

For our project that focuses on the factors of urbanization upon our Bellingham Bay locations, we decided to prioritize Dissolved Oxygen and pH levels.

DO being the amount of oxygen that's present in water, and in this case salty bay water. DO is an essential aspect to all marine life, an unusual change or decrease in DO—such as even below 4 milligram per liter—as a result of polluted systems can cause fish's mortality/death rate to rise, can halt salmon reproduction, and can even suffocate majority of other life that reside in found oxygen poor areas (ENR). A healthy DO concentration in ocean water is typically between 7 and 8 mg/L and around a DO saturation of 80-120% (ENR).

With pH, which is the expression of hydrogen ion concentration that's present within water—or a scale that specifies the acidity or alkalinity of an aquatic solution—an naturally present aspect to our atmosphere and Oceans that can change either due to polluted systems, or an increased concentration of CO₂ human/urban actions. And such pH changes can impact sensitive aquatic organisms like shell builders, fish reproduction, and even create an increase in harmful algae that can decrease DO levels (NOAA—Hypoxia). With pH, a healthy level is around 6.5 to 8.0 pH (EPA).

HYPOTHESIS:

Before all our testing at the various locations—Squalicum, the Marina, Glass Beach, and Larrabee—we believed that as a result with the the factors of urbanization, Squalicum and Glass Beach will show decreased DO levels (UtahStateUniversity) and decreased pH levels (NOAA) as a outcome of increased population within Bellingham, increase in beach foot-traffic, and point source pollution.

METHODS/LOCATIONS:

But first, what exactly is urbanization and the factors we are looking for in regards to our project and our area of study?

Urbanization is the increase in the proportion of people living in towns and cities—like Bellingham! With our growth rate of population since 2010 being 20.38% with an increase of 16,567 people (World Population Review)! There's a *lot* more people. With said increase of people, there's a seen increase in transportation, recreational activities, in electricity, in consumption and then waste—increased factors that play into certain roles within the relationship of DO and pH levels.

That said, at our locations—Squalicum, the Marina, Glass Beach, and Larrabee—the first couple of factors we were looking for was man-made litter/garbage on land on and around the water. The second being point source pollution either from railroads, factories, and other sewage effluent causes—point source pollution being, “any single identifiable source of pollution from which pollutants are discharged—with pipes, ditches, ships/factories, and sewage treatment plants,” (NOAA).

Another factor was foot-traffic/amount of activity each studied location gets—which we interviewed people asking their frequency at each location.

With all those factors kept in mind, we went to each tested location with the additional and very much needed tools necessary to help support our hypothesis—Many DO testing tablets, many pH tablets, a collection and waste cups, a handheld thermometer in degree celsius, and separate tubes for each DO and pH trial.

PROCEDURE:

Once we got to our locations, we first looked for trash, garbage, or man-made remnants. We made note of the number of people there at each location, and looked around for any point source pollution. After all that, we tested/checked the water temperature in degrees Celsius. We then collected a small sample in a sterile collection cup and then filled a small tube to the very tippy top before adding two DO tablets. We also filled another tube with about 10 ml to 20 ml with the same collected water and dropped one pH tablet. We shook the two tubes—the DO tablets needing longer to dissolve, and an additional five minutes to rest before a proper color reading. After that we looked at our DO/pH color matching sheet and took pictures of our results. We recorded our temperature, DO and pH findings on our data table for each location. With that we did two trials following the same steps at each of our four locations.

RESULTS:

From our methods in regards to our investigation, we documented a lot of man-made trash or garbage, and probable point source pollution from nearby industries, railroads etc., and received data from some very helpful strangers about their activity/and/or visits to each location within the last year—Such data was used for our concept of foot-traffic or human activity playing a role within decreased DO and pH levels. Additionally we also found that a number of people have been or reviewed our locations on google maps which we also took into consideration in the grand scheme of things.

Overall, our results from this investigation did support the first half of our hypothesis. After all our observations, discoveries, real-human response, and averaging all our data from our four locations the two “unhealthiest” places were Squalicum Beach—which we were predicting—but on a much more surprising note, Larrabee State Park.

