

Reserve Name JOB NERR Water Quality Metadata

Months and year the documentation covers: 01/01/2017 to 12/31/2017

Latest Update: 06/05/2019

I. Data Set and Research Descriptors

1) Principal investigator(s) and contact persons

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2) Entry verification

Deployment data are uploaded from the YSI data logger to a Personal Computer (IBM compatible) by Enid Malavé. Files are exported from EcoWatch in a comma-delimited format (*.CDF) and uploaded to the CDMO by Enid Malavé and Angel Dieppa where they undergo automated primary QAQC and become part of the CDMO's online provisional database. Excessive pre- and post-deployment data are removed from the file prior to upload with up to 2 hours of pre- and post-deployment data retained to assist in data management. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the Reserve where it is opened in Microsoft Excel and processed using the CDMO's NERRQAQC Excel macro by Enid Malavé and Angel Dieppa. The macro inserts station codes, creates metadata worksheets for flagged data and summary statistics, and graphs the data for review. It allows the user to apply QAQC flags and codes to the data, remove any overlapping deployment data, append files, and export the resulting data file for upload to the CDMO. Upload after secondary QAQC results in ingestion into the database as provisional plus data, recalculation of cDepth or cLevel parameters, and finally tertiary QAQC by the CDMO and assimilation into the CDMO's authoritative online database. Where deployment overlap occurs between files, the data produced by the newly calibrated sonde is generally accepted as being the most accurate. The final yearly file and metadata was submitted by Enid Malavé and Angel Dieppa. For more information on QAQC flags and codes, see Sections 11 and 12.

3) Research objectives

The principal objective is to record and track long-term changes and short term variability in water quality parameters that can be associated to changes in estuarine habitats. Through this, we support management decisions based on scientific data. A secondary objective is to promote the access and use of reliable baseline information by federal and local agencies, universities, researchers, educators and local communities to enhance the process by which they make decisions regarding their daily activities. This data is also invaluable in the identification and development of future monitoring and research activities.

A total of four data loggers (YSI 6600 V2, YSI 6600 V4) are deployed in Jobos Bay. Two sondes are deployed in the inner lagoons of the Mar Negro Component and the other two in the Jobos Bay. The instruments are suspended from a pole at a distance at about 0.5 meters from the bottom at each selected site. Data from stations 9, 10, 19 and 20 are being submitted to the Centralized Data Management Office as part of the System-Wide Monitoring Program. Measurements are taken at fifteen-minute intervals for approximately two-week periods. The sites are identified as representative of areas within the reserve and comparable to the sites that may be receiving impact from human activities from surroundings areas or may act as a habitat gradient in the Bay.

Station number nine (9), the impacted site, collects water quality data in a site associated with runoff from littoral and basin mangrove areas. This sampling station is located in the most inland lagoon, closest to the Thermoelectric Power Plant (oil and natural gas). It is subjected to runoff, which may include potential oil spill contamination from this industrial facility. Information compiled from historical environmental documents, indicate that station nine (9) was used as a disposal site for residues of the previously operating sugar mill operation, and therefore might have high organic input into the sediments.

Station number ten (10), located in a mangrove lagoon area towards the southwestern section of Mar Negro is considered the reference or non-impacted site.

Station number (19) is located over a sea grass bed (*Thalassia testudinum*) in the inner western part of the bay just northeast of Cayo Colchones. This station is located near the thermal outfall and operating piers of the Aguirre Power Plant Complex, both activities may have significant effects on sea grass communities. This area is exposed to barge stranding, sediment re-suspension and oil spills. Station number (20) is located on the eastern inner bay section of the Cayos Caribe cays. This station is just south of the mangrove islets associated with the Reserve's coral reefs. Water streams coming through the coral platform may help characterize water conditions of the main marine currents reaching Jobos Bay, as well as possible effects of industrial and chemical activities associated with Phillips Core, AES Coal Energy Plant and Pharmaceuticals located just east to this system.

4) Research methods

The National Estuarine Research Reserve Water Quality Monitoring Program began sampling at Station nine (9) on December 20, 1995 and Station ten (10) on February 1, 1996. Monitoring at station 19 began in April 2004 and at station 20 in June 2004. Long term water quality monitoring is being performed at these stations.

Before each YSI 6600 or EXO-2 data logger is deployed, calibration and maintenance is performed following the Standard Operation Procedures of the NEERS. Calibration standards are only required for pH, salinity, and turbidity, all other parameters are done as described in the manual. Buffer solutions for two-point calibration (pH 7 and pH 10) are purchased from a scientific supply company. Salinity is calibrated with a specific conductance standard 50 mS/cm and is purchased from YSI.

The two-point turbidity calibration is performed using a 0 NTU (DI water) and 126 NTU (for 6600 sondes) and 124 FNU (for EXO-2) standard purchased from a scientific company. YSI sonde 6600 v4 and EXO 2 are equipped with dissolved oxygen optical sensors, both are allowed to sit at least 24 hours after proper calibration. Weather conditions and tide stage are recorded in the field observation log during deployment. Measurements of DO, pH, salinity, specific conductance, turbidity, and temperature are taken at the deployment time to check the accuracy and functionality of the instruments.

Each YSI data logger is tied with steel cable to an iron galvanized pole, which is plunged into the sediments at each sampling area. Data loggers are suspended from a pole at approximately 0.5 meter from the surface of the selected site. Data is recorded every 15 minutes. The following measurements

are recorded: date, time, temperature, specific conductance, salinity, dissolved oxygen saturation, dissolved oxygen concentration, depth, pH, and turbidity, all stations have an optical chlorophyll-a sensor. Chl-a is an optional parameter non-required for SWMP program. Approximately, every two weeks the data loggers are retrieved, inspected, cleaned, data is downloaded into a personal computer and re-calibrated as noted previously. The data logger is then ready to be deployed again.

The data is processed through a standard quality control/quality assurance established for all 29 reserves within the system. It consists in submitting the raw data to the Centralized Data Management Office (CDMO) server where data undergoes through a macro to flag anomalies predetermine for each station. The data is sent back to the reserve to pass through a secondary QA/QC and finally resubmitted to CDMO for the final approval. Data may be available in different stages of the QA/QC process.

A Sutron Sat-Link2 transmitter was installed at the JOB20 station on 07/20/06 and transmits data to the NOAA GOES satellite, NESDIS ID # 3B0297EC. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen-minute data sampling intervals. Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at <http://cdmo.baruch.sc.edu>.

