Using GIS To Distinguish Wetland Vegetation/Shorelines from Current Drought Conditions in The Great Salt Lake.

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Intro

This project involves analyzing the Great Salt lakes' water reduction and its surrounding shoreline/vegetation response. The lake area currently is just less than 1700 square miles, and is the dead end of a 34,363 square mile drainage basin. The Great Salt Lake Basin includes Utah, Idaho, Wyoming, and Nevada and is fed by multiple systems and sources. The Great Salt Lake is fed mostly by surface water through drainage stream systems, but also has a small contribution of ground water. There are three sub basins that contribute the most water to the lake, which are the Bear River Basin, the Weber River Basin, and the Jordan/Provo River Basin. These systems connect to the Great Salt Lake in different areas but all end in the lake. A fourth basin, the West Desert Basin provides small amounts of water but is also a means for precipitation pathways to the other three basins.

These watersheds provide water to the lake, but a multitude of scenarios have been predicted to reduce flows that make it all the way to the lake. Drought conditions that are being experienced and forecasted for the future contribute largely to GSL reductions. The western United States have been experiencing drought conditions for many years now, and the impacts have been interpolated to be more and more influential on the Great Salt Lake's future size and capacity. Other limits placed on water inputs to the lake are the population growth and increased water demand of northern Utah particularly the Wasatch Front. Because the Great Salt Lake is fed by surrounding watersheds who gain their water from snow pack, drought conditions and climate change coupled with higher use of water can have large consequences for the lake systems and wetlands. This combination of less water with greater need has reduced the lake substantially, and my goal is to use GIS to explore the lakes response in water surface area and vegetation area.

Objective

The objective of this project is to gather existing data on the Great Salt Lake and display it to see what the Great Salt Lake is doing because of its reduced inflows. Combining water and vegetation data will help us visualize and understand what conditions are found on the ground. This benefits multiple people and organizations that work in everything from water quality to harvesting of minerals. It will help managers see what areas are losing permanently flooded vegetation or where reduced water conditions could increase concentrations of pollutants or algae. This project is quite broad and the scale of the lake is large, but the purpose is to show a general view of the lakes water levels and the plants that react to those levels.

Methods

My objective is to map the Great Salt Lake open water areas as well as wetland vegetation to show the changes in the lake. I set out to see how much the lake area had reduced, and if the lost lake area had been replaced by wetland vegetation or something else. Using data from the Utah AGRC website, I mapped the Great Salt Lake meander boundary which is a basic boundary where the GSL will potentially move to. This gave me an idea of the maximum lake area and an expectation of where the lake "should be". I then obtained the Utah wetlands data from AGRC and overlaid it. Then I created a 10 km buffer around the GSL meander line so that the wetlands around the lake could be incorporated into the analysis. The next step was to clip the wetland layer with the meander buffer to simplify the wetland layer to only the GSL and 10 km around it.

With this new area of interest, I then reclassified the layer to display the different distinctions of wetland. In this layer there were only broad distinctions of wetland type: emergent wetland, lake, and fresh water pond, but of those wetland types there are wetland codes which introduced nearly 50 different distinctions of wetland. These codes are the National Wetland Inventory acronyms used in the US that describe particular

