

Great Salt Lake Utah

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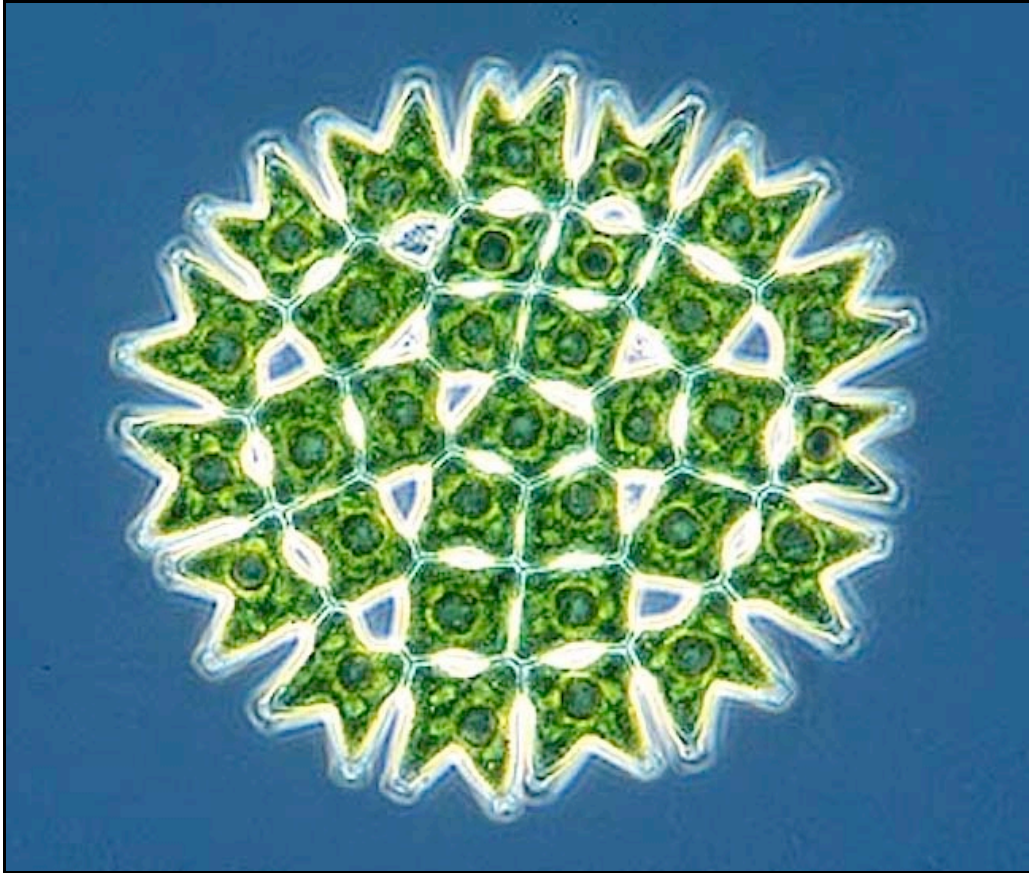
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Note: In PDF format most of the images in this web paper
can be enlarged for greater detail.



