Water Quality Monitoring projects to be integrated into the Puerto Rico Coral Reef Monitoring Program (PRCRMP)

Submitted to the DNER Coral Reef Conservation and Management Program (CRCMP)

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Contents

Development and Implementation of a Water Quality Monitoring Project in Shallow Coral Reef Areas Around Puerto Rico

The Environmental Protection Agency (EPA) and the Department of Natural and Environmental Resources (PR-DNER) are currently funding a project to collect water quality data in all 42 permanent stations of the Puerto Rico Coral Reef Monitoring Program (PRCRMP). This effort is the first to establish a baseline of water quality conditions collocated with biological monitoring as part of the PRCRMP. Data collected will be compiled in a database and integrated directly into the PRCRMP Database Compilation following the same spatial factors. According to the proposal, the water quality parameters to be collected are multivariate:

- Temperature (surface and bottom)
- Biochemical Oxygen Demand (surface and bottom)
- Chlorophyll “a” (bottom)
- Dissolved Oxygen (surface and bottom)
- Enterococcus (bottom)
- pH (surface and bottom)
- Turbidity (bottom)
- Salinity (surface and bottom)
- Secchi Disk Distance
- Settleable Solids (bottom)
- Total Suspended Solids (bottom)
- Total Phosphorus (bottom)
- Total Nitrogen (bottom)

Water quality sampling in each PRCRMP station will be conducted quarterly for two years. No permanent continuous sampling devices such as multiparametric sonde or buoy will be installed. To continue this project beyond its currently funded timeframe, the PR-DNER Coral Program is proposing the NOAA Coral Reef Conservation Program adapt and/or design this project to become a long-term monitoring program. Collaboration with NOAA CRCP, EPA, and the PR-DNER will be crucial to secure funding and continue long-term water quality monitoring. For the implementation of the first 2 years, the Coral Reef Specialist (a programmatic task of the PR-DNER Coral Program) will serve as a point of contact and liaison to transfer necessary information from the PRCRMP to the contractors working on the water quality sampling and support implementation with the water quality project coordinator and PIs.

Current project status

The project status as of September 2022 is:

- The proposal was reviewed and accepted by EPA and PR-DNER. For a copy of the proposal contact Angel Melendez (AngelMelendez@jca.pr.gov)
- The project will be implemented through a contract with the Caribbean Coral Reef Institute (CCRI) hosted at the Marine Sciences Department of the University of Puerto Rico - Mayaguez (UPRM-DMS). CCRI Contract is signed and in effect.
- Project Coordinator hired
- The water Quality Lab manager is still pending to be hired.
- Sampling was completed for the first 21 stations of the 2022-23 PRCRMP biological sampling cycle.
- No water quality data collected as of September 2022.

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Developing an Integrated Monitoring and Evaluation Framework: Evaluating Success of Land-Based Sources of Pollution Management on Culebra Island, Puerto Rico

During the last decades, the NOAA Restoration Center and the NOAA Coral Reef Conservation Program have invested millions of dollars in the management of dirt roads and other land-based sources of pollution in the Habitat Focus Area of Culebra. A Framework was developed to evaluate the impact of these watershed-scale interventions on coastal water quality and ultimately on the condition of marine habitats such as coral reefs and seagrass beds. A series of indicators have been identified in the framework, although currently there is no secured funding to collect such data. Priority indicators to detect the impact of best management practices (watershed interventions) on water quality include:

- Nutrient (TN, TP) and/or sediment load
- Water clarity (Light attenuation, turbidity, SSC, TSS, chl a, CDOM, PAR), Nutrient concentration (TN, TP, Ammonia, Nitrate+Nitrite, Orthophosphate)
- Sediment constituent accumulation

Currently, a series of priority sites associated with best management practices implemented were selected and permanent sediment traps installed to collect data on sediment constituent accumulation. Traps will be sampled bi-monthly to measure sedimentation rates and the contributions of carbonate and terrigenous material to the total sediment load. Currently, the project does not benefit from enough funding to install fixed in situ water quality sensors and/or continuous water sampling for lab processing. However, a multiparametric sonde was ordered to collect water quality data, and a citizen science program to collect basic qualitative observations is in place.

Current Project Status

The project status as of September 2022 is:

- Funding was allocated to continue the implementation of best management practices at the watershed scale and to conduct baseline water quality and seagrass status data.
- A contract is in effect with Protectores de Cuencas with NFWF funding for 2021-2023 to conduct sediment trap monitoring and sample processing. Water quality metrics to be collected include turbidity, chlorophyll-a, total suspended sediments, dissolved oxygen, salinity, water clarity via Secchi disk, and sediment constituent analysis.
- Multiparametric water quality sonde ordered.
- Sediment traps were installed in 13 sites near the shoreline in September 2022.
- Sampling to collect biological data on seagrass condition completed. DNER Coral Program has a copy of this seagrass data as part of the PRCRMP External Monitoring Unit.
- No water quality data collected as of September 2022.

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Puerto Rico Virtual Buoys and Water Quality Remote Sensing Data for PRCRMP Stations

Thanks to a collaboration with NOAA's Integrated Ocean Observing System, the Optical Oceanography Laboratory of the University of South Florida, and CARICOOS, 17 virtual buoys were created that compile and synthesize real-time and historical satellite data for areas of interest, especially in Puerto Rico. These areas of interest were selected by local stakeholders who conduct coral reef research and management actions.

