Clean Water for Reefs Puakō Citizen Science Program Report 2018

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INTRODUCTION:

"The health of our water is the principal measure of how we live on land"

– Luna Leopold

Clean Water for Reefs Puakō is a collaborative effort, spearheaded by The Coral Reef Alliance (CORAL) to address the ongoing concern of wastewater pollution in Puakō, Hawai'i. The grassroots effort ignited by the Puakō community in 2014 set out to manage impacts from wastewater caused by outdated infrastructure such as cesspools and septic tanks. *The Puakō Hawai'i Community Feasibility Study and Preliminary Engineering Report* investigated alternative technologies suitable for Puakō's geology, proximity to shore, and small lot sizes to recommend a solution.

To achieve maximum environmental and human health benefits, we investigated three alternative technologies, 1. Connection to a nearby facility 2. Construction of an independent treatment facility for Puakō, 3. Home Aerated Treatment Units (ATU) for individual properties. In 2015, Aqua Engineering and the Puakō Advisory Committee made a formal recommendation for an independent treatment facility for Puakō.

It is important to monitor the impact of improving wastewater technology in Puakō in order to demonstrate the success of this effort.

MONITORING THE IMPACT OF A WASTEWATER TRANSITION:

Front row from left: Dr. Courtney Couch, Dr. Tracy Wiegner, Jos Hill, Robin Pulkinnen, Cindy Punihaole, Lydia Smith, Erica Perez, Dr. Kim Falinski. Back row from left: Nakoa Goo, Justin Logan, Dennis, Bert Weeks, Lani Watson, Chad Wiggins. Not pictured: Cherie Kauahi, Dr. Bill Walsh, Lindsey Kramer, Kanoe Steward.

CORAL teamed up with The Nature Conservancy (TNC) to convene experts in planning, management, fishing, business, governance, research, and education to develop a monitoroing plan designed to measure the impact of the wastewater infrastructure transition. Details of this plan can be reviewed in: *Puakō Monitoring Plan for Assessing Impacts of Wastewater Treatment Upgrade Project (2016).* Plan authors identified the benefit of utilizing both professional researchers and citizen scientists to collect the monitoring data.

To best understand the benefit of transition, seven priority-indicators were identified to measure the efficacy of updated infrastructure; Clean Water, Pono Practices, Coral Health, Human Health, Community Pride, Property Value, and Knowledge & Awareness. Identified within each priority-indicator are the metrics and methods for measurement. Indicators identified as appropriate for citizen science include Community Engagement (CE), Nutrient Concentrations (NC), Fecal Indicator Bacteria Counts (BC), Property Value (PV), Vacation Rentals (VR), Hard Coral Cover and Algae Cover (PC).

Citizen Science Water Quality Monitoring

The monitoring experts group identified water quality parameters as a priority for citizen science monitoring. Programs throughout Hawai‘i demonstrate that residents and ocean goers are not only able to support data collection, but trained volunteers are capable of collecting data that meet rigorous research and regulatory standards. We identified an opportunity to incorporate the quality assured water quality monitoring methods designed by Hui O Ka Wai Ola, a successful citizen science program on Maui. Their Quality Assurance

Project Plan enables their team to collect data that is accepted into the State Hawai‘i Department of Health (HDOH) database which is then used to guide management. This is a cost effective solution to bridge data-gaps across our county and state.

The process to establish a water quality QA prgram for Hawai‘i Island requires collaboration with DOH and that the QAPP be adapted for the island, QA coordinators and volunteers be trained and labs certified. We decided to move ahead with the process to implement a QA program on Hawai‘i Island and leverage the current Puakō monitorg team in order to engage the Puakō stakeholders, practice the sampling methodology and prepare for launch of the QA program. In 2019, CORAL and our partners will establish the framework for the Hawai‘i Island Quality Assurance Project Plan (HI-QAPP) and utilize the momentum established with the Puakō citizen science team to expand to other communities who are also concerned about local water quality from stormwater or sewage pollution.

