, and emissions reductions also feature prominently.

Utah's agricultural heritage stands as a testament to adaptability and resilience. While we honor the past, we also need to protect the future of local food production in Utah. With continued support, Utah's farmers and ranchers will continue to sustain local communities and preserve our precious natural resources.

SUSTAINABILITY AND INNOVATION HAVE BECOME KEY TENETS OF UTAH'S AGRICULTURAL PRACTICES.

UTAH'S LAND *in the news*

As we've tracked Utah and national news through 2023, we have compiled some of the key land issues and topics that have appeared in media outlets this year.

01. PUBLIC LANDS CONSERVATION

The proposed BLM Public Lands Rule would put conservation on an equal footing with other land uses on federal public land. Proponents of the rule believe that it will help ensure healthy landscapes, abundant wildlife habitat, clean water, and balanced land-use decision-making. Others oppose the option for leasing land for conservation, which could limit recreation, mining, energy extraction and livestock grazing.

02. CHALLENGES OF A WET WINTER

In addition to water impacts, Utah's historic winter dramatically affected the state's public and private lands. In agriculture, crop planting was delayed and livestock births were endangered. In recreation, campsites and other areas were delayed in opening, but ski resorts had skiable snow well into the summer months. In towns and cities, some homes and neighborhoods were damaged by flooding, and Sugarhouse Park was temporarily turned into a lake.

03. NATIONAL PARK CROWD MANAGEMENT

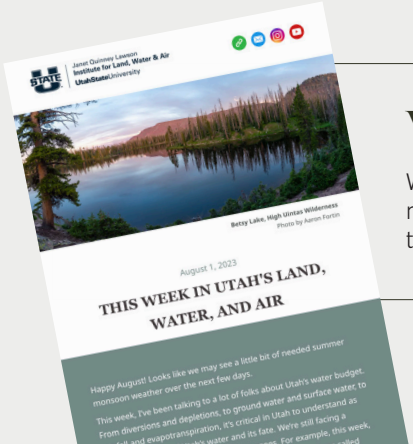
In an effort to create a better experience for the millions of visitors to Utah's "Mighty 5," a number of management efforts have spread out the visitor experience. Highlights include timed entry at Arches National Park and the pilot permit program for Angel's Landing at Zion National Park. Early results suggest these changes have been well received.

04. ANOTHER YEAR OF REPRIEVE FOR WILDFIRES IN UTAH

Despite unprecedented wildfires elsewhere in the hemisphere, including the Canada fires and the destruction of Maui's Lahaina, Utah's wildfires were mild in impact and even neighboring smoke hazed Utah skies for only a few days this year. At the same time, state agencies are still engaged in programs to reduce fuels for coming years.

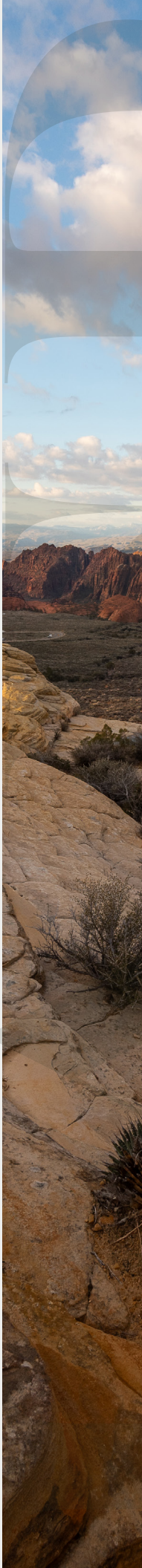
05. WILDLIFE AFFECTED BY WATER

Some wildlife were significantly impacted by Utah's wet winter, including mule deer in northern Utah who had a nearly 100% fawn mortality rate. Bird species benefited from increased water to wetlands near the south arm of Great Salt Lake, while white pelicans on Gunnison Island on the north arm saw a higher mortality rate, as Gunnison Island is still connected to the mainland and its predators. Also, 2023 will be remembered as year of grasshoppers.



What's going on in Utah's land, water and air?

We publish a weekly email newsletter, containing a categorized roundup of about 30 stories in local and national media outlets related to Utah's land, water, and air. Subscribe at: **usu.edu/ilwa/newsletter**.



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LEFT: *SNOW CANYON STATE PARK | WASHINGTON COUNTY*

Chapter 2

WATER

Key issues facing Utah's water

2.A WATER SHEPHERDING: DELIVERING SAVED WATER TO GREAT SALT LAKE

2.B VARIABILITY IN UTAH'S RESIDENTIAL WATER USE

2.C A CHANGING SUMMERTIME CLIMATE—IMPLICATIONS FOR WATER USE

2.D MANAGING UTAH'S DIVERSE GROUNDWATER BASINS

2.E TRACKING UTAH'S "VIRTUAL WATER" TRADE

2.F INTEGRATED WATER PLANNING IN THE GREAT SALT LAKE BASIN

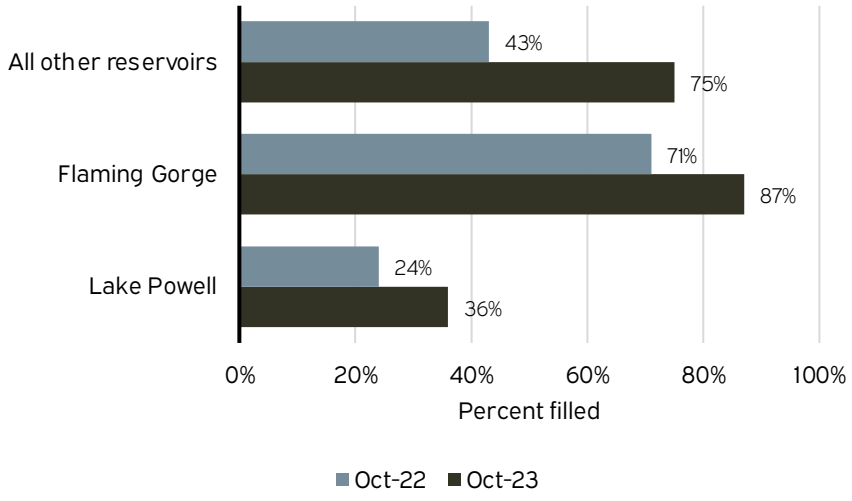
Chapter Summary by BRIAN STEED

What a difference one year can make! While 2022 was dominated by drought, 2023 saw the wettest winter on record, providing a temporary reprieve from the state's water woes. As of October 2023, statewide reservoir levels remain 75% full—a remarkable place for the end of irrigation season and a huge improvement over the prior year when reservoir levels were hovering in the mid to low 40% range.

Even though major concerns remain on the Great Salt Lake, the south arm of the lake rose by 5.5 feet after runoff season. The north arm of the lake rose only about a foot. The difference between the levels on the two arms of the lake was largely due to intentional manipulation of the breach in the Union Pacific causeway to control salinity levels in the south arm. In November of last year, the state made the decision to raise a berm in the causeway breach to increase mixing of fresh water and saline water and reduce salinity in the south arm. Accordingly, salinity levels in the south arm dropped to healthier levels from highs that threatened the vitality of brine shrimp and brine fly populations in the fall of last year.

Hopefully, 2024 delivers another great winter. But even if it doesn't, the state has continued ramping up water conservation programs to ensure that we have the water we need for ecological needs and human consumption into the future. In the remaining parts of this section, we detail approaches on how we are using, accounting, and planning for water for the future of the state.

Figure 2.I.1 Statewide reservoir storage (2022 & 2023)



Source: *Utah Division of Water Resources*

TRANSPORTED WATER

by SARAH NULL, BETHANY NEILSON
UTAH DIVISION OF WATER RIGHTS

2.A Water shepherding: delivering saved water to Great Salt Lake

TAKEAWAY» **Water conservation could benefit the Great Salt Lake if the water is carefully measured and tracked through rivers, canals, and other water pathways within the basin—a practice that will require adequate measurement and real-time information sharing.**

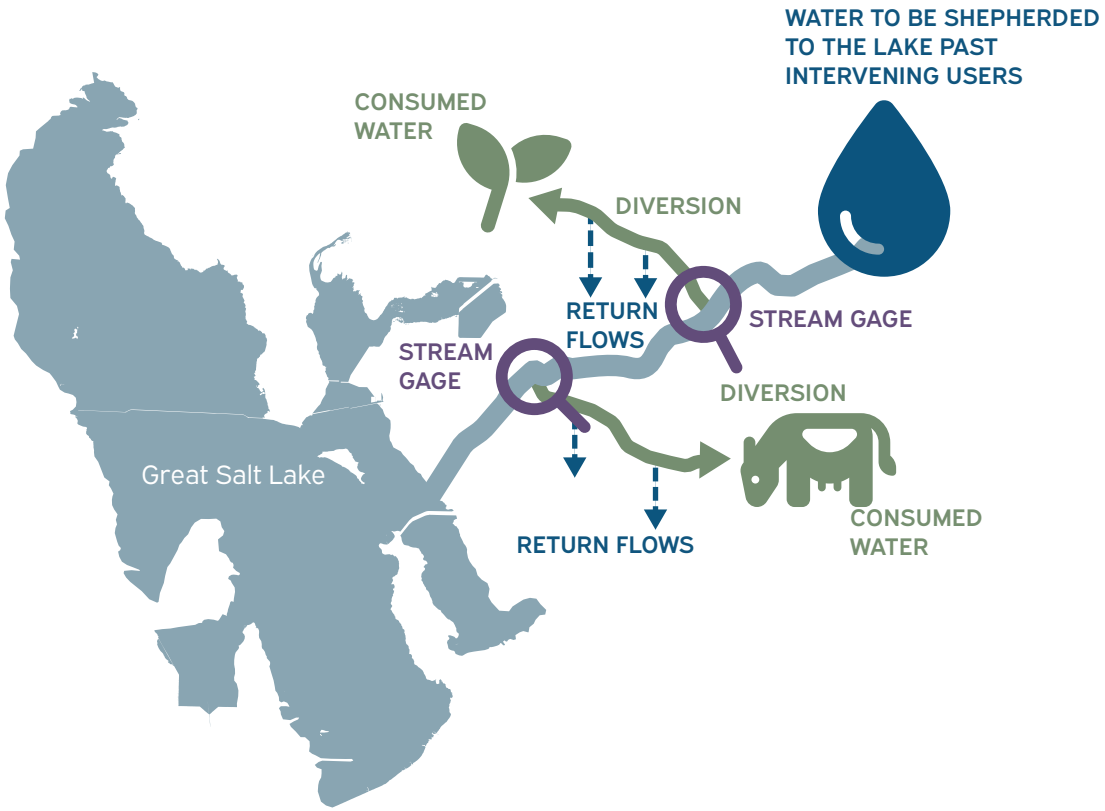
Water conservation is the adoption of practices that reduce water depletion to enhance water availability and minimize impacts on water supply, water quality, and the environment. Water shepherding is the legal authority and practice of distributing water through river systems and past intervening users to fulfill demands based on water right priority. Recent legislation in Utah provides a mechanism to lease or purchase water rights and to allocate water for instream flow or Great Salt Lake (water from these transactions can now be used to preserve or enhance the natural aquatic environment).

Delivering water to specific destinations requires thorough measurement and a detailed accounting of water movement. Utah Water Commissioners on 13 separate distribution systems within the basin actively monitor about 700 total measurement sites to distribute water to existing users. This process can be improved with additional measurements and better transparency of flows and water right accounting data. This can aid efforts to ensure saved water reaches its intended destination such as Great Salt Lake.

The Utah Division of Water Rights and Utah State University are working together to identify and prioritize locations for new measurement and telemetry equipment, improve sharing of streamflow and diversion information, and communicate water rights accounting information in a user-friendly format. The new cooperative work builds on the distribution and accounting systems developed and refined by the division beginning in 1919, which incorporates existing streamflow and diversion data, water rights information, and accounting tools. The new work provides opportunities to increase water data access and transparency for water users to change elements of their water rights, some of which may support Great Salt Lake and other ecosystems reliant on the complex water distribution systems throughout the state.

Figure 2.A.1 Conceptual model of water shepherding

Practices that reduce consumption cannot bring more water to Great Salt Lake unless measures are in place to monitor conserved water's movement through Utah's waterways.



DELIVERING WATER TO SPECIFIC DESTINATIONS REQUIRES THOROUGH MEASUREMENT AND A DETAILED ACCOUNTING OF WATER MOVEMENT.

GREAT SALT LAKE SUNSET | ANTELOPE ISLAND STATE PARK | DAVIS COUNTY

RESIDENTIAL WATER *by JEFFERY S. HORSBURGH*

2.B Variability in Utah's residential water use

TAKEAWAY» **Residential water use is highly variable both across households and across time. Our assumptions about and focus on per capita water use do not account for this.**

Residential water use in Utah is estimated to be as high as 169 gallons per capita per day. That is the second largest volume in the U.S. Public water suppliers serve nearly 98% of Utah's population, one of the highest rates in the country. Utah has high urban density, limited water availability, and a growing population. The cost of delivering water to urban areas makes managing and reducing demand vital to continue providing a clean and safe water supply.

Collecting the right data can help water providers manage demand and plan for the future. It is important to know the total amount of water used, and also how and when people use water. Factors to consider include daily consumption patterns, common uses like showers and toilets, how the distribution of those uses varies over time, and potential savings that conservation programs might achieve. Standard water use data does not typically show water-use peak times or volume and does not quantify indoor versus outdoor water use.

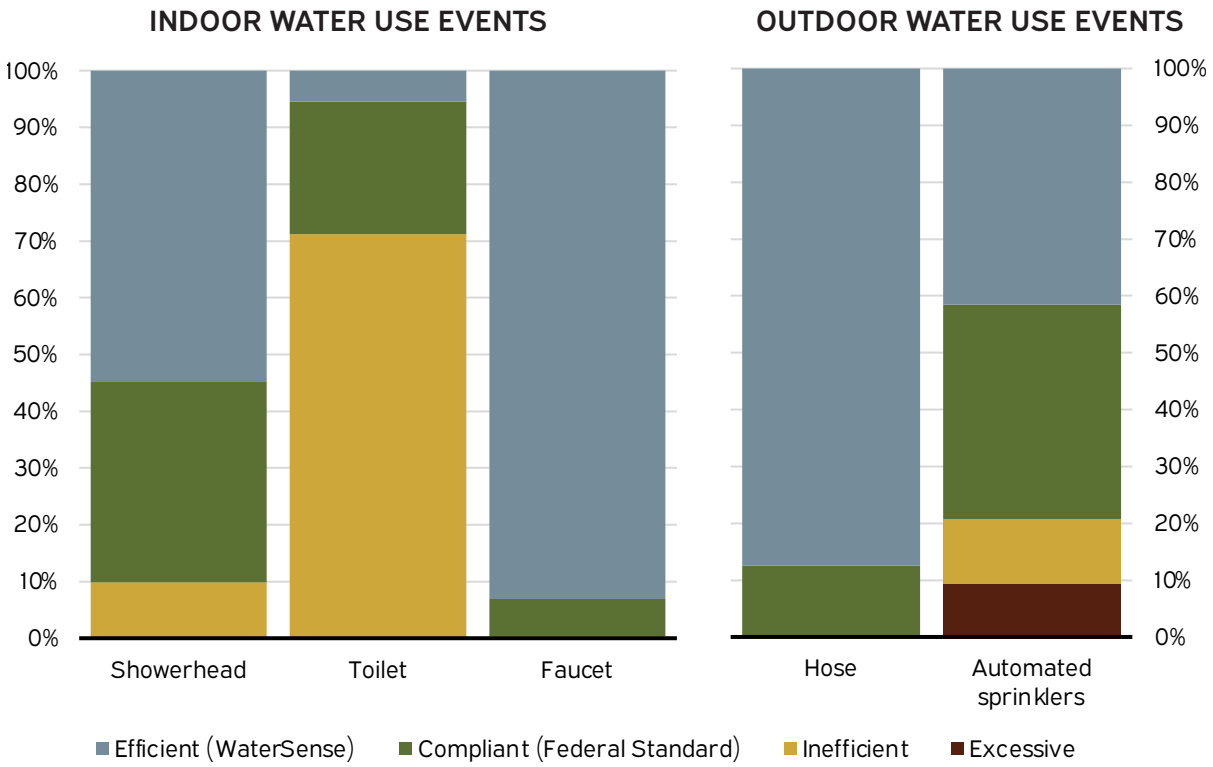
Utah State researchers have developed new technology to collect more accurate water-use data from residential households. This allows more detailed studies of behavior and more detailed understanding of distribution across various water uses. These studies have found that a single per capita water use estimate doesn't capture the difference between households, or even changes over time for a single household. Results also indicated that people generally are not overwatering their landscapes, indicating that saving water outdoors may depend on changing landscapes and not just watering less. Finally, researchers found significant opportunities for conservation inside homes, such as replacing inefficient water fixtures.

UTAH STILL HAS SIGNIFICANT OPPORTUNITIES FOR CONSERVATION INSIDE HOMES THROUGH REPLACING INEFFICIENT WATER FIXTURES.

RIGHT: *RESIDENTIAL SPRINKLER SYSTEM | CACHE COUNTY*

Figure 2.B.1 Water performance in tested residential homes (2019–2021)

Researchers studied residential water use in Logan and Providence (in Cache Valley) to determine trends. Graphs show the average percent of water use events that fell within each category across all tested homes.



WATER AND CLIMATE

by ROBERT GILLIES and JON MEYER

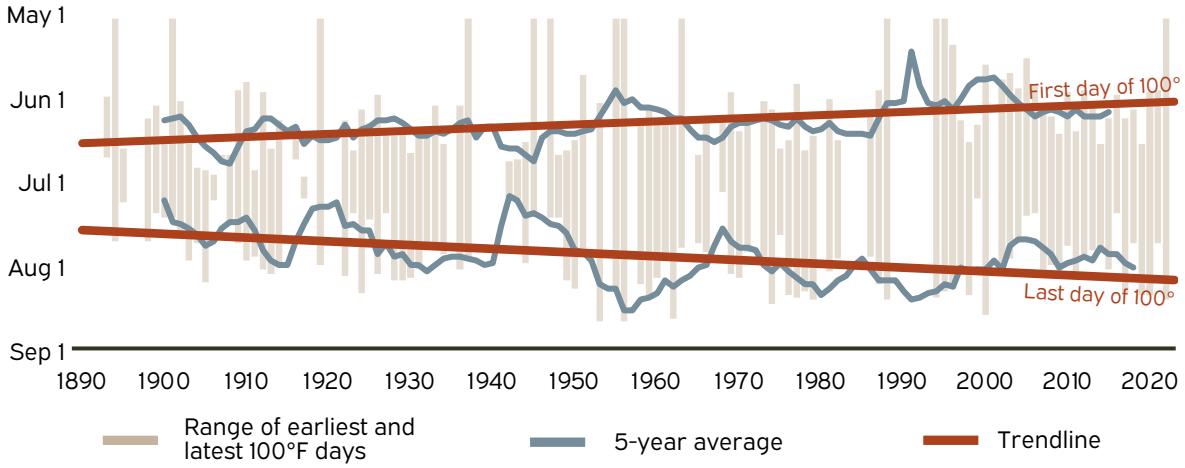
2.C A changing summertime climate–implications for Utah's water

TAKEAWAY» **An expanding and increasingly hotter warm season, coupled with a more variable monsoon seasonality, is stressing Utah's water supply.**

Utah's summer season temperatures are expanding earlier into spring, and later into fall. At the same time, the North American monsoon—oftentimes a significant summer water resource—is becoming more variable and erratic, with recent years experiencing both failed "non-soons" and record rainfall events. In addition, the monsoon is exhibiting increasing variability, which leads to reduced predictability. The alterations in timing of summer temperatures coupled with summer monsoon's increasing variability add greater risk to water resource management decisions. For example, limited water availability places added stress on the state's water supply.

