Microbial Contaminants in Florida Recreational Waters: Sources, Agents, and Illness Rates

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Introduction

This literature review is meant to provide information on microbial contaminants in Florida recreational waters. Sources of information included mostly peer-reviewed publications but also links to relevant news media and "gray literature" or reports. The results are reasonably comprehensive and should serve as a baseline for additional existing and future information. Medical information linking disease with recreational water as reported from this summary is likely conservative as medical practitioners may be unaware of the patient's recreational experience with potentially contaminated water. The lack of health risk warnings or cautions with on-site signage, which is common for most Florida recreational waters, creates ambiguity from the patient's and health provider's perspective as to a possible illness source. The following short excerpts from individual citations emphasize key findings on microbial agents such as fecal indicator bacteria, pathogens, their source and related illness rates where reported. This format is meant to facilitate the readers' interest in a specific agent, source or illness rate. Additionally, a hyperlink to the original publication is incorporated in each citation and readers are encouraged to review individual study details in greater depth for a more comprehensive understanding of the results. Intended user groups are public health professionals, policy makers, news media, educators and advocates for public health policy review or reform.

Literature Excerpts

- Cumulative daily excess health effects (sum of percentages of gastrointestinal [GI], skin, and respiratory illness) ranged from 7% to 22% at a non-point source subtropical marine recreational beach in Miami, Florida. Negative excess illness values represented days in which a higher illness percentage was reported in nonbathers when compared to bathers (Abdelzaher, A. M. et al., 2011).

- The beach selected for this study is the only beach in Miami-Dade County that permits dogs. Annually, (2002 to 2007), this beach gets placed under advisory for water quality violation for roughly 4.5 days. *Vibrio vulnificus*, *Staphylococcus aureus*, and protozoan pathogen *Giardia* spp. were detected in day two during high tide. *Enterococcus* was highest and exceeded regulatory levels on day two during high tide. *Giardia lamblia* at levels as low as 10 cysts ingested per person can be pathogenic (Abdelzaher, A. M., et al., 2010).

- *Vibrio alginolyticus* caused 131 cases (almost 20% of all vibriosis infections) of infection from exposing wounds to sea water from 1998 to 2007 in Florida. Swimming in coastal waters with a wound can lead to a *Vibrio vulnificus* infection as well. *V. vulnificus*, an opportunistic pathogen with a high mortality, can cause wound infections that can rapidly lead to septicemia (Baker-Austin, C., 2018).

- Florida has the highest rate of vibriosis of any state, with 20% of its cases coming from Indian River Lagoon on the Atlantic Coast. Florida's cases are evenly split between foodborne and wound exposure to *Vibrio* spp. (Barbarite, 2016).

- Florida beach sand at Ft. Lauderdale, Hollywood, and Hobie Beaches was a significant source of fecal indicator bacteria (FIB). FIB in wet sand was 100 times greater and dry sand (five meters above intertidal zone) was on average 1,000 times greater compared to the water column (Bonilla, T.D., et al., 2007).

- Sediments sampled at Siesta Key Beach had high concentrations of fecal coliforms and *Enterococcus*, potentially indicating that sediments act as reservoirs for these indicators (Brownell, M. J. et al., 2007).

- Evidence suggests warming temperatures are associated with the spread of potentially pathogenic *Vibrio* spp. and the emergence of human disease globally. Between 1992 and 2022, a long-term increase in *Vibrio* spp. infections was reported in Florida. Following Hurricane Ian in 2022, Florida's Department of Health received reports of 74 cases of *Vibrio vulnificus* infections with 17 confirmed deaths. October 2022 had the highest reports of *Vibrio* infection cases since 1992 in Florida Gulf Coast waters (Brumfield, K. D., et al., 2023).

- *Enterococci* exceedances are correlated to minimal wave energy and flat beach profiles, which characterizes most of the "Big Bend" region (Feng, Z. et al., 2016).

- Bathers were 1.76 times more likely to report GI illness; 4.46 times more likely to report acute febrile respiratory illness and 5.91 times more likely to report a skin illness relative to non-bathers. This study indicated that bathers may be at increased risk of several illnesses relative to non-bathers, even in the absence of any known source of domestic sewage impacting the recreational marine waters (Fleisher, J. M. et al., 2010).

