Quantifying bacterial transport by rainfall runoff under varying spatial, temporal and environmental conditions: Two preliminary studies centered on the Rincón Balneario

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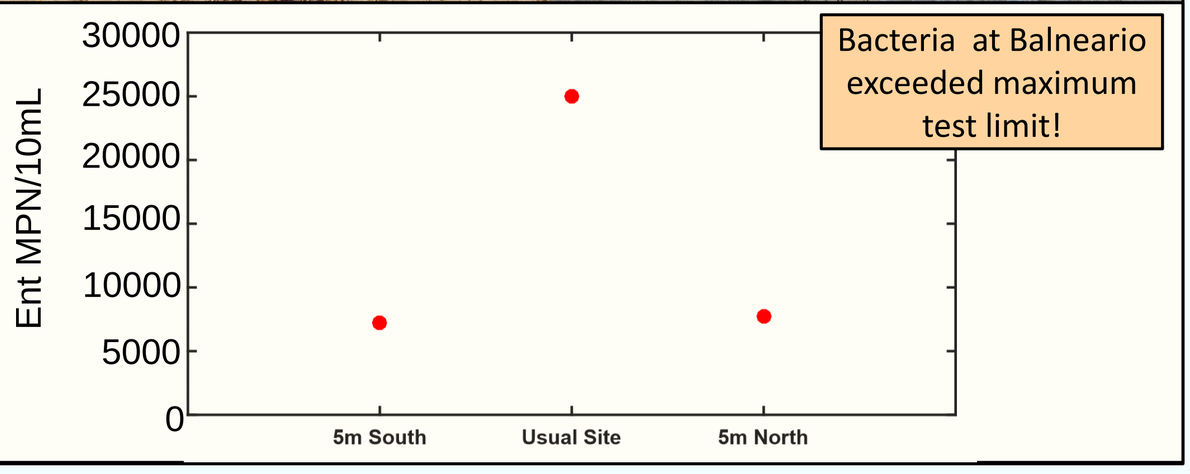
Abstract

Microbiological contamination of the nearshore marine environment by rainfall runoff is a recognized factor affecting public health risk in recreational waters, as well as potentially damaging to nearshore coral reef and littoral ecosystems. Two studies were conducted in the area of the public beach in Rincón by the Blue Water Task Force program of Surfrider Foundation-Rincón in March 2016 to help determine the various parameters that will need to be designed into a rigorous investigation of potential sources. Study A was conducted on March 14 during a critical (i.e. surface runoff entering the ocean) rainfall event of approximately ½ inch total, comparing bacterial transport at runoff maximum volume compared to minimum volume after the rain ended, and demonstrated a symmetrical dispersion pattern into coastal waters under ideal conditions (minimal mixing of water column at shoreline, no observable shore current). Study B was conducted on March 23 during a non-critical rainfall event of less than ¼ inch total, comparing bacterial transport of runoff from various catchment areas & surfaces, and relative turbidity. Bacterial analysis was conducted according to EPA-approved protocols and procedures using the IDEXX Enterolert DST methodology and Quantitray 2000 processing and test method, detecting enterococcus as the indicator species of fecal contaminant levels. Sampling conducted by BWTF personnel, and tests were performed by BWTF personnel at the Surfrider Rincón lab facilities located in Rincón.

