

# 2023

## Massachusetts Beach Testing Results: Annual Report



### Duxbury Beach, Duxbury, MA

*Photo by Mandy McNeill*

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## Executive Summary

Swimming is one of the most popular recreational activities in Massachusetts (EOEEA, 2017), with over 111 million individual trips to coastal beaches annually (EOEEA, 2007). Each year, the Massachusetts Department of Public Health (DPH), Bureau of Climate and Environmental Health's Environmental Toxicology Program collects beach water quality data from local health departments and the Massachusetts Department of Conservation and Recreation. This report provides a description and summary of that information.

- **Water quality:** In 2023, a total of 16,297 water samples were collected from 596 marine and 583 freshwater beach sampling locations. These locations represent 574 marine and 540 freshwater beaches statewide, with 100% of marine and 99.4% of freshwater beach communities reporting water quality information to DPH. Approximately 8.0% and 5.6% of samples exceeded the Massachusetts bacterial water quality standards for marine and freshwater beaches, respectively, higher than in previous years. While exceedances were above average in 2023, the overall low historical exceedance rates indicate that Massachusetts beaches generally have high water quality. Elevated bacteria accounted for 77% of beach posting days for poor water quality; additional reasons for notifications included cyanobacterial harmful algae blooms, rainfall (typically associated with elevated bacteria), and combined sewer overflows (CSOs).
- **Field data:** In 2023, nearly all water samples (98%) submitted to DPH had accompanying field data. Recent rainfall was identified as the most important factor contributing to elevated bacteria levels at recreational waterbodies. As in previous years, the exceedance rate was greatest in the 24 hours following rainfall. Pollution sources, particularly the presence of larger numbers of birds at marine and freshwater beaches, were also associated with higher levels of bacteria.
- **Public notification:** DPH published a new online beach water quality dashboard during the 2023 beach season (<https://www.mass.gov/info-details/interactive-beach-water-quality-dashboard>), which provides near real-time information on bacteria levels at public beaches, as well as information on current beach postings. The dashboard attracted over 65,000 page views and 43,000 unique visitors despite only being released at the end of July 2023. Individuals are also notified of unsafe conditions at beaches by physical signage that beach operators are required to post. In 2023, 97% of marine and 74% of freshwater beaches were in compliance with the public notification requirements. The lower compliance rate at freshwater beaches is likely to be a reporting failure, rather than a public notification failure, as the missed posting reports come from a small number of towns. DPH will work with these towns this coming season to improve reporting.

## Introduction

Health risks to swimmers associated with poor water quality have been documented in numerous studies (Marion et al., 2010; Wade et al., 2003). Beachgoers may be exposed to pathogens through recreational activities in and around polluted waterbodies (Hlavsa et al., 2015). In the United States, most swimming-associated illnesses are caused by a variety of pathogens associated with fecal contamination (Cabelli et al., 1982; USEPA, 2012). Fecal matter can enter beach water in a variety of ways: sewage treatment system failures, combined sewer overflows, discharge of sewage by boats, re-suspension of sediments, and rainfall with resulting surface runoff (Galfi et al., 2016; Rodrigues et al., 2016).

To minimize swimming-associated illness and injury and to notify the public about the quality of beach water, DPH regulations require regular water quality monitoring and public notification of unsafe conditions. All public and semi-public bathing beaches in Massachusetts are monitored for fecal indicator bacteria (FIB), and on occasion, harmful algae. Monitoring occurs during the beach season which generally begins the weekend of Memorial Day and ends during the weekend of Labor Day.

DPH adopted the U.S. Environmental Protection Agency (USEPA) criteria for enterococci and *E. coli* in marine- and fresh-waters in 2001. These criteria consist of both a single sample and geometric mean (geomean) value reported as colony forming units per 100 milliliters of water (CFU/100 mL) (see Table 1). When beach water exceeds these water quality standards, DPH requires that the beach be posted with a notice alerting the public to the possible risk of swimming.

