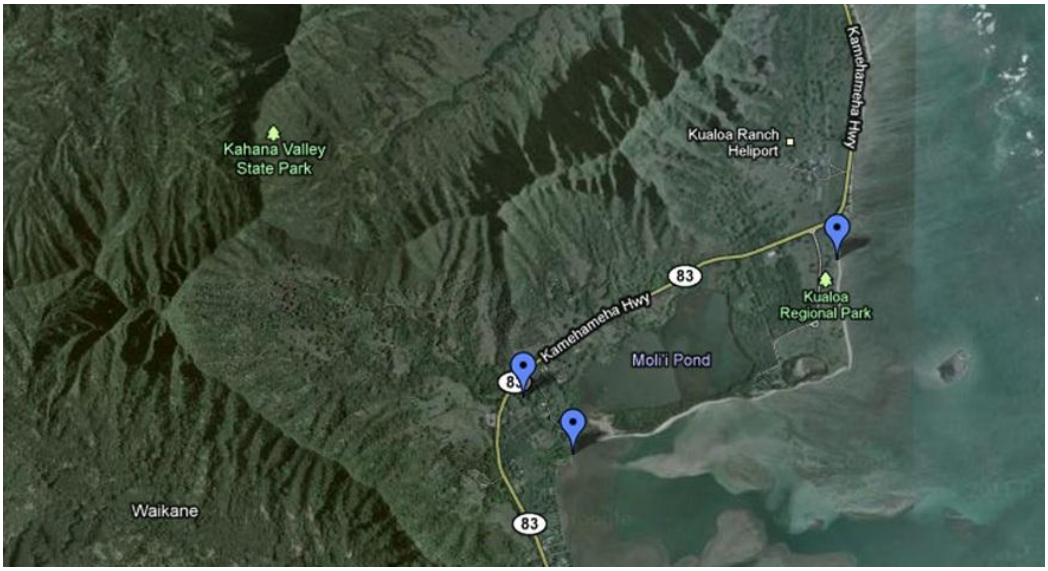
Kualoa Snapshot Water Quality Monitoring Day
February 12, 2011.

Background

On Saturday February 12, 2011 Hui o Koʻolaupoko (HOK) hosted the second annual Snapshot Water Quality Monitoring Day at Kualoa Beach Park, Oʻahu. HOK is a non-profit community organization whose mission is to: *protect ocean health by restoring the ʻāina, mauka to makai*. The mission is achieved through three program areas: 1. Community interaction and education (e.g. snapshot days), 2. On-the-ground restoration projects and 3. Project effectiveness monitoring (e.g. how effective was the restoration project at improving water quality?).

For this event, HOK staff and volunteers monitored Kāneʻohe Bay at Kualoa Beach Park swim area located near the first bathroom as well as two additional sites at Kualoa Ranchʻs Education Center which included: 1. Hakipuʻu Stream and 2. The ocean tidal flat at the mouth of Hakipuʻu Stream (See Photo 1 below for monitoring locations). The main objectives of the event were to engage the community in water quality monitoring, provide background information regarding water quality problems and collect a discrete amount of data to compare overtime (temporally) with future data. Based on the nature of a "snapshot" event, it is difficult to determine definitively the overall health of the location monitored. To have a greater understanding of water quality in a certain area, samples have to be collected frequently over a longer period of time.

Photo 1



Satellite image of Kualoa monitoring locations.

The parameters monitored for this event included: temperature, turbidity, salinity, dissolved oxygen (D.O.), pH, nitrates, phosphates, Coliform and Enterococcus bacteria. While the ocean and streams around Kualoa Beach Park are not listed on the Environmental Protection Agency's (EPA) 303(d) list of impaired and threatened water bodies, there are a variety of sources which could potentially degrade water quality including non-point source pollution from roads, parking lots, residential homes and agriculture. Pollutants from these sources can include nitrogen and phosphates from fertilizers and animal waste, gas and oil from vehicles, and sediment from eroding hill sides and stream banks. Additionally, water quality problems are compounded with the increase of impervious surfaces such as concrete, roads and roofs. These structures do not allow stormwater to infiltrate into the ground water. During periods of rain, pollutants from these surfaces are picked up, carried across the landscape and enter into storm drains, streams and ultimately the ocean.

Data gathered at water quality snapshot events will be used by HOK to help inform the public about water quality, pique the interest of island residents and provide a forum for education regarding non-point source pollutants.

Protocols

Protocols for each location were similar yet flexible enough to allow all of the various volunteers to participate in the event and utilized different equipment.

Volunteers used *LaMotte Low Cost Water Monitoring Kit* (Kits) to analyze temperature, D.O. p.H. nitrate, phosphate, turbidity and Coliform. In addition to the Kits, a YSI 556 unit was used to gather data for temperature, salinity, p.H and dissolved oxygen from samples collected in a 3-gallon plastic bucket. Volunteers also used a Hach 2100P Turbidimeter for collecting secondary turbidity readings.

