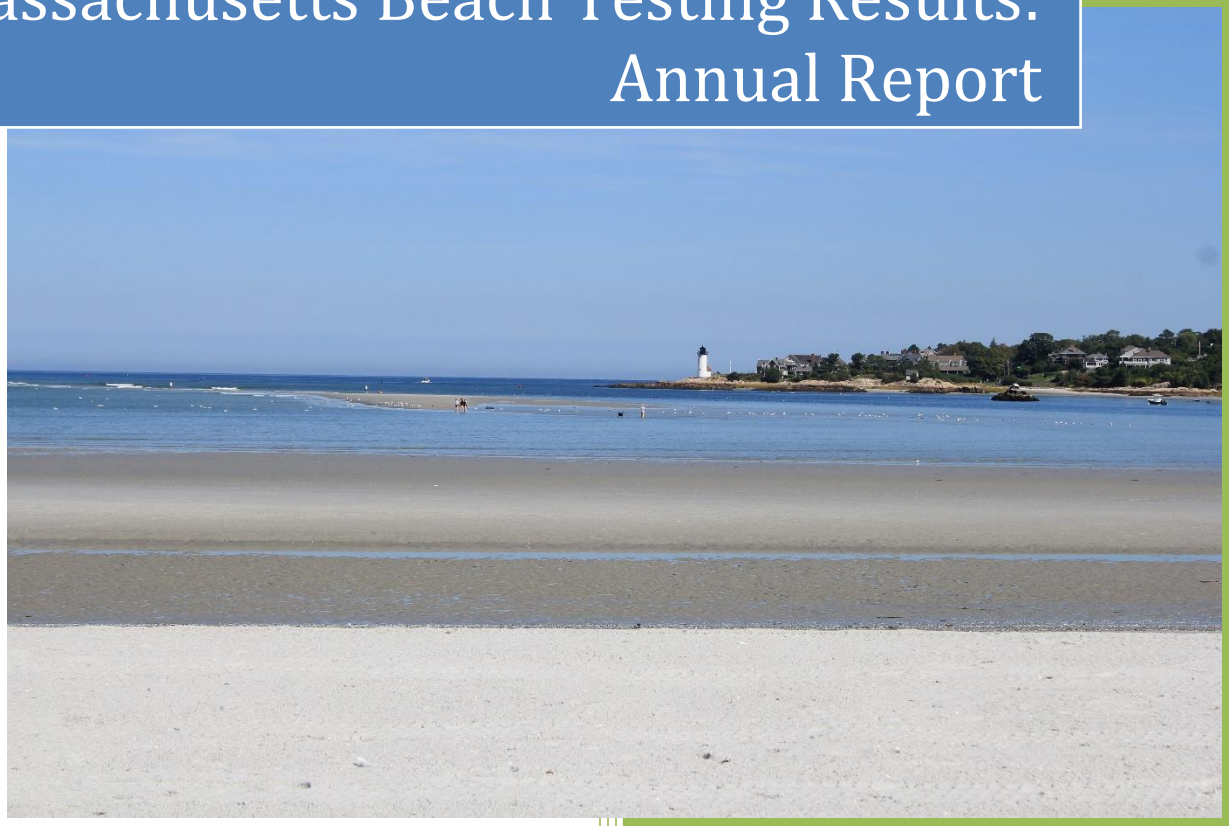
2021

Massachusetts Beach Testing Results: Annual Report



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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 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 2021, a total of 16,019 water samples were collected from 587 marine and 576 freshwater beach sampling locations. These locations represent 565 marine and 529 freshwater beaches statewide, with 100% of marine and 98% of freshwater beach communities reporting water quality information to DPH. Approximately 7.9% and 6.7% of samples exceeded the Massachusetts bacterial water quality standards for marine and freshwater beaches, respectively, higher than in previous years. While exceedances increased in 2021, 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.

- **Field data:** In 2021, a majority (99%) of water samples 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's marine beaches website (https://ma-beaches.healthinspections.us) provides near real-time information on bacteria levels at public marine beaches during the beach season, as well as information on historical bacteria levels. In 2021, approximately 19,262 users visited the website with peak usage occurring during the months of July and August. Individuals are also notified of unsafe conditions at beaches by physical signage that beach operators are required to post. In 2021, 96% of marine and 72% of freshwater beaches were in compliance with the public notification requirements.

