CHAPTER 14: GREAT SALT LAKE

14.1 OVERVIEW

The Great Salt Lake (GSL) is a unique and ecologically important ecosystem, yet numeric water quality criteria have generally not been developed for the lake yet. The lake's unique biogeochemistry and hydrology, has made it difficult to establish numeric criteria because scientific investigations of appropriate freshwater or marine standards are not applicable. Further, it has been difficult to establish expected or natural conditions without comparable reference sites. Despite these difficulties, the Utah Division of Water Quality (UDWQ) is committed to establishing numeric criteria and associated assessment methods for this ecologically and economically unique ecosystem.

Over the past several years DWQ has made significant headway towards understanding water quality on the GSL and assessing whether the GSL can support its beneficial uses as required by Clean Water Act (CWA) rules and regulations. As of 2008, a selenium standard for the lake was established and represents the lake's first numeric water quality criterion. Other numeric criteria will follow, but until they are developed UDWQ must develop procedures to interpret and apply the narrative standard to ensure that water quality is protected. In particular, protections are needed to assess beneficial use support, develop permit limits, implement antidegradation, and other CWA protections established through State and Federal regulations.

The overall strategy is to create assessment frameworks based on biological, physical and chemical parameters and use the frameworks to document if and how the beneficial uses are protected using the narrative criteria.

In the GSL Appendix of the 2008 Integrated Report, http://www.waterquality.utah.gov/WQAssess/Draft_2008IR_GSL_Appendix2.2.pdf, an assessment framework for Mercury and Nutrients were proposed that would use biological, physical and chemical indicators to assess the support of the lake's designated uses. This framework uses multiple lines of evidence, interpreted through a risk analysis, to ultimately assess support of aquatic life through the narrative standard. For each major bay (Gilbert, Gunnison, Bear River, and Farmington) of the GSL and the transitional wetlands, different lines of evidence were developed and weighted based on the distinct salinity and hydrologic regimes of these areas and their unique biological communities. Through this process, DWQ realized that each of these areas needed to be considered independently to further develop CWA programs. As a result, DWQ reclassified the designated beneficial uses of Great Salt Lake (Class 5) into five subclasses (5A-5E) in state code UAC R317-2-6. This reclassification is described in this document along with a characterization of each of these classes.

For this reporting cycle, a scoping level beneficial use assessment of Mercury in GSL was conducted and a process was developed that will allow UDWQ to use an Ecological Risk Assessment to interpret all mercury data in the context of beneficial use support. At present, additional data and information are necessary to perform the ecological risk assessment. DWQ anticipates that a beneficial use support determination will be made in the 2012 Integrated Report Cycle. Until then, the decision is to place the GSL in Category 3B, which includes waters where data and information are insufficient to determine an assessment status.

A preliminary Multimetric Index (MMI) for GSL Impounded Wetlands was also developed that uses multiple lines of evidence to quantify the physical, chemical, and biological condition of these waters (http://www.deq.utah.gov/Issues/gslwetlands/docs/FinalReport122209.pdf). Similar tools are being developed for other wetland classes with funds recently provided to DWQ through an EPA competitive grant. Ongoing data collection and research will focus on improving and validating the preliminary assessment framework for the impounded wetlands. It is anticipated that the MMI for impounded wetlands of Great Salt Lake will be formally adopted and used to make assessments on the 2012 Integrated Report cycle. DWQ will provide an update on progress of other GSL wetland assessments.

The development of all GSL programs is complex and involves the cooperation and close coordination of many stakeholders. Expertise is also required in numerous, sometimes unrelated, disciplines. Data collection activities must also be coordinated among different State and Federal agencies. All of these stakeholders have a vested, sometimes contrary, interest and/or various regulatory responsibilities. Continued coordination among all of these individuals will be critical to the development of a sustainable water quality program for Great Salt Lake.

14.2 REGULATORY REQUIREMENTS

The federal Water Pollution Control Act Amendments of 1972—also known as the Clean Water Act (CWA)—established the institutional structure for the U.S. Environmental Protection Agency (EPA) to regulate discharges of pollutants into the waters of the U.S., establish water quality standards, conduct planning studies, and provide funding for specific grant projects. The EPA has provided most states with the authority to administer many of the provisions of the CWA. Accordingly, UDWQ has assigned appropriate beneficial uses for waters of the State (UAC R317-2) and protects those uses through the development and enforcement of water quality standards (40 *Code of Federal Regulations* (CFR)131.11).

