# Monitoring seawater chemistry, benthic communities, and fish assemblages to assess the health of coral reefs in Puerto Rico

[1,2]**Nieves Ortiz, M.A.**, [2]Mejias, C., [1,2]Ricaurte, M., [1,2]Weil, E., [1,2]Courtney, T.A., [1,2]Cruz-Motta, J.J.
[1]Caribbean Coral Reef Institute (CCRI), [2]University of Puerto Rico Mayaguez (UPRM)

## BACKGROUND

In 1999, PR-DNER established the Puerto Rico Coral Reef Monitoring Program (PRCRMP) for shallow coral reefs areas (≤ 30 meters) to:

1. **Reveal the health** condition of **coral and reef fish species** of ecological and economic importance.
2. **Identify trends** in reef communities in response to environmental and human pressures.
3. **Enhance and develop** management strategies for reef protection.

Currently, DNER and CCRI-UPRM are collaborating to **monitor 16 water quality parameters at 42 PRCRMP sites for 2 consecutive years** (**fig. 1**) to:

4. **Assess the relative health** at these sites using the **Biological Condition Gradient (BCG)** and
5. **Inform** future coral reef water quality management criteria.

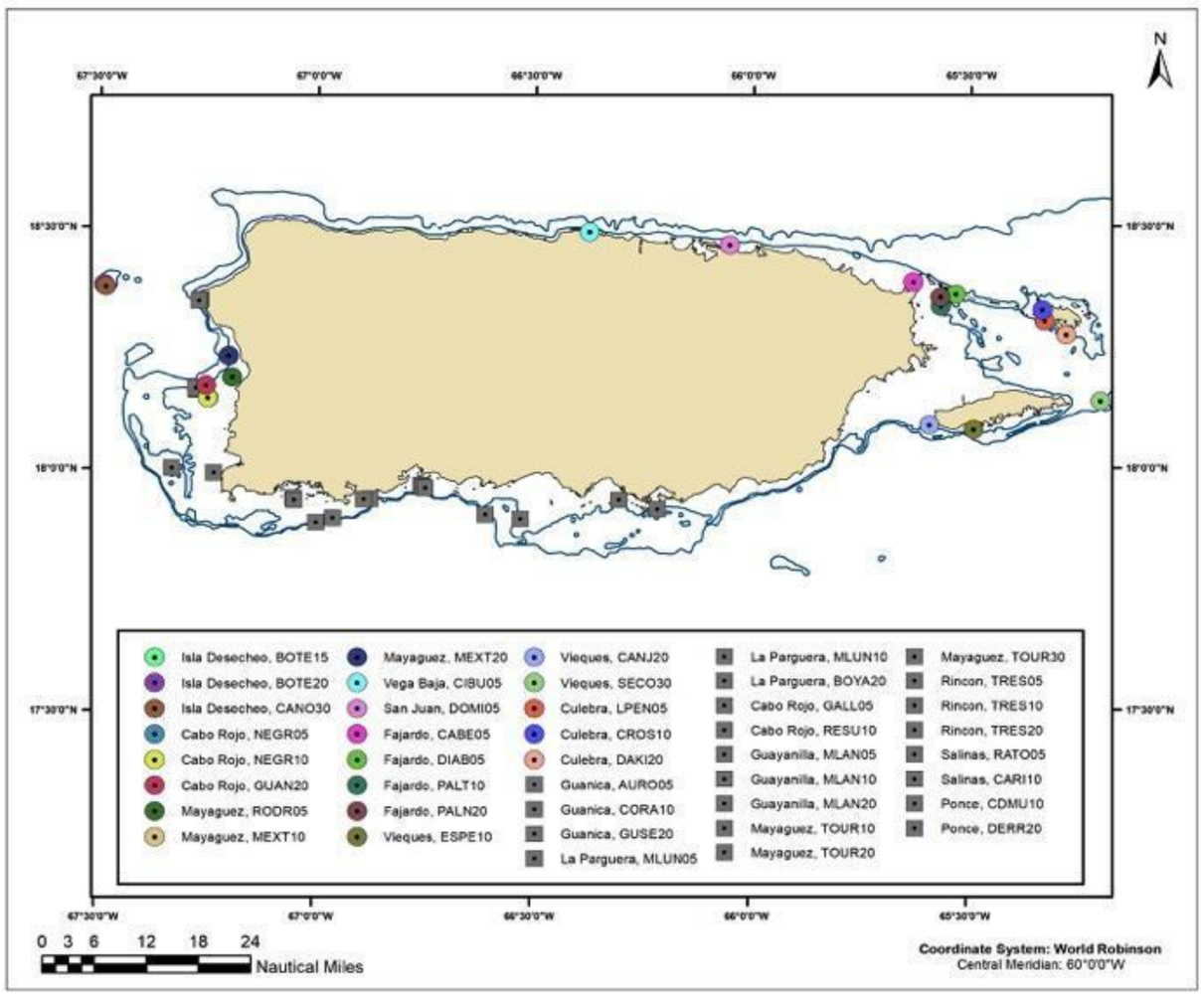



**Fig. 1** Map showing the location of 42 sites sampled by PRCRMP and now being sampled for seawater chemistry (prepared by Garcia-Sais, 2023).

