What affects the WATER QUALITY in ARIZONA?

Project 1#Group2:

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Hypothesis

The state of Arizona encompasses a diverse range of ecological environments. Phoenix is the capitol, the most densely populated city in the state and the 6th most populous in the US. 95% of Phoenix drinking water is sourced from the surrounding lakes and rivers. Climate change, population and urbanization of the valley of the sun add to the challenge of maintaining the waterways that feed the water treatment plants that in turn provide clean drinking water for the city. We feel that there may be a need for increased & consistent water quality monitoring & education efforts.

Questions

A.) How is water quality measured?

We determined that we needed to know how water quality was measured before we got further into what affects it. We determined that there are many types of calculations that contribute to various parts of what is considered water quality as a whole. Tests include: Alge, Conductance, Metals, Nutrients, including (TP)Total Dissolved Phosporus, (DOC) Total Dissolved Carbon, (TDN) Total Dissolved Nitrogen and various other tests that focus on Smell, Taste & Clairity of the water.

B.) What factors effect water quality?

Based on the data sets we found we noticed a number of things that effect the water quality. We also found that there is a direct relationship between the various levels of conditions being tested. For instance: High UVA or (water cloudiness) that is a result of water runoff, flash floods and such creates higher levels of dissolved carbon and nutrients in the water which in turn, lowers the amount of oxygen in the water and can enhance the algal growth. Conductance is also a highly relational measurement and high levels of conductance is an indication of an over abundance of inorganic dissolved solids in the water such as pollution, salt or magnesium, calcium, iron, and aluminum cations.

C.) Are there any unique factors for water quality in Arizona?

The unique factors for Arizona include the high temps and flash floods that happen in the summer as well as the susceptibility to bouts of serious droughts. We learned that although each state has its own water quality standards the issues that affect Arizona are also related to the availability of water in Arizona. Approximately 40% of phoenix drinking water comes from the the Colorado River and because of declining snow pack in the Colorado river basin the Colorado river is going through the worst drought in the past hundred years. The other 60% of drinking water comes from the Salt River which is fed by Horseshoe Reservoir and the belt of lakes that follow. Unique factors for water quality in Arizona will depend on the availability of water because the more concentrated water bodies get the higher the probability of heightened concentrations of minerals, metals, alge and other conditions.

D.) How has the water quality been affected over time?

We have looked at the results for various types of water quality tests and the answer to this varies according to the individual data sets. Conductance has increased over the course of the data set (2012-2016) for the levels in Roosevelt Lake. The average Conductance level for Roosevelt Lake, Canyon, Apache and Canyon Lakes is considered high and Roosevelt is one of the the highest. Conductance levels for Arizona Canal and the Salt River & Tempe Town Lake which is fed by both the Colorado River via CAP and the salt river, seems to have more extreme peaks and lows every consecutive year, highs in 2017 were 3x the lowest level that same year. Algal growth seems to be directly related to the concentration of minerals and (TP) dissolved phosphorus in the water.

Summary

The concern for and attention to water quality in the 6th largest city in the US is an important one. A few major things we found while examining the 10 separate data sets that make up the Regional drinking water quality monitoring program* is the interconnected nature of specific tests*, the trickle down effects of climate change and the problem of pollution that increases over time.

This project gave us information on what types of tests are used to help ensure water quality and to the concerns facing our water today. The data sets we worked with end in 2016 and although we were able to derive a visual of that data and see certain trends over time it would have been useful to have more current data as well for comparison.

By creating a map of the location sites, lakes, canals & rivers we were able to gain a deeper understanding of the lay of the land and the potential causes of increased Conductance related to pollution.

It is clear that there are conditions or practices that are negatively effecting the quality of water quality in Arizona and as Arizona continues to grow they will undoubtedly need to be addressed.

A study on the : long-term monitoring of water quality in select canals, reservoirs, and treatment plants of the greater Phoenix metropolitan area drinking water system, ongoing since 1998. By Paul Westerhoff, Arizona State University Milton Sommerfeld, Arizona State University at the Polytechnic Campus Peter Fox, Arizona State University Morteza Abbaszadegan, Arizona State University Dan Childers

Maps API

Locations Include: Roosevelt Lake,Saguaro lake,
Canyon Lake, Apache Lake, Bartlett Lake and a few Salt River testing locations

PHOENIX

The water sample results we discovered were collected at various sources such as reservoirs, dams, canals, water treatment plants and pumping stations but did not include coordinates for their location in the data set.

Using the google maps API we did a lookup for each of the locations that could be discovered and returned the latitude and longitude of each collection site. With the location information and the data from each sampling point we were able to generate a heat map with the gmaps API to show the relative arsenic levels mapped to each site to show where arsenic values were the highest.

The places we found to have the highest levels of arsenic were near downtown Phoenix and in Bartlett lake where they were above the CDC recommended threshold for safe drinking water.

