Dissolve Oxygen Assessment around Humboldt Bay

By: Melissa Collin and Simon Bueche

Abstract

Humboldt Bay has the word of mouth reputation of being a very dirty and unsanitary aquatic area. Dissolved oxygen in particular is a large factor in stream health and the right level is essential to aquatic ecosystems, specifically the salmon. We wanted to tests the dissolved oxygen in and near major waterways flowing into the bay to determine the bays health. This test would also tell which unhealthy waterways (if any) were flowing into the bay. We used a dissolved oxygen sensor device and a GPS in order to collect our data. We then input the collected data into arcmap to create maps of humboldt bay with the corresponding rivers and parcels. From our results, we concluded that the water was at an overall healthy dissolved oxygen level. We also concluded that there was no significant difference is DO levels between the different waterways. While there are a lot of components that make up water quality, based on our results this aspect of the water flowing into Humboldt Bay is healthy.

Introduction

Humboldt Bay has the word-of-mouth reputation of being a very dirty, unsanitary aquatic area. According to Humboldt Baykeeper, a non-profit organization we contacted, who monitors the quality of Humboldt Bay, the Humboldt Bay is actually a relatively clean water system, free of major chemical pollution. Instead, the main issue to worry about is e coli bacteria build up in commercial shellfish beds during certain parts of the year. We wanted to test and determine if the water feeding into the bay from rivers and streams was at an optimal level. To assess the waters health, we gathered primary data in the form of dissolved oxygen levels from the major streams flowing into the Humboldt Bay.

Dissolved oxygen (DO) is one of many indicators for the health of aquatic ecosystems. Dissolved oxygen is specifically all the O2 molecules not bound in the water itself, H20. DO is usually affected by temperature, salinity, atmospheric pressure (2). Colder, less saline waters hold more oxygen than warmer saline ones do. Oxygen diffuses into the water normally but can increase with aeration when the water is disturbed by rapids, fast flow or waterfalls (1).

All organisms require oxygen to live even in the water. Bottom feeders and smaller organisms require less dissolved oxygen to live, and larger ones like fish need more, anywhere between 4-15 mg/l (1). Around 7 mg/l is a healthy aquatic ecosystem capable of supporting a variety of life (2).

Coho, steelhead, and Chinook salmon all inhabit the tributaries feeding into Humboldt Bay (3). The species' numbers have been declining everywhere for a while. In Freshwater creek, salmon populations of Coho salmon in 2002 were 1810, while 2015 were lowered down to 718 individual salmons (3). One of the many factors that could be affecting the salmon population is dissolved oxygen. By performing these tests and data analysis we hope to see if significantly low or high DO levels are affecting the water in and around Humboldt Bay.

Methods

Data Collection:

To measure the dissolved oxygen levels of the streams feeding into Humboldt Bay, we rented dissolved oxygen sensor equipment from the Humboldt State University Forestry department. The equipment consisted of a probe that was attached to a handheld electronic sensor device and a gps unit. We held the sensor in the water for 1-2 minutes, so the reading had time to stabilize and we could have an accurate reading for dissolved oxygen. We noted DO level, DO saturation level, temperature, and marked the GPS coordinates of each location sampled. For testing locations, we took samples from all major waterways that flowed into the Arcata side of the Humboldt Bay.

Data Analysis:

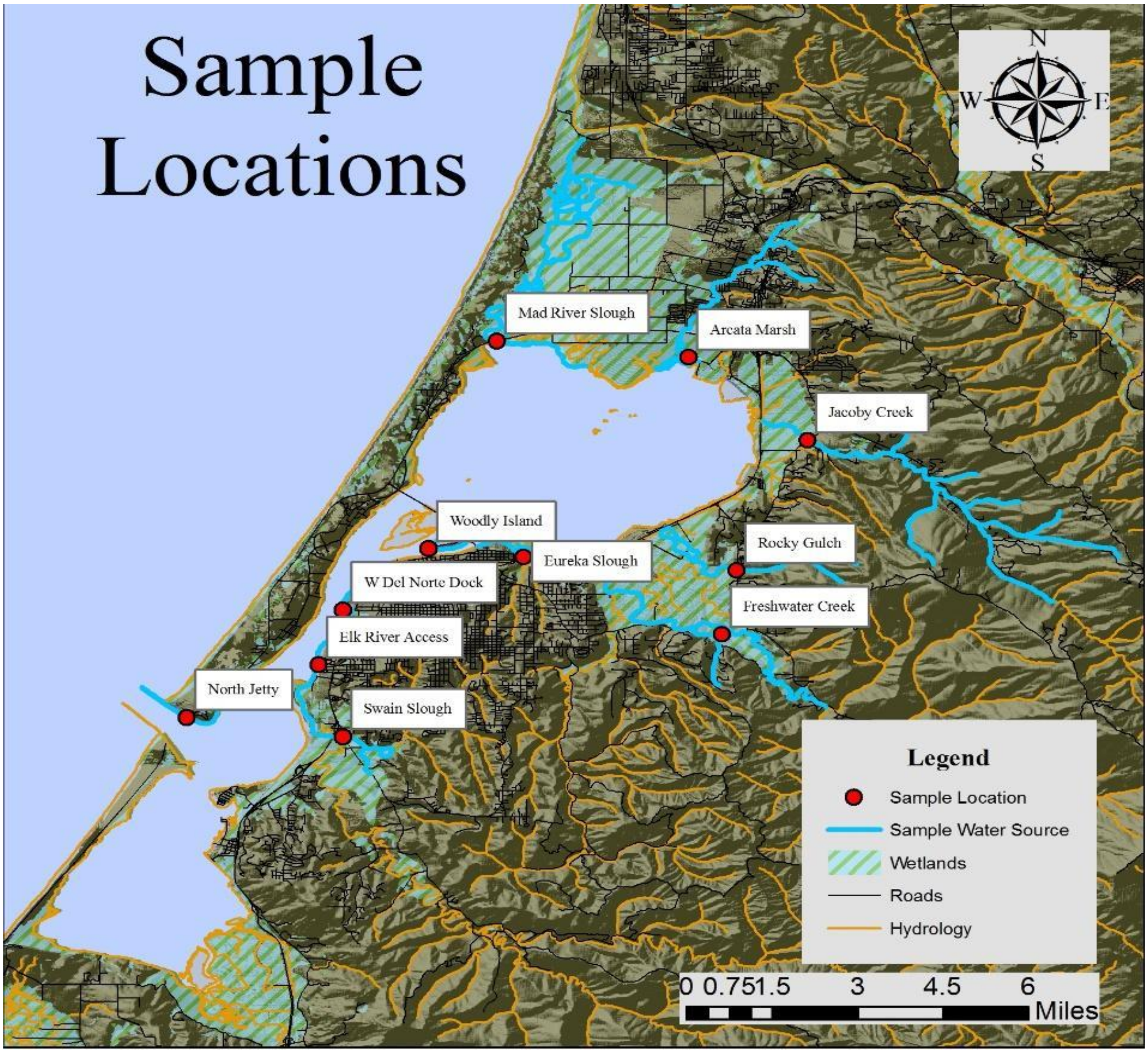
We began by downloading the data layers from various sources. The Humboldt County layer, roads layer, parcels layer, DEM layer, and city boundaries layer were downloaded from the Humboldt County GIS Data Download website. The Wetlands layer was downloaded from a link on Lab 6: Music Festival part 2, but could also be obtained through the US Fish and Wildlife Service. Finally, the hydrology layer was downloaded from the USDA NRCS Geospatial Data Gateway. After the data was all downloaded, We used a batch project to project all the layers in WGS 1984 UTM Zone 10 North. We then used the Geoprocessing tool:Clip to trim the layers to a smaller shapefile centered around Humboldt Bay. We also performed a select by attribute on the parcels layer to locate only parcels used for agriculture.