Lastly, volunteers collected Enterococcus samples which were placed on ice and processed by HOK staff in the organization's lab using a method developed by IDEXX Laboratories and approved by the EPA. The 10ml sample water is diluted with 90ml of distilled water (Step 1 in Photo 2 below). Enterolert reagent is added, mixed, and dissolved thoroughly by swirling (Step 2). The solution is then poured into a Quanti-tray 2000 multi-well pack (Step 3) and sealed (Step 4). Filled Quanti-trays are then placed in an incubator at 41°+/- 1°C for 24 hours (Step 5). An ultra violet (UV) lamp is then used to identify the number of fluorescing wells (Step 6). The fluorescing wells are counted and a Most Probable Number (MRN) chart converts the number of wells to an MPN in colony forming units (CFU) of enterococcus per 100ml of water.

Photo 2

Step 1 Step 2 Step 3 Step 4

Step 5 Step 6

Results

Participants noted information on local weather conditions which included overcast to heavily cloudy skies with intermittent rainfall during the event, ocean conditions of small waves to whitecaps and 1.85 inches [1] of rainfall within the previous 24 hours. At the beginning of the monitoring, the tide was approximately mid-stage of an incoming tide (+ 1.67‘ high tide at 11:18 am) at Mokuolo‘e, Kāne‘ohe Bay[2]. The results from the different methods (Kit versus YSI) were very similar across all parameters and most parameters were similar to results from the 2010 sampling event.

Kualoa Beach Park: Weather on date of sampling 2/12/2011

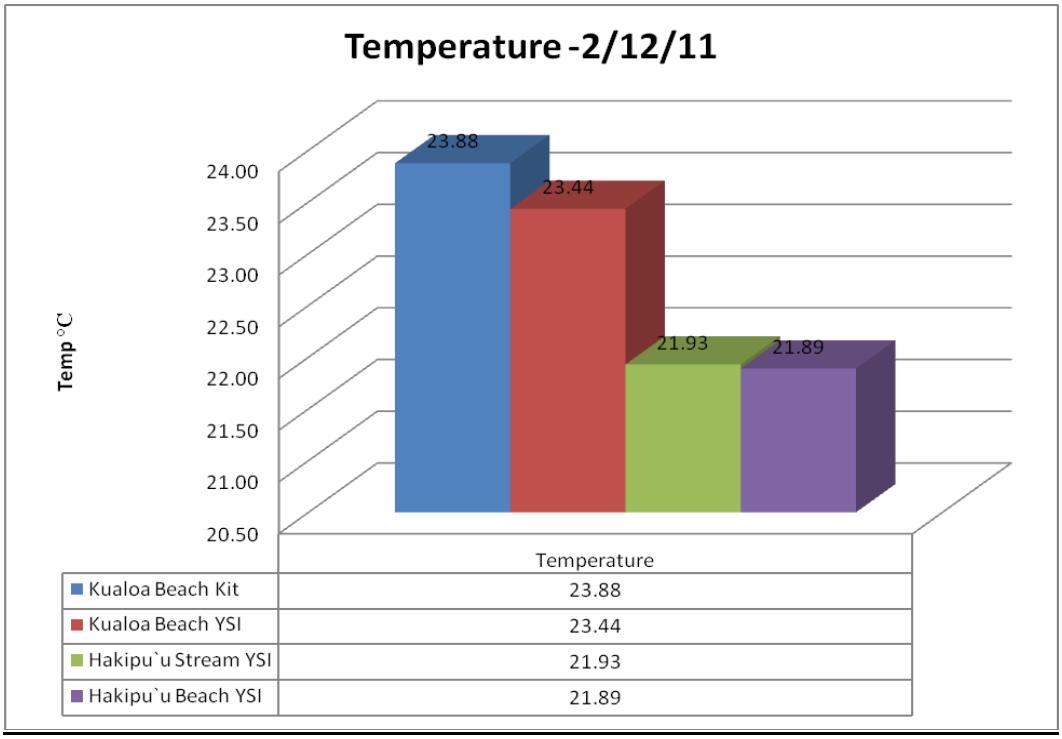
[1] http://www.prh.noaa.gov/hnl/Products/RRAHFO/RRAHFO.1102120800

[2] http://tidesandcurrents.noaa.gov/station_retrieve.shtml?type=Historic+Tide+Data

Temperature

Temperature is very important to water quality. It can affect the amount of dissolved oxygen in the water, the rate of photosynthesis by aquatic plants and the health of aquatic animals. In Hawai‘i, we expect to see temperatures from 16 °C to 27 °C.

