Project Title: Monitoring Water Quality in the Key West Ship Channel and surrounding ecologically and culturally significant coral reefs post-COVID-19 anthropause.

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Introduction:

There is global anecdotal evidence suggesting that coastal water quality (e.g. reduced turbidity) has improved during the COVID-19 anthropause (i.e. a reduction in human activity). In Key West, FL, reduction in shipping traffic has been identified as the primary reason for the perceived improvements to water quality (Briceño, 2021). The assumption is that less ship traffic results in less sediment re-suspension due to prop wash excavation (Murray & Associates, 2005). In a recent report based on over 25 years of water quality measurements and remote sensing data near Key West, FL, Briceño (2021) found that water quality improved (i.e. turbidity decreased while dissolved oxygen increased) during the recent anthropause. However, no measurements were taken in the Key West Harbor or within one mile of the shipping channel (a.k.a. navigation channel). Moreover, field samples focused on proven water quality indicators including turbidity, dissolved oxygen, and light attenuation coefficient (K_d) but did not test for other less common, yet critically important substances like hydrogen sulfide.

Hydrogen sulfide (H_2S) is highly toxic to marine organisms and causes rapid depletion of dissolved oxygen (DO) in marine waters (Asaoka et al., 2009). Hydrogen sulfide (H_2S) might have elevated importance during the transition from the anthropause to normal human activity (hereafter referred to as the "transition") as subsurface sediments, which have not been disturbed for over a

year, are resuspended into the water column by the resumption of human activity. Finally, coral reefs proximal to the Key West shipping channel maybe vulnerable to changes in water quality due to the transition. Of special importance is the patch reef at Eastern Dry Rocks (approximately 3.5 km west of the entrance to the Key West Shipping Channel), which has been identified by the Florida Keys National Marine Sanctuary (FKNMS) as one of seven "ecologically and culturally significant coral reefs" (www.fisheries.noaa.gov/iconic-reefs). Therefore, the proposed project intends to measure water quality at several locations including: (1) Eastern Dry Rocks- Sanctuary Preservation Area (EDR-SPA), (2) Western Dry Rocks coral reef, (3) the ship channel entrance near Fort Zachary Taylor State Park, and (4) at the entrance to the Key West Shipping Channel near marker buoy G3 (Table 1 and Figure 1). The current project will continue to: (1) maintain water quality monitoring equipment that are collecting and archiving continuous water quality measurements (i.e. turbidity, salinity, temperature, and depth), (2) collect bi-weekly water samples and measurements along the Key West Ship Channel for: (*i*) dissolved oxygen, (*ii*) pH, (*iii*) ammonia nitrogen (NH_3/NH_4^+), and (*iv*) H_2S from the water column and near the water/sediment interface. Water samples and water quality measurements will be taken every 2-3 weeks at locations as indicated in Table 1.

Table 1. Water quality sample locations

Site	Latitude	Longitude
KW01	24°34'8.53" N	81°48'9.69" W
KW02	24°33'49.45" N	81°48'1.59" W
KW03	24°33'44.30" N	81°48'31.47" W
KW04	24°33'24.23" N	81°48'40.28" W
KW06	24°32'53.40 N	81°48'49.52" W
KW07	24°32'21.98" N	81°48'52.25" W
KW09	24°31'40.98" N	81°48'32.03" W
KW12	24°30'34.55" N	81°48'11.29 W
KW14	24°29'21.89" N	81°48'7.32" W
KW16	24°28'27.45" N	81°48'6.24 W
EDR	24°27'40.0" N	81°50'45.9 W
WDR	24°26'43.55"N	81°55'39.34"W

KW01-16 = Sites in Key West Harbor/ship channel
EDR = Eastern Dry Rocks, FL
WDR = Western Dry Rocks, FL