In May 2017, CORAL and TNC collaborated to host the Puakō Citizen Science Development Workshop where we introduced the Hui O Ka Wai Ola quality-assured water-quality monitoring framework to Hawai‘i Island. Interested stakeholders and partners came together to learn how to measure the health of Puakō’s water by collecting nutrient (NC) and bacteria samples (BC). Eleven people attended the workshop who provided insight to site selection process, data management, roles and responsibilities, and received training under the Hui O Ka Wai Ola plan. We selected six monitoring sites and identified roles and responsibilities for coordinator, data management, chain-of-custody, lab coordinator, volunteer samplers, and lead trainer which were filled by CORAL, partners and volunteers.

Monthly surveys began in September 2017 to establish baseline water quality and provide the practice needed for team-leaders, coordinators, and volunteers to become proficient in the quality assurance methodology needed for state certification. CORAL is partnering with TNC, Surfrider Foundation, and the South Kohala Coastal Partnership to establish a Hawai‘i Island wide citizen science water quality monitoring Hui and data will be accessible through a Hui website. In the short term, CORAL is partnering with Surfrider Foundation Hilo Chapter’s Blue Water Task Force to make the Puakō dataset public on the national Blue Water Task Force platform.

METHODS:

Workshop participants used three criteria to select sites: 1. Location of professional research sample sites, 2. Current DOH sample sites, 3. Community-interest sites. Taking this into consideration the stakeholder group selected six sites. Five of these sites (Hapuna North, Hapuna South, Waialea North, Waialea South and Secrets) are new sites filling state

and research data gaps and one site (Paniau #3) overlaps with professional a research site to ground-truth data (see Map below)

Figure 1: 6 sites identified for citizen science water quality monitoring in the Puakō area.

Citizen science volunteers sampled all six sites once a month between the hours of 7 am and 10 am over a nine-month period. Site names and codes are as follows: Paniau (PAN), Secrets (SEC), Hapuna North and South (HPN & HPS), and Waialea Beach North and South (WAN & WAS). Teams sampled sites according to methodology described in the Hui o Ka Wai Ola Quality Assurance Project Plan (QAPP). Detailed specifications can be found in this document online: www.huiokawaiola.com/uploads/8/6/5/2/86526856/qapp_rev1.22_april2017.pdf.

The data collected include the following water quality parameters: ocean salinity, pH, temperature, organic nutrients (total dissolved nitrogen and phosphorous), fecal indicator bacteria (specifically *Enterococcus*), dissolved oxygen (DO), and turbidity.
Some parameters were measured in situ with field instruments (salinity, pH, temperature, dissolved oxygen), while others were analyzed by University of Hawai‘i at Hilo Analytical lab from grab samples (nutrients, bacteria). Metadata was also recorded to create a richer representation of how multiple variables may influence water quality. This includes weather conditions, time, lunar cycle, tide and number of humans present.

WATER QUALITY STANDARDS:
Nutrient standards based on Hawai‘i Administrative Rule (HAR) 11-54 established by the Hawai‘i DOH set minimum water quality standards under the provisions of the Clean

Water Act. The standards are set to protect designated uses of streams and marine waters (see Table 1).

Parameter	Geometric mean not to exceed the given value	Statistical threshold not to exceed the given value more than ten percent of the time	Statistical threshold not to exceed the given value more than two percent of the time
Total Nitrogen (ug N/L)	150.00 * 110.00 **	250.00 * 180.00 **	350.00 * 250.00 **
Total Phosphate (ug N/L)	20.00 * 16.00 **	40.00 * 30.00 **	60.00 * 45.00 **
Turbidity (NTU)	0.50 * 0.20 **	1.25 * 0.50 **	2.00 * 1.00 **
Enterococcus (CFU/100/mL)	35	130	N/A

Table 1: Department of Health Amendment and Compilation of Chapter 11-54 Hawai'i Administrative Rule, November 15, 2014 (11-54-6 & 11-54-8)

