

Swimming in the Great Lakes

The Great Lakes constitute America's third coast. More than 1,000 freshwater beaches stretch along 5,500 miles of Great Lakes shoreline in eight states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin). Great Lakes beaches provide more than 30 million people with direct access to the world's largest fresh water ecosystem, recreation throughout the year, and relief from the hot, humid dog days of summer. Unfortunately, many Great Lakes beaches are also polluted. Fifteen percent of Great Lakes beach samples violated public health standards for safe swimming in 2008, more than twice the national average. The specter of a rapid increase in violent storms resulting from climate change, as well as ecosystem impacts due to the introduction of invasive species, have the potential to exacerbate this health-threatening situation.

Since the federal BEACH Act was passed in 2000, more attention from beach managers, lawmakers, and scientists is being focused on these Great Lakes treasures. Before the Act was passed, just 250 Great Lakes beaches were being monitored. By 2008, the number of beaches monitored reached 1,395, with 557 (40 percent) monitored at least once per week. As a result of increased monitoring, most states now have a better sense of the scope of contamination at their beaches. Despite this improvement, a significant number of measures are needed to make Great Lakes beaches safe for public use and enjoyment. Legislatively, the Great Lakes Regional Collaborative represents an attempt by lawmakers to fill funding gaps for programs like the BEACH Act that currently fail to provide enough resources and money to address the causes of Great Lakes beach contamination.

Thirteen percent of Great Lakes beach samples violated public health standards for safe swimming in 2008, nearly twice the national average.

While more beaches in the Great Lakes are generally better monitored than in the past, there remains room for improvement in the methods, frequency and extent of monitoring, and the quality and timeliness of public notification of beach quality and safety. For example, there are 72 Tier 1 beaches (i.e., popular beaches and or beaches near potential pollution sources) in Wisconsin and one in Minnesota that are not being monitored. Monitoring methods and the frequency of monitoring high priority beaches are also inconsistent from state to state. Some beaches are monitored daily, while others are monitored weekly or even less often. In part, these inconsistencies appear to be the result of inadequate sources of funding and staffing levels. Unfortunately, the inconsistencies make water quality comparisons between beaches difficult, and infrequent monitoring provides insufficient protection of public health.

Like monitoring, public notification of beach quality and safety is critical to protecting public health. Here too, practices within the Great Lakes are inconsistent both within and across states. States differ not only in the information they use to make beach closing and advisory decisions, but also in how they convey this information to the public. While some states issue both advisories and closings, others issue only closings or only advisories.

Monitoring results reveal the extent to which sources of beachwater pollution remain unaddressed. Closings and advisories continue to rise steadily, but the sources of pollution are often not identified, much less controlled. A 2006 study estimated that 20 cities dump almost 25 billion gallons of untreated sewage into the Great Lakes each year through combined sewer overflows.¹ And combined sewer overflows are not the only source of contamination for the Lakes. Gaps in knowledge about the various pollution sources hinder the creation of a comprehensive plan and public action agenda to improve beach and water quality in the Great Lakes Basin so as to fully protect public health and safety. Further improvements to monitoring and public notification programs should include, at a minimum, (a) ensuring all popular coastal beaches are tested, (b) developing better indicators of the wide variety of potential swimming-related illnesses, and (c) turning around test results faster.

Most beach officials in Great Lakes states use traditional culture-based test methods that require about 24 hours to quantify bacterial indicator levels in beachwater samples—essentially telling people a day late that they should not have used particular beaches. Beach authorities in four Great Lakes states (Illinois, Indiana, Ohio, and Wisconsin) are successfully using predictive models at some of their beaches to make real-time beach closing and advisory decisions based on easily measured environmental parameters that allow for much more timely decision making. Also, many of the Great Lakes

states have participated in pilot projects to research rapid test methods for quantifying indicator bacteria levels and the link between these levels and illness rates in swimmers. Michigan and Ohio participated in the EPA’s National Epidemiological and Environmental Assessment of Recreational (NEEAR) Water Studies. These studies are being conducted to better understand the relationships between bacterial indicators, swimming at the beach, and impacts on human health. Beachgoers are interviewed and water samples are collected and analyzed for bacteria using several analysis methods including rapid test methods. Indiana and Minnesota have conducted studies of rapid test methods in addition to the NEEAR studies as well.

BACTERIA IN GREAT LAKES BEACHWATER

NRDC conducted a comparative analysis of water quality at beaches all along the U.S. Great Lakes shoreline using publicly available monitoring data from all eight Great Lakes states. The number and percentage of samples exceeding the BEACH Act standard for designated freshwater beaches were identified. Thirteen percent of all beachwater samples collected in 2008 exceeded the BEACH Act required daily maximum *E. coli* standard for designated freshwater beaches (235 colony forming units of *E. coli* per 100 ml of water).² These unsafe levels indicate the presence of human or animal waste in the water that could make swimmers sick. Over the four-year period during which NRDC has conducted this analysis of Great Lakes beaches, 12 to 15 percent of samples at the 455 beaches that reported monitoring data for each year had unsafe *E. coli* contamination—well above the national average.