At a majority of beaches in Massachusetts, water quality is considered to be unacceptable when two samples collected on consecutive days exceed the water quality standards. This approach is consistent with DPH regulations and has helped to minimize the impact of beach closures on vulnerable socio-economic populations, whose local beach may be the only accessible means of recreation during the summer.

Some of the highest use beaches operated by the state are in the urban areas of Boston, Lynn, Quincy, and Revere. Beaches with a history of multi-day elevated bacteria levels are required to post after a single exceedance. Posting is also required when the geomean of the five most recent samples exceeds the geomean standard.

| Beach Type | Indicator      | Single Sample | Geomean |
|------------|----------------|---------------|---------|
| Marine     | Enterococci    | >104          | >35     |
| Freshwater | Enterococci    | >61           | >33     |
|            | <i>E. coli</i> | >235          | >126    |

Table 1. DPH recreational water quality criteria (CFU/100 mL)

In addition to water samples, field data such as days since rainfall and potential pollution sources are required to be recorded at the time of sample collection. Field data help facilitate the interpretation of bacteria data and can improve the understanding of water quality at the local and state level.



Short Beach, Nahant, MA

Photo by Logan Bailey

## Water Quality

**Marine beach exceedances** During the 2023 beach season, 8,504 samples were collected and analyzed from 596 marine sampling locations in the 61 communities with marine beaches. Of these 596 locations, 254 (42.6%) had at least one bacterial exceedance. A total of 680 out of the 8,504 samples exceeded the 104 CFU/100 mL standard bringing the percentage of exceedances for marine waters to 8.0%. The 2023 exceedance rate is higher than the historic average (5.2%) (Figure 1).

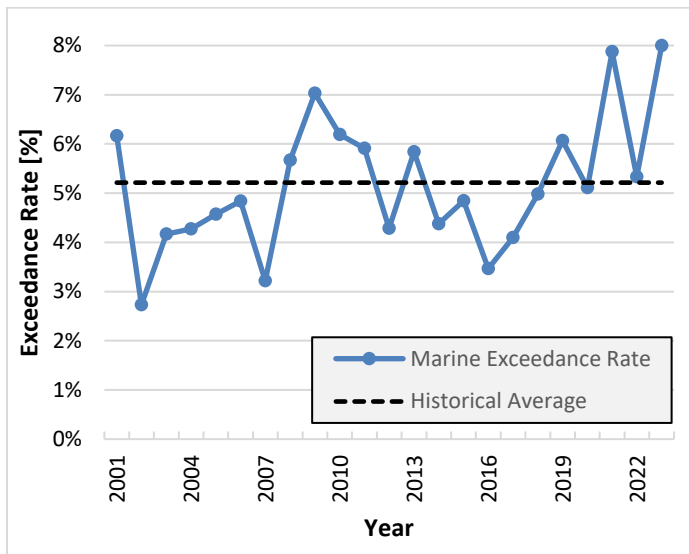


Figure 1. Marine beach exceedance rate (2001 – 2023).

**Freshwater beach exceedances** During the 2023 beach season, 7,793 samples were collected and analyzed from 583 freshwater sampling locations in the 181 communities reporting freshwater beach data. Most freshwater beaches (89%) used *E. coli* as the fecal indicator bacteria, with the other 11% using Enterococci. Among the 583 freshwater locations, 178 (31%) had at least one bacterial exceedance. A total of 433 out of 7,793 samples (5.6%) exceeded the single sample standard, which represents an exceedance rate above the historic average exceedance rate of 4.2% (Figure 2).