Utah's summer tourism, agricultural economies, and energy use are all inextricably tied to the region's climate. For example, an expansion of the summer season temperatures theoretically lengthens the growing season, but at the expense of irrigation demand. Higher temperatures worsen air quality problems. Earlier and longer springs and summers imply potential increases in utility bills. The summer monsoon is often responsible for "flash floods" through the development of convective systems, which also ignite wildfires. A longer drying season also exacerbates wildfire prospects. A hotter warm season has the potential to turn an even above-normal winter snowpack and spring runoff into less viable water supplies.

Figure 2.C.1 Date range of days with 100°F or higher in Moab, Utah (1893–2022)



The graph above shows how temperature has changed in Moab, Utah over the past 130 years. The red "alligator mouth" (red lines) shows the earlier and longer springs and summers.

LEFT: NAVAJO KNOBBS TRAIL | CAPITOL REEF NATIONAL PARK | WAYNE COUNTY

GROUNDWATER *by DENNIS NEWELL and TOM LACHMAR*

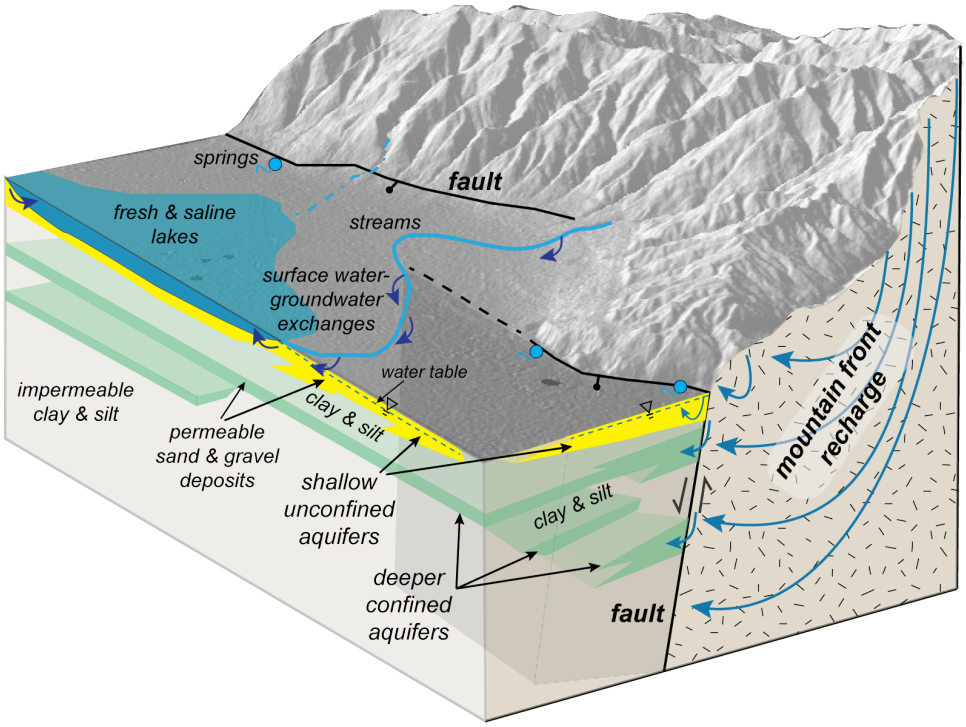
2.D Managing Utah's diverse groundwater basins

TAKEAWAY» **Understanding groundwater is key to managing Utah's limited water resource.**

Groundwater is present throughout Utah, but quantities suitable for public supply, irrigation, or industrial uses are only available in limited areas. Most of Utah's groundwater occurrences are found below valley floors in "basins" that are filled with sediments eroded from adjacent mountains. The geologic formations that readily transmit groundwater to wells or springs are called aquifers and are found at depths ranging from a few to hundreds of feet. Infiltration of rain and snowmelt in higher elevation areas recharge aquifers, a process that can take years to millennia. Long-term groundwater use that outpaces recharge may lower water levels in wells, reduce supply, and degrade water quality.

Although groundwater only accounts for 25% of the water used in Utah, it comprises nearly 60-70% of the water used for public supply and industrial purposes.

Figure 2.D.1 Aquifers and surface water–groundwater connections



Most of Utah's groundwater occurrences are found below valley floors in "basins." Groundwater is transmitted to wells or springs through aquifers.

ABOVE: GROUNDWATER WELL | CACHE COUNTY

Importantly, groundwater and surface water should not be considered as separate resources in many areas because groundwater and surface water are interconnected and should be managed together. In others, particularly where Lake Bonneville was present, groundwater is separated from surface water bodies by layers of impermeable clay. In these basins, groundwater may be managed separately from surface water to maximize the amount of water available for beneficial use.

Groundwater research in Utah is necessary to understand how aquifers receive recharge and how long it takes, how much is available for beneficial use, and how increasing demands coupled with climate change will impact long-term supplies.

VIRTUAL WATER by CHRISTOPHER LANT

2.E Tracking Utah's "virtual water" trade

TAKEAWAY» **Traded products add new dimensions to Utah's water balance sheet. Understanding all water gains and losses can help manage the system more efficiently.**

Understanding how we use water in Utah is more complicated than just streamflow. For example, virtual water is the water used to produce something, such as electricity or a crop, that is then traded—sometimes to other countries, but far more often among neighboring states. In fact, over 90% of the 1,700 gallons of water the average American uses each day is virtual water used to produce the food and energy they use. It need not be directly delivered through pipes from a local river, reservoir, or well. Rather, virtual water comes to us over the electrical grid or by truck or railroad car carrying lumber or one of America's primary crops—like corn, soybeans, wheat or hay—through numerous business transactions.

We can track the volume and direction of virtual water flows just like we do for rivers. Utah's virtual water exports (mostly to other western states, but some to China) exceed its imports (mostly from western and midwestern states). The difference between exports and imports is about equal to the combined flow of the Bear, Weber and Jordan Rivers to Great Salt Lake. American states trade huge quantities of virtual water with each other—20 times the volume that flows from Glen Canyon Dam to the Lower Colorado River each year.

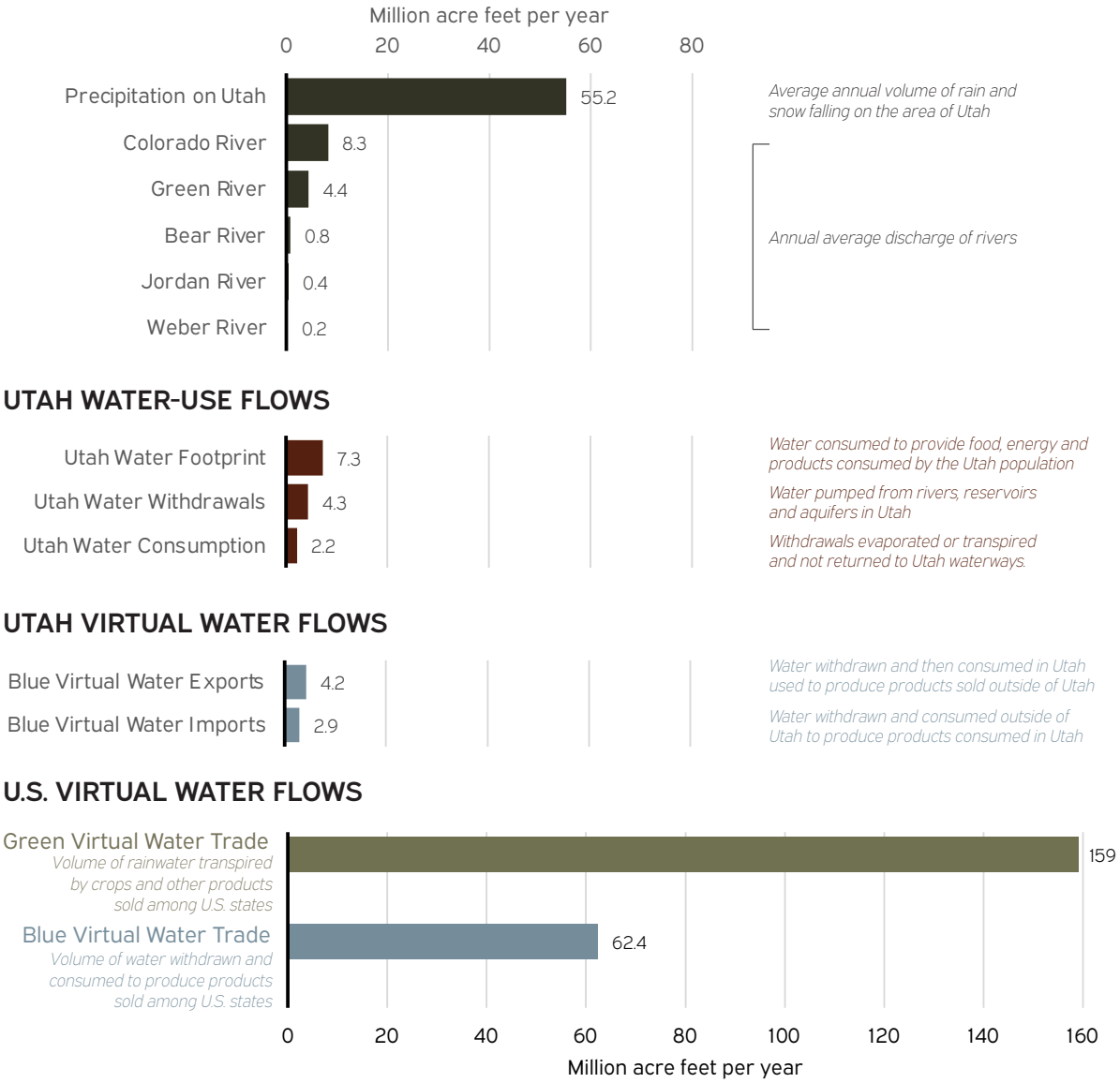
It is possible for Utah to access a larger share of this virtual water trade. For example, through the Utah Water Banking Act of 2020, farmers, acting voluntarily and in their own self-interest, could choose to lease out a part of their senior water rights instead of growing livestock feed, and instead buy it from the Midwest at a profit. In this way, farmers could import even more virtual water to meet Utah's growing needs.

LEFT: BALED ALFALFA | CACHE COUNTY

UNDERSTANDING HOW WE USE WATER IN UTAH IS MORE COMPLICATED THAN JUST STREAMFLOW.

Figure 2.E.1 Comparative annual flows of Utah rivers and virtual water trade

When it comes to Utah water use, there are a number of different ways that water enters and leaves the state. The figure below shows some of them. Green water imports and export numbers are not yet available for Utah, but future calculations will determine how the state could leverage them more fully.



GREAT SALT LAKE

by LAURA VERNON, Utah Division of Water Resources

2.F Integrated water planning in the Great Salt Lake Basin

TAKEAWAY» **Ensuring a resilient water supply for Great Salt Lake and water users throughout the basin.**

Attaining long-term water supply resiliency for water users in the Great Salt Lake basin—including the lake—requires a plan. For this reason, the Utah Division of Water Resources is working with federal, state, and local partners to complete the Great Salt Lake Basin Integrated Plan.

The first-ever water resources plan for the entire Great Salt Lake Basin integrates surface and groundwater modeling; existing plans, studies, research, data, models, tools, and strategies; and water user collaboration at an unprecedented scale. The plan provides a holistic understanding of current and future water supplies and demands throughout the basin, then identifies and evaluates actions that reduce water supply risks, minimize harm to future generations, and preserve ecosystems. The plan will:

- Assess current surface and groundwater supply in the basin
- Predict future water supplies and demands
- Coordinate efforts to gather and utilize data throughout the basin
- Investigate possible adaptation and mitigation strategies
- Analyze trade-offs between water users in the system
- Recommend actionable strategies to ensure a resilient water supply

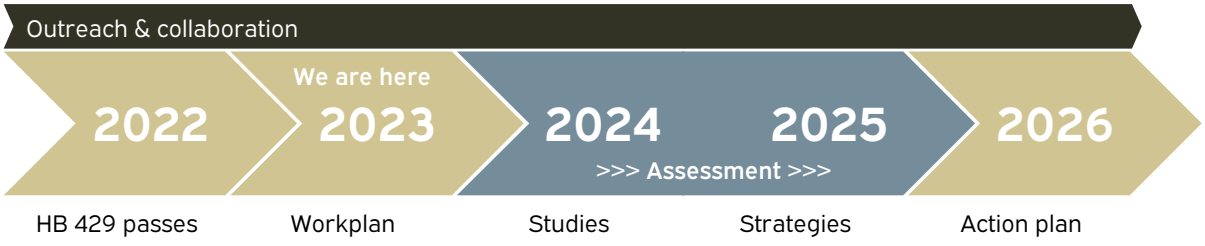
Through the planning process, water users and policymakers in the basin gain a comprehensive foundation for sound water management and decision-making. They also obtain tools and guidance for updating the plan into the future.

The complex nature of this effort calls for a workplan to detail how to fulfill the integrated plan within three years. The workplan is being developed by engaging stakeholders, building consensus, and prioritizing tasks that comprise the plan.

For more information, visit *https://water.utah.gov/gsl-basin-integrated-plan/*

BEAR RIVER BIRD REFUGE | BOX ELDER COUNTY

Figure 2.F.1 Great Salt Lake Basin Integrated Plan timeline



UTAH'S WATER *in the news*

As we've tracked Utah and national news through 2023, we have compiled some of the key water issues and topics that have appeared in media outlets this year.

01. AN UNPRECEDENTED WET WINTER

After a remarkably snowy winter, for the first time in three years, no area in Utah is in severe or extreme drought. This resulted in some flooding throughout the state. Most of Utah's reservoirs re-filled, and Utah's water situation was much improved. Wetter-than-normal spring and summer seasons continued to improve Utah's water supply.

02. ADDRESSING WATER LEVELS AT GREAT SALT LAKE

This winter, the berm separating the north and south arms of the lake was raised, to help address dangerous salinity levels in the south arm. As a result, lake levels increased 5.5 feet on the south arm, but only about a foot on the north arm. Legislation was passed to create better outcomes on the lake, including the creation of a Great Salt Lake Commissioner. Non-profits stepped in to bring water to the lake.

03. WATER QUALITY CHALLENGES

States must now take a more significant role in managing water quality, as the Supreme Court narrowed the scope of the Clean Water Act. PFAS, or "forever chemicals," caused policy changes in use of certain ski waxes in Park City and received additional funding to help decontaminate Utah's drinking water. An E. Coli outbreak in Lehi was caused by contaminated irrigation water, and harmful algal blooms still appeared in Utah lakes and reservoirs this year.

04. WATER CONSERVATION EFFORTS STILL NEEDED

Some small towns still experienced water shortages this year. Francis City and Apple Valley saw critically low water tanks, causing a halt on all outdoor watering and a boil water order, respectively. Even with increased water supply, conservation programs and efforts by the state and cities are creating more resources and incentives for using less water.

05. AGRICULTURAL IRRIGATION OPTIMIZATION

Programs were established to save water used by farmers and ranchers in the state. Ag optimization grants offered by the Utah Department of Agriculture and Food hope to save more than 60,000 acre-feet of water. A federal Conservation Reserve Enhancement Program is also providing farmers in the West more options for water conservation.

What's going on in Utah's land, water and air?

We publish a weekly email newsletter, containing a categorized roundup of about 30 stories in local and national media outlets related to Utah's land, water, and air. Subscribe at: **usu.edu/ilwa/newsletter**.

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LEFT: *FLAMING GORGE RESERVOIR | DAGGETT COUNTY*

Chapter 3

AIR

Key issues facing Utah's air

3.A PROGRESS AND PROBLEMS WITH NORTHERN UTAH'S PM2.5

3.B HOW GREAT SALT LAKE DUST AFFECTS UTAH'S PM10 LEVELS

3.C UINTA BASIN OZONE RETURNS IN A SNOWY WINTER

3.D AIR QUALITY ADVISORIES MAY NOT HAVE THE DESIRED IMPACT ON REDUCING VEHICLE EMISSIONS

3.E SEASONAL TEMPERATURE TRENDS

3.F REDUCING AIR TOXINS THROUGH SMARTER PESTICIDE MANAGEMENT

3.G DETERMINING THE THREAT OF HALOGENS ON THE WASATCH FRONT

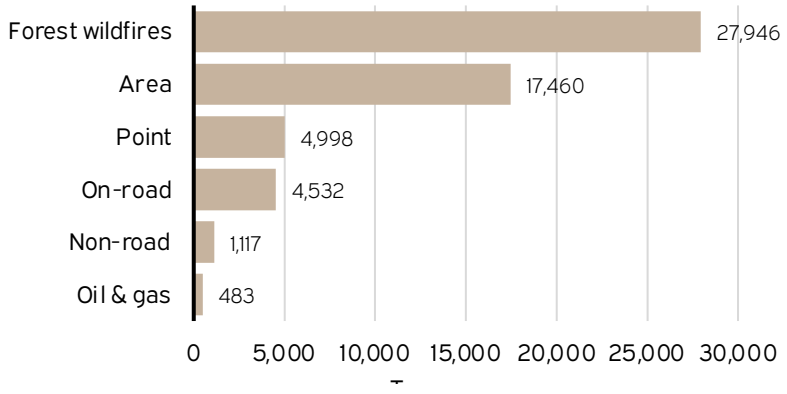
Chapter Summary by BRIAN STEED

Air quality remains top of mind for Utahns living along the Wasatch front and in the Uinta Basin. Although Utah has made some serious gains in air quality over the past decades, there is also cause for concern. In looking at the numbers for this year, we have seen fewer days of inversion and have seen lower levels of smoke pollution this summer from regional forest fires than we have seen in recent years. That has meant lower numbers of red or "unhealthy" air days than any year since 2019.

On the downside, Utah has seen an uptick in concern over summer ozone along the Wasatch Front and winter ozone in the Uinta Basin. Adding to the list of concerns is the emerging issue of dust blowing off the dry lakebed of the Great Salt Lake. Failure to address these new concerns will almost certainly draw regulatory action from air quality regulators from state and federal agencies.

Addressing these concerns will require better understanding and monitoring of contributing factors. In the remaining sections of this chapter, we examine some of the trends and analysis of our air quality and the human behaviors that affect it.

Figure 3.I.1 Utah $PM_{2.5}$ triennial emissions inventory



Under current federal law, Utah is required to collect a statewide emission inventory every three years. The 2017 triennial inventory is the most recent statewide inventory available.

Source: *Utah Division of Air Quality, 2022*

NORTHERN UTAH AIR *by RANDY MARTIN*

3.A Progress and problems with northern Utah's $PM_{2.5}$

TAKEAWAY» **Even with inversion episodes in 2023, northern Utah appears to have reached EPA "attainment" status for its airsheds.**

Particulate matter in the air can have a noticeable impact on human health when breathed in. $PM_{2.5}$ particles are particles less than or equal to 2.5 microns (µm) that can travel deep into the respiratory system.

The regulatory status of northern Utah counties has not changed in the past year. The Wasatch Front counties are still officially listed as "serious non-attainment," although recent three-year averaging periods have shown the airsheds have achieved "clean data" status. Cache County reached "attainment" status and is listed as "maintenance" as of June 2021.

For the most part, Utah's $PM_{2.5}$ measurements indicate continued improvement of the state's implemented $PM_{2.5}$ reduction programs. However, some challenging inversions during January and February 2023 resulted in several exceedances across the region (Figure 3.A.1).