Available parameters derived from the MODIS AQUA sensor are:

- Sea Surface Temperature
- Chlorophyll-a
- Turbidity
- Adg (443)
- PAR
- Kd (488)
- % Light Penetration

There are 17 virtual buoys located at:

- WEST: Mona Island, Culebrinas River, Tres Palmas, Rio Grande de Añasco, Bajo de Cico, La Parguera, Guánica Bay, Caja de Muertos, Jobos Bay, Arecibo and Vega Baja
- EAST: Ocean Park, Boca de Cangrejos, Fajardo River,
- Vieques: Vieques Buoy, El Seco
- Culebra: Luis Peña Chanel

To access this data and information follow these steps:

1. Go to the University of South Florida Optical Oceanography Laboratory website: https://optics.marine.usf.edu/

2. In the panel to the left press the sub-menu “Virtual Buoy Products” > “Puerto Rico”. Enter the region of interest menu and select a station.

3. In the "clickable map" you will find the map of the region with the virtual buoys, you can press the buoy to navigate to its information

4. The “Summary” tab offers various metadata about the virtual buoy including the coordinates, the depth at that location, and a description of the summary data table below. The table provides current data for the last 7 and 30 days for parameters derived from the MODIS/AQUA sensor. Anomalies and their relative intensity are color highlighted in this table.

5. The next 7 tabs above, next to “Summary”, offer information and data for each water quality parameter. For each parameter, a time series graph is offered with the monthly averages from 2000 to the present and another graph for the weekly averages by season from 2020 to the present. Both graphs show these averages with the climatology.

6. Monthly and weekly averaged data are available from the links provided on each parameter page. These can be copied and pasted into a program of your choice for handling and analysis.

Current Project Status

- Virtual Buoys are set up and automatically updated in near-real time. CARICOOS funded this effort.
- Access to the raw data is available through the USF Optical Oceanography Lab website summarized by weekly and monthly values.
- Temperature (Degree Heating Weeks), and KD490 data for each PRCRMP station were extracted from the NOAA Coral Reef Watch ERDDAP and the NASA Ocean Color Level 3 Browser website tool. This data is compiled per PRCRMP coordinates in the period 2000-2021.

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Jobos Bay National Estuarine Research Reserve – System-Wide Monitoring Program (SWMP)

As part of a nationwide network of water quality monitoring within reserves of the National Estuarine Research Reserves Program (NERRs), there are currently two permanent monitoring stations in the Jobos Bay National Estuarine Research Reserve (JBNERR) at Salinas, Puerto Rico (station 20 - 17.93032, -66.21147 and station 9 - 17.94306, -66.23858). These stations host multiparametric sondes that collect the following parameters on a real-time basis:

- Temperature
- Specific conductivity
- Salinity
- Dissolved oxygen % and mg/L
- Depth
- Ph
- Turbidity

Data is transmitted via satellite telemetry and is updated daily or weekly in an online database. The data can be graphed and downloaded using the tool provided by the NERRs Central Data Management Office at the following link: https://cdmo.baruch.sc.edu/dges/. Data from station 20 is the closest to an aggregated coral reef habitat, installed in the outer margins of the main Jobos Bay. Station 9 is within an extensive mangrove forest system deep within inner lagoons and canals known as Mar Negro. Data from station 20 can be considered as a proxy to explore conditions at the Cayo Caribes PRCRMP station (17.915435, -66.214007) located at the fringing reef on the seaward side of the mangrove shoreline where the water quality station is located.

Current Project Status

- Station maintenance is funded by the NOAA Office of Coastal Management as part of the annual budget of the JBNERR.
- The JBNERR Science Coordinator performs weekly surveillance and maintenance of the sensors as needed.
- Data is updated and available online at https://cdmo.baruch.sc.edu/dges/
- No stations are installed within the coral reef habitat.

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Other relevant sources of water quality information

EPA NEPAssist Tool

This tool provides a “browser” map to locate areas where EPA has given permission for discharges under the National Pollutant Discharge Elimination System (NPDES) permit program and water quality monitor locations, among other relevant locations to EPA under the Clean Waters Act. Locations are given along with metadata regarding the parameters collected, time scales, and other relevant information. The water sample results data is available for sampling locations using platforms such as EPA's Storage and Retrieval (STORET) System, a repository of physical, chemical, and biological monitoring data collected by multiple sectors.

Link: https://www.epa.gov/nepa/nepassist

CARICOOS

The Caribbean Coastal and Ocean Observing System (CariCOOS) is a node of the NOAA Integrated Ocean Observing System (IOOS) that serves as a hub of oceanographic field and modeling data. Currently, CariCOOS maintains an array of buoys in Puerto Rico that collect real-time oceanographic data such as wave parameters, winds, and currents. Furthermore, CariCOOS maintains an ocean acidification buoy in La Parguera Natural Reserve. This buoy has produced the longest time series for ocean acidification parameters in Puerto Rico. Other water quality data available through the CARICOOS website include data from the PR-DNER Coastal Water Quality Monitoring Program which focuses on bacteriological testing of shoreline waters around Puerto Rico. Graphs to visualize water quality data are available but the raw time series data is not yet accessible directly through the CariCOOS.org portal.

Link: https://www.caricoos.org/