

TESTING THE WATERS

24TH EDITION



The Impacts of Beach Pollution

Polluted beach water makes swimmers sick and hurts coastal economies. Illnesses associated with polluted beach water include stomach flu, skin rashes, pinkeye, respiratory infections, meningitis, and hepatitis. In addition to the health effects of polluted beach water, there may be deep financial impacts as well. Economists have estimated that a typical swimming day is worth approximately \$35 for each beach visitor, so the economic loss for each day on which a beach is closed or under advisory for water quality problems can be quite significant.

HEALTH RISKS

Diseases Caused by Pathogens in Bathing Waters

Polluted waters may contain disease-causing organisms called pathogens. The most common types of pathogens—bacteria, viruses, and protozoa—are those associated with human and animal waste. For instance, giardiasis is caused by the protozoan *Giardia lamblia*, North America's leading reported intestinal parasite.¹ Swimmers in sewage-polluted water can contract any illness that is spread by fecal contact, including stomach flu, respiratory infection, and ear and skin infections. Most swimming-related illnesses last from a few days to several weeks, but in some cases pathogens may cause severe, long-term illness or even death.

Sensitive populations such as children, the elderly, or those with a weakened immune system are particularly at risk for long-term effects. For example, research has shown that children under the age of nine have more reports of diarrhea and vomiting from exposure to waterborne pathogens than any other age group, with at least a twofold increase occurring over the summer swimming months.² There is usually a delay of several days to two weeks between contact with contaminated water and expression of symptoms, and most people who get sick from swimming are not aware of the link. Beachgoers can even become ill without going in the water. A 2009 study found a positive association between beach sand contact and the risk of gastrointestinal illness at beaches near a sewage treatment plant outfall.³



For more
information,
please
contact:

Jon Devine
jdevine@nrdc.org
(202) 289-6868
 switchboard.nrdc.org/
blogs/jdevine

www.nrdc.org/policy
www.facebook.com/nrdc.org
www.twitter.com/nrdc

On the basis of beach visitation rates and monitoring data, researchers have estimated that 689,000 to 4,003,000 instances of gastrointestinal illness and 693,000 instances of respiratory illness occurred each year between 2000 and 2004 at Southern California beaches.⁴ While these estimates are subject to a great deal of uncertainty, they provide insight into the potential for underreporting of such illnesses.

Contaminated Runoff and Incidence of Disease

Discharges of polluted urban runoff result in elevated bacteria levels and increased illness rates among swimmers, and the association between heavy precipitation (leading to increased runoff) and waterborne disease outbreaks is well documented.⁵ For instance, a 2012 California study investigated surfers' risk of contracting gastrointestinal illness during dry weather and in post-storm conditions in the coastal waters of Southern California based on enterococcus and fecal coliform concentrations in the water. The researchers found that "at most beaches, there are higher GI risks after rainfall than during dry condition[s]" and that "some beaches have significantly elevated health risks for surfers after a storm event."⁶

A large-scale 1995 epidemiological study, also in California, investigated possible adverse health effects of swimming in ocean waters contaminated by urban runoff.⁷ The study found an increased risk of illness associated with swimming near flowing storm drain outlets in Santa Monica Bay, compared with swimming more than 400 yards away. Swimmers near storm drains were found to have a 57 percent greater incidence of fever, for instance, than those swimming farther away.

NRDC supports a variety of solutions to beach pollution from contaminated runoff—including the use of permeable pavement and the installation of rain gardens to reduce runoff volume. To learn more, see "Community Measures to Prevent Beach and Ocean Pollution" on our [Smarter Living page](#).

Climate Change and Incidence of Disease

Climate change is expected to increase the incidence of diseases contracted by swimmers. Recreational waters located in areas where climate change causes increased precipitation and runoff are more likely to become contaminated with pathogens such as *Cryptosporidium parvum* and *Giardia lamblia*, which are associated with polluted runoff and combined sewer overflows. An article in *Climate Research* notes that, although there are uncertainties, "a wetter climate in the [mid-Atlantic region] could lead to higher [*Cryptosporidium*] loads in water."⁸ A major cryptosporidiosis outbreak in Milwaukee in 1993 killed 54 people and sickened more than 400,000 after stormwater compromised the performance of a drinking water treatment plant.⁹

The bacterium *Vibrio cholerae*, which causes cholera, is another pathogen that presents an increased threat to humans as a result of climate change. Extreme weather events and warmer waters can foster growth of the bacterium; one study found that *V. cholerae* was nearly 20

times more likely to occur at a temperature of 66.2°F or higher than at lower temperatures.¹⁰ Increased freshwater runoff, high in nutrients and low in salinity, also may favor the growth of *V. cholerae*. As one study of Chesapeake Bay concluded, "Increased climate variability, accompanied by higher stream flow rates and warmer temperatures, could favor conditions that increase the occurrence of *V. cholerae* in Chesapeake Bay."¹¹

