

## 50 Years of Puget Sound Water Quality

<	<b>Introduction</b>	Overview	Location	DateTime	Depth	Drinkability	Conclusion	>
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**The Aqua Analysts Present:**  
September Code Pudding Competition Submission  
*An Analysis on Water Quality*

### Meet the Team:

Fikru Yifter Kidane  
Tiffany Bergett  
Vanly Jackson

50 Years of Puget Sound Water Quality

Parameter	Units	Site Type				
		Large Lakes	Marine Intertidal	Marine Offshore	Streams and Rivers	Swimming Beaches
Ammonia Nitrogen	mg/Kg				6	
	mg/L	0	0	0	0	0
Biochemical Oxygen Demand	mg/L	1				
Chlorophyll a	mg/m3	4				
	ug/L	4		3		
Chlorophyll Field	ug/L	941		2		
Density	kg/m3			1,020		
Dissolved Organic Carbon	mg/L	3		2		
Dissolved Oxygen	mg/L	10		7	10	11
Dissolved Oxygen Field	mg/L	9	9	7	9	
Dissolved Oxygen Saturation Field	%	85				
E. coli	CFU/100ml	14		1	118	
	none		79			
Enterococcus	CFU/100ml	8		22	54	
	MPN/100g	8				
	ORG/100g	13	58	3	307	
	ORG/100ml	8	299		701	
Fecal Coliform	CFU/100ml	19		21	101	
	MPN/100g	9				
	none		53		1,821	
	ORG/100ml	28	90	1	386	248
Fecal Streptococcus	ORG/100g	372				
Hardness Calc	mg CaCO3/L	39				
Light Intensity (PAR)	umol/sm2			81		
Light Transmissivity	% light			87		
Nitrate Nitrogen	mg/L	0				
Nitrite + Nitrate Nitrogen	mg/L	0		0	1	3
Nitrite Nitrogen	mg/L	0				
Organic Nitrogen	mg/L	0				
pH	pH	8			7	8
	none	8				
pH Field	pH	8		8	7	8
	none					
Salinity	ppt	0	28	26		
	PSS			30		
Salinity Field	PSS	0		30		
Settleable Solids Gravimetric	mg/L	2				
Silica	mg/L	6		3	13	
Surface Light Intensity (PAR)	umol/sm2			1,038		
Temperature	deg C	12	11	11	11	11
Total Coliform	ORG/100ml	503				
Total Hydrolyzable Phosphorus	mg/L	0				

Here is an Overview of all Parameters and units that were used to measure water quality.

Sample averages were divided by Site Type for basic comparison.

47 Parameters were included in the original data.

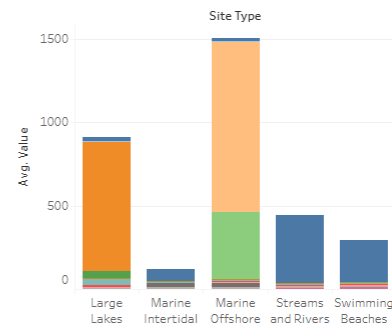
7 were excluded from the analysis due to complexity and minimal impact on water quality.

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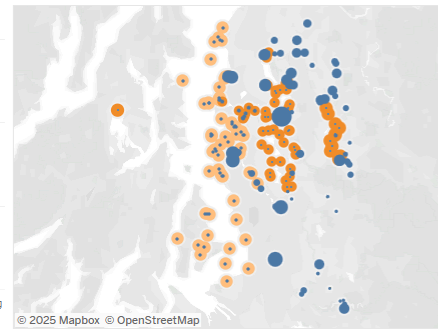
**Hydroscaapes:** Large Lakes had the highest chlorophyll values. Marine Offshore had the highest Density. River and Streams had the highest Bacteria.

**Area Map:** The map highlights water bodies in Puget Sound, with larger pins representing higher parameter values across sites.