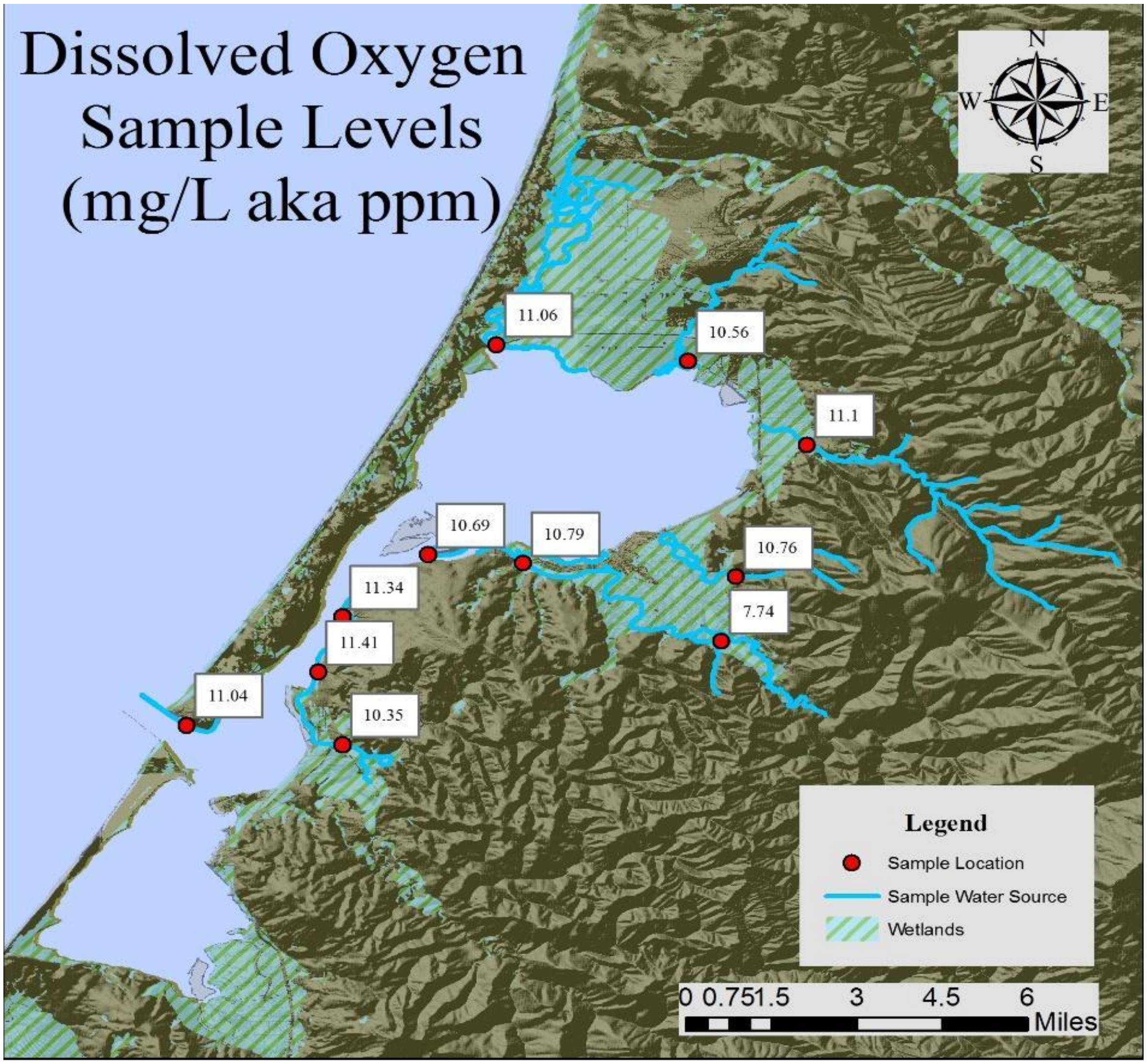
To input our coordinates, we created an excel sheet with the longitude and latitude of each site. We then added the excel sheet into ArcMap as XY data with the geographic coordinate system GCS WGS 1984. After exporting and re-adding the data layer, we projected it into WGS 1984 UTM Zone 10 North. In the attribute table we added a text field and added the names of all the points. We then added 3 float fields and added our collected data: the corresponding dissolved oxygen levels in mg/L, percent saturation of dissolved oxygen, and temperature in degrees Celsius.

