UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

Great Salt Lake Wetlands Water Quality Standards Workshops

Summary Report

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Introduction

To help develop narrative water quality standards for the Great Salt Lake wetlands, the Utah Division of Water Quality (UDWQ) hosted a set of Great Salt Lake Wetlands Conservation Action Planning Workshops on March 21-22, 2018 and May 23-24, 2018 at the Utah Department of Environmental Quality in Salt Lake City, Utah. Participating in the two workshops were 37 individuals representing 20 agencies and organizations (Appendix A). A range of expertise was represented by participants, including wetland science and management, natural resource monitoring and assessment, and law and policy practitioners. Participants had a high level of interest in conserving Great Salt Lake wetlands.

The objectives of the workshops were three-fold:

1. Provide "hands on" advice and assistance to UDWQ on developing narrative water quality standards for Great Salt Lake's (GSL) wetlands beneficial uses.
2. Understand UDWQ's regulatory authority for protecting wetland water quality at GSL.
3. Explore other conservation action strategies – beyond water quality standards – that might be developed and applied by stakeholders to enhance GSL wetland health and/or to abate potential future threats to beneficial uses, with a geographic focus on eastside GSL wetlands in Bear River Bay, Ogden Bay and Farmington Bay.

The methodology used for the project was Conservation Action Planning (CAP)[1]. CAP is a straightforward and proven approach for planning, implementing and measuring success for large landscapes or other conservation projects. CAP is science-based, strategic and collaborative, and has been applied at over 1,000 conservation projects, including in Utah for the Bear River and Willard Spur. Greg Low, who played a leading role developing the CAP methodology, facilitated the GSL Wetlands workshops. The 2018 GSL Wetlands CAP workshop built upon three previous GSL efforts that used the CAP framework:

1. The Definition and Assessment of Great Salt Lake Health[2] was conducted in 2011-2012 for the Great Salt Lake Advisory Council. This science-based assessment found that GSL was generally in good health and was supporting migratory birds, brine shrimp, and stromatolites.
2. A one-day follow-up Great Salt Wetlands CAP[3] was conducted in 2015 that elaborated on the key ecological attributes and indicators of three wetland targets: impounded wetlands, fringe wetlands, and playa/mudflats.
3. A two-day Willard Spur CAP workshop[4] was held in January, 2018. Those meetings found that while the indicators of health differed for the Willard Spur when it was in the flooded state vs. a drawdown summer state, overall the Willard Spur is in good health.

While UDWQ initiated the 2018 CAP workshops primarily to help inform the development of water quality standards for GSL wetlands, the sessions were also intended to help inform broader conservation planning efforts for these wetland ecosystems.

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[1] The Nature Conservancy. 2007. Action Planning Handbook: Developing Strategies, Taking Action and Measuring Success at Any Scale. The Nature Conservancy, Arlington, VA. Available Online.

[2] SWCA Environmental Consultants and Applied Conservation. 2012. Definition and Assessment of Great Salt Lake Health. Great Salt Lake Advisory Council, Salt Lake City, UT. Available Online.

[3] Utah Division of Water Quality. 2017. Great Salt Lake Wetland Conservation Action Planning Workshop 2015 Report. Available Online.

[4] Applied Conservation and Utah Division of Water Quality. 2018. Willard Spur CAP Workshop Report. Available Online.

Geographic Scope

The geographic scope of these CAP workshops encompassed the wetlands of GSL. GSL wetlands account for 85% of the wetlands in the state of Utah, encompassing approximately 425,000 acres of freshwater and brackish wetlands (Figure 1). Three major classes of wetlands exist around GSL: impounded wetlands, fringe wetlands and playa/mudflats (Figure 2). Wetlands are located primarily below an elevation of 4,218 feet where the deltas of the Bear, Weber, and Jordan Rivers meet the flat bed of GSL. The area wetlands cover expands and contracts according to the elevation of GSL; when GSL water level declines the area of wetlands expands. These wetlands are distributed primarily across three bays: Bear River Bay, Ogden Bay and Farmington Bay. They include both publicly and privately managed lands. Public lands include the federal Bear River Migratory Bird Refuge and several state Waterfowl Management Areas (WMA's). Private lands include nature preserves managed by The Nature Conservancy and the Audubon Society, as well as numerous private hunting clubs and other ownerships.