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 when the school year finishes in mid-June 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
	E. coli	>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.

Kenberma Beach, Hull, MA

Water Quality

Marine beach exceedances During the 2021 beach season, 8,403 samples were collected and analyzed from 587 marine sampling locations in the 60 communities with marine beaches. Of these 587 locations, 227 (39%) had at least one bacterial exceedance. A total of 662 out of the 8,403 samples exceeded the 104 CFU/100 mL standard bringing the percentage of exceedances for marine waters to 7.9%, which represents the highest exceedance rate at marine beaches since DPH adopted USEPA beach water quality criteria in 2001 (Figure 1).

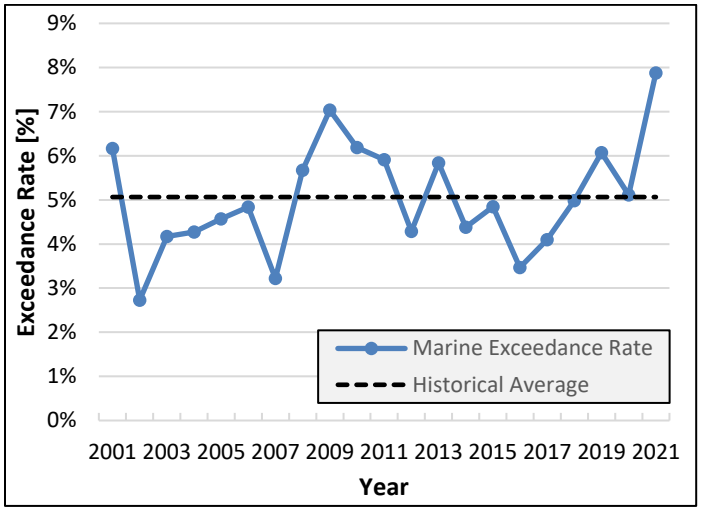

Figure 1. Marine beach exceedance rate (2001 – 2021)

Freshwater beach exceedances During the 2021 beach season, 7,616 samples from 576 freshwater sampling locations were collected and analyzed for the approved fecal indicator bacteria. Most freshwater beaches (89%) used *E. coli* as the indicator. Among the 576 freshwater locations, 194 (34%) in the 178 communities reporting beach data had at least one bacterial exceedance. A total of 509 out of 7,616 samples exceeded the standard bringing the percentage of freshwater exceedances to 6.7%, which represents the highest exceedance rate at freshwater beaches since DPH adopted USEPA beach water quality criteria in 2001 (Figure 2).

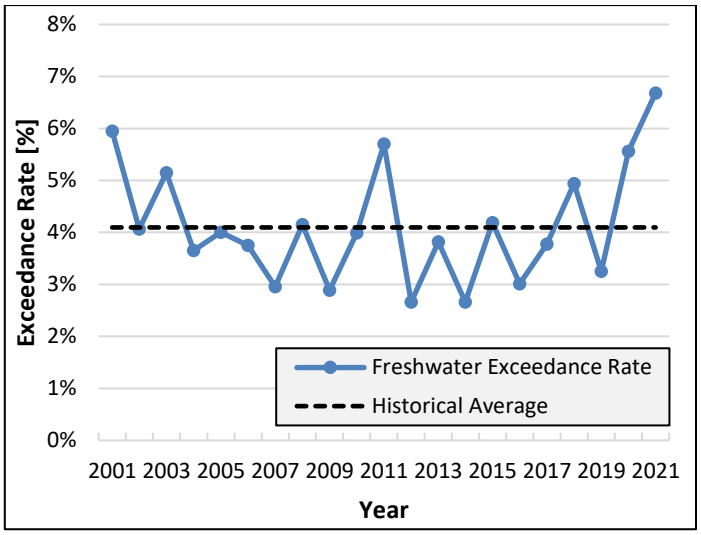

Figure 2. Freshwater beach exceedance rate (2001 – 2021)

Posting beaches In 2021, beaches were posted for 4,426 days, advising individuals 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 1,709 total posting days due to either elevated bacteria (93% of days), rainfall (7%), or combined sewer overflows (0.3%) (Figure 3). For freshwater beaches (Figure 3), there were 2,717 posting days, 67% of which were due to elevated bacteria, 33% due to cyanobacterial harmful algae blooms, and 0.2% due to rainfall.