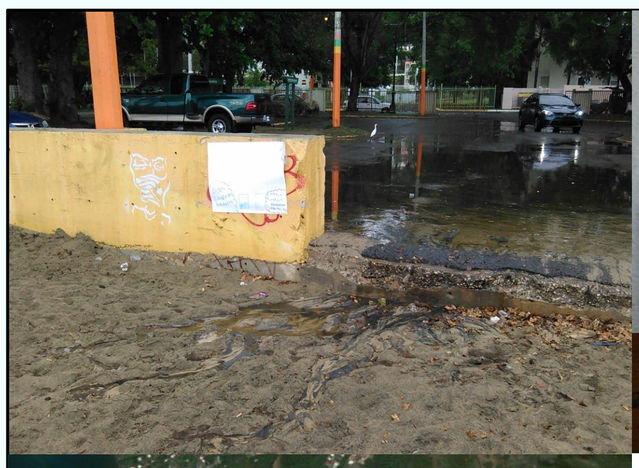
Study Area

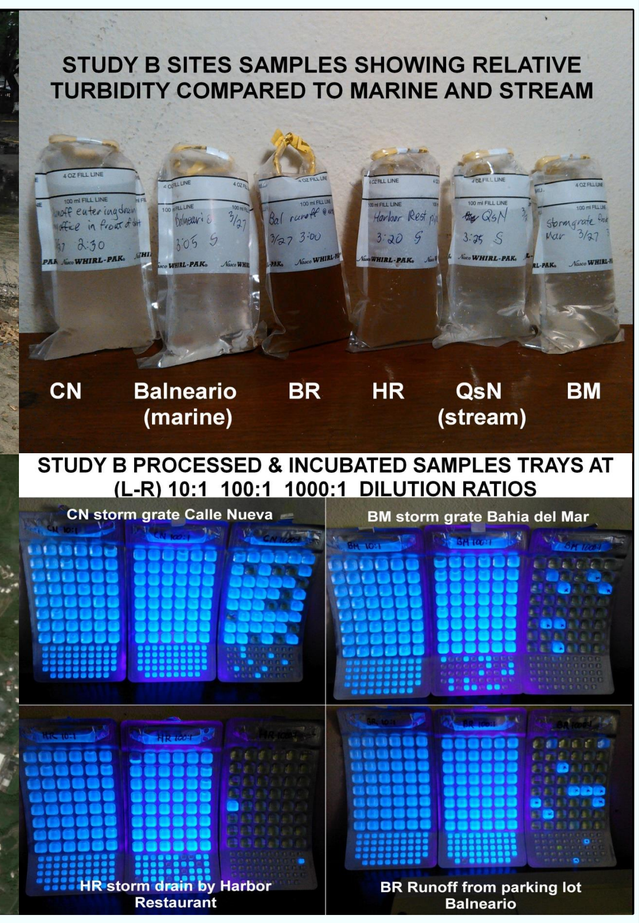
Study	Catchment Area (acres)	Approximate Runoff (gal/sec)	Type of surface cover
A Runoff A	0.25	20 (3:00 pm)	Mixed commercial, recreational park, public school and grounds, multi-unit residential
A Runoff B	0.25	2 (3:40 pm)	Mixed commercial, recreational park, public school and grounds, multi-unit residential
Study B CN	0.16	0.12	Urban (exclusively structures, hardened surfaces)
Study B BR	0.25	0.5	Mixed commercial, recreational park, public school and grounds, multi-unit residential
Study B HR	1.25	1.5	Mixed residential, commercial
Study B BM	0.12	0.12	Multi-unit residential, some undeveloped/vegetated