Under the CWA, states are required to develop water quality standards for their surface waters, including wetlands. The EPA has established numeric standards (toxicity thresholds) for many toxic pollutants; these standards are refined and used by the states in conjunction with assessments of the beneficial uses for the various types of water bodies. The application of national freshwater or marine quality criteria to Great Salt Lake is inappropriate because the lake has unique biogeochemical processes that alter the fate and transport of pollutants, and the lake supports unique species different from those upon which national criteria are based. As a result, DWQ is relegated to development of nutrient criteria as resources become available. To date, DWQ has established a single numeric water quality criterion for selenium, which is applicable to Class 5A, Gilbert Bay (UAC R317-2-14).

Until numeric criteria can be developed, the beneficial uses of GSL have are protected with the following narrative criterion (UAC R317-2-7.2):

> *It shall be unlawful, and a violation of these regulations, for any person to discharge or place any waste or other substance in such a way as will be or may become offensive such as unnatural deposits, floating debris, oil, scum or other nuisances such as color, odor or taste; or cause conditions which produce undesirable aquatic life or which produce objectionable tastes in edible aquatic organisms; or result in concentrations or combinations of substances which produce undesirable physiological responses in desirable resident fish, or other desirable aquatic life, or undesirable human health effects, as determined by bioassay or other tests performed in accordance with standard procedures.*

14.3 GREAT SALT LAKE BENEFICIAL USE CLASSES 5A-5E

The State of Utah reclassified the designated uses of GSL (Class 5) in 2008 into five subclasses (use Classes 5A, 5B, 5C, 5D, and 5E) that more accurately reflect different salinity and hydrologic regimes and the unique ecosystems associated with each of the four major bays (Gilbert, Gunnison, Bear River, and Farmington) and transitional wetlands. Classification of Great Salt Lake in this manner provides the UDWQ with the flexibility to develop scientifically defensible water quality criteria for each of these unique ecosystems. This flexibility is important because water quality criteria associated with aquatic life uses are intended to protect the species that occupy those waters, which differs among each of GSL's major bays (see Section 2.3). As a result, these distinct ecosystems were recently reclassified in UAC R317-2-6 into separate classes, which are described in this section.

Class 5A: Gilbert Bay

Geographical Boundary -- All open waters at or below approximately 4,208-foot elevation south of the Union Pacific Causeway, excluding all of the Farmington Bay south of the Antelope Island Causeway and salt evaporation ponds.

Beneficial Uses -- Protected for frequent primary and secondary contact recreation, waterfowl, shore birds and other water-oriented wildlife including their necessary food chain.

Class 5B: Gunnison Bay

Geographical Boundary -- All open waters at or below approximately 4,208-foot elevation north of the Union Pacific Causeway and west of the Promontory Mountains, excluding salt evaporation ponds.

Beneficial Uses -- Protected for infrequent primary and secondary contact recreation, waterfowl, shore birds and other water-oriented wildlife including their necessary food chain.

Class 5C: Bear River Bay

Geographical Boundary -- All open waters at or below approximately 4,208-foot elevation north of the Union Pacific Causeway and east of the Promontory Mountains, excluding salt evaporation ponds.

Beneficial Uses -- Protected for infrequent primary and secondary contact recreation, waterfowl, shore birds and other water-oriented wildlife including their necessary food chain.

Class 5D: Farmington Bay

Geographical Boundary -- All open waters at or below approximately 4,208-foot elevation east of Antelope Island and south of the []Antelope Island Causeway, excluding salt evaporation ponds.

Beneficial Uses -- Protected for infrequent primary and secondary contact recreation, waterfowl, shore birds and other water-oriented wildlife including their necessary food chain.

Class 5E: Transitional Waters along the Shoreline of the Great Salt Lake

Geographical Boundary -- All waters below approximately 4,208-foot elevation to the current lake elevation of the open water of the Great Salt Lake receiving their source water from naturally occurring springs and streams, impounded wetlands, or facilities requiring a UPDES permit. The geographical areas of these transitional waters change corresponding to the fluctuation of open water elevation.