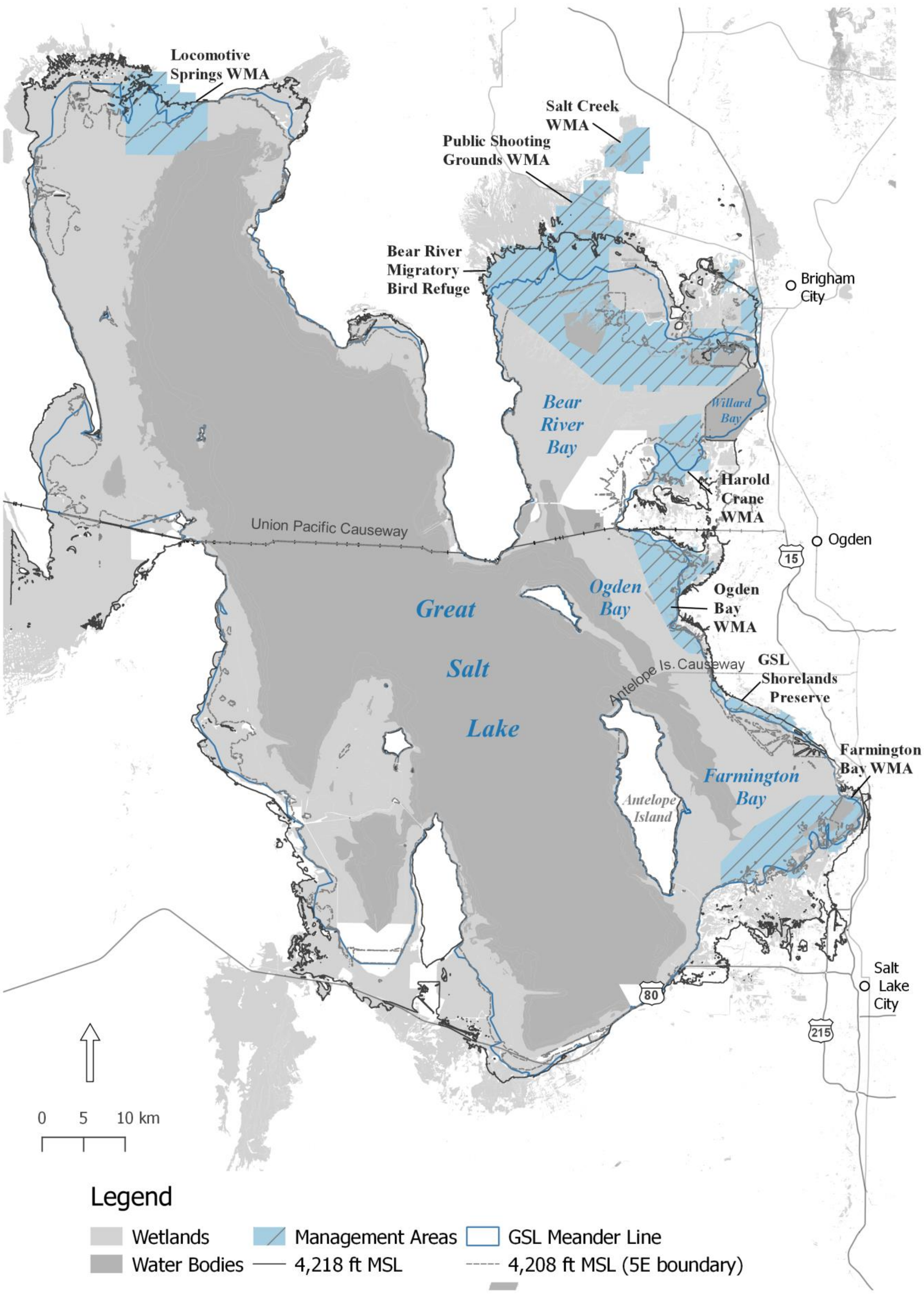
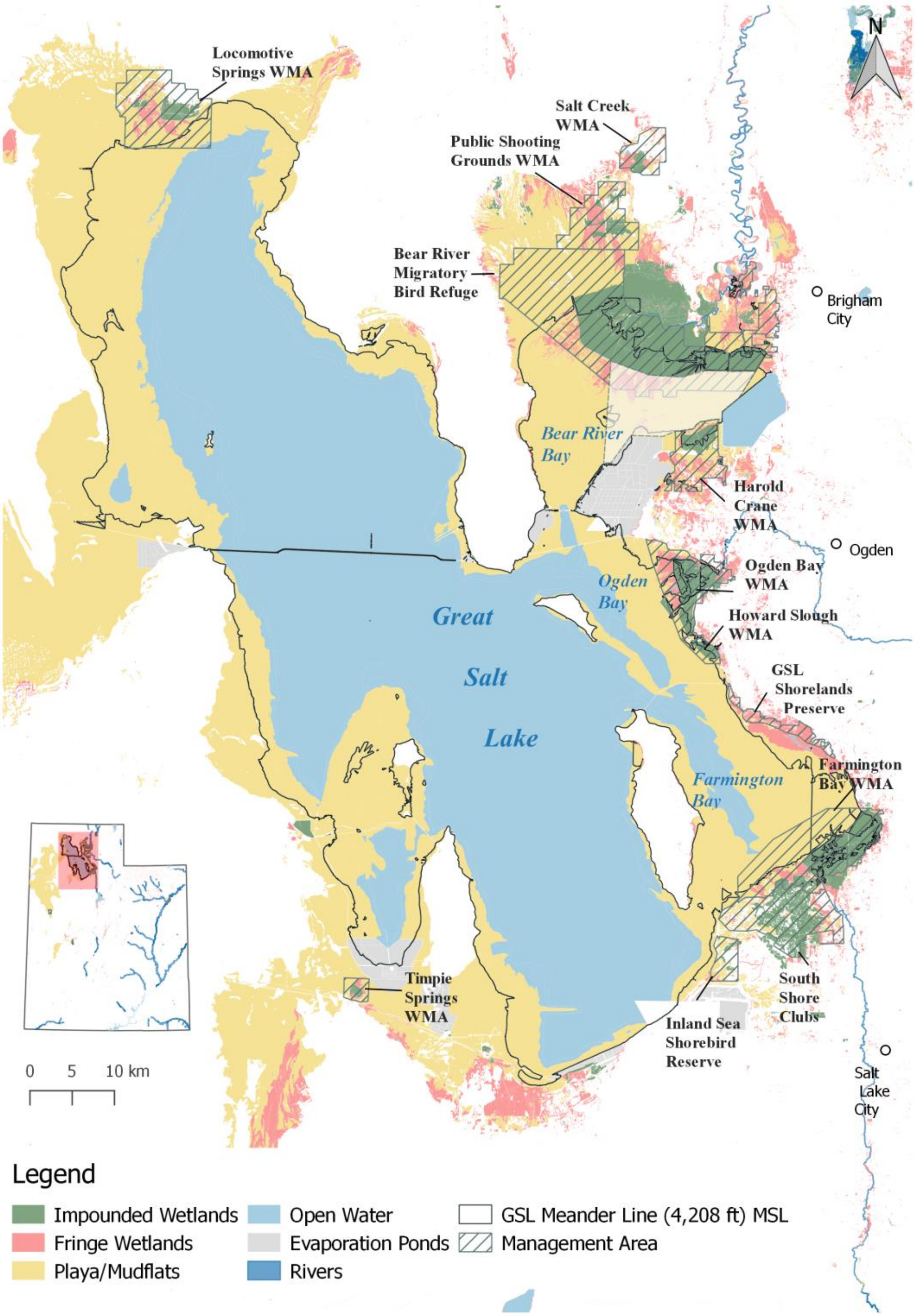


Figure 1. Great Salt Lake and associated wetlands. Data source: U.S. Fish and Wildlife Service National Wetland Inventory.



Wetland layer: U. S. Fish and Wildlife Service. 2017. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/wetlands/

Figure 2. Great Salt Lake wetland targets. Data source: U.S. Fish and Wildlife Service National Wetland Inventory.