For the 2008 beach season, the highest percent of exceedances among the Great Lakes states were in New York and Ohio (19%), followed by Indiana (18%), Illinois (15%), Wisconsin (14%), Pennsylvania (9%), Michigan (6%), and Minnesota (5%) (see Table 1). The highest percent of exceedances in Great Lakes urban areas were again found at beaches in Cleveland, Ohio (42%), followed this year by Milwaukee, Wisconsin (22%), Gary, Indiana (17%), Toledo, Ohio (15%), Chicago, Illinois (11%, with by far the largest number of samples), Duluth, Minnesota (9%), Detroit, Michigan (9%), and Green Bay, Wisconsin (0%) (See Table 2).

The dozen dirtiest Great Lakes beaches in 2008 were Jeorse Park Beach I in Lake County, Indiana (67%), followed by North Point Marina North Beach in Lake County, Illinois (61%), Jeorse Park Beach II in Lake County, Indiana (53%), Lakeshore Park in Ashtabula County, Ohio (53%), Crescent Sail Yacht Club beach in Wayne County, Michigan (52%), Wisconsin Point Beach 2 in Douglas County, Wisconsin (52%), Buffington Harbor Beach in Lake County, Indiana (50%), South Shore Beach in Milwaukee County, Wisconsin (49%), Euclid State Park in Cuyahoga County, Ohio (47%), Villa Angela State Park in Cuyahoga County, Ohio (45%), Fischer Park Beaches in Manitowoc County, Wisconsin (44%), and Krull Park in Niagara County, New York (42%).

More than 25 percent of the samples taken in 2008 at the beaches in Table 3 exceeded the standard for designated beaches. A handful of beaches are repeat offenders: more the 25 percent of the samples taken each year for the last four years, 2005 through 2008, exceeded health standards at the beaches listed in Table 4.

Figure 1. Percent of Samples Exceeding *E. coli* Standard for All Great Lakes States Combined, 2005–2008

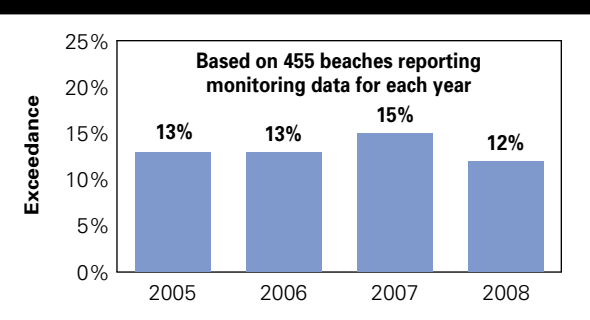


Table 1. Rank of States by Percent of Samples Exceeding the National Daily Standard, 2008

State	Total Samples	Percent Exceedances
Illinois	1,459	19%
Ohio	2,429	19%
Indiana	1,671	18%
Illinois	4,140	15%
Wisconsin	4,366	14%
Pennsylvania	1,534	9%
Michigan	5,008	6%
Minnesota	1,177	5%

Table 2. Rank of Great Lakes Urban Areas by Percent of Samples Exceeding the National Daily Standard, 2008

City	State	Total Samples	Percent Exceedances	Beaches
Cleveland	Ohio	326	42%	3
Milwaukee	Wisconsin	571	22%	11
Gary	Indiana	119	17%	3
Toledo	Ohio	53	15%	1
Chicago	Illinois	1,535	11%	22
Duluth	Minnesota	580	9%	15
Detroit	Michigan	121	9%	1
Green Bay	Wisconsin	13	0%	1

Table 3. Beaches with More Than 25 Percent of Samples Exceeding Daily National Standards, 2008 (limited to beaches with at least 10 total samples reported for the year)