Open coastal waters are considered marine waters bounded by the 183-meter or 600-foot (100 fathom) depth contour and the shoreline. For a complete list of standards set by the DOH, see HAR 11-54-6. Criteria for open coastal waters differ, based on fresh water discharge. "Wet" criteria apply when the open coastal waters receive more than three million gallons per day of fresh water discharge per shoreline mile. "Dry" criteria apply when the open coastal water receive less than three million gallons per day of fresh water discharge per shoreline mile. Puakō's average rainfall is 45 inches per year. For this analysis, we utilized the dry classification for Puakō but did not considered ground water input.

Enterococcus standards set by the Environmental Protection Agency (EPA) and enacted by the DOH are designed to protect the public from exposure to harmful levels of pathogens. These standards are for all recreational waters where the public enters the ocean. *Raw or inadequately treated sewage, sewage for which the degree of treatment is unknown, or other pollutants of public health significance, as determined by the director of health, shall not be present in natural public swimming, bathing or wading areas* (HAR 11-54-8).

RESULTS:

Paniau (PAN) samples consistently contain higher concentrations of nitrogen than all other sites as illustrated in Figure 1. This difference is often an order of magnitude greater than most sites, which is consistent with professional research data seen in *Local Engagement*

for Conservation Solutions: Measuring the Impact of Management Action in South Kohala, Hawai'i Island. Secrets (SEC) and Waialea North (WAN) have also exhibited high nitrogen values. Using DOH Nitrogen geometric mean standard seen in Table 1, our results show that 44% of all Puakō samples fall above the DOH threshold.