## BIOLOGICAL CONDITION GRADIENT (BCG) MODEL

The BCG model (**fig. 2**) can use information about different components of coral reef systems (e.g., fish assemblages, coral species, water quality) to deliver a numeric value (1-6) of the relative health of a site through expectations of "*having a composition and diversity comparable to that of the natural habitat*" (Bradley et al. 2020).

1. Natural structural, functional and taxonomic integrity is preserved.
2. Some additional taxa & biomass; ecosystem structure and function is fully maintained.
3. Evident changes in structure due to loss of rare native taxa; shifts in relative abundance; ecosystem function is fully maintained.
4. Moderate changes in structure due to sensitive taxa being replaced by more tolerant taxa; function is largely maintained.
5. Sensitive taxa markedly diminished; unbalanced distribution of major taxonomic groups; reduced function.
6. Extreme changes and alterations in structure and ecosystem function

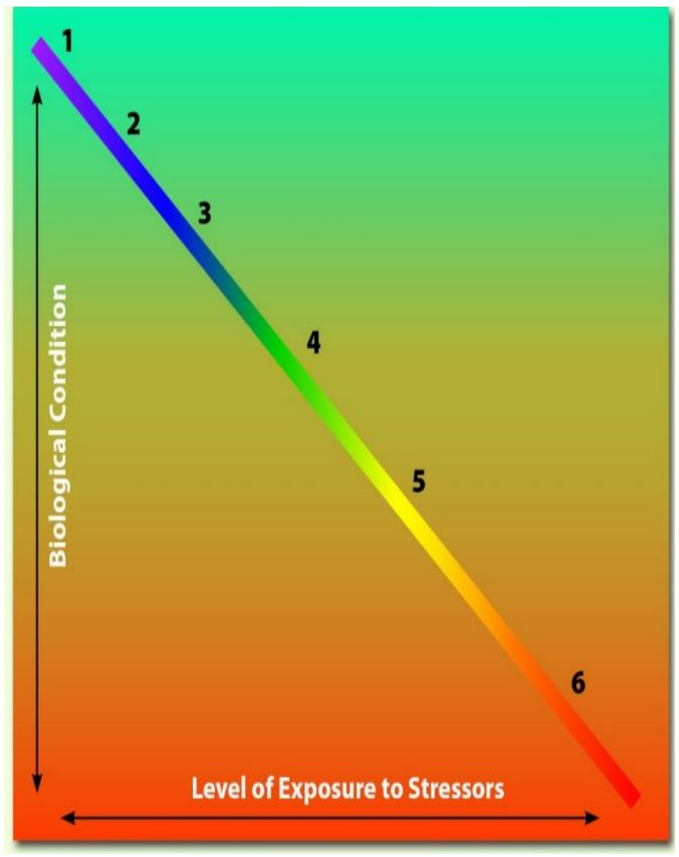
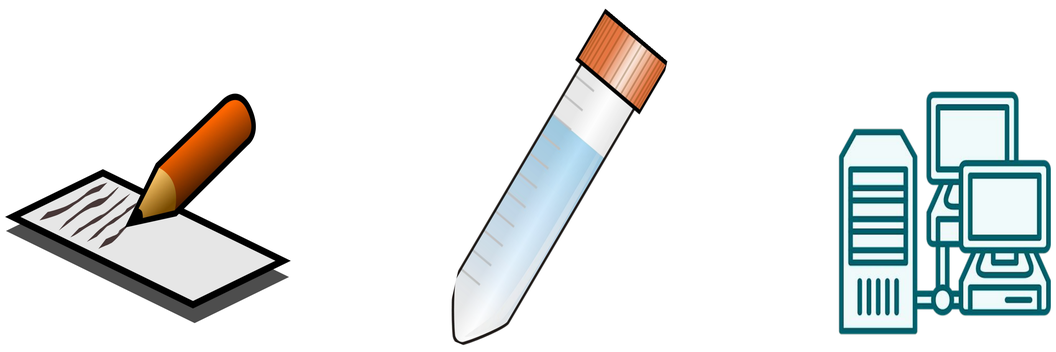