Carbon

Carbon itself is not a dangerous chemical in our drinking water, its main function is to absorb tastes and odors. There are a few factors that are used to test carbon levels:

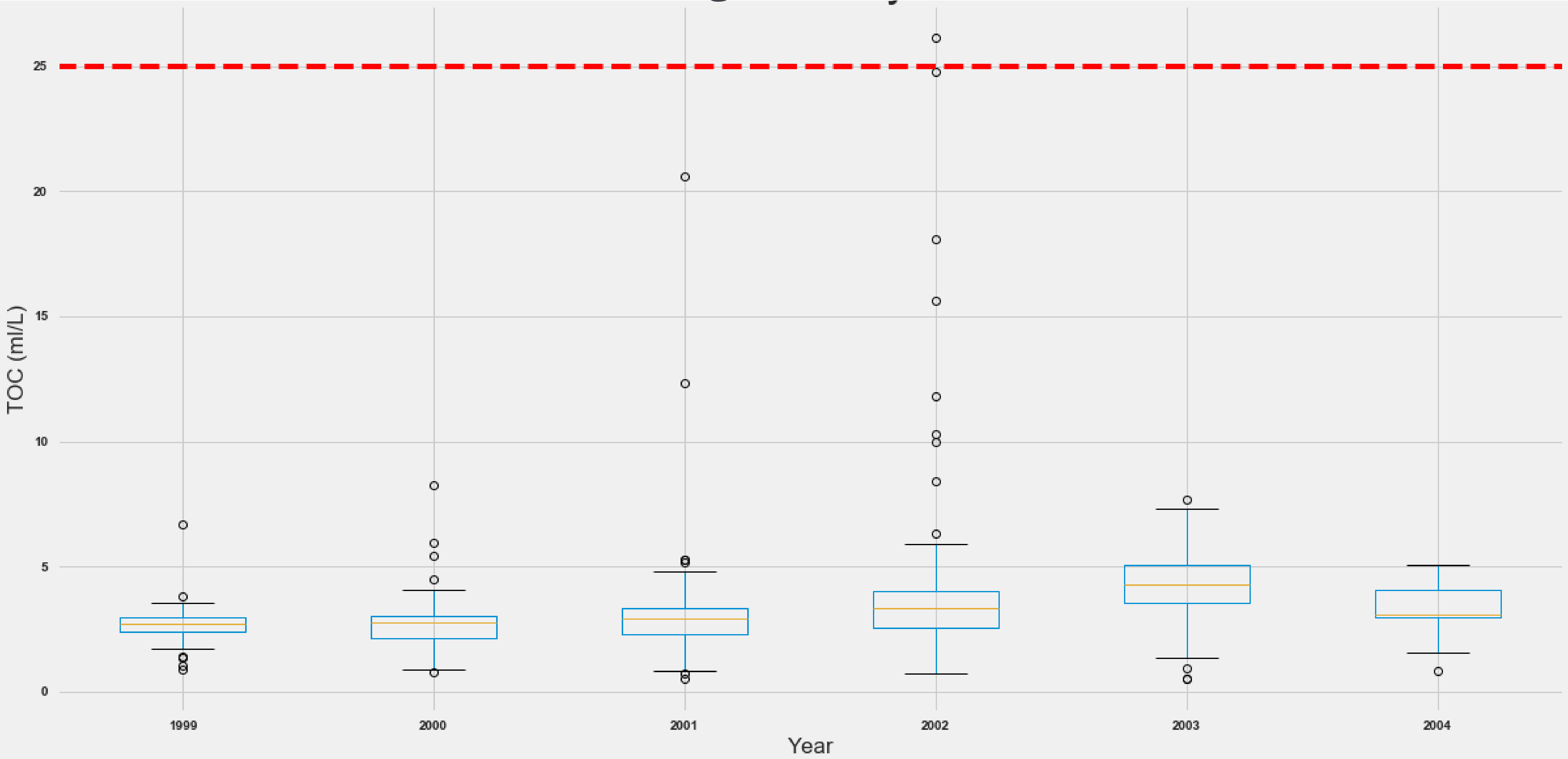
Total Organic Carbon (TOC), which is the amount of carbon found in organic compound and is a non-specific indicator of water quality. Most lakes and rivers have around 2-10 mg/L, however normal levels should not go over 25 mg/L.

Dissolved Organic Carbon (DOC), which covers a fraction of what total organic carbon can pass through a filter. Too much DOCin water can lead to an increase in bacteria growth. A safe level of DOC is 5mg/L or less.

Ultraviolet Absorbance (UVA). This is a water quality test parameter that uses UV rays to see the amount of carbon per centimeter (cm-1). While there isn't a certain amount that levels need to be, the less amount of carbon per centimeter, the better.

Specific Ultraviolet Absorbance (SUVA). It is the absorbance of UV light in a water sample at a specified wavelength and is normalized for DOC concentration. A normal level for SUVA is 2 L/mg-m or less. High levels of SUVA can also cause an increase in humic matter, which can create Disinfections By Product (DBPs).

Total Organic Carbon(TOC)