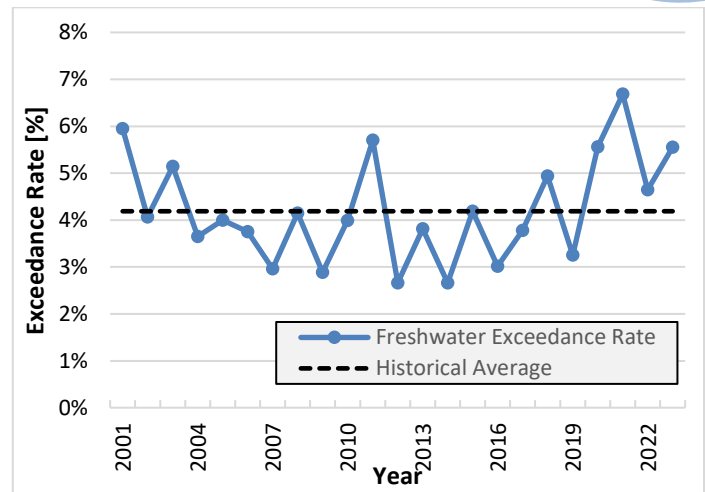


Figure 2. Freshwater beach exceedance rate (2001 – 2023).

**Posting beaches** In 2023, there were a combined 4,528 posting days across the 1,114 beaches where individuals were advised to not swim in the water. The majority of posting days were due to the exceedance or expected exceedance (e.g., rainfall) of a water quality standard. For marine beaches, there were 1,949 total posting days due to either elevated bacteria (91% of days), rainfall (1%), combined sewer overflows (5%), or other reasons (3%) (Figure 3). For freshwater beaches, there were 2,579 posting days due to either elevated bacteria (66%), cyanobacterial harmful algal blooms (29%), rainfall (1%), and other reasons (4%) (Figure 3). Other reasons for posting include: missed sampling, flash flood, petroleum in water, exceedances at adjacent beaches, and weed mitigation work at the beach.

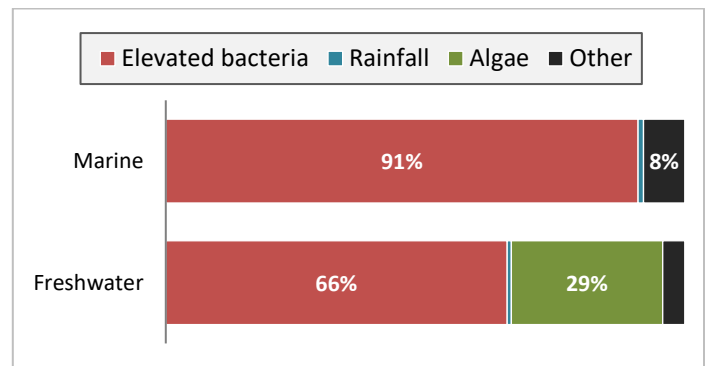


Figure 3. Posting details for marine and freshwater beaches in 2023.



**Rainfall** Rainfall is recognized as one of the major drivers of bacterial exceedances in beach water (Harder-Lauridsen et al., 2013). Historically, overall exceedances at both marine and freshwater beaches generally rise and fall with the total amount of summer rainfall, with some exceptions. In 2023, this pattern was observed in both marine and freshwater results (Figure 4). The rainfall data were obtained from the National Oceanic and Atmospheric Administration (NOAA, 2023). Data sets from two coastal communities, Boston and Chatham, were used to represent monthly rainfall amounts at marine beaches. For rainfall at freshwater beaches, data sets from Amherst and Ashburnham, along with those from Boston and Chatham, were used to represent monthly rainfall across the state.

