Corozal Bay Wildlife Sanctuary, Belize

Methodology for the Water Quality Monitoring of CBWS

July 2019

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INTRODUCTION

The Corozal Bay Wildlife Sanctuary (CBWS) was established in 1998 as part of the Belize National System of Protected Areas, mainly to provide protection to the larger population of the West Indian manatee (Trichechus Manatus), their extensive mangrove systems that carry out vital ecological functions, and their ability to adapt and recover from disturbances to maintain the integrity and functionality of the ecosystem. The area covering 178,000 acres (72,034 hectares) was also established as part of a transboundary protected area along with the Manatee Sanctuary State Reserve in Mexico, in accordance with bilateral agreements between the countries of Belize and Mexico (SACD, 2012; Arrivillaga et al., 2008; Kramer & Kramer, 2002).

Among the main pressures and threats to the CBWS are pollution by wastewater with low or no treatment from human settlements, as well as the discharge of agrochemicals due to the runoff of extensive agricultural areas that comprise this transboundary basin. Therefore, the present study aims to evaluate the water quality of the aquatic system based on five physicochemical parameters that includes an analysis of the spatial and temporal behaviour of these indicators, which serves as a tool for the Sarteneja Alliance for Conservation and Development (SACD) agency, in making decisions for the cleaning, protection and conservation of this important protected natural area.

OBJECTIVES

General Objectives:

Monitor the water quality of 75 sites and assess the trophic state of 14 sites representative of the Corozal Bay Wildlife Sanctuary (CBWS) aquatic system, to strengthen decision making for cleaning, protection and conservation.

Particular Objectives:

- Conduct long term monitoring water quality in 75 sites, based on five physiochemical indicators with a multiparameter probe.
- Assess water quality in 14 CBWS sites for contamination sampling, based on twelve physicochemical indicators.
- Identify and characterize the main sources of pollution for the CBWS, based on water quality indicators.
- Assess the condition and trophic state of the water system.
- Assess the spatial and temporal variation of water quality indicators.
- Strengthen the staff of SACD, in the decision-making for the CBWS cleaning, protection and conservation, with the information generated.

METHODS

Study Area

Seasonal Transect (YSI):

The monitoring sites were selected based on criteria such as human settlements, productive and recreational activities, and geographical features, that can influence the Corozal Bay water quality. The sanctuary was divided in two section; North Corozal Bay and East Corozal Bay. Each section was assigned with a shallow and a deep transect running parallel to the coastline. In addition, a portion of both rivers that flows into the system was included. A total of 75 point were assigned to represent the whole system (Figure 1). Full surveys are conducted once a season; Dry Season (April / May), Wet Season (July / August / September), and Norther Season (December / January).