Chart #1: Temperature

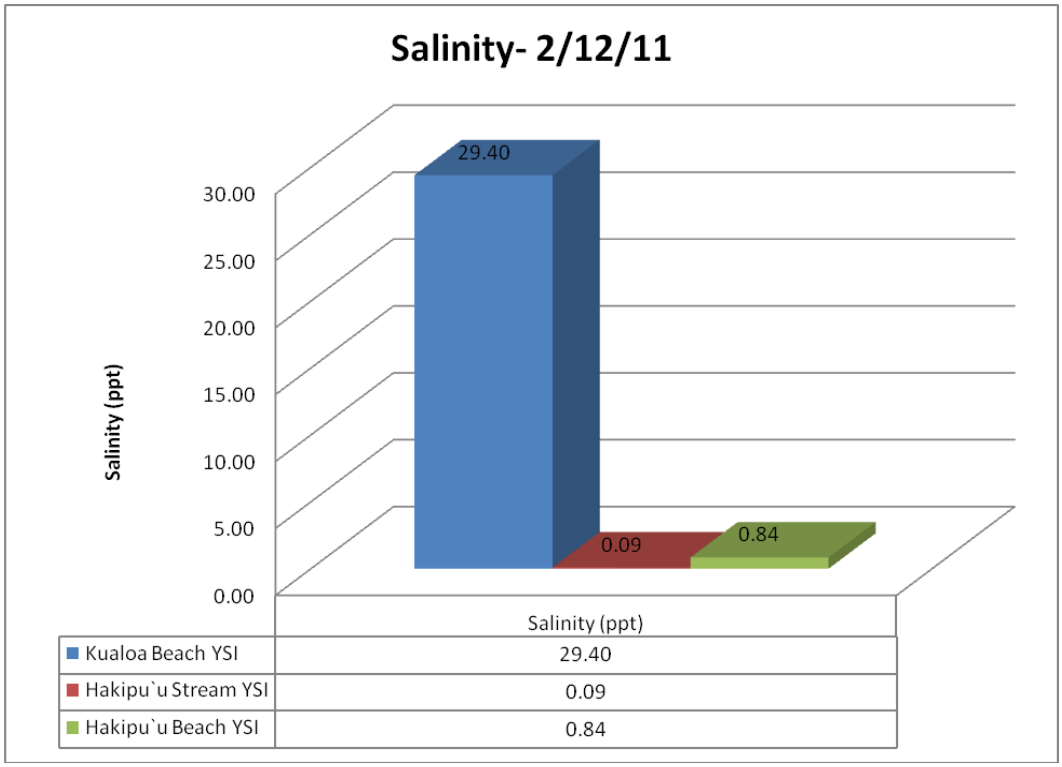


Temperature readings from the sampling Kits averaged 23.88 °Celsius (74.98° Fahrenheit) from five samples taken at the Kualoa Beach Park location which is consistent with the YSI reading of 23.44°C and the 2010 results of 23.43°C from the same location. Hakipu‘u Stream samples, taken with the YSI, revealed slightly cooler temperatures which may be attributed to consistent rain throughout the day, increased stream flow due to rainfall during sampling and thick canopy cover shading the stream.

Salinity

Salinity is the technical term for the saltiness of a water body. It influences the types of animals that can live in a body of water. Some fish can only live in fresh water or salt water while others like eels, puffer fish and oʻopu spend different parts of their life in the ocean and streams.

Chart #2: Salinity



Salinity was measured at all locations using only the YSI *556* as there is no method to test for salinity with the Kits. Salinity at Kualoa Beach Park measured 29.4 ppt (parts per thousand). 2010 readings showed a salinity of 33.57. The difference can most likely be attributed to a variation of weather at the 2 events; the 2010 event was held on a sunny day with no rainfall in the previous 24 hours. A salinity reading of 0.09 at the Hakipuʻu Stream sampling site falls within the threshold for a water body to be classified as freshwater. The low salinity reading at Hakipuʻu Beach is attributed to a sampling location on the tidal flats but within the stream channel and an out-going tide (tide peaked at 11am, sampling was at 12pm) which was allowing a high flow of storm water runoff to exit the stream. Salinity readings at this site would have presumably been higher if the tide had been incoming. The salinity readings are very standard for these environments as can be compared to other environments in Chart #3 below.