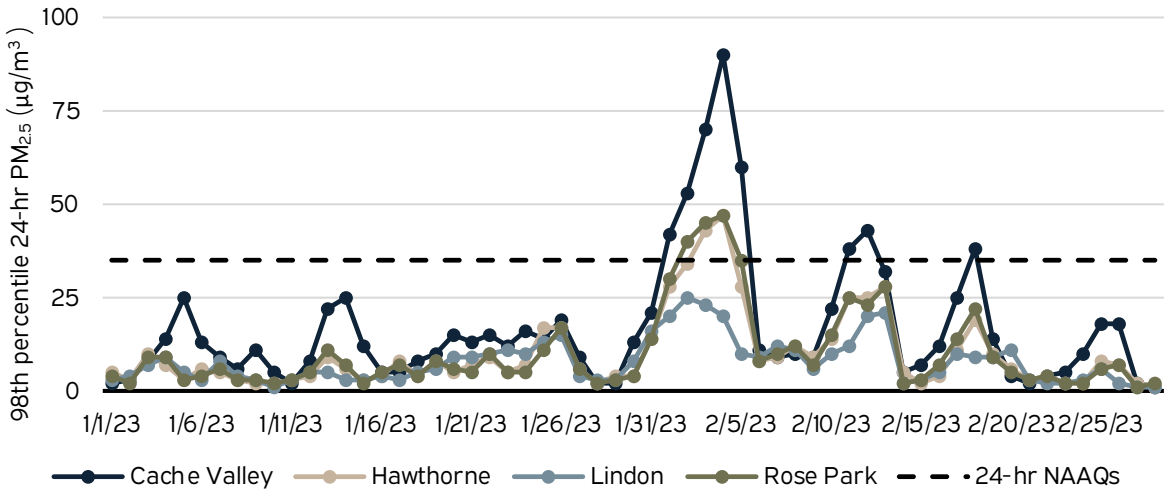
Northern Utah's winter was characterized by frequent storms and abundant snowfall, interspersed with brief high-pressure periods that allowed for multi-day inversions. The elevated concentrations observed were also some of the highest $PM_{2.5}$ values experienced across the region within the last decade.

Figure 3.A.2 shows that airsheds have mostly been below the NAAQs for the past three years, suggesting that "attainment" status across the regulatory three-year averaging period can be reached.

Winter 2023 demonstrates that, although implementation protocols have resulted in recent $PM_{2.5}$ reductions, northern Utah is only a few consecutive strong winters away from once again exceeding the National Ambient Air Quality Standards.

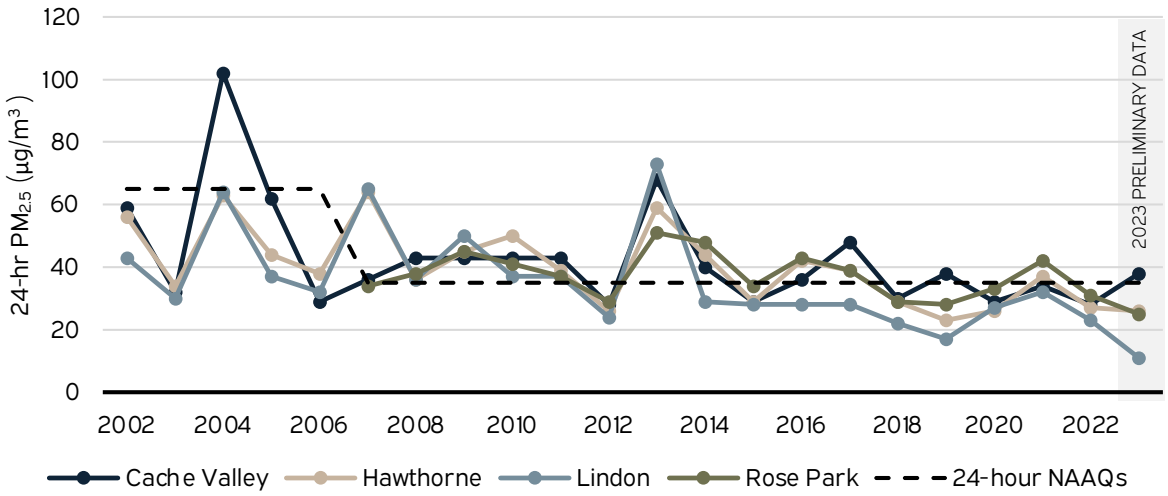
AERIAL VIEW OF USU CAMPUS / CACHE COUNTY

Figure 3.A.1 24-hour $PM_{2.5}$ along the Wasatch Front and Cache Valley (Winter 2023)



Inversion periods are evident above as the incidences of peaked $PM_{2.5}$ levels, lasting from about two-to-six days. These inversion/exceedance episodes are an important reminder that wintertime meteorological conditions are a significant component of many of Utah's seasonal air quality concerns.

Figure 3.A.2 Historical Wasatch Front and Cache Valley 98th percentile $PM_{2.5}$ values (2002-2023)



This graph shows the potential impact on the annual $PM_{2.5}$ trends on achieving attainment. Following federal protocols, a year's regulatory $PM_{2.5}$ concentration is reported as the 98th percentile of all the values measured. Three consecutive years of 98th percentile values are averaged and reported as an airshed's regulatory "design value".

WASATCH FRONT AIR *by RANDY MARTIN*

3.B How Great Salt Lake dust affects Utah's PM_{10} levels

TAKEAWAY» **Dust pollution could become a larger problem as the Great Salt Lake's playa gets drier.**

In the early to mid-1990's, areas along the Wasatch Front were declared non-attainment Air Quality Standards with PM_{10}, mostly during wintertime inversions. Since then, continued decreases in PM_{10} caused the airshed to be declared "maintenance" status in March 2020 with continued oversight through 2030.

More recently, however, PM_{10} has become a growing concern revolving around seasonal wind-blown dust potentially originating from the shores of the Great Salt Lake. These events frequently are observed in the spring and fall and are of limited duration.

As an example, a roughly nine-hour event occurred on June 23, 2023, wherein the measured wind speed at the Salt Lake Airport doubled from around 11 mph to 22 mph, accompanied by a wind direction shift. Figure 3.B.1 shows the hourly averaged PM_{10} values increased considerably.

Rather than exceedances of air quality standards, it is the short-term exposure to unhealthy concentrations of hazardous chemicals carried in the dust that have garnered recent attention.

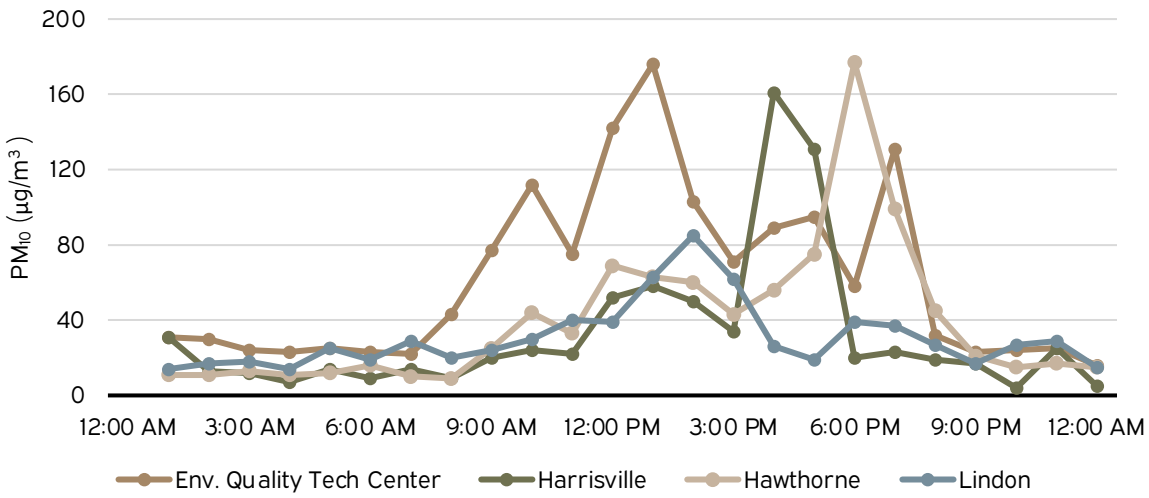
Research by several agencies and universities throughout Utah have shown Great Salt Lake dust composition to be variable but typically dominated by calcium, silica, magnesium, aluminum, sodium, iron, and potassium. Numerous other elements have also been identified within air-borne dust, including arsenic, copper, manganese, nickel, selenium, strontium, thallium, and vanadium.

A recent analysis of PM_{10} collected at two regulatory sampling sites found that, during observed dust events, the potential for inhalation of most of the observed elements increased ten-fold, but exposure to only four of the elements (magnesium, calcium, vanadium, and strontium) were enhanced above background dust expectations. This suggests the wind-blown dust from the Great Salt Lake playa provided additional levels of these elements.

In 2023, a working group was formed among Utah Division of Air Quality personnel and investigators across universities and colleges in northern Utah to coordinate, encourage commonality in sampling and analytical methods, and develop benchmark comparison criteria. The group is currently working to prioritize cooperative PM_{10} sampling campaigns for dust sources and composition.

EXPOSED LAKE BED | GREAT SALT LAKE | DAVIS COUNTY

Figure 3.B.1 PM_{10} levels in Salt Lake City during a dust event (June 23, 2023)



During the dust event PM_{10} levels from 10-25 µg/m³ to a maximum 177 µg/m³ were observed. The location nearest the playa (Env. Quality Tech Center) showed the longest, temporally-sustained PM_{10} increase. On the other hand, during this event, the Lindon location in Utah County showed a more moderate PM_{10} increase, from about 20 to 85 µg/m³.

RATHER THAN EXCEEDANCES OF AIR QUALITY STANDARDS, IT IS THE SHORT-TERM EXPOSURE TO HAZARDOUS CHEMICALS CARRIED IN THE DUST THAT HAVE GARNERED RECENT ATTENTION.

UINTA BASIN AIR *by SETH LYMAN*

3.C Uinta Basin ozone returns in a snowy winter

TAKEAWAY» **Winter ozone has declined over the past decade, but increased oil and gas activity, combined with unprecedented snow cover and inversions, led to a spike in high ozone this winter.**

The Uinta Basin occasionally experiences high ozone during winter months. Ozone is a respiratory irritant that impacts human health, and it is regulated by the U.S. Environmental Protection Agency. Winter ozone requires strong, multi-day temperature inversions, which only form when the basin is blanketed in snow. It also requires emissions of air pollution.

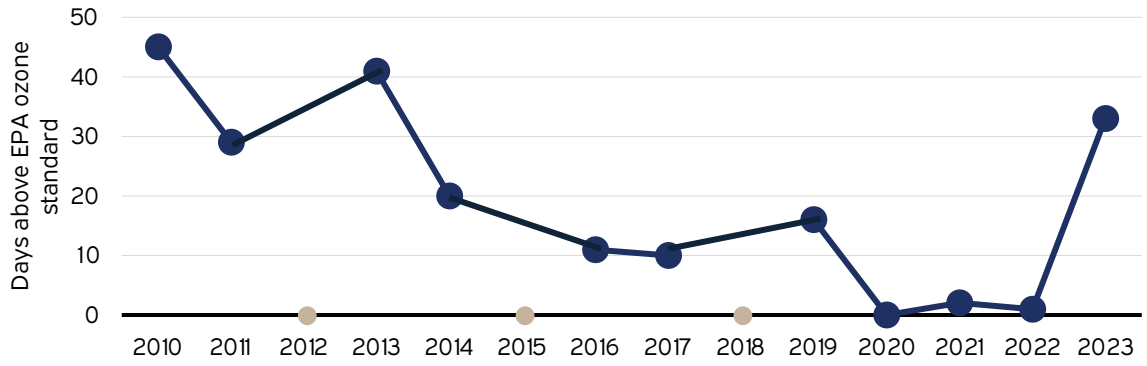
Most of the pollution that leads to winter ozone in the basin is emitted from the local oil and gas industry, and regulation that targets the industry may have a detrimental impact on the Uinta Basin economy.

The Uinta Basin is out of compliance with EPA air quality standards for ozone. Market forces and improvements to oil and gas operations have reduced emissions of ozone-forming pollution, and those changes led to a decline in winter ozone levels from 2010 through 2022. Because of that decline, the Uinta Basin was on the cusp of official compliance with the EPA ozone standard.

This year, a sharp uptick in oil and gas production, combined with unprecedented snow cover and many strong inversions, led to high ozone during the past winter, including 33 days above the EPA standard, and maximum ozone of 119 parts-per-billion (the standard is 70 parts-per-billion). This winter shows that more work is needed to reduce emissions and eliminate wintertime ozone in the Uinta Basin.

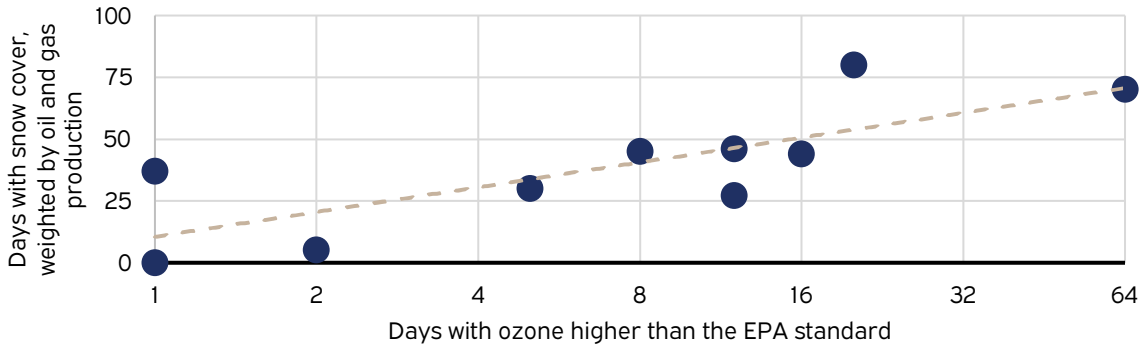
UINTA BASIN SNOWPACK | UINTAH COUNTY (JORDAN EVANS, USU)

Figure 3.C.1 Number of days with ozone above the EPA standard in the Uinta Basin (2010–2023)



2021, 2015, and 2018 were low/no snow years in the Uinta Basin, during which winter ozone does not form, and are shown in beige.

Figure 3.C.2 Correlation of Uinta Basin days with snow cover and days with ozone higher than the EPA standard (2010–2023)



A SHARP UPTICK IN OIL AND GAS PRODUCTION, COMBINED WITH UNPRECEDENTED SNOW COVER AND MANY STRONG INVERSIONS, LED TO HIGH OZONE DURING THE PAST WINTER.

UTAH'S AIR POLLUTION *by ARTHUR J. CAPLAN*

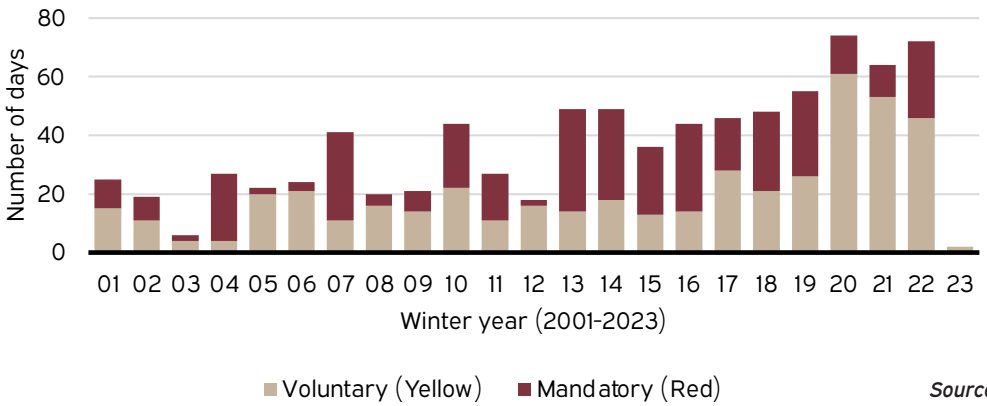
3.D Air quality advisories may not have the desired impact on reducing vehicle emissions

TAKEAWAY» **Issuing "yellow air day" advisories in northern Utah did not reduce vehicle trips or help reduce poor air quality during winter inversions.**

Using data on daily vehicle trips, $PM_{2.5}$ concentrations, and a host of climactic control variables, USU research tested the hypothesis that "yellow air day advisories" issued by the Utah Division of Air Quality resulted in drivers reducing the number of vehicle trips taken during northern Utah's winter-inversion seasons in the early 2000s. Winter inversions occur in northern Utah when $PM_{2.5}$ concentrations (derived mainly from vehicle emissions) become trapped in the lower atmosphere, leading to unhealthy air quality over a span of time known colloquially as "red air day episodes." When concentrations rose above 15 µg/m^3 toward the National Ambient Air Quality Standard (NAAQS) average daily threshold of 35 µg/m^3, residents were informed via different media sources and road signage that the region was experiencing a yellow air day. Residents were urged to reduce their vehicle usage during the day.

Results from this research suggest that the advisories provided at best weak, at worst perverse, incentives for reducing vehicle usage on yellow air days, and ultimately for mitigating the occurrence of red air day episodes during northern Utah's winter inversion seasons. A perverse incentive occurs when individuals react to an advisory by increasing their vehicle trips (and thus reducing their outdoor exposure to particulate pollution) in order to better protect themselves from the elevated $PM_{2.5}$ concentrations. Thus, "soft policies" such as issuing advisories are not, in and of themselves, sufficient to control vehicle emissions' impacts on air quality during inversions in northern Utah.

3.D.1 Yellow and red air days in Cache County (2000–2023)



** Starting in fall 2012, a new state air quality standard was adopted. "Yellow air" days (25.5 µg/m^3) became "voluntary action" days (15 µg/m^3), and "red air" days (35.5 µg/m^3) became "mandatory action" days (25 µg/m^3).*

Source: *airmonitoring.utah.gov*

"SOFT POLICIES" SUCH AS ISSUING ADVISORIES ARE NOT, IN AND OF THEMSELVES, SUFFICIENT TO CONTROL VEHICLE EMISSIONS' IMPACTS ON AIR QUALITY.

LIVING WITH POOR AIR DAYS | CACHE COUNTY

AIR TEMPERATURE

by WEI ZHANG, GRACE AFFRAM and CODY RATTERMAN

3.E Seasonal temperature trends

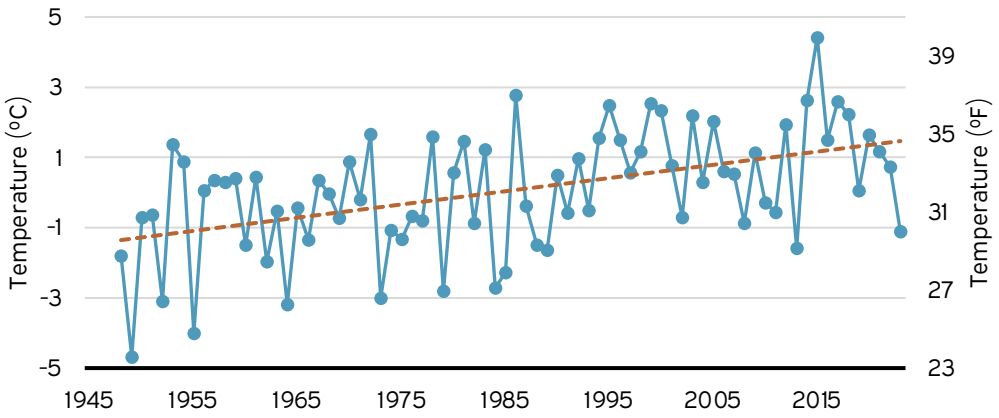
TAKEAWAY» **While the 2022-2023 winter was colder than average, it was not enough to break the trend of rising winter temperatures in Utah since 1948.**

Temperatures in Utah have trended upwards during cold seasons (January-March) and hot seasons (June-August) since 1948. While 2022-2023 winter temperatures were colder than average for the season, they did not overturn this long-term warming trend.

Snowpack accumulates during cold seasons and melts with spring warming. Increasing temperatures during cold seasons (Figure 3.E.1) indicate more rain, less snow, and more snowmelt. Higher temperatures during hot seasons will likely increase agricultural, municipal, and industrial water use, which puts stress on the availability of water resources (Figure 3.E.2). Precipitation deficit is a key driver in soil water shortage[3.E.1].