- More symptoms of illness were reported from individuals who visited the beach more than once during the time of the study. Symptoms reported were GI issues (stomach pain and diarrhea), skin rash, respiratory symptoms (cough, nasal congestion, and sore throat), and few with fever and chills. Only Florida residents were surveyed. (Fleming, L.E., et al., 2004)

- U.S. Recreational Water Quality Criteria (RWQC) of 2012, were discussed during a conference held 11–13 March 2013, in Honolulu, Hawaii. The vision for the future is development of effective RWQC guidelines based on epidemiologic and quantitative microbial risk assessment (QMRA) studies for sewage specific markers, as well as human enteric pathogens so that health risks for bathers at all recreational waters can be determined. The 2012 RWQC introduced a program for states and tribes to develop site-specific water quality criteria, and in theory this approach can be used to address the limitations associated with the measurements of the traditional FIB (Fujioka, R., et al., 2015).

- In 2006, Florida had an outbreak of norovirus outbreak of 50 cases in untreated recreational water. The risk of illness is much greater from viruses than bacteria, suggesting the concern of human enteric viruses in recreational water. Fecal indicator bacteria are not a concrete method to determine viral pathogens (Gibson, K.E., 2014).

- This study examined microbial risk assessment at two south Florida beaches. Norovirus and adenovirus cause the most cases of waterborne illness in humans from recreational activities. GI illness primarily originates from human fecal sources rather than non-human. Dog fecal contamination in water also presents health risks to humans. Water contamination from gull feces may present a health risk to humans, but less than human and dog feces (Gitter, A., et al., 2023).

- A man went knee-deep in the Gulf of Mexico near the Pinellas and Pasco County line to fish with a few scabs on his leg. Within 24 hours he had a fever and chills along with a burning sensation on his calf, later diagnosed as a *Vibrio vulnificus* infection. *Vibrio* affects the elderly and children the most (Griffin, J., 2019).

- A Florida beach exceeded state regulation of fecal coliforms in 58% and *Enterococci* in 50% of samples. The city made sewer repairs and relocated the restrooms at the beach. Following the remediation, fecal coliforms only exceeded standards in 7% of samples and *Enterococci* in 11%. This study looked at using microbial source testing to find which animal caused the fecal contamination to then assess how to mediate the situation (Harwood, V. J., et al., 2014).

- Waterborne infections can cause negative symptoms in both humans and animals. This study of Florida animals denotes 20 microbe types as sources of zoonotic diseases including *E. coli*, *Salmonella* spp., *Cryptosporidium* spp., *Giardia* spp., *Leptospira* spp., *Vibrio* spp., and *Campylobacter* spp. It is essential to vaccinate your pets and clean up after them to prevent zoonotic disease transmission (Jenkins, M., et al., 2021).

- In 2015, 82 waterborne disease outbreaks were reported in the United States with 57% being from recreational water exposure, and 15 outbreaks were from Florida alone. Children under 5 and elderly over 74 in Florida are more susceptible to waterborne diseases. Florida's counties with the most cases of waterborne illness are Miami-Dade, Broward, Palm Beach, and Hillsborough. These counties have large populations and large access to aquatic environments such as brackish water, freshwater, and marine ecosystems. Hispanic, nonwhite, and low-income populations are at higher risk of waterborne illness (Kamanmalek, S., et al., 2023).

- In 2011, the Florida Healthy Beaches program lost funding and many beaches were dropped from the program resulting in less frequent monitoring of fecal coliforms. Concentrations of fecal indicator bacteria at beaches is impacted by the availability of restrooms and showers, solid waste management, and beach access fees. Grooming of beach sand increases the concentration of fecal indicator bacteria in sediment. Bay or marsh beaches had higher fecal indicator bacteria exceedances, than open coast beaches (Kelly, E. A., et al., 2018).

- Stormwater runoff, restrooms next to water that are closed due to structural damage, and portable restrooms were sources of human pollution to the water at the beach sites used in this study. Phase one consisted of water samples before remediation, and the data showed fecal pollution above regulatory levels. Phase two, sampling after remediation efforts data saw improvement in water quality. Despite the improvement, sporadic sewage leaks still cause an influx in fecal indicator bacteria. In May of 2008, there was a sewage spill where enteroviruses were detected (Korajkic, A., et al., 2010).

- Fecal indicator bacteria are more prevalent in surface water than ground water in North Fort Myers. Exceedances to the Florida Department of Health's *E. coli* and *Enterococci* criteria resulted in moderate or poor conditions. Evidence shows there is a strong influence of human wastewater impacting local water conditions (Lapointe, B. E., et al. 2010). Many of the sampling locations were public recreational waters that don't require onsite risk notification rather than public bathing places (Lapointe, B. E., et al., 2018).

