hui o ko'olaupoko

Snapshot Water Quality Monitoring Day: October 8, 2011. Kailua and Waimānalo, Oʻahu

Background

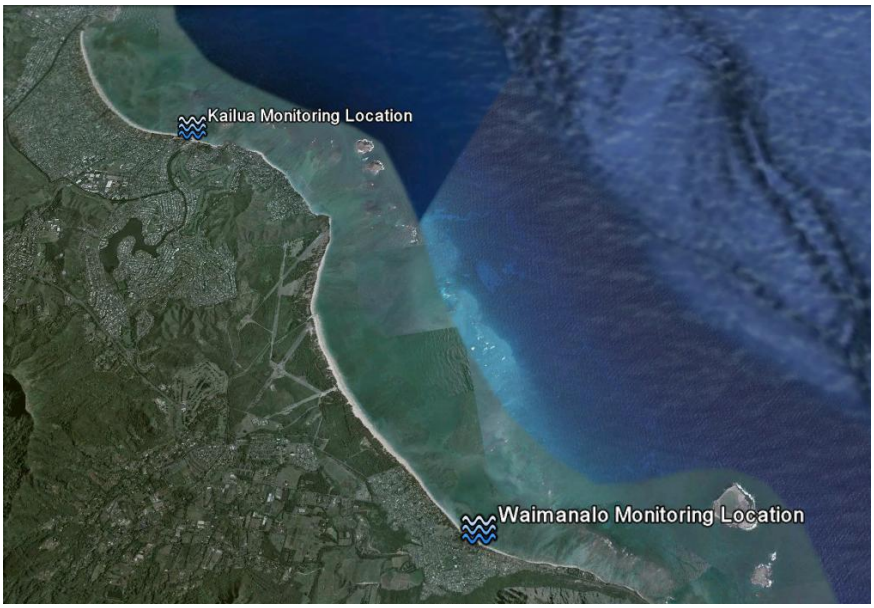
On Saturday October 8, 2011 Hui o Koʻolaupoko (HOK) hosted the 2011 Snapshot Water Quality Monitoring as part of World Wide Water Quality Monitoring Day in Kailua and Waimānalo. HOK is a non-profit community organization whose mission is to: *protect ocean health by restoring the ʻaina, mauka to makai*. The mission is achieved through three programs: 1. Community volunteering and education (e.g. water quality monitoring events), 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 four water bodies at two locations: the mouth of Kaʻelepulu Stream mauka of the sandbar and Kailua Bay and the mouth of Muliwaiʻōlena Stream mauka of the sandbar and Waimānalo Bay (see Map 1 on page 2). The main objectives of the event were to engage the community in water quality monitoring, provide background information regarding water quality problems from non-point sources and collect a discrete amount of data to compare spatially during a given timeframe (e.g. snapshot). 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.

The parameters monitored for each location included: temperature, turbidity, salinity, dissolved oxygen (D.O.), p.H., nitrate, phosphate, Coliform and Enterococcus bacteria. Both in Kailua and Waimānalo, water quality is potentially degraded from a variety sources including non-point source pollution from roads, parking lots, residential homes and agriculture. Pollutants include nitrogen and phosphates from fertilizers, gas and oil from vehicles, sediment from eroding hillsides and stream banks and animal waste. Additionally, water quality problems are compounded with the increase of impervious surface (e.g. concrete, roads and roofs) in the urban areas and following periods of rain, pollutants flow across the landscape and enter into storm drains, streams and ultimately the ocean.

Map1

Kailua and Waimānalo Monitoring Locations



At both locations, participants noted similar information on local weather conditions which included partly cloudy skies with no rainfall during the event and 0-0.02 inches of rainfall within the previous 24 hours[1]. Ocean conditions at both monitoring location consisted of ripples to small waves with no connection between either of the streams with the ocean. At the beginning of the monitoring, the tide was approximately mid-stage of an incoming tide (+ 1.86‘ high tide at 12:42 am) at Mokuolo‘e, Kāne‘ohe Bay[2], the nearest tide monitoring site.

Protocols

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

At both locations, 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, in Kailua 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 In Waimānalo, a YSI 85 was used to gather data for temperature, salinity, and dissolved oxygen from samples collected in a 3-gallon plastic bucket.

[1] http://www.prh.noaa.gov/hnl/Products/RRAHFO/RRAHFO.1110080800

[2]http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=20111008&edate=20111009&wl_sensor_hist=W1&relative=&datum=6&unit=1&shift=d&stn=1612480+Mokuoloe%2C+HI&type=Historic+Tide+Data&format=View+Data

Lastly, at both locations, volunteers collected 100ml water samples to test for Enterococcus. The samples are 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. For samples greater than .5ppm salinity, 10ml of the sample water is diluted with 90ml of distilled water (Step 1 in Picture 1 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 (MPN) chart converts the number of wells to an MPN in colony forming units (CFU) of enterococcus per 100ml of water

Picture 1

Step 1 Step 2 Step 3 Step 4

Step 5 Step 6

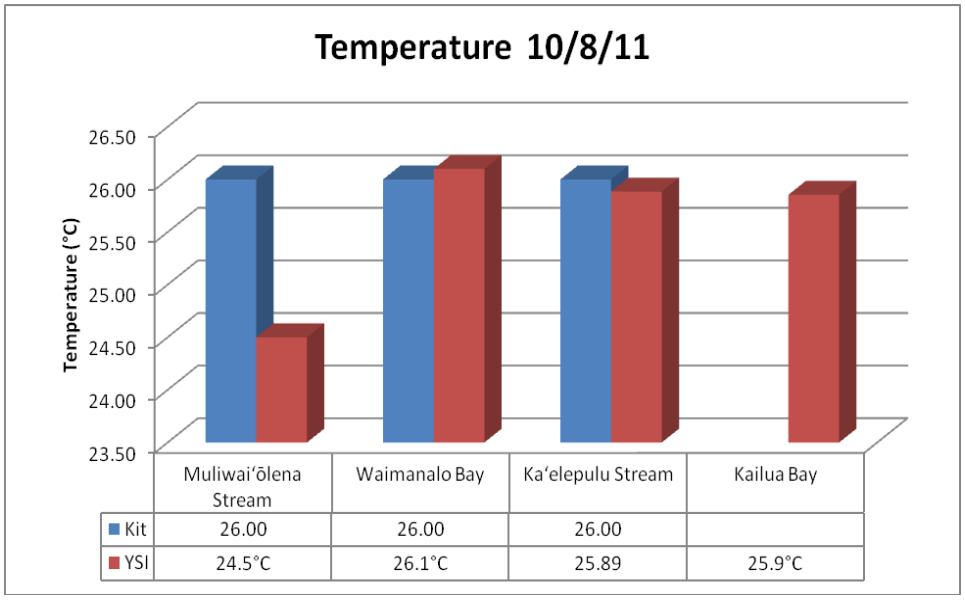
Results

Overall the data suggest the different sampling methods were fairly accurate when compared to one another. The YSI 556 and 85 are more accurate while the Kits are more objective and designed for education. Results also showed that data was very similar to the results from the 2010 sampling event at the same locations.

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

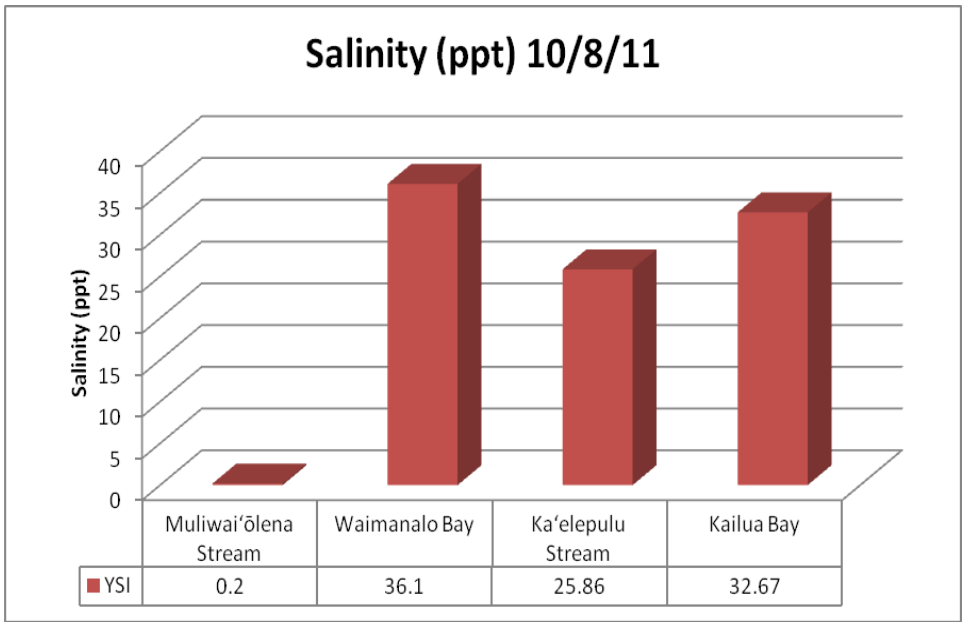


For temperature, data ranged from 24.5°C to 26.1°C. The temperature chart above shows the average temperature for all four locations using the two different protocols, no temperature data was recorded using the Kit at the Kailua Bay monitoring site. These data were consistent with past data collected in similar conditions. Past temperature results from Waimānalo and Kailua ranged from 23.65°C to 27.7°C at the 2010 sampling event and the 2009 results ranged from 24.33°C to 25.7°C.

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 O'opu 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 & YSI 85, as there is no method to test for salinity with the Kits. Salinity at the Kailua Bay monitoring location measured 32.67 ppt (parts per thousand). A salinity reading of 0.2 at the Muliwai'ōlena Stream sampling site falls within the threshold for a water body to be classified as freshwater whereas Ka'elepulu Stream is categorized as brackish water. This may be due in part to the intermittent opening of Ka'elepulu Stream to the ocean. The salinity readings are very standard for these environments as can be compared to other environments in Chart #3 below.

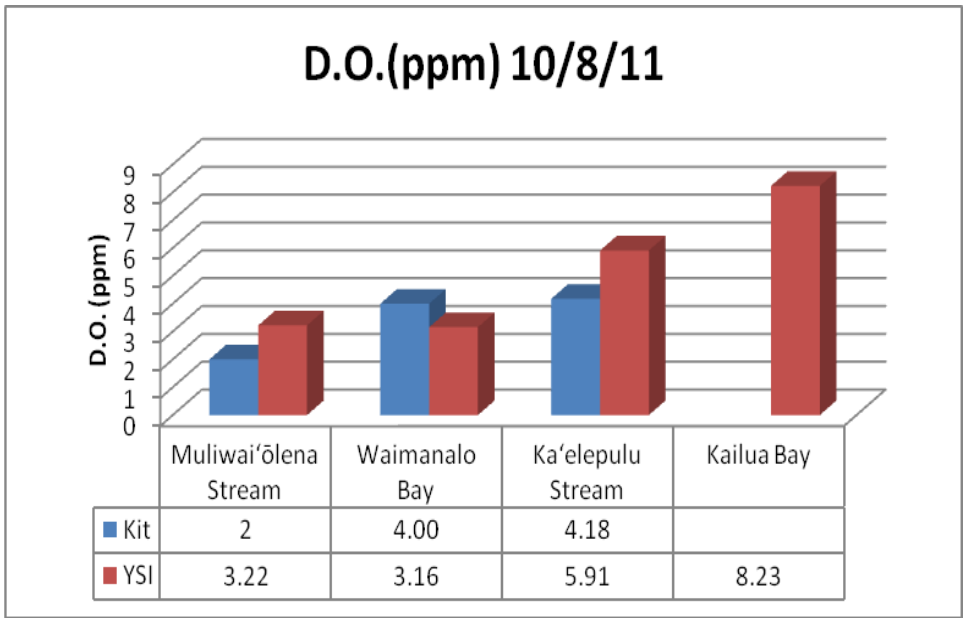
Chart # 3: Salinity comparisons

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 ranges were mostly consistent between the individual sites when comparing only the results from the YSI which is much more accurate than the Kits. These data in chart #4 above are very representative of past data collected at the various sites for the existing conditions with results only slightly lower in Waimānalo (2010 readings were 5.67-8.5) but all fall within the range of the State of Hawai'i standards.

p.H.

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

Chart #5: p.H. comparisons

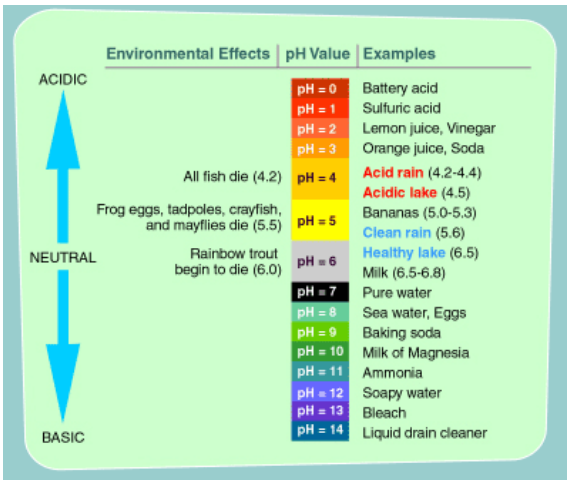
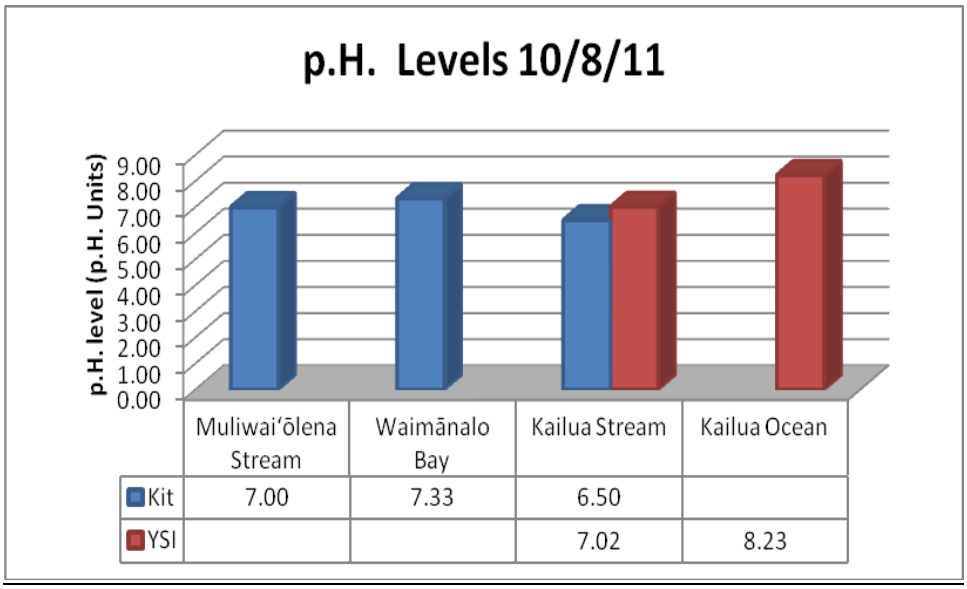


Chart #6: p.H.



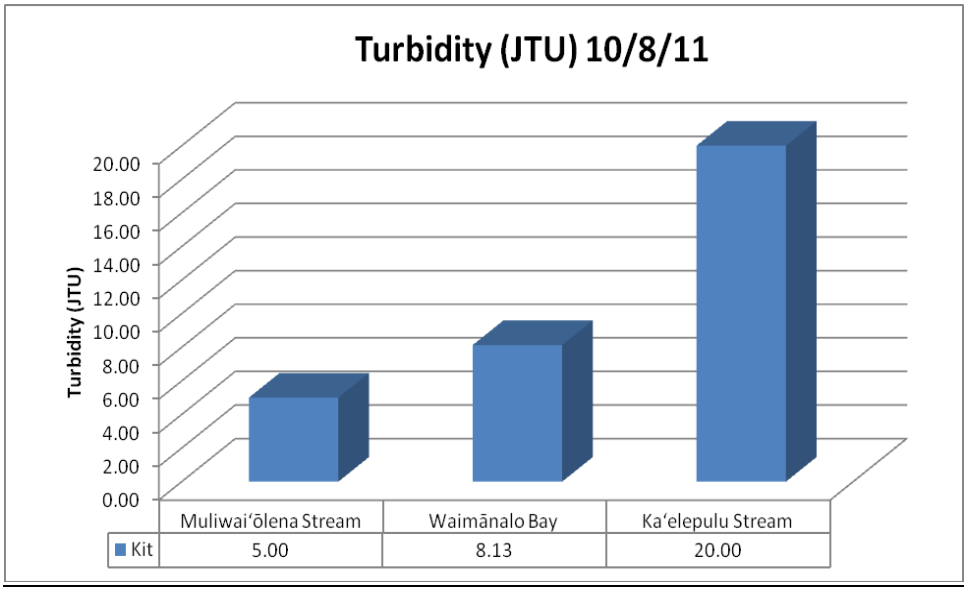
For p.H., data were mostly consistent across the various locations with two different protocols used—YSI 556 and LaMotte. For streams, the State of Hawai'i standard is 5.5 – 8.0 for p.H and 8.1 for the ocean. These data all fall within the acceptable range for p.H. as represented in chart #6 above. No p.H. data was collected in Muliwai'ōlena Stream or Waimānalo Bay with the YSI.

Turbidity

Turbidity is a measurement 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, urban runoff, algal blooms or sediments that have been churned

up by waves and wind. Often turbidity is higher depending on weather conditions such as wind stirring sediment in shallow areas of the near shore ocean environments or rainfall moving pollutants into the stream causing increased turbidity.

Chart # 7: Turbidity

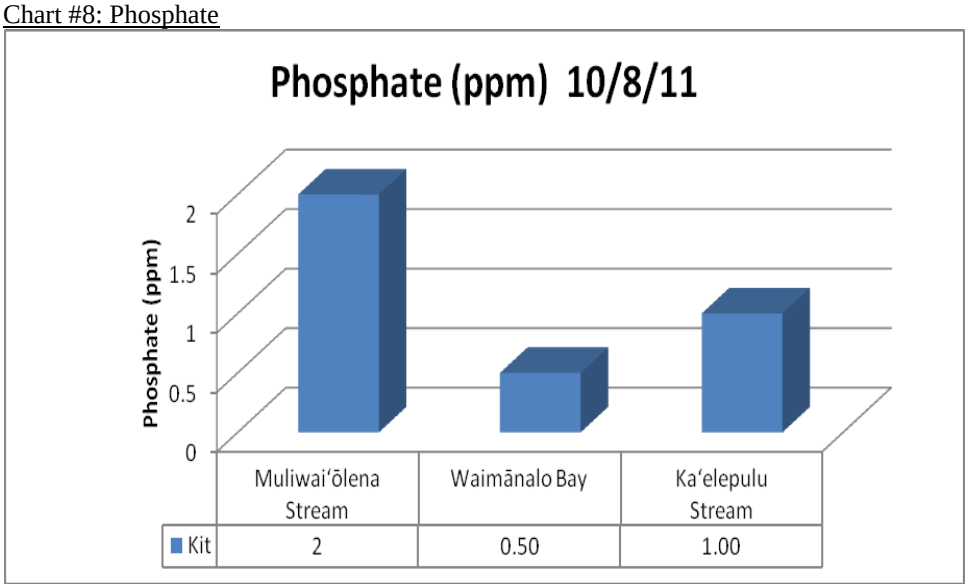


Turbidity ranges for this sampling event measured five JTUs in Muliwai'ōlena Stream to 8.13 JTU in Waimānalo Bay and 20 JTU in Kailua Bay. The significant variation likely has to do with the methods of collecting data. The LaMotte kits are much more objective and not as accurate and the digital Tubidmeters, which were not available for use at this event. The State of Hawai'i standard for turbidity is 2.0 NTU in the streams for the time of year this monitoring was conducted and 0.2 NTU for the ocean. Both NTU's and JTU's are interchangeable units, they differ only in that their name reflects the device used to measure turbidity. Several of the data points are higher than the standards but are comparable to past data collected in these areas. No turbidity data was collected in Kailua Bay.

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

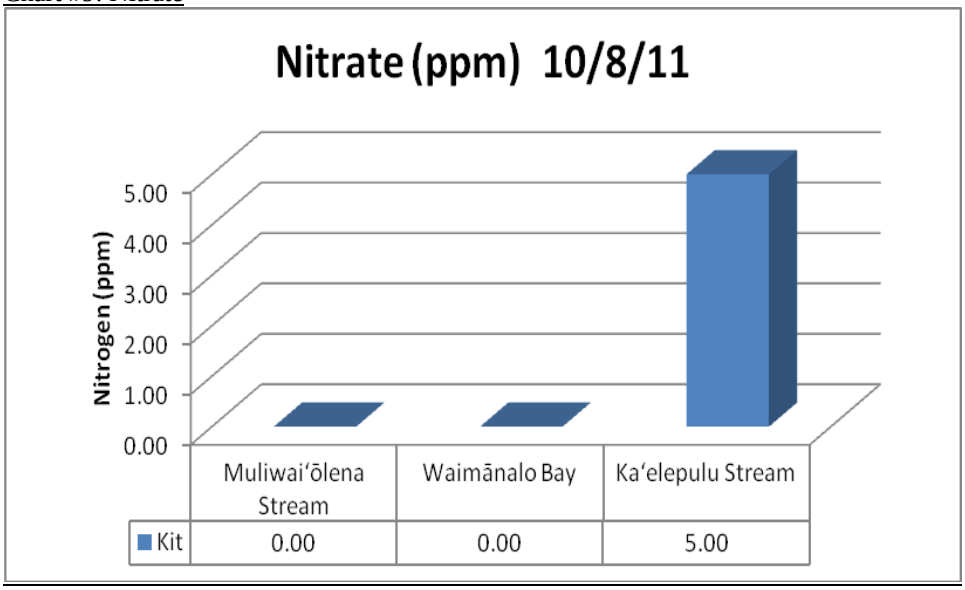


All Phosphate samples were collected using only the Kits. No phosphate data was collected from the Kailua Bay monitoring site. When compared to results from Kailua and Waimānalo Bays in September 2010 (results ranging from 0 to1ppm) and the State of Hawai'i standards, the results from this monitoring event fall within the acceptable and common range.

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 #9: Nitrate

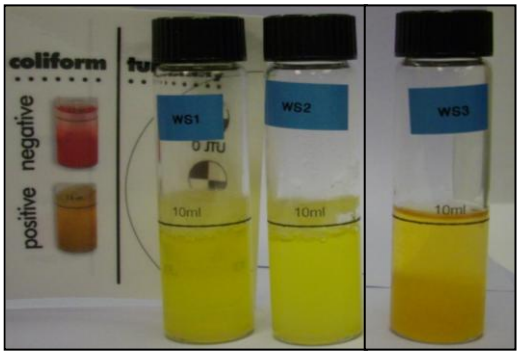


All Nitrate samples were collected using only the Kits. No Nitrate samples were taken from the Kailua Bay sampling location. When compared to results from Ka'elepulu Stream, Muliwai'ōlena Stream and Waimānalo Bays in September 2010 (results ranging from 0 to 3ppm) and the State of Hawai'i standards, the results for the 2011 sampling event at fall within the acceptable range and mirror baseline data from other locations throughout Ko'olaupoko.

Coliform

Coliform bacteria are present in the environment and also in the feces of all warm-blooded animals and humans. Coliform bacteria are unlikely to cause illness but their presence in drinking water indicates that disease-causing organisms could be in the water system.

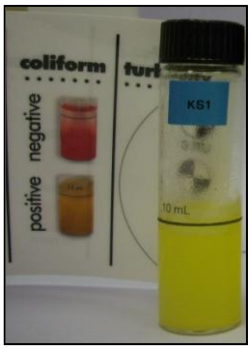
Coliform testing at the Kailua and Waimānalo sites showed positive results (Coliform detected) in all samples, see pictures 3 and 4 below. Results are either positive (> 20 Coliform colonies per 100 mL) or negative (< 20 Coliform colonies per 100 mL). Federal and State monitoring protocols all call for 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. One negative test (Coliform not detected) was included in Picture 3 below as a reference for the visual difference between negative and positive samples.