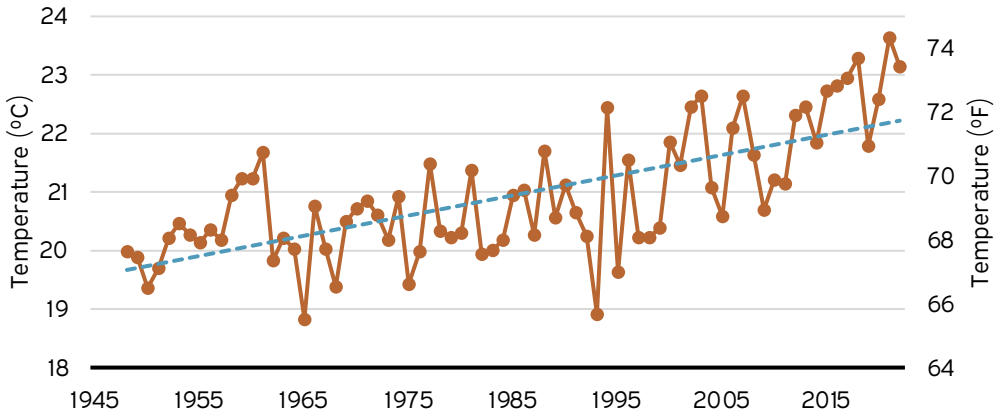
The combined effects of warming temperatures during both cold and hot seasons signify drying conditions and a shift in Utah's climate. If the warming trend continues, Utah will have a drier and hotter future along with the entire southwestern United States[3.E.2].

Figure 3.E.1 January–March Utah temperatures and trends (1948–2023)



THE COMBINED EFFECTS OF WARMING TEMPERATURES DURING BOTH COLD AND HOT SEASONS SIGNIFY DRYING CONDITIONS AND A SHIFT IN UTAH'S CLIMATE.

Figure 3.E.2 June–August Utah temperatures and trends (1948–2023)



LEFT: HEAVY SNOWPACK ON THE LA SAL MOUNTAINS | GRAND COUNTY

RURAL & AG AIR *by KIMBERLY HAGEMAN*

3.F Reducing air toxins through smarter pesticide management

TAKEAWAY» **A new tool provides guidance for optimal application of insecticides and other chemicals.**

Chemical insecticides can expose farm workers, rural homeowners, and others to toxins in the air, due to a process called volatilization. It happens when insecticide transfers from the leaf surface to a vapor in the atmosphere, due to light energy breaking down chemical bonds.

USU's PesticideToolkit website is helping farmers understand and plan for that process. The toolkit can improve pesticide usefulness, lower costs, help manage pesticide resistance, protect pollinators and beneficial insects, and aid understanding of insecticide exposure to humans through the air.

Insecticides harm insects for only a certain amount of time after being applied. Over time, the concentration in the leaves of crops decreases. The change in concentration in leaves over time depends on several factors. Those include the nature of the insecticide but also weather conditions (such as air temperature, wind speed, light intensity, and cloud cover) and crop characteristics (such as the length of the leaves). Insecticide behavior varies because these factors change with field location, season, and time of day.

To account for the complex interactions of these factors, the publicly-available model can predict insecticide behavior under given meteorological and crop conditions.

We designed the website for use by growers, sprayers, bee managers, extension services, pesticide regulators, and scientists. Users enter an insecticide, crop, and insect of interest. They then access weather information for the current day or manually enter weather details. They can use default values for leaf and soil properties or select their own.

The website creates a graph showing the change in insecticide concentration over the next seven days. If toxicology data is available, it will also show how long it takes for concentrations to no longer be harmful to the insect of interest (whether that's the targeted pest or a beneficial insect, like a pollinator).

This feedback helps farmers apply pesticides at the right time while avoiding potential negative health effects.

Table 3.F.1 Use cases for USU Pesticide Toolkit

FARMERS	REGULATORS	RESEARCHERS
Farmers can get a site- and condition-specific prediction of pesticide concentration after application. This can guide application timing based on the active ingredient of the pesticide.	Regulators can investigate recommendations for the pre-harvest interval (PHI), the re-entry interval (REI), and other timelines that are dependent on the rate of pesticide dissipation.	Researchers can assist with planning field work. The simulation of field work can guide decisions about sampling times as well as indicate conditions to record over the study.

THE TOOLKIT CAN IMPROVE PESTICIDE USEFULNESS, LOWER COSTS, HELP MANAGE PESTICIDE RESISTANCE, PROTECT POLLINATORS AND BENEFICIAL INSECTS, AND AID UNDERSTANDING OF INSECTICIDE EXPOSURE TO HUMANS THROUGH THE AIR.

CONSPICUOUS GRASSHOPPERS | GREEN CANYON | CACHE COUNTY


STOP
PRIVATE PROPERTY

URBAN AIR QUALITY

by RACHEL EDIE and NANCY DAHER, Utah Division of Air Quality

3.G Determining the threat of halogens on the Wasatch Front

TAKEAWAY» **Measurements of ambient halogens will help assess the new halogen emission inventory.**

Air quality in Utah is a complex and an ever-changing challenge impacting many areas of the state, but recent research has highlighted a previously underestimated class of chemicals that could make a difference in particulate matter and ozone levels along the Wasatch Front.

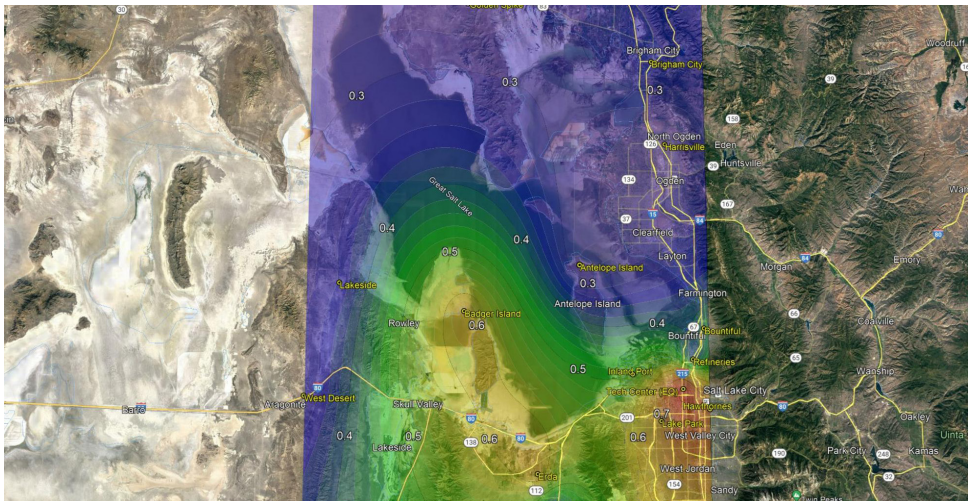
Halogens such as chlorine and bromine are highly reactive species, catalyzing numerous chemical reactions in the atmosphere. Although these species are probably best known for destroying the Earth's protective ozone layer in the stratosphere, they might also play an outsized role in Utah's ground-level air quality.

Halogens come from a variety of natural and anthropogenic sources including coal combustion, wastewater treatment, some mineral extraction, and sea spray. Despite being important for atmospheric chemistry, emissions from many of these sources are poorly constrained or sometimes, completely unknown. Utah's recent directive (HB220) to create a halogen emission inventory will help with the State's air quality modeling efforts and pollution control strategies, but a better understanding of ambient halogen concentrations is also a priority. The Utah Division of Air Quality and Utah State University are collaborating on a sampling campaign to better understand what halogen-containing compound concentrations look like along the Wasatch Front. Preliminary observations from the first phase of this three-part study (figure below) show enhanced hydrochloric acid concentrations along the southern part of the study area, including the Metro area and Badger island. The magnesium production operation of US Magnesium was offline during the sampling period. When complete, the study will constrain spatial variability of halogen levels and help identify hotspots and possible sources along the Wasatch Front.

Figure 3.G.1 Preliminary results from phase 1 of halogens study (Jan.-Feb. 2023)

Average hydrochloric acid concentrations (in parts per billion) are interpolated between the study measurement sites (yellow font). Warmer colors correspond to higher concentrations.

Source: *Dr. R. Martin, USU, 2023*



LEFT: *URBAN POWER PLANT | SALT LAKE COUNTY*

UTAH'S AIR *in the news*

As we've tracked Utah and national news through 2023, we have compiled some of the key air issues and topics that have appeared in media outlets this year.

01. HEALTH EFFECTS OF AIR POLLUTION

This year, a number of new studies further detailed the health impacts of air pollution on people. Health risks include high blood pressure, mental health issues like depression and anxiety, and even antibiotic resistance. Research indicates that breathing Utah's polluted air for a day is comparable to smoking up to five cigarettes. Poor air quality can lead to increased mistakes in tasks and has been linked to a heightened risk of breast cancer.

02. OZONE AND REGULATION

Utah faces significant ozone-related challenges, with a multimillion-dollar litigation process occurring between the state and the EPA regarding the "good neighbor" rule aimed at reducing downwind pollution. In June, the Tenth Circuit Court of Appeals granted a stay in the case brought by the State of Utah regarding the state-specific rule. In September, a federal appeals court rejected a general stay on the rule as it relates to all 26 participatory states. Litigation efforts continue as both parties appeal.

03. HALOGEN EMISSIONS' ROLE IN UTAH POLLUTION

Halogens, especially bromine, have diverse applications in industry and chemistry. However, concerns about environmental impacts have arisen. Emissions from the US Magnesium plant in Utah's Tooele County contributed to local air pollution. Lawmakers are amending an air quality bill to target this source. Additionally, studies and legislation focus on bromine emissions to address Utah's air quality issues.

04. NEW INVESTMENTS IN AIR QUALITY

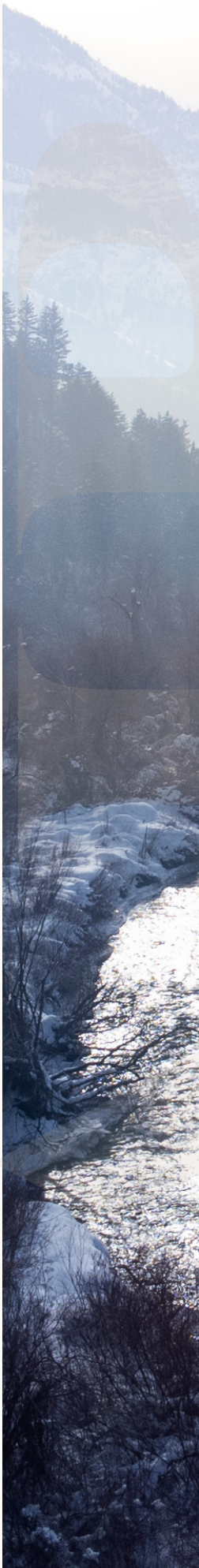
New funding will support the installation of monitors for dust storms and ozone levels and a state-of-the-art facility for clean-air transit vehicles. A federal initiative is providing air purifiers for K-12 classrooms, with doctors urging schools to act. E-bike incentives were announced in Salt Lake County. Nationally, NASA launched a new satellite, TEMPO, to enhance air pollution data.

05. LOOKING TO THE FUTURE OF CLIMATE IN THE WEST

While a wet winter has brought drought relief to the West, challenges persist. The threat of returning drought looms, influenced by El Niño patterns. Extreme heat could exacerbate wildfires and reduce air quality in affected regions.

What's going on in Utah's land, water and air?

We publish a weekly email newsletter, containing a categorized roundup of about 30 stories in local and national media outlets related to Utah's land, water, and air. Subscribe at: **usu.edu/ilwa/newsletter**.



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LEFT: *WINTER INVERSION LAYER | CACHE COUNTY*

Chapter 4

COLORADO RIVER

Key issues facing the Colorado River

4.A DECISIONS THAT LIE AHEAD FOR THE COLORADO RIVER

4.B CAN WE RELY ON DROUGHT-BUSTING "MIRACLES" IN THE COLORADO RIVER BASIN?

4.C IRRIGATION OPTIMIZATION AND AGRICULTURE'S FUTURE IN THE COLORADO RIVER BASIN

4.D DROUGHT AND WATER ACCESS HEAVILY IMPACT TRIBAL ECONOMIES

4.E THE FUTURE OF OUTDOOR RECREATION ON THE COLORADO RIVER

4.F MANAGING LAKE POWELL'S WATER LEVEL REQUIRES CONSTANT ATTENTION

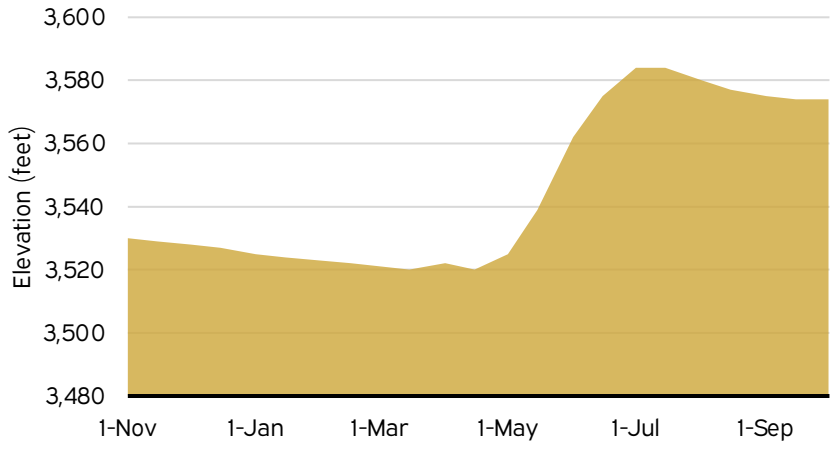
Chapter Summary by BRIAN STEED

The Colorado River system, a vitally important source of water to Utah and six other Southwestern states, is facing very real challenges. A big water year has helped the system avoid crisis in the short term. Lake Mead, Lake Powell, and Flaming Gorge all gained much-needed water this year. Inflows raised Lake Powell an amazing 65 feet. This gain in water was sufficient to allow access to boat ramps that had been inaccessible for several years.

Yet, major decisions remain in how the river system is to be managed. Even with the gain in elevation, Lake Powell remains at below 40% of capacity. Making matters more complicated, experts generally concede that the system is oversubscribed, creating uncertainty about how much water Utah can reliably count on receiving. The largest challenge to overcome is hydrology and the imbalance between supply and demand. The flows of the river are different than what was expected when the Colorado River Compact was negotiated between the states over 100 years ago.

Given this set of facts, the basin states have a number of decisions to make in the runup to 2026, when the current management plan for the river is set to expire. The states must agree on how much water to store and where. More problematically, the states must decide on how much and where water *will be used*. All of these questions require data and understanding. In the remaining sections in this section, we examine some of the ongoing work to understand the river, its importance, and its future.

Figure 4.I.1 Lake Powell elevation (Nov. 2022–Oct. 2023)



Source: *Lake Powell Water Database*

COLORADO RIVER / GRAND COUNTY (STEVE SMITH)

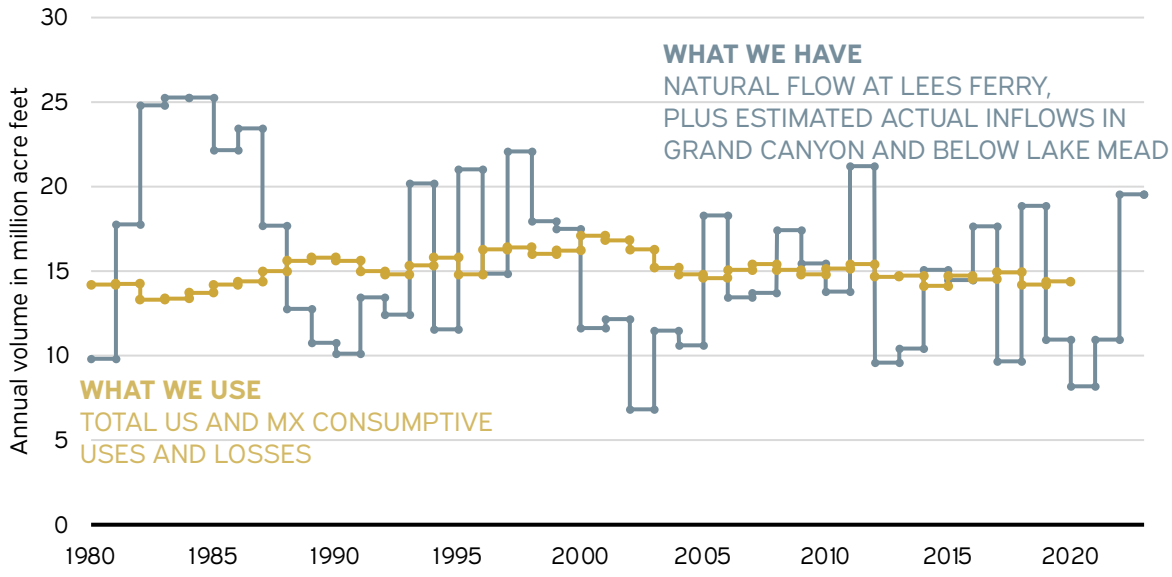
WATER *by JACK SCHMIDT*

4.A Decisions that lie ahead for the Colorado River

TAKEAWAY» **Despite a very wet winter, the best option for sustainable use and management of the Colorado River, and for the stability of Utah's growing communities, is to focus on significant reductions in consumptive use.**

Unregulated inflow to Lake Powell reservoir from this year's large snowpack was 13.6 million acre feet (maf), an amount significantly greater than the 9.6 maf average managers have seen during the past three decades. This year's inflow was second only to the inflow of 2011 that was the largest of the 21st century. The total annual water supply for the Colorado River Basin—the sum of unregulated inflows to Lake Powell, plus all upstream human uses and losses and all other water sources in the basin—is predicted to exceed the rate of human use of the river's water by almost 5 maf. A year of such a great snowfall and runoff might suggest to some that the water-supply crisis of the Colorado River is over. But the two largest reservoirs in the United States, Lake Mead and Lake Powell, are still more than 30 maf below full capacity. If 2023 were repeated multiple times, and basin-wide consumption remains as high as it is today, it would take six additional years to refill the two reservoirs—an unlikely scenario. The wet winter of 2023 came at a very

Figure 4.A.1 Basinwide water supply and basinwide water use



The figure above shows the comparative difference between total consumtive uses and losses and the natural flow at Lees Ferry (where Colorado River water leaves Utah) plus estimated actual inflows in Grand Canyon and below Lake Mead. There is a water surplus when the natural flow exceeds consumtive uses, and a water deficit exists when the consumtive uses are higher than natural flow. (Adapted from Schmidt et al 2023)

IT WOULD TAKE SIX ADDITIONAL WET YEARS TO REFILL LAKE POWELL AND LAKE MEAD — AN UNLIKELY SCENARIO.

ABOVE: *LONE ROCK BEACH | LAKE POWELL | KANE COUNTY*

fortunate time for managers, but it is only a temporary reprieve.

The clock of water shortage is still ticking. The climate of the Intermountain West continues toward aridification, and warm temperatures combined with dry soils will continue to reduce the flow of the Colorado River.

Our best option for the health of the Colorado River, and for the stability of growing communities, is to continue to find ways to make significant reductions in consumptive use. Everyone needs to play a part to save water in the region. Fundamental changes in the Law of the River are needed to negotiate strategies to reduce consumptive use everywhere in the basin. Making difficult choices to cut consumptive use and face the tradeoffs that come with growing populations isn't straightforward or easy, but it remains the reality for managers and communities. This year's wet winter has offered leaders time to negotiate a more thoughtful, adaptive solution. The challenge now is not to squander that opportunity.

WEATHER & CLIMATE *by SIMON WANG*

4.B Can we rely on drought-busting "miracles" in the Colorado River Basin?