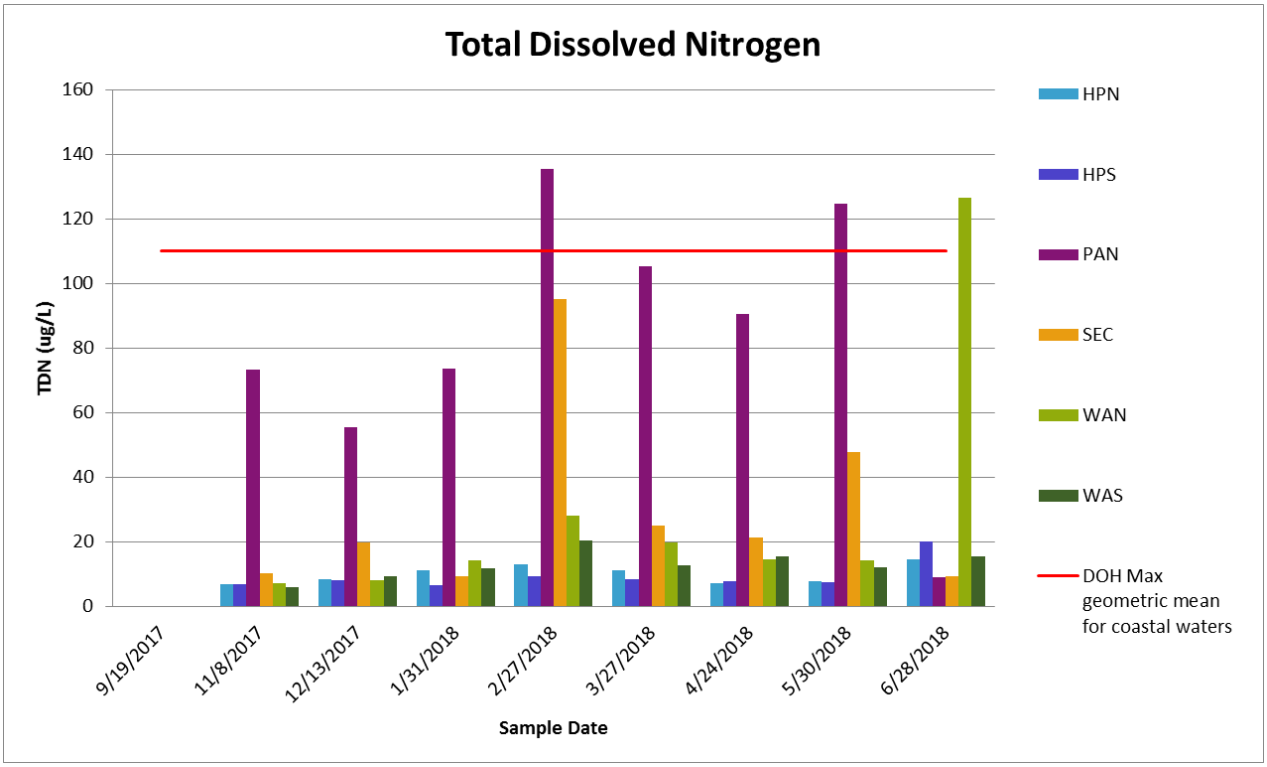

Figure 1: Total dissolved nitrogen (TDN) values across sample sites

Hapuna North, Hapuna South, and Paniau showed the highest levels of Total Dissolved Phosphorus compared to all other sites (Figure 2). None exceeded the DOH max geometric mean for coastal waters. These results are consistent with professional research data that identifies Paniau as a "sewage hotspot" (Wiegner & Abaya et. al, 2018). No correlation was apparent between TDP and any other parameters measured.

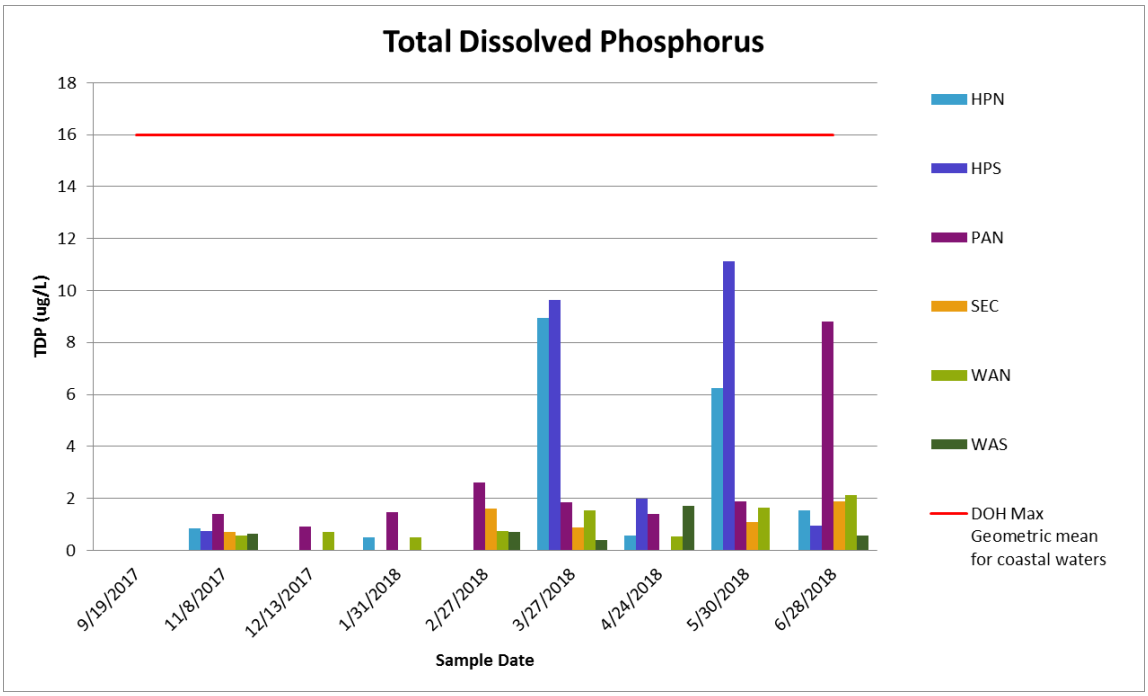

Figure 2: Total dissolved phosphorus (TDP) across sample sites

The highest concentrations of *Enterococcus* were found at Paniau, Secrets and Waialea North as seen in Figure 3 using the State of Hawai'i single sample maximum of 104 CFU/100mL. There is no statistical correlation between salinity and *Enterococcus* from the current sample size (Figure 4). The strongest correlation among parameters was seen in Figure 5, between nitrogen and *Enterococcus* with a moderate positive correlation of ($R2 = 0.34$).