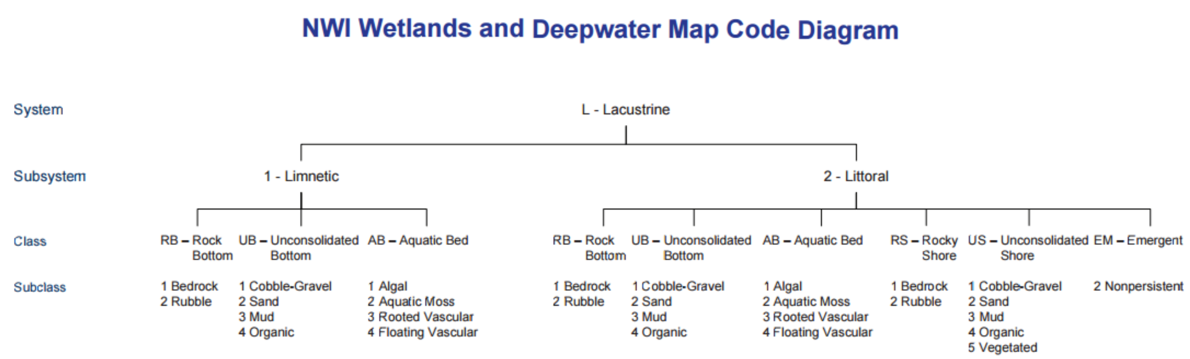


Figure 1

wetland features. Because there are duplicate codes and others that only vary in acronym, I used the US Fish and Wildlife interactive website to sort codes into the four arbitrary wetland types: Briefly Flooded, Seasonally Flooded, Permanently Flooded, and Emergent Wetland. Combining these codes allowed me to consolidate their corresponding polygon into these four layers that form my first map.