Type of Site vs Value by Bacteria, Carbon, Chlorophyll and 11 more



Area vs Value by Bacteria, Carbon, Chlorophyll and 11 more



Parameter Calculation  
(Multiple values)

Parameter Calculation  
Bacteria  
Carbon  
Chlorophyll  
Density  
Hardness  
Light  
Nitrogen  
Organic Matter  
Oxygen  
pH  
Phosphorus  
Salinity  
Temperature  
Turbidity

Avg. Value  
0  
1,000  
2,000  
2,764

Parameters need to be considered on an individual basis and cannot be compared with each other due to their different thresholds and units. However this does give an idea of what types of parameters have a higher concentration in different area's.

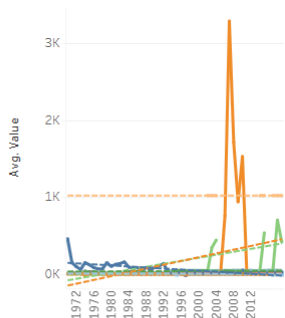
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**Year:** From 1970 to 2019, Chlorophyll spiked three before decreasing. Most other parameters remained stable across site types.  
**Time:** Chlorophyll saw three spikes before decreasing. Most other parameters stayed constant. Light increased with time of day.  
**Sample Integrity:** Shows the time gap between sample collection and analysis, highlighting the number of samples taken and their average values.

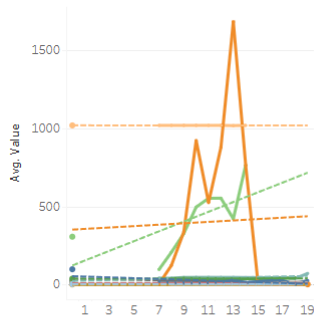
Site Type  
(All)

Parameter... (Multiple...) Parameter... Bacteria Carbon Chlorophyll Density Hardness Light

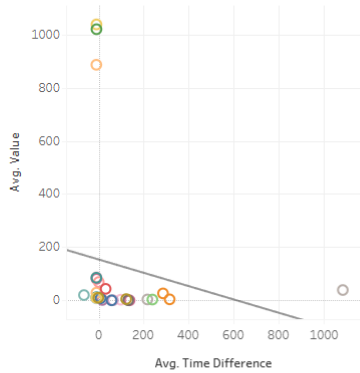
Year of Collection vs Value by Bacteria, Carbon, Chlorophyll and 11 more



Collection Hour of Day vs Value by Bacteria, Carbon, Chlorophyll and 11 more



Parameter Integrity Over Time



There is an exponential relationship between Time and Value.

Chlorophyll a and Dissolved Organic Compounds increase as the years and time of day increase.

Sample Integrity degrades after collection.

**Depth Variability:** Parameters like Dissolved Organic Carbon and Total Suspended Solids were collected at greater depths, indicating potential accumulation or the need for deeper sampling in marine offshore areas.

**Surface vs. Deep:** Parameters like Light Intensity and Fecal Coliforms were collected at shallower depths, relevant to surface or nearshore environments.

**Bacteria Concentration:** Data points for Bacteria are clustered near the surface, suggesting shallow water prevalence due to human/animal activity or warmer conditions.

**Parameter-Based Analysis:** The interactive nature allows exploration of how various parameters behave at different depths, revealing trends like increasing Oxygen with depth or concentrated Nitrogen at mid-levels.

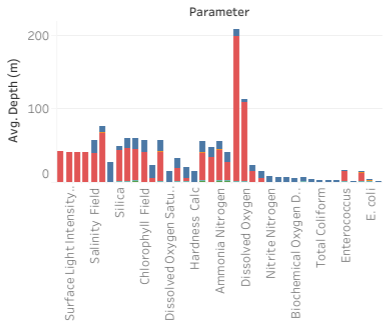
**Outlier Analysis:** Notable outliers at greater depths or with extreme values could signal ecological changes or pollution events.