Beneficial Uses -- Protected for infrequent primary and secondary contact recreation, waterfowl, shore birds and other water-oriented wildlife including their necessary food chain.

Note that the uses are intentionally general and the language used to describe the uses of these sub-classifications do not dramatically differ. However, the classes are still useful because the chemical and biological data collected from the different bays require independent interpretation. While all areas around GSL support birds, the specific uses of various bird species differ among each area of the lake. For instance, the food webs—organisms in the necessary food chain—of bird species often varies from one bay to the next. Also, while all the bays are hydrologically connected with an interdependence that cannot be ignored, their different salinities affect background chemical constituents and therefore, an appropriate interpretation of chemical data must be location-specific. As a result, it is anticipated that specific assessment methods and numeric criteria will be required for each of these classes.

14.4 LAKE ELEVATION BOUNDARY OF 4208 FEET

A lake elevation of 4208 feet was chosen as the boundary to distinguish GSL from its surrounding aquatic ecosystems. UDWQ chose 4208 feet as the maximum elevation because below this elevation, fluctuations in lake levels result in changes to soil salinity that subsequently cause important shifts in communities of aquatic dependent plants and animals and alters the aquatic life uses of 5E wetlands. These alterations are part of GSL's natural history and the resulting ecological succession is hypothesized to be among the many reasons for GSL's amazing biodiversity.

Over the years, UDWQ has been asked by stakeholders where the GSL ends and freshwater criteria apply. There are no clear rules that UDWQ could follow to demarcate the GSL from its surrounding environment, so any boundary selected is necessary and somewhat arbitrary. After consideration of various potential boundaries, the elevation of 4208 feet was determined to be an appropriate boundary due to some of the following reasons:

- The State of Utah owns and manages sovereign lands pursuant to the Equal Footing Doctrine. The bed of Great Salt Lake below the boundary of the surveyed meander line is sovereign land. The meander line is located between 4202 and 4212 feet above sea level with a general elevation of 4208 feet (personal communication Dave Grierson, FFSL). The surveyed meander line is the adjudicated, fixed and limiting boundary between sovereign land and upland owners (Great Salt Lake Comprehensive Management Plan 1999). Above the meander line, ownership is largely private consisting of numerous privately owned duck clubs, sanctuaries (the Nature Conservancy and National Audobon's Gilmore), and some mitigation preserves (the Legacy Nature Preserve, Inland Sea Shorebird Reserve and the Salt Lake International Airport Wetland)

- The West Desert Pumping Project was designed to alleviate the effects of flooding in Great Salt Lake by pumping water into the West Desert, lowering the lake level in the shortest period of time. Pumping north arm brines when the elevation in the South Arm is 4208 feet was determined by the State as optimal to meet environmental concerns, avoiding substantial start up and operational costs, and minimizing conflict with the US Air Force.
- According to USGS records recorded at Saltaire from 1881 to 2006, the mean annual average of the GSL is 4199.8 feet and 99% of the time, the mean annual elevation will be below 4209.79 feet
- The top of the Davis County Causeway is located at an elevation of crest at 4208.75 feet. When lake level is above this elevation, waters of Farmington Bay and Gilbert Bay would be free to mix (Gwynn, 1998).
- According to the GSL Comprehensive Management Plan, from an elevation of 4208 to 4212 (Zone 6) feet, many recreation, wildlife and other facilities close to the lake would experience damage due to flooding and the salinity of the lake would range from 4 to 6% in the South Arm and 15 to 17% in the North Arm. This is a significant change from Zone 4 (elevation of 4204' to 4208') where salinity of the lake would range from 9 to 12% in the South Arm and 20 to 24% in the North Arm.
- Major transportation (interstates and railroads), mineral industries and sewage treatment facilities are protected to at least 4208' (Great Salt Lake Comprehensive Management Plan (1999).

Despite these rationales, the elevation boundary of 4208 feet remains controversial and this boundary may be altered in the future if a more appropriate boundary can be identified.