- Fecal coliform density remained high in Sarasota Bay because of septic systems despite the effort made in the late 1980s to protect the Bay. During the 1996 rainy season, Phillippi Creek did not meet regulations for recreational usage. 53% of water samples with detection of pathogens were also in violation of the Environmental Protection Agency's regulation of fecal indicator bacteria (Lipp, E. K., et al., 2001).

- Seasonal changes of indicators and pathogens were assessed from monthly water samples over the course of a year at twelve stations in Charlotte Harbor. Microbial contaminants

were concentrated in areas of low salinity proximal to septic systems. During wet weather conditions, contaminants were detected at 75% of sample stations. Elevated water temperature was also a factor associated with higher contaminant levels (Lipp, E. K., et al., 2001).

- Failing wastewater infrastructure is a primary cause of water contamination and waterborne disease. As climate change increases the frequency of hurricanes, waterborne disease outbreaks are likely to become more prevalent. Economic and social burdens from waterborne disease outbreaks can be mitigated through predictive approaches (Mansky, C., 2024).

- Central Florida surface waters had *Salmonella* present throughout the year and the Suwannee River in northern Florida had *Salmonella* in 96% of samples. *Salmonella* is more resistant to solar radiation than *E. coli*, *Shigella flexneri*, and *Vibrio cholerae* (McEgan, R., et al., 2013).

- A man scraped his calf on a dock off St. John's River and began experiencing flu-like symptoms after returning home. Since 2010, there has been 700-1,200 cases of infection by group A *Streptococcus* (Padró Ocasio, B., 2019).

- Sediment was sampled for *Enterococci* bacteria at eight Florida beaches during wet and dry seasons at low tide. This study paired their sediment data with the Department of Health's water samples at the same beaches. *Enterococci* was found in all sediment samples and the supratidal zone had the highest levels of *Enterococci*. Beaches with high *Enterococci* levels in the sand experienced more frequent beach closures than beaches with low levels. Beach sand could be more closely linked to nonpoint contamination than the water. Beaches with relatively high levels of *Enterococci* in the sand should be tested more frequently (Phillips, M. C., 2011).

- *Staphylococcus aureus* including methicillin resistant *S. aureus*, MRSA, are human colonizing bacteria that commonly cause opportunistic infections primarily involving the skin in otherwise healthy individuals. As part of this study, adults and toddlers were exposed to water from a sub-tropical non-point source recreational marine beach near Miami, Florida. Results indicated that adults and toddlers can potentially shed *S. aureus* in marine water and sand that could lead to exposure and transmission to other beachgoers (Plano, L. R., 2011).

- This study examined waterborne illness reports in Florida from 1999 to 2019. Children ages 0-4 and elderly had higher rates of waterborne disease. Salmonellosis, campylobacteriosis, shigellosis, and giardiasis made up 87% of water-related infections during this study. Counties with the highest water-related diseases outbreaks were Miami-Dade, Broward, Palm Beach, Duval, and Hillsborough. Florida's geographic climate makes residents and tourists more susceptible to contracting waterborne diseases (Rhoden, K., et al., 2021).

- Fecal indicator bacteria suggest the presence of disease-causing microbes that tend to accumulate in beach water and sand. Pre-emptive closure of the Florida Keys beach sites occurred before Hurricane Irma made landfall as fecal indicator bacteria often increase after a hurricane. Post-hurricane sources of fecal indicator bacteria after a hurricane are related to runoff contaminated by debris and excessive erosion at beaches (Roca, M. A., 2019).

- Individuals were assessed for illness associated with head submersion at a subtropical recreational marine beach near Miami, Florida. Subjects were contacted seven days later to identify any illness. 35% of water samples exceeded regulatory levels of *Enterococci*. 31 bathers reported gastrointestinal illness, 12 reported respiratory illness, and 47 reported skin illness of those who responded to the seven-day follow-up call (Sinigalliano, C. D., 2010).