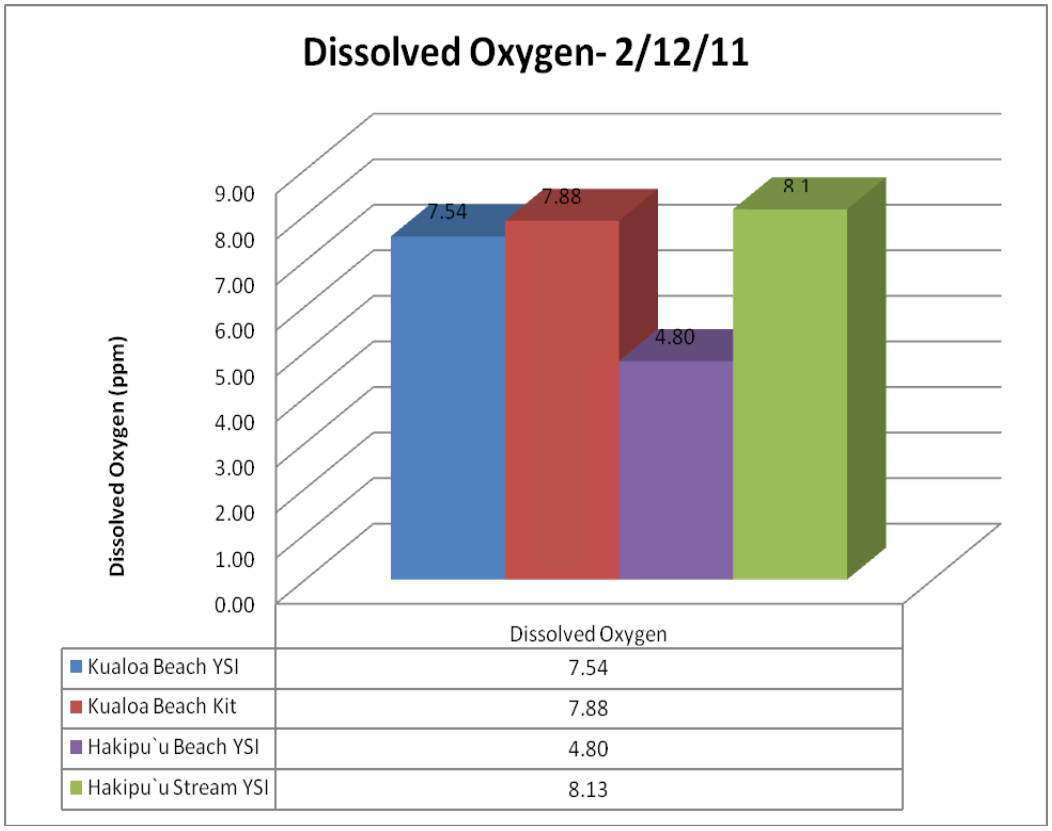
Chart # 3: Salinity comparisons

Fresh Water	Brackish water	Saline water
< 0.5 ppt	0.5 – 30 ppt	30 – 50 ppt

Dissolved Oxygen

Just as humans need to breathe oxygen to survive, so do all aquatic species. Cold water often contains more dissolved oxygen than warm water and dissolved oxygen (D.O.) levels can change depending on the time of day. In Hawai‘i, we expect to see D.O. levels between 5 and 10 parts per million (ppm).

Chart #4: Dissolved Oxygen



Dissolved Oxygen (D.O.) was consistent with other near-shore/beach environments that Hui o Ko‘olaupoko has monitored in the past. The average D.O. from reading at Kualoa Beach in 2010 was 8.64 mg/L (total of ten-samples) compared to the 2/12/2011 reading of 7.54 mg/L using the YSI. The low D.O. reading at Hakipu‘u Beach may be due to the reduced mixing in shallow waters upstream of the sample site where hau bushes (*Hibiscus tiliaceu)* cover the mud flats and the stream water is dispersed over a large area decreasing mixing and oxygenation rates. Despite Hakipu‘u Beach having the coolest temperature reading, its’ D.O. was the lowest. This is the limitation to snapshot data gathering as more data would need to be collected overtime to determine this relationship.

pH

pH is a measurement of the acidity of a solution. The pH scale ranges from 0 (very acidic) to 14 (very basic) and 7 is considered neutral. The pH of saltwater plays an important role in the Earth’s carbon cycle. The pH of natural water bodies is usually between 6.5 and 8.2. pH can be affected by industrial waste and agricultural runoff. Most aquatic organisms are adapted to a specific pH level and may die if the pH of the water changes even slightly. Chart #5 below helps illustrate pH of everyday items.

