Surfrider Foundation Rincón Blue Water Task Force
Water Quality Program Progress Report June 1- Nov 30 2016

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LONG-TERM GOALS

To maintain the regular BWTF monitoring program, and expand its' spatial/temporal scope as trained volunteers and other resources become available. To integrate this increase of data generation into the beach water quality predictive modeling program hosted by CariCOOS, and refine that modeling by conducting additional BWTF research on associated factors influencing marine water quality (quantifying / tracking influence of freshwater outflows, quantifying / identifying bacterial contributions of rainfall runoff at various locations, and measuring dispersion patterns into nearshore or littoral waters). To continue to make BWTF resources (lab facilities, trained volunteers, data management services, community outreach) available to specific CariCOOS related research projects, and promote this research to communities, NGOs or appropriate governmental agencies. To continue to collaborate with and/or mentor other community or non-profit NGO water quality programs elsewhere in PR with the objective of eventually integrating their data into the BWTF - this can be regarded as creating the infrastructure and groundwork necessary to replicate the PR Junta de Calidad Ambiental beach monitoring program should lack of federal funding cancel the JCA program.

MILESTONES / OBJECTIVES

The primary objective of maintaining regular weekly BWTF monitoring was successfully accomplished for 100% of testing dates during this period - 17 or 18 sites monitored from Jobos area on the north coast to Añasco on the west coast, covering about 45 miles of coastline.
The secondary objective of conducting additional research testing in the special project area (Reserva Marina Tres Palmas to Rincón Balneario, 5 sites) was accomplished for approximately 95% of supplemental testing dates, covering about a mile of coastline and involving both marine and freshwater monitoring.
The milestone of having the Rincón BWTF certified for the federal EPA equipment loan was accomplished, and BWTF personnel attended the EPA training and orientation workshop given at the Interamerican University campus in San German on Sept. 14. Unfortunately, significant delays by the EPA in actual delivery of the equipment meant that it could not be incorporated into the BWTF during this report period.

WORK COMPLETED

Approximately 520 water samples were collected, processed and tested using the IDEXX / Enterolert method (exclusive of collaborative research projects) by the BWTF, and those results were published to the Surfrider Rincón BWTF website, as well as copied to the CariCOOS web portal.

Data entry to the BWTF website was accomplished for the Playa Santa monitoring project for regularly sampled beach and freshwater sites, involving 4-6 sites twice a week.
BWTF lab facilities in Rincón were made available to several RUM students to conduct their CariCOOS water quality research projects during this reporting period.

MAJOR OUTCOMES

JCA vs BWTF weekly monitoring results, performance and compliance comparisons during reporting period.
Performance: Both the JCA and BWTF monitor 4 sites in common, Balneario Tres Hermanos in Añasco (3H), Rincón Balneario (RB), Balneario Pico de Piedras in Aguada (PP) and Playa Crashboat in Aguadilla (CB). The JCA sampling is scheduled for Mondays, the regular BWTF sampling is done on Wednesdays. Of the 26 potential regular sampling dates for the JCA program, sampling was accomplished 15 times (this includes scheduled dates where at least 3 of the 4 sites were sampled, and does not include several unscheduled 'resampling' dates) or an approximate 58% occurrence rate. Of the 27 potential regular sampling dates for the BWTF program, sampling was accomplished 27 times (includes scheduled dates where at least 3 of the 4 sites were sampled) for an occurrence rate of 100%.
Compliance: The JCA now uses (since October 2015) a yes/no system to determine public health risks ("appropriate for bathing" / "not appropriate for bathing") based on the current federal Beach Action Value of 70 (or more) Most Probable Number of Colony Forming Units (MPN CFU) of enterococcus bacteria per 100 ml of sample water. Previous to October 2015 the compliance standard was 34 MPN CFU. The BWTF uses a hybrid 3 tiered risk assessment based on the previous JCA and federal standards (most US state EPA programs still are using a version of these standards)- 'good' for MPN CFUs of less than 35, 'caution'/yellow alerts of MPN CFUs of 35 - 103, and 'dangerous' / various degrees of red alerts for MPN CFUs of 104 or more.
JCA: Of the 15 actual sampling dates, number of samples (n) = 59, JCA tests showed 22 individual samples not compliant with the BAV, an approximate 37.5% non-compliance rate. More specifically, three samples showed MPN CFUs of 70 -103 (CB=1, 3H=2) and 19 samples showed MPN CFUs of 104 or greater (3H= 6, RB= 6, PP= 4, CB= 3)
BWTF: Of the 27 actual weekly sampling dates, number of samples (n)= 102, BWTF tests showed 27 individual samples not compliant with the BAV, an approximate 26.5% non-compliance rate. More specifically. again three samples showed MPN CFUs of 70 - 103 (CB=1, 3H=2) and 24 samples showed MPN CFUs of 104 or greater (3H=5, RB=7, PP=8, CB=4)
CONCLUSIONS: Strict adherence to regular weekly monitoring can significantly lower the percentage of non-compliant sample results for these sites, while significantly changing the 'risk profile' of individual sites (particularly Pico de Piedras). Both these factors likely combine to produce a more accurate risk assessment of specific sites. Use of the BAV compared to the previous federal standard does not produce a significant change in risk assessment for these sites.