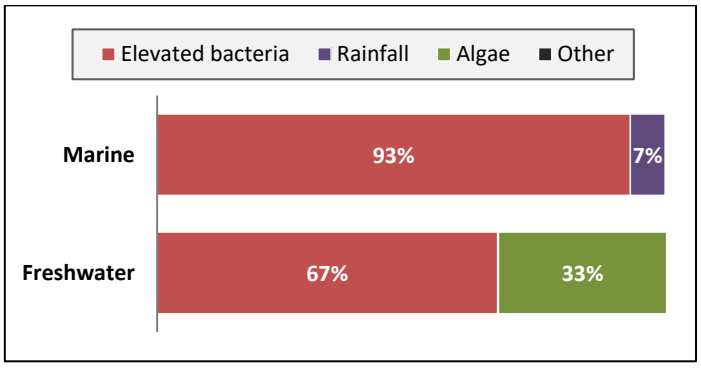

Figure 3. Posting details for marine and freshwater beaches in 2021

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 2021, 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, 2021). 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.

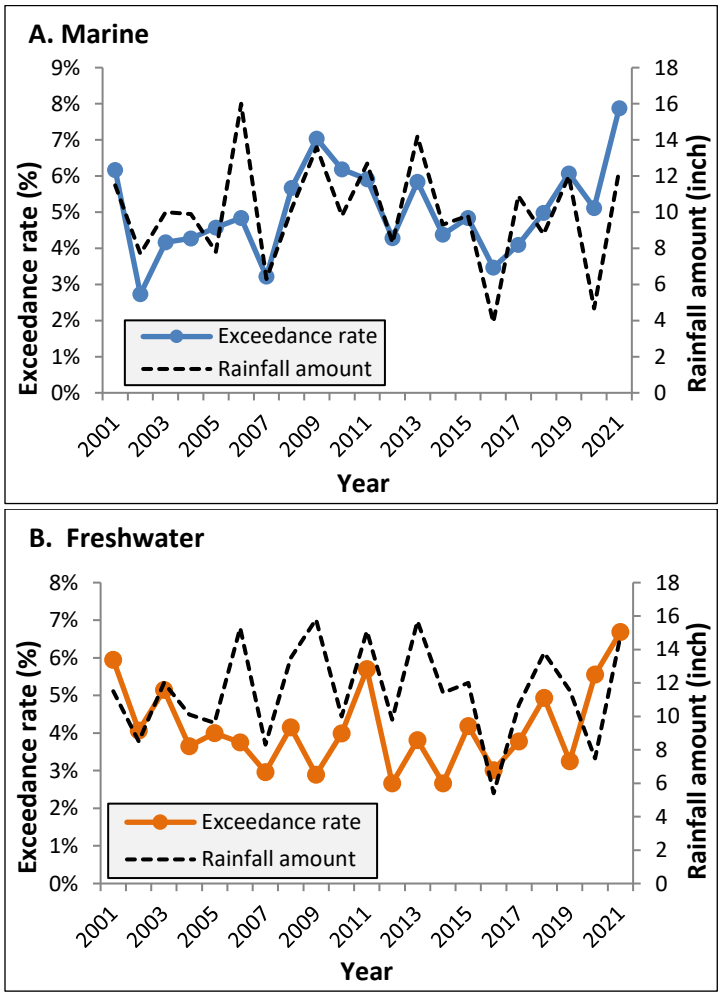

Figure 4. The historical relationship between rainfall amounts and exceedance rates at (A) marine and (B) freshwater beaches in Massachusetts from the 2001 to 2021 beach seasons

Rainfall amounts during summer 2021 varied considerably across the state. The Boston area experienced an uncharacteristically wet summer (total of 19.7 inches), while in contrast, rainfall totals in the Chatham area were low throughout the summer (5.0 inches). As seen in Table 2, the large amount of rain in the Boston area during July and August corresponded with very high exceedance rates at marine beaches in the North Shore, Boston, and South Shore regions.