Chart #5: pH ranges

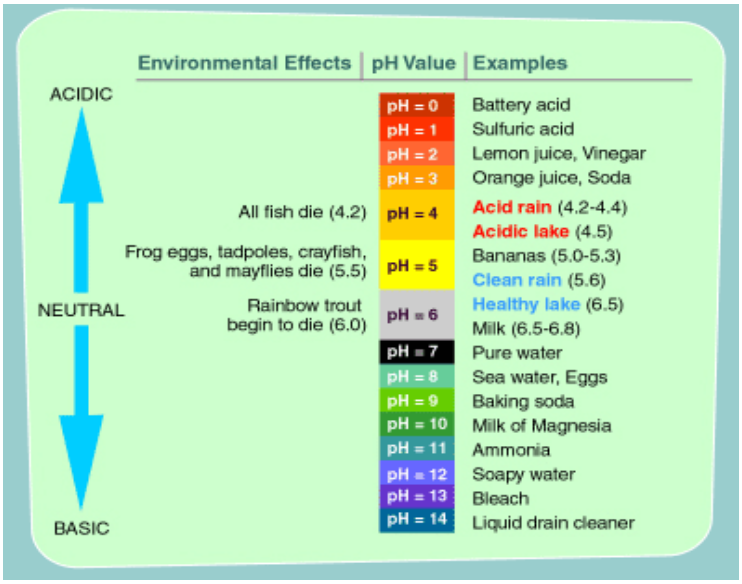
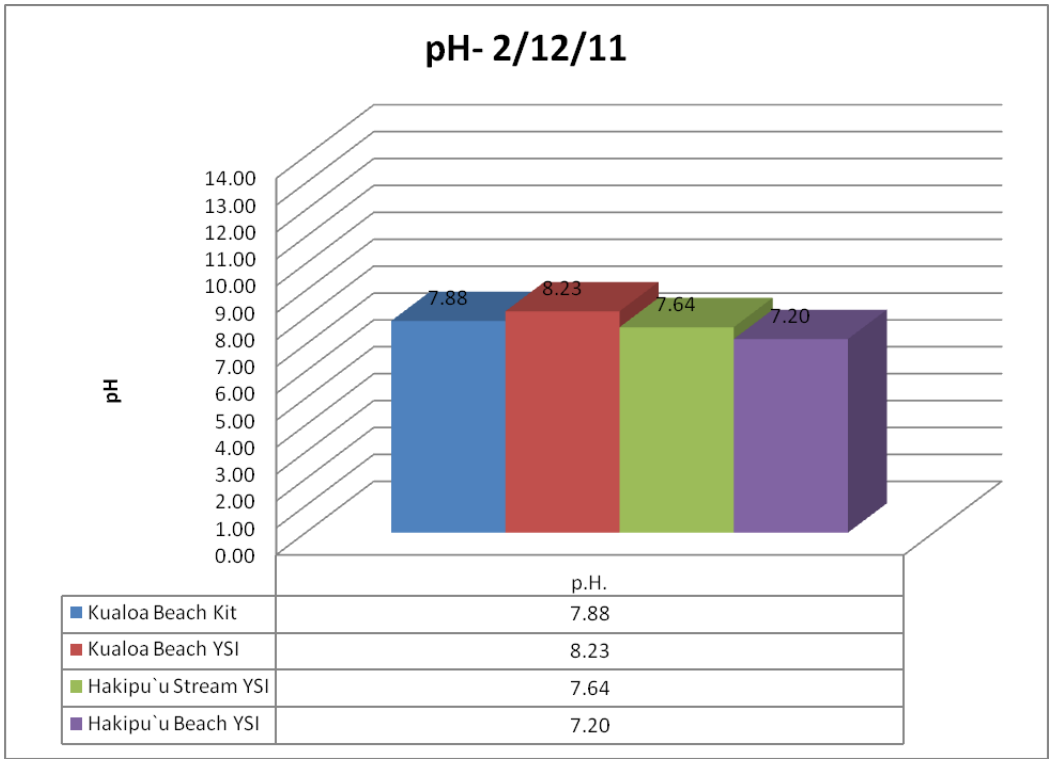


Chart # 6: p.H.

