

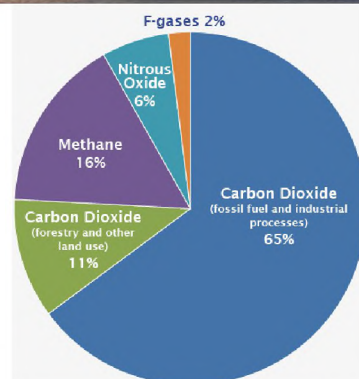


Sea levels are rising.

Two phenomena related to climate change contribute to accelerated global sea level rise:

- Thermal expansion: global atmospheric and ocean temperatures are rising, and water expands as it absorbs heat.
- Ice melt: melting glaciers and ice sheets increase freshwater runoff into oceans.

Greenhouse gases trap heat in our atmosphere resulting in rising ocean temperatures. Sources of greenhouse gases include the use of fossil fuels such as coal, oil, and natural gas to power our societies, which releases carbon dioxide and methane into the atmosphere. Other methane sources include emissions from landfills and agriculture.

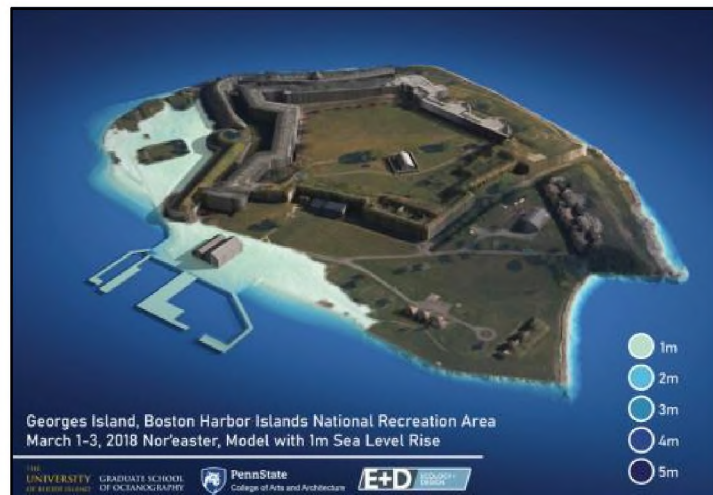
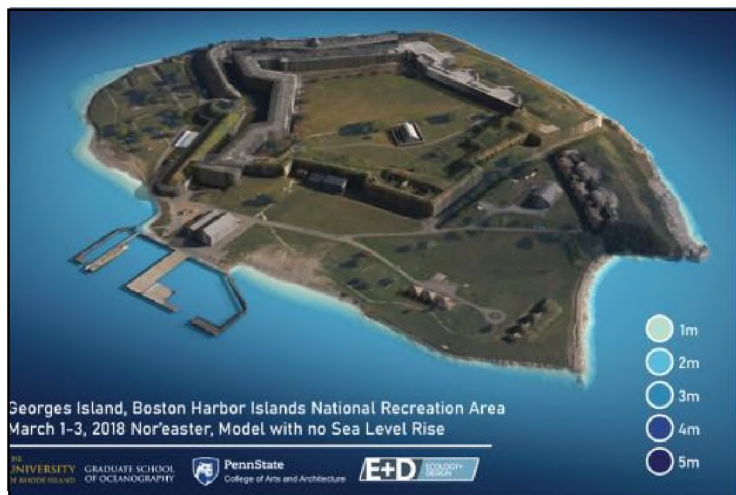
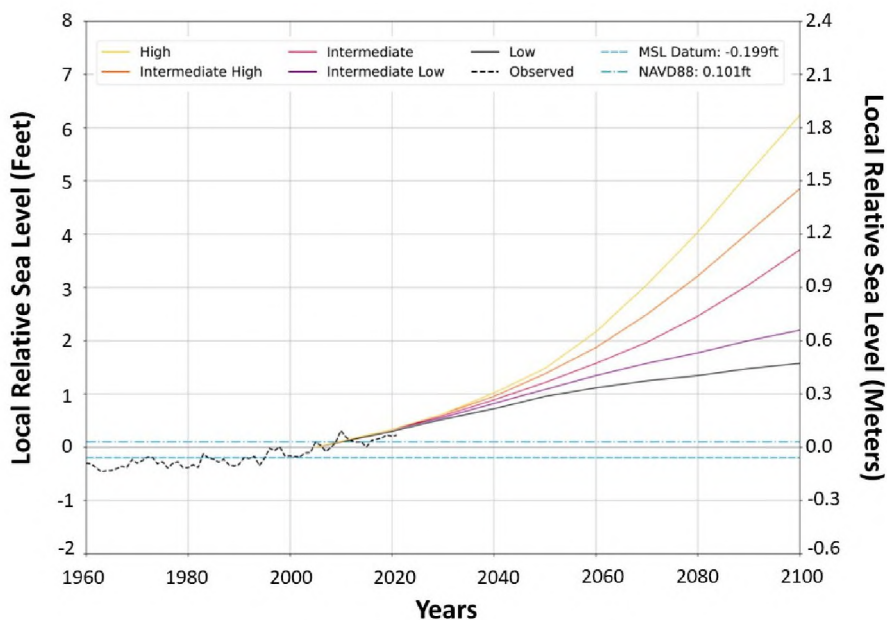


Greenhouse Gas Emissions by Gas

What is the future of sea level rise at Boston Harbor Islands?