5) Site location and character

The Jobos Bay National Estuarine Research Reserve (JBNERR) is located on the southern coastal plain of the island of Puerto Rico, a reserve within the West Indies geographical area. JBNERR is composed of two major areas: (1) Mar Negro, located on the western margin of the Bay, and (2) Cayos Caribe (a chain of 17 tear-shaped islets located to the southeast) and Cayos Barca (a chain of 7 tear-shaped islets located to the southwest boundaries) both with a back-reef system. The Mar Negro area comprises the bulk of the Reserve, and consists of mangrove forests and a complex system of lagoons and channels interspersed with salt and mud flats. Coral reefs and sea grass beds, with small beach deposits and upland areas fringe Cayos Caribe and Cayos Barca mangrove islands. Few areas in the watershed drain directly to the bay. Rio Seco to the north-east of the bay is active only during heavy rain events during the wet season. A small creek, Quebrada Coqui, near JBNERR’s pier to the north of the bay, drains into an extensive mangrove fringe forest in a laminar flow. During heavy rain events, Station 09 received runoff water from upland and finally, a diffuse flow of water reaches the bay from the local aquifer.

Station 9 is an impacted site and is located on the northeastern section of the Mar Negro component. This sampling station is associated with mangrove lagoon areas and receives runoff from mudflats, the Thermoelectric Power Plant, and adjacent areas. The tidal range varies from 12 to 14 inches near the monitoring station. During year 2017 the salinity at the vicinity of the monitoring station varied from 14.1 ppt to 41.0 ppt. The average depth at station 09 is 1.57 meter. The bottom is covered by a thick layer of thin sediments with a high content of organic material. *Microcoleus* sp. (blue-green algae), brown and green algae (*Caulerpa* sp.) are also present at this site, but a better assessment is needed. The station pole was located at 17°56'34.87"N and 66°14'18.64"W until 09/02/2010 12:00PM, then it was relocated to 17° 56' 35.0" N and 66° 14' 18.9" W approximately 65.0 meters from original position. The relocation was due to sedimentation issues and the construction of a new telemetry station. Fresh water input to the station comes only from runoff and rain. This station has been subject of several studies indicating the presence of relatively high level of copper and pesticides compared to other stations.

Statistics for station 9 during 2017

	Temp	SpCond	Sal	DO_pct	DO_mgl	Depth	pH	Turb
Min	24.6	23.41	14.1	4.6	0.3	0.28	6.9	0
Max	36.4	61.39	41.0	171.5	10.2	1.29	8.8	286
Average	29.5	54.68	36.1	64.7	4.0	0.61	7.8	8
Std Dev	1.7	3.69	2.7	31.0	1.9	0.13	0.2	18

Station 10 is located in a mangrove lagoon not impacted directly by any upland or marine activities. It provides a reference for comparison of data obtained in other stations, especially to the station in Mar Negro lagoon. The tidal range varies from 12 to 14 inches. During year 2017 the salinity at the vicinity of the monitoring station varies from 31.1 ppt to 36.3 ppt. The average depth at station 10 is 1.15 meter. The bottom is covered with a layer of fine sediments with organic material, followed by a layer of calcareous material mainly from shells and oysters. At this site, we can find sea grass (*Thalassia*), calcareous algae (*Halimeda* sp.), green algae (*Caulerpa* sp.) and brown algae (*Dictyota* sp.) among others. The pole is located at 17° 56' 19.00 N, 66° 15' 27.85 W. Fresh water input to the station comes only from runoff and rain. There is not any direct source of fresh water.

Statistics for station 10 during 2017

	Temp	SpCond	Sal	DO_pct	DO_mgl	Depth	pH	Turb
Min	24.5	9.85	5.5	0.3	0.0	0.37	7.4	0
Max	32.8	59.98	40.0	153.6	10.4	1.12	8.7	145
Average	29.1	52.52	34.5	81.7	5.2	0.65	7.9	2
Std Dev	1.6	6.52	4.7	21.7	1.3	0.09	0.2	8

Station 19 is located on the western inner section of the bay at a distance of 233 meters from Cayo Colchones Mangroves over sea grass beds (*Thalassia testudinum*). Tidal ranges in this area vary from 12 to 14 inches. During year 2017 the salinity at the vicinity of the monitoring station varies from 15.6 ppt to 37.9 ppt. The average depth at this station is of 1.5 meters. The YSI' sonde is deployed at about .05 meter from the bottom. The bottom is of sandy composition. Sea grass, algae, echinoderms and other related organisms could be found in the area. The pole is located at 17° 56' 34.49"N, 66° 13' 43.77"W. There is no freshwater input to this area.

Statistics for station 19 during 2017

	Temp	SpCond	Sal	DO_pct	DO_mgl	Depth	pH	Turb
Min	24.9	25.62	15.6	9.5	0.6	0.52	7.5	0
Max	32.0	57.11	37.9	153.9	9.7	1.31	8.3	357
Average	28.6	53.67	35.3	99.1	6.3	0.75	8.0	2
Std Dev	1.4	2.82	2.1	16.1	1.0	0.09	0.1	7

Station 20 is located in the inner eastern section at about 190 meters of Cayos Caribe Mangrove islets and at about 688 meters from the coral reef barrier. This station is the closest to Mar Caribe. It has a sandy bottom, with calcareous and coral fragments, sea grass (*Thalassia*) communities, echinoderms and other associated organisms. Tidal ranges in this area vary from 12 to 14 inches. During year 2017 the salinity at the vicinity of the monitoring station varies from 28.3 ppt to 37.6 ppt. The average depth of the site is 1.3 meters. There is no surface freshwater input to this area. The pole is located at 17° 55' 49.14"N, 66° 12' 41.30"W.

Statistics for station 20 during 2017

	Temp	SpCond	Sal	DO_pct	DO_mgl	Depth	pH	Turb
Min	24.6	44.10	28.3	50.5	3.3	0.03	7.5	0
Max	32.1	56.61	37.6	151.4	9.6	1.35	8.7	725
Average	28.4	53.30	35.1	102.2	6.5	0.79	8.1	3
Std Dev	1.3	1.83	1.4	17.9	1.1	0.11	0.2	11

Data from stations 9, 10, 19 and 20 is being submitted to the CDMO. Eight sondes are permanently devoted to taking readings from these two sites, to assure continuous readings while sondes are taken out of the water for data upload and maintenance. This will avoid data gaps for the stations between sonde maintenance procedures. Due to errors in calibration, turbidity data in these files is considered inadequate. All monitoring is considered long term.

6) Data collection period

Station nine (9) water quality monitoring began on December 20, 1995.

Station ten (10) water quality monitoring began on February 1, 1996.

Station nineteen (19) water quality monitoring began on April 1, 2004.

Station twenty (20) water quality monitoring began on May 13, 2004.