State	County	Beach	Tier	Monitoring Frequency	Total Samples	Percent Exceedance
IN	Lake	Jeorse Park Beach I	2	5/wk	73	67%
IL	Lake	North Point Marina North Beach	1	Daily	126	61%
IN	Lake	Jeorse Park Beach II	2	5/wk	75	53%
OH	Ashtabula	Lakeshore Park	2	4/wk	55	53%
MI	Wayne	Crescent Sail Yacht Club	1	2/wk	31	52%
WI	Douglas	Wisconsin Point Beach 2	3	1/wk	25	52%
IN	Lake	Buffington Harbor Beach	2	5/wk	72	50%
WI	Milwaukee	South Shore Beach	1	Daily	55	49%
OH	Cuyahoga	Euclid State Park	1	Daily	109	47%
OH	Cuyahoga	Villa Angela State Park	1	Daily	109	45%
WI	Manitowoc	Fischer Park Beaches	3	1/wk	36	44%
NY	Niagara	Krull Park	2	1/wk	24	42%
OH	Erie	Bay View West	3	3/wk	41	41%
WI	Manitowoc	Neshotah Beach	2	2/wk	39	41%
WI	Kenosha	Eichelman Beach	2	2/wk	43	40%
MI	Wayne	Pier Park	1	2/wk	35	37%
NY	Wayne	Pultneyville Mariners Beach	3	1/wk	19	37%
WI	Manitowoc	Red Arrow Park Beach Manitowoc	2	2/wk	36	36%
WI	Kenosha	Alford Park Beach	3	1/wk	23	35%
WI	Kenosha	Pennoyer Park Beach	3	1/wk	23	35%
WI	Manitowoc	Memorial Drive Wayside Beach South	2	2/wk	34	35%
NY	Erie	Woodlawn Beach-Woodlawn Beach State Park	1	1/wk	88	34%
OH	Cuyahoga	Edgewater State Park	1	Daily	108	34%
WI	Ozaukee	Harrington State Park Beach North	1	4/wk	65	34%
IL	Cook	Winnetka Elder Park Beach	1	Daily	67	33%
WI	Sheboygan	Kohler Andrae State Park North Picnic Beach	1	4/wk	54	33%

Table3 (continued)						
State	County	Beach	Tier	Monitoring Frequency	Total Samples	Percent Exceedance
IL	Cook	Evanston South Beach	1	Daily	151	32%
NY	Chautauqua	Sunset Bay Beach Club	3	1/wk	28	32%
NY	Chautauqua	Lake Erie State Park Beach	1	2/wk	41	32%
WI	Manitowoc	Hika Park Bay	3	1/wk	22	32%
WI	Ozaukee	County Road D Boat Launch Beach	1	4/wk	62	32%
WI	Ozaukee	Harrington State Park Beach South	1	4/wk	63	32%
IL	Cook	Northwestern University Beach	1	5/wk	58	31%
MN	St Louis	Park Point Southworth Marsh Beach	1	2/wk	61	31%
OH	Lorain	Lakeview Beach	2	4/wk	55	31%
WI	Ozaukee	Cedar Beach Rd Beach	1	4/wk	64	31%
MI	Arenac	Singing Bridge Beach	1	1/wk	10	30%
MI	Macomb	St. Clair Shores Memorial Park Beach	1	2/wk	144	30%
NY	Monroe	Ontario Beach	1	2/wk	246	30%
OH	Erie	Edison Creek	3	3/wk	40	30%
OH	Lorain	Century Beach	2	4/wk	96	30%
WI	Manitowoc	Memorial Drive Wayside Beach North	2	2/wk	37	30%
NY	Erie	Evans Town Park	2	2/wk	38	29%
WI	Kenosha	Southport Park Beach	3	1/wk	21	29%
WI	Milwaukee	McKinley Beach	1	Daily	45	29%
OH	Ottawa	Camp Perry	2	4/wk	53	28%
OH	Erie	Huron River West	3	3/wk	41	27%
IL	Lake	Waukegan South Beach	1	Daily	102	26%
NY	Erie	Lake Erie Beach	1	2/wk	39	26%

Table 4. Repeat Offenders: Beaches with More Than 25 Percent of Samples Exceeding Daily National Standards in 2005, 2006, 2007, and 2008 (alphabetical by state, county, and beach)

State	County	Beach	Tier	Monitoring Frequency	Potential Pollution Sources (reported by EPA)
IL	Lake	North Point Marina North Beach	1	Daily	Unknown
OH	Cuyahoga	Villa Angela St. Pk.	1	Daily	None Listed
OH	Ottawa	Camp Perry	2	4/wk	None Listed
WI	Kenosha	Eichelman	2	2/wk	Unknown
WI	Milwaukee	South Shore	1	Daily	Unknown
WI	Sheboygan	Kohler Andrae North Picnic	1	4/wk	Unknown

GREAT LAKES BEACH CLOSINGS/ADVISORIES AND POLLUTION SOURCES

• During 2008, U.S. Great Lakes beaches had 3,437 days of closings and advisories, and 2 extended closings and advisories (7 to 13 consecutive weeks). Including extended days, the total comes to 3,559 beach closing and advisory days.

