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Microbiological Water Quality at Reference Beaches and an Adjoining Estuary in Southern California during a Prolonged Drought

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EXECUTIVE SUMMARY

Elevated levels of fecal indicator bacteria (FIB) are a common problem in urban surface water and may lead to impairment of beneficial uses, such as swimming or other contact recreation. Once impaired, common regulatory solutions include establishing Total Maximum Daily Loads (TMDLs), and incorporating those TMDLs into National Pollutant Discharge Elimination System (NPDES) permits and other water quality management plans. A reference system approach is a critical element of these TMDLs, where natural sources are documented and a number of exceedance days are allocated based on the frequency at which "reference" sites with natural sources of bacteria exceed established FIB water quality standards. One previous study has documented natural background concentrations of FIB at "reference" beaches. However, the prolonged period of drought in the Southern California region provided an opportunity to characterize FIB concentrations at reference beaches during period of low freshwater input. It also provided an opportunity to intensify sampling effort in the adjoining bar-built estuary to provide the basis for accounting for natural sources of FIB in those naturally productive habitats.

The goal of this study was to characterize the natural background concentrations of *enterococci* (ENT), *E. coli* (EC), fecal (FC) and total coliform (TC) bacteria, and to categorize FIB water quality objective (WQO) exceedance frequency at "reference" recreational beaches and their adjoining estuary or mixing zones. Additionally, samples were analyzed for the HF183 human-associated fecal marker, which is indicative of the presence of human fecal contamination, to confirm that the reference beaches have minimal human impact.

Specific questions addressed in the study were:

1. How does the WQO exceedance frequency for FIB vary between wet weather, summer dry weather and winter dry weather at reference beaches and within the estuary or mixing zone?
2. How does FIB concentration at the beach vary by factors such as presence or absence of an estuary, water temperature, salinity, and number of antecedent dry days?

Reference beaches were selected though geographic information system screening of three criteria: 1) beaches that have minimal human impact were defined as open beaches with breaking waves, 2) the beach receives freshwater runoff from either a creek or an estuary, and 3) the runoff originates from undeveloped watersheds (>93% open space). In addition to these criteria, preference was given to sites in San Diego County. Two sites met these criteria: San Onofre Creek (San Diego County) and Deer Creek (Los Angeles County). Dry weather sampling was conducted weekly from October 1, 2014- April 30, 2016 within the surf zone, estuary or mixing zone, and contributing creeks. Storm sampling was conducted only in San Onofre Creek from January 1, 2014- April 30, 2016, but only one storm breached the creek mouth and was sampled. An intensification of sampling efforts was conducted within the Estuary of San Onofre Creek in order to quantify the natural background exceedance frequencies of bar-built estuaries. Analysis of samples for HF183 demonstrated that the level of human fecal contamination was low during winter and summer dry weather, supporting the concept that these are reference sites; any data associated with a positive HF183 result were removed from calculations of exceedance frequency. This study, which coincided with a major drought in Southern California, had five major findings:

1. The winter and summer dry weather ranges of FIB concentrations at both beaches were very low, with WQO exceedance frequencies in the range of 0% -3.5%. Such values are characteristic and comparable to results from previous FIB beach bacteria reference studies that had closed tidal inlets (such as the San Onofre Creek) or flow to the beach without an estuary (such as Deer Creek). Prolonged drought resulted in intermittent dry weather flow at Deer Creek and no dry weather flow at San Onofre Creek, which provides important context to interpret data on exceedance frequencies.
2. Concentrations of FIB in the estuary or freshwater mixing zone of both San Onofre and Deer Creeks were typically 1-3 in orders of magnitude higher compared to their respective beaches, with the highest WQO exceedance frequencies found in San Onofre Creek. This suggests that dry weather exceedance frequencies at the beach could have been greater had the mouth of the estuary been open to tidal exchange and dispersal to the surf zone.
3. FIB in San Onofre Estuary was characterized by high WQO exceedance rates, ranging from 40% (FC) to 92% (EC) for single samples and 72% (FC) to 100% (EC and ENT) for summer dry weather. During both winter dry sampling periods, single sample WQO exceedances ranged from 3.2% (TC) to 84%-93% (ENT), while geomean WQO exceedances during winter dry weather ranged from ~55% (TC) to 100% (ENT). The higher WQO exceedance frequencies of San Onofre Creek Estuary relative to the mixing zone of Deer Creek could be expected, given the abundance of labile organic matter typical in estuaries that can serve to support microbial growth and the presence of water birds in the estuary that excrete high concentrations of FIB.
4. At both beaches, no significant relationship was found with water temperature, salinity or antecedent dry days. In contrast to San Onofre Beach, where FIB concentrations declined with increasing duration of dry weather, the range and mean FIB concentration in San Onofre Estuary increased with increasing antecedent dry days and salinity, suggesting that freshwater input from the ephemeral channel tended to dilute concentrations, rather than be a source of bacteria to the beach. The slight increase in San Onofre Creek Estuary FIB concentrations as a function of temperature and the lack of surface freshwater input suggests that regrowth may be a factor, which is credible given the organic rich environment of San Onofre Creek estuary.
5. Only one storm was captured during this study because of extreme drought and all samples from that storm were found to be contaminated with a human source of fecal material; therefore, the results cannot be used to inform "natural background" exceedance frequencies.

Full text:
http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/936_MicrobiologicalWQRefBeaches.pdf