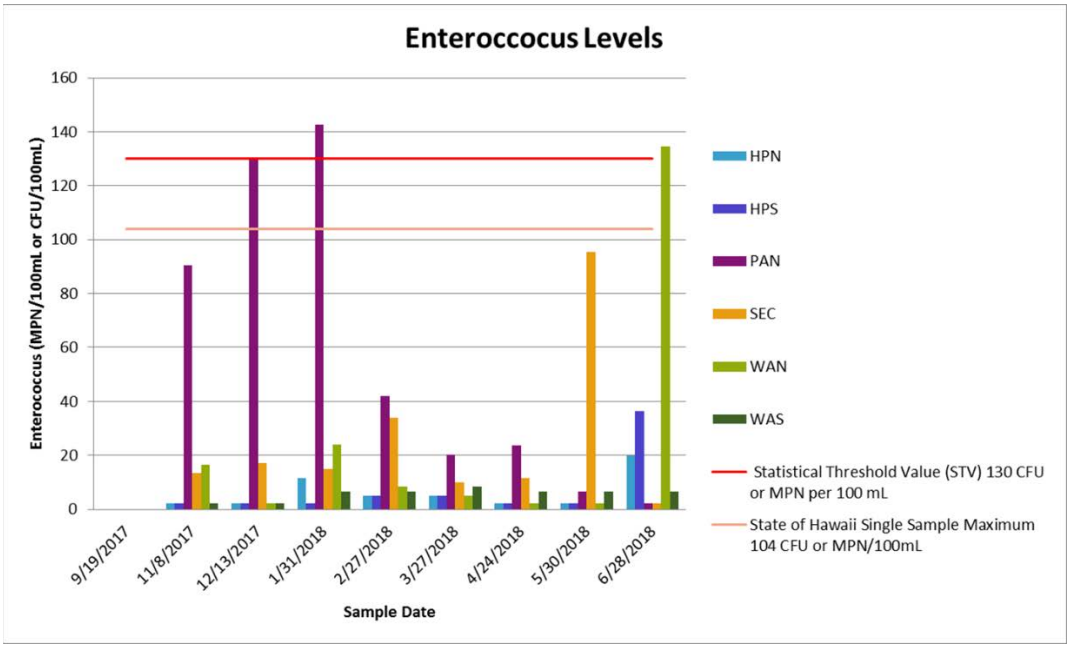

Figure 3: *Enterococcus* concentrations across all sites (Note: all values of "<10" were converted to 2.3 MPN/100mL for data analysis purposes.