- This study examined the reservoirs of FIB and water quality on the presence of allochthonous pathogens, the ecology, and virulence of *Vibrio vulnificus.* FIB in elevated concentrations is associated with higher risk for waterborne illness and an indicator of possible pathogens in the water. Stormwater was also shown to be an important reservoir/conveyance system for FIB, human-associated microbes, and pathogens. FIB concentrations in the water were positively associated with those in the sediment, submerged aquatic vegetation, and with 24-hour antecedent rainfall in Lake Corroll, a recreational lake in Tampa, Florida. *Enterococci* concentrations in 65.2% of samples exceeded the regulatory limit. Two testing sites had *Enterococci* concentrations higher than regulation in 18 of 20 samples taken. Differences in water quality were further demonstrated to impact the community structure of *Vibrio* spp. and may affect the relative abundance of strains with greater virulence potential (Staley, C., 2012).

- The surface water at the outfalls of wastewater treatment plants outside of Miami-Dade County have tested positive for pathogens such as norovirus and *Giardia* spp. Despite these outfalls being kilometers offshore, surface currents can expose local beaches to these pathogens causing poor water quality. Pepper mild mottle virus has consistently high concentrations in human feces and can circumvent false-negative results that other indicators may cause. Pepper mild mottle virus (PMMoV) was detected in 60% of samples. *Enterococci* concentrations in all the samples fell within EPA regulation. A previous study found that PMMoV is correlated to the concentration of adenoviruses in river waters, suggesting that PMMoV is not overestimating the human health risk of recreational water (Symonds, E. M., et al., 2016).

- In the month following Hurricane Ian landfall, 38 people fell ill and 11 died because of *Vibrio* infections contracted in Lee County, Florida. *Vibrio* species are becoming more prominent in the marine waters with rising water temperature (Teirstein, Z, 2023).

- Going to the beach with a pre-existing wound injury or children getting a minor wound at the beach could increase the likelihood of infection. 58.2% of children surveyed had pre-existing wounds, and 8.2% got an abrasion within one hour at the beach (Tomenchok, L. E., 2020).

- The use of in-ground waste disposal on the Keys has led to water contamination up to six miles offshore. Samples were taken near the Port Largo Canal and Molasses Reef. Genetic material from enteric viruses were commonly found in the samples, with a higher frequency of detection during rainfall in the summer months. The data from the study suggests a potential threat to human health and coral health (University of Georgia, 2007).

- Vibriosis has the highest rate of mortality of any intestinal disease. Cases are more frequent when the weather and water temperature are warmer. Wound related symptoms were reported in almost half of cases from 1998 to 2007. The median number of vibriosis cases reported in Florida annually is 20. *Vibrio alginolyticus* causes ear infections and illness in children (Weis, K. E., 2010).

- A previous study found that the majority of the Florida Keys' canals and near-shore water contained at least one enteric virus. The enteric viruses considered were hepatitis A, norwalk, and enteroviruses. For this study, the highest level of fecal coliform bacteria was at Key Largo. *C. perfringens* was detected at Key Largo and Key West. *Enterococci* was detected at Lower Matecumbe Key, Rock Harbor, and Key Largo. None of the levels detected were above the regulatory threshold that would require beach closure. This study found fecal indicators are not always accurate at detecting pathogens (Wetz, J. J., et al., 2004).

- This review noted that an average of 35,000 cases of waterborne illness occur in the U.S. annually. The federal Clean Water Act established in 1972 required every state to assess all its recreational-use waters for impairment, however, only 19 states have assessed 50% or more of lakes and rivers. Florida has assessed 95.1% of lakes, reservoirs, ponds, and wetlands with 75.1% rated too polluted for swimming. 60.9% of Florida's creeks, rivers, and streams have been assessed and 49% of those are too polluted for swimming. Florida is ranked the number one state for the most polluted lakes and streams (Williams, R., 2024).

- Elevated levels of *E. coli* are associated with rain and tide, high tide having the highest concentration. Hobie Cat Beach is the only beach in Miami-Dade County that permits dogs on the beach. This beach has poor water circulation due to its shallowness and location within a cove. Shallow waters, knee deep and below, have higher concentrations of *Enterococci* than chest deep water. Human and dog fecal matter contributes most to the *Enterococci* load (Wright, M. E., 2008).

- There was a total of 78 outbreaks of waterborne disease in the U.S., 38 in 2005 and 40 in 2006. 31 states reported at least one outbreak, Florida reported 7 outbreaks. One of Florida's outbreaks were from *Leptospira* causing leptospirosis in 43 people. Florida reported 55 individual cases of *Vibrio* infection. Another outbreak in Florida had people exhibiting symptoms of Seabather's Eruption after marine water exposure. From the 78 U.S. outbreaks, there were 4,412 persons ill, majority with gastroenteritis (Yoder, J., et al., 2008).