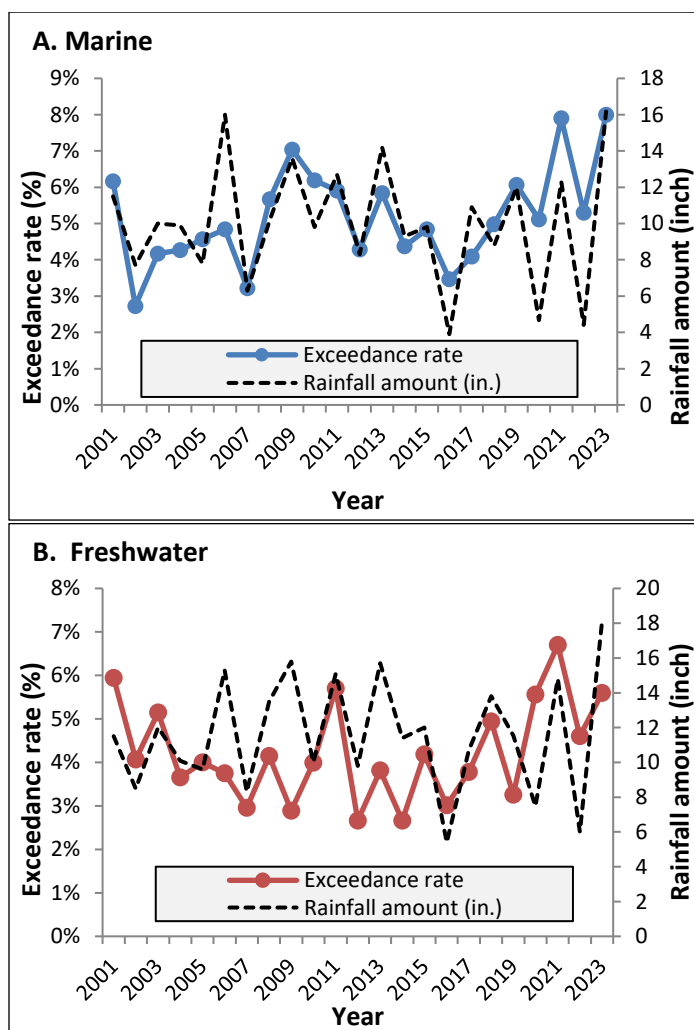


Figure 4. The historical relationship between rainfall amounts and exceedance rates at (A) marine and (B) freshwater beaches.

Occurrences of exceedances will typically drop as time between rainfall and sample collection increases. For both marine and freshwater beaches in 2023, samples collected in the 24 hours following rainfall were most likely to exceed the state standard (Figure 5).

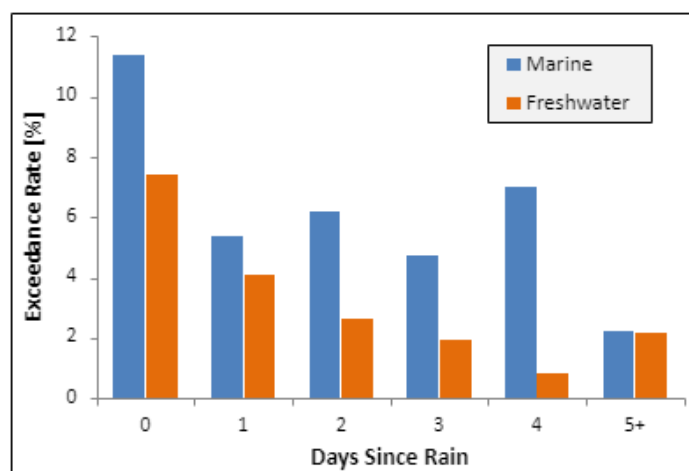


Figure 5. Relationship between the exceedance rate and days since rainfall in 2023.



Bank Street Beach, Harwich, MA

Photo by Irena Draksic

**Potential pollution sources** Starting in 2017, beach operators were asked to report the number of swimmers, birds, and dogs present in the water when a sample was collected. Figure 6 shows the mean bacteria levels of samples at marine and freshwater beach locations in 2023 compared to the number of reported swimmers, birds, and dogs. The data indicate that the presence of larger numbers of birds was associated with increases in bacteria levels at marine and freshwater beaches. No clear relationship was observed between bacteria levels and the number of humans or dogs present. Enterococci results at freshwater beaches were not included in this analysis due to the low number of samples.