Deployment and Retrieval Dates 2017:

Station 09			
Date/Time In		Date/Time Out	
12/13/2016	09:15	01/12/2017	10:15
01/12/2017	10:30	01/24/2017	09:45
01/24/2017	10:15	02/07/2017	10:00
02/07/2017	10:15	02/22/2017	09:00
02/22/2017	09:15	03/07/2017	09:15
03/07/2017	09:45	04/04/2017	10:15
04/04/2017	10:30	04/20/2017	10:00
04/20/2017	10:15	05/03/2017	09:30
05/03/2017	10:00	05/16/2017	10:15
05/16/2017	10:30	05/31/2017	09:45
05/31/2017	10:00	06/17/2017	22:15
06/20/2017	10:15	07/05/2017	10:45
07/05/2017	11:00	07/18/2017	09:30
07/18/2017	10:15	08/01/2017	10:30
08/01/2017	10:45	08/15/2017	11:00
08/15/2017	11:30	08/30/2017	10:00
08/30/2017	10:15	11/28/2017	10:30
11/28/2017	11:15	12/13/2017	10:15
12/13/2017	11:00	01/24/2018	12:30
Station 10			

Station 19			
Date/Time In		Date/Time Out	
12/20/2016	10:00	01/12/2017	22:45
01/17/2017	13:45	01/31/2017	10:45
01/31/2017	11:00	02/14/2017	10:15
02/14/2017	10:30	02/28/2017	10:00
02/28/2017	10:15	03/21/2017	10:15
03/21/2017	10:45	04/11/2017	09:00
04/11/2017	09:15	04/25/2017	09:30
04/25/2017	09:45	05/10/2017	09:30
05/10/2017	09:45	05/24/2017	12:15
05/24/2017	12:30	06/13/2017	09:30
06/13/2017	09:45	06/27/2017	11:30
06/27/2017	11:45	07/11/2017	04:45
07/11/2017	05:00	07/23/2017	05:30
07/25/2017	10:45	08/08/2017	09:30
08/08/2017	09:45	08/22/2017	10:45
08/22/2017	11:00	09/13/2017	09:45
09/13/2017	10:00	10/14/2017	01:15
11/28/2017	11:15	12/13/2017	12:00
12/13/2017	12:15	12/31/2017	09:45
Station 20			

Date/Time In		Date/Time Out	
12/13/2017	09:45	01/12/2017	09:45
01/12/2017	10:15	01/15/2017	23:00
01/25/2017	10:00	02/07/2017	10:45
02/07/2017	11:00	02/22/2017	09:45
02/22/2017	10:00	03/07/2017	09:45
03/07/2017	10:15	04/04/2017	11:00
04/04/2017	11:15	04/20/2017	09:15
04/20/2017	09:30	05/03/2017	10:30
05/03/2017	10:45	05/16/2017	10:30
05/16/2017	10:45	05/31/2017	10:45
05/31/2017	11:00	06/13/2017	16:45
06/20/2017	11:30	07/05/2017	11:45
07/05/2017	12:00	07/18/2017	10:15
07/18/2017	10:45	08/01/2017	11:00
08/01/2017	11:15	08/15/2017	10:45
08/15/2017	11:00	08/30/2017	10:45
08/30/2017	11:00	11/28/2017	11:15
11/28/2017	11:30	12/13/2017	11:30
12/13/2017	11:45	01/05/2018	13:45

Date/Time In		Date/Time Out	
12/20/2016	09:45	01/17/2017	10:45
01/17/2017	11:00	01/31/2017	10:15
01/31/2017	10:30	02/14/2017	10:30
02/14/2017	11:15	02/28/2017	09:30
02/28/2017	09:45	03/21/2017	09:00
03/21/2017	09:30	04/11/2017	09:15
04/11/2017	09:45	04/25/2017	09:00
04/25/2017	09:30	05/10/2017	08:45
05/10/2017	09:00	05/24/2017	11:30
05/24/2017	12:00	06/13/2017	10:00
06/13/2017	10:15	06/27/2017	12:00
06/27/2017	12:15	07/11/2017	04:45
07/11/2017	06:15	07/25/2017	10:00
07/25/2017	10:15	08/08/2017	10:15
08/08/2017	10:30	08/22/2017	11:00
08/22/2017	11:15	09/13/2017	10:00
09/13/2017	10:30	11/28/2017	09:30
11/28/2017	10:00	12/13/2017	09:00
12/13/2017	09:15	01/24/2018	11:30

***Note: All deployed sondes *in Station 10 and 19* are model EXO-2 except the ones with asterisk. In Station 20 we swapped to a model EXO-2 from 6/27/2017 to present. Station 9 sonde is a model YSI-6600.**

7) Distribution

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and process the data. Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:

National Estuarine Research Reserve System (NERRS). 2012. System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: www.nerrsdata.org; *accessed* 12 October 2012.

NERR water quality data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page www.nerrsdata.org. Data are available in text tab-delimited format.

8) Associated researchers and projects

The Jobos Bay NERR maintains four water quality monitoring stations as part of the System Wide Monitoring Program (SWMP) to monitor variability in the estuarine environment. Meteorological station collects continuous information that support water quality data intended to address short-term variability and long-term changes in estuarine water parameters within the bay (i.e., localized impacts of seasonal storms and hurricane events, variability due to tidal circulation, seasonal and interannual differences in rainfall, magnitude and influence of major events such hurricanes, spatial extent of oceanic and tidal forcing).

Our water quality monitoring program is a key component of SWMP. Variables measured include Temperature, Dissolved Oxygen, Turbidity, pH, Salinity and Depth in 4 permanent stations equipped with YSI datasondes. The program supports a nutrient monitoring at the same stations, nitrogen, phosphorus, and chlorophyll are measured in a monthly basis. Also, a diel nutrient sampling is performed in a monthly basis.

SWMP data has been used by:

- Caribbean Regional Association for the Caribbean Regional Coastal Ocean Observing System (CariCOOS) who monitors Real Time data from our SWMP stations.
- Environmental Quality Board for their biennial Puerto Rico 305(b)/303(d) Integrated Report
- Puerto Rico Energy Power Authority (PREPA)
- Department of Natural and Environmental Resources

II. Physical Structure Descriptors

9) Sensor specifications –

YSI 6600EDS V2/ YSI 6600EDS V4 data sonde:

Parameter: Temperature

Units: Celsius (C)

Sensor Type: Thermistor

Model#: 6560

Range: -5 to 50 C

Accuracy: +/- 0.15

Resolution: 0.01 C

Parameter: Conductivity

Units: milli-Siemens per cm (mS/cm)

Sensor Type: 4-electrode cell with autoranging

Model#: 6560

Range: 0 to 100 mS/cm

Accuracy: +/- 0.5% of reading + 0.001 mS/cm
Resolution: 0.001 mS/cm to 0.1 mS/cm (range dependant)

Parameter: Salinity
Units: parts per thousand (ppt)
Sensor Type: Calculated from conductivity and temperature
Model#: 6560
Range: 0 to 70 ppt
Accuracy: +/- 1.0% of reading pr 0.1 ppt, whichever is greater
Resolution: 0.01 ppt

Parameter: Dissolved Oxygen % saturation
Sensor Type: Optical probe w/ mechanical cleaning
Model#: 6150 ROX
Range: 0 to 500% air saturation
Accuracy: 0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 15% or reading
Resolution: 0.1% air saturation

Units: milligrams/Liter (mg/L)
Sensor Type: Optical probe w/ mechanical cleaning
Model#: 6150 ROX
Range: 0 to 50 mg/L
Accuracy: 0-20 mg/L: +/-0.1 mg/l or 1% of the reading, whichever is greater
20 to 50 mg/L: +/- 15% of the reading
Resolution: 0.01 mg/L