Note about TOC

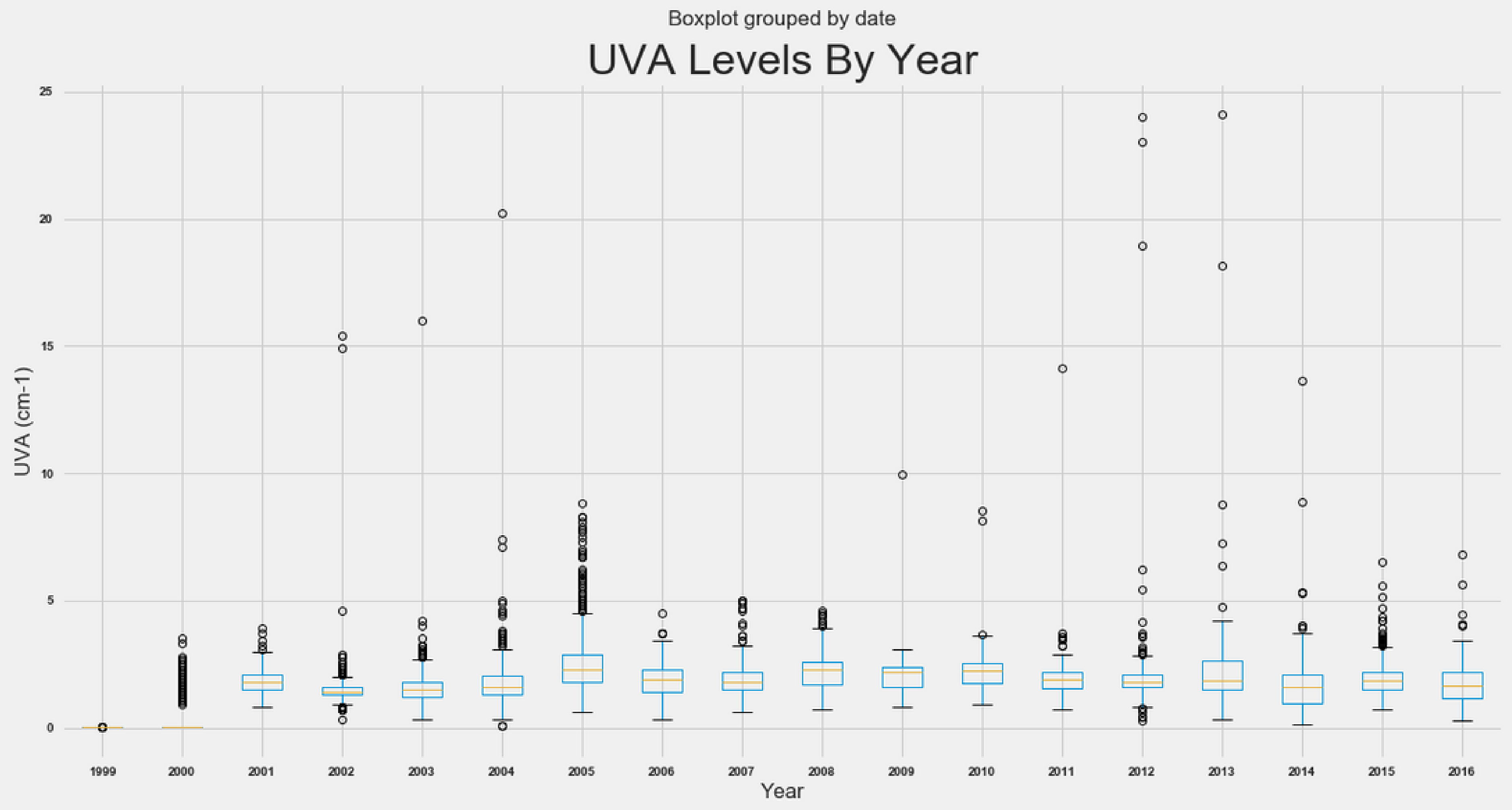
TOC is a very important reading for water quality especially before treatment.
TOC in source waters comes from decaying natural organic matter called NOM, as well as synthetic sources
TOC reading basically tells you the amount of NOM in the water source.

Why is this important?