Pediastrum a flat colony of Green Algae

Introduction

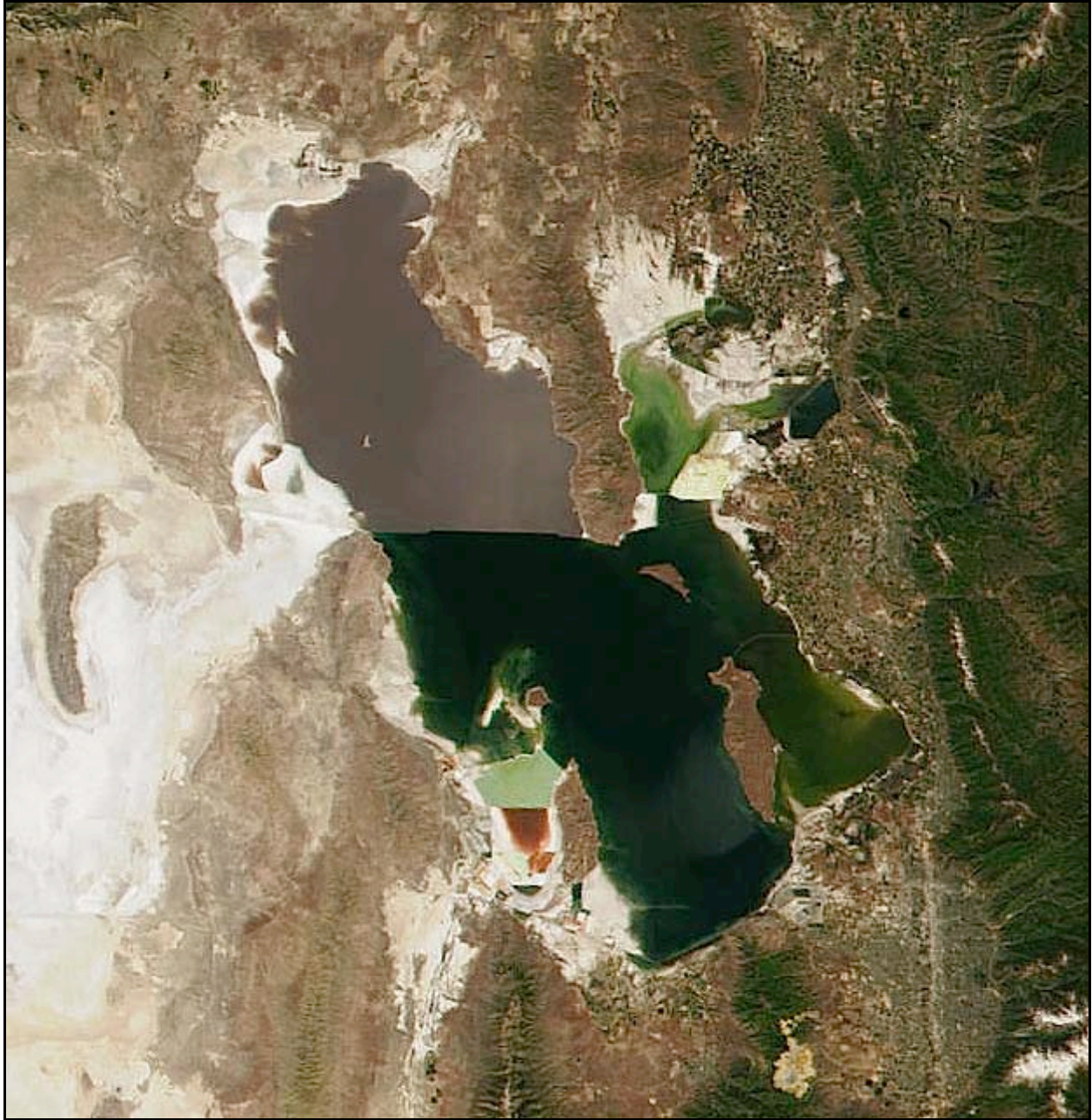
This series of papers and essays on the importance of plankton and phytoplankton is centrally important in understanding humanities roles in the future of all of life on Earth. This essay is presented to show how complex our roles is. For it is not only marine and freshwater bodies of water that are involved. Hypersaline bodies of water found in inland closed basins also play a part in this story and provide a unique picture of the role played by halophilic bacterium and algae in life on Earth. The Great Salt Lake in the state of Utah in the United States is only one example.

Some facts about the Great Salt Lake

- 1. It is the largest U.S. lake west of the Mississippi River.**
- 2. It is the 4th largest terminal lake (no outlet) in the world.**
- 3. It is a remnant of Lake Bonneville, a prehistoric freshwater lake that was 10 times larger than the current Great Salt Lake.**
- 4. It is about 75 miles long, and 28 miles wide, and covers 1,700 square miles and has a maximum depth of about 35 feet.**
- 5. The lake is hypersaline and is typically 3-5 times saltier than the ocean.**
- 6. It is fish free, the largest aquatic animals are brine shrimp and brine flies.**
- 7. It is one of the largest migratory bird refuges in Western North America.**



Great Salt Lake taken from SkyLab in 1973.