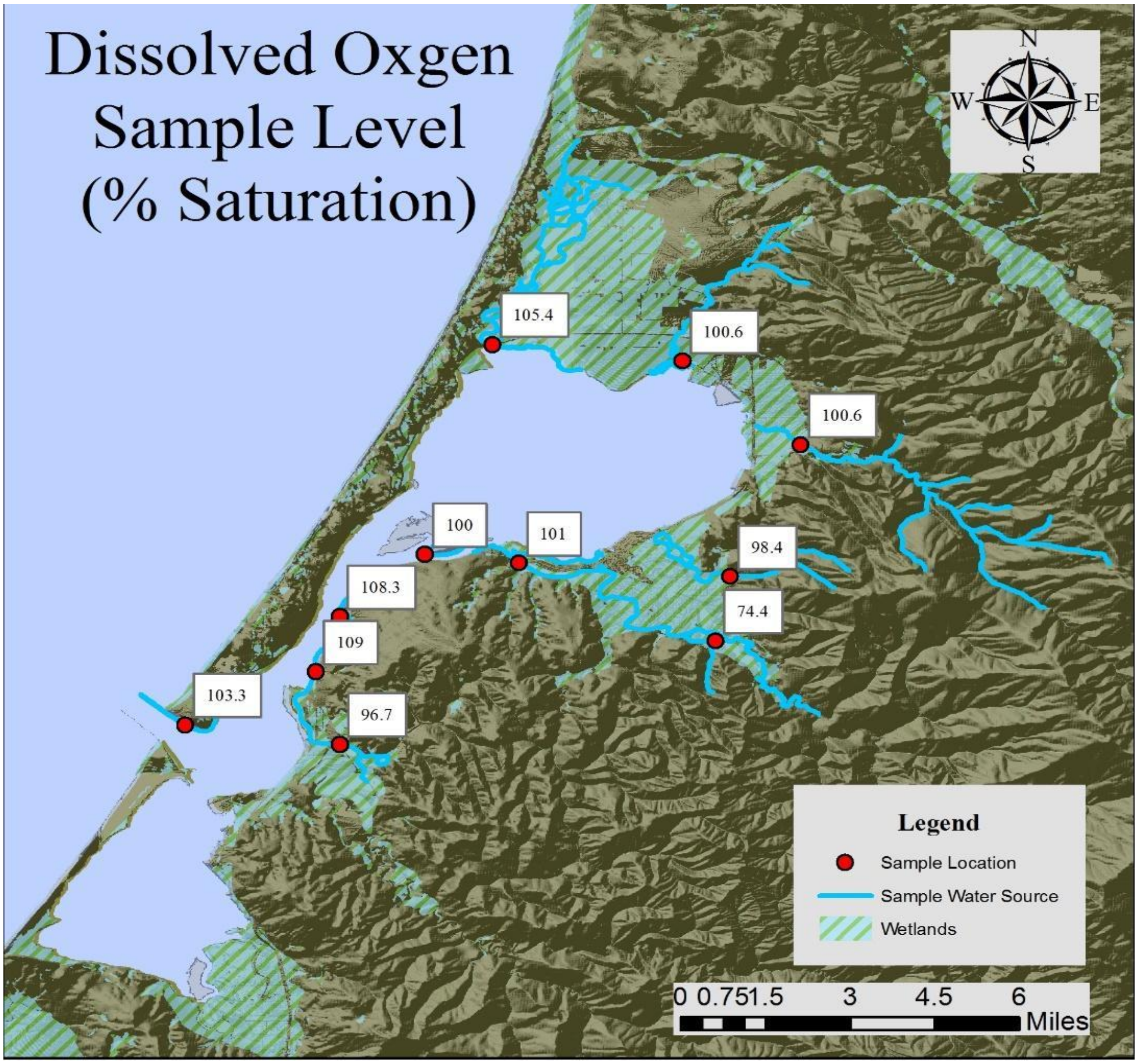
To select the sampled water bodies, we performed a manual select by attribute on areas both up and downstream of the sample locations. This was done manually since so many of the waterways are interconnected and because many of them on the hydrology layer were not named. Before making the final maps, we created a hillshade to add more depth to the map. First, we took the DEM layer and used the raster calculator so that the layer was only showing land. We then used the land DEM layer to create a hillshade and set it to 50% transparency. The wetlands layer was also set to 50% transparency for the final maps.