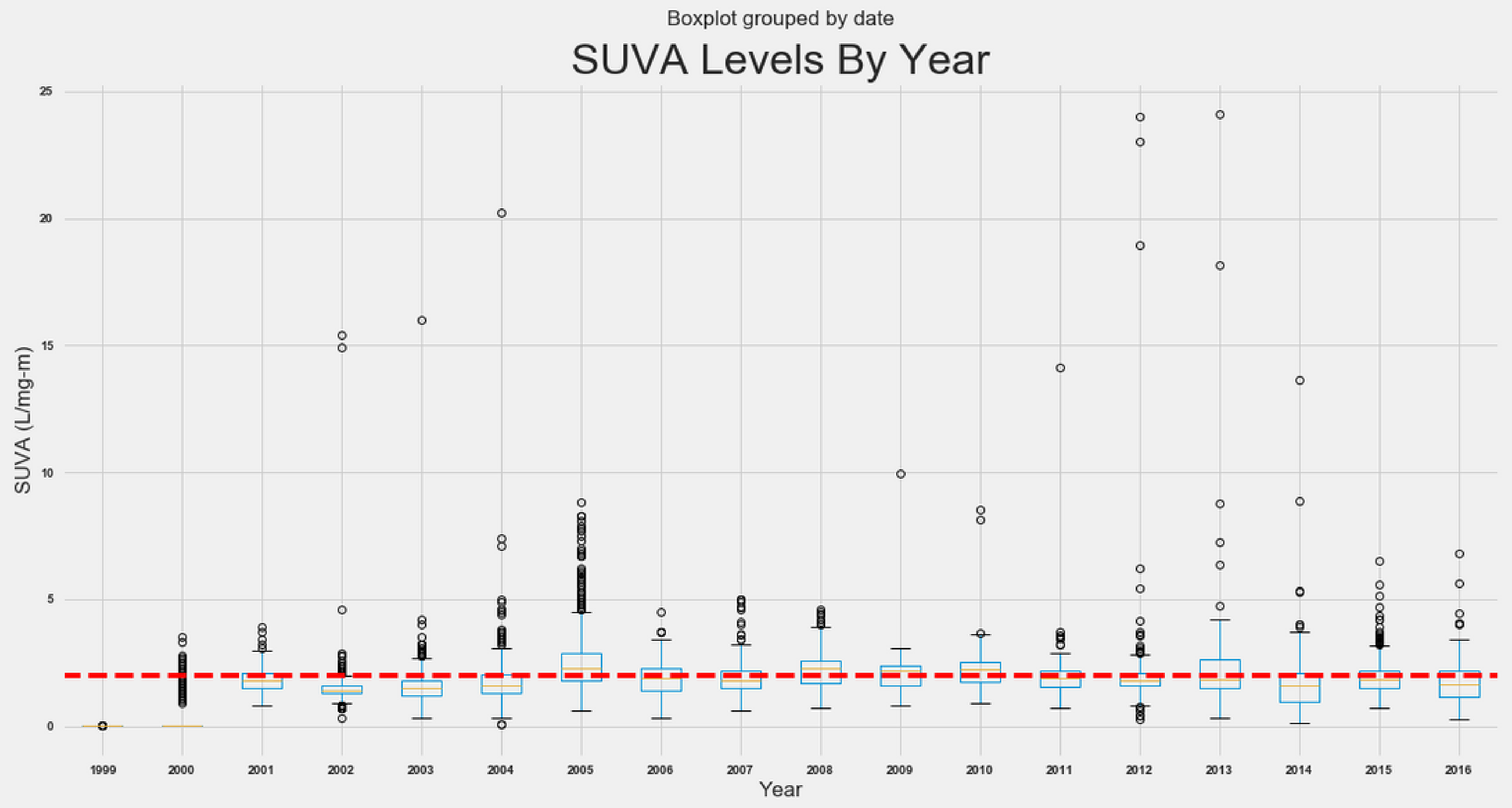
It is important because the water treatment plants treat water chloride containing disinfectants.
When the raw water is chlorinated, active chlorine compounds react with NOM and produce disinfection byproducts (DBPs). Studies have determined that higher levels of NOM in source water during the disinfection process will increase the amount of carcinogens in the processed drinking water.

From the data that is shown, there were a couple of years in the early 2000s where the levels of all four measurement tools went much higher than it should. Because of this, bacteria
levels were more than likely higher than they should have been, along with an increase in humic matter. While we didn't have an abundance of data on TOC levels, we were able to go as recent as 2016 with the other levels. Fortunately, we have seen a good consistent level for each measurement tool in the last 10 years of data.