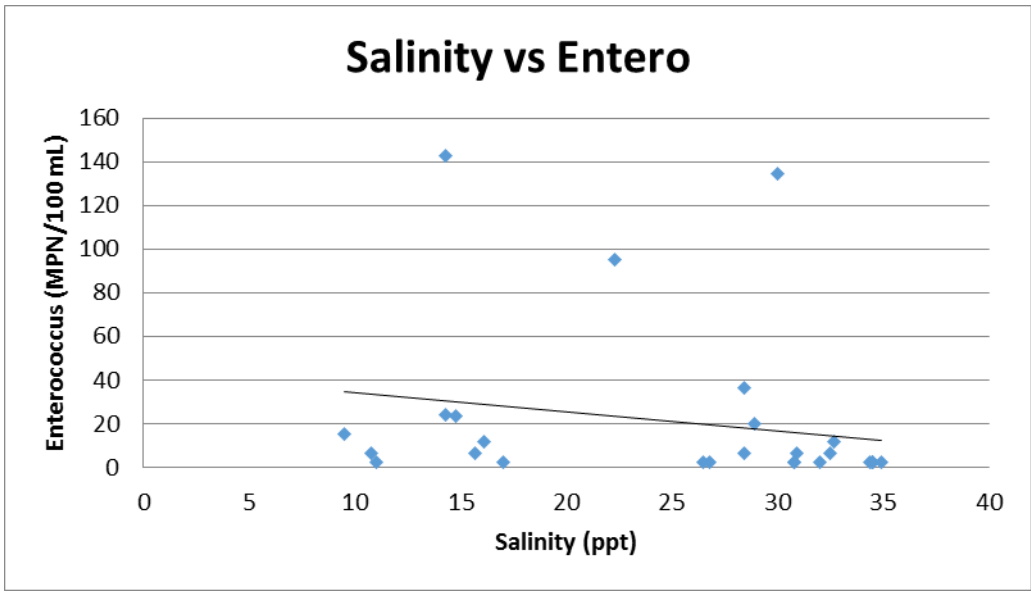

Figure 4: Salinity versus *Enterococcus*

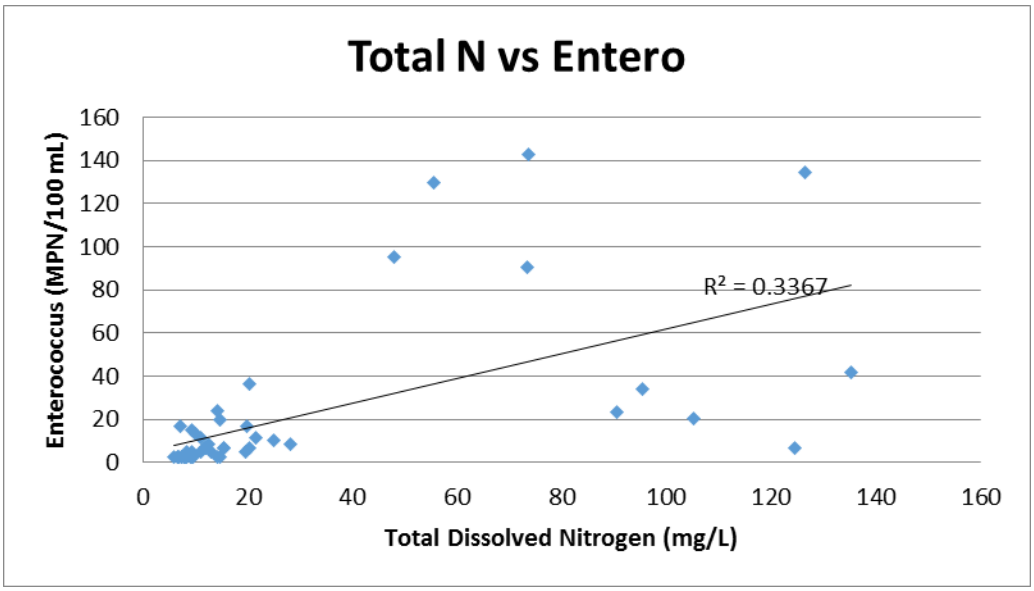

Figure 5: Total dissolved nitrogen versus Enterococcus

Figure 6, illustrates that the dataset for salinity is incomplete due to equipment failure. What can still be seen, however, is that Paniau has notably lower salinity than the other sites, suggesting a higher amount of fresh water input to the system. Paniau stood out among the other sites. Figure 7 shows a snapshot of all parameters at this particular site to determine if any relationships appear when representing the data in this way.