TAKEAWAY» **The frequency and intensity of drought-busting spring precipitation in the Colorado River Basin may decrease due to climate change, impacting water management strategies.**

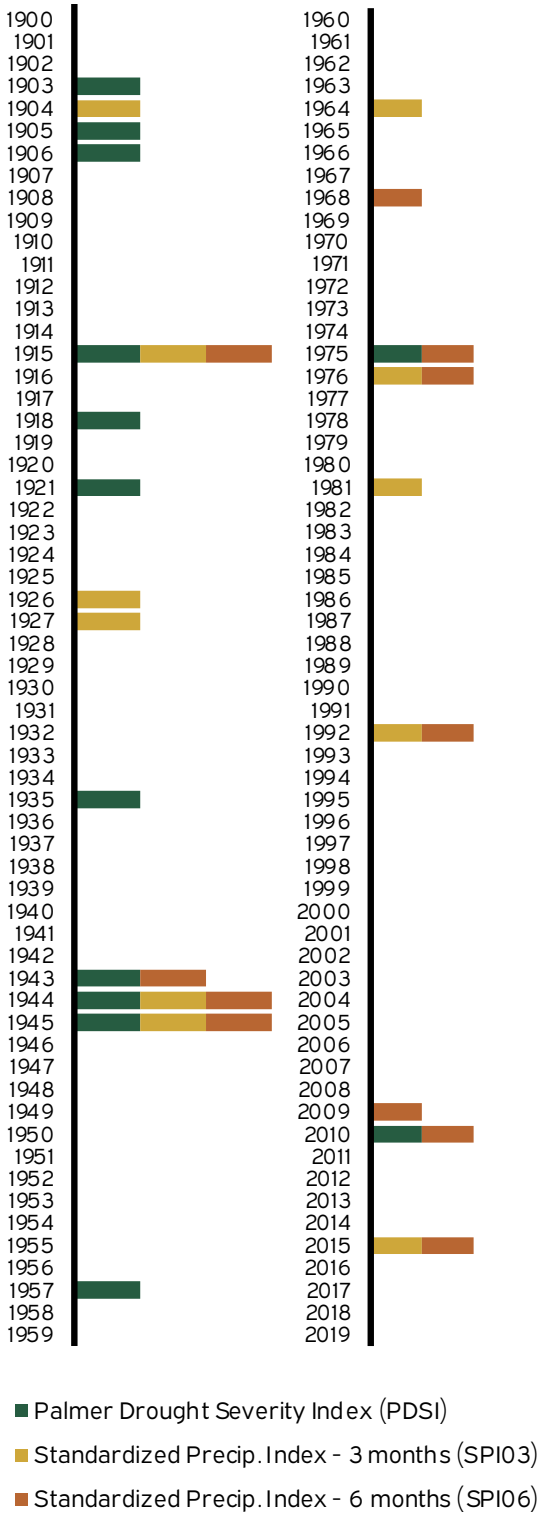
In recent years, we have witnessed drought-busting spring precipitation events in the Colorado River Basin, such as the so-called "Miracle May" of 2015. Some may consider spring 2023 to be another miracle. These events provide much-needed relief in times of severe drought, but their frequency and intensity have not been well researched or characterized. Our ongoing research aims to define and quantify these extreme dry-to-wet springtime transitions, which is crucial for understanding their future occurrence and potential impact on water management strategies.

As the world continues to warm, our research suggests that these miraculous events may become less frequent and less intense. This finding holds significant implications for water managers, as they must assume less-certain recurrence of such "miracles" and develop strategies to ensure an adequate water supply for agriculture, municipal uses, and ecological needs. As we delve deeper into the study of these events, it is essential to consider their spatial and temporal variability and the consequences they pose to different regions within the basin. For instance, an extreme dry-to-wet transition might benefit some areas while causing floods and fires in others, as was the case with the 2015 storm events that led to flooding in Texas.

We will continue to collaborate with stakeholders and water managers to identify the best metrics for characterizing these events and refine our understanding of their climatological characteristics. By doing so, we can better prepare for the challenges ahead and develop informed, adaptive strategies for managing water resources in the Colorado River Basin. With a proactive approach, including utilizing advanced climate prediction methods, we can mitigate some effects of climate change and ensure the basin's water supply remains sustainable for future generations.

AN EXTREME DRY-TO-WET TRANSITION MIGHT BENEFIT SOME AREAS WHILE CAUSING FLOODS AND FIRES IN OTHERS.

Figure 4.B.1 Historical miracle events calculated by three different indices



A miracle event occurs when at least four consecutively anomalously dry months are followed by at least three consecutive anomalously wet months.


WR-33

UTAH AGRICULTURE

by MATT YOST

4.C Irrigation optimization and agriculture's future in the Colorado River Basin

TAKEAWAY» **The Colorado River is vital to Utah food production and can thrive through strategic water optimization, deficit irrigation, and fallowing.**

Agriculture annually consumes about half of the total water share in the upper and lower basins of the Colorado River. This water supports over 360 thousand acres of irrigated cropland. The predominant crops include alfalfa and grass hay, accompanied by a significant portion of pastureland. These crops are well adapted to the high elevation, variable terrain, and frequent droughts that are common in the eastern half of Utah. Sprinkler (wheel-lines and pivots) irrigation is the dominant irrigation method, followed by surface irrigation. Water optimization is possible through water conveyance systems and on-farm improvements.

There are over 1,000 miles of open channel canals in this basin where water losses could be reduced. However, quantifying the opportunity for reduced water consumption is difficult due to high variability and high uncertainty in water losses and return flow in these delivery systems. On-farm improvements through advanced irrigation systems could reduce annual water consumption by up to approximately 10% or 36,000 acre-feet per year if all systems were converted to more-efficient sprinklers or drip irrigation. Changing crop types and ensuring they could be successfully marketed could save up to about one acre-foot per acre of consumption. These improvements would result in long-term investments in water reductions that would not reduce food production.

Deficit irrigation and fallowing provide the largest opportunities to reduce water consumption, with savings of up to two acre-feet per acre. These are short-term but sometimes necessary solutions that reduce crop production. Thus, combinations of optimization in off- and on-farm water use (long-term reductions), and deficit irrigation and fallowing, when necessary, will ensure that agriculture thrives and downstream demands are met.

ON-FARM IMPROVEMENTS THROUGH ADVANCED IRRIGATION SYSTEMS COULD REDUCE ANNUAL WATER CONSUMPTION.

NATIVE LANDS *by KYNDA CURTIS, MAN-KEUN KIM and TATIANA DRUGOVA*

4.D Drought and water access heavily impact tribal economies

TAKEAWAY» **Drought negatively impacts cattle and forage production on tribal lands, affecting economies and necessitating policies that support the resilience of Native American communities.**

Indigenous people in the Colorado River Basin have claims to Colorado River water. Tribes have ancestral land and reservations in the basin and rely on the river for agricultural, cultural, and economic purposes. Unfortunately, legal challenges continue to shape claims and the access many native people have to that water.

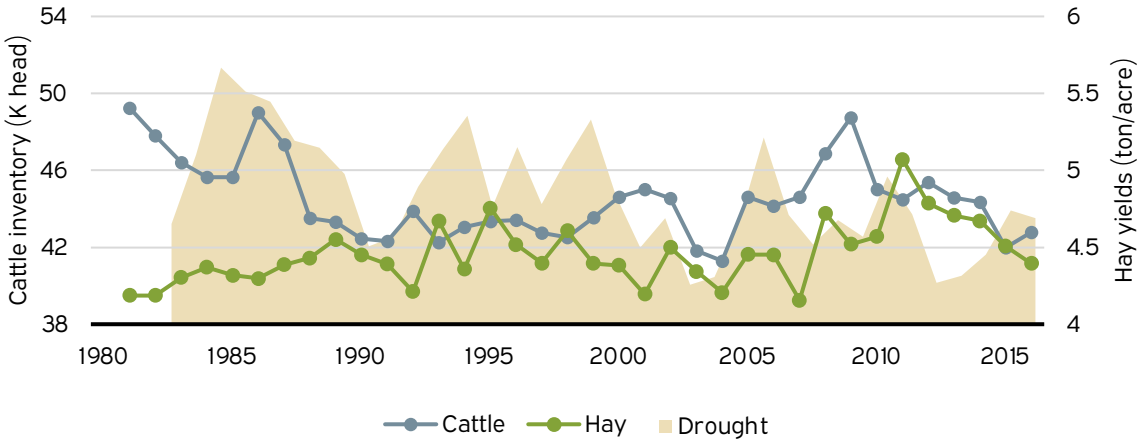
As part of the USDA-funded Native Waters on Arid Lands project, we examined the impacts of drought on tribal economies in the Southwest, focusing on reservations heavily reliant on agricultural production. Specifically, we evaluated the economic effects of drought on cattle and hay production sectors in Arizona, Nevada, New Mexico, and Utah and projected economic impacts given hypothetical drought scenarios.

Drought has significant negative consequences on tribal economies, specifically on cattle and forage production, with cattle inventory decreasing with each successive year of drought.

The economic losses resulting from drought scenarios were substantial for large reservation areas, such as the Uintah and Ouray Reservation, Navajo Nation, and

Figure 4.D.1 Direct impacts of drought on reservation cattle and hay sectors

This graph compares cattle inventory and hay yield on studied tribal lands over time (averaged across reservations by year). The Palmer Drought Severity Index (PDSI) is included as the yellow background area, with a range of -5.3 to 7.4.. This study was supported by the Native Waters on Arid Lands project, the Utah Division of Water Resources, and Utah State University Extension.



Tohono O'odham Nation. These losses have significant implications for the livelihoods of tribal communities, as agriculture plays a crucial role in their economic sustainability.

Climate change and drought affect the viability of tribal economies and disrupt traditional foodways and ceremonies, creating a range of adverse effects on the well-being of individuals and communities.

To address the negative impacts of drought on reservation economies, the study suggests a need to tackle barriers that hinder tribal communities' capacity to mitigate and adapt to drought and climate change. Some of these challenges include unsettled water rights, lack of financial and labor resources to monitor, prepare, and respond to drought conditions, and limited authority to prevent water pollution that originates outside reservations.

Our work underscores the importance of understanding and addressing the effects of drought on tribal economies. Developing targeted policies and support systems may enhance the resilience of Native American communities to climate-induced challenges and safeguard traditional ways of life.

Table 4.D.1 Reservations included in study

- Acoma Pueblo
- Duck Valley
- Goshute
- Hopi
- Jicarilla Apache
- Laguna Pueblo
- Mescalero Apache
- Moapa River
- Navajo Nation
- Pyramid Lake
- Pueblo of Isleta
- San Carlos
- Tohono O'odham
- Uintah and Ouray
- Washoe
- White Mountain
- Zuni Pueblo

FARM NEIGHBORING UINTA AND OURAY TRIBAL RESERVATION | EMERY COUNTY

RECREATION *by ANNA MILLER*

4.E The future of outdoor recreation on the Colorado River

TAKEAWAY» **The trend toward an increasingly dry climate has practical and economic impacts for recreation hubs on the Colorado River.**

Outdoor recreation in Utah accounts for 2.7% of the state's GDP, supports over 66,000 jobs[4.E.1] and is a vital part of the state's economy—but the water resources on which these experiences rely are in flux. Utah's section of Colorado River is an important recreation resource for Moab and Lake Powell. Drought has reduced the river's flows, decreasing water-based recreation opportunities for local, national and international visitors. For example, white-water rafting in Cataract Canyon (a popular stretch of river running from Moab to Lake Powell) is possible for 257 days per year in dry years, down from 362 days in wet years. However, the number of days considered 'optimal' for whitewater boating drops dramatically from 121 days in wet years to 37 days in dry years[4.E.2]. This substantial drop has important economic implications.

At Lake Powell, low water levels may mean that boat ramps can't reach the lake. In 2022, significantly low water levels prompted managers to close one marina for the season, and to build an extension to facilitate lake access at another ramp[4.E.3]. In May 2023, four of 15 boat launch ramps were closed to non-motorized access, and eight were closed to motorized access due to problematic water levels[4.E.4]. Although the record-breaking water year of 2023 may temporarily moderate this issue, ongoing aridification will likely continue to create real-world implications for recreationists and the state's tourism economy.

Models based on long-term data indicate that a 10.3-inch drop in Lake Powell's water level (equivalent to 100,000 less acre-feet of water) in a year are associated with over 5,000 fewer recreational visits to Lake Powell, and $374,000 less in annual visitor spending[4.E.5]. As a changing climate continues to push the Colorado River Basin toward aridification, Utah's recreation industry will need to be aware of thresholds that could change the way people use the land.

Figure 4.E.1 Annual visitation to Canyonlands National Park and Glen Canyon National Recreation Area (1965–2022)

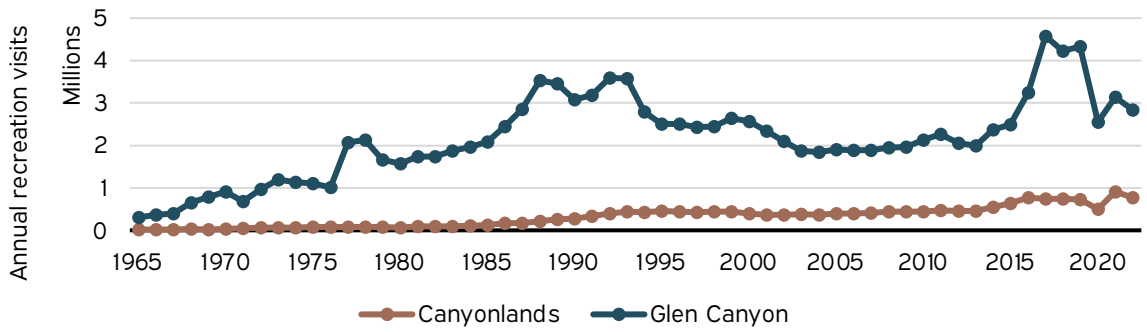
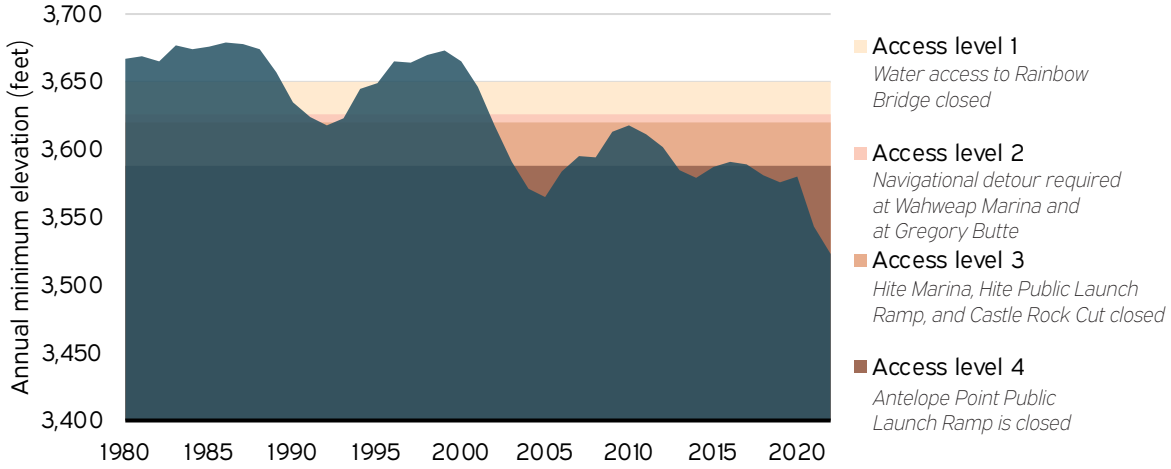


Figure 4.E.2 Lake Powell minimum elevation levels and key recreational access levels (1980–2022)



Source: *National Park Service, USBR*

LAKE POWELL MARINA | KANE COUNTY

RESERVOIRS

by AMY HAAS, Colorado River Authority of Utah

4.F Managing Lake Powell's water level requires constant attention

TAKEAWAY» **The Drought Response Operations Agreement (DROA) released approximately 580 thousand acre-feet of water from Flaming Gorge to Lake Powell in 2021 and 2022. Water managers should be careful to ensure such transfers don't incentivize further releases from Lake Powell to the Lower Basin.**

Lake Powell is a centerpiece of the Colorado River system with the capacity to store approximately 24 million acre-feet of water and make releases for municipal use, agriculture and power generation, while supporting native species recovery efforts and recreational interests. However, the reservoir has been declining since 2000, approaching critically low elevations in recent years and threatening safe operations of Glen Canyon Dam. To protect critical elevations at Lake Powell, the Bureau of Reclamation released approximately 588,000 acre-feet of water from Flaming Gorge Reservoir to Lake Powell in 2021 and 2022 under the Drought Response Operations Agreement (DROA).

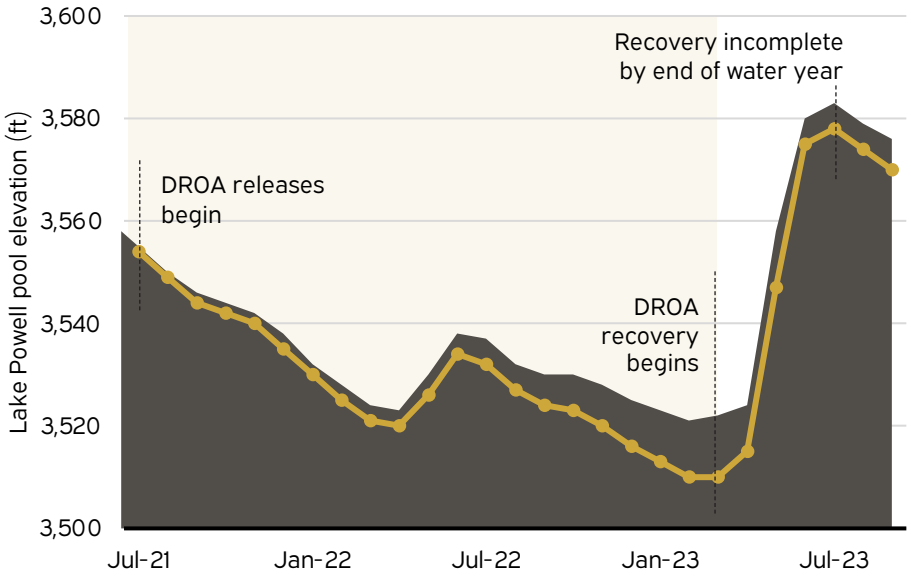
The combination of wet hydrology in 2023 and DROA releases succeeded in stabilizing Lake Powell elevations. Accordingly, additional releases from Flaming Gorge were suspended in March 2023 giving way to efforts to recover the previously released water. Full recovery at Flaming Gorge is anticipated in February 2024.

While DROA has proven to be both an effective and flexible tool, proper accounting is essential to ensuring DROA fulfills its objective. If not accounted for separately, the presence of DROA water at Lake Powell may lead to greater releases from Glen Canyon Dam for the benefit of the Lower Basin. This type of "mining" of Lake Powell can only be avoided if the Bureau of Reclamation ensures that future DROA releases are retained at Lake Powell until full recovery at Flaming Gorge, or any other participating upstream reservoir, is achieved. Unfortunately, this has not occurred and releases under DROA intended to protect Lake Powell ultimately have had the opposite effect. In 2023, the reservoir will be approximately 180,000 acre-feet lower had the DROA releases not occurred.

RELEASES UNDER DROA INTENDED TO PROTECT LAKE POWELL ULTIMATELY HAVE HAD THE OPPOSITE EFFECT.

FLAMING GORGE DAM | DAGGETT COUNTY

Figure 4.F.1 Lake Powell elevation scenarios with the Drought Response Operations Agreement (2021-2023)



Approximately 355,000 acre-ft of DROA water remaining in Lake Powell when balancing release is calculated results in about 177,500 acre-ft sent as part of balancing release.

COLORADO RIVER *in the news*

As we've tracked Utah and national news through 2023, we have compiled some of the key Colorado River issues and topics that have appeared in media outlets this year.

01. TEMPORARY WATER REDUCTION PLAN

The Colorado River negotiations have seen several key milestones. Six states in the basin initially agreed to a water-reduction plan, with California resisting. Federal proposals for water cuts brought further disagreements. Eventually, all seven states reached a temporary conservation agreement but faced skepticism regarding long-term solutions. Future management and federal assistance efforts are ongoing as they plan for the river's future beyond 2026.