Picture 3

Waimānalo Coliform Results
Negative results have the following (negative on far right of picture for comparison):

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



Picture 4

Kailua Coliform Results
Positive results have the following:

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

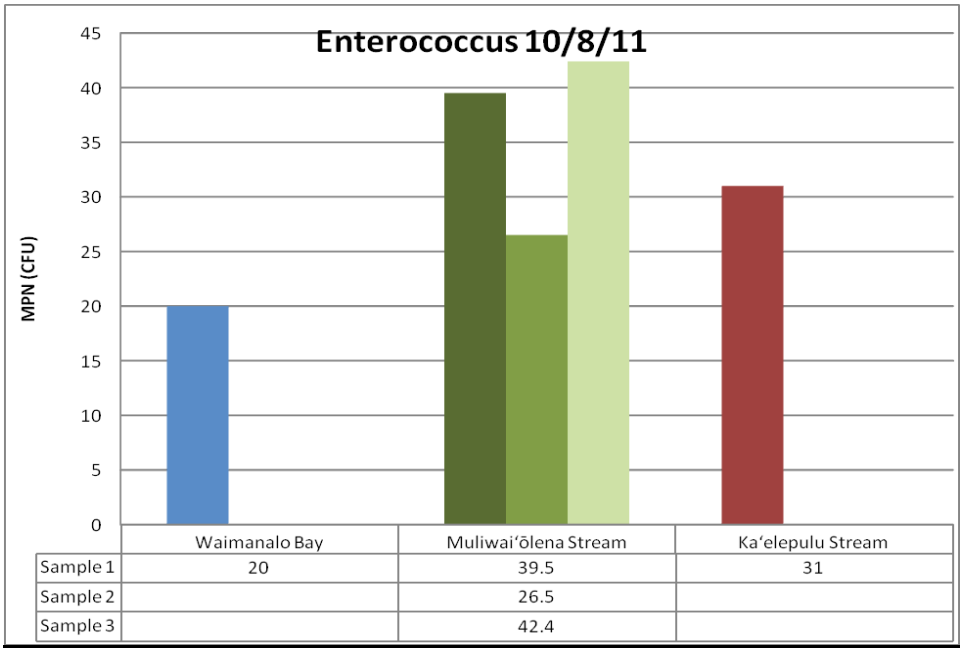
Enterococcus

Enterococcus bacteria can originate from both human and animal (mammals such as cats, dogs, mongoose, etc.) sources. This test does not distinguish the source of bacteria. Nevertheless, bacteria cane come from human impacts from surrounding communities, antiquated sewer systems and runoff which includes animal waste. Past data collected by HOK, primarily in Kaʻelepulu Stream, 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 Stream; however, ocean levels are generally not impacted unless the sandbar is opened and there is a connection of the two water bodies.

For this event, limited Enterococcus bacteria data were collected for all sites, see chart #10. All samples collected in Waimānalo and Kailua for this sampling event fell below the State of Hawaii criteria for one time sampling events. For inland streams, a onetime sample should not exceed 89 Colony Forming Units (CFU) and 104 CFU for ocean water. Enterococcus data can often vary dramatically, thus the protocols call for more samples to be collected at each event

than was collected at this event. More data, collected on a regular basis is needed to determine long-term trends.

Chart #10: Enterococcus comparisons



	Waimanalo Bay	Muliwai'ōlena Stream	Ka'elepulu Stream
Sample 1	20	39.5	31
Sample 2		26.5	
Sample 3		42.4	

Summary

Overall, these data are consistent with past data collected by HOK and for this "snapshot" in time, water quality mostly fell within the State standards. 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 Hawai'i 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 Waikiki Swim Club for funding to purchase monitoring supplies, Hawai'i Pacific University for the use of their YSI 85 and Surfrider O'ahu Chapter for the use of their Enterococcus processing equipment. Lastly, we like to thank all the volunteers who participated in the event. MAHALO