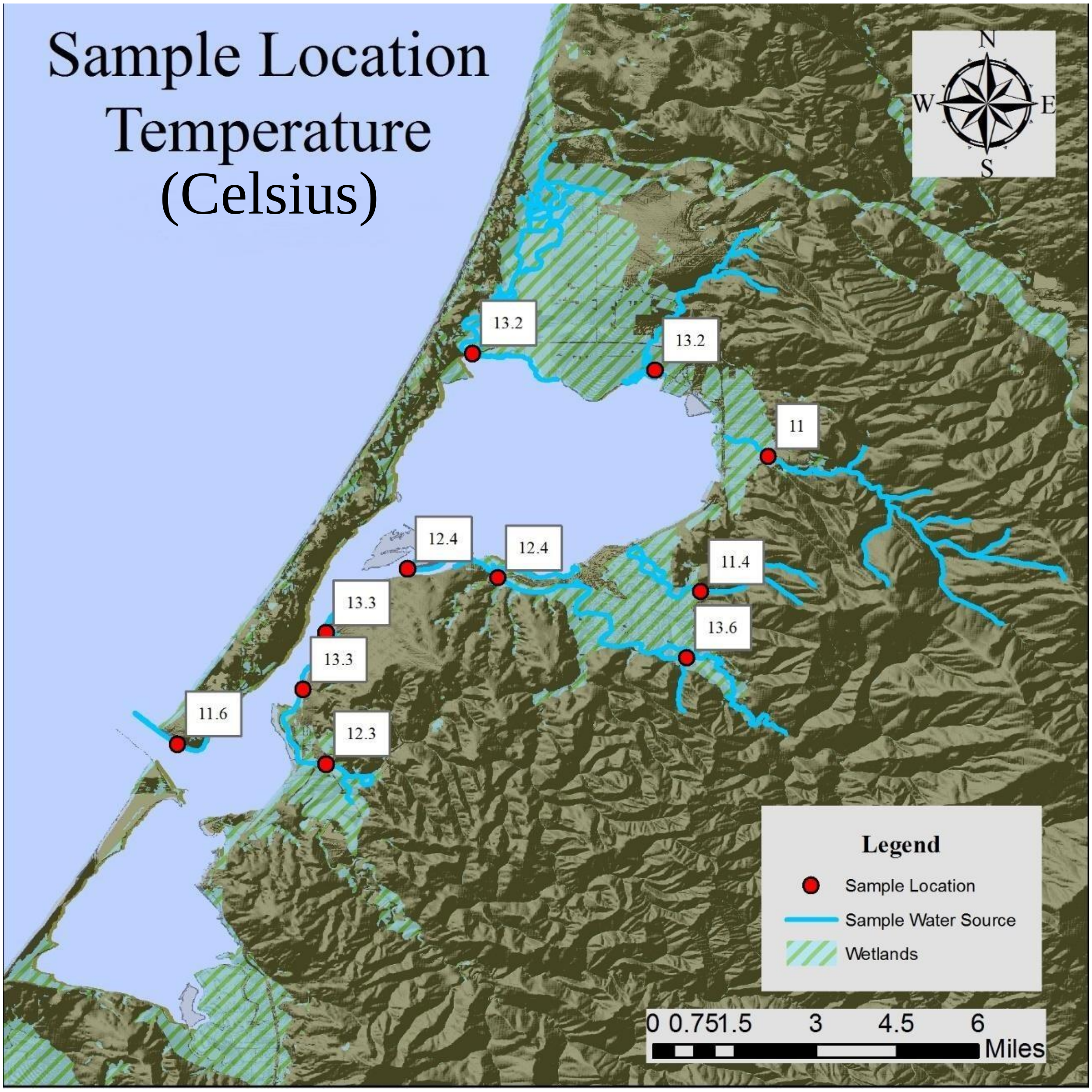
Results

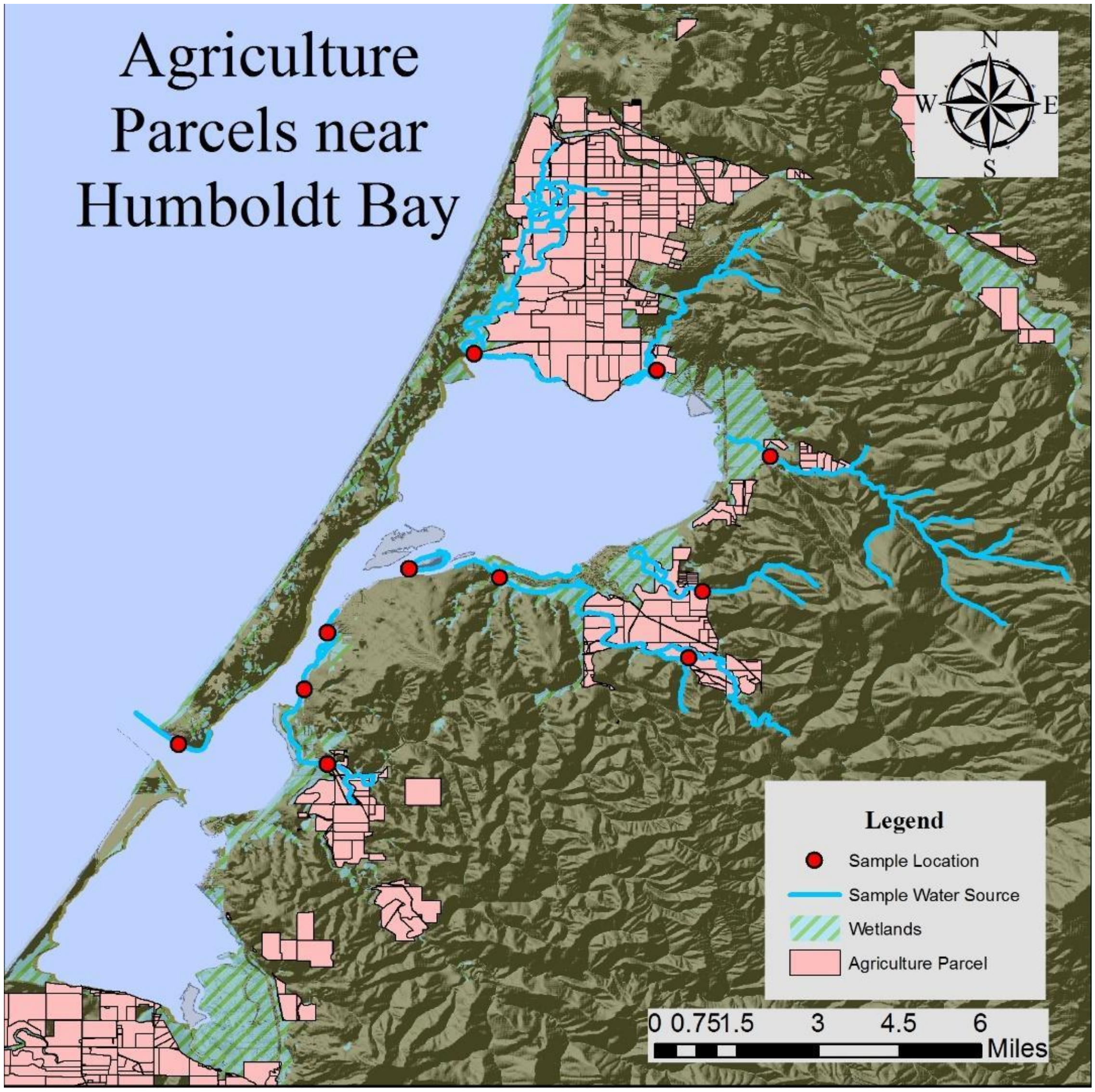
From our measurements, we observed little change in dissolved oxygen among the data points. All the measure points were around 10 or 11 mg/L, minus the freshwater creek location.