02. LAKE POWELL RISING ABOVE RECORD LOWS

Lake Powell's water levels have experienced significant fluctuations. In recent years, the lake reached record lows. However, heavy snowpack and wet weather patterns have led to notable rises, offering temporary relief. Still, hydrologists estimate it would take many years of above-average snowpack to fill the lake back to peak levels.

03. DISCUSSIONS ON THE FUTURE OF LAKE POWELL

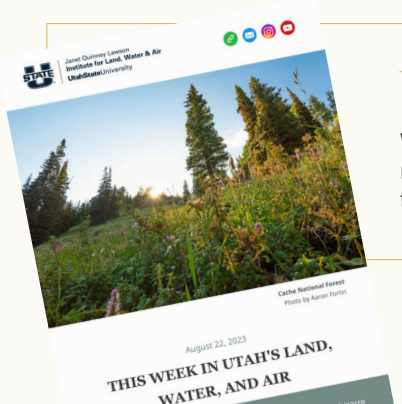
The Colorado River's water capacity to support Lake Powell and Lake Mead is in question, with concerns that these reservoirs may not refill in our lifetimes. Public input is sought on the fate of Lake Powell, with proposals ranging from draining it to restoring Glen Canyon. Some proposals suggest focusing on Lake Mead and restoring natural river flow. Debate rages over the potential impact on recreation and tourism.

04. INDIGENOUS PEOPLE'S WATER RIGHTS

Native American water rights took center stage in the Colorado River narrative. The Gila River Indian Community secured a deal with the U.S. government. The Navajo Nation faced a Supreme Court setback over treaty-based water access. Tribes' involvement gained importance in river operations, emphasizing inclusivity and consultation in the ongoing struggle for fair water allocation.

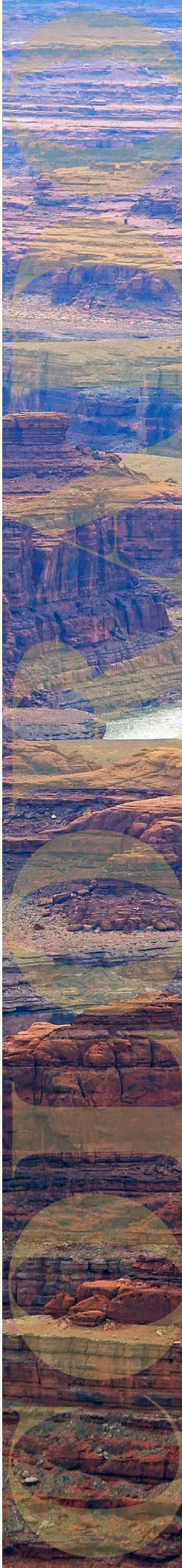
05. UNDERSTANDING COLORADO RIVER'S WATER SUPPLY

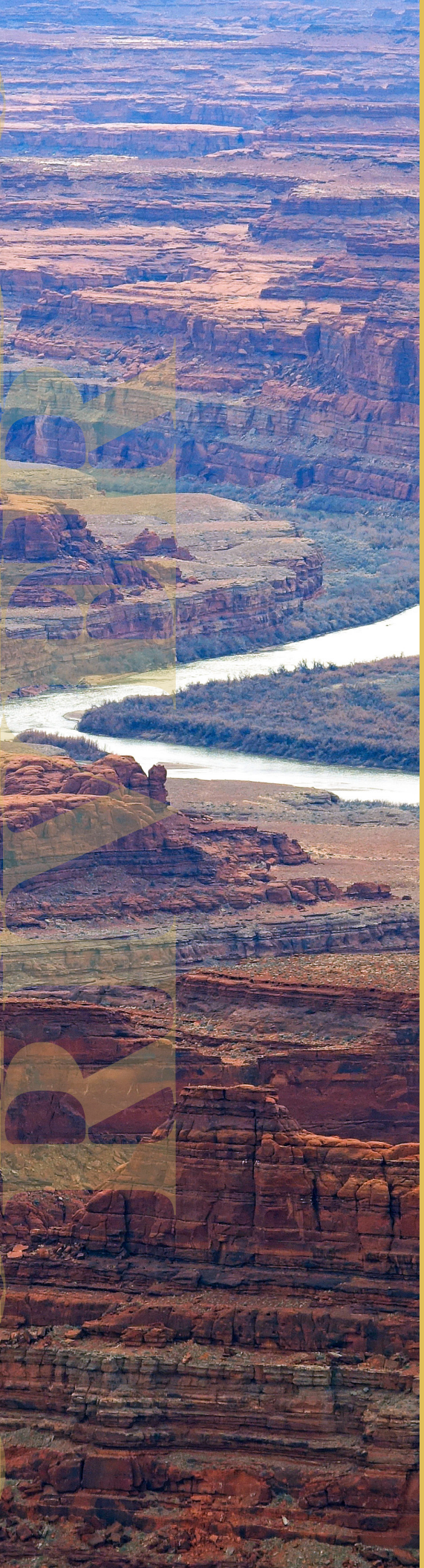
Evaporation from the Colorado River intensified disputes between Lower and Upper Basin states, as water allocation becomes meticulous. Researchers delved into sublimation, unearthing the river's hidden losses. Changes in long-term weather patterns exacerbate the problem, with higher temperatures deemed responsible for significant "water theft." Studies reveal that "low is the new average" on the Colorado River.



What's going on in Utah's land, water and air?

We publish a weekly email newsletter, containing a categorized roundup of about 30 stories in local and national media outlets related to Utah's land, water, and air. Subscribe at: **usu.edu/ilwa/newsletter**.





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LEFT: *COLORADO RIVER | CANYONLANDS NATIONAL PARK | GRAND COUNTY (STEVE SMITH)*

Chapter 5

ENERGY

Key issues facing Utah's energy

5.A A TEAM TO CHART UTAH'S ENERGY FUTURE

5.B CHARGED PERSPECTIVES ON SOLAR PROJECTS IN UTAH

5.C BENEFITS AND BARRIERS TO MOVING TOWARD NET-100% RENEWABLE ELECTRICITY

5.D CREATING A STRATEGY FOR SMART ELECTRIFIED TRANSPORTATION IN UTAH

5.E A CLEAN, SECURE ENERGY TRANSITION NEEDS UTAH'S CRITICAL MINERALS

5.F EXTRACTIVE INDUSTRIES AND UTAH'S ECONOMY

Chapter Summary *by BRIAN STEED*

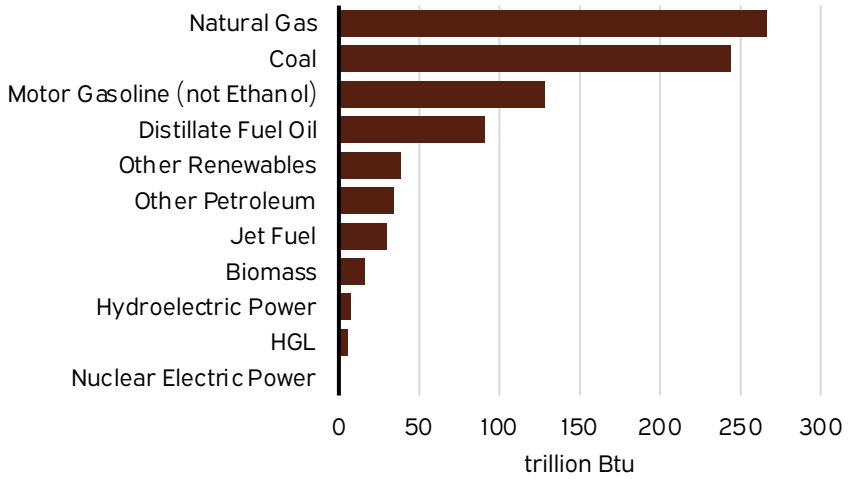
Utah law specifies that "It is the policy of the state that Utah shall have adequate, reliable, affordable, sustainable, and clean energy sources" (Utah State Code 79-6-301). Meeting each of these attributes is challenging. The pursuit of adequate, reliable and affordable energy sources has led to a reliance on carbon-intensive energy production. Indeed, according to the federal Energy Information Administration, 53% of Utah's electricity production came from coal-fired power plants in 2022. An additional 26% came from natural gas fired power in that same time frame. These sources, however, are frequently criticized as neither sustainable nor clean.

Utah has also seen a recent surge in wind and solar electricity generation, which are often held up as more clean, sustainable, and increasingly affordable. But these sources also have limitations in that they struggle at providing base-load power, calling into question their adequacy and reliability. Hence, Utah is seeking alternatives.

In 2023, Rocky Mountain Power indicated its intent to develop adequate, reliable, and carbon-free energy from nuclear sources. Plans are still in the works to identify how affordable and sustainable these efforts might be. Other sources such and geothermal and hydrogen are showing real promise to further meet the state's energy needs, but they are largely still in the development phase.

Energy will truly prove to be the challenge of our day, which highlights the necessity for quality research and innovative approaches. In the following sections, we highlight some of the insights of researchers at USU in the energy space.

Figure 5.I.1 Utah's energy sources (2020)



Source: *U.S. Energy Information Administration*

PLANNING *by BRIAN STEED*

5.A A team to chart Utah's energy future

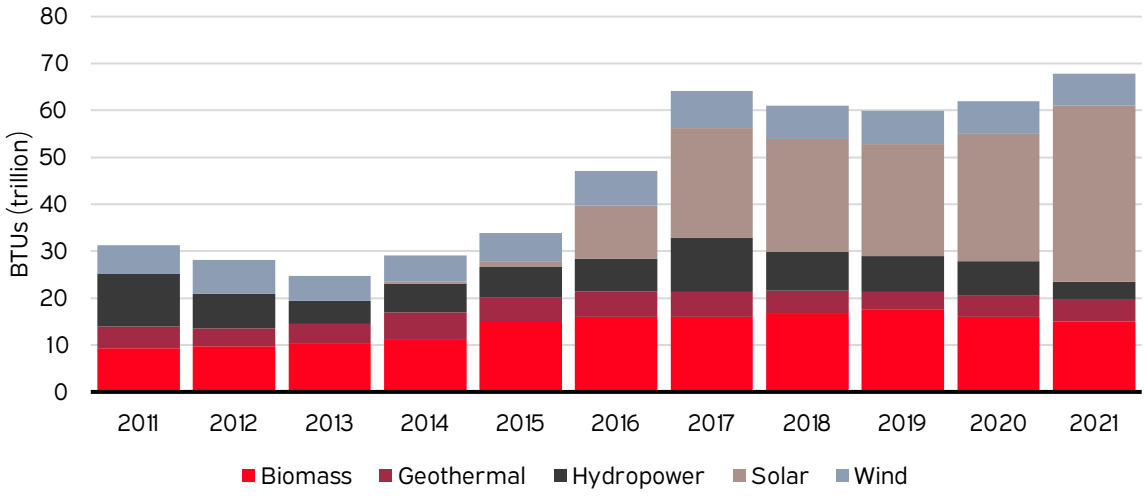
TAKEAWAY» **The Energy Strike Team's collaborative efforts are shaping a sustainable and diverse energy future for Utah, addressing critical issues from resource diversification to workforce development.**

The Energy Strike Team, a collaborative effort initiated by the Governor's Office of Energy Development in response to HB 426, has been diligently working towards shaping Utah's energy landscape. The primary objective of this task force is to align the state's energy policy with the goals of ensuring an energy supply that is adequate, reliable, affordable, sustainable, and clean.

One of the key focal points of discussion within the Energy Strike Team pertains to diversifying Utah's energy portfolio. Currently heavily reliant on fossil fuels, including coal and gas, Utah possesses ample resources to broaden its energy mix. The team grapples with questions about the right balance and how to harness the full potential of diverse energy sources, such as nuclear, geothermal, wind, and solar, while considering affordability and regional resource advantages.

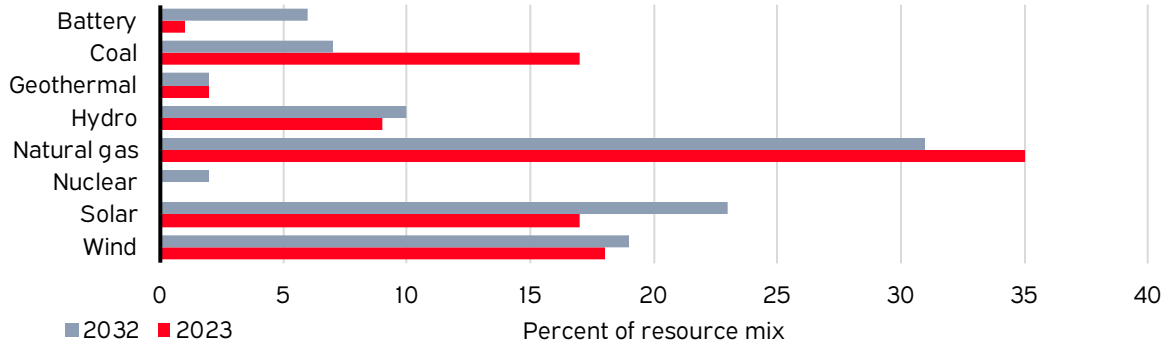
Moreover, energy storage has emerged as a critical concern, prompting discussions about policy reforms, state code amendments, and grid modernization. The team endeavors to explore how to meet these storage needs effectively. Workforce development is another vital area under scrutiny. The team examines

Figure 5.A.1 Utah renewable energy consumption by source (2011-2021)



Source: *United States Energy Information Administration*

Figure 5.A.2 Utah renewable energy consumption by source compared with future projections (2011–2021)



Source: *Western Electricity Coordinating Council*

how to cultivate a skilled workforce for the evolving energy sector and considers the role of educational institutions in this endeavor.

Natural resource exploration in Utah, including uranium for nuclear fuel and critical minerals for energy storage and technology, is also on the agenda. The team seeks ways to harness these resources responsibly and keep the associated jobs within the state of Utah.

Furthermore, the Energy Strike Team addresses the unique challenges faced by rural communities and tribal areas, striving to ensure equitable access to energy and economic opportunities.

The overarching goal is to create a sustainable, economically viable, and environmentally friendly energy future for Utah, all while accommodating a rapidly growing population. The team also aims to enhance the capabilities of the San Rafael Energy Research Center to support these ambitious objectives. Through these deliberations and collaborative efforts, the Energy Strike Team envisions a brighter and cleaner energy future for the state of Utah.

TESLA SUPERCHARGER STATION | BOX ELDER COUNTY

SOLAR ENERGY *by SARAH KLAIN*

5.B Charged perspectives on solar projects in Utah

TAKEAWAY» **Managing the political hot potato of expanding solar PV projects on Utah farms can be improved by understanding growers' opinions, particularly related to fair water policy.**

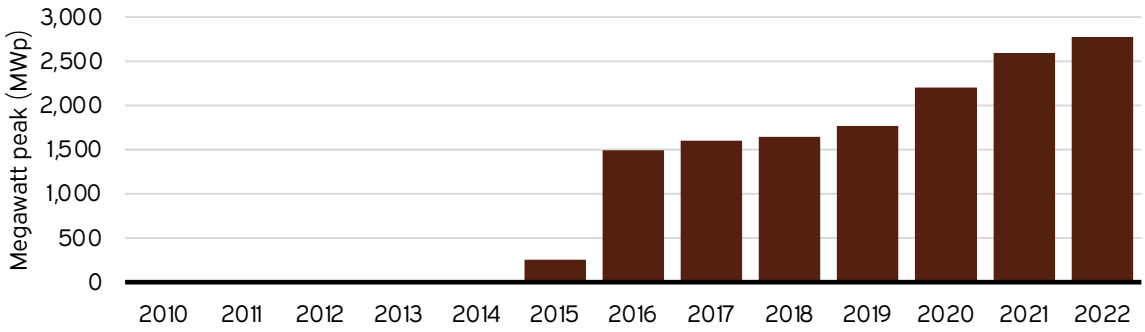
Transitioning to clean energy could help to improve Utah's air quality, but the transition depends on the extent to which individuals and communities accommodate clean energy technologies like solar photovoltaics. An efficient way of scaling up the use of solar energy is to build solar farms on agricultural land. In addition to clean energy, this could offer other benefits to Utah's people and environment—converting water intensive cropland to solar panels could reduce water consumption while generating steady lease income to landowners.

Inevitably, reducing agricultural water use involves trade-offs. New research is investigating conditions that may support or inhibit farmers from converting traditional farmland to solar farms, including concerns about losing future water rights. Interviews and surveys of growers will be able to identify other economic, environmental, cultural heritage and aesthetic considerations at play.

For example, is partial conversion of agricultural fields to solar panel fields more appealing to farmers than other methods of reducing water use? More broadly, this research identifies roles that growers see for themselves in processes for co-developing water conservation policies and managing solar energy development.

RURAL SOLAR FARM | CARBON COUNTY

Figure 5.B.1 Grid-connected solar photovoltaic capacity in Utah (2010–2022)



Source: *Solar Energy Industries Association*

ONE WAY OF SCALING UP THE USE OF SOLAR PHOTOVOLTAICS IS TO BUILD SOLAR FARMS ON AGRICULTURAL LAND. INEVITABLY, IT INVOLVES TRADE-OFFS.

Table 5.C.1 Utah Community Renewable Energy Program Participants

ANCHORS	PARTICIPANTS
Town of Castle Valley	Alta
Grand County	Coalville
Millcreek	Emigration Canyon Township
Moab	Cottonwood Heights
Park City	Francis
Salt Lake City	Holladay
Summit County	Kearns
	Oakley
	Ogden
	Salt Lake County
	Springdale

COMMUNITY ENERGY *by ROSLYNN MCCANN and EDWIN STAFFORD*

5.C Benefits and barriers to moving toward net-100% renewable electricity

TAKEAWAY» **With a coalition of Utah communities committed to moving to net-100% renewable electricity by 2030, USU researchers are examining barriers and finding opportunities in the strategy.**

Working independently of state goals, 18 Utah communities are voluntarily engaged in the Community Renewable Energy Program (CREP), representing about 25% of Utah's electricity demand. The program is an effort to achieve net-100% renewable electricity by 2030 and is the first of its kind in the nation. While communities participating in the program will not run completely on clean energy by the deadline, their efforts are projected to build enough new renewable sources across Rocky Mountain Power's system to offset participants' total annual electricity demand. The program creates a market-based motivation for renewable development by leveraging a large block of customers to work with their monopoly utility to meet renewable demand at a manageable price.

Researchers investigated how Salt Lake City, Park City, and Moab enacted net-100% renewable electricity resolutions, prompting the Utah Legislature to pass the Community Renewable Energy Act of 2019, which established an avenue for communities and Rocky Mountain Power to create the program. Twenty-three communities in Utah took the first step, but five have since dropped out of the program, concerned with administrative costs, impacts on electricity rates (communities are currently negotiating the program's rates with Rocky Mountain Power), and plans by Rocky Mountain to develop renewable energy sources independently of the program.

Wind and solar are among today's most cost-effective electricity sources, especially as issues of base load and energy storage continue to be addressed. In addition to creating better air quality in the state, renewable energy offers price stability while taking virtually no water from drought-prone systems and helping to mitigate climate change. This research is an important step into uncovering why some groups left the program and articulating lessons learned for ways communities and utilities can better collaborate to pursue net-100% renewable electricity.

THE COMMUNITY RENEWABLE ENERGY PROGRAM REPRESENTS ABOUT 25% OF UTAH'S ELECTRICITY DEMAND.

LEFT: *WIND TURBINES | SPANISH FORK CANYON | UTAH COUNTY*

ENERGY & TRANSPORTATION *by REGAN ZANE*

5.D Creating a strategy for smart electrified transportation in Utah

TAKEAWAY» **Freight transport creates significant challenges to moving more fully to electrified vehicles. Advances in batteries and charging infrastructure can help address these problems.**

Vehicles drive the national economy, transporting more than 11 billion tons of freight and traveling more than three trillion miles annually. However, transportation is also the single largest contributor to emissions and air pollution. Electrification can support cleaner air and reduce costs, but vehicle costs and infrastructure are significant barriers to widespread adoption.