	June	July	August
North Shore, Boston, & South Shore Regions			
Rainfall - Boston Station [in]	2.6	10.1	7.0
Marine Exceedance Rate [%]	**5.4%**	**19.7%**	**11.2%**
Cape, Islands, and Buzzard's Bay Regions			
Rainfall - Chatham Station [in]	1.2	1.8	2.0
Marine Exceedance Rate [%]	**4.0%**	**3.8%**	**6.0%**

Table 2. Regional marine beach exceedance rate and rainfall totals in summer 2021.

Occurrences of exceedances will typically drop as time between rainfall and sample collection increases. For both marine and freshwater beaches in 2021, samples collected in the 24 hours following rainfall were most likely to exceed the state standard (Figure 5). Overall, it is reasonable to conclude that the unusually rainy weather during summer 2021 was the primary factor behind the season's elevated exceedance rates.

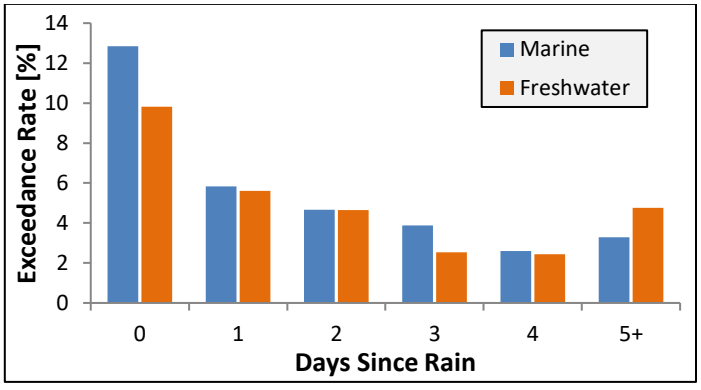

Figure 5. Relationship between the exceedance rate and days since rainfall in 2021

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 2021 compared to the number of reported swimmers, birds, and dogs. The data indicate that the presence of more than ten birds was associated with increases in bacteria levels at freshwater beaches, and to a lesser extent at marine beaches. The increased mean bacterial level seen at marine beaches with no swimmers is likely due to fewer people swimming at beaches during periods of rainfall or poor water quality. No clear relationship was observed between bacteria levels and the number of dogs present. Enterococci results at freshwater beaches were not included in this analysis due to the low number of samples.

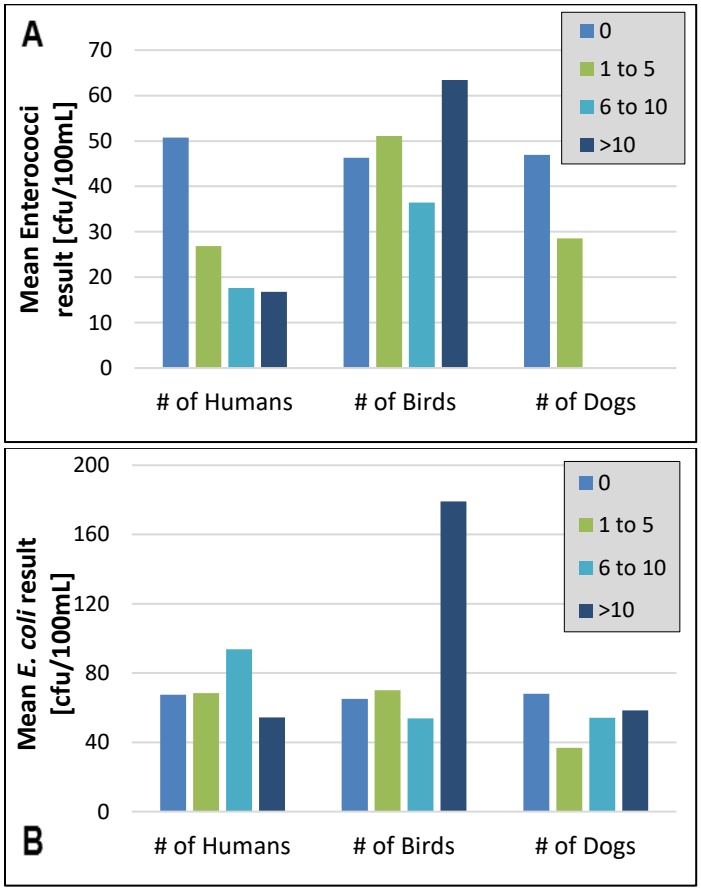

Figure 6. Mean bacteria levels and numbers of birds, dogs, and humans at marine (A) and freshwater (B) beaches in 2021

Environmental Justice Communities Beach access and water quality are particularly important in environmental justice (EJ) communities, as these communities are disproportionally 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 2020) were used to evaluate water quality of beaches located near EJ communities. In 2021, 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).