Conservation Action Planning

Conservation Action Planning is a process initially developed by The Nature Conservancy that has been used to tackle a variety of conservation issues across the globe. CAP has also been used around the Great Salt Lake several times and the workshops sought to build on that previous work. The CAP framework focuses on five steps:

1. Identify conservation targets (ecosystems or species)
2. Assess conservation target health based on key ecological attributes
3. Assess stress and sources that threaten target health
4. Develop conservation strategies
5. Measure success

Some CAP terminology used in this report includes:

- **Targets** are the ecosystems or species to conserve through CAP
- **Nested Targets** are the species or assemblages that depend on the health of the ecosystem's *targets*
- **Key Ecological Attributes** are the processes or traits that are important to the long-term health of *targets*
- **Indicators** are the measurable characteristics of *ecological attributes*
- **Rating scales** are the narrative interpretations of *indicators* that describe very good, good, fair, and poor condition classes
- **Health** is the integrity or viability of a target or nested target
- **Rankings** are the *health* categories of each target: very good, good, fair, and poor
- **Stresses** are those things that negatively impact key ecological attributes, thereby impairing the *health* of targets
- **Sources** are the causes of *stress* (e.g., if altered hydroperiod is a stress, upstream water use might be a source)
- **Strategies** are courses of action with specific objectives that decrease threats or increase target viability

Conservation Targets, Nested Targets & Beneficial Uses

Introduction

The first step of CAP is to identify a set of Conservation Targets. Targets are typically delineated as a limited number of ecological systems, species, or groups of species that are representative and protective of the full biodiversity in a focal conservation area. In conservation planning, these targets help define future conservation actions and associated goals. For UDWQ, these targets are also useful for the development of water quality standards, because they help define those ecological elements that require protection in order to ensure the long-term biological integrity of the ecosystem—the beneficial uses of the GSL Wetlands.

Conservation Targets for Great Salt Lake Wetlands

Typically, the first step in the CAP process is to determine which ecological systems represent an area's biological diversity and define these targets spatially within the area (in the case of Willard Spur, the CAP ecosystem targets were defined temporally). Different types of wetland ecosystems provide habitat for different bird guilds, which are of greatest conservation interest at GSL and represent its primary water quality beneficial uses. Three broad types of wetland ecosystems were identified in previous CAP workshops as the focal conservation targets: Impounded Wetlands, Fringe Wetlands, and Playa/Mudflats. Descriptions of these three targets are provided in the Table 1.

"Nested targets" are species or assemblages of particular ecological importance that depend on the health of the ecosystem targets. Utah's Division of Natural Resources (DNR) has published two reports that can be used to help define nested targets for GSL wetlands. The Wildlife Action Plan[5] identified a list of species of greatest need, including several species of birds, mollusks and amphibians that should be given careful consideration in conservation planning efforts. In addition, the Great Salt Lake Waterbird Survey[6] identified several species that are of regional or hemispheric importance. While these bird populations are not immediately threatened, conservation efforts should nevertheless attempt to ensure their protection due to the vital importance of GSL wetlands in maintaining their populations.

More than 250 species of migratory birds visit GSL wetlands every year during their spring and fall migrations. The diversity of wetland-dependent species visiting GSL can be divided into three guilds: waterfowl, shorebirds, and waterbirds. Waterfowl are large-bodied aquatic birds; they include ducks, geese, and swans. Historically, GSL impounded wetlands have been managed to support habitat for and hunting of waterfowl. Shallower wetland habitats are utilized by shorebirds: smaller-bodied birds with long legs and bills that allow foraging for macroinvertebrates in shoreline habitats. Waterbirds are a diverse group that includes piscivorous birds, colonial nesting birds, and other wetland-dependent birds that don't fit within other guilds.

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[5] Utah Wildlife Action Plan Joint Team. 2015. Utah Wildlife Action Plan: A plan for managing native wildlife species and their habitats to help prevent listing under the Endangered Species Act. Publication number 15-14. Utah Division of Wildlife Resources, Salt Lake City, UT. Available Online.

[6] Paul, D.S. and A.E. Manning. 2002. Great Salt Lake Waterbird Survey Five-Year Report (1997-2001). Publication number 08-38. Utah Division of Wildlife Resource, Salt Lake City, UT. Available Online.

Table 1. Great Salt Lake Wetland Targets: Description and Nested Targets

	Target Description	Nested Targets
Impounded Wetlands	Impounded wetlands are large, primarily open water wetlands that are typically managed to grow submerged aquatic vegetation (SAV), which provides forage and shelter for migratory birds and habitat for aquatic macroinvertebrates and fish. These wetlands are most often diked and equipped with water control structures that alter the inflow and outflow of water to deepen and extend flooding. Elevation, salinity, and hydrologic gradients within impounded wetlands support a mosaic of wetland types, from deeply flooded submergent wetlands to shallowly flooded meadows and mudflats during drawdown. This mosaic is spatially and temporally dynamic, shifting according to flooding depth and duration. Impounded wetlands do not include evaporation ponds.	*Waterfowl:* Dabbling and diving ducks, geese, and swans loaf and feed in SAV-dominated wetlands and nest in emergent and meadow wetlands. Species of interest include *Cinnamon Teal, Redheads*, and *Tundra Swans*. *Shorebirds:* Shorebirds forage in the shallow waters and nest along dikes. Significant populations of *American Avocets, Black-necked Stilts,* and *Wilson's Phalaropes* are found in this system. *Waterbirds*: Deeper water is foraging habitat for piscivorous birds, including significant populations of *American White Pelicans, Great Blue Herons,* and *Snowy Egrets*. Islands provide protected nesting habitat for colonial birds like *Franklin's Gulls* and *Black Terns*. *Forster's Terns* and *Eared Grebes* build floating nests on the open water.
Fringe Wetlands	Fringe wetlands are large, shallow, intermittently to semi-permanently flooded wetlands dominated by a mix of emergent vegetation and SAV. Spatial and temporal variation in salinity and hydrology create a mosaic of habitat types in fringe wetlands. Mudflats, meadows, emergent marsh, and submergent wetlands can be found in fringe complexes. Fringe wetlands are located near sources of freshwater, including streams and impounded wetland outlets. Fringe wetland area and habitat types within them expand and contract according to annual water availability.	*Waterfowl*: The mix of emergent and submergent vegetation provides nesting, loafing, and foraging habitat for large and small waterfowl. Fringe wetlands support significant nesting populations of *Cinnamon Teal*. *Shorebirds*: Meadow habitat provides foraging and nesting habitat for shorebirds. Large populations of *Black-necked Stilts* and *American Avocets* feed here. *Waterbirds*: Fringe wetlands provide breeding and foraging habitat for a portion of the largest global breeding population of *White-faced Ibis*
Playa /Mudflats	Playa/mudflats are temporarily flooded saline wetlands created by inter-annual or seasonal lake water and local water table fluctuations as well as precipitation. These flat, depressional wetlands dominate the GSL shoreline and support communities of freshwater and saltwater macroinvertebrates that provide seasonal food for migratory birds. Playa/mudflats, are mostly devoid of vegetation, yet remain important for nesting birds. Small or ephemeral patches of halophytic ('salt-loving') plant species are an important component of playa/mudflats. The specific locations of this habitat changes as GSL expands and contracts.	*Waterfowl*: Short halophytic vegetation provides foraging and loafing habitat for migrating waterfowl, including *Canada Geese*. *Shorebirds*: Expansive flat and salty playas and mudflats provide breeding and foraging habitat for many types of shorebirds. Significant populations of *Snowy Plovers, Black-necked Stilts, American Avocets, Long-Billed Dowitchers, Marbled Godwits, Western Sandpipers,* and *Long-billed Curlews* feed and nest here.