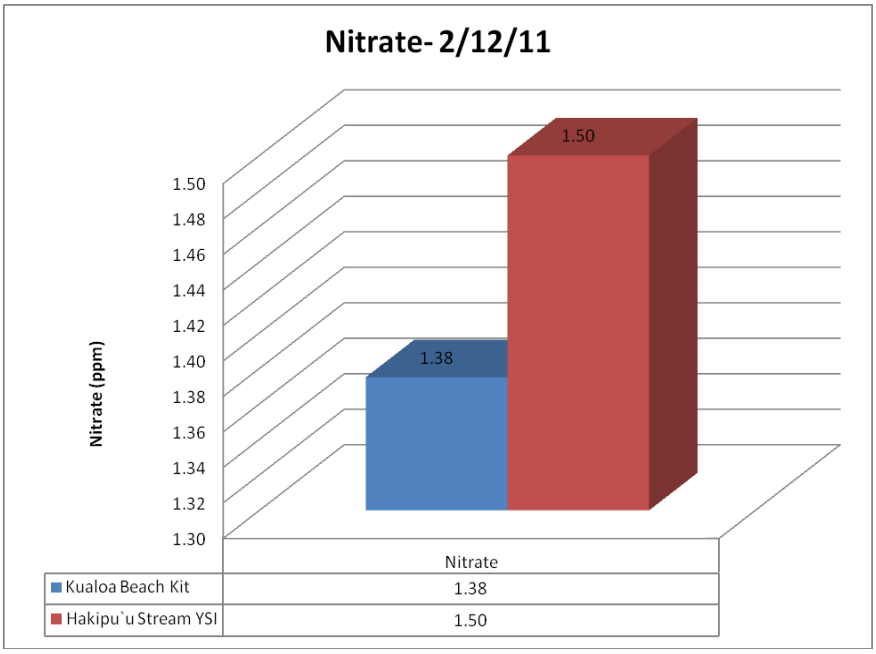


For pH, data for this event were very consistent with other monitoring efforts throughout Koʻolaupoko. The average pH at Kualoa Beach for the February 12, 2011 sampling event was 7.88 (from a total of 5 samples) and one sample taken with the YSI from Kualoa Beach, measuring 8.23 (see Chart #6 above). The State of Hawaiʻi criteria for pH in embayment areas is 8.0 pH units.

Nitrate

Nitrate is a nutrient needed by all aquatic plants and animals to build protein. Nitrates are released in to the environment by the excretions of living animals and the decomposition of dead plants & animals. Excessive amounts of nutrients such as Nitrates and increase plant & bacterial growth/decay which decrease the amount of oxygen available in the water. Fertilizers, agricultural runoff and sewage can contribute to high levels of nitrate in the water. A result of 5ppm or less is considered fair to good.

Chart #7: Nitrate



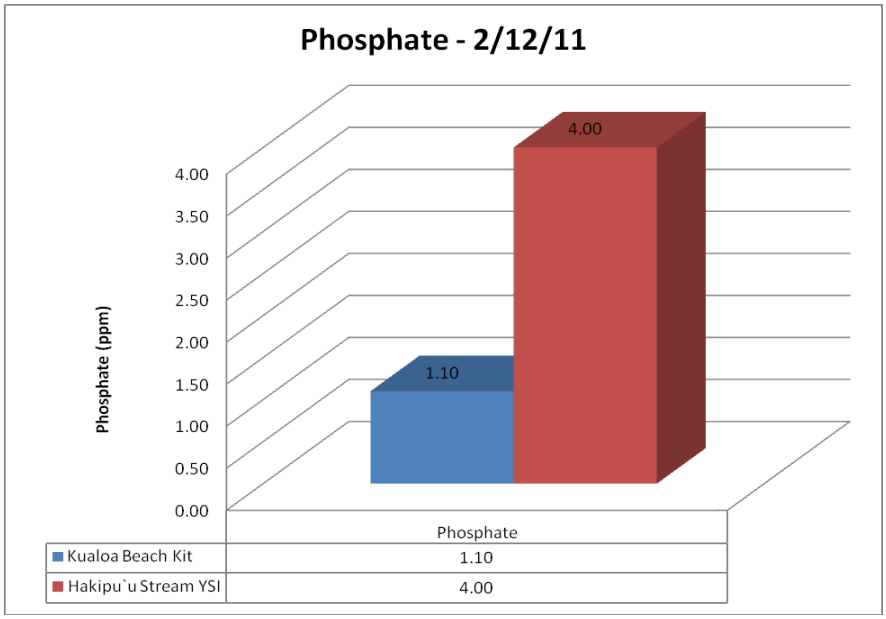
No Nitrate data was taken at the 2010 Kualoa Snapshot Water Quality Monitoring Day. However, when compared to results from Kailua and Waimānalo Bays in September 2010(results ranging from 0 to 3ppm) and the State of Hawai‘i standards, the results for the February 2011 sampling event at both Kualoa Beach Park and Hakipu‘u Stream fall within the acceptable range and mirror baseline data from other locations throughout Ko‘olaupoko.

Young volunteers read the results of their monitoring tests

Phosphate

Phosphate is a nutrient needed for plant and animal growth and is also a fundamental element in metabolic reactions. High levels of phosphates can lead to overgrowth of plants, increased bacterial activity and decreased oxygen levels. Phosphates come from sources including human & animal waste, industrial pollution and agricultural runoff. A result of 1 to 2 ppm is considered excellent to good.