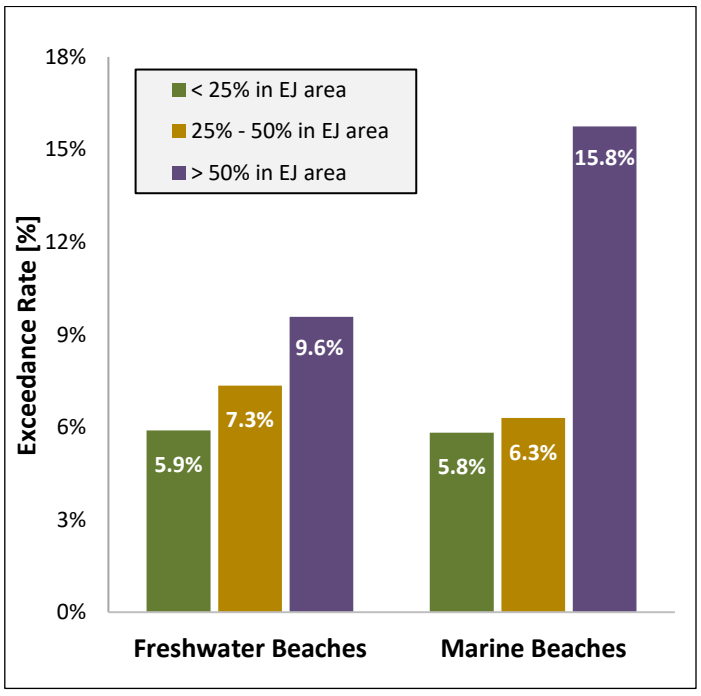

Figure 7. Relationship between beach exceedance rate and municipal EJ population data

Public Notification

Beach website The DPH beach monitoring website (https://ma-beaches.healthinspections.us/) provides the public with up-to-date marine beach testing and posting information and presents the data in an easy-to-use format. In 2021, 19,262 users visited the website during the beach season (this includes both new and returning users). An analysis of weekly usage data demonstrated a sudden increase in the number of users at the halfway point of the beach season (Figure 8), with a maximum number of users (n=3,008) occurring in week 8, in mid-July. A staggered decline in users occurred after this point (Figure 8), with website usage spiking during the second and fourth weeks of August (n=2,312 and n=1,839, respectively).

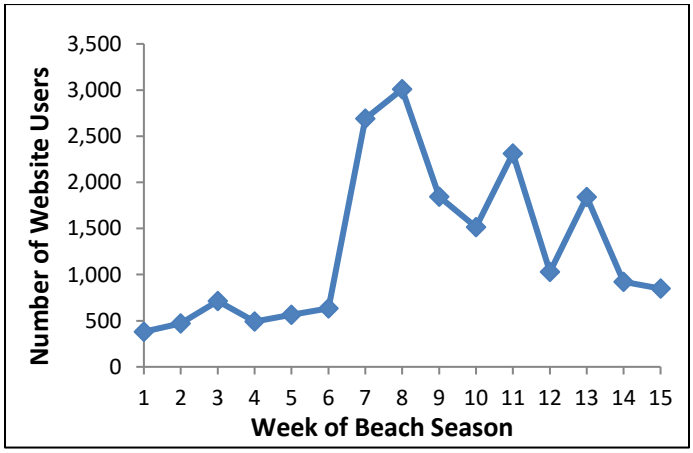

Figure 8. Number of DPH marine beach website users per week during the 2021 beach season

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. Marine and freshwater beaches were posted properly 96% and 72% of the time, respectively.

Conclusions

In 2021, the exceedance rates at both marine and freshwater beaches were greater than the historical average, likely due to uncharacteristically high amounts of rainfall during the summer months. However, average historical exceedance rates of 5.1% or less indicate that the state has beaches with generally high 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 marine results and postings via DPH's marine beaches website continued to be a highly utilized means of communicating with the public.

Acknowledgements

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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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