14.5 HYDROLOGIC AND GEOCHEMICAL DIFFERENCES BETWEEN CLASSES 5A-5E

14.5.1 Gilbert (Class 5A) and Gunnison Bay (Class 5B)

Prior to completion of the Southern Pacific railroad causeway in 1959, the hydrologic and geochemical characteristics of Great Salt Lake were typical of a terminal lake. The lake was considered to be well mixed from top to bottom with no density stratification (Gwynn, 1988). As lake volume, area and elevation increased, salinity decreased.

After completion, the rock fill causeway spanned from Promontory Point to the west shore of the lake and flow between the North arm and South arm was limited to two 15 foot by 20 foot culverts and the permeability of the rock fill causeway. As a result of the causeway, two ecologically distinct parts of the lake, Gunnison Bay north of the causeway and Gilbert Bay south of the causeway, developed. With limited exchange flow and 90% of the fresh water inflow coming into Gilbert Bay with little inflow to Gunnison Bay, Gunnison bay has become a highly saline system with an average salinity of 27% (as recorded by the USGS gage at Saline). At the same time, Gilbert Bay is much less saline with an average salinity of 14% recorded at the USGS gage at Salt Air. Overall, the salinity of Gilbert Bay fluctuates inversely with lake elevation while Gunnison Bay stays relatively constant, near saturation (Gwynn, 2002).

From September 1982 to June 1986, the level of Great Salt Lake in Gilbert Bay rose from 4199.8 feet to 4211.85 feet exceeding the previous historic high recorded in 1873 (Austin, 2000). This rapid rise caused extensive flood damage. In 1984, the state of Utah created a 290 foot breach in the causeway to lower the lake level in Gilbert Bay as an interim flood control remediation effort. As a more permanent flood control solution, the state legislature funded in 1985 the West Desert Pumping Project designed to pump large volumes of water into an area in the West Desert. From 1987 to 1989, 2.2 million acre feet of water and 695 million tons of salt were pumped out of the lake. Figure 14-1 illustrates the differences in salinity between the pre and post causeway conditions and the dramatic drop in salinity during the flood years. The new breach, the pumping, and the flooding caused an overall freshening of all GSL bays, but the relative among-bay differences in salinity (i.e., Gunnison Bay remaining more saline then Gilbert Bay) remained.