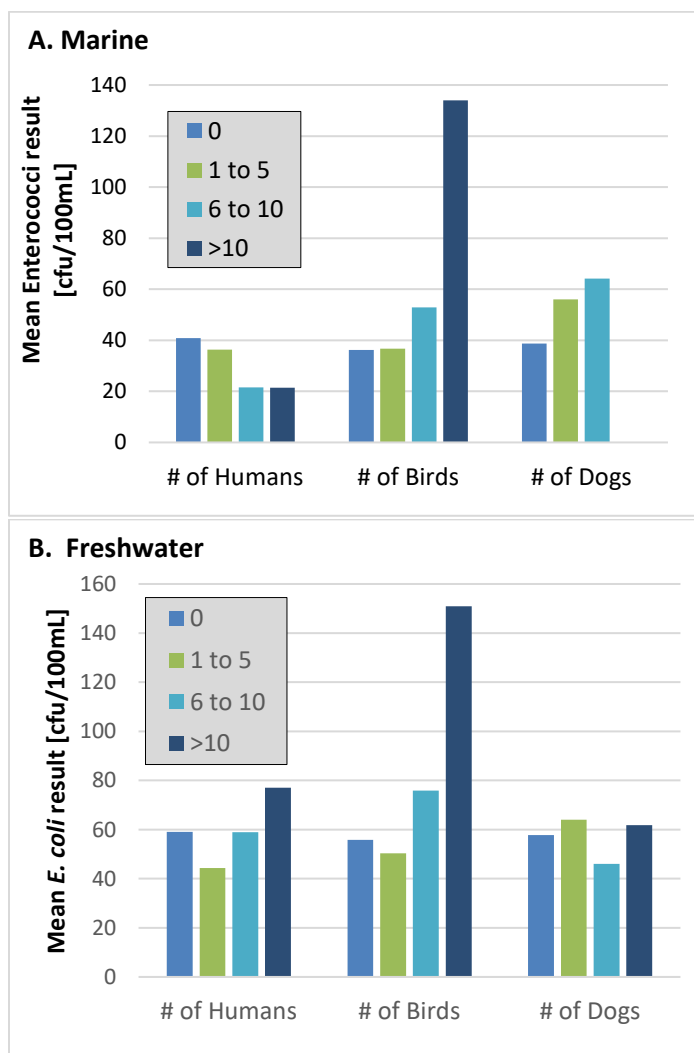


Figure 6. Mean bacteria levels and numbers of birds, dogs, and humans at marine (top) and freshwater (bottom) beaches in 2023.

**Environmental Justice Communities** Beach access and water quality are particularly important in environmental justice (EJ) communities, as these communities are disproportionately affected by the increased presence of environmental hazards and poor health outcomes (DPH, 2017). For example, EJ communities have high population densities, low income, and high levels of non-vehicle ownership. This means that more individuals in these communities, compared to other areas in the state, will tend to frequent a local public beach for cooling off or enjoying summer recreation. As rainfall is a significant factor in flushing enteric bacteria into beach water, any increase in rain near a population-dense EJ area will lead to an increase in exceedances.

Town EJ population data from the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA 2022) were used to evaluate water quality of beaches located near EJ communities. In 2023, beaches located in municipalities with more than 50% of the population living in EJ areas had a higher exceedance rate than other beaches (Figure 7).

