

# Study: Sticking to the sand might not be such good, clean fun for beachgoers

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Just when you thought it was safer to stay out of the water. Microbes that result in beach closures and health advisories when detected at unsafe levels in the ocean also have been detected in the sand, according to a recent study by a team of Stanford scientists.

Published in the July 1 issue of *Environmental Science and Technology*, the study found that sand at beaches all along the California coast contained some level of fecal indicator bacteria. Moreover, when the researchers looked closely at the sand quality at a popular beach in Monterey, Calif., they found evidence of human waste-raising doubt about the commonly held belief that some fecal indicator bacteria occur naturally in the sand and are therefore benign.

The team was led by Alexandria Boehm, assistant professor of civil and environmental engineering at Stanford, and included Kevan Yamahara, Blythe Layton and Alyson Santoro, all graduate students in Boehm's lab and co-authors of the study. They collected samples of sand at 55 beaches between Mexico and Oregon and tested for fecal indicator bacteria in the lab and out in the field.

They found that 91 percent of the beaches in the study had detectable levels of enterococci and that 62 percent of them had traces of *E. coli*. Swimming in water with high levels of those bacteria can cause a number of reactions, such as skin rashes or ear infections. According to the Natural Resources Defense Council (NRDC), if ingested or absorbed through an open wound, pathogens in the water can trigger more severe

ailments, including dysentery and hepatitis.

"Contaminated beach sands can actually act as bacteria sources," said Boehm, the Clare Booth Luce Assistant Professor in the Department of Civil and Environmental Engineering. "It means that the polluted sand is probably going to act as a source of fecal indicator bacteria to coastal waters-and will impact beach closures and advisories."

Since 1990, the number of beach closures and health advisories throughout the United States has increased steadily, according to the NRDC. In 2005, the council tallied more than 20,000 days of closures and advisories in the 29 states along the oceans and Great Lakes-a 5 percent increase over the previous year. The group attributed the rise to increasing coastal development, a year of heavy rainfall-which results in extra sewage runoff-and improved monitoring. NRDC began monitoring beach pollution nationwide in 1990.

To test their hypothesis, the Stanford researchers headed to Lovers Point-a popular recreational beach in Monterey-and collected exposed sand above the tide line that contained enterococci, bacteria also found in the intestines of warm-blooded animals. In a laboratory at Stanford, they ran filtered water from Monterey Bay over columns packed with the sand they had collected.

What they found confirmed their hypothesis: The concentration of bacteria in the sand decreased, while its presence in the seawater increased after it flowed through the sand samples.

The team then returned to Lovers Point to research the movement of bacteria from sand to sea in the field. The researchers collected sand from strategic locations that would follow the hypothesized flow of bacteria. They found that when the dry sand became submerged by seawater during the flooding tide, enterococci were removed from the

sand and transported into the water.

"The fact that the bacteria actually can be transported from the sand to the sea is important," Boehm said.

National standards for fecal bacteria in seawater were determined by the Environmental Protection Agency in 1986. In 1999, California became one of the first states to mandate weekly water quality tests during peak tourist season, which runs from May to October.

At Lovers Point, Boehm and her team found that the amount of enterococci washed from the dry sand to the sea during their study was high enough to cause a beach advisory. According to the Environmental Protection Agency, a single sample of marine water containing more than 104 enterococci bacteria per 100 milliliters is unsafe to swim in. Boehm found 120 enterococci per 100 milliliters during the flood tide at Lovers Point, a beach that earns an "A" grade for water quality from Heal the Bay, a nonprofit environmental organization.

The beaches that Boehm and her team included in their study represented a variety of natural and anthropogenic factors, from sand grain size to surrounding human development. And after analyzing the different sand samples and variables, they found that enterococci densities were higher at beaches with a significant degree of surrounding human development.

More specifically, at Lovers Point, the researchers tested for traces of human-specific genetic markers in the bacteria and indeed found that the enterococci most likely came from people.

"Some researchers have found that enterococci grow in the sand, that they occur naturally. So it's not linked to fecal input," Boehm said. "But in this case, we looked closely at Lovers Point, and there were actually

signatures of human waste."

In fact, Boehm recalled a storm drain at Lovers Point that was almost 250 feet away from the research site on the beach. During heavy rains, sewage systems can get overwhelmed and result in untreated sewage flowing directly out to sea.

"When we were at Lovers Point doing this experiment, there was a baby sitting in the sand, and she was literally eating the sand," Boehm said. "You have to wonder if that's a health threat."

Source: Stanford University

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