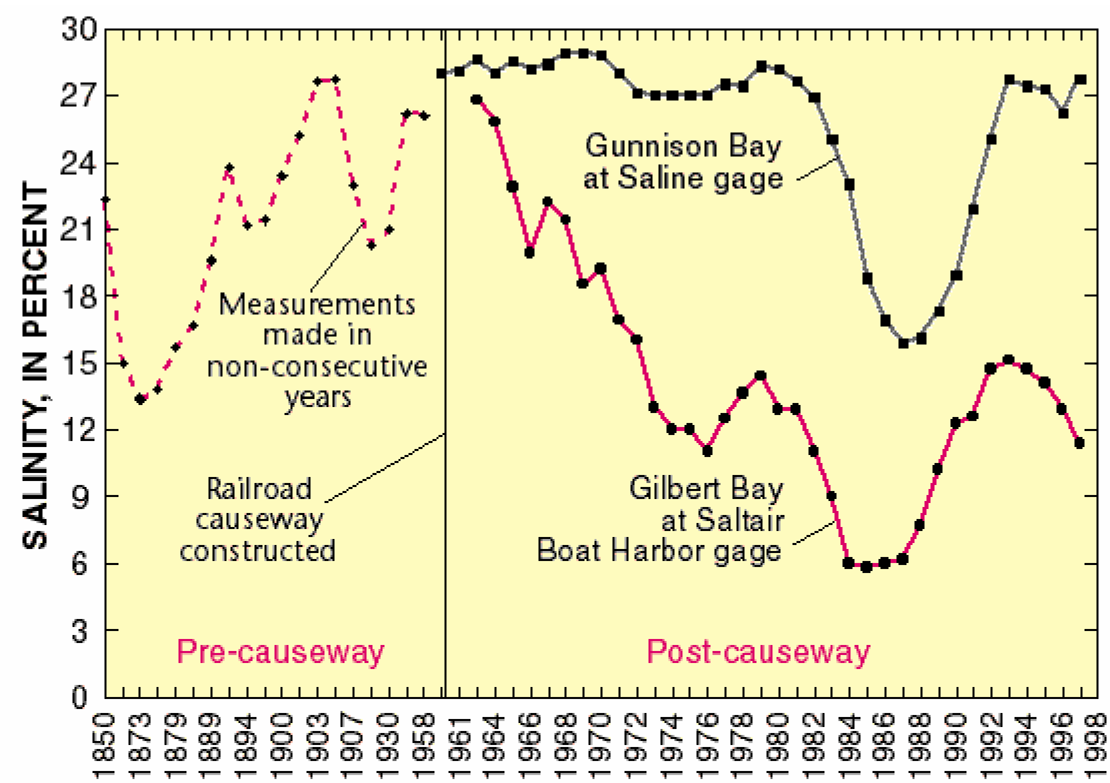

Figure 14-1 Salinity of Gunnison and Gilbert Bays pre and post causeway as reported by the USGS based on the Saline and Saltair gages

One of the GSL's unique hydrological characteristics is bidirectional flow through causeway breaches between the bays. This bi-direction flow is characterized by a deep, dense, and turbid brine layer overlaid by a less dense clearer brine layer. The movement of the layers through culvert openings is dependant on the density difference between the layers and the head differential (differences in elevation) between the bays. For instance, deep brine from Gunnsion Bay flows to Gilbert Bay as lighter surficial brine flows from Gilbert Bay to Gunnison Bay simultaneously and in opposite directions. These directions occasionally reverse due to storm events. The deep brine layer is characterized by extremely high salinity and anoxic conditions and thus few organisms survive in this layer. The dense brine layer also affects the fate and transport of pollutants because this layer creates reducing conditions that alter the cycling of phosphorous, nitrogen, and metals. Mixing of the deep brine and shallow brine layers and movement of the layers between culverts can also occur during wind events.

To characterize the hydrology and geochemistry for each Bay (Classes 5A – 5E), post flood conditions (from 1995 onwards) will be used to develop numeric criteria and assessment methods for the GSL.

14.5.2 Bear River Bay (Class 5C)

Bear River Bay is separated from Gilbert Bay by the Southern Pacific Railroad causeway that extends from Promontory Point to Little Mountain. One culvert allows for bi-directional flow between Bear River Bay and Gilbert Bay. The upper layer of water near the culvert contains 1 to 2% salt while the deeper brine layer is similar in salinity to the deep brine layer in Gilbert Bay. The thickness of the deep brine layer with the overlying less dense brine extending into the Bay is dependant on the inflow rate into the bay and wind conditions. North of the railroad causeway lies a dike and bridge managed by Great Salt Lake Minerals owned by Compass Minerals. The bridge opening is roughly 50 feet in length. Bear River Bay receives the most fresh water inflow of any of the bays from the Bear River and as a result, is the least saline. At an elevation of 4200', the maximum depth of water is 8' and the average depth of water is 2' (Gwynn, 1986). Before reaching the Great Salt Lake, the Bear River flows through the Bear River Migratory Refuge, owned and managed by the US Fish & Wildlife Service since 1928.

14.5.3 Farmington Bay (Class 5D)

Farmington Bay is separated from Gilbert Bay by the Davis County (Antelope Island) Causeway at the northern end and the Island Dike Road at the southern end of Antelope Island. The limited exchange of flow between Farmington Bay and Gilbert Bay is through 2, 10' x 15' culverts and a bridge at 4213.5'. The Bay is shallow with a maximum depth of 7 to 8 feet at a lake elevation of 4200' (Gwynn, 2000). The Bay receives inflows of fresh water from the Jordan River, numerous creeks, groundwater and the Central Davis Sewer district outflow. Bi-directional flow occurs at the culverts and the bridge opening where denser brines from Gilbert Bay flow into Farmington Bay underneath less dense fresher brines from the Bay. The south to north flow of less dense fresher brines through the causeway is due to the head differential between Farmington Bay and Gilbert Bay. The difference in the density of the brines causes the denser brines to flow from Gilbert Bay into Farmington Bay. This bi directional flow prevents the bay from being fresh water. When the lake elevation is above 4208.75' (the crest elevation of the Davis County Causeway), Farmington Bay and Gilbert Bay mix and the salinity becomes more equal to Gilbert Bay.