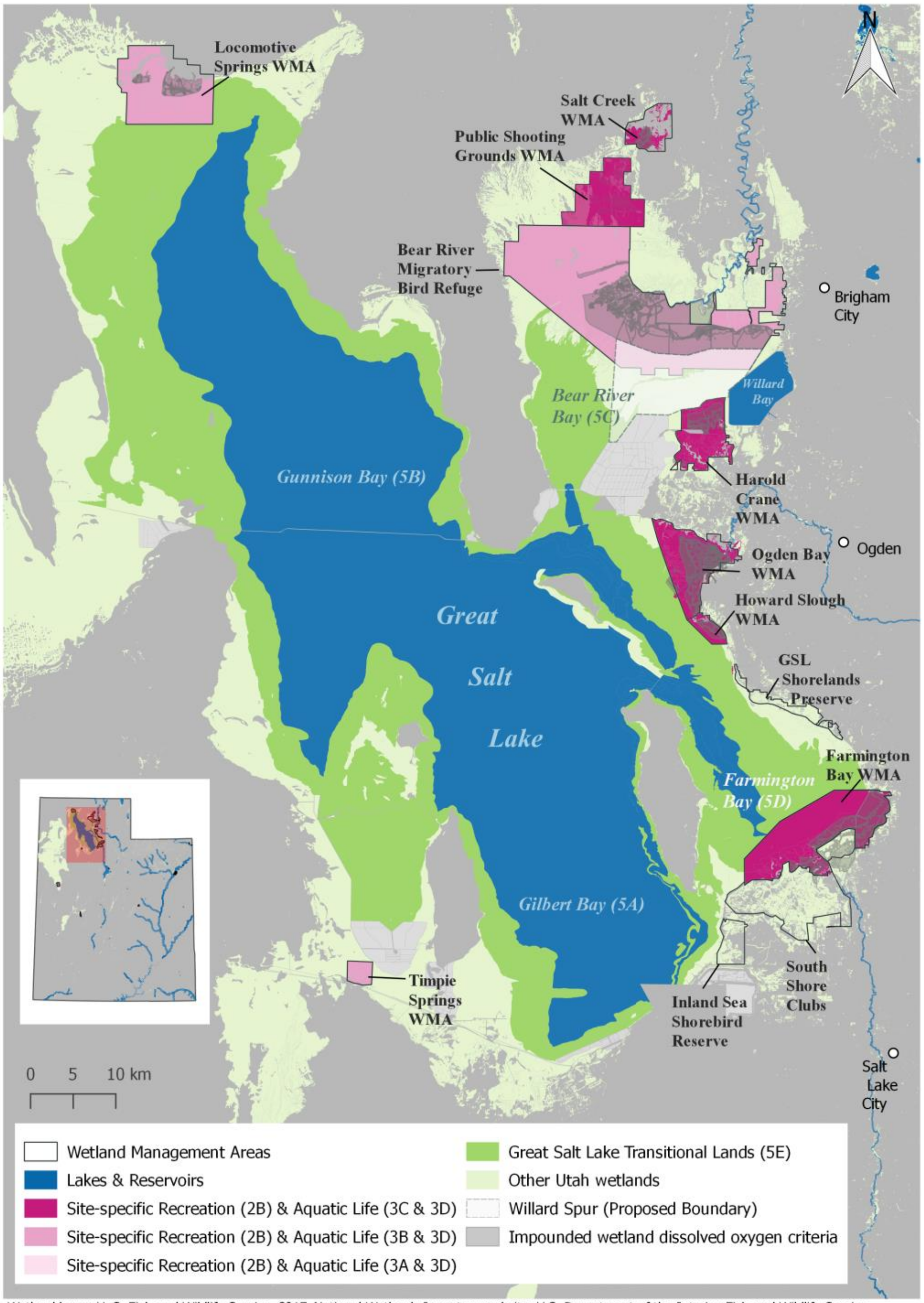
Water Quality Standards

Water quality standards define the water quality goals for a waterbody and have three main components: beneficial uses, criteria, and antidegradation. Designated beneficial uses specify the goals and expectations for how the waterbody is used. Utah has five classes of beneficial uses: drinking water, recreation (primary and infrequent primary), aquatic life (cold water and warm water fish, waterfowl, and shorebirds), agriculture, and Great Salt Lake[7]. GSL is unique in that it has its own use class. Currently, no single beneficial use is applicable to all GSL wetlands. Instead, recreation and aquatic life uses apply only to publicly managed wetlands, rather than to the contiguous complexes of GSL wetlands. The aquatic life uses that apply to state waterfowl management areas (WMA's) and federal wildlife refuges were chosen based on input from wetland managers.

Water quality criteria describe the minimum level of pollutants or pollution that must be maintained in order to protect the beneficial use. Numeric criteria specify the maximum pollutant concentration levels allowable for a waterbody while narrative criteria describe the desirable condition of a waterbody in terms of the pollution waters shall be "free from."[8] Narrative criteria are most relevant to GSL wetlands because wetlands are naturally dynamic in terms of hydrology, biology, and water quality, which makes assigning numeric criteria challenging. Antidegradation (not addressed at these meetings) is designed to protect existing uses and high quality waters. A number of Utah's beneficial use designations are assigned to GSL wetlands (Figure 3). The beneficial use class most relevant to the Targets and Nested Targets in particular is 5E Great Salt Lake Transitional Lands use class, defined as supporting "waterfowl, shorebirds and other water-oriented wildlife including other ecologically important organisms in their food web." Accurate description of wetland targets and the nested avian targets that utilize GSL wetlands will directly inform a wetland beneficial and narrative criteria use for GSL wetlands.

[7] State of Utah. 2018. Utah Administrative Code R317-2-6. Use Designations. Available Online.

[8] Environmental Protection Agency. 2018. What are Water Quality Standards? Available Online.