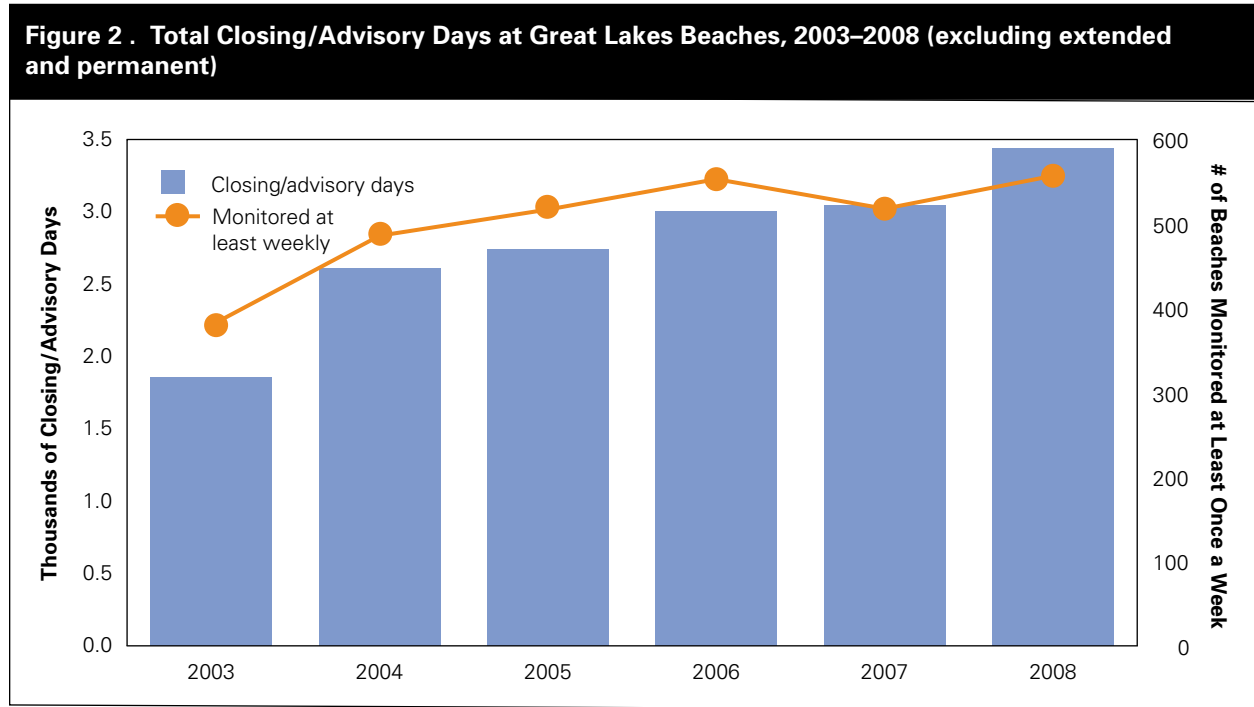
- The number of beach closing and advisory days increased 13 percent between 2008 and 2007 (3,437 vs 3,043 days) following a 1 percent increase in 2007 (see Figure 2).
- The continued high level of closings/advisories is an indication that frequent monitoring continues to reveal serious water pollution at our nation’s Great Lakes beaches. Figure 3 shows that 2,898 (84 percent) of the 2008 beach closing and advisory days were issued because water quality monitoring showed that bacteria levels exceeded health and safety standards (212 days more than in 2007).

Major reasons for beach closings and advisories in 2008 were as follows (see Figure 3):

- 84 percent were based on monitoring that detected bacteria levels exceeding beachwater quality standards.
- 11 percent were precautionary, due to rainfall known to carry pollution to swimming waters.
- Less than 1 percent were issued in response to known pollution events, such as sewage treatment plant failure or breaks in sewage pipes.
- 2 percent were due to other causes, such as strong waves.
- 3 percent (111) were preemptive due to real-time computer modeling that use readily measurable physical parameters such as wind speed and wave heights to predict indicator bacterial levels. This is the first time NRDC is able to report this reason for beach closings and advisories.

Major pollution sources listed as responsible for 2008 beach closings and advisories include the following (see Figure 4):