14.5.4 Transitional Waters along the Shoreline of the Great Salt Lake (Class 5E)

The Transitional Waters are defined as all waters below approximately 4,208-foot elevation to the current lake elevation of the open water of the Great Salt Lake. These wetlands receive their source water from naturally occurring springs and streams, impounded wetlands, or from wastewater discharges of facilities with UPDES permits. The geographical areas of these transitional waters changes with the fluctuation in open water lake elevation. Considerable land area is exposed or submerged with small changes in lake elevation. On average for every foot of change in elevation whether rising or lowering, it is estimated that 44,000 acres lake wide and 17,500 acres along the eastern shore are inundated or exposed (Cruff, 1986). The boundaries of wetland plant communities are limited by the salinity of the water and sediments. Species composition is dependant on the tolerance to salinity, time of inundation and the depth of water (Aldrich and Paul, 2002). Micro habitats may be formed in the transitional wetlands and include estuaries, shoreline playas, ephemeral pools and emergent marshes and within them freshwater invertebrates, fish, and birds become present. In turn, these microhabitats are important to birds because they provide foraging areas, staging areas during migration, and areas for breeding and brooding offspring.

14.6 GSL BENEFICIAL USES: WATERFOWL, SHORE BIRDS AND OTHER WATER-ORIENTED WILDLIFE INCLUDING THEIR NECESSARY FOOD CHAIN

The aquatic organisms found in GSL are those that can survive highly saline waters. These specialized aquatic organisms (e.g. brine shrimp) do so with little predation or competition for food sources and can subsequently thrive in these environments. As salinity decreases, more organisms become present and generally out-compete the salt tolerant organisms resulting in a gradual shift towards communities of fresh water organisms (Collister and Schamel, 2002). These discrete ranges of salinity result in biological communities dominated by different species, which subsequently alters the food web through alterations of the composition and abundance of organisms that occupy different ecological guilds. Annual variation in lake level, water temperature and salinity dictate the abundance of plants and animals, and the timing of many biological processes. Table 14-1 lists the salt water and fresh water organisms that are typically found within the Bays at an elevation between 4198’ to the boundary of 4208’ post 1987 flood conditions. For the 2012 Integrated Report, the biological communities and their habitats for purposes of water quality assessments will be further defined for classes 5A –5E.

Table 14-1 **Source of inflow, range of salinity and aquatic organisms present in Gunnison, Gilbert, Farmington and Bear River Bays**

BAY	SOURCE OF INFLOW	ESTIMATED SALINITY (%) (RANGE DETERMINED AT 4198' AND 4208' POST 1987)	PERIPHYTON AND PHYTOPLANKTON	BRINE SHRIMP (*ARTEMIA FRANCISCANA)*	BRINE FLIES (*EPHYDRA SPP*)	FRESHWATER SPECIES	AVIAN ENDPOINTS
Gunnison	Springs, Creeks, groundwater, Gilbert Bay bi directional flow	16 to 27%*	Halophylic bacteria, Chlorophyta *(Dunaliella salina)*	Solely at railroad causeway, no known reproduction	In littoral zone		
Gilbert	Jordan River (Goggin Drain, North Point), Kennecott Outfall, Lee Creek, Weber River, Howard Slough, Bear River bi directional flow Farmington Bay	7% to 15% *	Chlorophyta,(*Dunaliell viridis)* Cyanophyta (*Nodularia spumigena, A.halophytical*), Pyrrhophyta, Diatoms	Main population consisting of cysts, napulii, juveniles and adults	Main population consisting of brine fly larvae, pupae, and adults		Reproductive success and body condition