Wetland layer: U. S. Fish and Wildlife Service. 2017. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/wetlands/
Beneficial Uses: Utah Administrative Code. 2018. R-317.2.13.11 National Wildlife Refuges and State Waterfowl Management Areas, and other Areas Associated with Great Salt Lake. https://rules.utah.gov/publicat/code/r317/r317-002.htm#T15

Figure 3. Existing and proposed beneficial use classes that apply to GSL wetlands[9]

[9] State of Utah. 2018. Utah Administrative Code R317-2.13.11 National Wildlife Refuges and State Waterfowl Management Areas and other Associated Uses of GSL. Available Online.

Key Ecological Attributes, Indicators and Ratings

Introduction

A foundational element of CAP is the identification of Key Ecological Attributes (KEAs), indicators, and a rating scale that are used to assess the current health of the Targets. KEAs are broad ecological characteristics that define healthy conditions for a conservation target. Indicators are more narrow elements of the KEA that are used to monitor and assess the status of KEAs. The intrinsic assumption is that the combined indictors identified for a KEA provide a reasonable representation of the condition of the KEA. While it is true that indicators often may not measure every component of a KEA, they are useful because they provide a cost-effective way to measure the status of a KEA on an ongoing basis. By analogy, while a cardiogram is a more complete representation of cardiovascular condition, doctors generally rely on important indicators (e.g., blood pressure, cholesterol, BMI) that can be routinely measured over time. Rating scales help interpret indicators by placing potential observations into condition classes. Rating scales are often refined over time as more information about natural or acceptable variation in the selected indicators is better understood.

There are several ways in which KEAs and their associated indicators can inform the development and interpretation of water quality standards for GSL wetlands. They can be used both to help define language that describes desirable conditions—the "shalls", or the converse—the "shall nots"—for narrative water quality criteria[10]. The indicator health rankings can be used to inform the development of biological assessments that measure whether a body of water is supporting its beneficial uses or if water quality criteria have been exceeded. However, before such assessments are conducted, UDWQ will be required to develop and solicit comment on the assessment methods[11], which will be more detailed than those initially developed through the CAP process.

KEAs and Indicators

Participants at the CAP workshops divided into three break-out groups (one group for each target) to refine the KEAs and indicators for the GSL wetland targets. The final KEAs and indicators for the three wetland targets are presented below. The attributes and indicators listed in Table 2 are the third version, which began as a 'straw dog' (i.e., draft) of attributes and indicators assembled based on the work of previous GSL CAP meetings. Substantial revisions were made during the first CAP workshop, and the attributes and indicators were refined in the second one.

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[10] State of Utah. 2018. Utah Administrative Code R317-2-7.2. Narrative Standards. Available Online.

[11] State of Utah. 2018. Utah Administrative Code R317-2-7.3. Biological Water Quality Assessment and Criteria. Available Online

Table 2. Key Ecological Attributes and Indicators for GSL Wetland Targets

Key Ecological Attributes	Impounded Wetland Indicator	Fringe Wetland Indicator	Playa/Mudflat Indicator
Hydrologic Regime	Water available to meet broad management objectives, including: water level, residence time, pond flushing, habitat size, & habitat diversity. Water to maintain connectivity to other wetland targets	Flood timing & depth adequate to maintain multiple habitat types	Patterns of flooding & drying supportive of nested target needs
Chemical Regime	Toxic substances, including nutrients, remain below concentrations harmful to aquatic life	Toxic substances remain below concentrations harmful to aquatic life	Toxic substances remain below concentrations toxic to aquatic life
Chemical Regime			Soil & water salinity within a range supportive of nested target food webs
Nutrient Regime	Algal mats or Harmful Algal Blooms do not adversely affect aquatic life or impede recreational uses	Soil & water nutrient bioavailability favor native plant community	Nutrients cycle between soil, water, plants, macroinvertebrates & birds
Invasive species	Invasive species abundance does not adversely affect the populations of native aquatic plant & animal species		
Macro-invertebrates	Macroinvertebrate diversity & biomass supports nested targets & management goals	Healthy macroinvertebrate community supports nested targets; follows seasonal dynamics & salinity gradients	Adequate macroinvertebrate biomass to support nested targets
Plants	Dominance of native plant species	Dominance of native plant species	Vegetated area dominated by native halophytes
Plants	Healthy plant community (submerged & emergent) provides adequate habitat structure to support waterfowl & other nested targets		Bare ground & vegetated areas present
Size		Wetland area below 4,218 feet adequate to support nested targets	Adequate mudflat habitat area near fresh or brackish water & higher elevation playa refugia

Rankings

Preliminary narrative ratings were presented by UDWQ for several indicators, using the CAP scoring framework of Very Good, Good, Fair and Poor[12]. These narrative ratings were discussed and refined at the two CAP workshops. Workshop participants were requested to focus on developing narrative statements for the "Good" and "Poor" ratings, as these two levels serve as primary benchmarks for assessing ecosystem health. See Appendix B for narrative descriptions of "Good" and "Poor" ratings.

As a final step in the KEA process, workshop participants were asked to use the draft KEAs and rating scales to assess the current health of the three GSL wetland targets, looking at their distribution along the eastern shoreline where most GSL wetlands are located. Because the key attributes often have variable conditions over such a large geographic extent, the rating scale was extended beyond the basic four-grade scale to reflect these variable conditions. In addition, rankings were first estimated by three shoreline regions: Bear River, Ogden, and Farmington Bays; regional rankings were then rolled up into a single rank for each target. The draft rankings in Table 3 were developed by the three target breakout groups. It should be noted that these ratings were done as a relatively quick exercise, based upon the collective expert opinion of the three groups, and have not been further vetted. The purpose was to give the workshop participants the opportunity to develop a first approximation, for the purposes of helping to inform conservation strategies.

Table 3. Indicator Rankings for Key Ecological Attributes of GSL Wetland Targets

Key Ecological Attributes	Impounded Wetland Indicator	Fringe Wetland Indicator	Playa/Mudflat Indicator
Hydrologic Regime	Fair	Poor/Fair	Poor
Chemical Regime – Toxic Substances	Good/Fair	Good	Fair
Chemical Regime – Salinity	NA	NA	Unknown
Nutrient Regime	Fair	Fair	Unknown
Invasive species	Fair	NA	NA
Macroinvertebrates	Good	Unknown	Good
Plants – Native Species	Fair/Good	Poor/Fair	Fair
Plants – Structure	Good	NA	Good
Size	NA	Good	Good

[12] Parrish, J.D., D.P. Braun, and R.S. Unnasch. 2003. Are we conserving what we say we are? Measuring ecological integrity within protected areas. *Bioscience* 53(9): 851-860. Available Online.