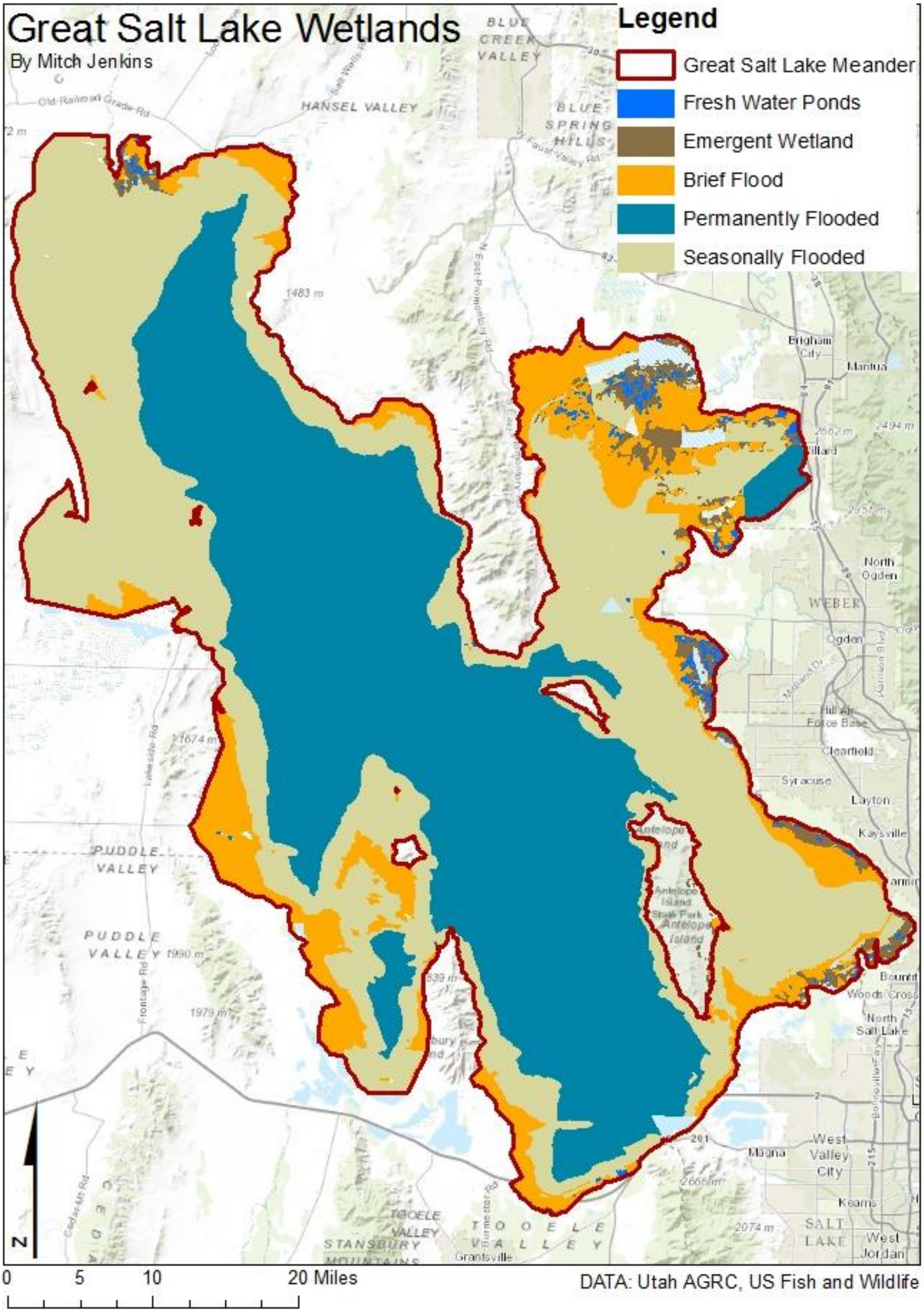
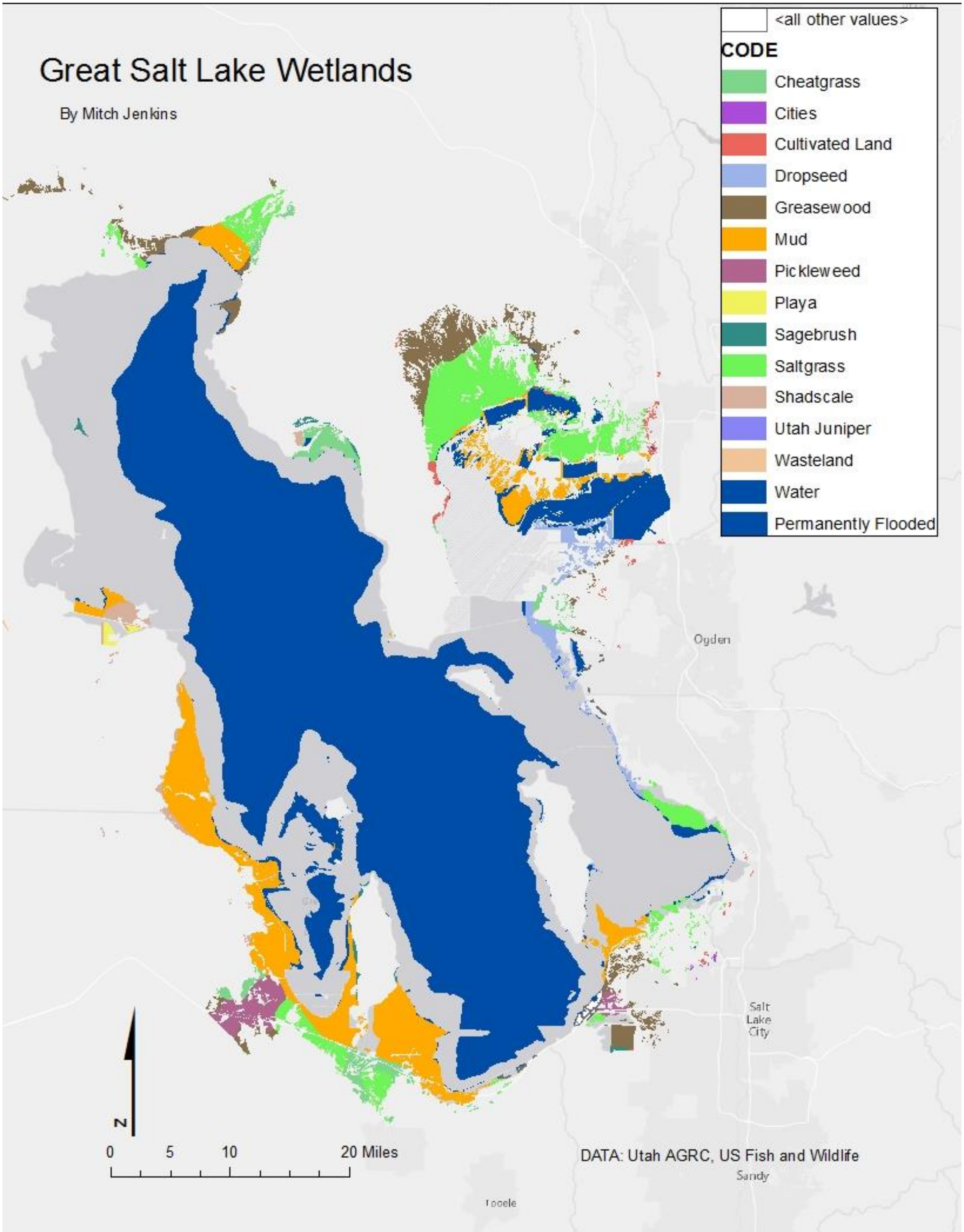