UVA



SUVA



Looking at all the data points in the original set was overwelming but I narrowed down the variables I wanted to look at to get a reading on the conductance. I choose to focus on Roosevelt Lake since I saw the highest mean in this location.

Lake Roosevelt is one of the most popular lakes in Arizona with close to 2 Million Visitors in 2012 when the study begain to less than 1.5 Million in 2016.

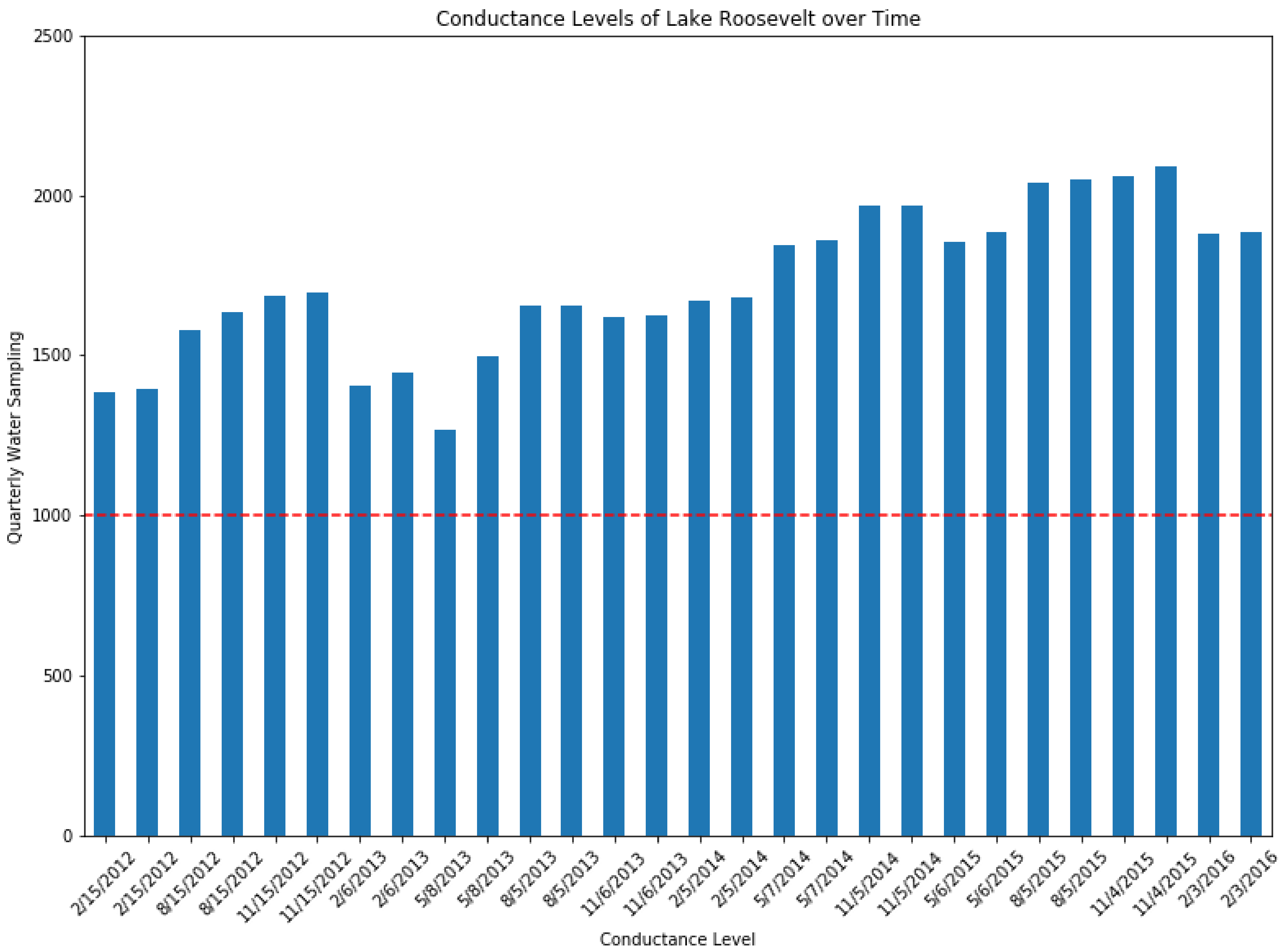
According to the EPA fresh waters that support fisheries range between 150-500 umhos/cm, and levels outside of this range could indicate that the waters are not suitable for certain type of fish of macroinverterbrates. Industrial waters can be as high as 10,000 umhos/cm

