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Towards establishing a human fecal contamination index in microbial source tracking

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ABSTRACT

The fecal indicator bacteria (FIB, such as Enterococcus) used to monitor recreational water quality do not differentiate human and animal fecal pollution, even though human fecal material represents a greater public health risk. Host-associated genetic markers that allow for source identification have been developed, but there is no agreed upon approach for integrating multiple samples exhibiting different marker signal strengths and varying levels of agreement among markers into an index that managers can use for prioritizing beaches with the greatest presence of human fecal contamination. As a first step towards developing such an index, we provided ten experts with a simulated dataset for 26 beaches where we systematically varied four factors: Enterococcus concentrations, frequency of detection for two human-associated markers, magnitude of the marker signal, and agreement between the markers. We then used the Delphi technique to establish consensus principles for how these factors should be used in ranking beaches with respect to human fecal contamination. The experts' initial ranking varied widely, but after three iterations of ranking and discussion, the experts converged on a consensus that: 1) frequency of samples that are positive for human-associated markers is of primary importance in ranking beaches; 2) magnitude of and consistency between the markers should be used to weigh marker frequency; and 3) general FIB data should receive the least weight. Using the expert's consensus, a conceptual mathematical algorithm is proposed to establish and index that consistently and transparently quantifies the relative probability of human fecal contamination at a beach.