Great Salt Lake Wetlands
By Mitch Jenkins
Legend
Great Salt Lake Meander
Fresh Water Ponds
Emergent Wetland
Brief Flood
Permanently Flooded
Seasonally Flooded
N
0
5
10
20 Miles
DATA: Utah AGRC, US Fish and Wildlife

Figure 2

At this point I began analyzing the map to look for areas of potential lake area loss. I determined the Briefly Flooded areas to be my first focus because of the combined wetland descriptions. All wetland codes within the brief flood area have water on them for short periods of the early growing season and I guessed that those would be possible areas of shoreline retreat. So, I added the Dominant Vegetation data to the map and clipped it with the Briefly Flooded Polygon. This layer presented the Briefly Flooded area and which dominant plants are contained in it.

I then moved to the next wetland type, the Seasonally Flooded areas of the lake. I carried out the same procedure to obtain the dominant vegetation for this Seasonal area by clipping the vegetation layer with the Seasonally Flooded polygon. Like the previous operation, this produced a layer of dominant vegetation within the Seasonally Flooded areas.

At this point I began analysis of the attribute tables of each map to see what could be learned from them. I had to break down the dominant vegetation attribute table because it also used a coding system to describe each land cover. The code descriptors were contained within the file geodatabase which made them easier to correlate. I then exported these tables into Excel for simple statistical review.


Great Salt Lake Wetlands
By Mitch Jenkins
<all other values>
CODE
Cheatgrass
Cities
Cultivated Land
Dropseed
Greasewood
Mud
Pickleweed
Playa
Sagebrush
Saltgrass
Shadscale
Utah Juniper
Wasteland
Water
Permanently Flooded
Ogden
Salt Lake City
Sandy
Tooele
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20 Miles
DATA: Utah AGRC, US Fish and Wildlife

