Anna Deakins
Professor Lynda Sperry
Biology 1010
Great Salt Lake Chemistry

The State of Utah, in coordination with the Utah Division of Water Resources, is tasked with the study of the Great Salt Lake in order to monitor lake ecology, manage natural resources and maintain lake health. The state has deemed these tasks necessary in order to sustain the nearly $300 million in resource revenue and provide protection for the surrounding wetlands and islands which are home to hundreds of migratory bird species.

The chemistry of the Great Salt Lake has been annually measured via salinity tests by the Utah Geological Survey. Brine density measurements have also been conducted since the completion of the repairs on the causeway in 1959.

It has been determined that the six major chemicals present in the lake are: chloride (54.5%), sodium (32.8%), sulfate (7.2%), magnesium (3.3%), potassium (2%) and calcium (.2%). As a part of the annual testing it was determined in 2005 that mercury levels had risen to unsafe concentrations, thus prompting the state to issue warning against eating the local ducks. In comparisons of sodium only, Great Salt Lake is 26% more sodium dense than the Dead Sea and 10% more sodium dense than a typical ocean. It is estimated that the total salt content of the lake is between 4.5-4.9 billion tons. The salinity of Great Salt Lake was greatly affected in the mid-1950s with the completion of the South Pacific Rail Road's causeway across the lake that divided the lake into two separate environments: the North Arm and the South Arm. The result of this causeway has been the inhibition of natural flow throughout the lake. There is now South-to-North water flow, but little North-to-South flow. This unidirectional circulation of water resulted in salt concentrating more heavily in the North Arm and increased brine concentration in

the South Arm. Per the research conducted by the Utah DNR and compiled by J. Wallace Gwynn, "the greater density south-arm brine comes from, and is maintained over time by, the north to- south flow of northarm brine moving through the lower part of the causeway fill, and through the deeper portions of the two culverts in the causeway." The South Arm has remained less saline due to the three fresh-water tributaries that feed into it: the Bear, the Weber and the Jordan rivers. Conversely, since the North Arm does not receive these fresh water channels, its saline content has remained constant, at nearly 25% salt content. The unequal saline content is further exasperated by the North Arm receiving less annual precipitation and higher evaporation than the South Arm. The higher evaporation rate in the North arm further serves to concentrate the salt-to-water ratio.

Due to the sodium-logged water, Great Salt Lake does not freeze. The sodium chloride molecules "re-arrange" the water molecules: the positive Na molecules align with the negative O side of the water molecule, and the negative Cl molecules align with the positive H side of the water molecule. Because of this "re-arranging" the H_2O cannot bind into a lattice, thus impeding the formation of ice. Another result of the saline environment is that salt-loving phytoplankton called *Dunaliella viridus,* and salttolerant bacteria thrive in the lake. The presence of these organisms has the tendency to turn the waters of Great Salt Lake pink and produce foam on the shoreline. The foam is due to *Dunaliella viridus*. As the phytoplankton metabolize they secrete organic compounds called "surfactants", which are similar to soaps. The surfactants combat the surface tension of the water and allow for bubbles to form on waves and pile on the shoreline. *Dunaliella viridus* does more for the lake ecology than produce foam: they serve as food for the Brine Shrimp, *Artemia salina*. The Brine Shrimp eat the *Dunaliella viridus,* a form of algae, and in turn keep the waters of Great Salt Lake clean. The population of Brine Shrimp in the lake in

turn provides food for the hundreds of species of migratory birds that come through the Pacific and Central Flyways. They stopover in Great Salt Lake since it is a plentiful source of food.

Works Cited

Case, W. 2010. Pink Water, White Salt Crystals, Black Boulders, and the Return of Spiral Jetty! Utah Geological Survey, http://geology.utah.gov/surveynotes/geosights/spiraljetty.htm

Gwynn, W. 2010. A Lake Divided – A History of the Southern Pacific Railroad Causeway and Its Effect on Great Salt Lake, Utah. Utah Geological Survey, http://geology.utah.gov/utahgeo/gsl/lakedivided.htm

Gwynn, W. 2010. What Causes the Foam on Great Salt Lake? Utah Geological Survey, http://geology.utah.gov/surveynotes/gladasked/gladfoam.htm

Milligan, M. 2010. Do you have any information on the hydrologic cycle specific to Utah? Utah Geological Survey, http://geology.utah.gov/surveynotes/gladasked/gladhydr.htm#gslbasin