Comparison of increased temporal frequency of BWTF sampling at Rincón Balneario
In addition to the 27 regularly scheduled weekly monitoring dates, 26 samples were collected on a bi-weekly basis during the weekends, most often on Sundays, for a total n=53 (on sampling dates when research transects were performed, only the data from the specified regular monitoring station at the Balneario are included) In either scenario, all non-compliant samples exceeded 104 MPN CFU. The weekly sampling yielded 7 non-compliant samples per 27

monitoring dates, for a non-compliance rate of approximately 25.9%. The bi-weekly sampling yielded 15 non-compliant samples per 53 monitoring dates, for a non-compliance rate of approximately 28.3%.
CONCLUSION: Increased frequency of sampling did not significantly change the risk profile for this site. But it is interesting to note that all non-compliant samples fell into the 'Red Alert' category, well above the BAV standard, during the reporting period.

Comparison of increased temporal BWTF monitoring of the Reserva Marina Tres Palmas
Two sites within the RMTP were monitored biweekly during this report period, at Steps (ST) and South RMTP (SR, the southern littoral limit of the RMTP). Both sites had weekly sampling number n=27, for biweekly sampling ST n=53, SR n=52. For dates when research transects were performed at Steps, only the specified regular monitoring station data are included.
Steps: weekly monitoring yielded one sample exceeding the BAV, and six samples exceeding 104 MPN CFU, for a non-compliance rate of approximately 25%. Biweekly sampling yielded only a single additional sample (exceeding 104 MPN CFU) for a non-compliance rate of approximately 15%.
South RMTP: weekly monitoring yielded one sample exceeding the BAV, and one sample exceeding 104 MPN CFU, for a non-compliance rate of approximately 7.4%. Biweekly monitoring yielded one sample exceeding the BAV, for a non-compliance rate of approximately 5.75%.
CONCLUSION: Increased temporal sampling significantly reduced the incidence of non-compliant samples at Steps. It is to be noted however, that for four of the six sampling dates that exceeded 104 MPN CFU, obvious Brown Water conditions pertained (wave swash flooding the drainage channel containing the mangrove area, especially during high tides) and thus these conditions are a major localized factor affecting water quality at this site.

Rincón Marina Lagoon basin monitoring
A biweekly BWTF research monitoring project was initiated in May 2016 to record various water quality parameters and physical changes of this enclosed body of water over the course of time. During this report period, 52 samples were collected at the site and tested for enterococcus bacterial levels using the standard IDEXX / Enterolert methodology. Additional measurements were taken on sampling dates to roughly determine temperature, turbidity, pH and Dissolved Oxygen (DO) using various analogue methods, including reagent / color comparator charts for pH and DO. The water level of the lagoon was observed to fluctuate up to one foot above normal (four instances of observed rainfall runoff contributions, three instances of salt water intrusion) however the time required for water levels to return to normal after these contributions varied widely, from three days to two weeks.
General Observations: Neither temperature nor turbidity were definitely linked to other parameters. All rainfall runoff incidents were linked to significant increases in bacterial counts (as well as one salt water intrusion) however bacterial counts fluctuated between 0 and the test maximum limit of 24192 MPN CFU independently of new water inputs or any other parameter, a seemingly random pattern. DO levels showed a slight increase (1-2 ppm) for rainfall runoff and salt water intrusion incidents, however DO fluctuated between 0 and 6 ppm with no linkage to other parameters, and pH varied between 6 and 9 with no strong linkage to any other parameter.
CONCLUSION: For a basically 'closed system' with minimal new water inputs, the widely fluctuating and independently variable parameter measurements suggest that there are unidentified biological and/or chemical processes occurring within the lagoon basin.

Additionally, the variable time periods observed for returning the water level to normal after new water inputs may indicate unidentified infiltration and/or exfiltration mechanisms that could influence water quality parameters.