Threats to Swimmers from Harmful Algal Blooms

[Harmful algal blooms \(HABs\)](#), often called red tides, are a growing problem in surface waters where nutrient-rich pollution can spur algal growth. Several species of phytoplankton produce potent toxins that can make people sick if they are exposed to contaminated water or if they eat contaminated fish or shellfish. These organisms are a natural part of the ocean ecosystem, but when conditions are right, they experience a rapid growth in number, resulting in a "bloom." HABs can last for days, weeks, or months and cause serious and potentially life-threatening symptoms in humans, including diarrhea, nausea, vomiting, abdominal cramping, chills, diminished temperature sensation, muscle aches, dizziness, anxiety, sweating, seizures, numbness and tingling of the mouth and digits, paralysis, and cardiovascular and respiratory ailments.¹² Approximately 10 percent of all food-borne disease outbreaks in the United States are caused by eating seafood contaminated by algal toxins.¹³ And because they can aerosolize, toxins produced by harmful algae can cause respiratory distress even in beach visitors who do not enter the water.^{14, 15}

The incidence of HABs has increased dramatically over the past 30 years. Indeed, analyzing data spanning nearly 50 years from the southwest coast of Florida, researchers at the University of Miami determined that *Karenia brevis* red tides are occurring with greater frequency, closer to shore, and during more months of the year. They attribute this to greater inputs of nutrients into coastal waters from increased agricultural runoff and sewage discharges in the watershed over that time period.¹⁶ In 2011, the Great Lakes suffered one of the worst algae blooms in decades—so large, in fact, that the slimy green cyanobacteria were visible from space.¹⁷

As is the case with pathogens, warmer waters may result in expanded ranges for some harmful algae species.¹⁸ According to a 2009 Chesapeake Bay Foundation report:

Climate change might be expanding the range of a few new toxic species of algae into the estuary, and causing others to bloom earlier, according to a 2008 report by a scientific advisory committee of the U.S. EPA Chesapeake Bay Program. For example, a toxic alga normally associated with Florida and the Gulf Coast, *Alexandrium monilatum*, in 2007 was believed to have been responsible for killing whelks (a species of sea snail) in the York River in Virginia. It was the first known bloom in this area, and it represented a potential shift northward, according to the EPA committee report. A large bloom of a toxic alga normally found in the Caribbean Sea, *Cochlodinium polykrikoides*, killed young fish and oysters in the lower Chesapeake Bay in August 2007.¹⁹

Efforts to deal with red tides have focused on mitigating the effects of these events, primarily through improved systems to monitor for harmful algal blooms and to educate and communicate the risks to the general population. Techniques to prevent HABs involve restricting the movement of harmful algal species via the shellfish market and in ship ballast water. For example, ballast water may be heated or chemically treated to prevent the introduction of invasive species, and trade may be restricted in shellfish from areas experiencing red tides. However, significantly reducing the number of red tide events will require strong efforts to control nitrogen and phosphorus pollution from sources such as sewage systems, urban and suburban stormwater, septic tanks, and agricultural runoff.²⁰

[To learn more about the health impacts of HABs as well as how to protect your family, please see NRDC's "Tides of Trouble: Increased Threats to Human Health and Ecosystems from Harmful Algal Blooms."](#)

ECONOMIC IMPACTS

Each year, Americans take more than 900 million trips to coastal areas.²¹ In fact, beaches, rivers, and lakes constitute the top vacation destinations in the nation.²² Yet our waters provide more than just recreation—vacationers spend approximately \$44 billion annually during these coastal trips.²³ In 2010, the nation's shoreline-adjacent counties contributed an estimated \$6 trillion toward the nation's gross domestic product and 47 million jobs.²⁴ Economic activity directly associated with the ocean pumped more than \$222 billion into the U.S. economy in 2009.²⁵

Polluted water puts these revenues at risk. Fouled beaches result in a loss of utility for those who have planned to visit and swim in the water; this impacts local economies in the form of lost tourist dollars and the jobs they support.