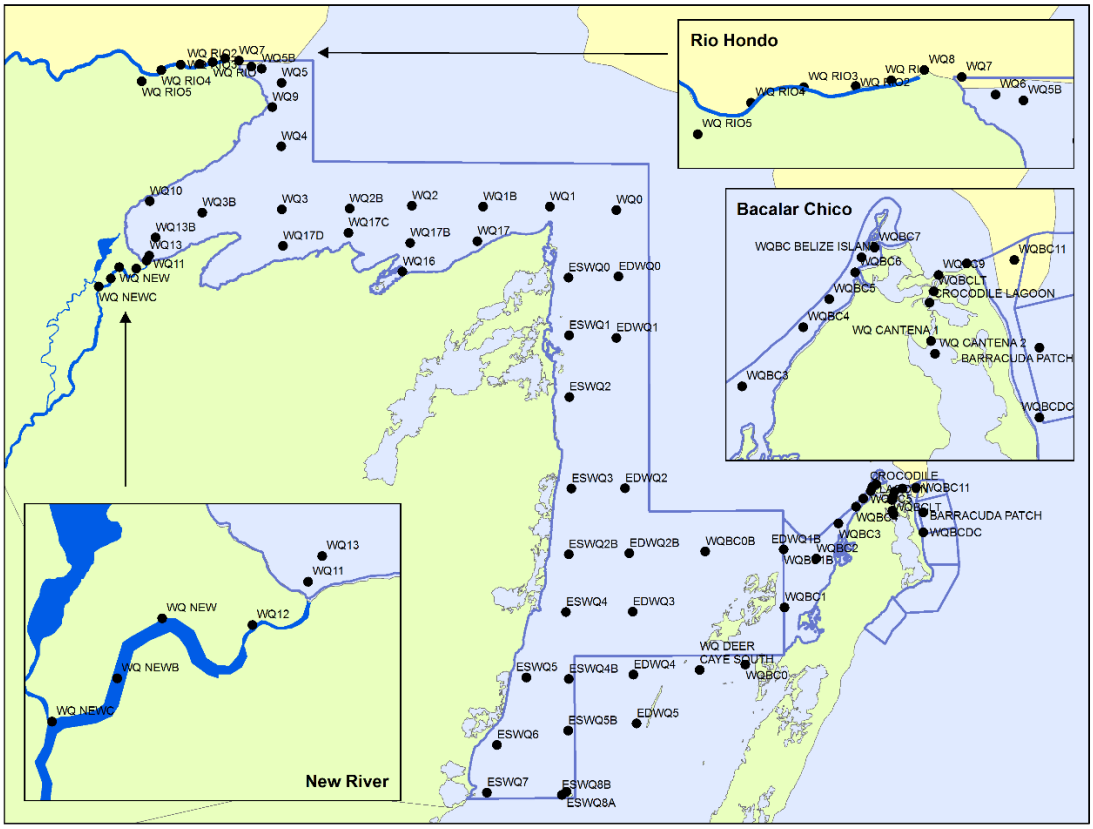

Figure 1.

Contamination Sampling (Van Dorn):

The location of the monitoring sites was based on criteria such as human settlements and productive and recreational activities, that can influence the Corozal Bay water quality. Thus, sites 1 and 2 are in front of New River that flows into this system, site 3 is in front of the Corozal City, sites 5 and 6 in the Orchid Bay area. The site 8 is in the vicinity of the Sarteneja Village, and sites 9 to 14 are in the communication channel of Corozal Bay with the Caribbean Sea (Figure 2).

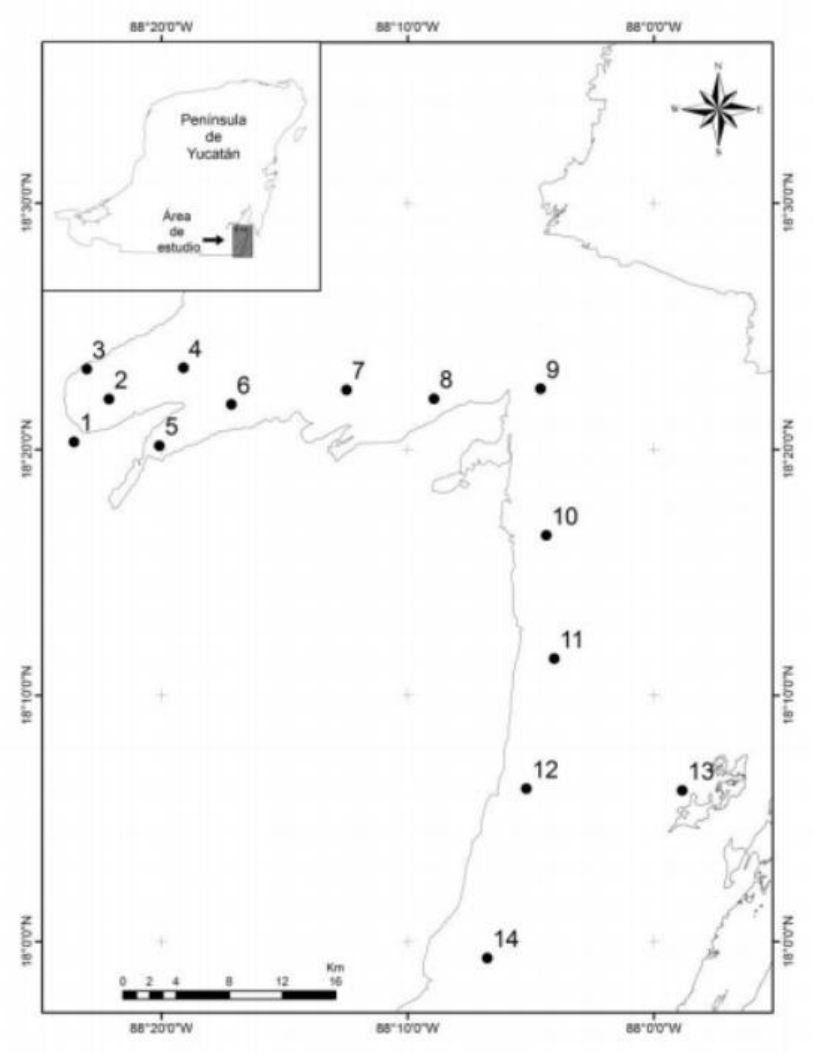

Figure 2.