Great Salt Lake Utah, May 31, 2001

The sharp line across the center of this NASA Terra satellite image of Great Salt Lake, Utah, is caused by the restriction of water flow by a railroad causeway. The colors of the lake result because the lake is hypersaline. North of the causeway salinities are higher, and the water turns purplish from the pigments of halophilic (salt loving) Archaea. South of the causeway the greenish color is from photosynthetic bacteria and algae. Note that in 2001 the lake surface area had expanded to near its former high water mark after several years of normal or above average freshwater inflow.



Great Salt Lake in 2003

In 2003, however, note how much the surface area of the great lake has shrunk since 2001, and how the north arm of the lake has turned a reddish brown. The answer lies in a decrease of freshwater inflow in the intervening years and the attendant increase in salinity. Red algae, such as *Dunaliella Salina* and the beta-carotene and Halobacterium (Haloarchaea) it releases thrive in the hypersaline waters that result. This image was taken from the International Space Station.

Web Reference

http://en.wikipedia.org/wiki/Dunaliella_salina



Halobacterium salinarum

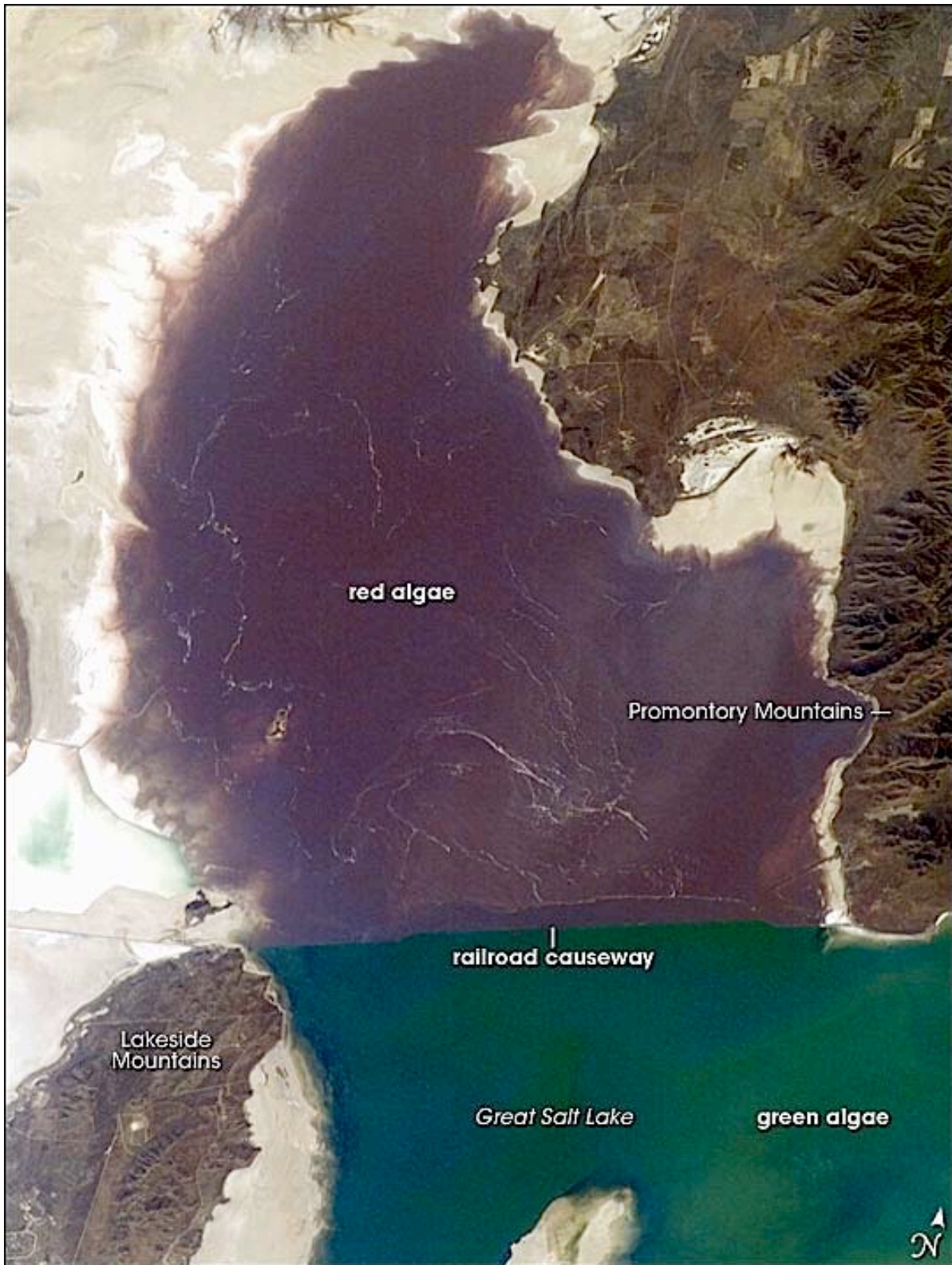
Cells of Halobacterium, a halophilic (salt loving) Archaea bacterium, as seen through a high-powered microscope, The individual cells in this image are about 5 microns long. Halobacteria's pigment bacteriorhodopsin is what gives the reddish hue to the lake brine.