Site Type  
(All)  
0

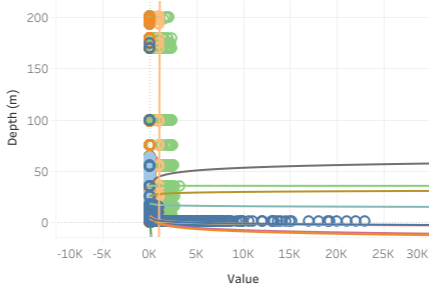
Site Type  
Large Lakes  
Marine Intertidal  
Marine Offshore  
Streams and Rivers  
Swimming Beaches

Parameter Calculation  
Bacteria  
Carbon  
Chlorophyll  
Density  
Hardness  
Light  
Nitrogen  
Organic Matter  
Oxygen  
pH  
Phosphorus  
Salinity  
Temperature  
Turbidity

Depth of Collection by Parameters



Depth of Collection vs Values by Bacteria, Carbon, Chlorophyll and 11 more



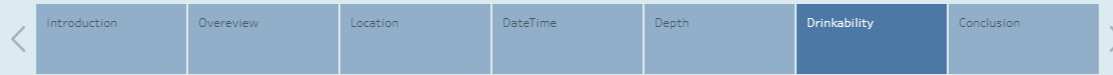
There is an exponential relationship between the Depth a sample was taken can affect Parameter Values.

Salinity and Nitrogen increases as depth increases.

Light, Oxygen, Bacteria, Chlorophyll, and Turbidity decreases as depth increases.

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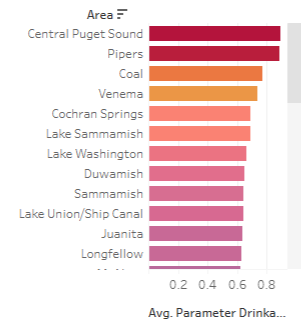
Animations are paused for this complex viz. Try filtering out more data.



**Drinkability-Bacteria (Map):** Bacteria levels vary significantly across Puget Sound, with red areas indicating higher concentrations of pollution, especially in marine and nearshore areas.  
**Drinkability-Time (Line Chart):** Bacteria levels decrease over the day, with the trendline varying by site type. Large Lakes and beach areas show higher bacteria levels in the morning, while Marine Offshore bodies of water see a high increase around noon.

Avg. Parameter Drinkability: 0.5357 to 0.8951  
Avg. Bacteria Drinkability: 0.6250 to 1.0000  
Bacteria Set: (All)  
Site Type: (All)

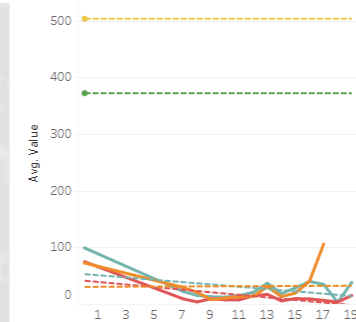
Drinkability by Parameters for Area



Drinkability by Bacteria for Area



Collection Hour of Day vs Value by Bacteria



The single most important factor for water quality is if it's safe for humans to drink.

When looking at the major parameters that make water drinkable, Puget Sound is on of the worst offenders.

If we narrow down the parameters to look at bacteria (The kind often found in FECAL MATTER) we can see there are trends but the waters are still unsafe

Water quality increases slightly with the time of day

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Well, folks, after swimming through mountains of data (not literally, of course—we've seen how drinkable some of these places are!), one thing's for sure: Central Puget Sound isn't winning any awards for drinkability. Between the murky depths and chlorophyll doing its best impression of a roller coaster Puget Sound has its fair share of quirks. But hey, at least we now know where not to fill our water bottles!

On the bright side, if you're looking for a solid science experiment or an extreme game of "how much bacteria is too much?"—we've got you covered. Just make sure to bring your goggles and lab coat to Central Puget Sound, because, well... you might need a few test tubes and a hazmat suit.

But in all seriousness, let's toast (with filtered water, of course) to the future of cleaner, healthier water for everyone! If bacteria, nitrogen, and other mystery parameters have taught us anything, it's that there's always something brewing beneath the surface. Cheers to making Puget Sound less... well, sound scary to drink from!