**Fig. 2** Diagram for interpreting the BCG model (EPA 2016)

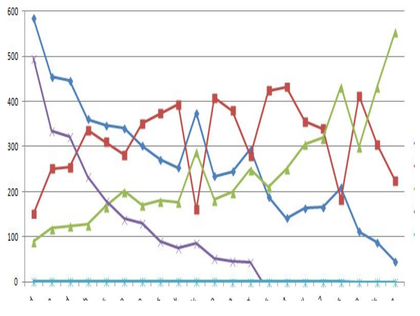
## PROJECT OUTPUT

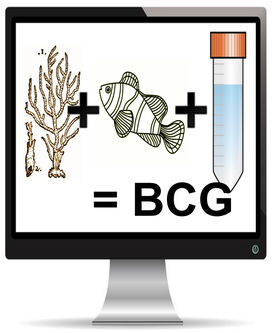
**We will *feed* water quality data to the BCG model (Fig. 2) to assess *relative health* at the 42 sites and provide a 2-year data set of the following 16 water quality parameters following U.S. EPA Standard Protocols** (method in parentheses): **1)** temperature (SM2550B), **2)** biological oxygen demand (SM5210), **3)** chlorophyll-a (SM10200H), **4)** dissolved oxygen (SM 4500-OH), **5)** enterococcus (SM9230B/C/D), **6)** pH (EPA150.2), **7)** turbidity (EPA180.1), **8)** salinity (SM2520B), **9)** secchi depth, **10)** settleable solids (2540F), **11)** total suspended solids (SM2540D), **12)** total phosphorus (EPA365.4), **13)** total kjeldahl nitrogen (EPA351.1), **14)** nitrate-nitrite (EPA353.2), **15)** total alkalinity (Dickson et al. 2007), **16)** dissolved inorganic carbon (Dickson et al. 2007).

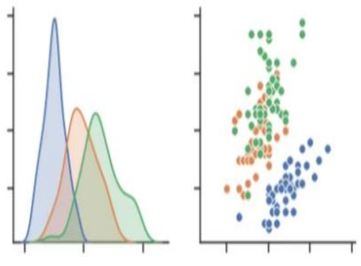
## METHODS



1. **Design and implement** a water quality monitoring program.
2. **Sample** 16 water quality parameters (**WQP**) for 2 years.
3. **Upload** data into EPA Water Quality Data Portal.





4. **Describe patterns** of spatial and temporal variation of the 16 WQP.
5. **Implement the BCG model** using coral, fish, and WQP data.
6. **Assess covariation** between WQP and BCG results.

## CCRI's Water Quality Lab

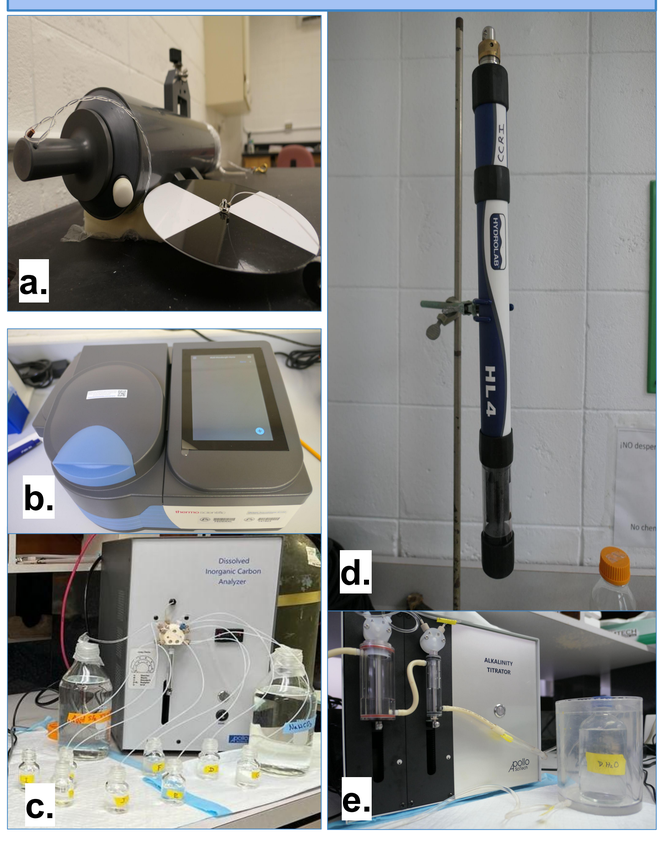



**Fig 3. a.** Van Dorn bottle and secchi disk, **b.** Orion Aquamate Spectrophotometer, **c.** Dissolved Inorganic Carbon analyzer, **d.** Hydrolab HL4 Sonde, **e.** Total Alkalinity analyzer

## HIGHLIGHTS

1. Through their collaboration with DNER, **CCRI has developed a state of the art seawater quality laboratory, which is the first of its kind in a public institution in Puerto Rico**.
2. This is the first time that the BCG model will be used to assess seawater quality to address health in coral reefs.
3. This project supports and promotes the **U.S. Clean Water Act**
4. Data from this project will be made available through CCRI's webpage: https://www.uprm.edu/ccri/
5. For further questions, please contact us at: ccri@uprm.edu

## REFERENCES

- Bradley et al. (2020) *Mar Pollut Bull.* 159: 55pp.
- Dickson AG, Sabine CL, Christian JR. (2007) *North Pacific Marine Science Organization*
- EPA (2016) *Fact Sheet for Water Quality Managers*. 822F-16/002 February 2016