Web References

<http://en.wikipedia.org/wiki/Halobacteria>

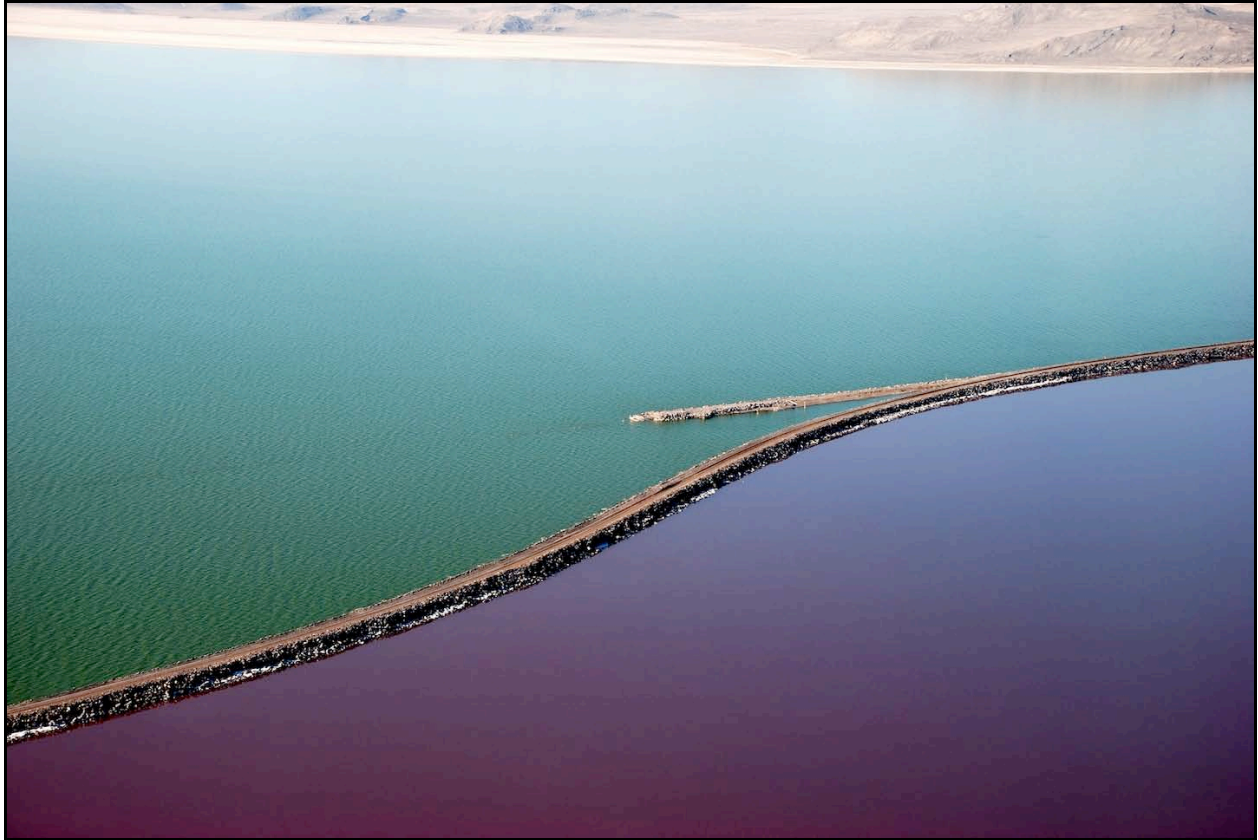
http://microbewiki.kenyon.edu/index.php/File:Halobacteria_1.jpg

http://science.nasa.gov/science-news/science-at-nasa/2004/10sep_radmicrobe/



Great Salt Lake in 2007

Image taken from the International Space Station.