Parameter: Non-vented Level - Shallow (Depth)
Units: feet or meters (ft or m)
Sensor Type: Stainless steel strain gauge
Range: 0 to 30 ft (9.1 m)
Accuracy: +/- 0.06 ft (0.018 m)
Resolution: 0.001 ft (0.001 m)

Parameter: pH – bulb probe
Units: pH units
Sensor Type: Glass combination electrode
Model#: 6561
Range: 0 to 14 units
Accuracy: +/- 0.2 units
Resolution: 0.01 units

Parameter: Turbidity
Units: nephelometric turbidity units (NTU)
Sensor Type: Optical, 90-degree scatter, with mechanical cleaning
Model#: 6136
Range: 0 to 1000 NTU
Accuracy: +/- 2% of reading or 0.3 NTU (whichever is greater)
Resolution: 0.1 NTU

Parameter: Chlorophyll Fluorescence

Units: micrograms/Liter
Sensor Type: Optical probe w/ mechanical cleaning
Model#: 6025
Range: 0 to 400 ug/Liter
Accuracy: Dependent on methodology
Resolution: 0.1 ug/L chl a, 0.1% FS

YSI EXO Sonde:

Parameter: Temperature
Units: Celsius (C)
Sensor Type: Thermistor
Model#: 599870-01
Range: -5 to 50 C
Accuracy: -5 to 35: +/- 0.01, 35 to 50: +/- .005
Resolution: 0.01 C

Parameter: Conductivity
Units: milli-Siemens per cm (mS/cm)
Sensor Type: 4-electrode cell with autoranging
Model#: 599870-01
Range: 0 to 200 mS/cm
Accuracy: 0 to 100: +/- 0.5% of reading or 0.001 mS/cm; 100 to 200: +/- 1% of reading
Resolution: 0.001 mS/cm to 0.1 mS/cm (range dependant)

Parameter: Salinity
Units: practical salinity units (psu)/parts per thousand (ppt)
Sensor Type: Calculated from conductivity and temperature
Range: 0 to 70 psu
Accuracy: +/- 1.0% of reading pr 0.1 ppt, whichever is greater
Resolution: 0.01 psu

Parameter: Dissolved Oxygen % saturation
Sensor Type: Optical probe w/ mechanical cleaning
Model#: 599100-01
Range: 0 to 500% air saturation
Accuracy: 0-200% air saturation: +/- 1% of the reading or 1% air saturation, whichever is greater 200-500% air saturation: +/- 5% of reading
Resolution: 0.1% air saturation

Parameter: Dissolved Oxygen mg/L (Calculated from % air saturation, temperature, and salinity)
Units: milligrams/Liter (mg/L)
Sensor Type: Optical probe w/ mechanical cleaning
Model#: 599100-01
Range: 0 to 50 mg/L
Accuracy: 0-20 mg/L: +/- 0.1 mg/l or 1% of the reading, whichever is greater
20 to 50 mg/L: +/- 5% of the reading
Resolution: 0.01 mg/L

Parameter: Non-vented Level - Shallow (Depth)
Units: feet or meters (ft or m)

Sensor Type: Stainless steel strain gauge
Range: 0 to 33 ft (10 m)
Accuracy: +/- 0.013 ft (0.004 m)
Resolution: 0.001 ft (0.001 m)

Parameter: pH
Units: pH units
Sensor Type: Glass combination electrode
Model#: 599701(guarded) or 599702(wiped)
Range: 0 to 14 units
Accuracy: +/- 0.01 units within +/- 10° of calibration temperature, +/- 0.02 units for entire temperature range
Resolution: 0.01 units

Parameter: Turbidity
Units: formazin nephelometric units (FNU)
Sensor Type: Optical, 90-degree scatter
Model#: 599101-01
Range: 0 to 4000 FNU
Accuracy: 0 to 999 FNU: 0.3 FNU or +/-2% of reading (whichever is greater); 1000 to 4000 FNU +/-5% of reading
Resolution: 0 to 999 FNU: 0.01 FNU, 1000 to 4000 FNU: 0.1 FNU

Parameter: Chlorophyll
Units: micrograms/Liter
Sensor Type: Optical probe
Model#: 599102-01
Range: 0 to 400 ug/Liter
Accuracy: Dependent on methodology
Resolution: 0.1 ug/L chl a, 0.1% FS

Dissolved Oxygen Qualifier (Rapid Pulse / Clark type sensor):

The reliability of dissolved oxygen (DO) data collected with the rapid pulse / Clark type sensor after 96 hours' post-deployment for non-EDS (Extended Deployment System) data sondes may be problematic due to fouling which forms on the DO probe membrane during some deployments (Wenner et al. 2001). Some Reserves utilize the YSI 6600 EDS data sondes, which increase DO accuracy and longevity by reducing the environmental effects of fouling. Optical DO probes have further improved data reliability. The user is therefore advised to consult the metadata for sensor type information and to exercise caution when utilizing rapid pulse / Clark type sensor DO data beyond the initial 96-hour time period. Potential drift is not always problematic for some uses of the data, i.e. periodicity analysis. It should also be noted that the amount of fouling is very site specific and that not all data are affected. If there are concerns about fouling impacts on DO data beyond any information documented in the metadata and/or QAQC flags/codes, please contact the Research Coordinator at the specific NERR site regarding site and seasonal variation in fouling of the DO sensor.

Depth Qualifier:

The NERR System-Wide Monitoring Program utilizes YSI data sondes that can be equipped with either vented or non-vented depth/level sensors. Readings for both vented and non-vented sensors are automatically compensated for water density change due to variations in temperature and salinity; but for all non-vented depth measurements, changes in atmospheric pressure between calibrations

appear as changes in water depth. The error is equal to approximately 1.02 cm for every 1 millibar change in atmospheric pressure, and is eliminated for vented sensors because they are vented to the atmosphere throughout the deployment time interval.

Beginning in 2006, NERR SWMP standard calibration protocol calls for all non-vented depth sensors to read 0 meters at a (local) barometric pressure of 1013.25 mb (760 mm/hg). To achieve this, each site calibrates their depth sensor with a depth offset number, which is calculated using the actual atmospheric pressure at the time of calibration and the equation provided in the SWMP calibration sheet or digital calibration log. This offset procedure standardizes each depth calibration for the entire NERR System. If accurate atmospheric pressure data are available, non-vented sensor depth measurements at any NERR can be corrected.

In 2010, the CDMO began automatically correcting depth/level data for changes in barometric pressure as measured by the Reserve's associated meteorological station during data ingestion. These corrected depth/level data are reported as cDepth and cLevel, and are assigned QAQC flags and codes based on QAQC protocols. Please see sections 11 and 12 for QAQC flag and code definitions.

NOTE: older depth data cannot be corrected without verifying that the depth offset was in place and whether a vented or non-vented depth sensor was in use. No SWMP data prior to 2006 can be corrected using this method. The following equation is used for corrected depth/level data provided by the CDMO beginning in 2010:
 $((1013-BP) * 0.0102) + \text{Depth/Level} = \text{cDepth/cLevel}$.