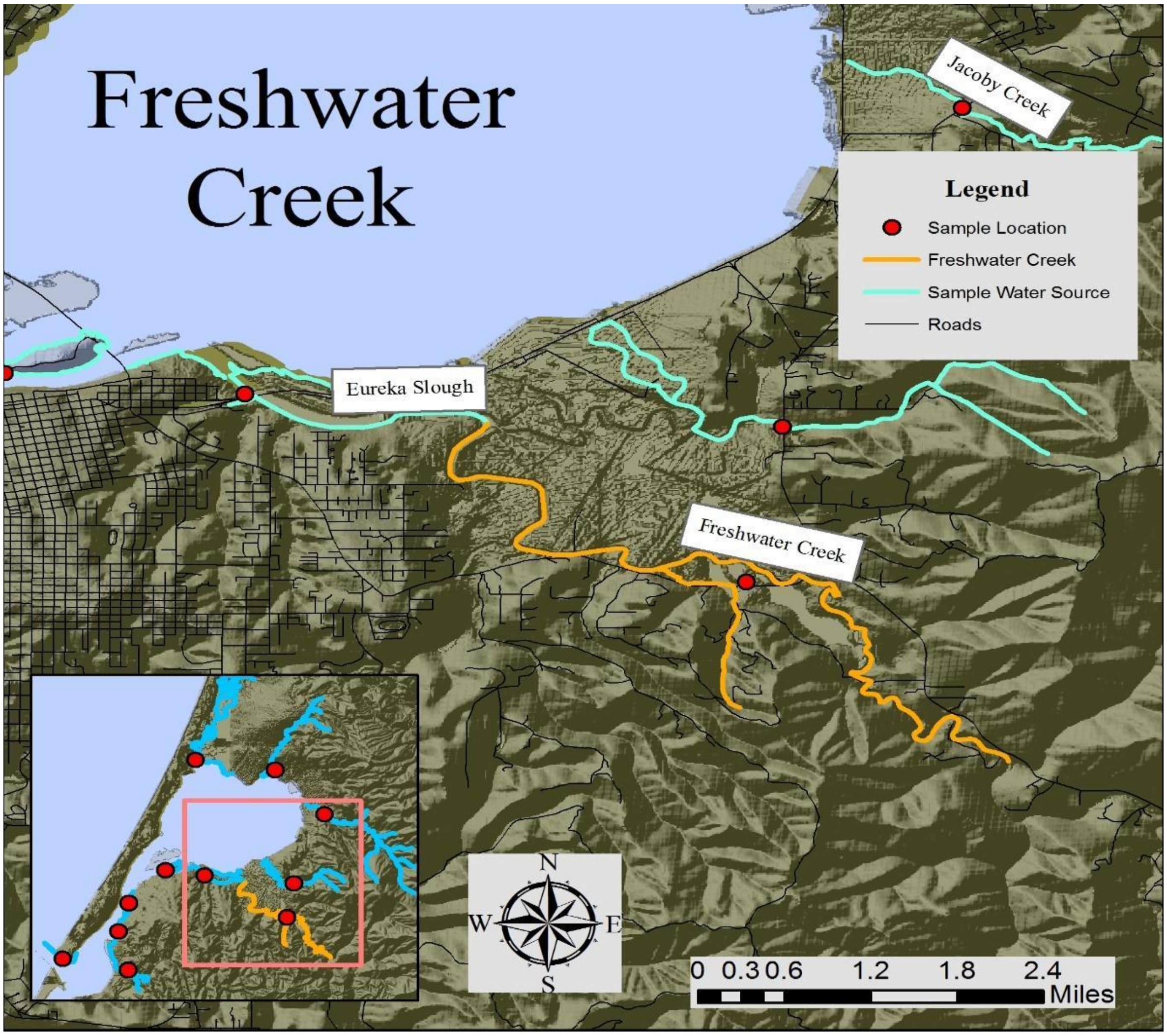

Sample
Locations
N
W
E
S
Mad River Slough
Arcata Marsh
Jacoby Creek
Woodly Island
Eureka Slough
Rocky Gulch
W Del Norte Dock
Freshwater Creek
Elk River Access
North Jetty
Swain Slough
Legend
Sample Location
Sample Water Source
Wetlands
Roads
Hydrology
0 0.751.5 3 4.5 6
Miles


Dissolved Oxygen
Sample Levels
(mg/L aka ppm)
N
W
E
S
11.06
10.56
11.1
10.69
10.79
10.76
11.34
7.74
11.41
11.04
10.35
Legend
Sample Location
Sample Water Source
Wetlands
0 0.751.5 3 4.5 6
Miles


Dissolved Oxgen
Sample Level
(% Saturation)
N
W
E
S
105.4
100.6
100.6
100
101
98.4
108.3
74.4
109
103.3
96.7
Legend
Sample Location
Sample Water Source
Wetlands
0 0.751.5 3 4.5 6
Miles


Sample Location
Temperature
(Celsius)
N
W
E
S
13.2
13.2
11
12.4
12.4
11.4
13.3
13.6
13.3
11.6
12.3
Legend
Sample Location
Sample Water Source
Wetlands
0 0.751.5 3 4.5 6
Miles


Agriculture
Parcels near
Humboldt Bay
N
W
E
S
Legend
Sample Location
Sample Water Source
Wetlands
Agriculture Parcel
0 0.751.5 3 4.5 6
Miles



These dissolved oxygen levels are well within the acceptable levels for salmon populations to live in. In addition, dissolved oxygen percent saturations were at a normal levels and temperatures had a small range. While quite a few of the waterways run through or nearby agriculture parcels, it did not seem to have any effects on the dissolved oxygen levels. Freshwater creek recreation area was our one outlier, however our sample area may have been just a stagnant water pool on the rainy day that we measured. Because of safety and private property, we were limited on where we could sample for some waterways. Other factors that could have affected our results were a small sample size, location, time of day, weather, time of year, and data collection errors.