Potential Threats

After assessing current health, potential Sources of Stress (aka threats) are identified that could impair the future health of the targets. Stresses are the inverse of the KEAs – the adverse ecological impacts. Sources are the potential human causes of the stress. The identification and prioritization of future threats is integral in helping to identify and prioritize those management actions that are most likely to be protective of GSL wetlands. Similarly, these threats can also be used by UDWQ to identify or prioritize statements that should be included in narrative water quality criteria.

A full-blown CAP process typically takes a day to complete a comprehensive threat ranking assessment; since the GSL Wetland Workshop was compressed in time, a rapid threat assessment was done via voting by the participants, with the goal of developing strategies to address the highest rated threats. Each participant was asked to indicate what they thought to be the ten highest potential sources of stress that might emerge over the next decade, with votes distributed as desired across the three targets. The voting tally is presented in Table 4.

Two potential sources of stress stood out in the voting: (1) *altered hydrologic regime from upstream water withdrawal*; and (2) *altered vegetation composition from invasive species (i.e., Phragmites)*. These two predominant threats were followed by threats of excessive nutrients from point source discharges, altered hydrologic regime from land use conversion, and reduced wetland size from land use conversion.

Table 4. Sources and Stresses to wetland targets according to voting. Stresses (in rows) and sources (in columns) are tallied for all wetlands (ALL GSL), impounded wetlands (IW), fringe wetlands (FR), and playa/mudflats (PL)

	Select Greatest Potential Sources of Stress									
Stresses	Point Source Discharges	Upstream Water Withdrawal	Management of Dams & Diversions	Invasive species	Land Use Conversion	Other Nonpoint Sources	All GSL	IW	FR	PL
Altered hydrologic regime	7	**52**	15	7	17	0	**98**	27	40	31
Excessive toxicity	2	0	0	0	1	4	**7**	3	2	2
Excessive nutrients	17	1	0	4	0	7	**29**	17	10	2
Reduced macro-invertebrates	0	9	1	5	2	3	**20**	6	7	7
Altered plant composition	0	12	1	**33**	0	4	**50**	14	27	9
Altered SAV	3	2	0	3	1	2	**11**	11	-	-
Reduced Size	0	12	1	2	15	0	**30**	-	16	14
All GSL	**29**	**88**	**18**	**54**	**37**	**17**				
Total IW	18	22	4	20	6	8				
Total FR	7	39	7	23	16	10				
Total PL	4	27	7	11	14	2				

Strategies

The last step in the CAP process is to develop strategies that address potential threats or to enhance the health of the conservation targets. In CAP, strategies include three elements: Objectives, Strategic Actions and Action Steps. The development of effective strategies can be challenging process that can take a full day or longer in a full-blown CAP process; again, for the GSL Wetlands CAP the process was abbreviated, with the goal of developing a credible first iteration of strategies to address the two most critical threats. Break-out groups met during the second workshop to develop strategies to address threats from upstream water withdrawal and invasive species. A third group met to address issues regarding wetland size and dynamics, with the goal of integrating this work into the strategies.

Two strategic objectives were established by the break-out groups and refined by large-group discussion were as follows:

1. Maintain sufficient water flow (acre/feet) and a "minimum dynamic area" (acres) of GSL wetlands and bays so that they are in "Good" condition.
2. Decrease Phragmites cover around GSL by 50% (~13,000 acres) by 2028.

The Strategic Actions proposed for consideration to achieve the objectives are presented in Appendix C.

The third 'wetland size' breakout group developed two recommendations, which were used in addressing the strategies above. First, they developed the idea of a 'minimum dynamic area' to reflect the fact that GSL wetlands are an ever-changing mosaic of habitat types between seasons and years, but that there is a minimum area required to support the health of targets and nested targets. Second, water availability measured as acre-feet (a water rights-specific unit of measure) is the driver of wetland size.

Next Steps

Considerable progress was made in the development of KEAs, indicators and ratings at the two workshops. However, these will likely continue to be developed over time and tailored for specific conservation purposes. For instance, indicator ratings used for conservation action plans may differ from those used by UDWQ for assessment purposes. UDWQ will use the information from the CAP workshops to develop and adopt water quality standards for GSL wetlands. Various questions, suggestions and issues were raised by participants over the course of the workshop, which UDWQ staff will take under advisement as they proceed to develop the standards.

Applying water quality standards to wetlands may be challenging for a few reasons:

1. Wetlands have highly variable seasonal flooding – water is not always present, which makes measuring water quality difficult
2. Wetland area and habitat type shift between years according to water availability so wetland target/type classifications may change every year
3. Biological assessment methods to monitor the ability to support aquatic bird uses in wetlands have not been developed in Utah
4. Alternative approaches to address impairment due to pollution (covered by narrative criteria), not pollutants (addressed by numeric criteria), are in the process of being developed

Participants had questions about how standards might be applied to wetlands, once they are established. UDWQ has established processes for assessing lakes and streams, determining if beneficial uses are being supported, and developing water quality management plans for impaired waters. Existing processes for monitoring and protecting water quality in other water bodies will need to be modified in order to be appropriate for wetlands. UDWQ monitors water quality and the biological community of lakes and streams across the entire state and reports these results in biennial Integrated Reports. For waters that have been identified as impaired (i.e., not supporting their beneficial use), a Total Maximum Daily Load (TMDL) study is conducted to identify the sources of pollutants and minimize point and non-point sources. However, alternative approaches are required when narrative criteria are exceeded because that is often caused by pollution (e.g., altered hydrology, nuisance algae), rather than a single, identifiable pollutant (e.g., copper). Harmful Algal Blooms (HABs) are an example of addressing exceedances of Utah's narrative standard. The statewide narrative standard prohibits pollution that causes "undesirable human health effects" and "scum," which are the effects of HABs. In recent years UDWQ has developed assessment methods and routine monitoring to detect the presence of HABs, which requires three lines of evidence: cyanobacteria cell density, cyanotoxins those cells produce, and elevated chlorophyll-a concentration. A similar approach could be adapted for monitoring and detecting impairments in wetlands.