While electric vehicles (EVs) represent just over 1% of all registered vehicles in Utah today, their annual growth rate now exceeds 50%, and estimates predict more than 500,000 EVs in the state by 2035. The need for fast charging ports in the state is expected to grow from approximately 300 today to more than 2,000 in that same time frame. An even larger challenge is addressing zero-emission solutions for the 1.5 million light trucks and 100,000 heavy trucks in the state. A battery-powered electric semi-truck with a 500-mile range would require batteries that weigh over 20,000 pounds and cost over $150,000.

With this in mind, the ASPIRE Center at USU is developing and deploying advanced technologies to minimize vehicle battery size while maximizing electric utility and charging infrastructure utilization. ASPIRE is a National Science Foundation Engineering Research Center headquartered at USU that has received more than $100 million in commitments for research projects and pilot demonstrations. Pilots of technologies from ASPIRE and its partners are being deployed over the next two years in Utah, Indiana, Florida, and Michigan, and have gained national and international attention in public media.

Deployments in Utah include AI-based smart-charge management, in-road dynamic wireless charging for port vehicles, and a one-megawatt wireless power charging system for semi-trucks to be deployed at USU's Electric Vehicle and Roadway (EVR) research facility and at the Utah Inland Port in Salt Lake City. The system will provide valuable data and experience for further electrification planning development on Utah's I-15 corridor and other future projects.

ASPIRE has been designated as the lead research institution in Utah for strategic planning around electrified transportation. In this role, ASPIRE will coordinate across state agencies, communities, and industry sectors in developing a unified electrified transportation plan and in pursuing resources and policies to implement the plan. In a related project funded by the U.S. Department of Energy, ASPIRE is also developing an urban multi-modal freight corridor electrification plan for Utah together with more than 20 partners, including the state's leading utility and transit agency, national labs, and key state government agencies.

ASPIRE's long-term goals are designed to bring society to the tipping point of electrified transportation, where primary barriers are addressed and sufficient momentum and funding are present to carry the transformations forward with continued innovation.

RIGHT: *ELECTRIC VEHICLE TESTING ON TRACK AT USU ELECTRIC VEHICLE AND ROADWAY RESEARCH FACILITY (ASPIRE)*

WHILE ELECTRIC VEHICLES REPRESENT JUST OVER 1% OF ALL REGISTERED VEHICLES IN UTAH TODAY, THEIR ANNUAL GROWTH RATE NOW EXCEEDS 50%, AND ESTIMATES PREDICT MORE THAN 500,000 EVs IN THE STATE BY 2035.

RENEWABLE ENERGY *by JEFF TAYLOR, PHILLIP FERNBERG, and JAMIE BUTIKOFER*

5.E A clean, secure energy transition needs Utah's critical minerals

TAKEAWAY» **Mineral extraction and clean energy development require striking a delicate balance.**

Utah is uniquely positioned to play an outsized role in supplying critical minerals for the United States' ongoing clean energy transition. Last year, Utah's non-fuel mineral production was valued at over $3.6 billion, up 16% from 2020[5.E.1]. Over the coming decades, Utah will receive more attention as rising demand and renewed efforts to secure U.S. supply chains elevate the importance of the state's critical minerals.

At least 38 of the 50 critical minerals designated by the U.S. Geological Survey are found in Utah, including many needed for renewable energy technologies. Lithium and magnesium extracted from Great Salt Lake salt brines are critical for rechargeable batteries used in electric vehicles. Tellurium from the Bingham Canyon Mine is used in solar cells. Vanadium from Southeast Utah could be used for grid-scale energy storage, and thorium from the same region is used for nuclear power. Monazite deposits throughout Utah contain rare-earth elements needed for permanent magnets in wind turbines. By 2040, global demand for critical minerals used in clean energy technologies is projected to quadruple[5.E.2]. Managing growing demand will require careful planning to ensure high industry standards, address market fluctuations, and balance sustainable extraction in sensitive areas.

While demand increases, so do efforts to reduce U.S. dependence on foreign mineral sources. Utah could play a key role in securing domestic supply chains for renewable energy development. For more than a decade, Utah has been a top-ten state for non-fuel mineral production. Utah is currently one of two states with commercial lithium production and the only state producing beryllium, magnesium, and indium. Utah also produces or has produced other minerals with energy impact, including copper, zinc, antimony, molybdenum, gallium, germanium, and uranium.

Table 5.E.1 Critical minerals currently produced in Utah

COMMODITY	ELEMENT SYMBOL	TOP GLOBAL PRODUCER	NOTABLE UTAH LOCATIONS
Beryllium	Be	United States (UT)	Juab Co.
Helium	He	United States	Grand, Emery, San Juan Co.
Magnesium metal	Mg	China	Great Salt Lake
Potash	K (KCl, K2, SO4)	Canada	Great Salt Lake, Tooele Co. (Bonneville Salt Flats), Grand and San Juan Co. (Paradox Basin), Millard Co. (Sevier Lake)
Platinum and Palladium	Pt, Pd	South Africa, Russia	Salt Lake Co. (Bingham mine)
Rhenium	Re	Chile	Salt Lake Co. (Bingham mine)

Table 5.E.2 Established critical mineral resources in Utah

COMMODITY	ELEMENT SYMBOL	TOP GLOBAL PRODUCER	NOTABLE UTAH LOCATIONS
Aluminum	Al	Australia (bauxite)	Beaver Co.
Fluorspar	F(CaF2)	China	Juab Co.
Indium	In	China	Juab Co.
Lithium	Li	Australia	Great Salt Lake, Grand and San Juan Co. (Paradox Basin)
Uranium	U	Kazakhstan	San Juan, Grand, and Emery Co.
Vanadium	V	China	San Juan, Grand, and Emery Co.

Source: *Utah Geological Survey*

KENNECOTT COPPER MINE | SALT LAKE COUNTY

MINING & ENERGY *by JOHN BAZA, Utah Division of Oil, Gas and Mining*

5.F Extractive industries and Utah's economy

TAKEAWAY» **Utah's extractive industries encompass a wide range of raw material extraction processes, presenting challenges in quantifying their overall economic impact. At the same time, they play a significant role in the state's economy.**

The term "extractive industries" broadly refers to companies or individuals involved in the extraction of energy resources and mineral materials from the earth, which are utilized by consumers globally. These resources include crude oil, natural gas, coal, metals, salts, chemicals, strategic and critical minerals, fuel minerals like uranium and vanadium, as well as construction materials such as stone and rock.

In the United States, these raw products are subject to free market business transactions, with some being traded in futures contracts on national commodity exchanges. These resources and materials, which play a role in maintaining a certain standard of living, possess intrinsic value to the public and economic value that drives businesses to invest in and profit from their conversion into usable products. It's worth noting that even agricultural commodities rely on mineral fertilizers, chemicals for crop cultivation, metals for machinery fabrication, and refined petroleum and hydrocarbons for power generation.

In the state of Utah, there exists a substantial economic presence in the petroleum and mining extractive industries. It is important to acknowledge that both of these industries consist of three key components:

1. An upstream sector that involves the extraction of raw materials from the ground.
2. A midstream sector responsible for transporting these raw materials to processing facilities.
3. A downstream sector focused on processing or refining raw materials into consumable products that are then distributed to end-users.

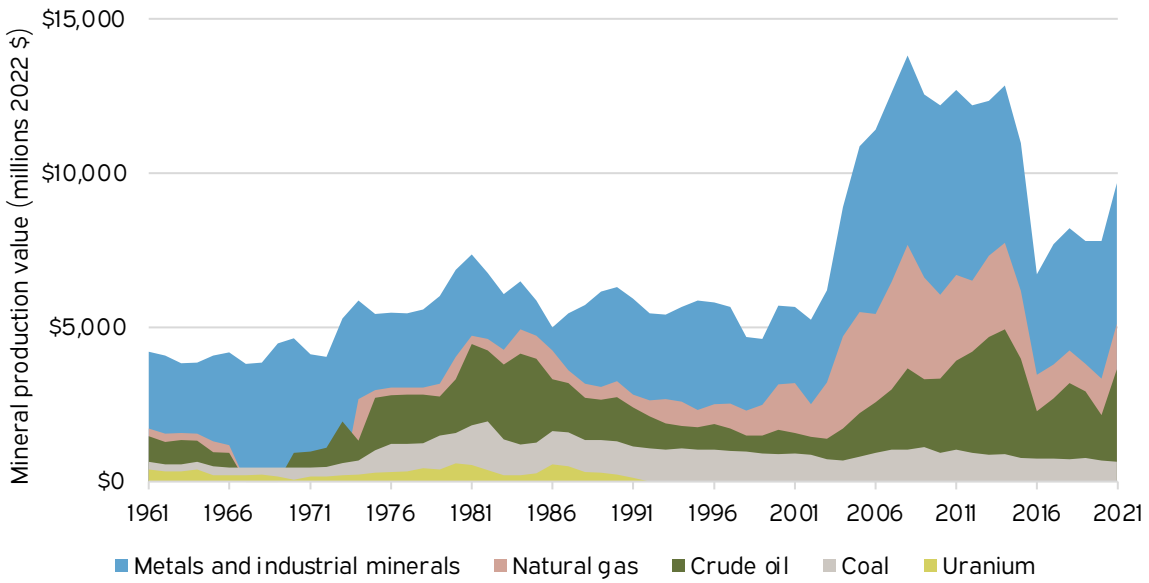
However, it is challenging to locate comprehensive studies that accurately represent the economic impact of all three operational sectors. Some studies aggregate economic value from both upstream and downstream sectors while disregarding the financial contributions of the midstream sector. Additionally, other reports may depict the benefits of tax and royalty revenue to the government based on wellhead or market values of produced commodities, without considering the value-added contributions from midstream transportation or downstream processing.

It is indeed a complex task to correlate the total economic value of all operational sectors, whether collectively or individually. The operational sectors associated with Utah's petroleum and mining industries can potentially contribute billions of dollars annually to the state's economy, possibly accounting for a significant portion of the yearly gross product, estimated at around 10-15%.

UTAH'S PETROLEUM AND MINING CAN CONTRIBUTE BILLIONS OF DOLLARS ANNUALLY TO THE STATE'S ECONOMY.

PHOSPHATE ORE MINE | UINTA COUNTY

Figure 5.F.1 Annual value of Utah energy and mineral production, inflation adjusted to 2022 dollars (1960–2022)



Source: *Utah Geological Survey; U.S. Geological Survey; Utah Division of Oil, Gas and Mining; U.S. Energy Information Administration; Utah Tax Commission.*

UTAH ENERGY *in the news*

As we've tracked Utah and national news through 2023, we have compiled some of the key energy issues and topics that have appeared in media outlets this year.

01. UTAH'S ENERGY TRANSITION

Utah's energy landscape is evolving in 2023, spurred by various factors. Calls for action, tax credits, and climate change concerns are driving the shift to cleaner energy sources. Public support for renewable energy, conservation efforts, and reduced emissions are evident across the Western U.S. Companies, along with government initiatives, are shaping this transition, presenting both environmental and economic opportunities for the state.

02. ALTERNATIVE ENERGY ADVANCES

Utah is diversifying its energy landscape with nuclear technology, hydrogen blending, and geothermal projects. Some policymakers see nuclear power as a grid-stabilizing solution. The state is exploring aquifer thermal energy and solar energy on public lands. Grid-forming inverters show promise, while drought impacted hydropower.

03. UINTA BASIN RAILROAD PROJECT

The Uinta Basin Railroad project has faced setbacks as the U.S. Court of Appeals rejected the Surface Transportation Board's approval, citing environmental and financial concerns. The project is currently paused, pending a potential restart of the environmental review or a petition to the U.S. Supreme Court by its developers.

04. FEDERAL LAND DESIGNATION IN ARIZONA

The Baaj Nwaavjo I'tah Kukveni Grand Canyon National Monument proposal in Arizona sparked controversy. While aimed at safeguarding sacred areas and limiting mining, Utah leaders objected, and Arizona Senate Republicans plan to sue over potential uranium mining restrictions. The monument grants tribes co-stewardship but raises the debate over conservation versus resource access.

05. UTAH OIL, GAS, AND COAL

Utah's traditional energy sector is marked by efforts to reduce waste and environmental impacts. Calls for capturing lost natural gas, cleaning up abandoned wells, and highlighting the climate harm of gas leaks impacted the oil and gas industry. Coal mining is declining, with Carbon County seeing its first coal-free period, raising questions about job losses. Additionally, concerns over coal-related pollution persist, as evidenced by coal ash dumping sites and emissions regulations. The state's energy future is closely tied to the transition from coal to cleaner alternatives.

What's going on in Utah's land, water and air?

We publish a weekly email newsletter, containing a categorized roundup of about 30 stories in local and national media outlets related to Utah's land, water, and air. Subscribe at: **usu.edu/ilwa/newsletter**.

CHAPTER 5 REFERENCES

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LEFT: *SALT LAKE CITY AT NIGHT | SALT LAKE COUNTY*

Land, Water, and Air Bills Passed During the 2023 Utah Legislative Session

Agriculture

H.B. 114 | **Theft Defense Amendments**
Albrecht
This bill provides that it is not a defense to theft of livestock that the livestock is sick, injured, or a liability to the owner.

H.B. 169 | **Urban Farming Assessment Act Amendments**
Peterson K
This bill provides that a county may limit an authorization of urban farming to either cultivating crops or engaging in livestock production or may allow both.

H.B. 221 | **Fodder Production Systems Grant Program**
Birkeland
This bill expands the environmental improvement projects for which grants may be awarded.

H.B. 257 | **Greenbelt Mentor Amendments**
Kyle
This bill requires a county or commission to waive the acreage requirement for agricultural assessment if the assessed property fails to meet the acreage requirement because of a qualified utility or governmental entity exercising eminent domain or threatening eminent domain.

H.B. 371 | **Working Farm and Ranch Protection Fund**
Snider
This bill renames the LeRay McAllister Critical Land Conservation Program; establishes the LeRay McAllister Working Farm and Ranch Fund; addresses county use of rollback taxes; and addresses county use of rollback tax funds.

H.B. 397 | **Urban Farming Assessment Amendments**
Kohler
This bill provides that a portion of land withdrawn from assessment under the Farmland Assessment Act is not subject to a rollback tax if the land is eligible for, and the owner applies for, assessment under the Urban Farming Assessment Act; establishes a renewal application under the Urban Farming Assessment Act; for property that was previously assessed under the Farmland Assessment Act, addresses eligibility and application of the rollback tax under the Urban Farming Assessment Act.

S.B. 9 | **Agricultural Advisory Board Sunset Extension**
Sandall
This bill extends the sunset date of the Agricultural Advisory Board from 2023 to 2028.

S.B. 187 | **State Fair Park Amendments**
Sandall
This bill provides for the dissolution of the Utah State Fair Corporation; creates the State Fair Park Authority as a successor entity to the Utah State Fair Corporation, with similar but modified duties; authorizes the Authority to impose a special event sales tax; requires the State Tax Commission to distribute to the authority certain sales tax revenue generated from a hotel on fair park land; makes property on state fair park land subject to the privilege tax and provides for revenue from the tax and from personal property tax to be paid to the Authority; modifies provisions relating to the operation, maintenance, construction, and modification of buildings and facilities on state fair park land; authorizes the Authority to issue bonds and enacts provisions relating to the bonds;.

Agricultural and Domestic Animals

H.B. 184 | **Veterinary Education Loan Repayment Program**
Albrecht
This bill creates the Veterinarian Education Loan Repayment Program within the Department of Agriculture and Food; specifies the program's duties; specifies what a qualified veterinarian must do to be eligible for payment from the program; authorizes the use of program funding for certain program administration costs; requires annual reporting by the program; authorizes rulemaking to administer the program; designates program funding as nonlapsing.

H.B. 187 | **Veterinary Practice Amendments**
Kohler
This bill exempts certain individuals who test a bovine for pregnancy from the requirement to be licensed under the Veterinary Practice Act.

H.B. 523 | **Egg Retailer Amendments**
Wilcox
This bill addresses exemptions from regulations for the sale of shell eggs.

S.B. 61 | **Livestock Collision Amendments**
Owens
This bill requires a railroad to report livestock strikes; clarifies liability for damages to livestock caused by railroad operations; creates a process for a livestock owner to be compensated for livestock damaged by a railroad; provides an appeal process regarding the actual fair market value of damaged livestock; modifies and clarifies requirements regarding a railroad's duty to construct and maintain fencing along railroad rights-of-way; requires each railroad to pay a fee based on mileage to cover damages to livestock caused by railroad operations; allows the Department of Agriculture and Food to pay for costs of administration and staff salary related to the administration of livestock damage claims from fees paid by railroads; grants rulemaking authority to the Department of Agriculture and Food regarding compensation for livestock damaged by a railroad; prohibits a railroad from entering into an indemnification agreement related to damages to livestock.

S.B. 108 | **Animals Shelter Revisions**
McKell
This bill addresses the methods by which an animal shelter or animal control officer may euthanize an animal; requires an animal shelter that euthanizes animals to adopt a euthanasia policy and training program; and makes technical changes.

S.B. 113 | **Local Agricultural Amendments**
Sandall
This bill, except for certain exceptions, prohibits a municipality or a county from adopting or enforcing an ordinance or other regulation that prohibits or effectively prohibits the operation of an animal enterprise or the use of a working animal.

S.B. 259 | **Department of Agriculture and Food Amendments**
Owens
This bill addresses changes to the state veterinarian responsibilities; provides labeling requirements for pet treats; modifies labeling requirements for seed; creates a restricted account; and makes technical and conforming changes.

LEFT: *FALL FOLIAGE | CACHE COUNTY*

Air

H.B. 220 | **Emissions Reduction Amendments**
Stoddard
This bill requires the Division of Air Quality (division) to conduct an inventory related to certain emissions; requires the division to complete an emissions reduction plan for certain emissions; requires the division to recommend state standards limiting halogen emissions; requires the division to publish the inventory, plan, and recommendations on the division's website; and requires the division to report on the inventory, plan, and recommendations.

H.B. 319 | **Uintah Basin Air Quality Research Project Amendments**
Chew
This bill repeals the sunset date for the Uintah Basin Air Quality Research Project.

S.C.R. 2 | **Concurrent Resolution Regarding the Environmental Impact of Vehicle Idling**
Fillmore
This resolution provides data on fuel expended idling compared with restarting an engine; encourages Utahns to turn off their engines, especially in areas where sensitive populations congregate; and encourages certain businesses, organizations, and entities to place signs educating drivers on the fuel savings of restarting an engine instead of idling.

Energy and Mining

H.B. 144 | **High Cost Infrastructure Development Tax Credit Amendments**
Albrecht
This bill provides that the corporate high cost infrastructure development tax credit does not automatically expire for lack of use before the 2027 tax year; modifies the definition of "high cost infrastructure project" to include the storage or production of all fuels; defines an "underground mine infrastructure project"; adds an "underground mine infrastructure project" to the definition of "infrastructure" for purposes of being eligible for a high cost infrastructure development income tax credit; includes severance tax revenue in the calculation of the taxpayer's high cost infrastructure development tax credit; and provides that a high cost infrastructure project that begins in the taxable year before an applicant makes a tax credit application is eligible for a tax credit.

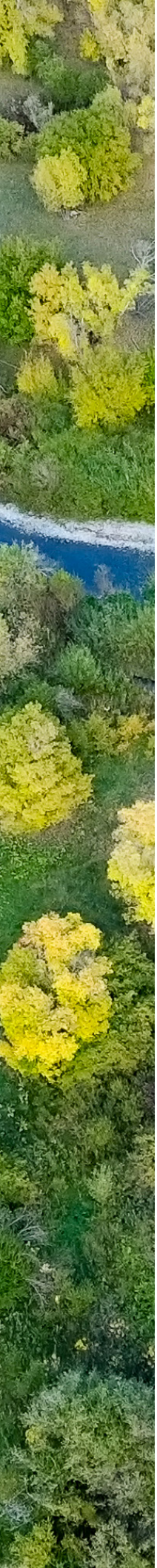
H.B.321 | **Mineral Lease Amendments**
Christofferson
This bill introduces an online option for the disclosure of a mineral lease application; and modifies the deadline for disclosing an application.