Chart #8: Phosphate



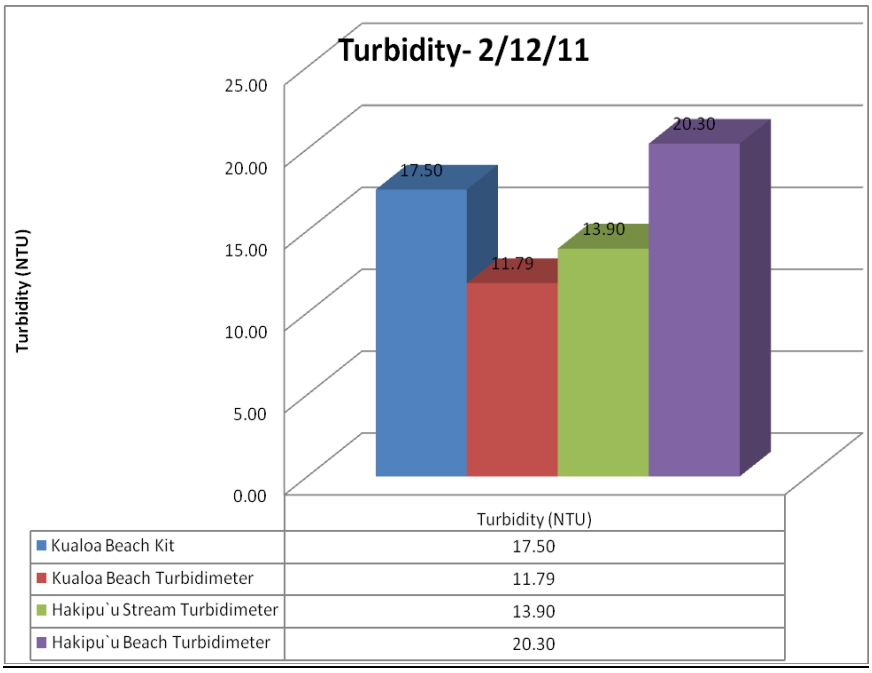
No phosphate data was taken at the 2010 Kualoa Snapshot Water Quality Monitoring Day. However, when compared to results from Kailua and Waimānalo Bays in September 2010 (results ranging from 0 to1ppm) and the State of Hawai‘i standards, the results for Kualoa Beach Park fall within the acceptable and common range while Hakipu‘u Stream showed Phosphates at 4ppm which is considered fair.

Kualoa Beach Park Weather: February 12, 2011

Turbidity

Turbidity is a measure of the clarity of water. Murky/cloudy water is caused by the presence of silt, clay, organic/inorganic matter and microscopic organisms. Turbidity is often the result of land-based sources of erosion and urban runoff or algal blooms and sediments that have been churned up by waves and wind.

Chart # 9: Turbidity



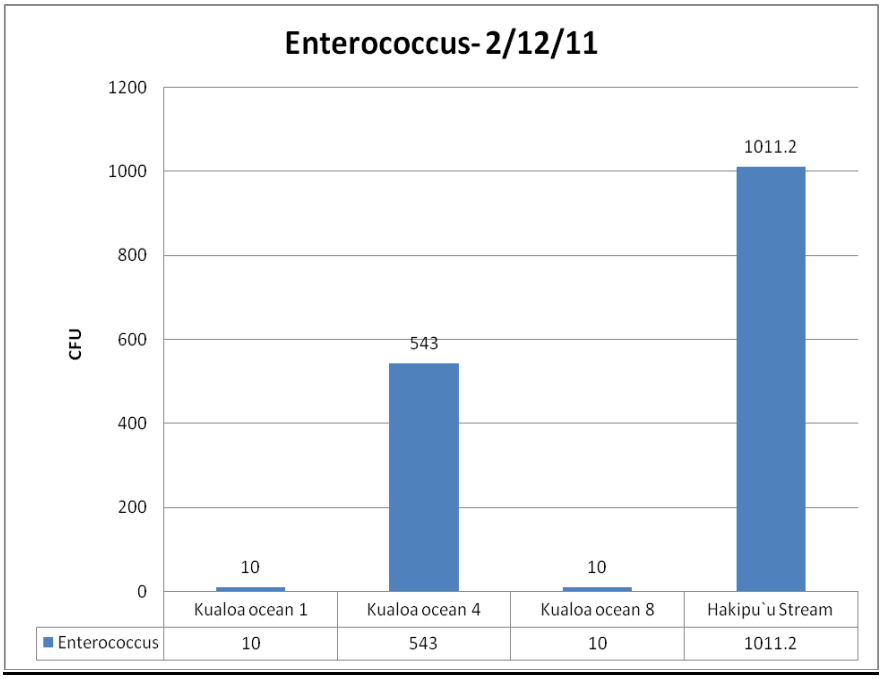
Turbidity averaged 17.5 JTU when using the Kits (based on a total of five samples) and 11.79 NTU with the Turbidmeter, see Chart #9 [Both JTU (Jackson Turbidity Unit) and NTU (Nephelometric Turbidity Unit) are roughly equivalent].

The State of Hawai‘i turbidity criteria for in Kāne‘ohe Bay is 0.4 NTU. This data notes levels higher than the criteria; however, inclement weather prior to the event could have contributed sources of erosion and urban run-off and choppy ocean conditions also stir up sediment and sand. Turbidity results from the 2010 Kualoa sampling event showed an average reading of 2.63NTUs. While the 2010 snapshot event results are also out of compliance with State of Hawai‘i turbidity criteria, visual observations from that event suggested very clear ocean conditions.