Coastal tourism, attributable in part to clean beaches, generates substantial revenues for state and local governments as well as for businesses lining the coasts. Economists estimate that a typical swimming day is worth approximately \$35 for each individual.²⁶ Depending on the number of potential visitors to a beach, the loss of beach days due to warnings or closures can be quite significant. For example, one study estimated economic losses as a result of closing a Lake Michigan beach due to pollution could be as high as \$37,030 per day.²⁷

Other economic impacts come in the form of medical costs to stricken beachgoers. Some areas either do not monitor their beaches or do not close them when water quality fails to meet standards. This can result in lower short-term losses for local businesses, but it also means that those who get sick will incur medical costs and lost workdays as a result. A Southern California study, for instance, concluded that each year, fecal contamination at Los Angeles and Orange County beaches caused between 627,800 and 1,479,200 excess gastrointestinal illnesses, with a public health cost of \$21 million to \$51 million.²⁸ According to the Centers for Disease Control and Prevention, hospitalizations



for three common waterborne diseases—Legionnaires' disease, cryptosporidiosis, and giardiasis—cost the health care system as much as \$539 million annually.²⁹

Another example of the potential for economic harm from beach pollution is found in Florida. One analysis of southeast Florida estimated that there were more than 18 million "person-days" of visits to natural reefs in four counties, leading to \$2.7 billion in spending and supporting more than 40,000 full- and part-time jobs.³⁰ Yet coral reefs are being adversely impacted not only by rising water temperatures and increasing nutrient loads, but also by pathogen pollution from sources such as untreated or inadequately treated sewage. Fecal contamination from sewage in the Florida Keys is thought to be a major source of disease in coral.³¹

Investments in improving water quality result in greater economic returns. For instance, a 2007 Brookings Institution study concluded that the \$26 billion Great Lakes Regional Collaboration Strategy to clean and preserve the Great Lakes would result more than \$50 billion in long-term economic benefits and between \$30 and \$50 billion in short-term "multiplier benefits."³² A 2007 study by the National Oceanic and Atmospheric Administration found that an improvement in water quality in Long Beach, California, to the healthier standards of Huntington City Beach would create \$8.8 million in economic benefits over a 10-year period.³³ A 2001 study of the Chesapeake Bay compared the 1996 water quality of the bay with the quality it would have had if legislation to clean the waters had not been passed. The study estimated that the water quality improvements increased annual boating, fishing, and swimming revenue by \$357.9 million to \$1.8 billion.³⁴

Cleaning up the sources of pollution so that beach water does not pose a risk to bathers is the optimal solution to the challenges described here. In the meantime, protecting public health will require improved beach water monitoring and the closing of beaches when contamination is detected or suspected, rather than allowing people to swim and get sick. Given the large number of people who visit our coastal waters and the substantial economic value of coastal tourism, the cost of monitoring programs is well justified.