Great Salt Lake Causeway 2008

(The view is looking to the west. North is on the right)

The photo above shows the causeway that cuts across Great Salt Lake in Utah. The original transcontinental railroad was built to the north of the lake and completed in 1869. In 1904, the Southern Pacific Railroad created a shorter route directly across the lake called the Lucin Cutoff, reducing the distance of the railway by 42 mi (68 km).

The original rail was built with a 12 mile (19 km) open trestle in the middle of the lake. This trestle allowed free flow of the brine from the north arm of the lake to the southern portion. However, by the 1950s the trestle became too expensive to maintain and was replaced with an earth-fill causeway.

The causeway however impeded the free exchange of water from the north and south. Most of the flow of freshwater into the lake comes from the south arm. By 1988, the south arm of the lake was several feet higher than the north arm, and the salinity of the south arm had fallen significantly.

A 100 ft (30 m) breach in the causeway installed in 1988 allowed the elevations and salinity to equalize to a certain extent. Further modifications to the breach along with lake level fluctuations have kept the salinity in the north arm at saturation levels (about 27 percent salt) while the south arm fluctuates between 5 and 15 percent.

The lower salinity of the south arm creates a different ecosystem than that of the north arm. The south arm is dominated by cyanobacteria and green algae, both of which color the water green. However, the higher salt content of the north arm, allows the growth of the red alga *Dunaliella Salina*. It is this alga, and the beta-carotene and Halobacterium it releases, that gives the north arm water its distinctive wine red color.

Web References

<http://epod.usra.edu/blog/2012/09/great-salt-lake-causeway.html>

<http://www.ucmp.berkeley.edu/bacteria/cyanointro.html>

<http://en.wikipedia.org/wiki/Halobacteria>

<http://en.wikipedia.org/wiki/Haloarchaea>



Evaporation Ponds Near Great Salt Lake

The photo above shows an airborne view of evaporation pond clusters adjacent to Great Salt Lake in Utah. Water from the Great Salt Lake is pumped into the desert flats that border the lake and when this water evaporates, salt, potassium, calcium and other minerals, are left behind. The colors of the ponds result from both the variations in salinity and from the algae content.