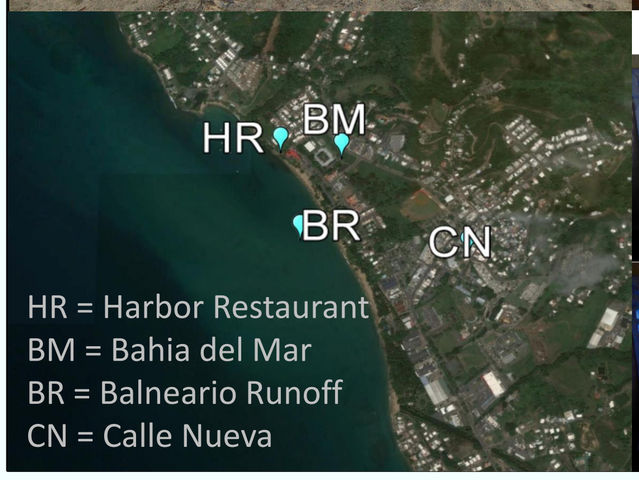
Study A: March 14, 2016



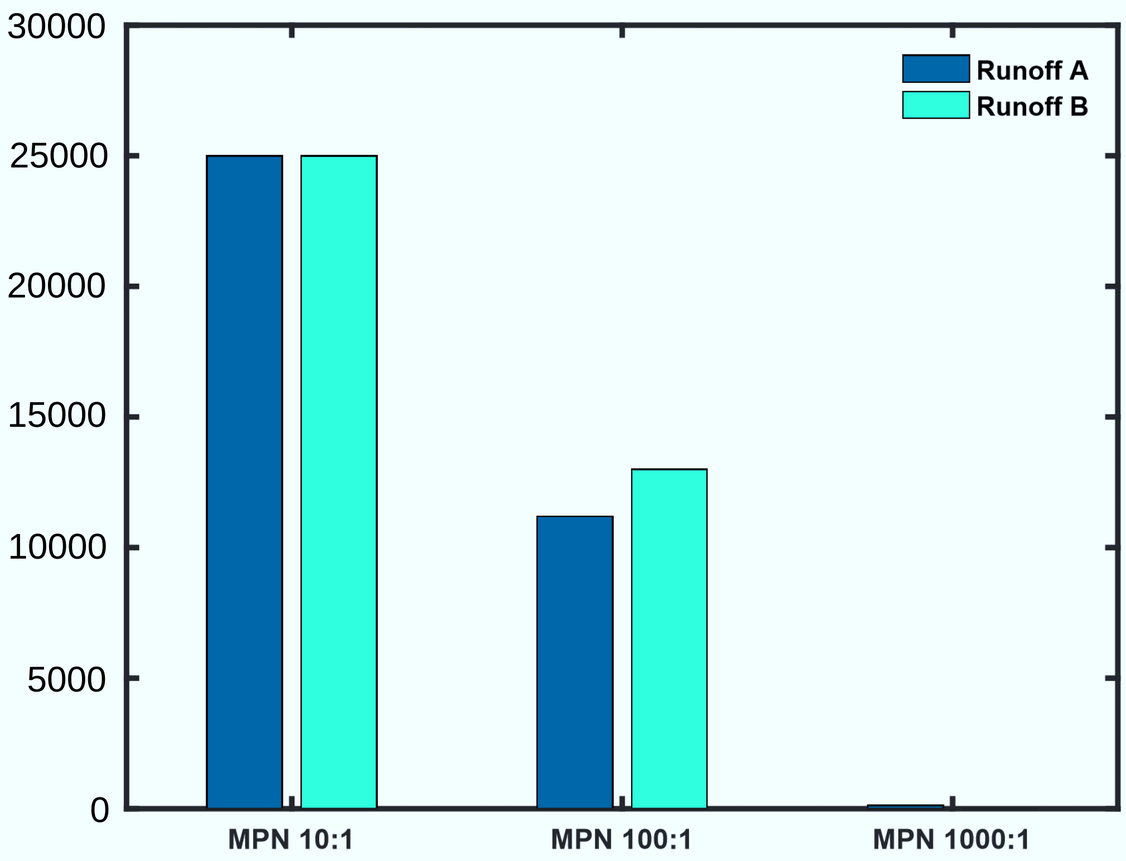
Study B: March 23, 2016



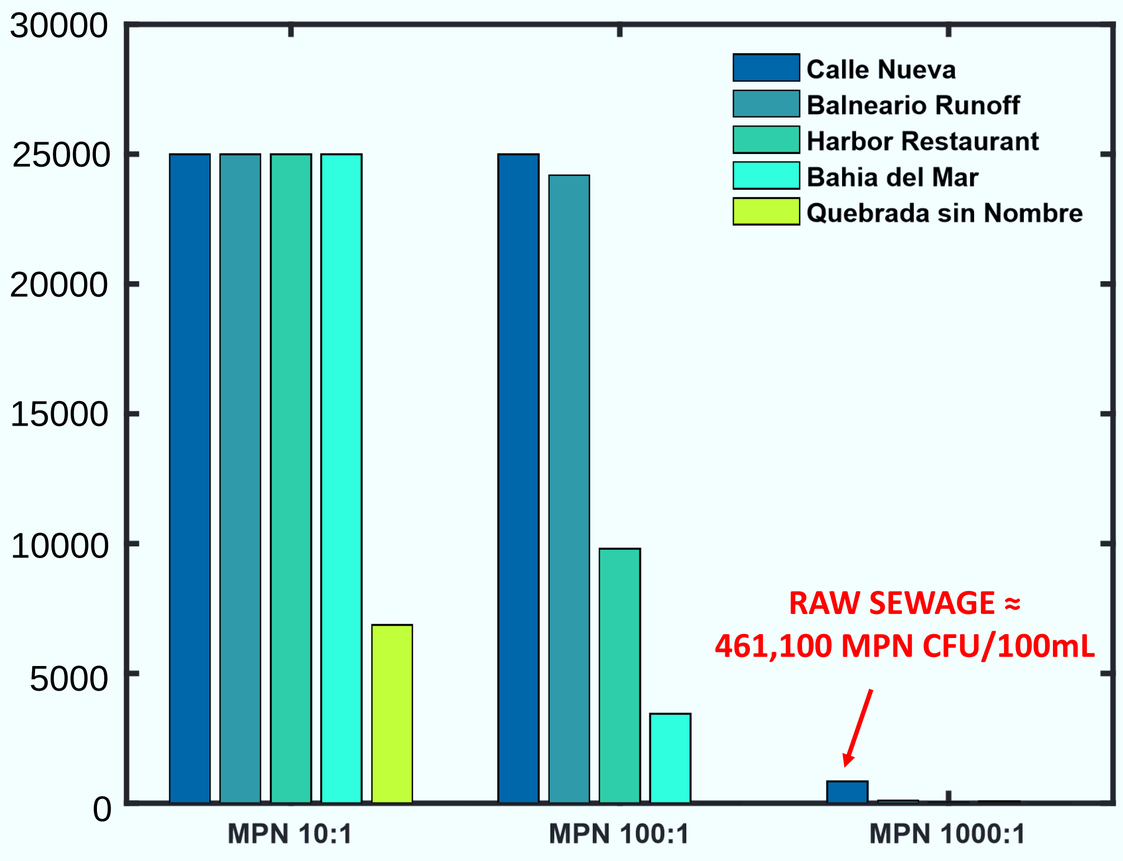




Critical surface runoff entering the ocean
Rainfall event of approximately ½ inch total



Non-critical surface runoff entering the ocean
Rainfall event of less ¼ inch total



Conclusion and Future Work

These studies suggest that predicting bacteria contamination in recreational and nearshore marine waters presumably transported by rainfall runoff will depend on accurately modeling two principal factors:

1. In the larger scale spatial/temporal sense, the extent and dispersion of runoff contamination seems linked to total rainfall amounts and duration, as well as environmental conditions present at that time. The installation of accurate localized weather stations and ADCP current profilers would greatly assist generating data needed for this modeling both of bacterial loads and dispersion patterns/rates into the littoral under varying environmental conditions.
2. In the smaller scale spatial/volumetric sense, the type of land use and surface cover needs to be taken into account for various runoff outflow locations, especially the percentage of naturally vegetated surface areas. Bacterial loading does not seem correlated to turbidity, but does seem linked to the type of surface cover – with urban runoff transporting the most bacteria per volume. Even sub-critical rainfall amounts cause extremely contaminated runoff to enter storm drains at low volumes, thus entering freshwater ecosystems or the nearshore marine environment with the potential for localized but very dangerous health and environmental hazards that may not be obvious to the general public.