- Fecal contamination all along the Phillippi Creek (Sarasota County) is evident based on the use of four indicators of pollution. The water quality does not meet Florida state standards or Federal guidelines for safe swimming and should not be open for recreational purposes to protect the public from acquiring waterborne disease. The sites impacted by septic tanks (625 and BR) were found to have the greatest levels of contamination (Zhou, X., and Rose, J. B., 1995).

Citations

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Geographic area: Miami-Dade County Florida

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Geographic area: Virginia Key in Miami-Dade County, Florida

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Geographic area: Worldwide with mention of Florida
Waterborne agent / illness: *Vibrio* spp.

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Geographic area: Indian River Lagoon, Florida
Waterborne agent / illness: *Vibrio vulnificus*, *V. parahaemolyticus*, and *V. cholerae* causing vibriosis.

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Geographic area: Siesta Key Beach Florida and Deer Prairie Slough in Myakka River, Myakka River State Park FL

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Geographic area: Southwestern Florida
Waterborne agent / illness: *Vibrio* spp. causing vibriosis.

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Waterborne agent / illness: Campylobacteriosis, Cryptosporidiosis, Acute Giardiasis, Hepatitis A, Legionellosis, Salmonellosis, Shiga Toxin-Producing *Escherichia coli* (STEC) Infection, Shigellosis, Vibriosis

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Geographic area: Bonita Springs, Florida

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Geographic area: Subtropic marine environments in Florida
Waterborne agent / illness: Gastrointestinal illness, acute febrile respiratory illness, skin illness

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Geographic area: Two beaches in Miami-Dade County Florida

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Geographic area: Florida and other U.S. states and territories

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Geographic area: Florida and other U.S. States
Waterborne agent / illness: Norovirus

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Geographic area: Crandon Park Beach and Haulover Beach in Miami, Florida.

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Waterborne agent / illness: *Vibrio vulnificus* infection

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Geographic area: Florida and studies from other states and countries

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Geographic area: Florida; Brevard, Indian River, Volusia, and Sarasota counties.
Waterborne agent / illness: Amebic encephalitis, Campylobacteriosis, Cholera (*Vibrio cholerae* type O1), Cryptosporidiosis, Cyclosporiasis, *Escherichia coli* infection, Shiga toxin producing, Giardiasis, Hepatitis A, Hepatitis E, Legionellosis, Leptospirosis, Melioidosis, Poliomyelitis, Salmonellosis, Shigellosis, Tularemia, Typhoid fever (Salmonella serotype Typhi), and Vibriosis (*Vibrio* species and closely related organisms, not *Vibrio cholerae* type O1).

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Waterborne agent / illness: Otitis externa (swimmer's ear), norovirus infection, giardiasis, and cryptosporidiosis

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Geographic area: Hillsborough County, Florida

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Geographic area: Sarasota County, Florida

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Geographic area: Charlotte Harbor estuary in southwest Florida

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Waterborne agent / illness: Salmonellosis, Campylobacteriosis, Shigellosis, Giardiasis.

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Waterborne agent / illness: Necrotizing fasciitis from group A *Streptococcus*.

Phillips, M. C., Solo-Gabriele, H. M., Piggot, A. M., Klaus, J. S., & Zhang, Y. (2011). Relationships Between Sand and Water Quality at Recreational Beaches. *Water Research*, *45*(20), 6763. https://doi.org/10.1016/j.watres.2011.10.028
Geographic area: beaches in Miami-Dade and Broward counties Florida

Plano, L. R., Garza, A. C., Shibata, T., Elmir, S. M., Kish, J., Sinigalliano, C. D., Gidley, M. L., Miller, G., Withum, K., Fleming, L. E., & Solo-Gabriele, H. M. (2011). Shedding of *Staphylococcus aureus* and methicillin-resistant *Staphylococcus aureus* from adult and pediatric bathers in Marine Waters. *BMC Microbiology*, *11*(1), 5. https://doi.org/10.1186/1471-2180-11-5
Geographic area: Miami-Dade County, Florida
Waterborne agent / illness: *Staphylococcus* infection

Rhoden, K., Alonso, J., Carmona, M., Pham, M., & Barnes, A. N. (2021). Twenty years of waterborne and related disease reports in Florida, USA. *One Health*, *13*. https://doi.org/10.1016/j.onehlt.2021.100294
Waterborne agent / illness: *Salmonella* causing salmonellosis, *Campylobacter* causing campylobacteriosis, *Shigella* causing shigellosis, *Giardia lamblia* causing giardiasis, hepatitis A, *Cryptosporidium* causing cryptosporidiosis, *Legionella* causing legionellosis also known as Legionnaires' Disease, *Vibrio* spp. causing vibriosis, etc.