Figure 3

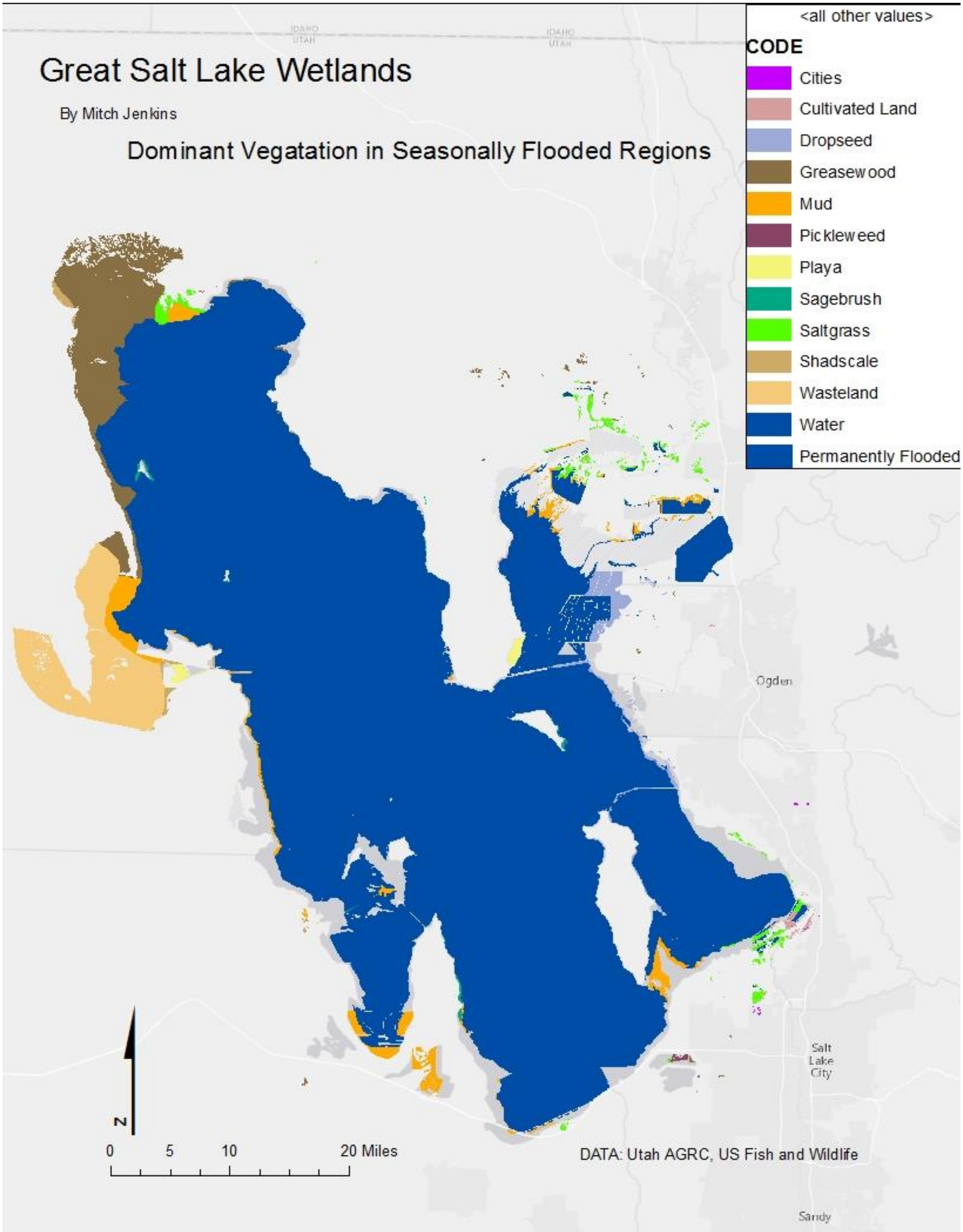
Great Salt Lake Wetlands
By Mitch Jenkins
Dominant Vegatation in Seasonally Flooded Regions
<all other values>
CODE
Cities
Cultivated Land
Dropseed
Greasewood
Mud
Pickleweed
Playa
Sagebrush
Saltgrass
Shadscale
Wasteland
Water
Permanently Flooded
Ogden
Salt Lake City
Sandy
N
0
5
10
20 Miles
DATA: Utah AGRC, US Fish and Wildlife

Figure 4

Results

Creating these maps involved more data management than I have ever had to do before but after everything was reclassified and consolidated the maps that were generated were concise and informative. After joining the wetland data to the dominant vegetation data I had a map that contained surface water area for four separate lake sections. Underneath these four sections the map contains dominant vegetation data that describe what grows most commonly in that section.