Enterococcus

Enterococcus is a bacteria found in the intestines of all warm blooded animals. Enterococcus bacteria can originate from both human and animal (mammals such as cats, dogs, mongoose, etc.) sources. When it is found in a water body, it indicates the potential presence of fecal matter in the water. This test does not distinguish the source of bacteria. Nevertheless, bacteria can come from human impacts from surrounding communities, antiquated sewer systems and runoff which includes animal waste.

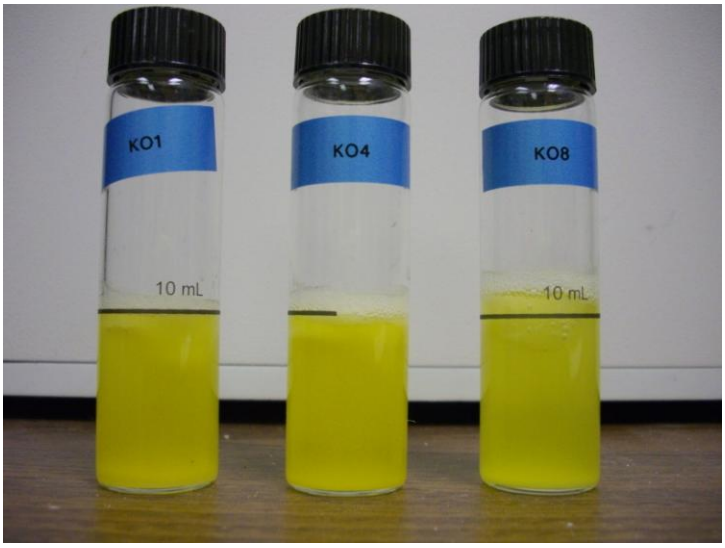
Chart 10: Enterococcus



Enterococcus bacteria samples were collected at the same location as the other parameters. One-time Enterococcus sampling events should not exceed 89 CFU (Colony Forming Units) for inland streams and 104 CFU for ocean water less than 300 meters from shore. At Kualoa Beach Park, three ocean samples were collected with varying results, with one exceeding the standard at 543 CFU and two samples well below the standard at 10 CFU. One sample was also taken from Hakiupu‘u Stream which showed a result of 1011.2 CFU (see Chart #10), which is more than 12 times the State of Hawai‘i‘s criteria. Past data collected by HOK, at the Kualoa Beach Park, following periods of dry conditions see Enterococcus levels often near zero. Conversely, following periods of heavy rain, Enterococcus levels often spike (over the State limit) in the bodies of water. Enterococcus data can often vary dramatically like this, thus the protocols call for more samples to be collected (a minimum of five over a 30-day period) at each event than was collected at this event. More data on a regular basis is needed to determine long-term trends.

Coliform

Lastly, Coliform testing at the various sites showed positive results (Coliform detected) in all samples. Results are either positive (> 20 Coliform colonies per 100 mL) or negative (< 20 Coliform colonies per 100 mL). Coliform bacteria are naturally present in the environment and human digestive tract. Their presence in water can serve as an indicator of sewage or fecal contamination. Federal and State monitoring protocols all call for using Enterococcus sampling as it is more accurate and results are completed in twenty-four hours (rather than 48 hours for Coliform) for quicker response time if there is a water quality violations. However, Coliform testing is a great educational tool because it’s inexpensive very easy to perform.



Kualoa Coliform Results

Positive results have the following:

- ✓ Cloudy liquid gel
- ✓ Gel rises to surface
- ✓ Turns yellow with many gas bubbles

Negative results have the following:

- – Clean liquid gel
- – Gel remains at bottom of tube
- – Turns red or yellow with no gas bubbles

Summary

Overall, these data are consistent with past data collected by HOK at Kualoa Beach Park and throughout Koʻolaupoko. However, for this particular "snapshot" in time our tests note higher than normal turbidity, enterococcus and Coliform levels. This can most likely be attributed to heavy rainfall prior to and during the sampling event. Rainfall acts as a broom, sweeping many land-based pollutants into streams and nearshore areas. More data needs to be collected, particularly for enterococcus to establish good baseline data and see changes over time. HOK consistently seeks funds (private, state and federal) to continue monitoring water quality and works as closely as possible with the State of Hawaiʻi to share data. For future snapshot monitoring days, volunteers will be invited again to participate and learn about local water quality.

Acknowledgements

HOK would like to thank all of the volunteers who participated in the second Snapshot Water Quality Monitoring Day at Kualoa Beach Park on February 12, 2011.Mahalo also to Surfrider Foundation, Oahu Chapter for the use of the Idexx machine to process enterococcus samples and to the Castle Foundation for their continued support.

MAHALO NUI LOA