H.B. 425 | **Energy Security Amendments**
Ivory
This bill modifies provisions related to the regulation of energy. It requires a project entity to provide notice to the Legislative Management Committee 180 days prior to: the disposal or sale of any project entity asset; and the decommissioning of a coal-powered electrical generation facility. It requires the Office of Energy Development to: conduct a study of a project entity; and report the results of the study to the Public Utilities, Energy, and Technology Interim Committee. It also modifies the state energy policy to promote the state's energy independence by: promoting the use of energy resources generated within the state; and promoting the use of clean energy sources by considering the emissions of an energy resource throughout the entire life cycle of the energy resource; provides legislative findings; requires a qualified utility to inform the Office of the Attorney General when a proposed federal regulation would result in the early retirement of an electrical generation facility; authorizes the Office of the Attorney General to take any action to defend the state's interests with respect to electricity generation by a qualified utility facing a proposed federal regulation that would result in the early retirement of an electrical generation facility.

S.B. 62 | **Hydrogen Amendments**
Hinkins
This bill directs the Department of Natural Resources to establish a hydrogen advisory council within the Office of Energy Development which may advise on issues related to hydrogen.

Hunting and Firearms

H.B. 219 | **Firearms Regulations**
Lisonbee
This bill declares the state's commitment to the Second Amendment to the United States Constitution; and declares that the state and its political subdivisions will not enforce federal regulations that purport to restrict or ban certain firearms, ammunition, or firearms accessories.



H.B. 2/26 | **Sale of a Firearm Amendments**
Maloy
This bill directs the Bureau of Criminal Identification to create an online process that allows an individual involved in the sale of a firearm to determine if the other party to the sale has a valid concealed carry permit or the firearm has been reported as stolen; and includes a sunset date.

H.B. 237 | **Hunting Mentor Amendments**
Albrecht
This bill creates a hunting mentor program; describes the circumstances under which a minor may use an adult's permit under the program.

H.B. 341 | **Electronic Stamp Designation**
Bolinder
This bill authorizes the Division of Wildlife Resources (division) to provide for the purchase of an electronic duck stamp on the division's website; requires the payment of a fee for the purchase of an electronic duck stamp on the division's website.

H.B. 461 | **Airport Firearm Possession Amendments**
Gricius
This bill provides when a firearm that was seized as part of a criminal offense at an airport may be returned to the firearm's owner; modifies the offense of possession of a dangerous weapon at an airport; restricts the ability of a prosecutor to seek the forfeiture of a firearm under certain circumstances; and makes technical and conforming changes.

Land

H.B. 261 | **Fire Related Amendments**
Snider
This bill addresses prescribed fires, pile burns, and nonfull suppression events on private land; provides for transfers to the Wildland-urban Interface Prevention, Preparedness, and Mitigation Fund; modifies procedures related to closed fire seasons; addresses when burning is allowed, including addressing when permits are required, notice requirements, criminal penalties, and liability; addresses the Wildland Fire Suppression Fund; enacts provisions related to wildland-urban interface fire prevention, preparedness, and mitigation.

H.B. 396 | **Paleontological Resources Amendments**
Elison
This bill modifies provisions related to paleontological resources and collections. It provides that a city of the first or second class that has a paleontology museum may retain, curate, and manage specimens, collections, and paleontological resources recovered on lands owned or controlled by the city.

S.B. 75 | **Sand and Gravel Sales Tax Amendments**
Sandall
This bill distributes the local sales and use tax revenue from sales made by ready-mix concrete manufacturers to each county, city, and town with a sand and gravel extraction site within its boundaries; specifies a formula by which the State Tax Commission apportions the revenue; requires the county, city, or town to use the revenue for class B and class C roads; provides direction related to sourcing in-state sales made by certain establishments.

Outdoor Recreation

H.B. 55 | **Off-Highway Vehicle Registration Requirements**
Albrecht
This bill exempts a snowmobile from the requirement to obtain and display a license plate for an off-highway vehicle and amends provisions related to off-highway vehicle safety courses.

H.B. 93 | **Outdoor Recreation Modifications**
Stratton
This bill increases the amount that may be used each fiscal year for the Recreation Restoration Infrastructure Grant Program; amends the types of entities that are eligible to receive an infrastructure grant through the Outdoor Recreational Infrastructure Grant Program.

H.B. 224 | **Outdoor Recreation Initiative**
Stenquist
This bill creates the Recreation Coordinated Investment Initiative; grants rulemaking authority; requires reporting; and addresses funding of the initiative.

H.B. 299 | **Boating Amendments**
Snider
This bill diverts a portion of the uniform fee on certain vessels to fund boating related grants; creates the Utah Boating Grant Account; provides for the administration of a grant program by the Office of Outdoor Recreation

related to the Utah Boating Grant Account; addresses boating safety requirements.

H.B. 384 | **Outdoor Recreation Infrastructure Amendments**
Stenquist
This bill amends the Outdoor Adventure Infrastructure Restricted Account and the makeup of the Outdoor Adventure Commission.

Management

H.B. 30 | **Wildlife Resources Code Recodification**
Snider
This bill clarifies rulemaking authority; addresses compensation of employees; clarifies delegation to employees of use of fireworks; clarifies review by regional advisory councils of cooperative wildlife management units.

H.B. 31 | **Wildlife Resources Recodification Cross References**
Snider
This bill changes relevant cross references; and makes technical changes.

H.B. 39 | **State Resource Management Plan Amendments**
Stratton
This bill adopts a state resource management plan to replace a previously adopted plan.

S.B. 5 | **Natural Resources, Agriculture, and Environmental Quality Base Budget**
Sandall
This bill supplements or reduces appropriations otherwise provided for the support and operation of state government for the fiscal year beginning July 1, 2022 and ending June 30, 2023 and appropriates funds for the support and operation of state government for the fiscal year beginning July 1, 2023 and ending June 30, 2024.

S.B. 10 | **Wildlife Sunset Related Amendments**
Sandall
This bill modifies provisions related to a board, committee, or council created under Title 23, Wildlife Resources Code of Utah.

S.B. 147 | **Department of Environmental Quality Adjudicative Proceedings Amendments**
McKell
This bill addresses adjudicative proceedings of the Department of Environmental Quality.

Sustainability

H.B. 110 | **Waste Tire Recycling Modifications**
Snider
This bill modifies provisions related to waste tire recycling. It repeals provisions related to certain municipal landfill deposits.

H.B. 217 | **School Energy and Water Reductions**
Bennion
This bill authorizes the state board to issue grants related to energy and water reductions; provides for prioritizing certain projects; requires rulemaking; requires use of an evaluation panel; requires reporting; and provides a repeal date.

Symbols

H.B. 92 | **State Mushroom Designation**
Watkins
This bill designates the porcini as the state mushroom.

H.B. 137 | **State Crustacean Designation**
Lesser
This bill designates the brine shrimp as the state crustacean.

Water

H.B. 33 | **Water Related Liability Amendments**
Albrecht
This bill makes conforming amendments addressing governmental immunity; clarifies language related to operators of a water facility; addresses liability of an owner or operator of a water facility, stream, or river along certain trails; codifies standard of care; addresses liability of an owner or operator of a water facility; addresses interference related to a water facility.

H.B. 207 | **Compact Commission Amendments**
Snider
This bill addresses representation of the state related to compacts; amends provisions related to the Utah members of the Bear River Compact commission; amends provisions related to the Columbia Interstate Compact.

H.B. 208 | **Criminal Trespass Amendments**
Chew
This bill addresses criminal trespass on private property related to use of public waters. It establishes the elements of and penalty for certain criminal trespass; specifies certain defenses; and provides for statutory damages, attorney fees, and court costs.

H.B. 488 | **Utah Lake Authority Amendments**
Brammer
This bill modifies provisions governing the Utah Lake Authority Board. It changes membership requirements for the Utah Lake Authority Board.

H.B. 491 | **Amendments Related to the Great Salt Lake**
Shultz
This bill enacts the Great Salt Lake Commissioner Act, including: providing for the appointment of the commissioner; addressing duties and authorizations of the commissioner; addressing relationships with other state agencies; addressing the strategic plan; creating the Office of the Great Salt Lake Commissioner; addressing the Great Salt Lake Advisory Council; and addressing the Great Salt Lake Account; provides for protected records; provides that the Department of Natural Resources will provide facilities to the commissioner and office; addresses the Division of Forestry, Fire, and State Lands; modifies provisions related to ongoing administration of water trust provisions; addresses the compensation of the commissioner; expands the Board of Water Resources to include an individual who represents the interests of the Great Salt Lake.

H.B. 513 | **Great Salt Lake Amendments**
Snider
This bill modifies provisions related to severance taxes; clarifies minerals with royalties going to the Great Salt Lake Account; addresses mineral leases or royalty agreements related to the Great Salt Lake; provides for royalties for certain elements and minerals; requires a study and reporting.

S.B. 34 | **Water Infrastructure Funding Study**
McCay
This bill directs the Department of Natural Resources (department) to study the use of property tax revenue to fund water infrastructure, treatment, and delivery; and make recommendations for future funding; and requires the department to submit a written report to the Natural Resources, Agriculture, and Environment Interim Committee and the Revenue and Taxation Interim Committee.

S.B. 53 | **Groundwater Use Amendments**
Vickers
This bill corrects punctuation related to storage as a beneficial use; modifies provisions related to recharge of an aquifer.

S.B. 76 | **Water Amendments**
Sandall
This bill provides for a study; addresses grants for environmental improvement projects; requires certain municipal and county planning commissions to consult with the Division of Water Resources in development of general plans; addresses consultation with the Department of Agriculture and Food; requires notification of irrigation and canal companies in certain circumstances; requires counties to notify certain public water systems and request feedback on how elements of the general plan affect certain water planning; requires counties to consider planning for regionalization of public water systems; provides for action by the director of the Division of Drinking Water to establish regional source and storage minimum sizing standards or adjust system-specific sizing standards; addresses a change application by a shareholder of a water company; provides what may be included in a water conservation plan; modifies requirements related to the Division of Water Resources making rules for regional water conservation goals; requires the Division of Water Resources to consult with watershed councils under certain circumstances; changes the membership of the Water Development Coordinating Council; directs the Water Development Coordinating Council to take actions related to the coordination of growth and conservation planning.

S.B. 119 | **Per Capita Consumptive Use**
McKell
This bill provides that per capita consumptive use is the standard in certain geographic areas; requires reporting districts to calculate per capita consumptive use; describes how per capita consumptive use is to be calculated; requires reporting to the Division of Water Rights; addresses scope of section regarding the

calculation, publication, or dissemination of consumptive water use numbers; and clarifies that specific agencies shall comply with the per capita consumptive use provision.

S.B. 158 | **Local Government Water Amendments**
McKell (3/3/2023)
This bill modifies provisions related to determining the basis for an exaction for a water interest imposed by certain local government entities; addresses water source protection ordinances.

S.B. 236 | **Legislative Water Development Commission Amendments**
Hinkins
This bill modifies provisions related to the Legislative Water Development Commission.

S.B. 251 | **Secondary Water Metering Requirements**
Hinkins
This bill modifies penalty provisions; provides for an alternative metering requirement under certain conditions; allows the issuing of grants for projects other than metering under certain conditions.

Water Conservation

H.B. 150 | **Emergency Water Shortages Amendments**
Albrecht (3/1/2023)
This bill amends the powers of the Department of Agriculture and Food; provides for the use of money in the Agriculture Resource Development Fund for emergency water shortages loans; addresses governmental immunity; enacts the Water Preferences During Emergencies chapter, including: providing for scope of the chapter; outlining the process for declaring a temporary water shortage emergency; addressing water use preferences under a temporary water shortage emergency; providing for compensation related to water use preferences; and addressing rulemaking by the Department of Agriculture and Food; repeals existing statutes related to water preferences and a study.

H.B. 307 | **Utah Water Ways**
Musselman
This bill provides for the creation of a new nonprofit, statewide partnership addressing water. It directs oversight of the creation of a partnership and the state's role in that partnership; outlines powers and duties of the partnership; addresses the selection of an executive director and board of directors; requires reporting; and addresses the role of water supply entities.

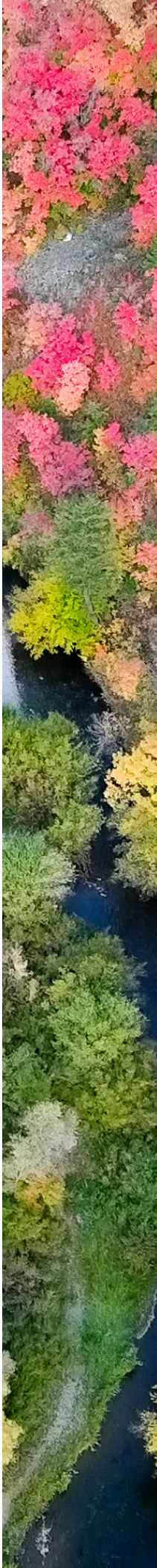
H.B. 349 | **Water Reuse Projects Amendments**
Snider
This bill defines terms; addresses approval of water reuse projects, including providing that the director of the Division of Water Quality approves; prohibits approval of certain water reuse projects impacting the Great Salt Lake; authorizes rulemaking; creates exceptions; addresses water replacement plans; provides for investigation of water reuse impacts as part of the integrated assessment of the Great Salt Lake.

H.B. 450 | **Landscaping Requirements**
Wilcox
This bill modifies provisions regarding water wise landscaping.

S.B. 118 | **Water Efficient Landscaping Incentives**
Sandall
This bill authorizes water conservancy districts to receive grants to provide incentives; provides conditions on when an owner may receive an incentive; addresses rulemaking authority; addresses tracking of local government implementation of water use efficiency standards; and makes technical and conforming changes.

S.B. 144 | **Water Instream Flow Amendments**
Hinkins
This bill allows for certain change applications related to delivery of water to reservoirs.

S.B. 191 | **Condominium and Community Association Amendments**
Harper
This bill provides that a community association rule may not prohibit low water use on lawns during drought conditions; requires a community association created before March 5, 2023, and adopt required rules



regarding water efficient landscaping before June 30, 2023.

S.B. 277 | **Water Conservation and Augmentation Amendments**
Sandall
This bill modifies the purposes for which money in the Water Infrastructure Restricted Account may be used; provides for transfer of certain loan payments from the Water Resources Conservation and Development Fund to the Water Infrastructure Restricted Account; codifies a grant program for agricultural water optimization; provides for public information and reporting regarding the grant program; addresses agricultural water optimization change applications and water savings; repeals provisions related to the Agricultural Water Optimization Task Force.

H.B. 406 | **Land Use, Development, and Management Act Modifications**
Whyte
This bill prohibits a municipality from requiring an assurance bond for private landscaping and removes ability of municipalities to use bonding to enforce water conservation ordinances.

Wildlife

H.B. 45 | **Domesticated Elk Program Amendments**
Stratton
This bill amends provisions related to the state veterinarian's powers related to the investigation, quarantine, and destruction of domesticated elk that may be infected with a disease spreading pathogen; importing domesticated elk into the state; and tracking imported domesticated elk; requires the Department of Agriculture and Food to study the importation of domesticated elk into the state, including from east of the 100 degree meridian.

H.B. 112 | **State Fish Hatchery Maintenance Account Amendments**
Albrecht
This bill modifies the amount of money to be deposited into the State Fish Hatchery Maintenance Account.

H.B. 121 | **Wildlife Habitat Account Amendments**
Peterson T
This bill addresses amounts that go to wetlands that are beneficial to waterfowl; addresses amounts that go to upland game projects.

H.B. 327 | **Pollinator Pilot Program Amendments**
Matthews
This bill extends the sunset date for the Pollinator Pilot Program.

H.B.447 | **Transplant of Wildlife Amendments**
Chew
This bill clarifies the procedures for the transplant of animals; requires the adoption of a mitigation plan before transplanting certain animals; imposes requirements for the mitigation plan.

H.B. 469 | **Wildlife Related Amendments**
Snider
This bill requires the Division of Wildlife Resources to notify the Division of Professional License of a suspension of the privilege to hunt or fish; addresses hunting with an air rifle; addresses the taking of cougars; modifies provisions related to use of trail cameras; creates the Wildlife Land and Water Acquisition Program; modifies provisions related to cooperative wildlife management units; addresses rulemaking by the Division of Professional Licensing; addresses when the Division of Professional Licensing is to refuse to issue, refuse to renew, or revoke a registration related to hunting guides and outfitters; provides for certain fees.

S.B. 112 | **Aquatic Invasive Species Amendments**
Sandall
This bill requires the payment of a fee and display of an aquatic invasive species decal before launching or operating a vessel; addresses the display of an aquatic invasive species decal obtained by payment of a fee; addresses the imposition of resident and nonresident fees.

The Janet Quinney Lawson Institute for Land, Water and Air in 2023

TOP LEFT: *GOVERNOR SPENCER COX AND EXEC DIRECTOR BRIAN STEED AT AN PANEL DISCUSSION AT USU |* ***TOP RIGHT:*** *BRIAN STEED AND MANAGING DIRECTOR ANNA MCENTIRE AT GROWING WATER SMART WORKSHOP WITH MUNICIPAL LEADERS |* ***BOTTOM LEFT:*** *INSTITUTE MEMBERS MEET WITH BEAR LAKE WATCH ON BEAR LAKE |* ***BOTTOM RIGHT:*** *CONGRESSMAN BLAKE MOORE JOINS ENERGY DISCUSSION AT USU.*

Vision

We envision a Utah with a high quality of life for our citizens that values and optimizes our state's shared resources while managing continued growth.

Mission

The institute guides Utah land, water, and air policy by connecting decision makers with high-quality research.

Values

- Data-driven decision making
- Compelling communication
- Shared partnerships
- Non-partisan perspective
- Listening and feedback

The Institute for Land, Water, and Air has moved forward on its mission of guiding Utah land, water, and air policy in Utah by connecting policymakers with high-quality research. In our first year of staffed operations, we have been able engaged with the state on major projects integral to Utah's shared resources.

We've partnered with the state legislature, state agencies, and other universities on the **Great Salt Lake Strike Team**. Last year, the team provided decisionmakers data insights and policy assessments on the lake; this year, the team will help provide expertise for the new Great Salt Lake strategic plan. We've also engaged with the Great Salt Lake Collaborative, as media outlets throughout the state report on key issues impacting the lake.

We're beginning a large interdisciplinary research program on **Bear Lake**, Utah's fourth-largest waterbody. With participation from faculty and students from across campus, we'll work with local, state, and federal government leaders, as well as non-profits and businesses, on addressing a number of critical issues in Bear Lake Valley.

At USU, we've introduced a number of campus-wide programs to support research and collaboration on land, water, and air issues. The **ILWA Impact Grant** has funded six researchers on projects designed to positively impact Utah. We've established two faculty working groups on the Colorado River and energy issues, and we've hosted a number of workshops, lectures, and community events.

The Institute has brought a number of high-level **visitors to campus**, including Gov. Spencer Cox, Lt. Gov. Diedre Henderson, Congressman Blake Moore, and Darren Parry of the Northwestern Band of the Shoshone Nation. We're looking forward to the coming year as we continue to expand our capacity and impact.

In October 2021, the Janet Quinney Lawson Foundation gave the lead gift of $7 million to name the Janet Quinney Lawson Institute for Land, Water, and Air. The generous gift creates an endowment that provides core support for the important work of the institute in perpetuity and is a fitting tribute to the legacy ofJanet Quinney Lawson's steadfast support of USU.

Additional funding for the Janet Quinney Lawson Institute for Land, Water, & Air comes from the following sources:

- Utah State University
- RioTinto Kennecott
- My Good Fund
- Chevron Corporation

LEFT: *STATUE OF JANET QUINNEY LAWSON OUTSIDE USU NATURAL RESOURCES BUILDING*

Janet Quinney Lawson
Institute for Land, Water & Air
UtahStateUniversity