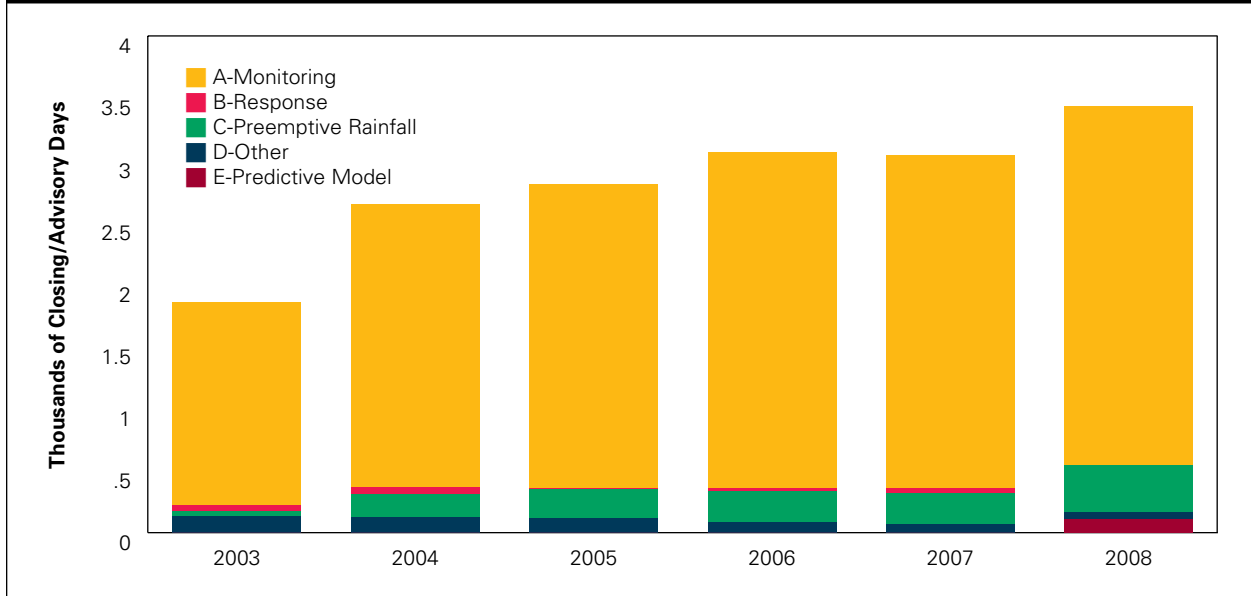
- Unknown sources of pollution caused 3,015 closing/advisory days (88 percent of this year’s total), compared to 1,994 days in 2007.
- Polluted runoff and stormwater caused or contributed to 550 closing/advisory days (16 percent of this year’s total), compared to 914 days in 2007.



Note: Because of inconsistencies in monitoring and closing/advisory practices among states and the different levels of data submission over time, it is difficult to make comparisons between states or to assess trends based on the closing/advisory data.

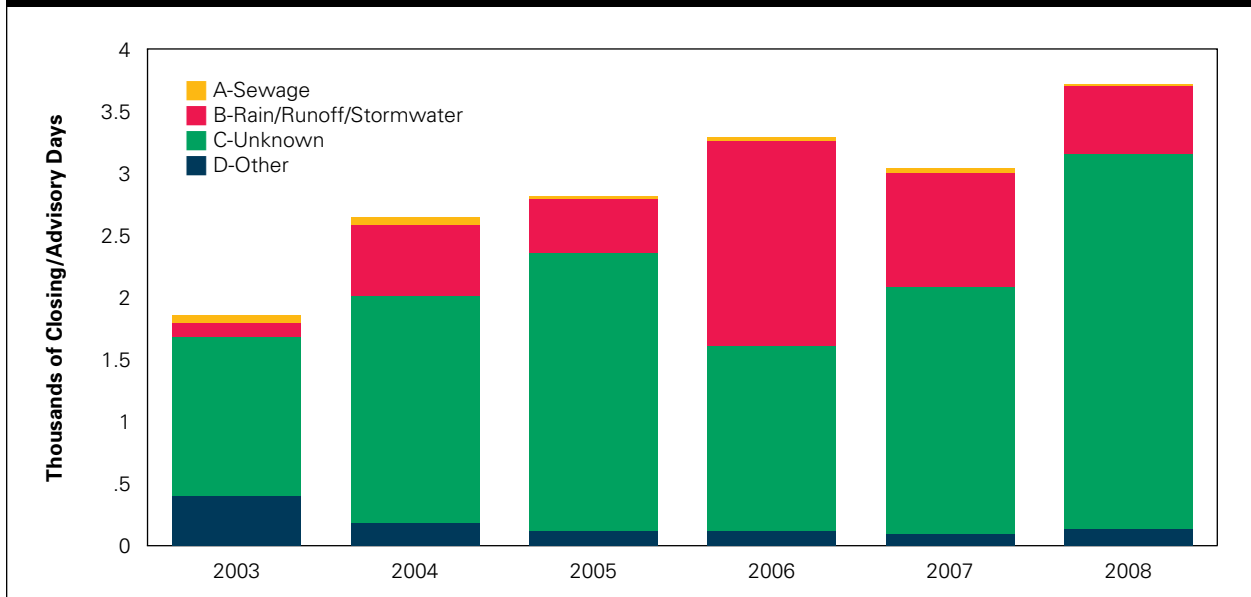
- Sewage spills and overflows caused or contributed to 16 closing/advisory days (<1 percent of this year’s total), compared to 44 days in 2007.
- Elevated bacteria levels from miscellaneous sources (boat discharges, wildlife, etc.) accounted for 134 closing/advisory days (4 percent of this year’s total), compared to 91 days in 2007.