I focused on the Briefly Flooded and Seasonally Flooded sections for my analysis because of their potential to change from open water to something else. The Briefly Flooded region has an area of 451 square miles, which is around 26% of the total lake area. In the Briefly Flooded map, I found that 33 percent of the lake area was dominated by Salt Grass, saltwater/drought tolerant grass that can live in up to 2 inches of water or high water table depths. The environment that this plant grows in helps us infer what condition this 33% lake area is like. It is likely that water level is variable and can fluctuate but that water is often present. Another plant that helps us see what water levels are like is the Greasewood plant that makes up 17% of the Briefly Flooded section. Unlike Salt Grass, Greasewood can only live in standing water for 40 days, so standing water can only be present in these areas for that long. Another inference that can be made is the progression of less water tolerant plants toward the center of the lake. This suggestion is that if drought conditions continue vegetation regimes could change in areas where water is present for less time. Other vegetation has also moved in on the GSL shore, Cheat Grass is present up to the shore in the northern part of the lake and even cultivated land up to the shoreline.

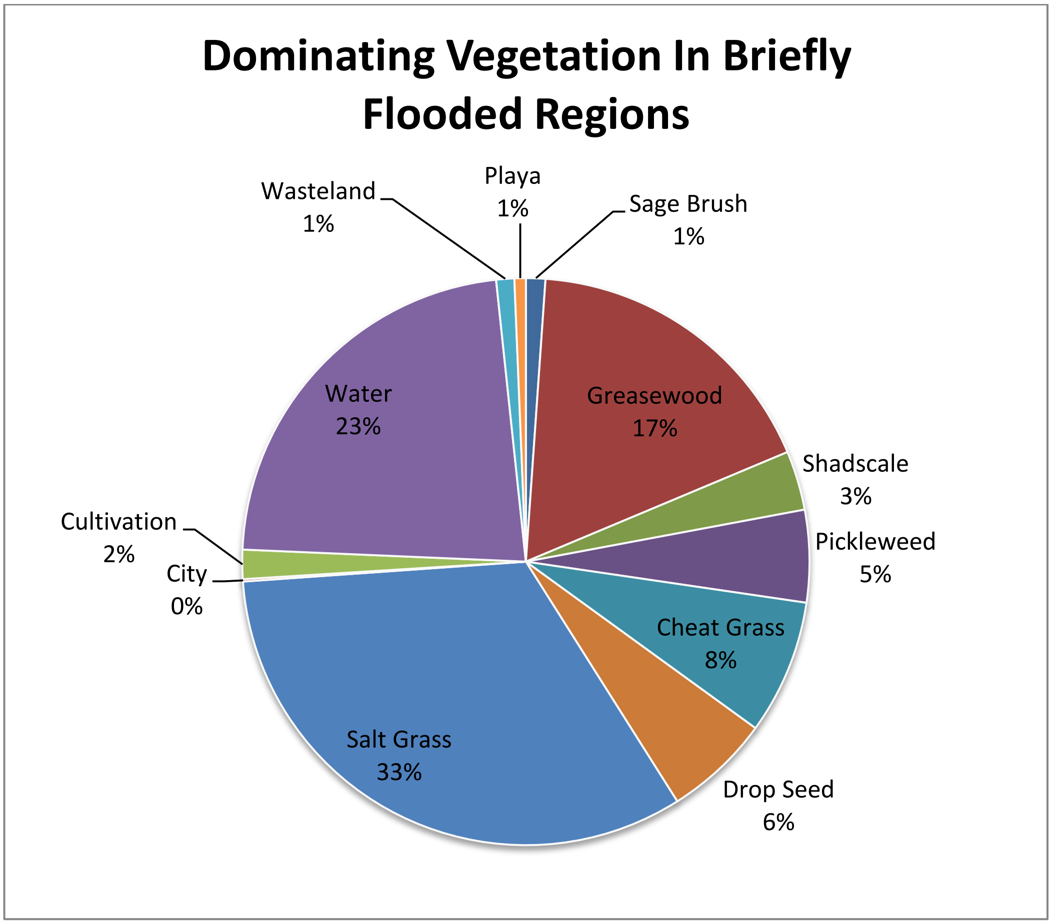

Figure 5

It is important to also consider the “water” distinction in these sections because it tells us where water is present more abundantly. If water is the most dominant, it is likely that the water is either deeper than vegetation will be successful in, or it is there for longer periods of time than certain vegetation can handle. Surface water accounted for 23% of the Briefly Flooded region. This suggests there are more permanent open water area, or that there are places that aren't affected as heavily by reduced water supply.