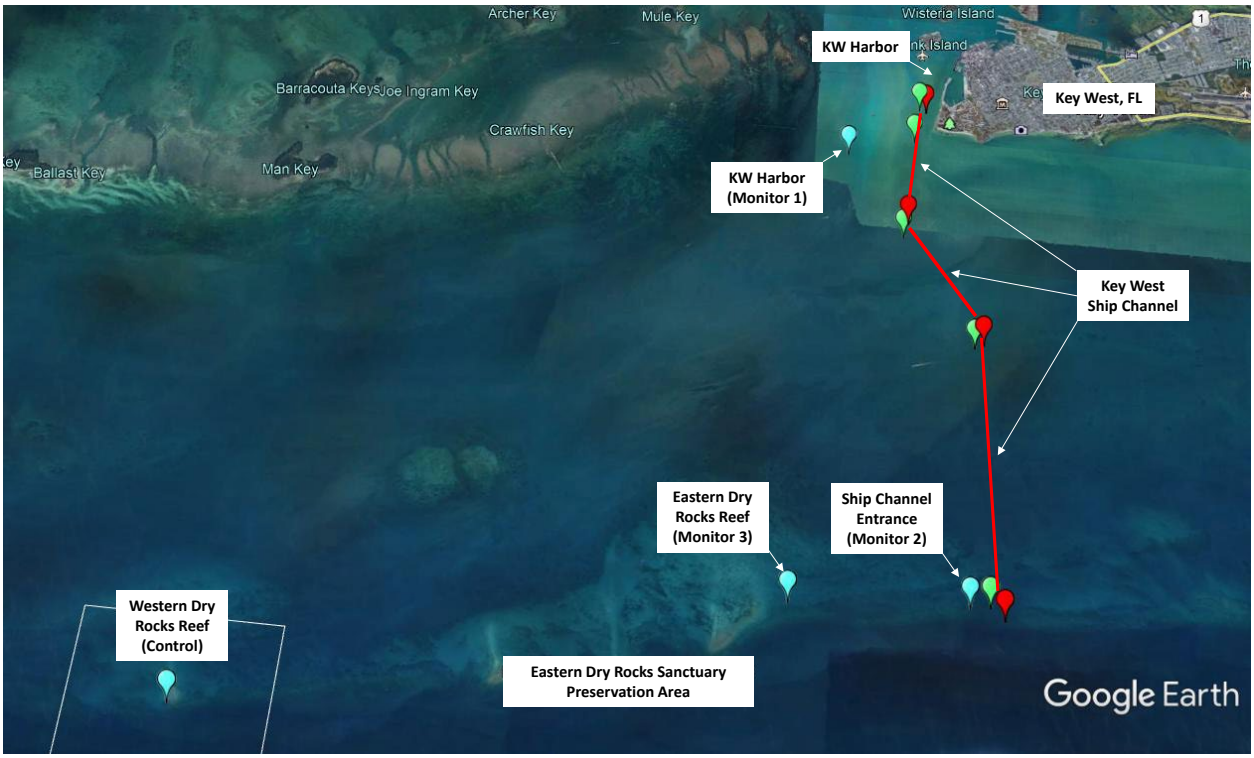

Figure 1. Aerial view of the Key West Ship Channel (red) with locations of four YSI 6600 Data Sondes deployed on July 2, 2021 (light blue markers).

Materials and Methods:

On June 17, 2021, four YSI 6600 Data Sondes (Xylem Analytics, Inc.), each equipped with an internal depth sensor and conductivity, temperature, and turbidity sensor probes (here to referred to as "equipment"), were transferred from the National Parks Service to The College of the Florida Keys (CFK) for a period of no less than six months. On July 2, 2021 the equipment was deployed at each of the four (Figure 1 – blue marker). The equipment was deployed on the seafloor using cinder block anchors with polyvinyl chloride (PVC) mounting brackets and 3mm chain (Figure 2).

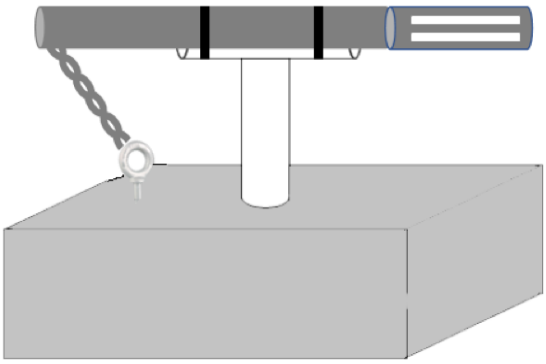

Figure 2. A schematic of the apparatus used to secure the water quality monitoring sonde deployed at various locations in the Florida Keys National Marine Sanctuary.

The College employed a team of American Academy of Underwater Science (AAUS) certified scientific divers and deployed the equipment at the pre-determined locations from CFK's 42-foot Marine Science & Technology Corinthian catamaran vessel (Figure 3). The current proposal intends to support bi-weekly trips for equipment sensor maintenance, battery changes, and data downloads over the next several months, as long as resources last.

Figure 3. The College of the Florida Keys 42 ft. Corinthian catamaran vessel (FKCC-2) that will be used to support the Key West water quality monitoring project.

In addition to deployment of the equipment, water samples will be taken at depth (i.e. near the sediment/water interface). Samples will be tested for H_2S, pH, ammonia nitrogen (NH_3/NH_4^+), and turbidity using a litmus test for H_2S (range = 0.0-2.0 ppm) (Industrial Test Systems, Inc. #481297-20), an Echo Smart 2 pH meter, a LaMotte SMART 3 Colorimeter for NH_3/NH_4^+, and a LaMotte 2020 turbidity meter, respectively. Titrations (API Saltwater Master Kit) will be used to corroborate NH_3/NH_4^+, and pH measurements. Archived turbidity data from the "equipment" will be compared to water sample turbidity measurements to correct for data "drift" due to fouling over the duration of the equipment deployment, should it exist.