Conductance is caused by dissolved salts and inorganic materials: High Conductance levels are an indication of pollution.

*Conductance is measured in us/cm. It stands for microsiemens per centimeter (µS/cm, uS/cm) which is a decimal fraction of the SI unit of electrical conductivity siemens per meter.

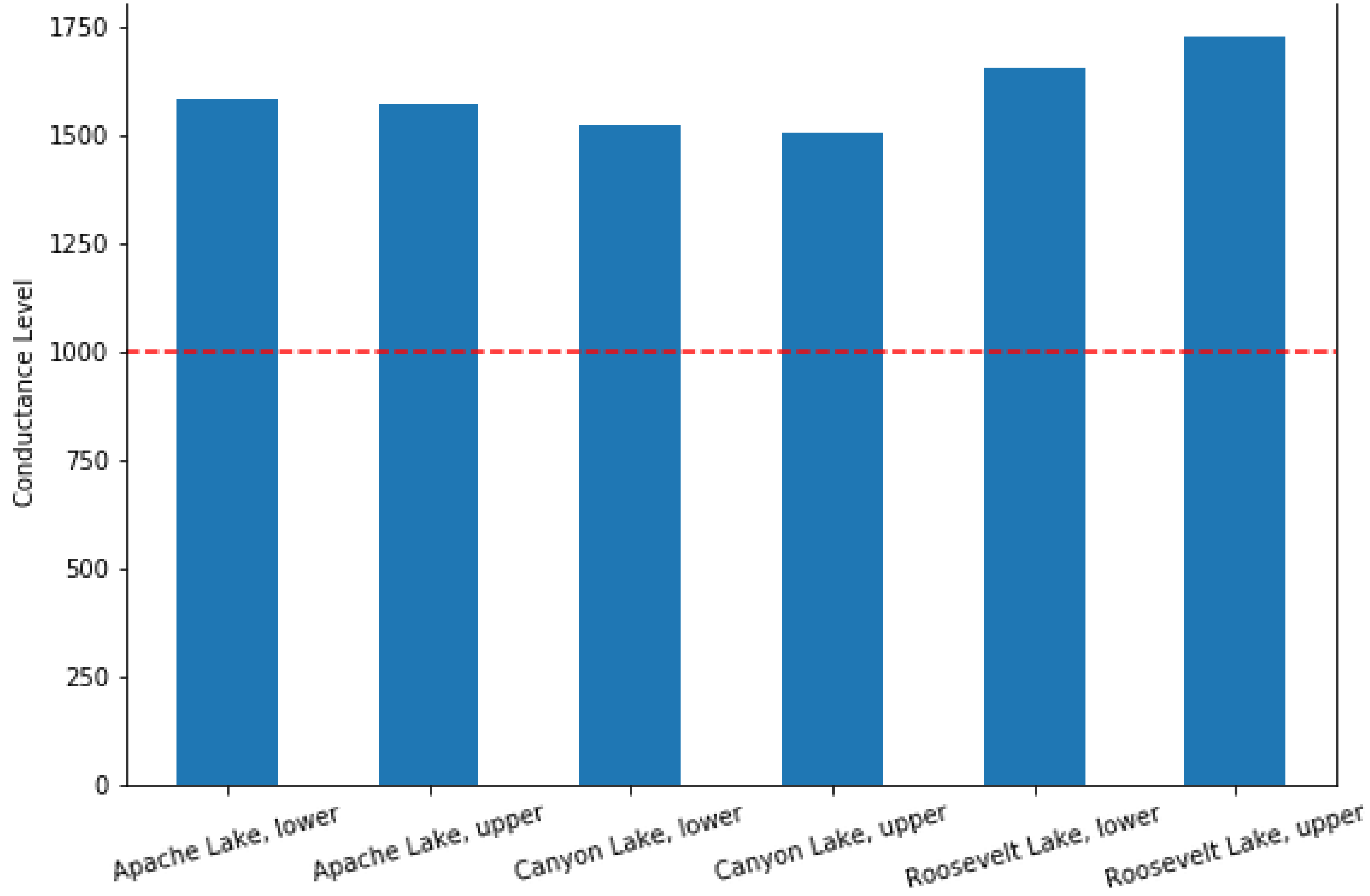
Conductance

In Lake Roosevelt



Conductance

In Arizona Lakes



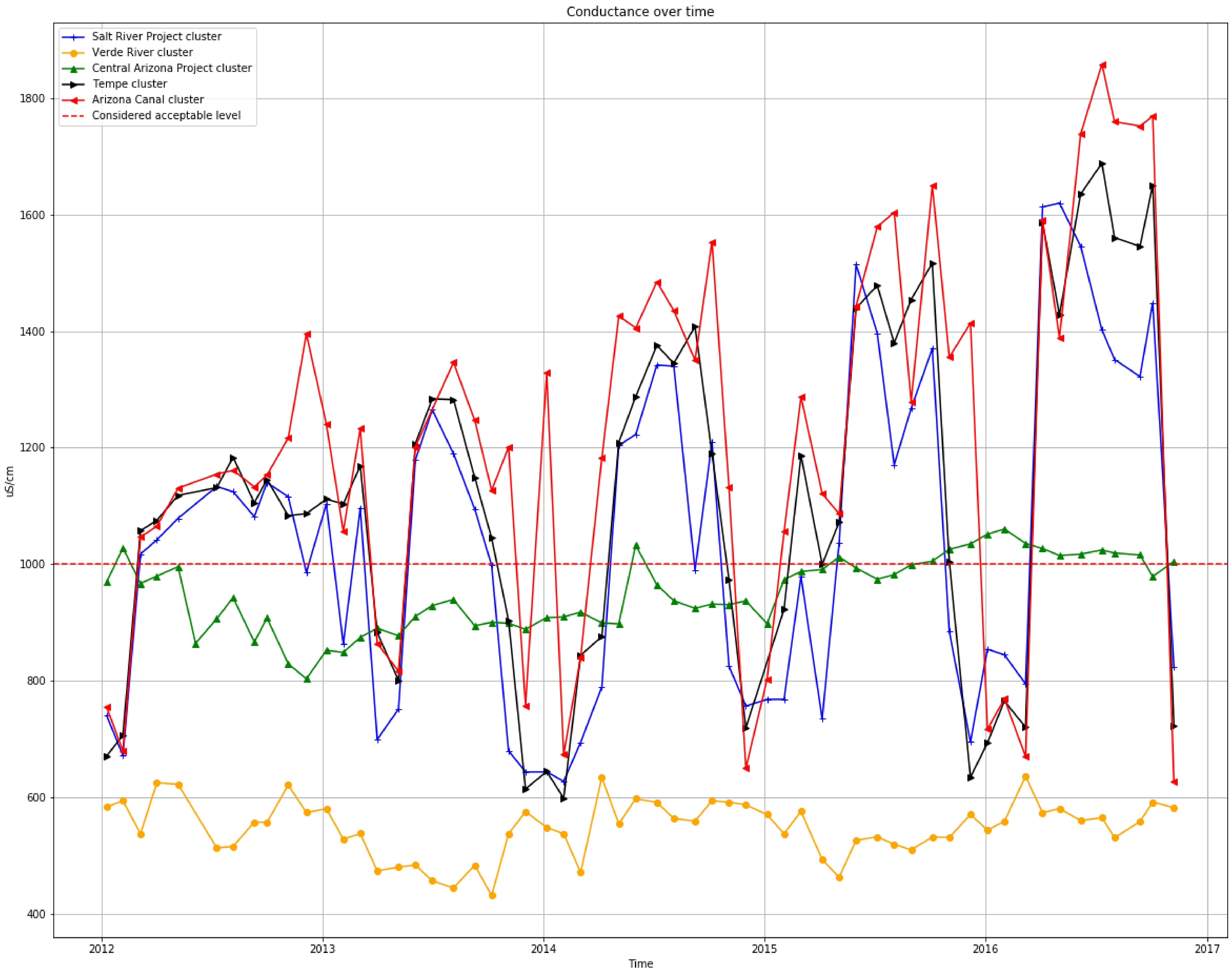
Site Location	Mean	Median	Variance	SD	SEM
Apache Lake, lower	1582.750000	1607.5	80925.379630	284.473865	53.760507
Apache Lake, upper	1571.677419	1612.0	85721.292473	292.781988	52.585197
Canyon Lake, lower	1522.266667	1583.5	81985.995402	286.331967	52.276826
Canyon Lake, upper	1506.709677	1574.0	73422.746237	270.966319	48.666988
Roosevelt Lake, lower	1651.857143	1609.5	58805.904762	242.499288	45.828058
Roosevelt Lake, upper	1724.178571	1684.0	52733.411376	229.637565	43.397421

Here we can see that there is the largest mean Conductance level is Roosevelt Lake.
I also created a Data Frame for the TDN or Total Dissolved Nitrogen but the levels did not vary as much as the Conductance.