While it will be a challenge to address water quality in wetlands, Utah is following the example of other states that have developed wetland-specific beneficial uses and narrative criteria. Western states, including California and Washington, have been able to detect impairment of aquatic life or wildlife beneficial uses in wetlands caused by salinity, sediment, and altered hydrology. Those examples of wetland water quality standards and the data gathered from wetland experts in the GSL Wetland CAP meetings will help UDWQ as they move forward with standard development.

Appendix A – Workshop Participants

Participant	Representing
Ann Neville	The Nature Conservancy
Ariel Calmes	Western Resource Advocates
Ashley Kijowski	Utah Division of Wildlife Resources
Aubie Douglas	Utah State University
Becka Downard	Utah Division of Wildlife Resources
Chad Cranney	Utah Division of Wildlife Resources
Chris Cline	U.S. Fish and Wildlife Service
Chris Bitner	Utah Division of Water Quality
David England	Utah Division of Wildlife Resources
David Richards	Oreohelix
Diane Menuz	Utah Geological Survey
Dick West	South Shore Duck Clubs
Ella Sorenson	Audubon Society
Greg Low (facilitator)	Applied Conservation
Heidi Hoven	Audubon Society
Jack Ray	Rudy Duck Club
Jason Jones	Utah Division of Wildlife Resources
Jason Hardman	Salt Lake Mosquito Abatement District
Jeff Den Bleyker	Jacobs
Jeff Ostermiller	Utah Division of Water Quality
Jim Van Leeuwen	Utah Division of Wildlife Resources
John Luft	Utah Division of Wildlife Resources
Jodi Gardberg	Utah Division of Water Quality
John Neill	Utah Division of Wildlife Resources
Keith Hambrect	Utah Division of Forestry Fire & State Lands
Keith Lawson	Salt Lake Mosquito Abatement District
Laura Vernon	Utah Division of Forestry Fire & State Lands
Marisa Egbert	Utah Division of Water Resources
Michelle Baker	Utah State University
Miles McCoy-Sulentic	Utah Geological Survey
Pam Kramer	Utah Division of Wildlife Resources
Rachel Buck	Utah State University
Rich Hansen	Utah Division of Wildlife Resources
Stephanie Graham	U.S. Fish and Wildlife Service
Suzan Tahir	Utah Division of Water Quality
Theron Miller	Wasatch Front Water Quality Council
Toby Hooker	Utah Division of Water Quality
Zane Badger	Ambassador Duck Club

Appendix B. Narrative Health Ratings for GSL Wetland Targets

Conservation Target: Impounded Wetlands

Key Attribute	Impounded Wetland Indicator	Poor	Fair	Good	Very Good	Current Ranking			
						Bear	Ogden	Farming-ton	GSL
Hydrologic Regime	Water available to meet broad management objectives[13], including: water level, residence time, pond flushing, habitat size, & habitat diversity. Water to maintain connectivity to other wetland targets	Insufficient water to meet management objectives in most years		Adequate water to meet management objectives except in drought years		Poor	Good	Fair	Fair
Chemical Regime	Toxic substances, including nutrients, remain below concentrations harmful to aquatic life[14]	Substances at concentrations that are toxic to aquatic life		Ambient concentrations of toxic substances at or below thresholds toxic to aquatic life		Good/ Fair	Good/ Fair	Good/ Fair	Good/ Fair
Nutrient Regime[15]	Algal mats[16] or Harmful Algal Blooms do not adversely affect aquatic life or impede recreational uses	>80% algae cover during the growing season, persist greater than a 2-year period		≤ 25% algae cover during a single season		Good	Fair	Fair	Fair

[13] BRMBR Habitat Management Plan (2004) has guidance on the timing of flooding and flushing in impounded wetlands. Available Online.

[14] Utah Administrative Code R317 Table 2.14.2 lists toxic substance criteria for aquatic life. Available Online.

[15] UDWQ (2015) Impounded Wetland Reference Report shows the distribution of nitrogen concentrations (Fig 25) based on four surveys of impounded wetlands. Available Online.

[16] UDWQ (2014) Integrated Report shows algal mat distribution in impounded wetlands (Figure 4-5). Available Online.

Key Attribute	Impounded Wetland Indicator	Poor	Fair	Good	Very Good	Current Ranking			
						Bear	Ogden	Farming-ton	GSL
Invasive Species	Invasive species abundance does not adversely affect the populations of native plant & animal species	1 or more invasive species present & pervasive		No invasive species pervasive		Fair	Fair	Fair	Fair
Macro-invertebrates[17]	Healthy macroinvertebrate diversity relative to seasonal changes & naturally occurring salinity gradients	Plant-associated Macroinvertebrate Index (PMI)[18] score in the lowest 25th percentile		PMI score in the highest 50th percentile		Good	Good	Fair/ Poor	Good
Macro-invertebrates[19]	Macroinvertebrate diversity & biomass (g/m^2) support nested targets & management goals	Low biomass of desirable functional groups		Adequate biomass of desirable functional groups		Good	Good	Good	Good
Plants	Dominance of native plant species	Native species cover <50%		Native species cover >75% of vegetated area		Fair	Fair	Fair	Fair/ Good
Plants[20]	Healthy plant community (submerged & emergent) provides adequate habitat structure to support waterfowl & other nested targets	Peak SAV cover[21] over very little of open water area (e.g. 25%)		Peak SAV cover over most of spatial extent (e.g. 75%) of open water area		Good	Fair	Poor	Good

[17] UDWQ (2015) Impounded Wetland Reference Report describes the Plant-associated Macroinvertebrate Index (Fig 17). Available Online.

[18] UDWQ (2014) Integrated Report shows PMI distribution in impounded wetlands (Figure 4-6). Available Online.

[19] 2015 GSL Wetland CAP suggested 1.5-2.5 g/m^2 of macroinvertebrate biomass (excluding gastropods) was indicative of good conditions. Available Online.