Salinity Units Qualifier:

In 2013, EXO sondes were approved for SWMP use and began to be utilized by Reserves. While the 6600 series sondes report salinity in parts per thousand (ppt) units, the EXO sondes report practical salinity units (psu). These units are essentially the same and for SWMP purposes are understood to be equivalent, however psu is considered the more appropriate designation. Moving forward the NERR System will assign psu salinity units for all data regardless of sonde type.

Turbidity Qualifier:

In 2013, EXO sondes were approved for SWMP use and began to be utilized by Reserves. While the 6600 series sondes report turbidity in nephelometric turbidity units (NTU), the EXO sondes use formazin nephelometric units (FNU). These units are essentially the same but indicate a difference in sensor methodology, for SWMP purposes they will be considered equivalent. Moving forward, the NERR System will use FNU/NTU as the designated units for all turbidity data regardless of sonde type. If turbidity units and sensor methodology are of concern, please see the Sensor Specifications portion of the metadata.

Chlorophyll Fluorescence Disclaimer:

YSI chlorophyll sensors (6025 or 599102-01) are designed to serve as a proxy for chlorophyll concentrations in the field for monitoring applications and complement traditional lab extraction methods; therefore, there are accuracy limitations associated with the data that are detailed in the YSI manual including interference from other fluorescent species, differences in calibration method, and effects of cell structure, particle size, organism type, temperature, and light on sensor measurements.

10) Coded variable definitions

Sampling station:	Sampling site code:	Station code:
Station 9	ST09	job09wq
Station 10	ST10	job10wq
Station 19	ST19	job19wq
Station 20	ST20	job20wq

11) QAQC flag definitions

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter's associated flag column (header preceded by an F_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicate data that is missing and above or below sensor range. All remaining data are then flagged 0, passing initial QAQC checks. During secondary and tertiary QAQC 1, -3, and 5 flags may be used to note data as suspect, rejected due to QAQC, or corrected.

- 5 Outside High Sensor Range
- 4 Outside Low Sensor Range
- 3 Data Rejected due to QAQC
- 2 Missing Data
- 1 Optional SWMP Supported Parameter
- 0 Data Passed Initial QAQC Checks
- 1 Suspect Data
- 2 *Open - reserved for later flag*
- 3 Calculated data: non-vented depth/level sensor correction for changes in barometric pressure
- 4 Historical Data: Pre-Auto QAQC
- 5 Corrected Data

12) QAQC code definitions

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the deployment or YSI data sonde, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, but some comment codes (marked with an * below) can be applied to the entire record in the FRecord column.

General Errors

- GIC No instrument deployed due to ice
- GIM Instrument malfunction
- GIT Instrument recording error; recovered telemetry data
- GMC No instrument deployed due to maintenance/calibration
- GNF Deployment tube clogged / no flow
- GOW Out of water event
- GPF Power failure / low battery
- GQR Data rejected due to QA/QC checks
- GSM See metadata

Corrected Depth/Level Data Codes

- GCC Calculated with data that were corrected during QA/QC
- GCM Calculated value could not be determined due to missing data

GCR Calculated value could not be determined due to rejected data
 GCS Calculated value suspect due to questionable data
 GCU Calculated value could not be determined due to unavailable data

Sensor Errors

SBO Blocked optic
 SCF Conductivity sensor failure
 SDF Depth port frozen
 SDG Suspect due to sensor diagnostics
 SDO DO suspect
 SDP DO membrane puncture
 SIC Incorrect calibration / contaminated standard
 SNV Negative value
 SOW Sensor out of water
 SPC Post calibration out of range
 SQR Data rejected due to QAQC checks
 SSD Sensor drift
 SSM Sensor malfunction
 SSR Sensor removed / not deployed
 STF Catastrophic temperature sensor failure
 STS Turbidity spike
 SWM Wiper malfunction / loss

Comments

CAB* Algal bloom
 CAF Acceptable calibration/accuracy error of sensor
 CAP Depth sensor in water, affected by atmospheric pressure
 CBF Biofouling
 CCU Cause unknown
 CDA* DO hypoxia (<3 mg/L)
 CDB* Disturbed bottom
 CDF Data apart to fit conditions
 CFK* Fish kill
 CIP* Surface ice present at sample station
 CLT* Low tide
 CMC* In field maintenance/cleaning
 CMD* Mud in probe guard
 CND New deployment begins
 CRE* Significant rain event
 CSM* See metadata
 CTS Turbidity spike
 CVT* Possible vandalism/tampering
 CWD* Data collected at wrong depth
 CWE* Significant weather event

13) Post deployment information

STATION 09			Post Deployment Calibration Values		
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Date In	Date Out	SpCond (50mS/cm)	DO%	pH (7)	Turb (0 NTU)
12/13/2016	01/12/2017	43.17	98.7	6.65	6.9
01/12/2017	01/24/2017	50.88	100.1	6.87	-0.5
01/25/2017	02/07/2017	49.06	100.4	7.06	-0.3
02/07/2017	02/22/2017	49.24	98.9	6.95	0.0
02/22/2017	03/07/2017	49.80	98.5	7.02	0.4
03/07/2017	04/04/2017	50.40	99.3	6.99	0.6
04/04/2017	04/20/2017	50.19	94.7	6.98	-0.1
04/20/2017	05/03/2017	49.62	95.4	7.00	0.7
05/03/2017	05/16/2017	49.52	98.4	7.02	0.9
05/16/2017	05/31/2017	49.67	90.5	6.77	0.2
05/31/2017	06/20/2017	49.0	100.3	6.73	0.9
06/20/2017	07/05/2017	49.18	97.7	7.03	1.4
07/05/2017	07/18/2017	49.12	99.8	6.34	0.2
07/18/2017	08/01/2017	49.83	91.1	6.99	0.4
08/01/2017	08/15/2017	51.62	84.6	7.35	0.9
08/15/2017	08/30/2017	49.05	100	7.09	0.4
08/30/2017	11/28/2017	50.35	95	*	0.9
11/28/2017	12/13/2017	49.76	98.5	6.66	1.3
12/13/2017	01/24/2018	49.50	84.9	7.05	8.5

STATION 10		Post Deployment Calibration Values			
		SpCond (50mS/cm)	DO%	pH (7)	Turb (0 NTU)
12/13/2016	01/12/2017	48.24	100.9	6.97	0.39
01/12/2017	01/24/2017	50.57	93.8	6.98	-0.59
01/25/2017	02/07/2017	49.21	98.9	6.90	0.37
02/07/2017	02/22/2017	50.15	99.8	7.05	0.80
02/22/2017	03/07/2017	49.48	100.3	6.92	0.53
03/07/2017	04/04/2017	49.50	99.2	6.95	3.22
04/04/2017	04/20/2017	50.06	97.5	7.07	-0.41
04/20/2017	05/03/2017	49.0	94.1	6.95	2.49
05/03/2017	05/16/2017	49.28	99.5	7.00	0.17
05/16/2017	05/31/2017	49.37	79.7	6.92	0.23
05/31/2017	06/20/2017	49.03	100.5	7.00	0.64
06/20/2017	07/05/2017	49.25	86.2	7.05	0.21
07/05/2017	07/18/2017	49.92	100.6	6.98	0.29
07/18/2017	08/01/2017	49.16	99.8	7.00	0.05
08/01/2017	08/15/2017	49.2	98.1	6.98	1.71
08/15/2017	08/30/2017	49.16	102.3	7.00	0.89
08/30/2017	11/28/2017	45.26	97.6	7.15	2.59
11/28/2017	12/13/2017	48.88	97.2	6.90	2.07

