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QMRA as a compliment to epidemiologic studies estimating bather risk at recreational beaches

The US EPA and WHO have set recreational water quality standards based on epidemiologic studies to protect human health at beaches. These studies have largely been limited to sewage-impacted sites and resources are unlikely to be available to assess the myriad of other impacted sites. Here we describe how quantitative microbial risk assessment (QMRA) can be used to assess unstudied pathogen sources in a systematic way to describe risk uncertainty. A QMRA was constructed based on a recreational beach primarily impacted by seagull feces, assumed to contribute only *Campylobacter* and *Salmonella*. The pathogen dose distribution was derived from the concentration of the fecal indicator in the water column using an uncertain ratio of indicator to pathogen concentrations. The probability of gastroenteritis was calculated using dose-response relationships from the literature. All uncertain model parameters were represented by probability distributions and sampled in a Monte Carlo analysis, allowing subsequent parameter importance analysis. Based on the high uncertainty of human-infectious pathogens in gull feces, the predicted probability of infection from gulls is of potential concern when the water quality indicator is near the single sample water quality standard (104 enterococci / 100 mL). This pathogen uncertainty is common with many animal sources of fecal contamination; hence, it is important that future research focus on specifying pathogen densities to allow comparison of risk estimates from epidemiologic studies with QMRA, which may ultimately allow risk characterization from unstudied sources of fecal contamination at recreational beaches.