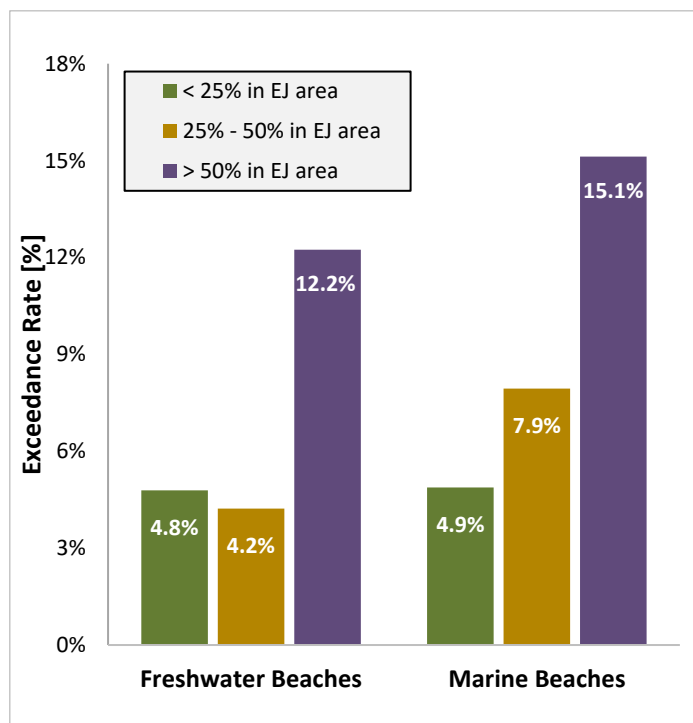


Figure 7. Relationship between 2023 beach exceedance rate and municipal EJ population data.

## Public Notification

**Beach website** During the 2023 season, DPH published an online beach water quality dashboard (<https://www.mass.gov/info-details/interactive-beach-water-quality-dashboard>) to provide the public with up-to-date beach testing data and beach posting information in an accessible, easy-to-use format. The dashboard is updated twice daily throughout the beach season (Memorial Day to Labor Day).

Between its launch on July 30<sup>th</sup>, 2023, and the end of April 2024, the dashboard was viewed over 65,000 times by nearly 43,000 unique visitors. Since the dashboard stops updating once the beach season ends on Labor Day, most of the page views occurred during August 2023. Despite being live for only 5 weeks of the beach season, the dashboard attracted 6 times more page views than the previous DPH website did over the entirety of the 2022 beach season.

In 2023, DPH also developed a new data portal for local health departments, beach operators, and testing laboratories to use when reporting beach water quality results and beach posting information to DPH. This portal replaced and improved upon DPH's previous beach data reporting system. The portal was piloted by coastal communities during the 2023 season and will be available statewide for the 2024 season.

**Beach postings** When water quality standards are exceeded or other safety concerns exist, beach operators are required to post signage at the beach advising individuals of the hazard and recommending they stay out of the water. This is an essential part of the public notification system. Based on posting data reported to DPH, marine and freshwater beaches were posted properly 97% and 74% of the time, respectively. The lower compliance rate at freshwater beaches is likely to be a reporting failure, rather than a public notification failure, as the missed posting reports come from a small number of towns. DPH will work with these towns this coming season to improve reporting.

## Conclusions

In 2023, the exceedance rates at both marine and freshwater beaches were well above the historical average due in large part to the high amount of rainfall in Massachusetts during the summer of 2023. However, average historical exceedance rates of 5.2% at marine beaches and 4.2% at freshwater beaches indicate that the state has beaches with generally good water quality. Elevated bacteria levels, rainfall events, and cyanobacterial harmful algal blooms were the primary drivers of beach posting days for poor water quality. Public notification of beach testing results and postings via DPH's new dashboard was a highly utilized means of communicating with the public.

## Acknowledgements

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Plum Island Beach, Newbury/Newburyport, MA

Photo by Kate Adams

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**For more information, please visit:**  
DPH Beaches website: <http://www.mass.gov/beaches>

DPH Algae website: <http://www.mass.gov/dph/algae>

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STEPS

**Forty Steps  
Beach**  
Operated by the  
Town of Nahant  
781-581-0026  
Permit # NHT-5  
Dates of Operation  
June 1 thru August 31  
Beach is NOT Monitored for  
Bacteria Outside of Date Range

40 Steps Beach, Nahant, MA

Photo by Logan Bailey