12/13/2017	01/05/2018	44.51	98.8	*	13.92
STATION 19		Post Deployment Calibration Values			
		SpCond (50mS/cm)	DO%	pH (7)	Turb (0 NTU)
12/20/2016	01/12/2017	49.74	29.4	6.97	7.12
01/17/2017	01/31/2017	48.46	98.3	7.11	-1.35
01/31/2017	02/14/2017	49.40	100.2	7.02	0.46
02/14/2017	02/28/2017	49.59	100	6.99	0.62
02/28/2017	03/21/2017	49.50	82.2	7.10	0.82
03/21/2017	04/11/2017	49.10	97.1	7.10	1.08
04/11/2017	04/25/2017	49.87	100.4	7.07	0.72
04/25/2017	05/10/2017	49.41	95.8	7.16	0.22
05/10/2017	05/24/2017	49.57	98.1	7.01	0.14
05/24/2017	06/13/2017	49.10	61.3	6.94	0.80
06/13/2017	06/27/2017	49.22	99.8	7.06	0.23
06/27/2017	07/11/2017	49.41	97.8	6.99	0.36
07/11/2017	07/25/2017	49.48	99.0	7.18	0.71
07/25/2017	08/08/2017	49.84	98.6	6.97	0.19
08/08/2017	08/22/2017	50.50	98.6	7.01	1.94
08/22/2017	09/13/2017	49.0	98.9	7.05	1.15
09/13/2017	11/28/2017	32.83	98.8	7.13	41.69
11/28/2017	12/13/2017	50.31	99.7	7.15	1.0
12/13/2017	12/31/2017	50.11	24.8	7.13	22.15

STATION 20		Post Deployment Calibration Values			
		SpCond (50mS/cm)	DO%	pH (7)	Turb (0 NTU)
12/20/2016	01/17/2017	50.3	98.6	6.73	29
01/17/2017	01/31/2017	49.17	97.8	7.04	0.0
01/31/2017	02/14/2017	49.0	100.2	7.00	1.6
02/14/2017	02/28/2017	49.0	100.4	7.10	0.5
02/28/2017	03/21/2017	49.90	101	7.08	0
03/21/2017	04/11/2017	49.04	96.4	7.44	0.8
04/11/2017	04/25/2017	49.8	99.6	7.02	0.4
04/25/2017	05/10/2017	50.01	96.1	7.50	0.1
05/10/2017	05/24/2017	49.43	97.4	7.39	0.6
05/24/2017	06/13/2017	50.07	98.7	6.99	0.20
06/13/2017	06/27/2017	49.64	99.8	7.33	0.0
06/27/2017	07/11/2017	49.60	95.8	7.00	1.21
07/11/2017	07/25/2017	49.61	100.4	7.05	2.20

07/25/2017	08/08/2017	49.98	99.0	7.01	0.62
08/08/2017	08/22/2017	50.48	99.1	7.07	0.97
08/22/2017	09/13/2017	49.50	98.5	7.01	0.27
09/13/2017	11/28/2017	48	98.5	7.09	0.45
11/28/2017	12/13/2017	46.6	99.1	7.02	4.94
12/13/2017	01/24/2018	51.91	105.4	7.25	0.58

*Bad sensor

14) Other remarks/notes

Data are missing due to equipment or associated specific probes not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. Any NaNs in the dataset stand for “not a number” and are the result of low power, disconnected wires, or out of range readings. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

Hurricane Maria impacted the entire reserve and all four stations beginning on September 19th. The deployments starting 8/30 for Stations 9 and 10, and 9/13 for Station 20 are very long and don't end until 11/28. Station 9 used a 6 series sonde for this deployment and Stations 10 and 20 used EXOs. Due to this long deployment data is considered suspect during the following times for the stations. The depth at all four sites was also impacted at all four sites after the Hurricane.

Station 9: 9/28

Station 10: 10/15

Station 20: 10/15

Notes on Hurricane Maria; taken from ‘Effects of Hurricane Maria over physical parameters (Temp, Salinity, Depth) at four water quality monitoring stations, mangroves, and benthic communities of the Jobos Bay National Estuarine Research Reserve, Salinas-Guayama, Puerto Rico.

By Angel Dieppa-Ayala¹ and Edwin Alfonso-Sosa² (1Jobos Bay National Estuarine Research Reserve, 2Ocean Physics Education)

On September 21, 2017 Puerto Rico was hit by Hurricane Maria and Jobos Bay NERR SWMP stations recorded anomalies on several parameters as measured by our YSI EXO-2 sondes. One of the most significant ones are related to the tide surge that increased the water level at 0.97 meters over the average of previous days (measured at 15 minutes interval) and decreasing it as it passed to 0.26 meters below the average of previous days at Station 20; the difference in height was 1.23 meters. The maximum temperature recorded occurred at Station 10 was 33.80 oC creating a differential of 8.20 oC with a range of 25.30 oC to 33.80 oC. Salinity range was 35.60 at Station 9 to 5.5 at Station 10.

As explained by physical oceanographer Dr. Edwin Alfonso-Sosa, the solar annual constituent of the tide (Sa), is responsible for the extreme tides in Puerto Rico during Sept to Nov. Hurricane Maria decreased the temperature between 4.20 to 8.20 degrees below previous days average and consequently decreasing the density of the water. It took about 18 to 20 days for the temperature to recover to normal values affecting significantly and unprecedentedly the density of the water. Due to this, the water level remained below the expected values for about 18-20 days after its landfall as seen in the graphs for all stations.

This hurricane affected mangroves principally by defoliation. This effect was strongly observed over the south-west side of the forest that received the strongest winds, interestingly the north-east side showed minor signs of defoliation. Since defoliation over red mangrove (*Rhizophora mangle*) affect the meristematic growth, those fringe mangroves are not recovering. Basing mangrove forest is dominated by black and white mangrove (*Avicennia germinans* and *Laguncularia racemosa* respectively), during the past 17 months we observed a gradual recovery, new growth, and sprouting regrowth is evidenced. Other significant effects were observed over benthic communities, the tidal surge force pushed out of the water thousands of sea urchins (mainly *Lytechinus variegatus* or green sea urchin) sea cucumbers, ascidians (mainly *Ascidia nigra*), sponges, and seagrasses. In 2012, a first sight of the invasive seagrass *Halophila stipulacea* was reported. Prior to the hurricane we started observing and monitoring the presence of this flowering marine plant was observed mainly at the Caribe Cays canals. After the hurricane it has been widespread all over the bay in an unprecedented event principally colonizing bare open spaces but has been observed coexisting with other seagrasses. It is hypothesized that marine currents forced by the hurricane is responsible for spreading this seagrass all over the bay. Its growing characteristics also helped the plant to take advantage of the bay conditions. Other effects include beach erosion, seagrasses removal, mangroves die off during subsequent months, and hypoxia events as evidenced in graphs mostly at Station 9 and 10.