Endnotes

- 1 Health Canada, "Guidelines for Canadian Drinking Water Quality: Supporting Documentation—Protozoa: Giardia and Cryptosporidium," Water Quality and Health Bureau, Healthy Environments and Consumer Safety Branch, Health Canada (2004): 11, www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/protozoa/protozoa.pdf.
- 2 Centers for Disease Control and Prevention, "Giardiasis Surveillance—United States, 2009-2010," September 2012, www.cdc.gov/mmwr/preview/mmwrhtml/ss6105a2.htm?s_cid=ss6105a2_w.
- 3 Heany, C.D., et al., "Contact with Beach Sand Among Beachgoers and Risk of Illness," *American Journal of Epidemiology* 170, no. 2 (May 2009), aje.oxfordjournals.org/content/170/2/164.full.pdf+html.
- 4 Brinks, M.V., et al., "Health Risk of Bathing in Southern California Coastal Waters," *Archives of Environmental & Occupational Health* 63, no. 3 (Fall 2008).
- 5 Curriero, F.C., et al., "The Association Between Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1949-1994," *American Journal of Public Health* 91, no.8 (August 2001), www.ajph.org/cgi/reprint/91/8/1194.pdf.
- 6 Tseng, L.Y., and S.C. Jiang, "Comparison of Surfing Health Risk in Dry Weather and Post-Storm Conditions Using Quantitative Microbial Risk Assessment (qMRA) for Southern California Beaches," Department of Civil and Environmental Engineering, University of California, Irvine, May 2012, water.epa.gov/type/oceb/beaches/upload/TsengLinda.pdf.
- 7 Haile, R., et al., "An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay," Santa Monica Bay Restoration Project (1996), cited in 64 Fed. Reg. 68,721 (December 8, 1999).
- 8 Benson, Keith, Patricia Kocagil, and James Shortle, "Climate Change and Health in the Mid-Atlantic Region," *Climate Research* 14, no. 5 (May 2, 2000): 245-253.
- 9 Curriero, F.C., et al., "The Association Between Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948-1994," *American Journal of Public Health* 91, no. 8(August 2001), www.ajph.org/cgi/reprint/91/8/1194.pdf.
- 10 Louis, V.R., et al., "Predictability of Vibrio Cholerae in Chesapeake Bay," *Applied and Environmental Microbiology* 69, no. 5 (May 2003): 2773-2785.
- 11 Ibid.
- 12 Woods Hole Oceanographic Institution, "The Harmful Algae Page," www.whoi.edu/redtide/.
- 13 Van Dolah, Frances M., "Marine Algal Toxins: Origins, Health Effects, and Their Increased Occurrence," *Environmental Health Perspectives Supplements* 108, no. S1 (March 2000).
- 14 National Oceanic and Atmospheric Administration, Center of Excellence for Great Lakes and Human Health, "Frequently Asked Questions: What Are the Dangers of Harmful Algal Blooms?" www.glerl.noaa.gov/res/Centers/HABS/faqs_dangers_habs.html.
- 15 Woods Hole Oceanographic Institution, "The Harmful Algae Page," www.whoi.edu/redtide/.
- 16 Brand, L.E., and A. Compton, "Long-Term Increase in *Karenia Brevis* Abundance Along the Southwest Florida Coast," *Harmful Algae* 6, no. 2 (February 2007): 232-252.
- 17 Praetorius, Dean, "Lake Erie's Toxic Algae Bloom Seen from Space: Green Scum Rampant in the Great Lakes," *The Huffington Post*, October 14, 2011, www.huffingtonpost.com/2011/10/14/lake-eris-toxic-algae-bloom_n_1010902.html.
- 18 Moore, S.K., et al. (2008); Mortsch, L., et al., "Climate Change and Water Quality in the Great Lakes Region: Risks, Opportunities, and Responses," report prepared for the Great Lakes Water Quality Board of the International Joint Commission (August 2003): 91.
- 19 Chesapeake Bay Foundation, "Bad Water 2009: The Impact on Human Health in the Chesapeake Bay Region" (July 2009): 9.
- 20 See generally Woods Hole Oceanographic Institution, "Prevention, Control and Mitigation of Harmful Algal Blooms: A Research Plan" (September 2001): 9-10, www.whoi.edu/science/B/redtide/pertinentinfo/PCM_HAB_Research_Plan.
- 21 U.S. Environmental Protection Agency, "Liquid Assets: A Summertime Perspective on the Importance of Clean Water to the Nation's Economy," publication no. 800-R-96-002 (May 1996): 2.
- 22 U.S. EPA, Office of Water, "Coastal Watershed Factsheets - The Beach and Your Coastal Watershed," April 1998, <http://water.epa.gov/type/oceb/fact2.cfm>.
- 23 U.S. Environmental Protection Agency, "Liquid Assets: A Summertime Perspective on the Importance of Clean Water to the Nation's Economy," publication no. 800-R-96-002 (May 1996): 2.
- 24 National Ocean Economic Program, Market Data, Coastal Economy Data, Shore Adjacent Coastal Zone Counties, noep.mbari.org/Market/coastal/coastalEcon.asp.
- 25 Ibid.
- 26 Rabinovici, S.J., et al., "Economic and Health Risk Trade-Offs of Swim Closures at a Lake Michigan Beach," *Environmental Science and Technology* 36, no. 10 (2004): 2742.
- 27 Ibid.
- 28 Given, S., et al., "Regional Public Health Cost Estimates of Contaminated Coastal Waters: A Case Study of Gastroenteritis at Southern California Beaches," *Environmental Science and Technology* 40, no. 16 (2006): 4851.
- 29 Centers for Disease Control and Prevention, Division of Media Relations, "Waterborne Diseases Could Cost Over \$500 Million Annually in U.S." CDC Newsroom, July 14, 2010, www.cdc.gov/media/pressrel/2010/r100714.htm.
- 30 Johns, G.M., et al., "Socioeconomic Study of Reefs in Southeast Florida," final report, October 19, 2001, revised April 18, 2003, coastalsocioeconomics.noaa.gov/core/reefs/02-01.pdf.
- 31 Whitfield, J., "Sewage Casts Pox on Reefs," *Nature*, June 18, 2002.
- 32 Austin, J.C., et al., "Healthy Waters, Strong Economy: The Benefits of Restoring the Great Lakes Ecosystem" Brookings Institution (September 2007), at 2, 5, 10, www.brookings.edu/metro/pubs.20070904_gleiecosystem.pdf.
- 33 Leeworthy, V.R., and P.C. Wiley, "Southern California Beach Valuation Project: Economic Value and Impact of Water Quality Change for Long Beach in Southern California," National Oceanic and Atmospheric Administration, February 2007.
- 34 Morgan, C., et al., "Benefits of Water Quality Policies: The Chesapeake Bay," *Ecological Economics* 39, no. 2 (November 2001): 271-284.