Web Reference

<http://epod.usra.edu/blog/2012/08/evaporation-ponds-near-great-salt-lake.html>



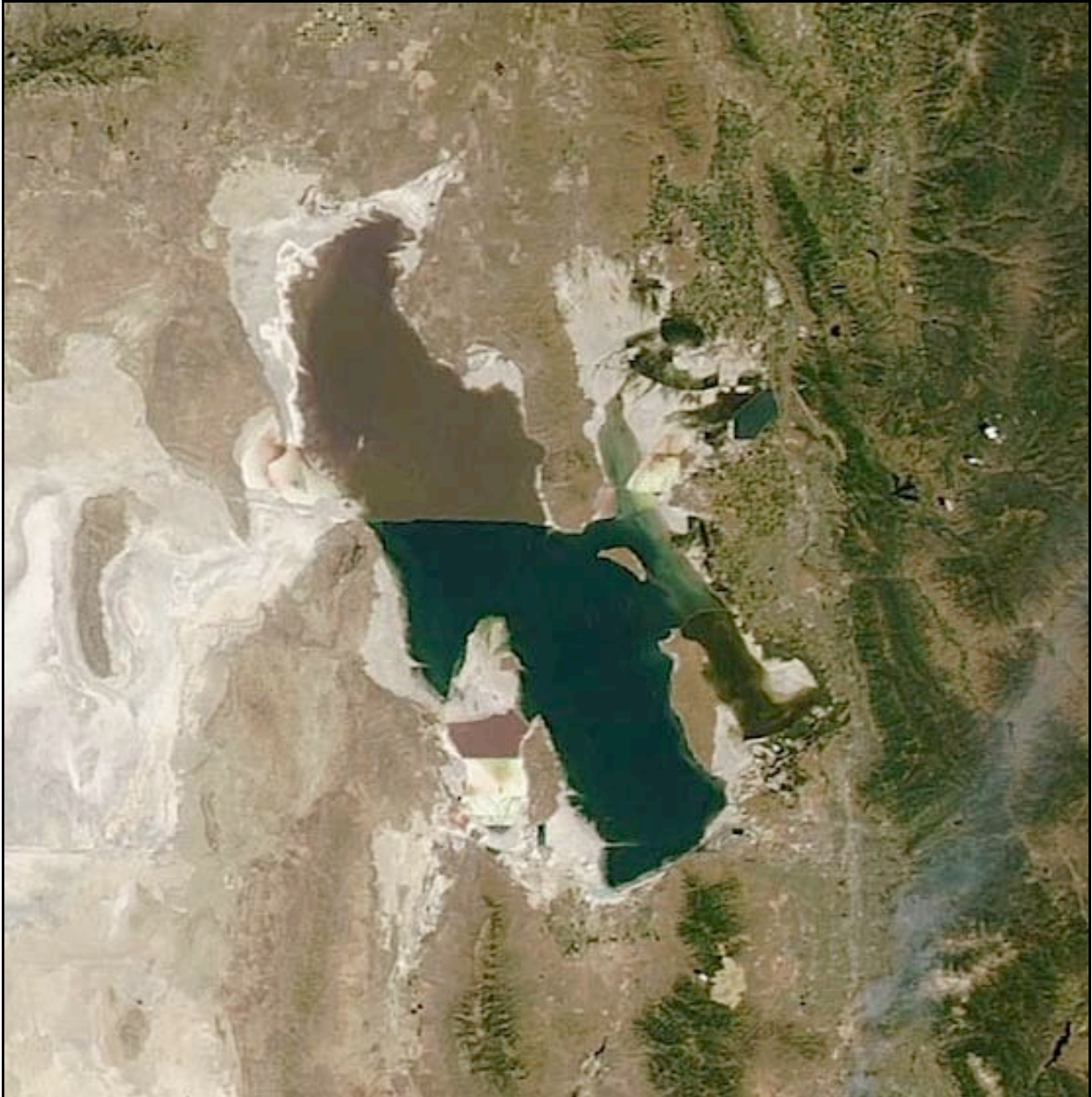
Great Salt Lake, June 13, 2008

Note the variation in the color of the water in the north arm of the lake during 2008 resulted from different levels of salinity throughout the year and the resulting algal species blooming at different times. Image taken from NASA's Aqua satellite.



Great Salt Lake, December 31, 2009

Because the Great Salt Lake is hypersaline it doesn't freeze over in the cold, high altitude winters of Utah. Image from NASA Terra satellite.



Great Salt Lake, June 22, 2012

Note the lake has almost recovered in size from the drought years of 2003 to 2010. The purplish-brown color of the north arm of the lake would indicate different algae blooming as the salinity of the water decreased as freshwater runoff filled the north arm. The same conditions also apply to the north arm in the picture of the lake taken in 2001. Image taken from NASA's Aqua satellite.