Because these lakes are connected in this order: Roosevelt Lake,
Apache Lake,
Canyon Lake.
It would seem to suggest that what happens to Roosevelt will equally effect the next in succession as the salt river continues on its path.

This graph shows the mean conductance in all three lakes. As you can see Roosevelt has the highest mean levels and that all three are in a state above optimal level for a fresh water lake.

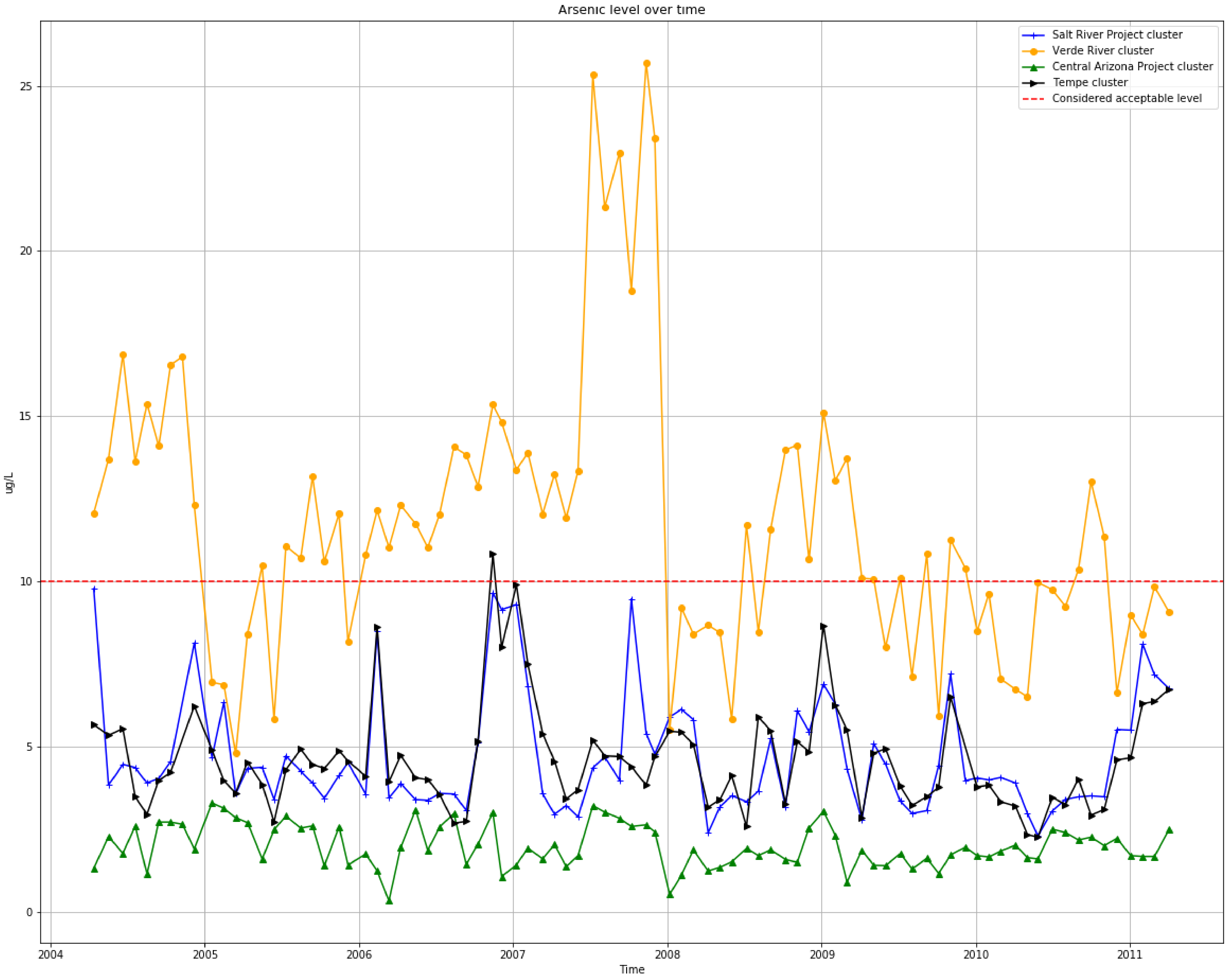
Conductance in Arizona Canals & Rivers



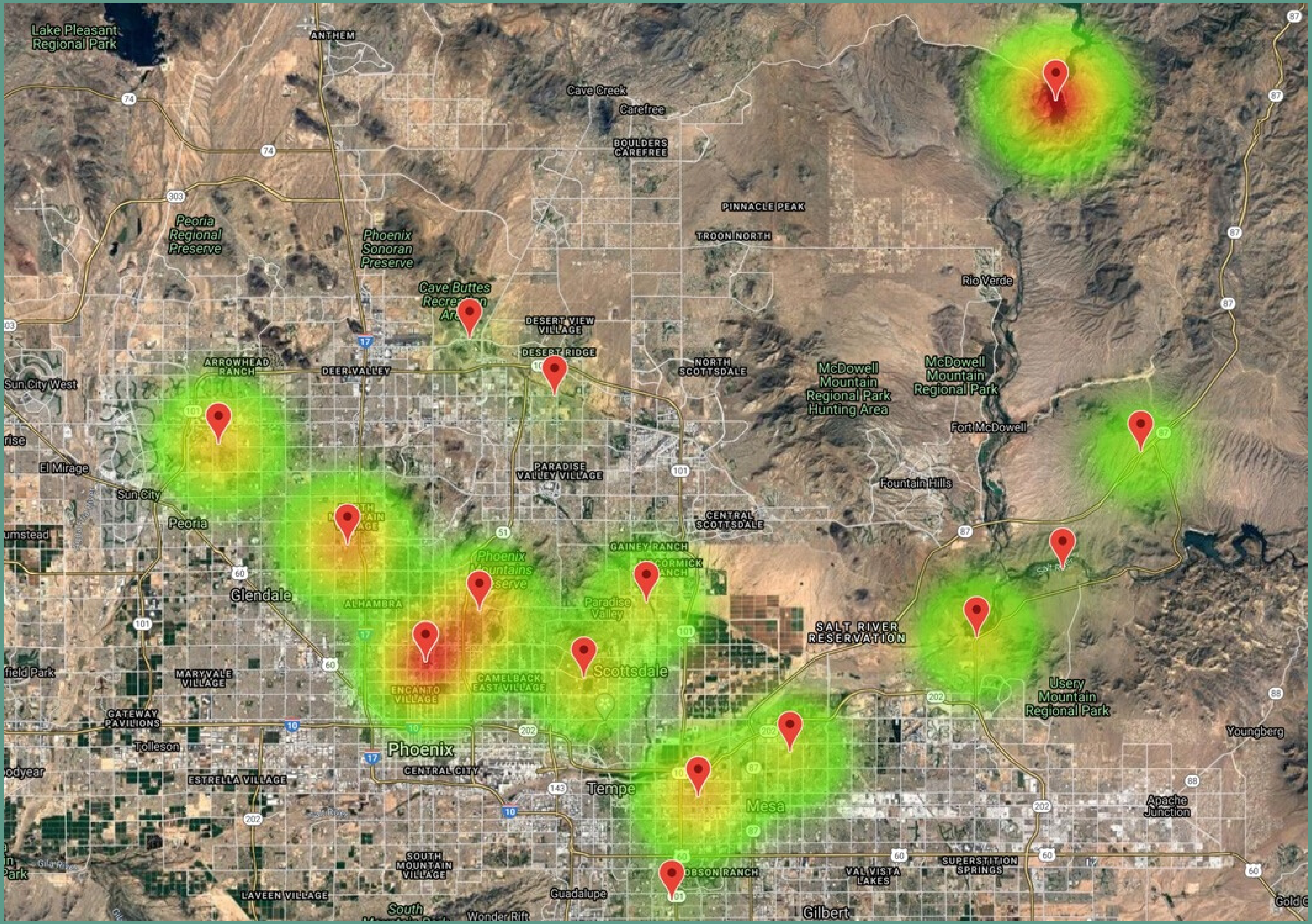
This line graph attempts to analyze the mean conductance of each cluster over a period of time between 2012 - 2017. What we can see here is that according to our analysis this is a tale of two outcomes. The first being that SRP, Arizona Canal, and Tempe follow the same yearly rise and fall. At the same time the Verde river cluster and Central Arizona Project are much more stable throughout the year. I would hypothesize that the locations and use of these clusters have an effect on the algae content in the water. Next steps for this would be mapping out each cluster to see exactly where they flow. When that's known we can drill down into each cluster, like in the case of arsenic to see if there are any hot spots in terms of algae growth that would affect the data.

Arsenic in Arizona Canals & Rivers

ArsenicThis data comes from the arsenic csv where the rivers and canals were measured for arsenic levels between 2004 - 2011. The rivers and canals are the primary source of the samples. This is a line graph that shows the mean levels of each waterway cluster. The measure of arsenic is in micrograms per litre (ug/L). This graph gives a pretty clear picture of arsenic levels at the time. Obviously the Verde River cluster has the highest level of arsenic over the entire testing period available. Then Central Arizona project is consistently the lowest with respect to arsenic levels. The