Figure 3. Reported Reasons for Closings/Advisories at Great Lakes Beaches, 2003–2008



Key: (A) Based on monitoring that detected bacteria levels exceeding standards. (B) In response to known pollution event without relying on monitoring. (C) Preemptive due to rain known to carry pollution to swimming waters. (D) Other reason. (E) Real-time, predictive computer modeling.

Figure 4. Sources of Pollution that Caused Closings/Advisories at Great Lakes Beaches, 2003–2008



Key: (A) Sewage spills and overflows. (B) Polluted runoff, stormwater, or preemptive due to rain. (C) Unknown. (D) Other reasons, including those with no source information provided.

Health Risks

Pathogens in sewage-contaminated beachwater can cause a wide range of diseases that threaten human health, including ear, nose, and throat problems, gastroenteritis, dysentery, hepatitis, and respiratory illness. The consequences of these swimming-associated illnesses can be greater for children, elderly people, pregnant women, cancer patients, and others with weakened immune systems.

Pollution contributes to the contamination of popular beaches. Land development near the lakes and the attendant contaminated runoff in particular continues to be a significant contribution to the contamination. This problem is a significant and growing threat. As noted in the report “Global Climate Change Impacts in the United States” by the Interagency Global Climate Research Program, torrential downpours will increase the frequency of dangerous stormwater runoff-related health risks.³ This problem is potentially made worse by increasing heat waves driving the public to beaches for relief. Additionally, there is growing evidence that broad changes in the freshwater environment of the Great Lakes brought about by invasive species (especially the mussels filtering particles and allowing sunlight to pierce deeply into the Lakes) are promoting conditions that nurture bacteria, including *E. coli*, thereby deepening the threat.⁴

The Centers for Disease Control and Prevention (CDCP) compiles self-reported accounts of illnesses and reports on disease outbreaks associated with beachwater recreation. Within the Great Lakes region, the most recent report (2003–2004) found 9 accounts of illness suffered by visitors to swimming beaches in Ohio’s in 2003. In 2004, there were 9 illnesses reported in Minnesota by visitors to swimming beaches, and 18 reported illnesses at a state park in Wisconsin.⁵ Most of these cases were gastrointestinal illnesses; 3 were related to skin irritation. In the CDCP’s previous report (2001–2002), there were accounts from 40 people who became sick with gastroenteritis after swimming at a public beach in Minnesota in 2001, and 66 people became sick with gastroenteritis after swimming at a public beach in Wisconsin.⁶ Many people who become ill from swimming in contaminated water do not make a connection between their symptoms and the water, partly because the onset of symptoms is delayed. Given that the CDCP’s report relies on self-reporting, the actual number of illnesses suffered by swimmers in the Great Lakes can be much higher and CDCP has no reliable estimate for the number of unreported waterborne disease outbreaks.⁷

As part of its requirement to develop more protective health standards under the BEACH Act, the EPA conducted studies in 2003 at two Great Lakes beaches to determine illness rates for gastrointestinal and respiratory infections among swimmers. At Indiana Dunes National Lakeshore on Lake Michigan in Indiana, it was found that those who had any contact with water were almost twice as likely (10%) to have gastrointestinal illness compared with those who did not (5%). The risk of gastrointestinal illness was 14 percent at a beach located on Lake Erie near Cleveland, Ohio. The presence of the indicator organism enterococcus was associated with the increased risk of illness. The study concluded that enterococcus measured using rapid methods can predict gastrointestinal illness after swimming in fecally contaminated freshwater and that samples collected each morning could allow beach managers to assess the microbiological safety of the beach before most beachgoers are exposed.⁸ A 2002 pilot study at Indiana Dunes National Lakeshore in Indiana found that 17 percent of survey respondents who swallowed water contracted respiratory illness and 13 percent contracted gastrointestinal illness.⁹

Bacterial Standards

Seven of the eight Great Lakes states are using the BEACH Act single sample standard to inform beach closing/advisory decisions. This standard is 235 cfu/100 ml of *E. coli*. Michigan’s single-sample standard is 300 cfu/100 ml of *E. coli*.

Two of the Great Lakes states use a geometric mean standard based on at least five samples over a 30-day period to inform beach closing/advisory decisions. Minnesota applies the BEACH Act geometric mean standard of 126 cfu/100 ml and Michigan applies a geometric mean standard of 130 cfu/100 ml. Great Lakes states that do not apply the geometric mean standard when making closing and advisory decisions are Illinois, Indiana, Ohio, Pennsylvania, and Wisconsin. In New York, local beach authorities decide whether or not to apply the geometric mean when making closing and advisory decisions.