Methodology

Seasonal Transect (YSI):

Water quality monitoring is carried out during the months of April, August and November, which represent the dry, rain and northern seasons, respectively. SACD personnel conducted sampling of physicochemical parameters starting at the surface and at each 1-meter depth until reaching the bottom. The survey consists of 50 sites in Corozal Bay and 25 sites in Bacalar Chico Marine Reserve which are sampled within 72 hours. Dissolved oxygen, salinity, temperature and pH are measured at a depth of 1-meter interval in the water column, with a multiparameter probe. Transparency is measured with a Secchi disk and depth is recorded with a depth sounder.

YSI Sampling Protocol:

1. Move to the correct georeferenced location previously selected and named (e.g. ESWQ1)
2. Start the YSI Multiparameter and provide 10 minutes to warm up.
    a. One person will deploy the YSI probe at the surface making sure that sensors are fully covered by water and stirring gently to dislodge any air bubbles trapped against the sensors. Then the process will be repeated for every 1-meter depth until reaching the bottom.
    b. The person with the YSI handheld device will wait for the readings to stabilize and then reads out the parameters out for the person recording. Log in YSI readings electronically in the YSI for future uses.
    c. YSI is removed from water and stored until it is used again.
    d. This will record conductivity, dissolved oxygen, pH, and temperature.
    e. After competing the monitoring activity sensors must be rinsed with distilled water and stored.

f. Store hard copies and download data from the hand-held device.

3. Measure depth- typically measured with depth sounder; in case it's not working then a large tape with weights is used.
4. Record water transparency using a secchi disk
    a. Lower the secchi disk until it cannot be seen then raised slowly until it appears and mark the reading.
    b. Measurements are recorded in centimetres.
    c. When taking a measurement do not use sunglasses.

Contamination Sampling (Van Dorn):

In 2017and 2018, water quality monitoring was carried out during the months of April, August and November, which represent the dry, rain and northern seasons, respectively. SACD personnel conducted the collection of water samples and in situ measurements of physicochemical parameters in the water column of 14 sites in Corozal Bay. Dissolved oxygen, salinity, temperature and pH were measured at a depth of 1 meter in the water column, with a multiparameter probe and transparency with a Secchi disk. The water samples were collected in triplicate with a Van Dorn bottle at a depth of 1 meter from the water column. The samples were deposited in previously washed plastic containers based on protocol of the ECOSUR Laboratory Quality System and stored on ice to be transported by SACD staff for analysis in the ECOSUR laboratory. Subsequently the samples were filtered for analysis of dissolved nutrients and chlorophyll a.

For the nutrient's measurement, will be used the modified techniques currently accrediting in the ECOSUR Chemistry Laboratory by the Mexican Accreditation Entity. Ammonium will be evaluated by alkaline phenol and sodium hypochlorite method (Solórzano, 1969). Orthophosphates as reactive

phosphorus soluble by the Murphy and Riley molybdenum blue method (1962). Inorganic nitrogen as nitrites by the sulfanilamide method and nitrates are measured as nitrites after reduction in a Cd-Cu column (Parsons et al., 1984). The silicates by the Schwartz ammonium molybdate method (1942, in: Contreras, 1984). And chlorophyll a will be evaluated by the acetone extraction method (90%) with Millipore 0.45 µm filters (Parsons et al., 1984).

With the nutrient data, two water quality indicators were obtained for the aquatic system: a) Eutrophication Index of Karydis et al (1983), which involves the total concentration of each nutrient in a body of water and the nutrient concentration by each monitoring site, in a given period of time; and b) the Condition Index from the determination of reference values per nutrient (EPA, 1992).

Bottle Preparation:

1. Bottles must be cleaned before collecting samples.
2. Each bottle and cap must be washed with phosphate free soap.
3. Then bottles and caps must be soaked in an acid wash for at least 20 minutes.
4. Bottles are then air dried and ready to use.

Sampling Protocol:

3. Move to the correct georeferenced location
4. Take the YSI parameters first
    a. One person will deploy the YSI to 1 meter and holds it at the same place.
    b. The person with the YSI handheld device will wait for the readings to stabilize and then reads out the parameters out for the person recording. Log in YSI readings electronically in the YSI for future uses.
    c. YSI is removed from water and stored until it is used again.
    d. This will record conductivity, dissolved oxygen, pH, temperature and turbidity.