Figure 7: Table showing test results from the sample sites

Number	Locations	Longitude	Latitude	DO (mg/L aka ppm)	DO % Saturation	Temperature (Celcius)
1	Samoa Blvd Bridge	-124.1489554	40.86551166	11.06	105.4	13.2
2	Arcata Marsh	-124.1002646	40.86092382	10.56	100.6	13.2
3	Eureka Slough-Target	-124.1421804	40.80542197	10.79	101	12.4
4	Freshwater Creek	-124.0916596	40.78410193	7.74	74.4	13.6
5	Jacoby Creek	-124.0698992	40.83791417	11.1	100.6	11
6	Rocky Gulch	-124.0880239	40.80169349	10.76	98.4	11.4
7	W Del Norte Dock-Cosco	-124.1881543	40.79076062	11.34	108.3	13.3
8	Elk River Access	-124.1942948	40.77559033	11.41	109	13.3
9	Swain Slough	-124.1880871	40.75572802	10.35	96.7	12.3
10	North Jetty	-124.2277279	40.76103336	11.04	103.3	11.6
11	Woodly Island	-124.1663002	40.80781107	10.69	100	12.4

Conclusion

From our results, we can conclude that the dissolved oxygen levels entering the bay from major waterways are at normal levels. Although many of the tributaries lie downstream from agricultural or timber harvest areas, these seem to only be affecting the turbidity of the water, and not the dissolved oxygen which is essential to aquatic organism life. The water based on DO levels is more than healthy, however, we have to account for when we are taking these samples. All of our DO samples were on rainy days, where DO would be more likely to be higher not only because of the added mixing with weather, but adding more freshwater in the form of rain decreases salinity;by increase the amount of space for dissolved oxygen in the water column.

While 2017 so far has been a good year for rain, the effects of the drought still linger. While previous water level data was unavailable for the small streams we sampled, it would not be wrong to assume they were much lower than this year in the previous years where the drought was more severe. The California Department of Fish and Wildlife conducted a survey in 2014 assessing juvenile salmon populations and how they were affected in salmon creek, one of the southernmost tributaries to the Humboldt bay. The survey concluded that “reduced rainfall and freshwater inflows produced conditions where salinity (and water temperature) was greater than it was in previous years and dissolved oxygen concentrations were lower” (4). We can assume that both freshwater creek and salmon creek would be affected in similar way, and the decline in salmon populations in freshwater creek and other north humboldt bay tributaries seems to correlate with the drought and decreased waterflow. Now that the water levels are healthier than during the drought, salmon and other water dwelling creatures will hopefully have the means to increase their populations to more sustainable levels.

Acknowledgements

We would like to take the time to thank the HSU forestry department for allowing us access to their GPS and dissolved oxygen sensing equipment, and our Lab instructor Dr. Amy Rock for advice and guidance.

Bibliography

1. Fondriest Environmental, Inc. “Dissolved Oxygen.” Fundamentals of Environmental Measurements. 19 Nov. 2013. Web. < http://www.fondriest.com/environmental-measurements/parameters/water-quality/dissolved-oxygen/ >.

2. Dissolved Oxygen. Retrieved April 21, 2017, from http://www.krisweb.com/stream/do.htm

3. Humboldt Bay Tributaries. Retrieved April 21, 2017 from http://www.casalmon.org/salmon-snapshots/location/humboldt-bay-tributaries-1

4. California Department of Fish and Wildlife, "Drought Stressor Monitoring Case Study: Extended Periods of Brackish and Hyper-Saline Conditions in the Stream-Estuary Ecotone of Salmon Creek, Humboldt Bay 2014". Retrieved April 23, 2017 from https://www.wildlife.ca.gov/Drought/Projects/Salmon-Creek