In addition to direct measurement of *E. coli* levels, which typically take 24 hours for results, four states (Illinois, Indiana, Wisconsin and Ohio) are using predictive models at eight beaches (Lake Street Beach, Marquette Park Beach, and Wells Street Beach in Lake County and Ogden Dunes Beach and West Beach - Indiana Dunes National Lakeshore in Porter County, Indiana; Forest Park Beach in Lake Forest, Rosewood Beach in Highland Park, and South Beach in Waukegan, Illinois; South Shore Beach in Milwaukee, Wisconsin; and Huntington Beach in Cuyahoga County, Ohio).

Predictive models allow real-time estimates of *E. coli* levels based on easily measured physical parameters such as wind direction and water temperature. Real-time measurements allow for real-time beach closing/advisory determinations, which are more protective of public health. These models need to be tailored to the unique conditions at each beach, thus requiring significant research and development time. Studies suggest that use of these models results in closings and advisories that better protect public health than those issued based on day-old monitoring results.¹⁰

Economic Effects

Water pollution has a significant economic effect on Great Lakes states. Failing to invest in clean water costs Great Lakes states jobs, job productivity, tourism and property-tax dollars, and economic growth. One study estimated economic losses as a result of closing a Lake Michigan beach due to pollution as ranging between \$7,900 and \$37,000 per day. The study also anticipated additional economic losses from polluted waters due to swimming-related illnesses and from beachgoers' lost use of the beach.¹¹ Another study by the University of Chicago, estimates swim bans at Chicago beaches cost the local economy approximately \$2.4 million a year.¹²

Beaches are the top vacation destination in the country. And coastal tourism, dependent in part on clean beaches, generates substantial revenues for state and local governments. According to the Report of the U.S. Commission on Ocean Policy, ocean-related tourism and recreation contributed roughly \$29 billion and 1.67 million jobs to the U.S. economy in 2000.

Boating is a significant source of economic revenue for the Great Lakes. Nearly one-third of the nations' boats are registered in the Great Lakes. In 2003, direct revenue from Great Lakes boating was \$16 billion and it was responsible for 107,000 jobs. Indirect revenue from boating related industries such as manufacturing, marinas, charter operations, restaurants, lodging and other businesses located near docking facilities increased the total number of jobs to 244,000 and revenue to \$19 billion.¹³

Beach-related products, such as swimsuits, sunscreen, beach chairs, towels, boogie boards, and surfboards, generate hundreds of millions, if not billions of dollars each year in sales. Sunscreen lotions and potions alone earn manufacturers revenues of about \$640 million a year.¹⁴

RECOMMENDATIONS FOR GREAT LAKES COMMUNITIES

- **The U.S. EPA should allow BEACH Act funding to be used for source elimination.** This recommendation was made by a panel of experts at EPA's 2006 National Beaches Conference. Local officials in the Great Lakes indicate they lack information on sources of contamination and funds to remediate the sources. Two Great Lakes states (Ohio and Indiana) indicate that they conduct no source identification or prevention activities at their Great Lakes beaches. Congress should pass the Clean Coastal Environment and Public Health Act (H.R. 2093/S. 878), which would reauthorize the federal BEACH Act of 2000, increase the authorized funding and, in the stronger Senate version, allow that funding to be used for identifying and correcting sources of beachwater contamination.

- **Congress should also pass the American Clean Energy and Security Act** (H.R. 2454, also known as ACES), which will reduce emissions of global warming pollution and help communities prepare for flooding, sea level rise, increased stormwater pollution, sewer overflows, and other adverse impacts of climate change

- **Monitor every popular beach in the Great Lakes.** There are still 73 popular Great Lakes beaches (beaches given an EPA "Tier 1" status) that are not monitored (1 in Michigan and 72 in Wisconsin). Many of the beaches are not monitored due to lack of funding, lack of accessible labs, and the perception that beaches located away from urban areas are not as susceptible to contamination. As the 2002 outbreak in Door County demonstrated, however, non-urban beaches are vulnerable to bacteria inputs. BEACH Act money can be used to establish labs in non-urban areas. If passed, the Clean Coastal Environment and Public Health Act would increase the amount of grant funds made available to states each year.

- **Conduct routine sanitary surveys to identify sources of beach contamination.** In 2002, more than 60 people got sick in Door County after swimming in contaminated water. Prompted by the outbreak, the county initiated the "beach

contamination source identification project” to identify sources of contamination and pinpoint appropriate monitoring stations. Door County now monitors more than half its beaches and has implemented best management practices at many of its beaches to reduce pollution sources. In 2006, the U.S. EPA announced a program to make \$500,000 in grants available for conducting sanitary surveys at Great Lakes beaches. Through an EPA grant, Lake County in Illinois began piloting a sanitary sewer survey methodology at its beaches in 2007. These programs should be expanded throughout the Great Lakes.