BAY	SOURCE OF INFLOW	ESTIMATED SALINITY (%) (RANGE DETERMINED AT 4198' AND 4208' POST 1987)	PERIPHYTON AND PHYTOPLANKTON	BRINE SHRIMP (*ARTEMIA FRANCISCANA)*	BRINE FLIES (*EPHYDRA SPP*)	FRESHWATER SPECIES	AVIAN ENDPOINTS
	bidirectional flow						
Farmington	Jordan River, Surplus Canal, Salt Lake Sewage Canal, Central Davis Sewer District Outflow, Gilbert Bay bi directional flow, Creeks (Kays, Holmes, Farmington, Crystal, Spring)	2 to 6%**	*Nitzschia* spp, Chlorophyta,(*Dunaliell viridis)* Cyanophyta (*Nodularia spumigena*), Diatoms			Corixids, Chironomids, fish near sources of inflow, emergent and submergent vegetation	Reproductive success and body condition
Bear River	Bear River, Gilbert Bay bi	1 to 6%**				Corixids, chironomids,	Reproductive success and

BAY	SOURCE OF INFLOW	ESTIMATED SALINITY (%) (RANGE DETERMINED AT 4198' AND 4208' POST 1987)	PERIPHYTON AND PHYTOPLANKTON	BRINE SHRIMP (*ARTEMIA FRANCISCANA)*	BRINE FLIES (*EPHYDRA SPP*)	FRESHWATER SPECIES	AVIAN ENDPOINTS
	directional flow					fish from 4200' upwards, Freshwater invertebrates, emergent and submergent vegetation	body condition

* Figure 14-10 Great Salt Lake Comprehensive Management Plan

**Estimated

14.7 UPDATE OF ASSESSMENT EFFORTS

14.7.1 Mercury

Over the past several years UDWQ has devoted considerable resources to assessing the extent to which mercury poses a risk to GSL aquatic birds and organisms in their food chain. Researchers from US Fish & Wildlife Service, the Utah Division of Wildlife Resources, US Geological Survey, Utah State University and UDWQ collected data in the water, sediment, aquatic birds, and their food chain for mercury concentrations from key focus areas funded by an EPA Regional Geographic Initiative (RGI) grant and state funds. The data from this study and others (i.e., USFWS, Vest et al.) were compiled and compared to literary benchmarks assembled by EPA and USFWS. The results of this effort are detailed in Part 1 of the GSL Mercury Assessment (Appendix A-1). While these efforts have greatly improved our understanding of mercury in GSL, enough questions currently remain that UDWQ believes that decisions regarding mercury impairment should be postponed. For instance, selection of the most appropriate benchmarks to use for quantifying biological responses to mercury have not been finalized. In addition, the linkage between avian tissue concentrations and exposure to GSL as opposed to other waters visited by birds remains unknown. These data gaps will be investigated and incorporated into an ecological risk assessment framework to help UDWQ determine if GSL fails to meet its beneficial uses due to mercury pollution. Part 2 of the GSL Mercury Assessment (Appendix A-2) provides an overview of the ecological risk assessment process and the problem formulation for Mercury in Great Salt Lake. This framework more clearly highlights specific data and information needed to perform the ecological risk assessment. Nonetheless, UDWQ anticipates that a beneficial use support determination will be made by the 2012 Integrated Report Cycle. Until then, the decision is to place the GSL in Category 3B which includes waters where data and information are insufficient to determine an assessment status.

14.7.2 Selenium

The first numeric water quality standard for selenium for Great Salt Lake was established in state rule (UAC R317-2-14) in November, 2008. This selenium water quality standard of 12.5 mg/kg is a tissue-based standard based on the complete egg/embryo of aquatic-dependent birds that use the waters of Gilbert Bay (Class 5A), Great Salt Lake. Establishing this standard required a 4-year arduous process led by a Selenium Steering Committee comprised of prominent stakeholders who were advised by an international scientific panel of selenium experts. While this standard became state rule in the Utah Administrative Code, it is awaiting approval by the Environmental Protection Agency, Region 8. The delay in approval is due to legal questions regarding the nexus of the Clean Water Act administered by EPA and the Migratory Bird Treaty Act administered by the US Fish & Wildlife Service. Nonetheless, DWQ continues to protect Great Salt Lake for selenium by monitoring egg tissue in aquatic birds, refining the trophic transfer model through ecosystem monitoring, evaluating trigger selenium concentrations that initiate various monitoring, assessment and management actions and identifying management actions to mitigate further increases in selenium concentrations if an upward trend is observed. The results of these efforts will be reported in the 2012 Integrated Report.