Comparison of Quebrada Cambija and Quebrada sin Nombre freshwater outflows
These quebradas are the two closest freshwater outflows to the Balneario monitoring station, with the potential to affect WQ at the beach site. The BWTF has been monitoring weekly the Quebrada sin Nombre (QsN) since Jan. 2014, biweekly since Feb. 2015, its outflow is located about 220 m north of the Balneario station. When the Rincón Mixing Experiment was scheduled, the BWTF conducted preliminary monitoring of the Quebrada Cambija (CQ) whose outflow is located about 100 m south of the Balneario station. Subsequent to the RME the BWTF began conducting biweekly at the QC, also measuring temperature, turbidity, pH and DO using analog methods at both sites in addition to the IDEXX / Enterolert tests.
Observations: The outflow volume of the QsN is uniformly 50-100% greater than the QC under all environmental conditions, occasionally 200-300% more. The QsN has significantly higher bacterial counts than the QC under all conditions, however both the bacterial counts and other parameters generally move in parallel for both sites (i.e. an increase or decrease in bacteria, or temperature or pH etc at one site is mostly frequently mirrored by a relatively equivalent change at the other). This is an interesting observation, since the watershed for the QsN is exponentially larger (at least 25X) than the watershed for the QC.
CONCLUSION: It would seem that both sites would have approximately the same statistical probability of being able to affect WQ at the Balneario site, but no correlation has been found to date. It is unlikely that a probative correlation would ever be possible without the use of other methods (tracer dye releases and/or multiple small drifters tracking). Without further data it seems more probable that the isolated unexplained fluctuations of WQ at the Balneario are caused by a very localized and intermittent source(s) at the Balneario area itself.

RELATED PROJECTS

Quasi- realtime Biosensor Project - co-PI Pedro Resto. On three occasions Dr. Resto (and Dr. Guillermo Serrano) installed benchtop biosensor prototypes at the duplicate BWTF lab facilities located in Steve Tamar's house in Rincón, for 48-72 hour experimental test runs. Steve monitored the prototype performance during these runs, and provided real time reports and/or photos when requested, while conducting parallel standard IDEXX testing to verify the biosensor results. In addition, Steve conducted independent research on known contaminated marine and freshwater samples using the standard IDEXX method, but testing the processed samples every hour during incubation to help determine the volumetric, dilution, and temporal parameters that would potentially affect the biosensor performance.
Developing a functional prototype and subsequent field trials would almost certainly involve leveraging of CariCOOS funding with future partnerships/collaborators.

Rincón Mixing Experiment- PIs Sylvia Abudo and Miguel Canals. BWTF personnel were involved in virtually all phases of this project, particularly the water quality component involving collecting, processing and testing multiple marine and freshwater samples hourly during the project period. BWTF lab facilities and materials were made available to CariCOOS, and orientation and training was provided to the student teams and community volunteers. Assistance was given during the setup, maintenance, and removal of the temporary project headquarters at the balneario, transport of lab equipment and supplies, providing of tables and

other physical logistical support. Unfortunately there was not sufficient rainfall at that time to conduct the next phase of the Rainfall Runoff Assessment during the RME, to follow up preliminary research already conducted by the BWTF.
Replicating the RME in the future (during significant rainfall events, and/or during significant wave swell conditions) might possibly involve leveraging CariCOOS funding.

Playa Santa Water Quality monitoring project- PI Geraldine Gomez. Steve Tamar provided some training and technical advice to Geraldine concerning the sampling routines, site assessment, or lab work associated with her project. As well as entering her data from regularly sampled sites on the BWTF website, he provided advice / suggestions regarding the graphics preparation of the results for her poster and presentation regarding this project.

WORK PLAN FOR UPCOMING PERFORMANCE PERIOD (Dec. 1 – May 31 2016)

To continue the basic weekly BWTF monitoring program, and hopefully add further sites as trained volunteers become available.
To continue the biweekly research monitoring in the special project area of the RMTP to Balneario coastline for a full calendar year (until May 2017), with the primary objectives of verifying or eliminating the influence of nearby freshwater outflows on beach WQ at the Balneario, creating more precise risk profiles for RMTP sites, and using these extra data to refine and verify performance of the CariCOOS WQ predictive modeling.
To incorporate the new EPA-provided equipment into the BWTF program, and produce digitally-generated measurements of additional WQ parameters of temperature, pH, DO, conductivity and salinity during the loan period - with the eventual objective of determining if the BWTF should purchase similar equipment as a permanent part of the BWTF program. To compare digitally-generated measurements to the analog measurement results and, if necessary, apply a corrective factor / algorithm to render previous analog measurements more accurate. Determine which method is more efficient on a cost vs accuracy vs utility basis.
To continue working with CariCOOS (principally Sylvia Abudo) to develop a WQ reporting website that is more robust, flexible and scalable than the existing BWTF format for use by researchers, as well as making it more user-friendly / intuitive for use by the general public.
To continue to be prepared to conduct the next phase of the Rainfall Runoff Assessment project, should a significant rainfall event be predicted to occur during what is typically the dry months in Rincón. These data would help refine the WQ predictive modeling.

PUBLICATIONS & PRODUCTS

Online data sets available to the public

Surfrider Foundation Rincón BWTF website (current and historical data) in graphical/map format as well as CSV:
http://www.surfrider.org/blue-water-task-force/chapter/4

BWTF data also available via CariCOOS:
http://www.caricoos.org/map/beach-water-quality