other two seem to follow pretty closely. The next steps for this data would be to drill down further into each cluster to see if there are any specific testing sites that are outliers that may have an effect on the data. It would also be useful to drill down into the salt river and Tempe clusters to determine if we are looking at the same sites since these two clusters so closely match eachother.



Arsenic



Locations Include: CAP Central Arizona Canal, Salt River & Bartlett Lake.

The U.S. Environmental Protection Agency (U.S. EPA) set an arsenic maximum contaminant level (MCL) for public water supplies at 0.010 mg/L. This is equivalent to 0.010 parts per million (ppm)

Resources

The World Health Organization estimated that up to 80 % of all sicknesses and diseases in the world are caused by inadequate sanitation, polluted water or unavailability of water (WHO 1997)

"Arizona's citizens and its economy are among America's most vulnerable to the growing adverse impacts of climate change. Climate change will have significant impacts on water resources and economic opportunities. Recent polling shows that the majority of voters in Arizona believe that state and federal governments should do more to address these impacts..Water Scarsity...Both groundwater and surface water resources are already over-allocated across much of the state. Increased population and economic growth will face water supplies that are already inadequate and diminishing with climate change, necessitating reallocations – largely out of agriculture – and different patterns of use. Economic And Environmental Impacts Of Climate Change In Arizona".- Robert by Repetto, Ph.D.

Regional drinking water quality monitoring program: long-term monitoring of water quality in select canals, reservoirs, and treatment plants of the greater Phoenix metropolitan area drinking water system, ongoing since 1998

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