The chart to the right represents observed annual relative sea level for 2016-2021 and projections through 2100. This chart puts historic trends in context with 2022 NOAA projections^{1,2} for future sea level rise at the Boston tide gauge based on different climate change scenarios.

Projections are a way of visualizing a range of possible futures. They can aid in park planning by helping managers determine which resources are most threatened by sea level rise in a given time frame.



The images show modeled water levels on Georges Island during a 2018 Nor'easter event with no sea level rise (left) and with 1 meter (3 feet) of sea level rise (right). These images show how storms that frequently occur in the Northeast will have much more damaging impacts in the future when sea levels are higher. These modeled images were developed by the University of Rhode Island and Penn State University.



How is sea level rise impacting the Boston Harbor Islands?

Boston Harbor Islands National and State Park encompasses over 35 miles of coasts and shoreline on 30 islands and four peninsulas located between Boston's mainland and the open Atlantic Ocean. Its shores and coastlines are constantly reshaped by physical processes like wind, storms, and tides. Rising sea levels and increased storm surge, however, are causing more dramatic changes to these coastlines. The islands feature sandy and rocky beaches, coastal bluffs, salt marshes, developed shorelines, and a vast array of plants and animals that are dependent on intertidal habitats that will be impacted by changes in tide heights. The park also includes important buildings, lighthouses, and cultural landscapes, including three national historic landmarks (Fort Warren, Boston Light, and Long Wharf).



- Lovells Island is one of the more threatened islands in the park. The northwest side of the island features exposed bluffs made of glacial till, which are eroding at very high rates due to strong waves. In the figures above, aerial imagery shows the retreat of bluffs on Lovells Island from 1995-2021, and a photo series shows a profile view of bluff erosion from 2006 -2021. Erosion can be attributed to storm wave impacts, which are compounded by sea level rise. Photos: Boston University.
- The south beach on Lovells Island is a key location for breeding birds, but much of the habitat the birds rely on for nesting is being eroded away.
- Relative sea level rose by 0.28m (0.92ft) in Boston between 1825 and 2017³ and is projected to keep rising. Higher sea levels can lead to more frequent high tide flooding and higher storm surges, often causing challenges for coastal structures. For example, Fort Warren on Georges Island is historically significant as a defensive post for conflicts from the Civil War to World War II. Flooding and higher sea levels could damage the fort.
- The northeast corner of Gallops Island and the west side of Rainsford Island have low-lying historic cemeteries. Increased flooding due to sea level rise at these locations could damage these historic resources.



The Boston Harbor Islands provide important habitat for many shorebirds including the American Oystercatcher. Photo: NPS, NCBN

How is the park responding to sea level rise?

The park is partnering with several universities and organizations to research coastal flooding impacts and possible climate adaptation solutions. For example, scientists at Boston University are combining numerical models and field data to assess how flooding and erosion are impacting natural and cultural resources. Also, the Stone Living Lab partnership is researching "nature-based solutions" to coastal erosion. These efforts provide park managers with the necessary information for developing plans to address resource loss or damage.

What can you do to help?

- Reduce your carbon footprint: power down electronics or reduce your thermostat. Go to carbonfootprint.com to calculate your carbon footprint and find ways to make changes.
- Volunteer with organizations working to protect coastal habitats that provide natural defenses against sea level rise.
- Support climate mitigation and adaptation policies. Contact your representatives in Congress to let them know you care.
- Visit coastal areas and support the parks and communities that are taking actions to prepare for sea level rise.

Additional Resources

1. <https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>: 2022 Sea level rise technical report
2. <https://www.coast.noaa.gov/floodexposure>: A tool to visualize coastal hazards as well as societal, infrastructure, and ecosystems exposure to those hazards
3. Talke, S. A., Kemp, A.C., Woodruff, J. (2018). Relative sea level, tides, and extreme water levels in Boston harbor from 1825 to 2018. *J. Geophys. Res. Oceans*, 123, 3895-3914.

Note: The sea level rise projections, storm surge projections, and other information presented here are for general educational and awareness purposes only. They should not be used for site-specific analysis, navigation, permitting, or legally binding activities.