Jobos Bay NERR System Wide Monitoring Program (SWMP) Stations.



Station 9	Temp (°C)	Sal	cDepth (m)
Max	33.80	35.60	1.72
Min	25.60	14.10	0.49
Diff	8.20	21.50	1.23
Average (prev days)	30.78	33.45	0.75

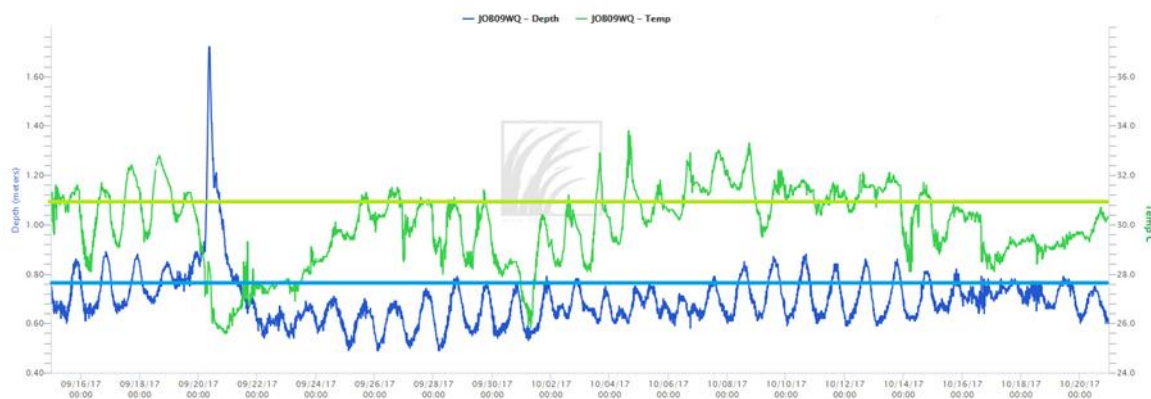
Station 10	Temp (°C)	Sal	cDepth (m)
Max	32.50	33.20	1.50
Min	25.30	5.50	0.45
Diff	7.20	27.70	1.05
Average (prev days)	30.99	31.46	0.71

Station 19	Temp (°C)	Sal	cDepth (m)
Max	31.70	34.90	1.77
Min	26.70	15.60	0.55
Diff	5.00	19.30	1.22
Average (prev days)	30.91	34.19	0.81

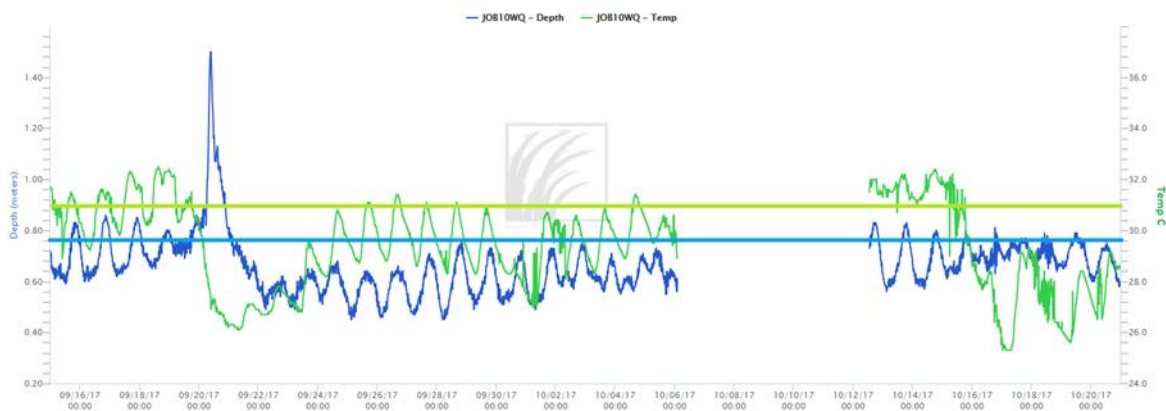
Station 20	Temp (°C)	Sal	cDepth (m)
Max	31.70	34.90	1.83
Min	27.50	30.30	0.61
Diff	4.20	4.60	1.22
Average (prev days)	30.25	34.40	0.96

Depth and Temperature at Station 9, 10, 19, and 20 from September 15 to October 20, 2017.
Solid lines represent the average of each parameter prior to hurricane landfall.
*Note: depth is relative and not related to a specific datum.

Station 9



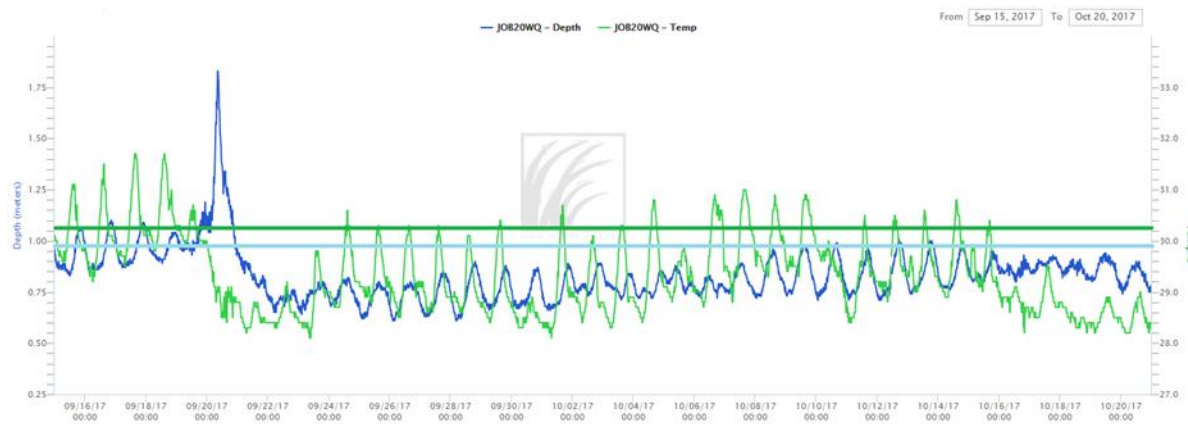
Station 10



Station 19



Station 20



Conductivity/Salinity comments:

JOB09WQ: New conductivity sensor 13M102023 for 07M100799 Data sonde on 08/28/2017.

JOB10WQ:

JOB19WQ: New conductivity sensor 16F101022 for 14K101408 EXO sonde on 11/30/2017.