The Seasonally flooded map depicts the regions within the map that have water covering them for more time during the year and is a much larger area. Most of this area is dominated by surface water, but there are areas were vegetation is more common. In the North West corner there is an abundant patch of Greasewood and Salt Grass, but compared to the mudflat and other dominant features it is relatively small. I found this map to be informative at a glance, but that most of its attribute table suggested that when the seasonal water is not present it is most often mudflat.

Discussion

The conclusions of this GIS analysis show that you can make inferences about characteristics of an area given available data. I found that my methods supplied me with maps that accomplish what I set out to do, but there is room for improvement. The scale I displayed in this project is very large which required me to lump data together so that it could be viewable, but doing this introduced less accuracy. An assumption that I made in the building of these maps was that the vegetation data that I used could still be applied to the current lake conditions. I moved past these issues and assumptions to accomplish my task, but for better accuracy I would need to use more current vegetation data.

Conclusion

Since I am an undergrad student I don't have a research project unlike my classmates, so I was able to create a project that I really want to know about. I have never done wetland classification before and I found myself diving deeper and deeper into it. Using GIS helped take raw wetland data and turn it into something viewable, and then reclassifying it to make it informative. Exploring the wetland vegetation type in highly variable regions of the lake helps us understand what can be expected in the future. It also helps us focus on where improvements can be made. My next step is to take these maps and use them as areas of interest for a remote sensing application to map phragmites and cattail reeds along the banks of the GSL. My hope is that this will bring greater accuracy to the maps and to supply others with a map of the troublesome invasive plants. This state is known for the Great Salt Lake, and even though there are varying opinions on letting usable water all the way to the lake or what is causing reductions in available water, maps like the ones I am developing can help inform people of what is happening out there.

Figures

Figure 1: Wetlands and Deepwater Habitats Classification Hierarchy Flow Chart (US DEV of Fish and Wildlife)

Figure 2: Great Salt Lake Wetlands Map showing five wetland distinctions including the Briefly Flooded and Seasonally Flooded regions in the lake.

Figure 3: Briefly Flooded region with corresponding dominant vegetation display.

Figure 4: Seasonally Flooded region with corresponding dominant vegetation display.

Figure 5: Pie Chart describing the percentage of dominant vegetation within the Briefly Flooded region.

Sources and References

Lall, U. and M. Mann, (1995), "The Great Salt Lake: A Barometer of Low-Frequency Climatic Variability," Water Resources Research, 31(10): 2503-2515.

Manning, A. H. 2002, Using noble gas tracers to investigate mountain-block recharge to an intermountain basin, Ph.D. dissertation, University of Utah, 187 pp.

Cowardin, Lewis M. *Classification of wetlands & deepwater habitats of the US*. DIANE Publishing, 1979.

“Black Greasewood”, USDA NRCS Plant Guide Online
http://plants.usda.gov/plantguide/pdf/pg_save4.pdf

“SALTGRASS DISTICHLIS SPICATA” USDA NRCS Plant Guide Online
http://plants.usda.gov/factsheet/pdf/fs_disp.pdf

“Great Salt Lake Basin Watershed Description”
http://www.greatsaltlakeinfo.org/Background/Description

Data

“Wetlands” http://gis.utah.gov/data/water-data-services/

“Great Salt Lake Meander Line” http://gis.utah.gov/data/water-data-services/

“Dominant Vegetation” http://gis.utah.gov/data/bioscience-overview/