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# Tidal forcing of enterococci at marine recreational beaches at fortnightly and semi-diurnal frequencies

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### ABSTRACT

Marine beach water quality is typically monitored in early morning once a week without respect to tidal condition. To assess the effect of tide on this public health warning systems, we analyzed enterococci (ENT) data from 60 southern California marine beaches with differing geomorphology, orientation and proximity to runoff sources. ENT concentrations during spring tides were significantly higher ( $p < 0.1$ ) than those during neap tides at 50 of the beaches (83%); and at over half of them, water samples were more likely to be out of compliance with the ENT single sample standard during spring tides compared to neap. Tide stage had a smaller effect; ENT concentrations varied according to tide stage at 27% of the beaches. When tide range (spring/neap) and tide stage (ebb/flood) conditions were considered together, spring-ebb tides yielded the highest ENT concentrations and the greatest chance of exceeding the single-sample standard at the majority of beaches. Proximity to a terrestrial runoff source, slope of the runoff source, slope of the beach and orientation of the beach had minimal influence on tidal modulation of ENT concentrations. The presence of spring and spring-ebb tide signals at such a great percentage of beaches suggests that tide should be considered in design and interpretation of beach monitoring program data. It also suggests that ENT delivered by tidally-forced mechanisms other than terrestrial surficial runoff are widespread. Possibilities include ENT-laden groundwater (saline and fresh) from the beach aquifer, as well as ENT-enriched sands, decaying wrack, and bird feces near the high water line.

### Full Text

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