Generation of Enterococci Bacteria in a Coastal Saltwater Marsh and Its Impact on Surf Zone Water Quality

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Elevated levels of enterococci bacteria, an indicator of fecal pollution, are routinely detected in the surf zone at Huntington State and City Beaches in southern California. A multidisciplinary study was carried out to identify sources of enterococci bacteria landward of the coastline. We find that enterococci bacteria are present at high concentrations in urban runoff, bird feces, marsh sediments, and on marine vegetation. Surprisingly, urban runoff appears to have relatively little impact on surf zone water quality because of the long time required for this water to travel from its source to the ocean. On the other hand, enterococci bacteria generated in a tidal saltwater marsh located near the beach significantly impact surf zone water quality. This study identifies a potential tradeoff between restoring coastal wetlands and protecting beach water quality and calls into question the use of ocean bathing water standards based on enterococci at locations near coastal wetlands.

Introduction

Beaches are an important part of the culture and economy in California. An estimated 550 million people visit California's public beaches annually for a total economic benefit to the state of over 27 billion dollars (*1*). To protect beach-goers from exposure to waterborne disease, a new state law mandates the implementation of recreational water quality monitoring programs at public beaches with 50 000 or more annual visitors. Specifically, the law requires monitoring for total coliform (TC), fecal coliform (FC), and the enterococcus (ENT) groups of bacteria, all of which may indicate the presence of fecal contamination. The state also enforces a set of uniform standards for TC, FC, and ENT bacteria including single-sample standards (10 000, 400, and 104 most probable number (MPN) or colony forming units (CFU)/100 mL) and 30 day geometric mean standards (1000, 200, and 35 MPN or CFU/100 mL); a lower single-sample standard for TC of 1000 MPN or CFU/100 mL also applies when the TC/FC ratio falls below 10. The enterococci standard conforms closely to the national guidelines for marine water quality criteria published by the U.S. Environmental Protection Agency (*2*). If indicator bacteria levels in the ocean exceed any of the above standards, the local health officer is required to either post signs that warn against swimming in the water or close the ocean to the public if a sewage spill is suspected. The state standards and U.S. Environmental Protection Agency guidelines are based on a series of epidemiological studies that link gastrointestinal illness and exposure to ocean water containing high levels of indicator bacteria, particularly ENT (*3*−*11*). The origin of ENT in these epidemiological studies was presumed to be anthropogenic sources of fecal pollution, such as sewage, agricultural runoff, and urban runoff.

Huntington State and City Beaches in southern California have been heavily impacted by the passage of the new regulations. According to data provided by the Orange County Health Care Agency, there have been a total of 99 postings at Huntington State and City Beaches between July 26, 1999, when the bill went into effect, and September 5, 2000, approximately 72% and 25% of which were triggered by violations of the ENT single-sample and geometric mean standards, respectively. Persistently high levels of indicator bacteria in the surf zone at Huntington State and City Beaches in the summer of 1999 led to an extensive survey of the local sewage infrastructure (*12*). No significant sewage leaks were discovered, prompting speculation that urban runoff from the nearby Talbert Watershed was a source of fecal pollution (*12*). The present study was designed to test this hypothesis and, more broadly, to characterize the sources and transport of ENT in tidally influenced flood control channels and a saltwater marsh. ENT was the focus of this study because this particular group of indicator bacteria is responsible for the vast majority (97%) of beach advisories issued at Huntington State and City Beaches.

Field Site

The Talbert Watershed encompasses 3400 hectares in the cities of Huntington Beach and Fountain Valley. The watershed drains an urbanized area consisting of residential developments, commercial districts, plant nurseries, and light industry. This area of southern California has separate stormwater and sanitary sewer systems, so dry and wet weather runoff flows to the ocean without treatment.

Runoff from the Talbert Watershed is conveyed along street gutters to inlets that connect to underground stormwater pipelines. These pipelines connect to a network of three flood control channels (Fountain Valley, Talbert, and

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