Bonneville Salt Flats

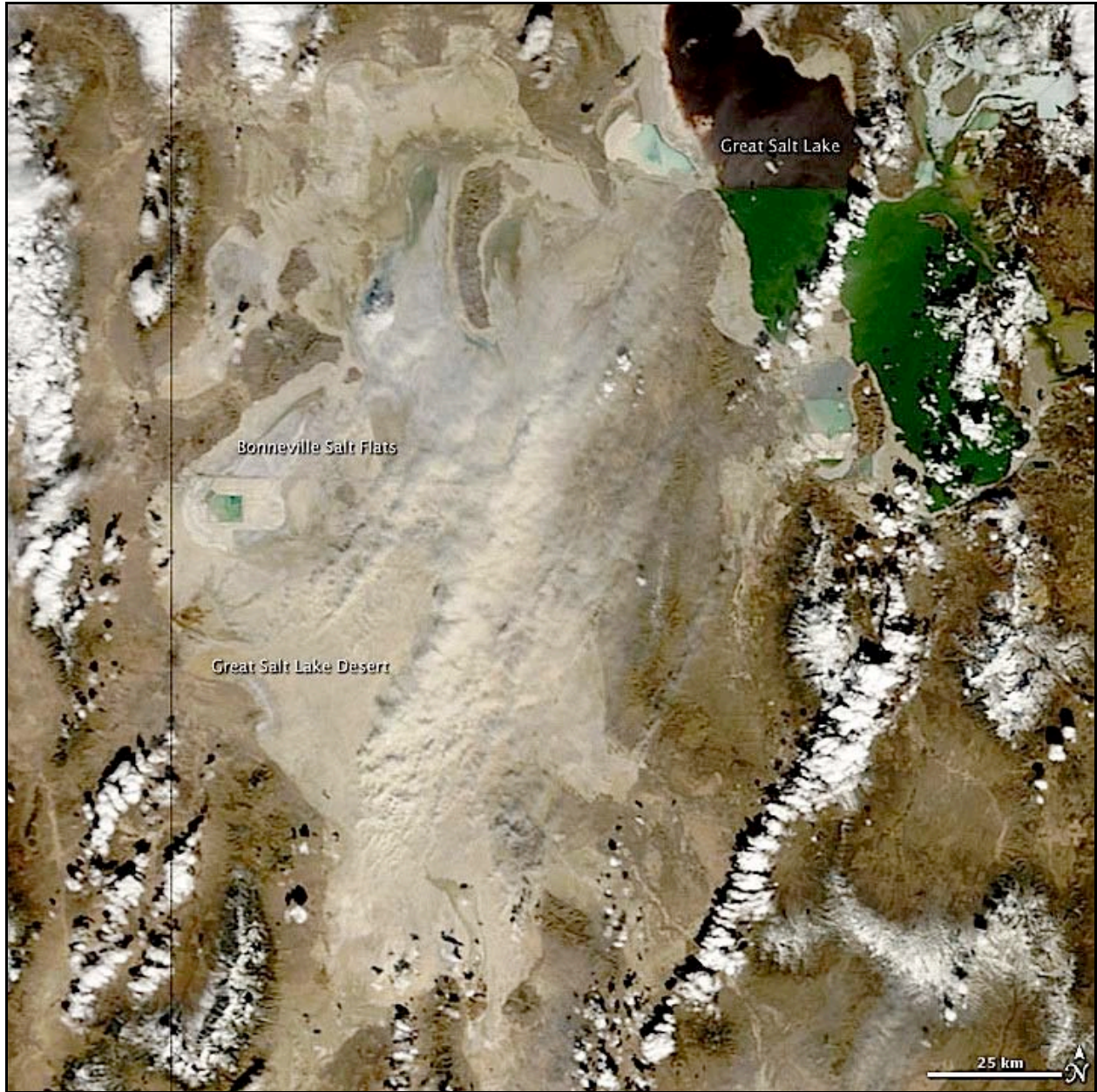
Winter and springtime snow and rainfall replenish and revive the surface minerals, including sodium chloride (table salt), potassium and magnesium that compose the Bonneville Salt Flats; a 159 sq mi (412 sq km) pan left behind by the prehistoric waters of vanished Lake Bonneville.

The ancient lake covered much of western Utah and eastern Nevada during the Pleistocene ice ages. Due to climate change and geologic factors, the great lake dried up thousands of years ago, leaving behind only encrusted basins like this and a notable remnant, the Great Salt Lake.

The salt plain is so extensive and flat that in late summer and fall, when the standing water has evaporated, racing aficionados bring their powerful vehicles to the Bonneville Speedway, hoping to break speed barriers and achieve land speed records -- a tradition here that dates back a century.