Roca, M. A., Brown, R. S., & Solo-Gabriele, H. M. (2019). Fecal indicator bacteria levels at beaches in the Florida Keys after Hurricane Irma. *Marine Pollution Bulletin*, *138*, 266–273. https://doi.org/10.1016/j.marpolbul.2018.09.036
Geographic area: Florida Keys

Sinigalliano, C. D., Fleisher, J. M., Gidley, M. L., Solo-Gabriele, H. M., Shibata, T., Plano, L. R. W., Elmir, S. M., Wanless, D., Bartkowiak, J., Boiteau, R., Withum, K., Abdelzaher, A. M., He, G., Ortega, C., Zhu, X., Wright, M. E., Kish, J., Hollenbeck, J., Scott, T., … Fleming, L. E. (2010). Traditional and molecular analyses for fecal indicator bacteria in non-point source subtropical recreational marine waters. *Water Research*, *44*(13), 3763–3772. https://doi.org/10.1016/j.watres.2010.04.026

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Waterborne illness / agent: FIB and various pathogens including *Vibrio vulnificus*.
Geographic area: Lake Carrol Tampa, Florida

Symonds, E. M., Sinigalliano, C., Gidley, M., Ahmed, W., & Breitbart, M. (2016). Faecal pollution along the southeastern coast of Florida and insight into the use of pepper mild mottle virus as an indicator. *Journal of Applied Microbiology*, *121*(5), 1469-1481. https://doi.org/10.1111/jam.13252
Waterborne agent / illness: pepper mild mottle virus
Geographic area: southeastern coast of Florida

Teirstein, Z. (2023, October 24). Flesh-eating bacteria cases spiked in Florida after Hurricane Ian. Scientific American. https://www.scientificamerican.com/article/flesh-eating-bacteria-cases-spiked-in-florida-after-hurricane-ian/
Geographic area: Florida, Lee County

Waterborne agent / illness: Vibriosis caused by *Vibrio* spp.

Tomenchok, L. E., Gidley, M. L., Mena, K. D., Ferguson, A. C., & M., H. (2020). Children's Abrasions in Recreational Beach Areas and a Review of Possible Wound Infections. *International Journal of Environmental Research and Public Health*, *17*(11), 4060. https://doi.org/10.3390/ijerph17114060
Geographic area: Crandon and Haulover beaches in Miami-Dade County Florida, and Stewart and Seawall beaches in Galveston County Texas.
Waterborne agent / illness: Infections caused by *Vibrio* spp., *Aeromonas* spp., *Shewanella* spp., and halotolerant *Staphylococcus aureus*.

University of Georgia. (2007, July 25). Contaminated water reaches Florida's offshore keys. ScienceDaily. https://www.sciencedaily.com/releases/2007/07/070724173343.htm
Geographic area: Florida Keys

Weis, K. E., Hammond, R. M., Hutchinson, R., & Blackmore, C. G. (2010). *Vibrio* illness in Florida, 1998–2007. *Epidemiology and Infection*, *139*(4), 591–598. https://doi.org/10.1017/s0950268810001354
Waterborne agent / illness: *Vibrio* spp. causing vibriosis.

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Geographic area: Florida Keys

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Geographic area: Hobie Cat Beach, Virginia Key, Florida

Yoder, J., Hlavsa, M., Craun, G., Hill, V., Roberts, V., Yu, P., Hicks, L., Alexander, N., Calderon, R., & Roy, S., Beach, M. (2008, September 12). *Surveillance for waterborne disease and outbreaks associated with recreational water use and other aquatic facility – Associated health events --- United States, 2005--2006*. Centers for Disease Control and Prevention. https://www.cdc.gov/mmwr/preview/mmwrhtml/ss5709a1.htm
Geographic area: Florida, U.S., and U.S. territories
Waterborne agent / illness: Leptospirosis, *Vibrio* infection, Gastroenteritis

Zhou, X., & Rose, J. B. (1995). (rep.). *Phillippi Creek Water Quality Report* (pp. 1–34). St. Petersburg, Florida. https://sarasota.wateratlas.usf.edu/upload/documents/Phillippi-Creek-Water-Quality-Report-USF-1995.pdf
Geographic area: Sarasota, Florida

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