14.7.3 Great Salt Lake Wetlands

In December, 2009, UDWQ developed a preliminary Multimetric Index (MMI) for the Great Salt Lake Impounded Wetlands that includes quantitative indicators of water chemistry, submerged aquatic vegetation, surface mats, and benthic macroinvertebrates. These indicators provide multiple lines of evidence that together quantify the relative condition of GSL's impounded wetlands (please access the report and all materials at the UDWQ wetlands website at http://www.deq.utah.gov/Issues/gslwetlands/index.htm). Ultimately, this MMI will allow UDWQ to assess support of aquatic life beneficial uses for these waters. Impounded wetlands are defined as wetlands where the hydrology has been artificially modified through the use of berms, weirs, and culverts to create open water features. Per the updated National Wetland Inventory (US Fish and Wildlife Service, 2008), there are approximately 100,000 acres of such impounded wetlands in and along Great Salt Lake. Ongoing data collection and research will focus on improving and validating the preliminary assessment framework. It is anticipated that the MMI for impounded wetlands of Great Salt Lake will not be formally adopted until 2012.

The MMI for impounded wetlands represents the first step towards UDWQ's management program for assessing all of Great Salt Lake Wetlands. Program tasks to be completed in an iterative manner include: 1) Develop Monitoring and Assessment Methods for Wetland Ecosystems starting with impounded wetlands; 2) Adopt an Assessment (Decision) Framework; 3) Revise Existing Water Quality Standards; 4) Implement a Water Quality Management Strategy for Great Salt Lake Wetlands and; 5) Outline a Comprehensive Great Salt Lake Wetland Water Quality Management Strategy.

The development of this MMI was significantly aided by the input of the Great Salt Lake Wetland stakeholders and scientists. UDWQ will continue to engage stakeholders through the ongoing Great Salt Lake Wetlands Workgroup with the intent to strengthen future assessment frameworks by incorporating input from scientists and other stakeholders, with different areas of expertise.

14.7.4 Nutrients

Collaboration between EPA and DWQ resulted in a nutrient assessment framework for Farmington Bay that was part of the Great Salt Lake appendix in the 2008 Integrated Report. Paleolimnological research is underway to evaluate changes in key water quality parameters and biological assemblages over the last 200 years. The results of this study (draft report due April, 2011) will provide preliminary conclusions of nutrient impacts to Farmington Bay.

14.7.5 Coordination of Great Salt Lake Monitoring Efforts

Numerous state and federal agencies as well as academic researchers have and are currently collecting data from the GSL. To maximize the exchange of knowledge, data and resources, UDWQ intends on holding a GSL monitoring workshop in 2010. The goal of the workshop will be to identify potential opportunities to collaborate with sampling programs under way by other entities.

14.7.6 Scoping Requirements for the Development of a Hydrodynamic Model for GSL

DWQ has contracted for the development of a GSL water quality model to assist in future implementation of GSL water quality standards. Objectives include the development of a strategy that identifies objectives, requirements, and options for assessing how changes in pollutant loads to the lake will affect lake concentrations. Initial criteria that include water quality concerns, key water chemistry issues and hydrodynamic processes in GSL will be used to evaluate model options. The criteria will be refined to identify and evaluate alternative water quality models, and provide a recommended path forward.

14.8 CONCLUSION AND NEXT STEPS

UDWQ is striving to develop water quality assessments and endpoints for GSL that measure beneficial use support to determine water quality goals and to evaluate management actions. Our efforts for the next reporting cycle are detailed in the individual reports on Mercury (see Great Salt Lake Assessment for Mercury Parts 1 and 2 of this report), Selenium (http://www.deq.utah.gov/Issues/GSL_WQSC/docs/GLS_Selenium_Standards/index.htm) and the Great Salt Lake Wetlands (http://www.deq.utah.gov/Issues/gslwetlands/docs/FinalReport122209.pdf). UDWQ is in the process of creating a Great Salt Lake website at greatsaltlake@utah.gov (scheduled to go live September, 2010) that will provide all materials pertaining to UDWQ Great Salt Lake issues. The results of additional research on selenium and nutrients as well as the effort to increase coordination with partnering agencies to monitor and manage the lake will be posted on the website. Stakeholder participation and resources are integral to us achieving these goals.

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