Web Reference

<http://epod.usra.edu/blog/2013/05/bonneville-salt-flats-and-pilot-peak.html>

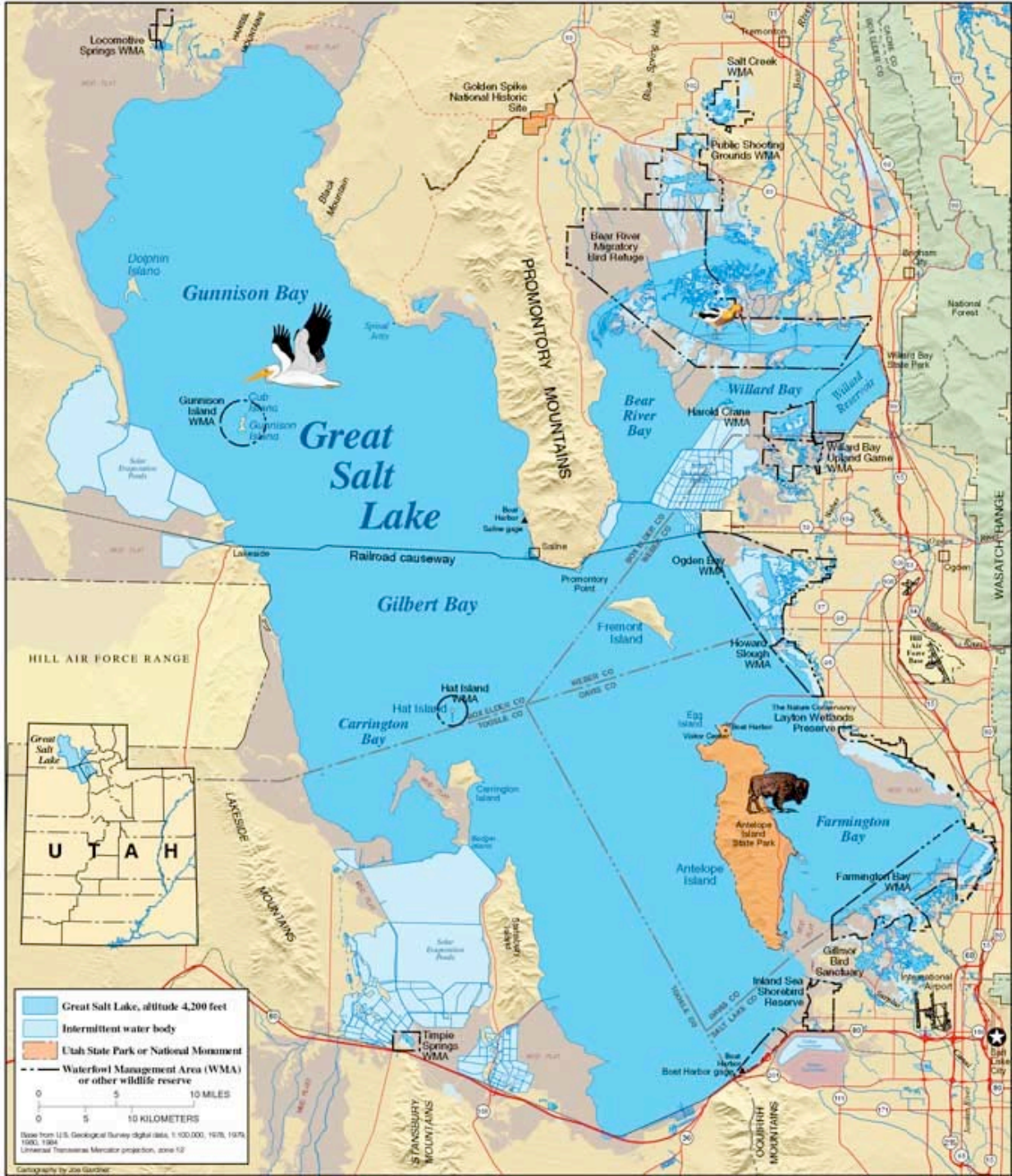


Remnants of Ancient Lake Bonneville

Winds blasted across northern Utah on Wednesday, March 4, 2009 ahead of a winter storm that was making its way east across the region. The winds scoured dust off the Great Salt Lake Desert and Bonneville Salt Flats and showered it down across the northern part of the state. This image of the dust storm was captured by the MODIS instrument on NASA's Terra satellite. The dust clouds show up as pale ripples above the duller tan of the underlying desert.

Web Reference

<http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=37312>



USGS Map of Great Salt Lake Utah

For more on the Great Salt Lake (including an enlargeable map of the above) go to:

<http://pubs.usgs.gov/wri/wri994189/PDF/WRI99-4189.pdf>