[20] Several studies support SAV condition and cover indicators: UDWQ (2018) Willard Spur summary [Available Online], UDWQ (2015) Impounded Wetland Reference Report [Available Online], and Miller and Hoven (2007) FBWMA Phase I Ecological Assessment [Available Online]

[21] UDWQ (2014) Integrated Report characterized SAV condition in impounded wetlands. Available Online

Conservation Target: Fringe Wetlands

Key Attribute	Fringe Wetland Indicator	Poor	Fair	Good	Very Good	Current Ranking			
						Bear	Ogden	Farming-ton	GSL
Hydrologic Regime	Flood timing & depth adequate to maintain multiple habitat types[22]	Brief or absent flooding over multiple years leads to dominance of mudflat or upland types		Annual flooding maintains a balance of five habitat types		Fair	Fair	Fair/ Good	Poor/ Fair
Chemical Regime	Substances remain below concentrations harmful to aquatic life[23]	Substances at concentrations that are harmful to aquatic life		Ambient concentrations of toxic substances below thresholds harmful to aquatic life		Good	Good	Good	Good
Nutrient regime	Soil & water nutrient bioavailability[24] favor native plant community	Nitrogen & phosphorus concentrations in the highest 75th percentile for wetland type; large algal mats		Nitrogen & phosphorus concentration in the lowest 50th percentile for that wetland type; no large algal mats		Unknown	Good	Fair	Fair

22 BRMBR Habitat Management Plan (2004) has guidance on flooding depth and timing for multiple habitat types [Available Online]. UDWQ (2018) Willard Spur summary describes habitat type changes caused by hydrologic isolation [Available Online].

23 Utah Administrative Code R317 Table 2.14.2 lists toxic substance criteria for aquatic life. Available Online.

24 UDWQ (2016) Fringe Wetland Report shows the summary statistics of nitrogen and phosphorus concentration from a survey of fringe wetlands (Table 17). Available Online.

Key Attribute	Fringe Wetland Indicator	Poor	Fair	Good	Very Good	Current Ranking			
						Bear	Ogden	Farming-ton	GSL
Macro-invertebrates	Healthy macroinvertebrate community[25] supports nested targets; follows seasonal dynamics & salinity gradients	Low diversity of functional feeding groups		High diversity of functional feeding groups		Unknown	Unknown	Unknown	Unknown
Plants	Dominance of native plant species[26]	Native species cover <50%		Native species cover >75% of vegetated area		Poor/ Fair	Poor/ Fair	Poor/ Fair	Poor/ Fair
Size	Wetland area below 4,218 ft MSL adequate to support nested targets[27]	Decreased acreage below 4,218 ft MSL		Adequate annually flooded acreage below 4,218 ft. MSL		Good	Good	Good	Good

[25] UDWQ (2016) Fringe Wetland Report lists the macroinvertebrate taxa found in fringe wetlands (Table 10 and 11). Available Online.

[26] UDWQ (2016) Fringe Wetland Report shows the relative cover of invasive plant species in fringe wetlands (Figure 5). Available Online.

[27] GSL Wetland CAP (2015) suggested 8,000-11,000 acres was indicative of good conditions and <6,000 acres indicated poor conditions. Available Online

Conservation Target: Playa/Mudflats

Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Ranking			
						Bear	Ogden	Farming-ton	GSL
Hydrologic regime	Patterns of flooding & drying supportive of nested target needs [28]	Multiple years of no flooding or extended deep (>7 inches) flooding during spring & fall		In most years, shallow (<7 inches) early spring ponding or saturation followed by drawdown		Poor	Poor	Poor	Poor
Chemical Regime	Toxic substances in soils remain below concentrations harmful to aquatic life[29]	Substances at concentrations harmful to aquatic life		Ambient concentrations of toxic substances at or below harmful thresholds		Fair	Fair	Fair	Fair
Chemical Regime	Salinity within a range supportive of nested target's food web	Hypersaline conditions caused by lack of water that exceed macro-invertebrate tolerance (excludes rising GSL)		Brackish to saline soil salinity		Poor	Unknown	Unknown	Poor
Nutrient regime	Nutrient cycling between soil, water, plants, macroinvertebrates & birds	Nitrogen & phosphorus accumulate in soils		Nitrogen & phosphorus regularly cycle from water to soils to plants, macro-invertebrates, & birds		Unknown	Unknown	Unknown	Unknown

[28] 2015 GSL Wetland CAP suggested May flooding was most indicative of a healthy hydrologic regime. Available Online

[29] The Environmental Protection Agency has developed Ecological Soil Screening Levels of some toxic contaminants. Available Online

Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Ranking			
						Bear	Ogden	Farming-ton	GSL
Macro-invertebrates	Adequate macroinvertebrate biomass(g/m^2) to support nested targets	Low biomass of desirable functional groups		Adequate biomass of desirable functional groups		Good	Fair	Good	Good
Plants	Vegetated area dominated by native halophytes[30]	Increased species richness driven by invasive species		A few (≤3) native halophytes dominant, especially *Salicornia rubra, Sueada calceoliformis, & Allenrolfia occidentalis*		Good	Fair	Good	Fair
Plants	Bare ground & vegetated areas present	Loss of dynamic condition, playa/mudflats never vegetated or lost to constantly expanding Phragmites		In most years area is dominated by bare ground with sparse, fringing vegetation; periodic expansion of native halophytes		Good	Good	Good	Good
Size	Adequate mudflat habitat area near fresh or brackish water & higher elevation playa refugia [31]	Decreased area & connectivity inadequate to support shorebird nested target		Adequate shallow gradient mudflat area between fringe wetlands & GSL open water & playa habitat to support shorebird nested target		Good	Good	Good	Good

[30] Wetland Plants of Great Salt Lake (2017) lists native and introduced playa species. Available Online

[31] GSL Wetland CAP (2015) suggested 18,000 - 23,000 acres was adequate for good conditions and <13,000 acres indicated poor condition. Available Online

Appendix C – Strategies and Objectives

#	Objectives, Strategic Actions with Steps, and Indicators
Objective	**1. Maintain sufficient flow (acre/feet) and a "minimum dynamic area" (acres) of wetlands and bays so that they are in "Good" condition.**
Strategic action	Define "Good" condition of wetland health based upon key ecological attributes for the wetland targets
Strategic action	Understand the value of water for ecosystem services and the value of a healthy Great Salt Lake and watershed (e.g., using a model)
Strategic action	Utilize existing water and create new avenues to get water to the Great Salt Lake
Strategic action	Provide financial incentives for water users to conserve and sell/lease water
Strategic action	Persuade decision-makers to support sufficient water in Great Salt Lake using various tools and approaches (e.g., models, other saline lakes dying, air quality)
Objective	**2. Decrease Phragmites cover around Great Salt Lake by 50% (~13,000 acres) by 2028.**
Strategic action	Create of a Phragmites "czar" (Department of Natural Resources)
Strategic action	Outreach and education (Department of Natural Resources & USU Extension)
Strategic action	Improve access to existing funds (interagency)
Strategic action	Follow treatment BMPs (cattle, herbicide) on 1300 acres/year (all landowners)
Strategic action	Annual coordination meeting (czar)
Strategic action	Monitor and evaluate (universities)