DISCUSSION:

We'll start off with what we got pretty accurate with our hypothesis.—Just like we thought, Squalicum Beach *did* end up having lower DO and pH levels—With an average DO of 4 mg/l, A 43% DO Saturation Rate, and a pH of 6.75—such a low pH reading where potentially most of our shell builders can't build and maintain their calcium carbonate shells or skeletons, which means that their shells and skeletons can sadly start to dissolve (NOAA—Ocean Acidification). Besides that, with our observations of urbanization, we were subject to a lot of litter or human remnants along the beach, graffiti, and point source pollution from Bellingham Cold Storage and a still active railway at Squalicum Beach. So our relationship concept between urbanization and DO, and pH was witnessed at this location. But where we also thought that Glass beach would

also have decreased DO and pH levels... we were proved wrong. Although we saw a lot more trash, point source pollution and other well . . . unhealthy behaviors at Glass Beach our test results from Glass beach were an average DO of 8 mg/l, 95% DO Saturation and a pH of 7.25. And according to these trials and tests, Glass Beach overall was technically the “healthiest” location (ENR., EPA). Then, with our next location, in third place, our results from the Bellingham Marina where we were considering normal—were right at the cusp of what’s considered healthy. Even with motor controlled boats, nearby fishing and shipping facilities, our DO results averaged out to be 6 mg/L, and a 80% DO Saturation, and an average pH of 7 upon the scale. That being said, we were vastly surprised to see that Larrabee State Park was in second place under Squalicum Beach for lowest DO and pH. With an average DO of 6 mg/L, 72% DO saturation rate, and a pH of 6.25—an even lower pH than our Squalicum average but with similar if not even healthier standards for our friendly shell-builders. That said, overall, our findings support our hypothesis by demonstrating that there is a relationship between DO and pH in regards to the varied factors of Urbanization—Our studied locations (like Squalicum Beach) with observed peak point source pollution, human-remnants, and foot-traffic did indeed have both decreased DO and pH levels. But on the other hand, our findings can also combat our hypothesis with the point being that even the most highly trafficked, point source polluted areas—like Glass Beach—can have normal or even healthy levels of both DO and pH.

With everything said and done, we believe that we are mostly if not pretty happy with our findings. We started off by wondering if what we did as people—and the frequency of our activities—impacted our local beaches and bays. And that curiosity developed into how do we measure that? What can we use that has the ability to help reflect our actions upon our region? Such an ability we found in what our Dissolved Oxygen and pH levels could tell us, what discoveries and secrets have they have revealed to other researchers who pursued the same curiosity as ours. We believe that we took our own approach towards this discovery, into this journey of the relationship of humanity and the region we depend on through the effects of urbanization, and the looking glass of DO and pH.

That being said, by the end of our investigation we do have to admit the shortcomings, the shortcomings of possible additional trials—as some of our temperatures in degree celsius didn’t make the most sense for our region—and test more spread out locations, and collect more data into creating a metric of foot-traffic/human activity. However, our findings reflect what we were expecting and our hope for a surprise within the overall research project.

After all, our observations, discoveries, and surprises made our research project what it is. Our findings upon the relationship between dissolved oxygen, and the pH levels found as they vary being a function of urbanization tell us that our DO and pH levels aren’t where we want them to be. We found that the correlation between us and our beaches is a factor to consider. A reason to conserve. To study and even improve for future generations of us and of our marine life. Which

is a reason to continue this investigation, to expand locations, to collect more data from tests, and increase observations, and create a further dialogue with real individuals within our region.

In the end, our epic journey into Dissolved Oxygen and pH levels here within Bellingham Bay and the Salish Sea Region doesn't end here. Our work done and shown to you today isn't the end, It's not even close to complete and whole picture of all the secrets our land withholds—but this journey and our findings from Squilicum, the Marina, Glass Beach, and Larrabee State Park is the beginning of something larger than life and important to any living organism on land, sea, and sky.

Thank you.

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