5. Measure depth- typically measured with depth sounder; in case it's not working then a large tape with weights is used.
4. Label the bottles for each site
    a. Label the bottles using tape and a pen.
    b. Each bottle should be labelled with the site name, then the date and the name of the collector on the last line.
5. Take water samples
    a. Open the Van Dorn water collectors. Check that both valves are closed before deploying.
    b. Submerge the water collector to 1 meter, then drop the weight attached to the string to close the bottle and pull it out.
    c. Connect the rubber tube to one of the valves of the collector.
    d. Open the valve with no rubber tube first then followed by the one with the rubber tube.
    e. Fill the large bottle first followed by the small bottles make sure that bubbles are not created while filling the small bottles. If bubbles are formed change the tilt to get a smooth flow.
    f. Dump any remaining water from the collector and repeat steps for 'Take water samples' for the replicates 2 and 3.
6. After all samples are filled for the specific site immediately place them in the ice box and salt-sprinkle salt over the ice to lower the freezing point.
7. Repeat step 1 to 6 for the remaining sites.

After collecting all samples, by the SACD personnel, it is transported to the laboratory in ECOSUR where they are filtered immediately for the test on dissolved nutrients and chlorophyll A.

EQUIPMENT

1. GPS
2. YSI Multiparameter Probe
3. Secchi Disk
4. Tape measure
5. Van Dorn Water collector
6. Plastic Bottles
7. Rubber Tube/ small hose
8. Tape/labels
9. Ice box
10. Ice
11. Salt
12. Data sheet
13. Pencils
14. Sitemap

QUALITY ASSURANCE PLAN

Method	Seasonal Transect - YSI
References	Maria Sgambati (2012). Use and Care of the YSI ProPlus Quattro Water Monitoring Probe. Wildtracks, 2012 YSI Professional Plus User Manual. YSI Incorporated Ronald L. Ohrel, Jr. and Kathleen M. Register (2006). Volunteer Estuary Monitoring: A Methods Manual. US Environmental Protection Agency / Ocean Conservancy
Quality control	All personnel using equipment are fully trained in use and care. One person is designated as responsible for the safety of the YSI equipment during surveys. **YSI PROBES ARE FULLY CALIBRATED THE DAY BEFORE USE.** The YSI probe is stored safely when not in use. All transect are completed within 72 hours. Fresh batteries are installed before each survey day.
Environmental Impact Mitigation	Ensure the outboard engine is functioning well, no oil leaks. Dispose of all lube containers, equipment batteries and garbage appropriately.
Data Storage and Analysis	Store: Hard copies and Excel files Analysis: Using Ocean Data Viewer. Seasonal Changes, annual comparisons, climate change baseline
Reporting / Dissemination	Post survey report integrated into quarterly report to Forest / Fisheries Departments. Data sharing agreements with interested parties. Annual Monitoring Reports

Method	Contamination Sampling (Van Dorn)
References	Maria Sgambati (2012). Use and Care of the YSI ProPlus Quattro Water Monitoring Probe. Wildtracks, 2012 YSI Professional Plus User Manual. YSI Incorporated Ronald L. Ohrel, Jr. and Kathleen M. Register (2006). Eutrophication Index of Karydis et al (1983). The Condition Index from the determination of reference values per nutrient (EPA, 1992). The Maximum Permissible Limits (MPL) established as Ecological Criteria of Water Quality for the protection of brackish or marine water aquatic life, by the Ministry of Urban Development and Ecology of Mexico (SEDUE, 1989).
Quality control	All personnel using equipment are fully trained in use and care. 1 person is designated responsible for safety of the YSI and equipment. **YSI PROBES ARE FULLY CALIBRATED THE DAY BEFORE USE.** The YSI probe is stored safely when not in use. Fresh batteries are installed before each survey day. All Water samples are collected within 72 and are kept in ice. Transportation of water samples to the laboratory must be within 24 hours.
Environmental Impact Mitigation	Ensure the outboard engine is functioning well, no oil leaks. Dispose of all lube containers, equipment batteries and garbage appropriately.

Data Storage and Analysis	Store: Hard copies and Excel files Analysis: Using Ocean Data Viewer. Seasonal Changes, annual comparisons, climate change baseline
Reporting / Dissemination	Post survey report integrated into quarterly report to Forest / Fisheries Departments. Data sharing agreements with interested parties. Annual Monitoring Reports