Education and Outreach

The current project has been incorporated into the CFK Marine Data Collection course (OCB 2102C). Students collect, measure, and record data during field laboratory sessions throughout the Fall semester 2021, which ends on December 9, 2021. The students will analyze the data using basic descriptive statistical methods (e.g. mean/median values, histogram bar charts, etc.) and prepare a final technical report and presentation as a part of their course activities and graded assignments.

Literature Cited:

Asaoka, S., T. Yamamoto, S. Kondo, S. Hayakawa. 2009. Removal of hydrogen sulfide using crushed oyster shell pore water to remediate organically enriched coastal marine sediments. *Bioresource Technology*. Vol. 100 (18): 4127-4132.

Briceño, H. 2021. Preliminary Assessment of Surface Water Clarity Changes in Key West during the COVID-19 Anthropause. Florida International University, Institute of Environment, Water Quality Monitoring Lab.

Murray, T.J, & Associates. 2005. The Impacts of the Cruise Ship Industry on the Quality of Life in Key West. RFQ No: 04-001. City of Key West Naval Properties Local Redevelopment Authority.

Budget and Justification:

The expenses for the proposed project are outlined below in spreadsheet format (Table 2) followed by a budget narrative. Table 2. outlines the proposed expenses to sustain the current water quality monitoring efforts in the Key West harbor/ship channel and surrounding areas of ecological concern. The line-item Budget Justification immediately follows Table 2.

Table 2. KW Ship Channel WQ Monitoring Budget

a. Personel	**Qty**	**Unit**	**Unit Price**	**Total**
Scientific Divers	88	hr	$ 17.50	$ 1,540
b. Fringe	-	%	-	$ 308
c. Travel	-	-	-	$ -
d. Equipment	-	-	-	$ -
e. Materials and Supplies				
Hydrogen Sulifide (H2S) test strips	6	packs	$ 28.85	$ 173
YSI 6600 turbidity probes	1	probe	$1,848.75	$ 1,849
YSI 6600 dissolved oxygen (DO) probes	4	unit	$2,125.00	$ 8,500
YSI CTD Calibration solution (55K µS/cm)	24	liter	$ 14.38	$ 345
YSI Turbidity Calibration std. (10 NTU)	6	liter	$ 130.00	$ 780
f.Contractual				
g. Other				
Vessel	11	day	$ 950.00	$ 10,450
Misc.	-	-	$1,000.00	$ 1,000
Subtotal				**$ 24,945**
MTDC				**$ 24,945**
CFK Indirect (48%)	**waived for the current project**			**$ 11,974**
Total				**$ 36,919**

Budget Justification:

a. Personnel:

- Scientific divers – this is the rate for College Technical employees, including scientific divers based on the College Salary Schedule.

b. **Fringe** – All CFK employees have fringe costs associated with employment including social security or FICA, and Medicare.

c. **Travel –** There are no travel costs associated with the proposed project.

d. **Equipment:** There are no equipment costs associated with this proposed project.

e. **Materials and Supplies**

- Hydrogen Sulfide (H_2S) test strips (Industrial Test Systems, Inc. #481297-20) – These are litmus test strips used to test water samples for dissolved H_2S.
- YSI 6600 dissolved oxygen probes – Each YSI 6600 data sonde has four ports for various sensor types. The YSI 6600 data sondes provided by NPS are currently equipped with three sensor probes (conductivity, turbidity, and temperature). Therefore, the remaining data port will be equipped with a YSI 6600 dissolved oxygen probe (see Appendix A). Dissolved oxygen is a critical chemical water quality parameter and may be affected by disturbances and resuspension of benthic sediments into the water column. Therefore, continuous high-resolution data like that collected by the YSI 6600 oxygen sensor are very important.
- YSI 6600 turbidity probes – Turbidity has been identified as a critical water quality parameter. Therefore, this request is for a spare turbidity probe as backup for the probes on the four YSI data sondes transferred from NPS to the College for the project. Each data sonde has one turbidity probe (total = 4 probes). The probability of all four probes failing is low. But, we anticipate a possible need for at least one back-up probe should one of the existing turbidity sensors fail.
- CTD calibration standards – Each YSI 6600 with the CTD sensor requires about 500ml of conductivity calibration solution (i.e. an index for salinity). Calibrations must be conducted

immediately before each deployment and calibration solutions cannot be used more than once. Therefore, we estimate about 2l per trip for a total of 24l for about 6 months.

- Turbidity calibration standards (10 NTU) – This is a standardized calibration solution for the LaMotte turbidity meter. It is needed to ensure proper calibration of the device and accurate turbidity measurements.

f. Other

- Vessel – This is the internal College cost for running the vessel for a full day trip (8-10 hr). We anticipate each trip (i.e. deployment, data downloads, field collections, and maintenance) to last no more than 8 hours and will plan trips between 9:00 AM – 5:00 PM EST.
- Miscellaneous – This is an estimated cost associated with unforeseen expenses associated with the project.