- **Strengthen programs for control of contaminated stormwater and combined sewer overflows, both of which are significant causes of closings and advisories at Great Lakes beaches.** Green infrastructure approaches that use soil and vegetation to reduce and filter stormwater flows and lessen the volume of raw sewage discharges from combined sewers are proving promising in Great Lakes cities, such as Chicago and Milwaukee.¹⁵ These approaches have been endorsed by U.S. EPA and should be expanded throughout cities in the Great Lakes.

- **Require real time reporting and direct public notification of sewage overflows.** Congress should pass the Sewage Overflow Community Right-to-Know Act (H.R. 753/S. 937) to ensure uniform notification of the public and public health authorities across the Great Lakes.

- **Incorporate public education into beach management programs.** Public education continues to be an important tool for reducing bacterial inputs to beaches. Interested communities should contact organizations such as the Alliance for the Great Lakes (www.GreatLakes.org) to start an adopt-a-beach program to help monitor and eliminate sources of contamination at their beach.

- **Address issues associated with living pollution.** Invasive species such as the zebra mussel have already made fundamental ecological changes to the Great Lakes, and many researchers believe these changes have created ideal conditions for bacterial growth which impacts public health. Many of these species were stowaways in the ballast tanks of ships, which has led some states to strengthen anti-invasive species laws regulating ballast dumping in their waters. However, stronger legal protections are necessary to prevent the continued introduction and spread of alien species, bacteria, and viruses. The US EPA’s ballast water general permit should be updated to be consistent with stricter state standards. Additionally, press for full funding of Great Lakes restoration and collaboration initiatives which will allow EPA to continue funding research and habitat restoration in the region to help stem the impacts of invasive species.

Notes

1 Sierra Legal, “The Great Lakes Sewage Report Card”, November 2006.

2 In 2008, 13 percent of monitoring samples at Great Lakes coastal beaches exceeded the Beach Act’s daily maximum E. coli standard (based on 21,784 samples at 558 beaches). However, in order to make a meaningful comparison from year to year, NRDC includes only those beaches consistently reporting monitoring data results each year between 2005 and 2008. Based on the results of this set of 455 Great Lakes beaches, exceedances decreased to 12 percent in 2008 from 15 percent in 2007.

3 Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.), “Global Climate Change Impacts in the United States,” Cambridge University Press, 2009, <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts>.

4 Englebert ET, McDermott C, Kleinheinz GT. Effects of the nuisance algae, Cladophora, on Escherichia coli at recreational beaches in Wisconsin. *The Science of the total environment*. 2008 Oct;404(1):10-7.

5 Eric J. Dziuban, et al., “Surveillance for Waterborne-Disease Outbreaks Associated with Recreational Water—United States, 2003–2004,” in *Morbidity and Mortality Report*, Centers for Disease Control and Prevention, December 22, 2006, 55(SS12);1-24.

6 Jonathan S. Yoder, M.P.H., et al., “Surveillance for Waterborne-Disease Outbreaks Associated with Recreational Water—United States, 2001–2002,” in *Morbidity and Mortality Report*, Centers for Disease Control and Prevention, October 22, 2004, 53(SS08);1-22.

7 Ibid., p. 3.

8 Wade, Timothy J., R. L. Calderon, E. Sams, M. Beach, K. P. Brenner, A. H. Williams, A. P. Dufour, “Rapidly Measured Indicators of Recreational Water Quality Are Predictive of Swimming-Associated Gastrointestinal Illness,” *Environmental Health Perspectives* Volume 114, Number 1, January 2006

9 Alfred Dufour, Rebecca Calderon, Timothy Wade, Elizabeth Sams, and Michael Beach, *National Epidemiological and Environmental Assessment of Recreational (NEEAR) Water Study*, “West Beach Pilot Study 2002,” a powerpoint presentation prepared by U.S. EPA.

10 Shannon Briggs, Michigan Department of Environmental Quality, personal communication, June 2009.

11 Sharyl J. M. Rabinovici, Richard L. Bernknopf, Anne M. Wein, Don L. Coursey, and Richrd L. Whitman, “Economic and Health Risk Trade-Offs of Swim Closures at a Lake Michigan Beach,” in *Environmental Science and Technology*, vol. 38, no. 10, 2004, p. 2742.

- 12 Dr. Sabina L. Shaikh, "Value of Chicago Beaches," University of Chicago, February 20, 2006.
- 13 Great Lakes Commission, "Great Lakes Recreational Boating's Economic Punch," July 2007.
- 14 "New-Wave Sunscreens," *Chemical & Engineering News*, Volume 83, Number 15, American Chemical Society, Washington, D.C., April 11, 2005, pp. 18-22, <http://pubs.acs.org/cen/coverstory/83/print/8315sunscreens.html>.
- 15 Kloss, et al., *Rooftops to Rivers*, Natural Resources Defense Council, 2006, <http://www.nrdc.org/water/pollution/rooftops/contents.asp>.