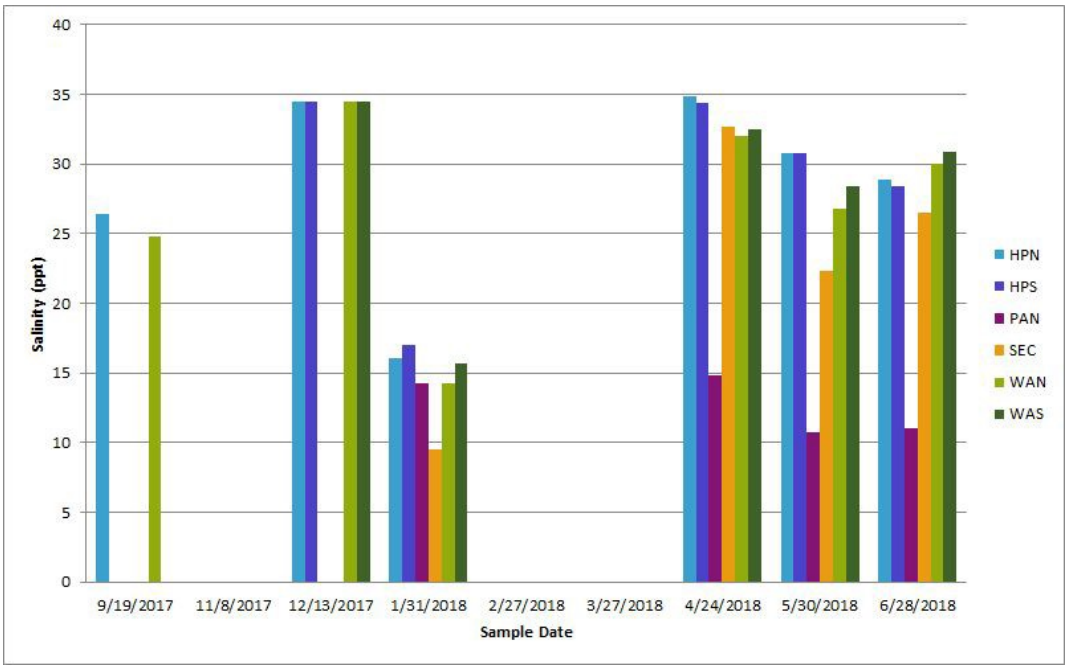

Figure 6: Salinity values across all sites

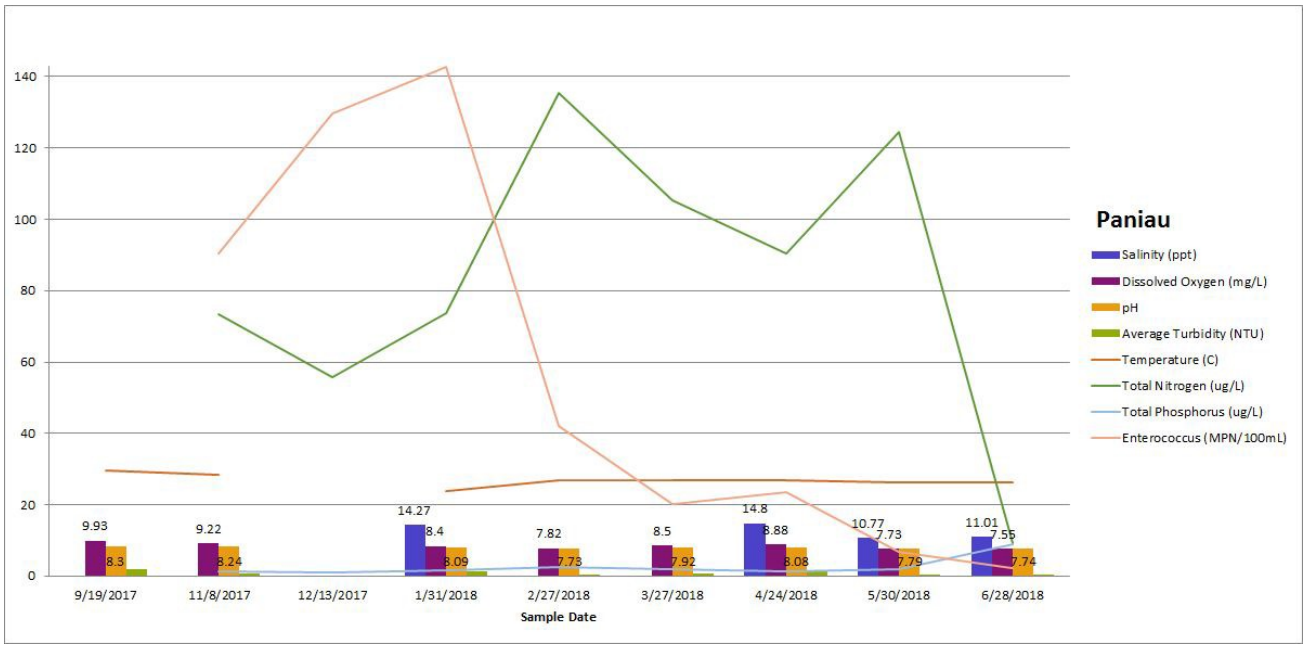

Figure 7: All parameters over time at Paniau

DISCUSSION:

The results presented in this report show concentrations of pollutants that are of public concern. The Puakō sites (Paniau and Secrets) tend to have higher amounts of nitrogen and bacteria, and lower salinity. There is also a weak correlation between nitrogen and bacteria, which supports the theory that these pollutants are both coming from the same source, which would likely be wastewater. According to the HAR 11-52-6 (2014), the total

dissolved nitrogen geometric mean for coastal waters should not exceed 0.10 mg/L (110 ug/L). While this data set may not be large enough or frequent enough to accurately calculate a geometric mean according to DOH standards, it is worth noting that Paniau exceeds 0.1 mg/L of TDN on three consecutive sample dates. Natural Energy Lab Hawai'i Authority (NELHA) reports that 73.3 ug/L is typical of surface seawater, which is exceeded in most of the Paniau samples. The DOH cites that total dissolved phosphorus should not exceed 16.0 ug/L; so, while all values fall within that limit, it is still worth investigating the spikes in TDP at Hapuna. This could be an indicator of a pollutant introduced by humans, due to the high traffic in this area.

Looking at the data, multiple occurrences of high fecal indicator bacteria in public waters was identified. At least three *Enterococcus* values have exceeded the single sample maximum (HDOH 2012) and Statistical Threshold Value (USEPA 2012) for of 104 CFU/100 mL and 130 CFU/100 mL respectively. This serves as a red flag to closely monitor these areas for public health. The DOH is unable to sample as frequently as may be necessary to identify safety issues or identify fluctuations in time. Achieving quality assured certification could fill in the gaps in the existing state monitoring plan and assist the DOH in keeping the population safe.

Many figures created from the existing data had too much noise to see any signals, so were omitted from this report. There was also expected values within normal ranges for the dissolved oxygen, pH, and temperature; turbidity values were highly variable. Simply monitoring temperature over time is very useful in the context of coral health due to bleaching events occurring during extended periods of high sea surface temperature. As more samples are processed and the dataset grows over time, there will be a clearer picture of water quality at these sites. An increase in sample size will increase the statistical power and allow any correlations to emerge. It is also essential to collect consistent data in order to determine the efficacy of an onsite treatment facility once it is constructed.

If feasible, it could be beneficial to expand the fecal indicator bacteria profile to include other species that are more specific to cesspool pollution. Likewise it could be helpful to plot parameters against tide height to determine whether pollutant concentration increases occur during times when groundwater is flowing into the sample area. This data, however, does suggest a relationship between freshwater and nitrogen and bacteria concentrations but is not significant. It is out of the scope of this project to measure nitrogen levels in the groundwater, however, previous studies have demonstrated that cesspools are a primary source of nitrogen in nearshore waters.

Mahalo to all the volunteers who have dedicated their time and effort to make this project possible.

Sources:

https://coral.org/puako/

Falinski, K., *Hui O Ka Wai Ola Quality Assurance Project Plan,* Revision: 2.0v22-2017, 2017

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