JOB20WQ: <-3>, CCU 10/12/2017 y 10/24/2017 at 11:00.

DO Data comments:

JOB09WQ:

JOB10WQ:

JOB19WQ:

JOB20WQ: New DO cap 14J102949 on 15F103586 DO sensor on 11/06/2017.

pH Data comments:

JOB09WQ: From 09/19/2017 at 14:16:19 to 11/28/2017 at 10:30 sensor broken, <-3>SSM.
09/20/2017, Hurricane María landfall.

JOB09WQ: New pH sensor 16B6561 for 07M100799 Data sonde on 11/28/2017.

JOB10WQ: From 01/05/2018 sensor broken, no post-deployment pH data.

JOB19WQ: New pH sensor 16F100060 for 16J100690 EXO sonde on 11/27/2017.

JOB20WQ: New pH cap 16D for 14K101594 sensor installed on EXO sonde 13J101770 on 12/01/2017.

JOB20WQ: From 05/03/2017 at 21:15 to 05/09/2017 at 1:00 <1> SSM. In post-deployment pH slope is out of range.

Chlorophyll Data comments:

JOB09WQ:

JOB10WQ:

JOB19WQ:

JOB20WQ: chlorophyll sensor 16F100582 changed in the field from 15G100841 sonde to 13J101770 sonde on 09/11/2017 at 09:45.

Turbidity Data comments:

JOB09WQ: From 11/24/2017 at 08:15 to 11/28/2017 at 10:30, 1, CBF. Fouling presence, tunicates, barnacles and crab inside cup.

JOB10WQ

JOB19WQ

JOB20WQ:

Depth Data Comments:

Station 20: From 01/01/2017 to 06/27/2017 at 12:00 the sonde deployed was a YSI6600 model, at 12:15, the sonde was swapped with a YSI EXO-2 model. Since there is a sensor offset from both models, a slight difference in depth of 0.10 meters.

Notes:

JOB09WQ: From 06/17/2017 at 22:30 to 06/20/2017 at 10:00 <-2> GPF Power failure/ low battery

JOB09WQ: On 10/12/2017 at there was infield maintenance performed. The sonde was hooked up to the Sutron dataogger power cable at that time.

JOB09WQ: From 12/07/2017 at 10:45, <-3> GMC Instrument Maintenance

JOB10WQ: From 01/15/2017 at 23:15 to 01/25/2017 at 09:45 <-2> GPF Power failure/ low battery

JOB10WQ: 02/22/2017 at 11:15 <-3> GOW

JOB10WQ: From 06/13/2017 at 17:00 to 06/20/2017 at 16:45 <-2> GPF Power failure/ low battery

JOB10WQ: From 10/06/2017 at 02:15 to 10/12/2017 at 12:30 <-2> GPF Power failure/ low battery

JOB10WQ: On 10/12 12:45 new batteries were installed

JOB19WQ: From 01/12/2017 at 23:00 to 01/17/2017 at 13:30 <-2> GPF Power failure/ low battery

JOB19WQ: From 07/23/2017 at 05:45 to 07/25/2017 at 10:30 <-2> GPF Power failure/ low battery

JOB19WQ: From 10/14/2017 at 01:30 to 11/28/2017 at 10:45 <-2> GPF Power failure/ low battery

JOB20WQ: From 10/12/2017 at 11:00-11:15 there was infield maintenance performed and data is marked -3 GSM CMC.

Other: 09/06/2017, Irma hurricane day, past near to the north of Puerto Rico. CRE
09/20/2017, Hurricane María landfall, CWE.

Significant rain events:

Date	Precipitation (mm)	Event associated with
01/11/2017	1.8	
01/25/2017	2.5	
02/06/2017	2.8	
02/24/2017	2.8	
03/02/2017	2.0	
03/13/2017	0.51	
03/16/2017	0.80	
03/22/2017	12.45	
03/23/2017	12.19	
03/24/2017	12.19	
03/25/2017	18.80	
03/26/2017	3.81	
03/27/2017	0.25	
04/10/2017	4.1	
04/26/2017	4.3	
04/28/2017	21.6	
04/29/2017	7.4	
04/30/2017	1.3	
05/01/2017	23.4	
05/08/2017	0.30	
05/09/2017	5.3	
05/11/2017	21.8	
05/13/2017	0.30	
05/29/2017	6.1	
05/30/2017	0.5	
05/31/2017	4.8	
06/02/2017	0.30	
06/03/2017	0.50	
06/11/2017	3.8	
06/12/2017	0.50	
06/15/2017	1.8	
06/17/2017	0.50	
06/19/2017	5.6	
06/21/2017	6.5	
06/24/2017	4.3	
06/25/2017	16.8	
07/04/2017	3.0	
07/08/2017	5.1	
07/09/2017	0.50	
07/11/2017	5.1	

07/13/2017	14.2	
07/14/2017	0.25	
07/15/2017	0.76	
07/18/2017	0.25	
07/21/2017	4.6	
07/30/2017	3.6	
07/31/2017	4.1	
08/03/2017	0.76	
08/04/2017	8.6	
08/05/2017	3.3	
08/06/2017	6.6	
08/17/2017	80.0	
08/19/2017	5.3	
08/27/2017	17.8	
08/29/2017	9.9	
09/01/2017	28.7	
09/02/2017	0.25	
09/04/2017	0.25	
09/05/2017	11.7	
09/06/2017	25.9	Hurricane Irma
09/07/2017	10.4	
09/08/2017	1.78	
09/10/2017	9.7	
09/11/2017	5.84	
09/14/2017	28.2	
09/15/2017	3.05	
09/19/2017	12.2	
09/20/2017	73.4	Hurricane María
09/21/2017	46.48	
09/22/2017	5.59	
09/23/2017	27.43	
09/24/2017	6.6	
09/26/2017	0.76	
09/30/2017	10.67	
10/01/2017	0.25	
10/05/2017	35.5	
10/06/2017	31.7	
10/07/2017	0.76	
10/09/2017	31.7	
10/10/2017	31.2	
10/11/2017	15.2	
10/13/2017	5.1	
10/14/2017	0.25	
10/15/2017	72.9	
10/16/2017	106.7	
10/17/2017	7.62	
10/18/2017	63.75	
10/21/2017	1.52	
10/27/2017	2.28	

10/28/2017	2.28	
10/29/2017	14.22	
10/30/2017	9.39	
11/06/2017	19.6	
11/07/2017	21.6	
11/08/2017	12.7	
11/09/2017	0.76	
11/10/2017	0.25	
11/11/2017	12.2	
11/12/2017	0.25	
11/13/2017	6.35	
11/14/2017	8.89	
11/15/2017	9.14	
11/16/2017	12.7	
11/18/2017	20.57	
11/19/2017	4.06	
11/20/2017	13.46	
11/23/2017	2.54	
11/27/2017	1.77	
12/06/2017	0.51	
12/13/2017	2.54	
12/18/2017	1.01	
12/25/2017	0.25	
12/26/2017	0.25	
12/28/2017	2.28	

Significant rain events*: