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Town of Yarmouth Vulnerability Assessment

March 2024



YARMOUTH
MAINE

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INTRODUCTION

Climate change brings a range of hazards to Maine that threaten our health, infrastructure, and environment - but local solutions are within reach. At a community scale, we can build capacity to adapt to present, and projected, climate hazards and their resulting impacts. We can build local climate resilience by reducing existing vulnerabilities and take steps to mitigate future hazards. Towards this end, the Town of Yarmouth is undertaking an effort to assess and adapt to the threats climate hazards bring, both now and into the future.

The information presented in this report is compiled from local, regional, state and national data; interviews with municipal department heads; public input including surveys, workshops, and community conversations; and collaboration with Yarmouth town staff and the Yarmouth Climate Action Task Force.

The purpose of this assessment is to:

- Identify the hazards that Yarmouth will likely face due to climate change
- Provide a baseline for the community resources, infrastructure, and natural resources most at risk to climate impacts
- Inform Yarmouth's Climate Action Plan to better identify adaptation strategies
- Be adaptive, with the ability to be updated as new information becomes available

This assessment is not:

- Designed to dive into site-specific vulnerabilities but rather point to areas that may need further study
- An indicator of definitive problems that will occur but provides guidance on what could be most at risk in the coming years due to climate change

KEY TERMS

Hazard A physical process or event, exacerbated by climate change, that can bring harm to people, communities, or ecosystems

Impact The potential effect a climate hazard can have on human or natural assets and systems

Stressor A chronic condition or trend related to climate change that can exacerbate pre-existing hazards

Shock Acute events occurring over a specific period of time, such as heat waves or dangerous weather events, made more severe or frequent by climate change

Risk The potential for negative consequences where something of value is at stake. In the context of the assessment of climate impacts, risk can be assessed by multiplying the probability of a hazard by the magnitude of the negative consequence or loss

Vulnerability A measure of risk to a threat, incorporating the likelihood of the threat occurring and the severity of the impact if it occurs

Adaptation The process of adjusting to or preparing for changing conditions to reduce the vulnerability of impacted assets

Resilience The capacity of communities or natural environments to adapt and/or recover quickly from impacts

Source: U.S. climate Resilience Toolkit <https://toolkit.climate.gov/content/glossary#:~:text=A%20condition%2C%20event%2C%20or%20trend,change%20that%20can%20exacerbate%20hazards>

Data and Methodology

This report relies on national, state, regional, and local data to assess climate hazards, historical records, future projections, and impacts on local assets. There is currently limited hyper-local data on climate hazards and much of the modeling to predict future conditions is being done at the regional or state level. Therefore, this assessment relies on information from The Maine Climate Council's Scientific and Technical Subcommittee "[Scientific Assessment of Climate Change and Its Effects in Maine](#)" and the regional analysis of hazards conducted by partner organizations such as Casco Bay Estuary Partnership, Friends of Casco Bay, and Gulf of Maine Research Institute. Since there is a lack of localized data collection tools (tide gauges, weather service stations, etc.), this assessment uses regional data with specific discussions of Yarmouth's particular context when possible.¹

The data analysis for this vulnerability assessment generated quantitative-based information on how infrastructure, community services, and natural resources in Yarmouth are exposed to climate hazards. When assessing specific vulnerabilities, this report uses Town-provided data—both quantitative and qualitative—where available and is supplemented with state provided data analyzed at the local level.

This assessment uses the best available data and modeling tools currently available; however, every dataset has limitations. The State of Maine and regional partners are continuing to research climate change and provide updated models, data, and resources. As improved data and more powerful models become available, this vulnerability assessment will need to be updated and refined.

SEA LEVEL RISE

The Maine Climate Council recommends taking a scenario-based approach which considers a range of potential future sea levels and adopts the approach of committing to manage for a higher probability, lower risk scenario, but also preparing to manage for a lower probability, higher risk scenario. The State recommends committing to manage for 1.5 feet of relative sea level rise by 2050, and 3.9 feet of sea level rise by the year 2100, but preparing to manage for 3.0 feet by 2050, and 8.8 feet by 2100.²

For this report, we looked at two different sea level rise scenarios: Highest Astronomical Tide (HAT)+1.6 feet and HAT+3.9 feet of sea level rise. These datasets, available from the Maine Geological Survey, both align with the State's recommendation of committing to manage 1.5 feet of rise by 2050 and preparing to manage 3.0 feet by 2050.³ Assets which show flooding under either of these scenarios means that water will be frequently seen inundating these locations during high tides.

See Attachment A for more information on sea level rise.

Uncertain Climate Future

Climate change scenarios and pathways are developed to explore future emissions, related impacts and risks, and possible mitigation and adaptation strategies. These modeled scenarios and pathways are based on a range of assumptions including socio-economic variables and mitigation, and only provide a hypothetical future that could unfold given the presence or absence of climate policies. Therefore, how communities mitigate, prepare for, and adapt to climate change will impact what the future will look like. To read more about potential climate change scenarios, please visit the [IPCC's most recent climate assessment](#) and the [Fifth National Climate Assessment](#)

100-YEAR FLOODING EVENTS

To determine the impacts of 100-year floods, particularly along inland waterways, this report uses 2050 projected 100-year flooding data from First Street Foundation's Flood Factor⁴ rather than FEMA Floodplain Management. While FEMA floodplain information reflects current estimates and historic flood risk, it does not project future risk under a changing climate. Most notably, it does not take into account increased precipitation. Flood Factor includes flooding from all types in its application – rain, river, tidal and storm surge. According to First Street Foundation, by not accounting for precipitation, FEMA's Special Flood Hazard Area (SFHA) designation leaves over half of the country's risk unaddressed.⁵ However, Flood Factor uses a single methodology on a national scale, which may limit the accuracy at a local level. Currently this is the best available data, but it should be checked frequently and updated as new and better data is created.

The map below shows the difference between First Street Foundation's Flood Factor and FEMA Floodplain. If Yarmouth wishes to calculate more localized projections, it can explore developing site-specific flood modeling to account for factors such as local topography and elevation.

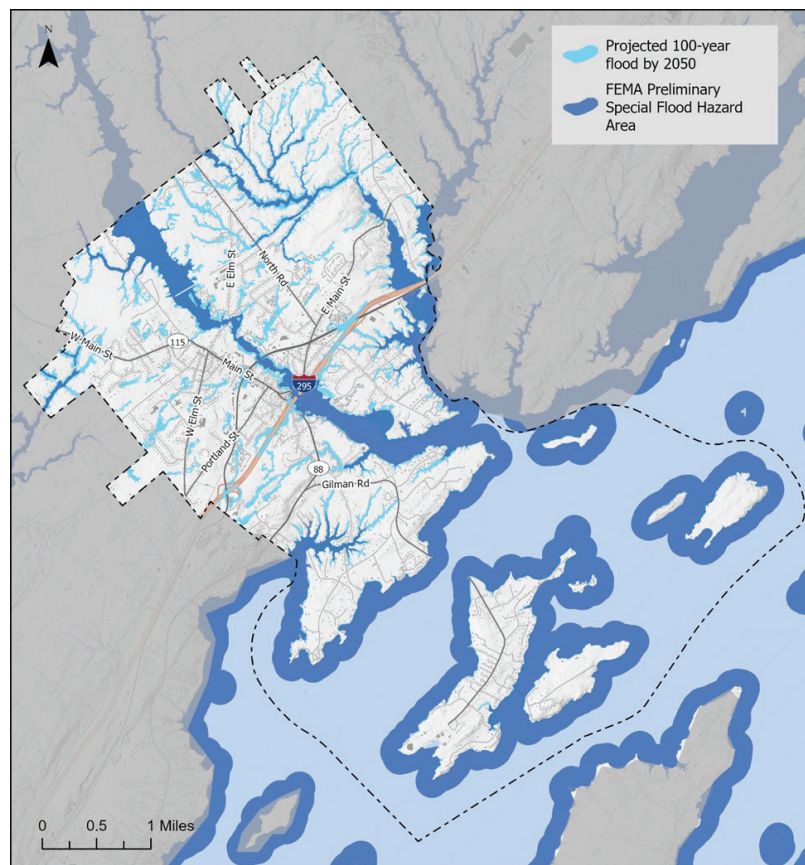


Figure 1: Comparison between FEMA Special Flood Hazard Areas (dark blue) compared to FloodFactor (light blue).

Unlike FloodFactor, FEMA does not take sea level rise or increased precipitation into consideration. Source: FEMA, FloodFactor.

CLIMATE HAZARDS

Like many other coastal towns, Yarmouth is already beginning to experience warmer air temperatures, increased precipitation, more severe storms, and sea level rise from climate change. Climate hazards degrade infrastructure and pose risks to people, ecosystems, and infrastructure.

Yarmouth is not alone in experiencing climate hazards and their resulting impacts. The Casco Bay region and state are experiencing similar trends across all hazards. Since local data is not available, this section relies primarily on regional and state data to assess the historical trends and future projections.

This section provides information on the following climate hazards Yarmouth will face:



Warming, more variable temperatures



Changing precipitation patterns



Sea Level Rise



Changing Ocean Conditions

What is the Yarmouth community concerned about?

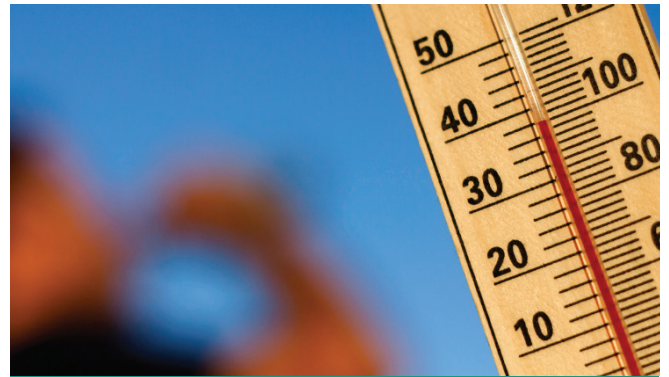
- The top climate hazard concern expressed in the survey was changes in seasonal weather followed by extreme weather events.
- The changing snow patterns are challenging public works to figure out snow treatment storage and staffing.
- Residents and staff said the past year (2022) was the worst year for ice, resulting in lack of ice skating on the public ponds.
- Residents perceive that rising ocean temperatures are bringing in more shark sightings and causing concern for the safety of swimmers.
- There is a perception that climate events are happening more frequently and accelerating, especially inland flooding.
- There is a concern about flooding across Yarmouth in these specific areas:
 - Causeway to Littlejohn Island
 - Camp SOCI
 - Between East Main Street and Spring Street
 - Along Gables Drive
 - Library and area around downtown
 - Yarmouth boat yard
 - Yarmouth Historical Society

Warmer, More Variable Temperatures

Rising concentrations of greenhouse gases in the atmosphere increase the average annual global temperature. Rising concentrations of greenhouse gases in the atmosphere increase the average annual global temperature. While all regions of the globe will experience impacts from climate change, the northeastern region of the United States is warming at a faster rate than the global average.⁶ Maine has already experienced an average annual temperature increase of 3.2 degrees Fahrenheit compared to 1895.⁷ **Every year since 1997 has been above that average.**⁸

As a coastal community, Yarmouth has experienced slightly more warming than the state average and is projected to have annual temperatures 3.5 to 4 degrees Fahrenheit higher than 1895 by 2050.⁹

The change in temperature that Maine experiences will shift seasonal patterns in the region. As temperatures increase, the warm seasons (when the average daily temperature is above freezing) become longer and the cool seasons become shorter. Global climate projections indicate that Maine's warm season will be two weeks longer by 2050.¹⁰ This is coupled with a projected increase in days with a high heat index. The National Weather Service recorded seven high heat days in the region in 2021 (temperatures reached or exceeded 90°F), an increase from the four recorded in 2019.¹¹ **The region will experience 20 to 30 more high heat days annually by 2050 and the winter season will shrink by one to two weeks.**¹²



Impacts

Human

- Increased heat-related illnesses
- Increased vector-borne diseases (i.e. Lyme)
- Strain on the health care system
- Worsening air pollution
- Changing tourism seasons

Infrastructure

- Increased buckling, softening, and cracking of roadways
- Increased energy consumption

Ecosystem

- Agricultural shifts
- Increased frequency of pest outbreaks
- Shifting ecosystems (i.e. invasive species)

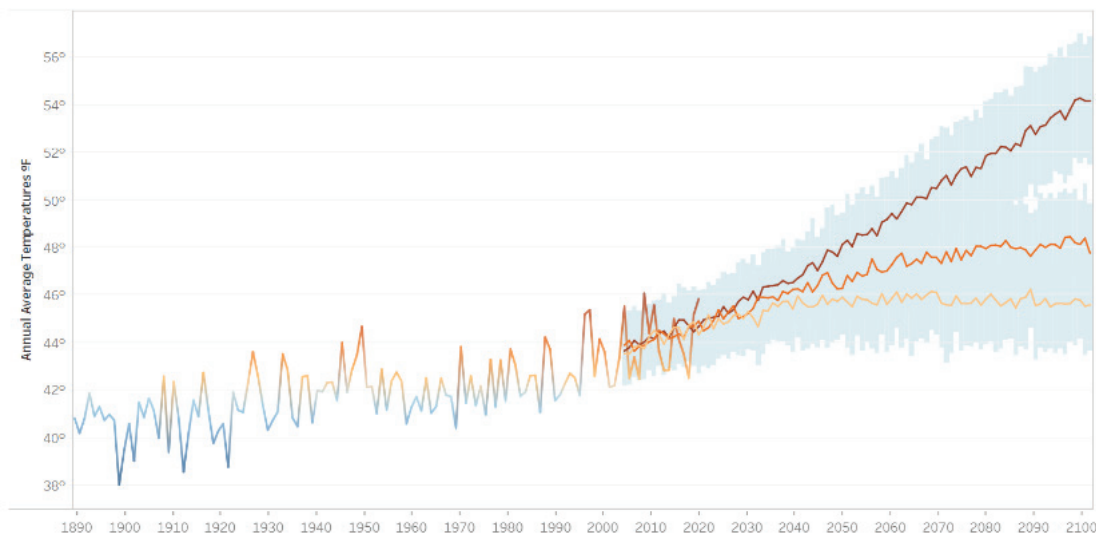


Figure 2: Average Annual Temperature in Maine from 1895 to 2022 and projected temperature increase based on three different RCPs. Source: Maine Climate Dashboard

Changing Precipitation Patterns

Higher temperatures will increase water evaporation from oceans and freshwater sources, resulting in overall higher humidity. Warmer air holds more moisture causing precipitation events to become more frequent and intense. By tracking annual precipitation patterns, the University of Maine determined that rainfall in Maine has increased 15% since 1895. This trend will likely continue, with a projected 5% additional increase in precipitation by 2050.¹³

Not only will total annual precipitation increase, but the frequency of heavy storms will increase. Since the late 1990's the northeastern U.S. has also experienced more frequent heavy precipitation events, primarily in summer and fall.¹⁴ A study in Farmington, Maine found that the area experiences 10–15 more precipitation events in a year than during the previous century and more of these events are large rain events.¹⁵ Additionally, The University of Maine completed assessments that indicate Nor'easters, ice storms and/or bomb cyclones—a rotating system of clouds that grows into a rapidly intense storm due to a sudden drop in atmospheric pressure— will become more frequent.¹⁶

While average annual precipitation is projected to increase, warmer overall temperatures and less snowpack will create the conditions for longer periods of drought. Between periods of precipitation, warmer temperatures will cause higher evaporations rates for lakes, rivers, and other water bodies. Maine is considered a “wet” state but has experienced 35 statewide droughts since 1990.¹⁷ The changing atmospheric conditions of the state will increase the occurrence of one-to-three-month droughts and reduce summer stream flow.¹⁸

Although overall precipitation will increase, annual snowfall will decline as temperatures rise. Since 1895, the average amount of snowfall in a year has decreased by 20% and the duration of snowpack has also decreased by two weeks. Coastal Maine is likely to experience 50% less snowpack by 2050 under the conditions of the IPCC's medium emission scenario.¹⁹ As a result, **the region will see more inches of rainfall annually, but it is projected to be concentrated in more intense storms with periods of increased drought in between.**

CURRENT EVENTS

In the current winter season, Yarmouth has experienced several intense rainstorms. The storm on December 23 caused extensive flooding, power outages, and damage to coastal communities in Cumberland and York Counties.²⁰ Winds up to 70 miles per hour and waves over 13 feet were recorded in towns neighboring Yarmouth during this storm. The second week of 2024 brought back-to-back rainstorms, with intense winds and waves causing damage along the coast.²¹ The rise in both frequency and intensity of storms indicates that this region is already experiencing the impacts of a warming climate.



Impacts

Human

- Decrease in property and municipal tax base
- Decline in water quality

Infrastructure

- Coastal and inland flooding
 - Coastal and inland erosion
 - Overburdened wastewater systems
 - Building and roadway damage

Ecosystem

- Agriculture damage
- Decline in ecosystem health
- Wildfires

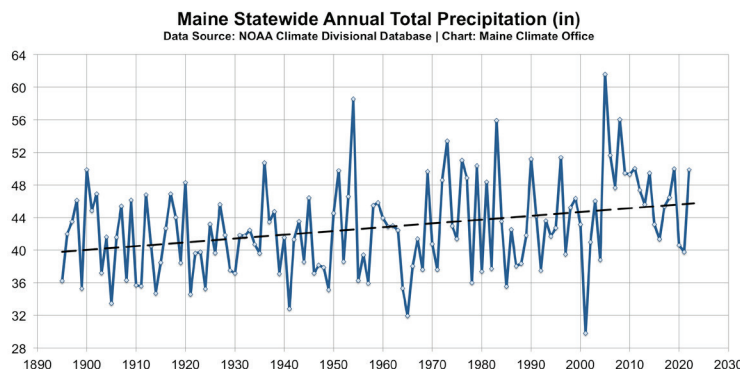


Figure 3: Maine Statewide Annual Total Precipitation in inches. *The linear trend (dashed line) indicates total precipitation has increased by 6 inches over this time period.*

Source: Maine Climate Office, [Maine Climate Office \(umaine.edu\)](https://umaine.edu)

Sea Level Rise

Global average sea level has increased by roughly 7-8 inches since the early 1900s, with almost half of that rise occurring since 1993.²²

The water levels in Casco Bay have risen by 7.5 inches since record-keeping began in 1912. While sea levels had been rising at a rate of 0.07 inches per year, that rate has accelerated to 0.12 inches since 1990.²³ This rate equates to about 1 foot of sea level rise per century but is predicted to accelerate further, as climate change worsens.

Higher sea levels mean higher tides reach further inland, causing more frequent “sunny day” or “nuisance” flooding, defined as when coastal water levels reach or exceed 2 feet above the long-term average daily high tide. In Greater Portland, nuisance floods historically happened about five times per year, but lately have occurred 12 or more times a year, especially during winter Nor’easters.²⁴

Assessments from the State estimate that by 2050, at least a 1-foot rise in sea level will lead to an increase of 98 flooding events per year in Portland.²⁵ Depending on various climate change scenarios—that is how greenhouse gas emissions and socio-economic development change— sea levels may rise to over 3 feet in 2050 and over 8 feet in 2100.



Impacts

Human

- Decrease in property and municipal tax base
- Contaminated groundwater

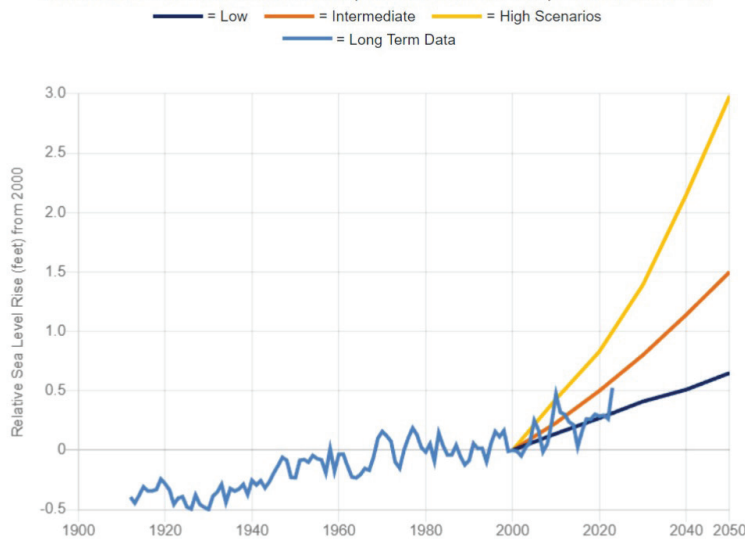
Infrastructure

- Coastal and inland flooding
- Coastal erosion
- Strain on stormwater systems

Ecosystem

- Shifting ecosystems
- Changing groundwater levels and salt accumulation in soil

Annual Sea Levels Referenced to 2000, NOAA Station 8418150, Portland undefined



NOTE: The intermediate scenario is the “commit to manage” and the high scenario is the “plan to prepare” level in the Maine Won’t Wait Climate Plan. Low, Intermediate, and High scenarios are based on Sweet et al., 2017.

Figure 4: Annual sea level rise at the Portland tide gauge from 1912 to 2022.

The trend lines so potential rise based on low (blue), intermediate (orange), or high (yellow) sea level rise scenarios.

Source: Maine Sea Level Rise Dashboard

Rising Ocean Temperatures and Acidification

Ocean temperatures in the Gulf of Maine have been rising at an accelerating rate, warming three times as fast as the global average over the past three decades, and seven times as fast in just the past 15 years.²⁶ Between 2004 and 2013, the Gulf of Maine warmed by 0.41°F (0.23°C) per year, a rate faster than 99% of the world's oceans. Bodies of water along the Maine coast are expected to continue warming at an above average rate; water temperatures in Casco Bay have increased over 2.5°F (1.4°C) between 1993 and 2022. The Gulf of Maine experienced its warmest year on record in 2021, with an average surface temperature of 54.1°F- coming in just ahead of 2022 as the second warmest year with an average surface temperature of 53.7°F.²⁷

Oceans act as a “carbon sink,” absorbing atmospheric carbon dioxide, thus helping alleviate the impacts of climate change. As the atmospheric concentration of carbon dioxide rises, the ocean absorbs more carbon dioxide, causing the water to become increasingly acidic. Acidification is further increased by stormwater runoff with prominent levels of nutrients such as nitrogen, creating algal blooms which can release toxins harmful to humans and marine species. Acidification impacts the health of the ocean and harms marine life.

Globally, oceans have become 30% more acidic in the past 100 years.²⁸ The Gulf of Maine may have a higher susceptibility to ocean acidification because of its relatively low pH and colder waters, which more readily absorb carbon dioxide. Research predicts that the acidity of the Gulf of Maine will continue to increase rapidly in the coming decades and at a faster pace than the global average.²⁹



Impacts

Human

Changes in food supply

Ecosystem

Decline in marine species health, particularly shellfish

Harm to fishing industry

Rising Water Temperatures

Friends of Casco Bay Sentinel Site Temperature Data
May through October Annual Averages

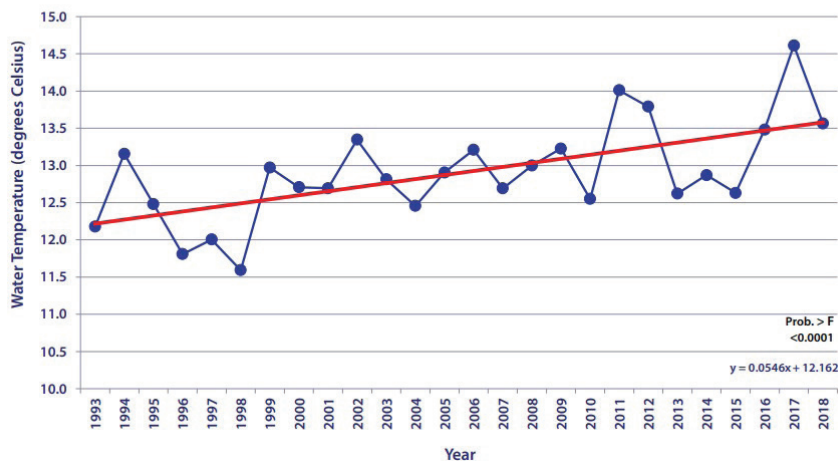


Figure 5: Average annual water temperature in Casco Bay from 1993 to 2019.

Data is taken from Friends of Casco Bay's three Sentinel Sites, which are located offshore in Broad Sound, nearshore by Clapboard Island, and at the mouth of Portland Harbor.

Source: Friends of Casco Bay

EXISTING SOCIAL VULNERABILITIES

Due to existing social vulnerabilities, the burden of climate change will not be felt equally across the community. People with existing social vulnerabilities will be disproportionately impacted by climate hazards. Communities with higher populations of at-risk individuals will be less resilient to climate hazards, and have less capacity to prepare for, respond to, or recover from climate events. Using demographic information to identify the populations most vulnerable to climate hazards allows the Town of Yarmouth to better direct planning and resources when preparing for future climate impacts.

How Yarmouth is addressing social vulnerabilities:

- Yarmouth Cares about Neighbors and the Aging in Place Program provides many resources and support across the community.
- Yarmouth Community programs are seeing an increase in total students and students requiring services – both language needs and physical mobility needs. Community Services is having trouble keeping up the increase in demand for resources.
- There is great communication across municipal departments to make sure people are getting the services that they need. Yarmouth Community service works closely with the police department, who often bring supplies to older and more vulnerable populations.

Total Households

3,612

Total Population

8,903

Natural Resource Industry is defined as those working in agriculture, forestry, fishing and hunting, and mining.

Cost burdened are households who spend 30% or more of their income on housing expenses. Significantly cost-burdened households spend more than half of their income on housing costs.

Multi-Unit Structure is a housing structure with 3 or more units.

Crowding is a household with more people than rooms. This includes owner-occupied and renters

KEY TERMS

Social vulnerability refers to factors that may weaken a community's ability to adapt to or recover from a disaster and is an indicator of community resilience. Examples: Age, race, households with no vehicle, financial burden.

DATA

To identify populations with the potential for high social vulnerability, demographic data in this report relies primarily on American Community Survey (ACS) 5-year estimates (2017-2021) from the U.S. Census Bureau. Variability across Yarmouth was analyzed at the block group level, which is the smallest geographic unit available. Unfortunately, all data is inherently flawed and has limitations. However, this analysis still provides Yarmouth with baseline information and the ability to assess social needs across town.

The Maine Social Vulnerability Index (SVI) developed for the Maine Climate Council identifies 17 social demographic characteristics that contribute to an individual's or household's vulnerability to climate impacts.³⁰ This assessment looked at each SVI factor along with additional key climate-related metrics to highlight Yarmouth's social vulnerability.

See Attachment B for more information on the data, limitations, and methodology.

Table 1: Yarmouth Social Vulnerability Index Characteristics. Source: U.S. Census Bureau

Demographic		Socioeconomic		Housing	
Age 65 or over	1,647 (18.5%)	Below poverty level	986 (11.3%)	Multi-unit structure	564 (15.6%)
Age 65 or over and living alone	415 (25.2%) ³¹	Self-employed	822 (23.7%)	Mobile homes	32 (0.9%)
Age 18 or younger	2,177 (24.5%)	No high school diploma	260 (4.2%)	Crowding	25 (0.7%)
People of Color	634 (7.1%)	Unemployed	268 (3.7%)	Single Parent Household	242 (7.0%)
Speaks English less than well	15 (0.4%)	Natural Resource Occupation	19 (0.4%)	Household with no vehicle	89 (2.6%)
Living with a disability	566 (16.3%)	Median household income	\$90,942	Renters	869 (25.1%)
		Cost burdened households	1,278 (38.4%)	Older Housing Stock	1,1503 (41.6%)

Notes: Calculations for each factor are based on different populations. For example, age and race or ethnicity factors are calculated based on total population while linguistics is determined for total population 5-years-old and older. Housing factors are calculated based on total households or housing units. Please see *A lifeline and social vulnerability analysis of sea level rise impacts on rural coastal communities (2018)* by Johnson, et. al. for a full description. Data Source: U.S. Census Bureau

COMPOUNDING SOCIAL VULNERABILITY

Each individual factor increases a person’s vulnerability to climate change; however, many people and households experience multiple factors. The more simultaneous factors someone experiences, the harder it will be to adapt to climate change. For example, an elderly resident living alone may also live in poverty and lack access to a vehicle. Evacuating during a severe storm could be difficult due to decreased mobility, reliance on public transportation, fewer communication channels, and limited financial means.

Key Takeaways

Overall Yarmouth has low social vulnerability. Yarmouth is more educated and has a higher median household income than Cumberland County or the state of Maine.³²

Demographics. Yarmouth has a higher median age than Cumberland County. In particular, the town has a larger percentage of residents 75 years and over and a higher percentage of residents under the age of 18. Both populations have a higher risk of heat-related health impacts and are more reliant on others for assistance during a disaster.

Lack of affordability. The town has a high rate of both renters and homeowners who are cost burdened. This lack of affordability limits residents’ ability to respond to and recover from climate events.

Building Stock. Yarmouth also has a high percentage of older buildings. With over 40% of households built before 1970, many houses may lack energy efficient upgrades and be more susceptible to damage during storms.

Despite Yarmouth’s low social vulnerability, there are still geographic regions in town that are more at risk than others. Future actions should consider how resources are distributed across the Town to reach the people most at risk. The data show the greatest amount of overlapping social vulnerability in neighborhoods along I-295 and Route 1. Certain factors discussed further below will have a larger impact on Yarmouth’s overall vulnerability.

Table 2: Yarmouth social characteristics versus Cumberland County.

Source: U.S. Census Bureau

Factor	Yarmouth	Cumberland County
Median Age	44.8	41.9
65 years and over	19%	19%
75 years and over	9%	7%
Under 18 years	25%	19%%
Homeowners who are cost burdened	32%	23%
Renters who are cost burdened	51%	44%
Households below poverty status	11%	9%
Median building age	1974	1974

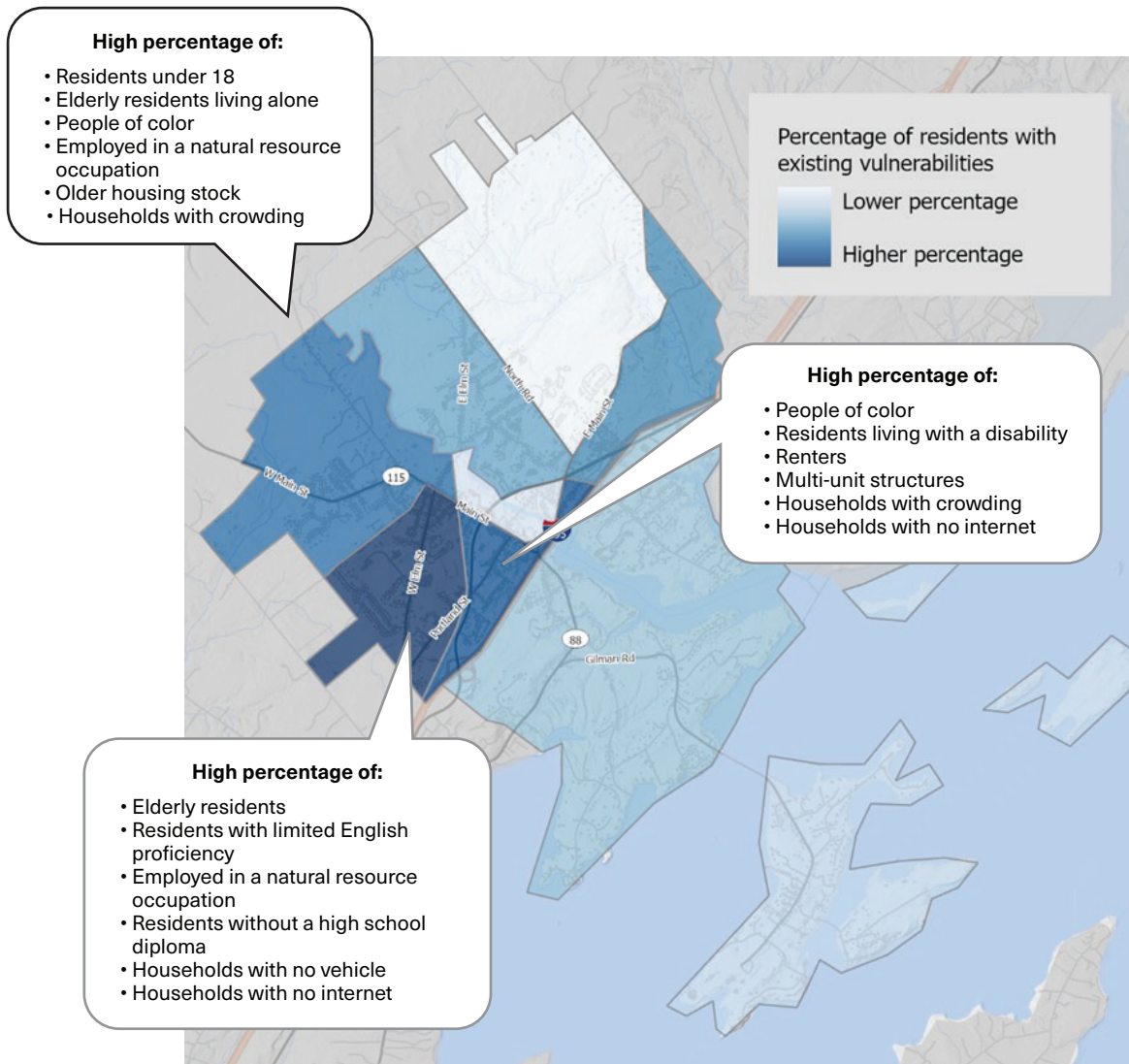


Figure 6: Overall social vulnerabilities in Yarmouth by census block groups.

Darker shades represent a higher percentage of vulnerable populations.

Source: U.S. Census Bureau

Demographics

Concerns:

Town staff indicated the town is having trouble meeting the physical needs of those with disabilities—for example, there is no accessible or inclusive playground equipment.

Through the planning process, residents and staff expressed concern about being able to support New Mainers and overcome language barriers.

The community identified that older adults and people with mobility challenges have limited options for transportation to access all of the services required.

What the town is doing well:

The Town has a contract with Southern Maine Aging Agency to meet in the library with older adults or people with disabilities to help find additional resources and apply for aid.

Age 24.5% of Yarmouth's population is under 18
18.5% of Yarmouth's population is over the age of 65
Over 25% of adults who are 65 and over live alone. That is almost 5% of the total population

WHY THIS MATTERS:

Older and younger populations are more at risk for impacts from extreme heat and cold and often have weakened immune systems which makes them more prone to health-related climate impacts. Also, both populations are more likely to rely on caregivers for basic needs.

People identified by the ACS as having a **disability** are those who report having serious difficulty with specific functions and uses follow-up questions to capture six aspects of disability— hearing, vision, cognition, ambulation, self-care, and independent living.

Health and Disability 16.3% of households in Yarmouth have someone living with a disability

WHY THIS MATTERS:

Residents experiencing poor health or a lack of access to health care will be inherently more susceptible to dangers such as high heat, worsening air quality, and power outages caused by intense storms. The social marginalization of people with disabilities further increases the threat of isolation during a climate-related event

Language, Race, and Ethnicity Just over 7% of the population are People of Color
Less than 0.5% of the population speak English less than well

WHY THIS MATTERS:

Race and ethnicity are strongly correlated with disparities in health, exposure to environmental pollution, and vulnerability to natural hazards. Due to historic and institutional racism, communities of color tend to have multiple socioeconomic factors that make them more susceptible to climate impacts. People who are linguistically isolated or have limited English proficiency may be less likely to hear about upcoming events/emergencies or have challenges communicating their needs during an emergency.

SOCIOECONOMIC

Many of the available town resources are not fully utilized, especially for those in the middle income who may still be struggling. People in need don't seem to know about the programs or options available.

Concern:

The town staff recognizes that more residents appear to be struggling financially as the number of requests for heat assistance has tripled in the past year.

Financial Insecurity

11.3% of the population is living below the federal poverty line

38.4% of total households are cost burdened. 32.6% of homeowners are cost burdened while 57.7% of renters are cost burdened

WHY THIS MATTERS:

Financially insecure households are less likely to have property insurance or savings for added or unexpected expenses such as higher energy or food costs, are unable to repair property damage from flooding or severe storms, purchase air conditioning, upgrade to energy efficient appliances (i.e., rooftop solar panels or heat pumps), or evacuate or relocate in case of a disaster.

Employment

3.7% of the working age population is unemployed

0.4% of Yarmouth's population works in a natural resource occupation

WHY THIS MATTERS:

Added expenses of climate change—such as increasing energy costs or repairs due to storm damage—are particularly detrimental for seasonal workers, those living on a fixed income, and the unemployed. Individuals who are unemployed will also have a harder time relocating in case of a climate disaster. The natural resource industry is particularly vulnerable to the shifts in ecosystems and changing terrestrial and marine conditions that put pressure on job security.

HOUSING

Access to Internet

6.8% of households have no internet subscription. Some households may elect not to have internet even if it is available.

WHY THIS MATTERS:

Lack of access to key resources, such as broadband, limits a household's ability to communicate, respond, and recover during a climate crisis. Without access to technology, communities miss crucial warnings, evacuation notices, and other disaster-related information.

Renters

25.1% of housing in Yarmouth is occupied by renters

WHY THIS MATTERS:

Renters have far less freedom in preparing for climate hazards than homeowners, as major renovations or upgrades are ultimately decided by the property owner. Sometimes rental properties are not as well maintained and less likely to be retrofitted or weatherized. Renters, especially those who are low- or moderate-income would be less adaptable to climate disasters and would have a harder time finding new housing. Additionally, renters are also often newer to the community and may have less knowledge of local hazards and be less connected to available resources.

Older Housing Stock

41.6% of houses in Yarmouth were built before 1970

WHY THIS MATTERS:

Older buildings are often less energy efficient, both for keeping warm in the winter and cool in the summer, costing residents more money on heating/cooling and exposing them to more extreme temperatures. In addition, houses built before 1970 were constructed prior to modern building codes, such as smoke alarms, that help reduce risk.

HOME HEATING

The source of heating for a house has an impact on both greenhouse gas emissions and vulnerability. Fuel oil, kerosene, propane, and natural gas all release carbon dioxide into the atmosphere. The cost of fuel varies by heating source and places further stress on financially insecure households.³³ Heating (or cooling) the home using electricity provides a more cost-effective, sustainable solution to help combat climate change. However, electrification must be paired with grid upgrades and resilience measures to ensure that the electrical grid can withstand increased consumption, and remain resilient against climate hazards.

In Yarmouth

The majority of Yarmouth homes are heated by fuel oil.³⁴ This is both one of the more costly heating sources and a greater emitter of greenhouse gases. Conversion away from oil will both reduce emissions and increase resiliency for the residents.

Table 3: Home heating fuel sources in Yarmouth. Source: U.S. Census Bureau, 2021

Heating Fuel	Number of households (%)
Natural Gas	482 (13.9%)
Propane	435 (12.6%)
Electricity	256 (7.4%)
Fuel Oil or kerosene	2,125 (61.4%)
Wood	76 (2.2%)
Solar Energy	47 (1.4%)
Other Fuel	42 (1.2%)



RISKS TO CRITICAL INFRASTRUCTURE

Climate hazards cause damage to critical infrastructure such as roads, buildings, and utilities. Today's infrastructure was not built to withstand the types of extreme climate events we currently experience or conditions we expect in the future. Although a 100-year storm has a low percent chance of occurring in any given year, the most valuable infrastructure and access to neighborhoods needs to be protected given the potential impacts. Below is a summary of the potential climate hazards and resulting impacts on Yarmouth's critical infrastructure.

Key Takeaways

- The biggest risk to infrastructure is flooding along the Royal River due to increased precipitation and severe storms, combined with the influence of sea level rise.
- Predicted flooding along Route 1 and Main Street will disrupt transportation, limit transit, and impact access to community resources throughout town.
- Predicted flooding will restrict access to Cousins Island and Littlejohn Island including cutting off ferry access.
- Wastewater infrastructure is relatively resilient due to the location of the wastewater treatment plant and presence of generators at pump stations. However, flooding may limit access to wastewater infrastructure and pump stations without generators may be knocked out, posing risks to the system.
- Waterfront infrastructure, including docks, marinas, and town landing, are at risk of flooding. This would strain the working waterfront economy and limit access to the islands.

Key Concern:

The backlog of capital work prevents timely infrastructure repairs and upgrades. This often means infrastructure is extended past their intended lifespan and are more at risk of failing.

FEMA VS FLOODFACTOR

Towns generally rely on FEMA FIRM mapping to assess impacts. This is necessary due to the regulatory purposes of these maps. However, FEMA mapping does not take sea level rise or climate change into consideration. Instead, this assessment uses State of Maine data and FloodFactor to assess impacts. These sources go beyond FEMA FIRM maps and present a more comprehensive and worst case scenario approach for planning. For more information please see the Data and Methodology section above and Attachment A.

Transportation

Transportation infrastructure is at risk of flooding from a combination of sea level rise, increased levels of storm surge, and increased precipitation. It is not just coastal roadways and bridges that are at risk but inland infrastructure as well. Increased intensity of storms leads to erosion and damage to infrastructure, disruption in transportation services, and increased maintenance and repair costs.

Concern:

Residents are concerned about flooding restricting access to the Cousins Island Ferry, as this serves critical transportation for students and residents from Chebeague Island.

How Yarmouth is doing well to adapt:

The Town uses a Road Pavement Management System to assess roadway needs.

The Department of Public Works does a great job clearing the roads so there has been little impediment for emergency services or access to residents.

VULNERABLE ASSETS IN YARMOUTH

The town has over 100 miles of roadway. Jurisdiction over the roads varies between MaineDOT, the Town of Yarmouth, and private owners. Modeling shows that in 2050, approximately 6 miles of roadway would experience some degree of flooding during a 100-year storm event.

Table 4: Transportation infrastructure in Yarmouth that is vulnerable to flooding based on projected 2050 100-year flood, 1.6 ft of sea level rise, and 3.9 feet of sea level rise. Inundation is determined by sea level plus highest astronomical tide (HAT)

	1.6 ft SLR	3.9 ft SLR	100-year flood
Roads	US Route 1, Main St, E Main St, plus 7 local or neighborhood roads	US Route 1, Main St, E Main St, plus 15 local or neighborhood roads	US Route 1, Main St, E Main Street, Route 88, Route 115 Marina Rd, W Elm St, Lafayette St, North Rd, plus over 50 local or neighborhood roads
Bridges	US Route 1, Main St, E Main St, Gilman Rd, Talbot Rd	Same as 1.6 ft SLR	Bridges from 3.9 ft SLR plus: Elm St, Granite St, Bayview St, Bridge St, Berlin Subdivision
Rail	None	None	Portions of Amtrak Line and Unused Line
Transit	Flooding at Cousins Island Wharf and roads along shuttle route would disrupt ferry service		Flooding on I-295 and US Route 1 could disrupt service
Marinas and Docks	All public and private marine infrastructure are at risk, including the Town Landing		
Culverts	State Route 88/Lafayette St	State Route 88/Lafayette St	State Route 88/Lafayette St

Roads and Bridges

By 2050, climate change threatens to bring increased chances of flooding to major local and state roadways and bridges within Yarmouth. This includes portions of I-295, US Route 1, and State Route 88. In addition, local corridors are vulnerable to flooding due to increased precipitation and severity of storms, cutting off neighborhoods.

- Those living on Little John Island are most at risk during a storm event as the bridges connecting the islands to the mainland are vulnerable to flooding. This would make emergency access or evacuation difficult. Sea level rise also threatens to inundate and damage the bridges. The bridge to Cousins Island may also be at risk, especially during a strong storm surge, but needs further elevation assessment.
- On the mainland, the neighborhoods between North Street and the Royal River have higher vulnerability to flooding and lower ability to adapt due to the limited number of connector roads to get to or from the neighborhood.
- Large storm events and sea level rise threaten to flood Yarmouth Landing.
- Analysis shows increased flooding during large storm events could cut off access to the wastewater treatment facility. However, the Town is currently undertaking a major project on the access road to alleviate flood risk to the plant.
- Aside from the bridges connecting the mainland to Cousins Island and Little John Island, bridge elevations across the Royal River should be assessed in greater detail to ensure future flooding does not cut off access.

The MaineDOT Environmental Office developed a risk evaluation tool, Transportation Risk Assessment for Planning and Project Delivery (TRAPPD), to assess bridges and large culverts based on a set of 12 questions with criteria that span the range of risks including budget, process, schedule, events, and safety. Scoring is applied based on a summation of the questions and is used along with asset condition and performance to evaluate the overall priority and risk associated with the asset.³⁵ Of the 23 bridges in Yarmouth assessed as part of the program in 2018, 9 bridges were classified into the highest risk category.

Hazards and Impacts



Precipitation and Flooding

- Temporary inundation
- Disruption to services
- Increased degradation and erosion
- Increased chance of damage from intense storms
- Larger amounts of runoff and sediment overflow



Sea Level Rise

- Temporary and permanent loss of infrastructure
- Risk of damage and erosion



Warming Temperatures

- Buckling, cracking, and softening of road pavement due to warmer temperatures will shorten the lifespan of the infrastructure and create poor driving conditions



People and Community

- Access to neighborhoods, businesses, and key community assets are cut off. This can strand residents and prevent emergency vehicle access.



Economic

- Increased costs for maintenance and repair. Emergency repairs, retrofitting culverts to appropriate sizing, and more frequent paving or replacement due to shorter lifespans will cost the town money.
- Disruptions to supply chains caused by flooded infrastructure will harm the local economy.



Natural Resources

- Undersized or degraded culverts create barriers for habitat migration.

Railways

Although there are no passenger rail stations in Yarmouth, the Amtrak Downeaster line which transports passengers from Brunswick to Boston runs through Yarmouth. The portion of rail which crosses the Royal River is vulnerable to flooding in 2050 in a 100-year storm. Further analysis should be completed to ensure bridge height would exceed expected flooding levels.

Transit

The Metro Breez runs along I-295 and US Route 1 through Yarmouth with stops at Exit 15 Park and Ride, Town Hall, and Hannaford. Metro Breez is an express bus service running between Portland and Brunswick with more than a dozen daily round trips Monday through Friday and five trips on Saturday.

In 2050, the I-295 northbound exit and entrance ramps along with Route 1 across Maine Street and the Royal River are vulnerable to flooding. This would limit access and reduce mobility for those who rely on the transit service.

Chebeague Transportation Company operates a ferry service between Cousins Island and Chebeague Island. The ferry operates 7 days a week with 10 round trips Monday through Thursday, 11 roundtrips on Friday and Saturday, and 7 roundtrips on Sunday. Visitors and seasonal residents park at a satellite lot just off Route 1 in the Town of Cumberland and take a shuttle between the parking lot and pier. The Cousins Island Wharf is vulnerable to flooding and at risk of disruption of transit service. In addition, the road from the mainland to Cousins Island and Wharf Road would experience flooding from sea level rise and storm surge, disrupting shuttle service from the parking lot to the ferry.

Marinas and Harbors

Yarmouth has 18 mooring fields with over 400 moorings, and approximately 300 moorings at the marinas and boat yard. All of Yarmouth's private marinas as well as its Town Landing, are vulnerable to sea level rise and flooding which would limit access for commercial fishing and recreational boaters. Sea level rise could cut off ramp access for boats to enter and exit the water during sunny day high tides.

Harbor floats can withstand winds of 45 mph, but faster wind speeds from increased severity of storms could impact infrastructure, temporarily flood boat launch areas, and cut off access for marine vessels to return to shore.

Culverts

The Nature Conservancy developed an analysis of culverts at risk of overtopping in a flood. The culvert along State Route 88/Lafayette St next to the Yarmouth Boat Yard was assessed as at high risk for overtopping. This culvert should be examined and potentially improved. There were no large culverts assessed through MaineDOT's Trappd Score.

A more extensive culvert study should be conducted to assess the capacity of smaller culverts.



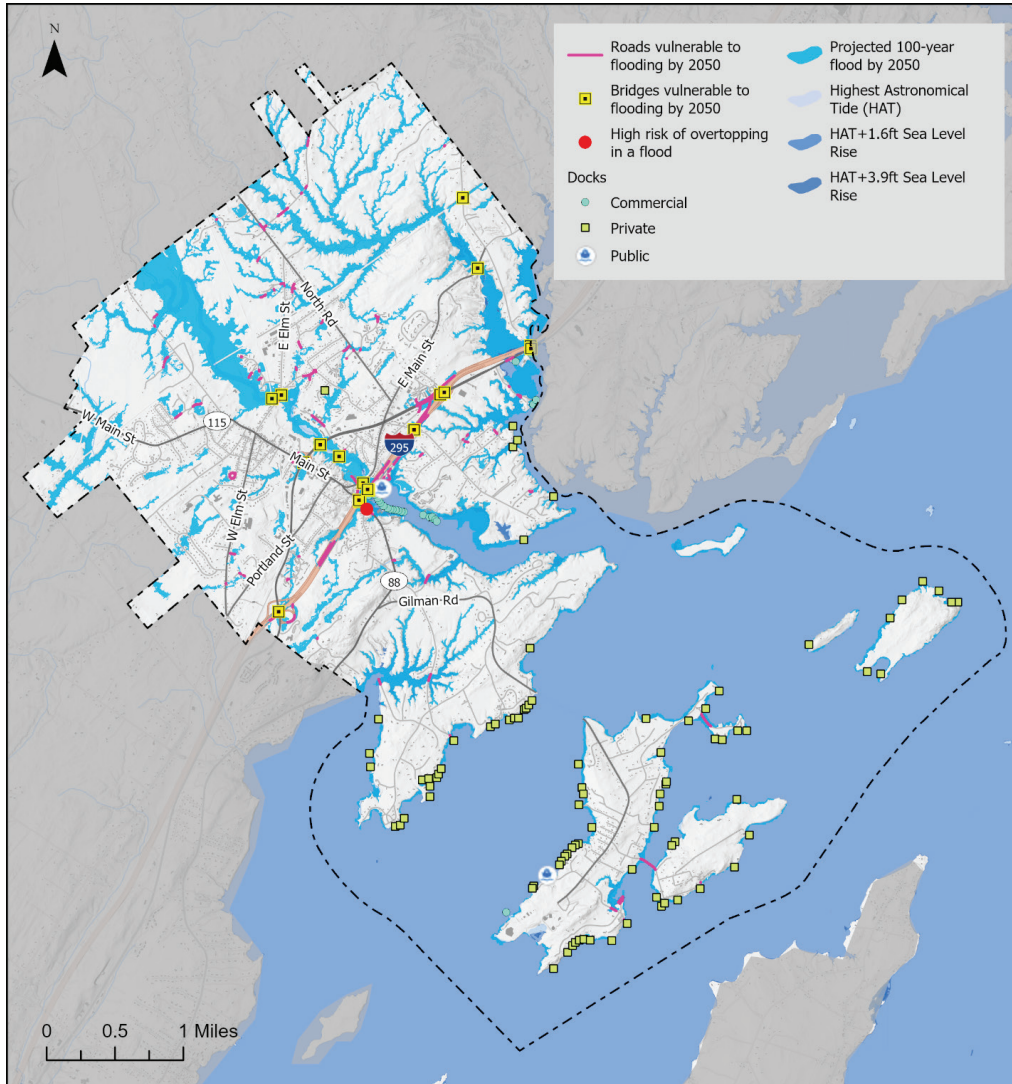


Figure 8: Transportation infrastructure at risk of flooding by sea level rise or 100-year storms by 2050. Source: Town of Yarmouth, Maine Geological Survey, MaineDOT, Maine DEP, FloodFactor

Wastewater, Stormwater, and Drinking Water

Sea level rise, increased precipitation, and increased flooding severity pose new risks to the daily operation and structural integrity of water systems—wastewater, stormwater, and drinking water.

Pump stations in low elevation areas may become inundated during intense precipitation events that flood an area faster than a station can pump out. This could create inflow and infiltration issues and impact the overall wastewater system..

Flooding or debris from intense storms could cut off access to infrastructure for repairs or inspections. Inundated infrastructure will have reduced capacity to convey flow, creating the possibility of overflows and threats to water quality. Increasing strain on pipelines may increase leaks and create overflows into waterways, directly contaminating waterways with untreated sewage or contaminated stormwater. Overwhelmed management systems lead to backups that cause localized flooding.³⁶

Failure and/or damage to these systems could degrade water quality and impact public health (see Natural Resource – Water Quality for more information). Any disruptions to the water systems could further impact residents and business owners.

Hazards and Impacts



Precipitation and Flooding

- Lack of access to infrastructure for service and repair
- Increased chance of damage from intense storms
- Inundate and overwhelm system
- Higher runoff and sediment overflow in systems



Sea Level Rise

- Temporary and permanent loss of infrastructure
- Risk of damage and erosion
- Groundwater infiltration



People and Community

- Impacts to public health from a decline in water quality



Economic

- Increased costs for maintenance and repair



Natural Resources

- Increased contaminants in water bodies
- Impacts to ecosystems from decline in water quality

Concern:

Residents have noticed poor drainage between East Main Street and Spring Street which has caused flooded properties, and a large amount of stormwater runoff that floods the woods on the south side of town along Hillside Street

How Yarmouth is adapting:

- Most pump stations can be controlled by phone so they don't require access during storm events.
- Yarmouth is part of Interlocal Stormwater Working Group, which is a regional collaboration of communities to work collaboratively to implement the Clean Water Act Municipal Separate Storm Sewer System (MS4) permit. As part of this permit, the town maintains an extensive GIS based storm drain system inventory.

WASTEWATER IN YARMOUTH

The Yarmouth Water Pollution Control Department operates and maintains the wastewater infrastructure in the Town which includes a treatment plant that treats approximately 830,000 gallons per day of wastewater, a Rapid Drain Sand Filter on Cousins Island serving 40 homes, 30 wastewater pump stations, 40 miles of gravity sewer lines, 20 miles of low pressure sewer lines, 800 manholes, 10 on site electrical generators at select pump stations and 3 trailer mounted portable electrical generators. There are an additional 25 private pump stations in town.

- Based on analysis for flooding in 2050, the wastewater treatment plant will not be directly impacted due to its location on a steep bluff along the coast. However, surrounding adjacent bluffs have been assessed to be unstable and future erosion could impact the plant. The road leading to the treatment plant could be vulnerable to flooding by 2050 during storm events, which would limit access. The Town recently completed a culvert upsizing project on the access road that should mitigate some degree of risk to this roadway and access to the plant.
- Most of the vulnerable wastewater infrastructure, including pump stations and pipelines, is situated along the Royal River.

Table 5: Wastewater infrastructure in Yarmouth that is vulnerable to flooding based on different flooding scenarios.

Asset	1.6 ft SLR	3.9 ft SLR	100-year Flood
Wastewater Treatment Plant	No Impact	No Impact	No direct impact, but access road may be flooded
Pump Stations	0	2	10 town pump stations and 3 private pump stations
Miles of Pipeline (in flooded areas)	0.07	0.27	3.98 4 miles
Force Main	0.03	.11	0.96
Gravity	0.04	.16	2.82
Low Pressure	0	0	0.17
Sewer outfall (in flooded area)	4	4	2
Sewer manholes (in flooded areas)	0	4	66

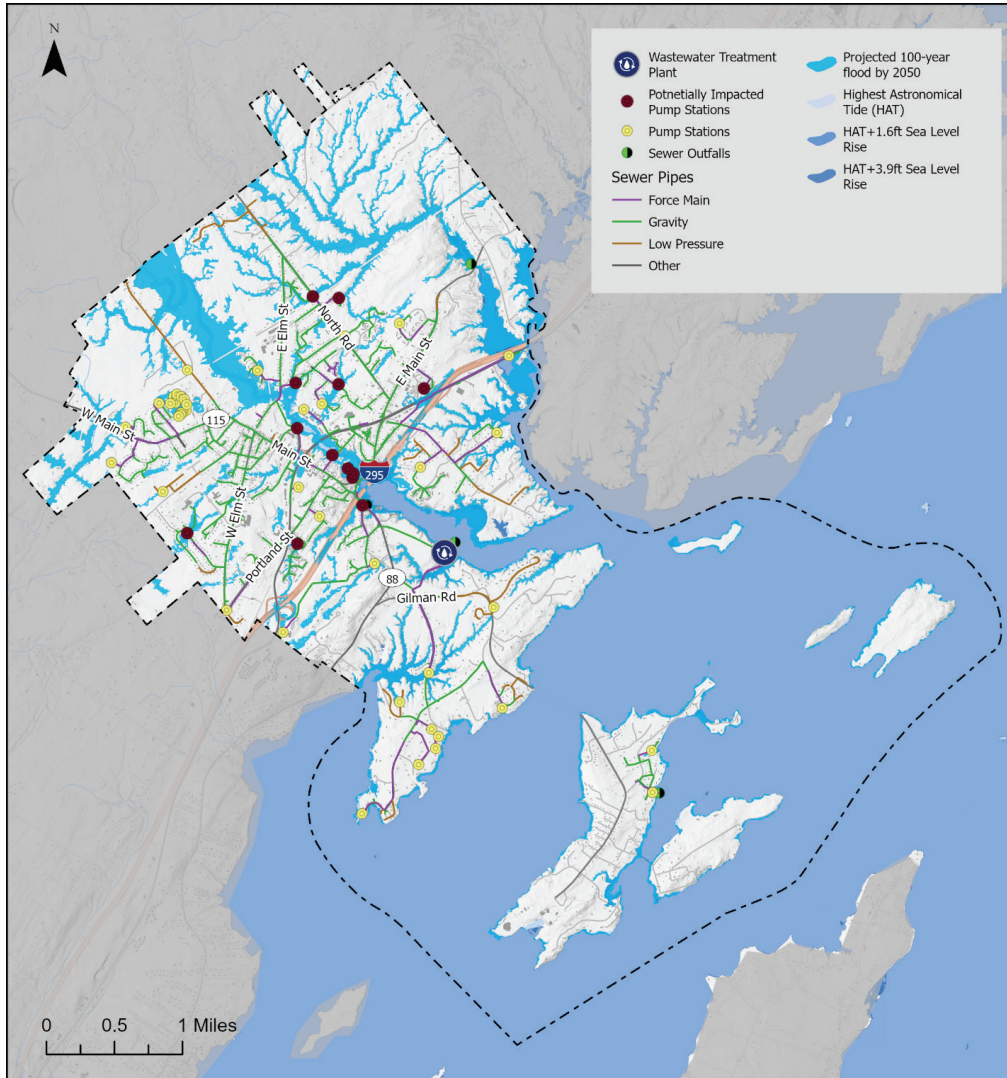


Figure 9: Wastewater infrastructure at risk of flooding by sea level rise or 100-year storms by 2050. Source: Town of Yarmouth, Maine Geological Survey, FloodFactor

STORMWATER IN YARMOUTH

Yarmouth maintains a Stormwater Management Plan and is subject to the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4s) which is issued by the Maine Department of Environmental Protection (DEP). The most recent permit went into effect in 2022 and is approved for five years.

- Yarmouth's stormwater system will be most impacted by flooding along the Royal River during a 100-year flood event which could overwhelm the system and limit access points for repairs.
- Culverts will need to be assessed in future studies to better assess how well the system can handle a 100-year flood event.
- Pipelines in flooded areas, especially those in areas impacted by sea level rise, could see increased pressure and deterioration.

Table 6: Stormwater infrastructure in Yarmouth that is vulnerable to flooding based on different flooding scenarios.

Asset	1.6 ft SLR	3.9 ft SLR	100-year Flood
Miles Of Drainage Pipeline In Flooded Areas	0.07	0.19	3.95
Drainage Outfall	10	11	146
Drain Catch Basins	2	6	147
Drain Manhole	1	1	21
Yard Drain	0	0	15



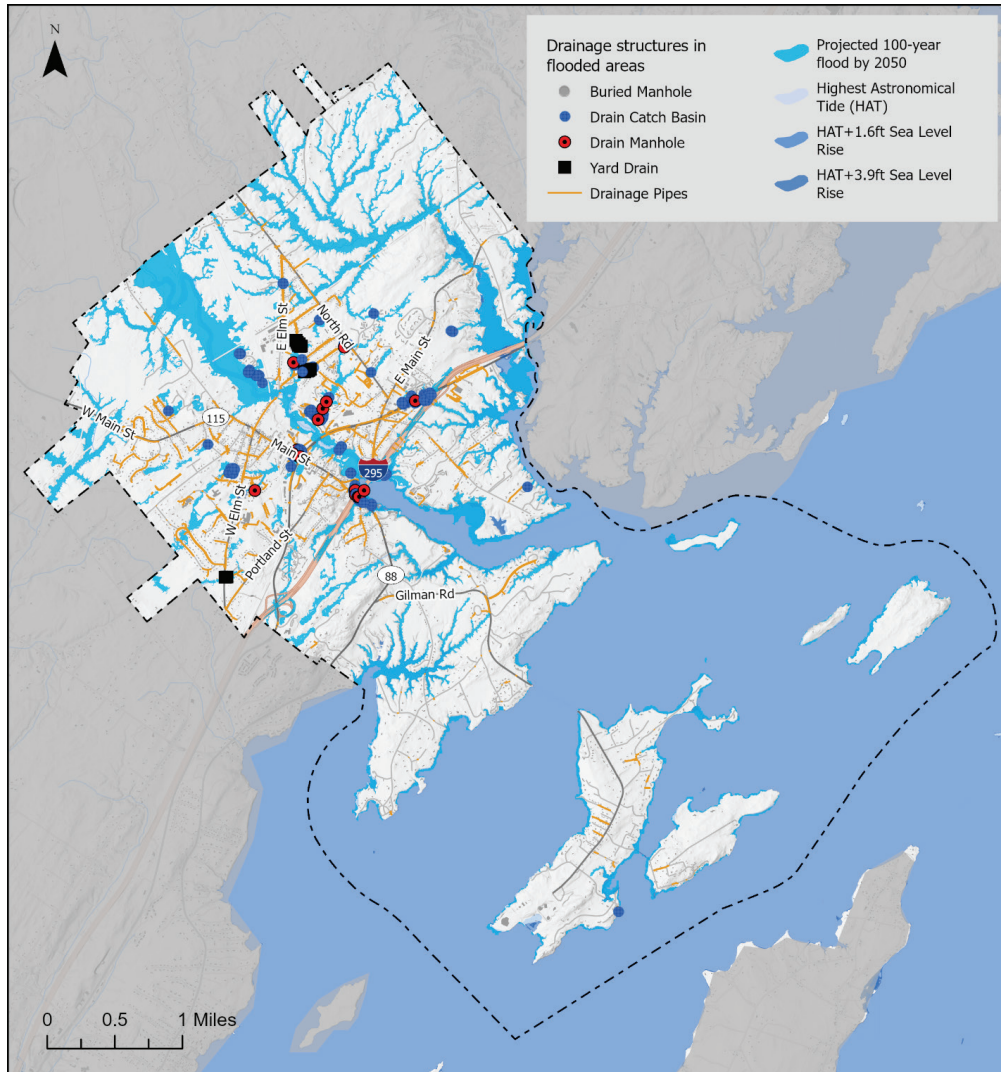


Figure 10: Stormwater infrastructure at risk of flooding by sea level rise or 100-year storms by 2050. Source: Town of Yarmouth, Maine Geological Survey, FloodFactor

DRINKING WATER IN YARMOUTH

Drinking water in Yarmouth is managed by the Yarmouth Water District (YWD), a quasi-municipal not-for-profit organization that serves Yarmouth, North Yarmouth, and part of Cumberland. The YWD serves more than 3,000 homes and businesses, maintains almost 80 miles of water mains, over 400 hydrants, and three storage tanks — two of which are in Yarmouth. In 2021, the YWD produced more than 296 million gallons of water from its four wells and an additional 75 million gallons were purchased from the Portland Water District to support the Wyman Energy Plant.³⁷

Data on drinking water networks is protected for safety. Therefore, the vulnerability of specific drinking water infrastructure assets has not been assessed for this study.

For information on drinking water quality see the section in Community Assets below.

Buildings

Homes, businesses, and municipal buildings are directly impacted by increasing precipitation and heavy storms. Those along the coast risk flooding from sea level rise and storm surges. Older housing stock are especially susceptible to damage and higher energy costs if they have not been properly maintained or retrofitted for energy efficiency. As climate change intensifies, residents in the Town of Yarmouth will see increased property damage. For more information on the economic impact from building and property damage see Vulnerable Community Assets section.

VULNERABLE ASSETS IN YARMOUTH

According to analysis, almost 1,200 parcels in the town may experience at least a minor degree of flooding during a 100-year storm, however, most would not impact structures on the property. Flood Factor analysis predicts 113 buildings could experience flooding by 2050 during a storm event, and up to 16 buildings could be impacted by sea level rise. Most impacted buildings are in flooding zones along the Royal River and tributaries to Pratt Brook. According to Risk Factor, there are 119 properties in Yarmouth that have greater than a 26% chance of being severely affected by flooding over the next 30 years.³⁸ This represents 9% of all properties in Yarmouth.

More buildings in town may be damaged by strong storms or high winds, however, these impacts are harder to project at a local scale and cannot be assessed through this report. Older buildings or buildings which have not been upkept are most at risk of damage from severe storms.

Several key properties impacted by projected climate scenarios include:

- Town owned buildings including Town Hall, Merrill Memorial Library, and Yarmouth History Center
- Over 70 residential buildings including 10 condo buildings, a nursing home, and 2 affordable housing buildings
- Approximately 15 commercial properties
- A building on the Wyman Energy Center property, not connected to the main plant.

Hazards and Impacts



Precipitation and Flooding

- Damage from flooding and extreme weather
- Temporary inundation



Sea Level Rise

- Temporary and permanent loss of property



Warming Temperatures

- Increased energy costs



People and Community

- Strain on community resources and services
- Decline in public health



Economic

- Change in property value
- Increased costs for repair, maintenance, and retrofits

Table 7: Buildings in Yarmouth that are vulnerable to flooding based on different flooding scenarios

Asset	1.6 ft SLR	3.9 ft SLR	100-year Flood
Buildings Impacted	8	16	113
Parcels Impacted	402	437	1,186

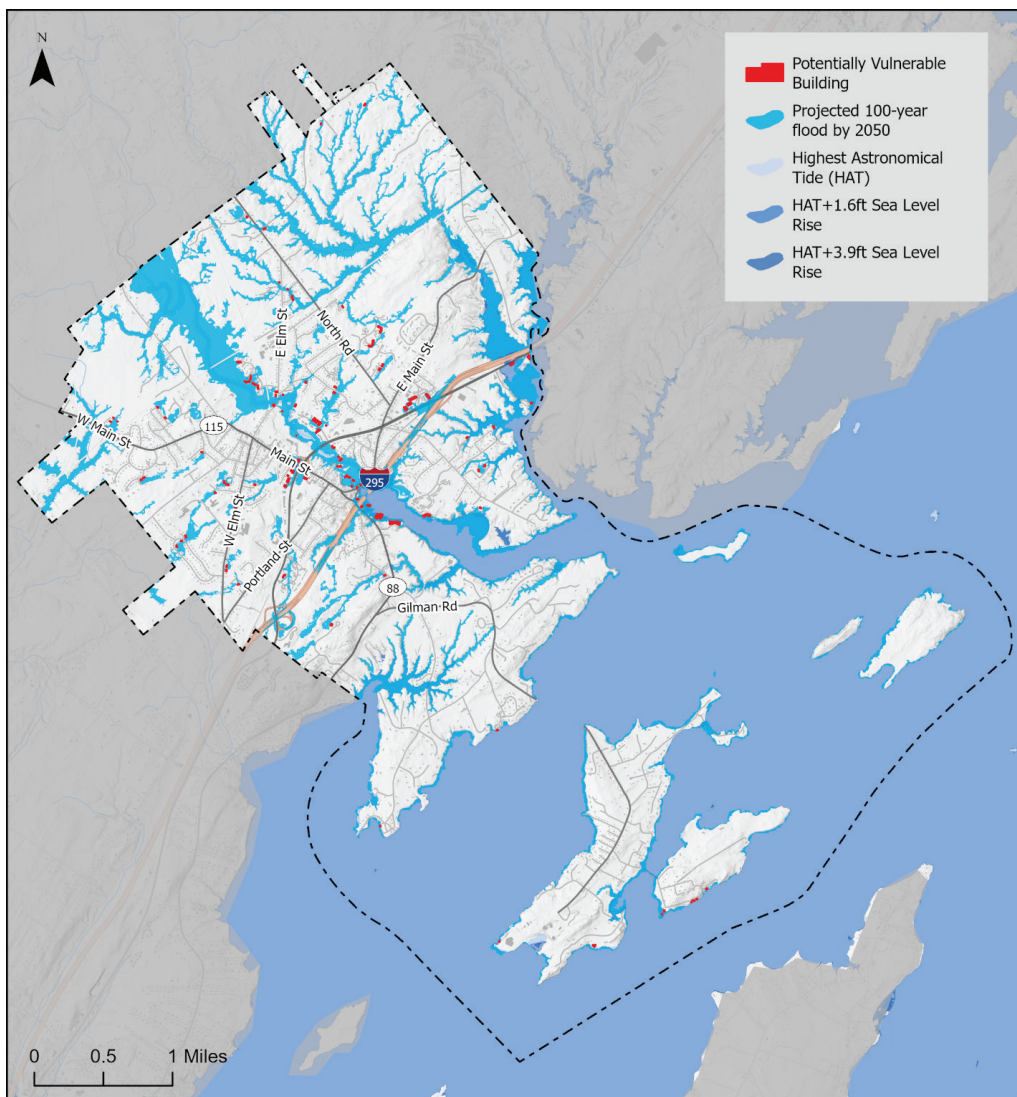


Figure 11: Building at risk of flooding by sea level rise or 100-year storms by 2050.

Source: Town of Yarmouth, Maine Geological Survey, FloodFactor

Power and Information

Energy and information systems, including radio towers, data centers, substations, transmission and cable lines, are growing increasingly vulnerable to climate change, with both direct and indirect impacts threatening the efficiency of the system and the reliability of supply. Faster wind speeds, heavier precipitation events and storm surges, and flooding will increasingly disrupt transmission lines, inundate substations and data centers, and erode communications systems.

Indirectly, the projected temperature changes may shift patterns in energy use, causing strains on both system reliability and capacity. Strain on the energy grid from increased demand or disruptions in equipment due to climate change could create financial burdens on residents, businesses, and the Town. As the intensity and prevalence of heat waves increase, higher demand for air conditioning increases the strain on power lines, increasing the chance of partial power outages and brownouts on high heat days. Through the bipartisan infrastructure land and inflation reduction act, Maine is already investing heavily in grid upgrades to support electrification and ensure reliability.

In Yarmouth

The energy and communications systems that service Yarmouth are interconnected within broader regional systems, and most assets are serviced by private utilities which have ultimate jurisdiction over any infrastructure systems. Understanding local infrastructure connections in the context of both the regional systems and climate hazards is necessary to determine potential actions for risk mitigation. These plans should be included in local emergency management plans.

Yarmouth uses cell towers to communicate and control remote pump stations. Damage or disruption to these systems could also impact wastewater assets.

The Wyman Power Station is an oil-fired power plant located on Cousins Island. The plant which was built in 1957 now only operates on a largely on-call basis— if another plant goes offline or when there is a large demand for energy. The plant provides energy beyond Maine, but for the greater New England area. It last helped keep electricity flowing to New England in December 2022.³⁹ There is one out building on the Wyman Power Station property which is vulnerable to sea level rise; however, heavy storm events could damage the plant. With rising fuel costs and changing ownership, the future of the plant is unknown.

VULNERABLE COMMUNITY ASSETS

Climate hazards will have a direct impact on Yarmouth's social and economic health. Impacts on housing security, food security, and public health will also bring economic stressors. As mentioned earlier, climate change will not affect everyone equally; it will be felt most by those most vulnerable. Climate change may even further compound social inequity by amplifying many of the existing vulnerability factors. Being a smaller town, Yarmouth does not have the same ease of access to various nonprofit and social organizations as larger cities, and thus relies on regional support and collaboration. To account for the most vulnerable populations, Yarmouth will need to expand support to address heightened social vulnerability from climate change, and to ensure equitable processes and outcomes in future planning for climate resilience.

Key Takeaways

- The biggest concern for the community will be access to resources during flooding events. Flooded roads and properties can make navigation difficult and limit the ability to distribute resources.
- The downtown area is most at risk of flooding and high heat impacts and also includes the highest concentration of community resources. Maintaining access to this area, especially for those most vulnerable, will be critical.
- Yarmouth residents will experience a range of physical, emotional, and mental health impacts. These impacts will be similarly felt across all communities in the greater Portland region.
- Rising ocean temperatures and ocean acidification could cost the fishing industry thousands of dollars of revenue each year.

The Town recently received a grant for a community mental health resource position to share across three towns. Continued investment in resources such as this can help bolster resilience to climate change and the associated impacts.

Concern:

"The Town needs a better way to contact residents and businesses in case of emergency. Right now the only options are via social media or to self-enroll in Code RED."

What makes Yarmouth resilient:

Yarmouth Cares About Neighbors (YCAN) is a vital community resource that provides a range of services to bolster community resilience. Programs include Aging in Place, fuel assistance, food donations, Ride Programs and more. Maintaining this resource increases Yarmouth's ability to adapt and respond to climate change.

Public Health

Climate change impacts a wide range of public health concerns for both physical and mental wellbeing. For example, extreme heat poses serious health consequences from dehydration to heat stroke. Increased precipitation can contaminate water bodies and reduce water quality. Climate change can affect human health by impacting the severity or frequency of existing health problems, such as asthma and Lyme disease. In this section we will highlight the possible public health impacts that Yarmouth will need to prepare for.

Concern:

In the public survey, "air pollution and air quality" was a top concern for residents.

AIR QUALITY

Climate change will likely exacerbate poor air quality over time, as rising temperatures speed up the chemical reactions that create smog, and changes in wind patterns may potentially reduce local air circulation, trapping pollution at the ground level.⁴⁰ Additionally, Maine is susceptible to pollution from sources located hundreds of miles away. In the summer of 2023, fires in Canada impacted the air quality index in Maine, prompting the State's Department of Environmental Protection to issue three separate air quality alerts.⁴¹ Increasing severity and prevalence of wildfires, in Maine and beyond, increases particle pollution.

Increases in temperature and humidity will influence air pollution, affecting the number of cases and severity of respiratory conditions.⁴² Higher annual temperatures are likely to bring earlier flowering, more pollen production, and the potential for a longer pollen season. Higher levels of pollen, pollution, and particulate matter can cause irritation and infection; trigger allergic responses, asthma, and other respiratory stress; and even cause serious cardiovascular problems such as heart attacks and strokes or lead to chronic respiratory conditions. In 2021, 12.5% of adults in Maine had asthma.⁴³ Residents with existing health conditions will be more vulnerable to poor air quality.

In Yarmouth

There is no specific air quality measurement for Yarmouth, however, the Environmental Protection Agency (EPA) maintains a monitoring station in Portland for Cumberland County. Overall, Cumberland County has relatively clean air. The EPA's Air Quality Index report is an indicator of overall air quality and takes into account all of the criteria air pollutants measured at the monitoring station.⁴⁴ The graph below shows the number of days where the Air Quality Index experienced unhealthy days. The County has not experienced any "Very Unhealthy" or "Hazardous" days in the last 20 years. Cumberland County has experienced 7 years (2001–2003, 2005, 2007, 2010, 2013) where the 8-hour ozone daily maximum concentration exceeded the National Ambient Air Quality Standard of 0.070 ppm which was set in 2015.⁴⁵

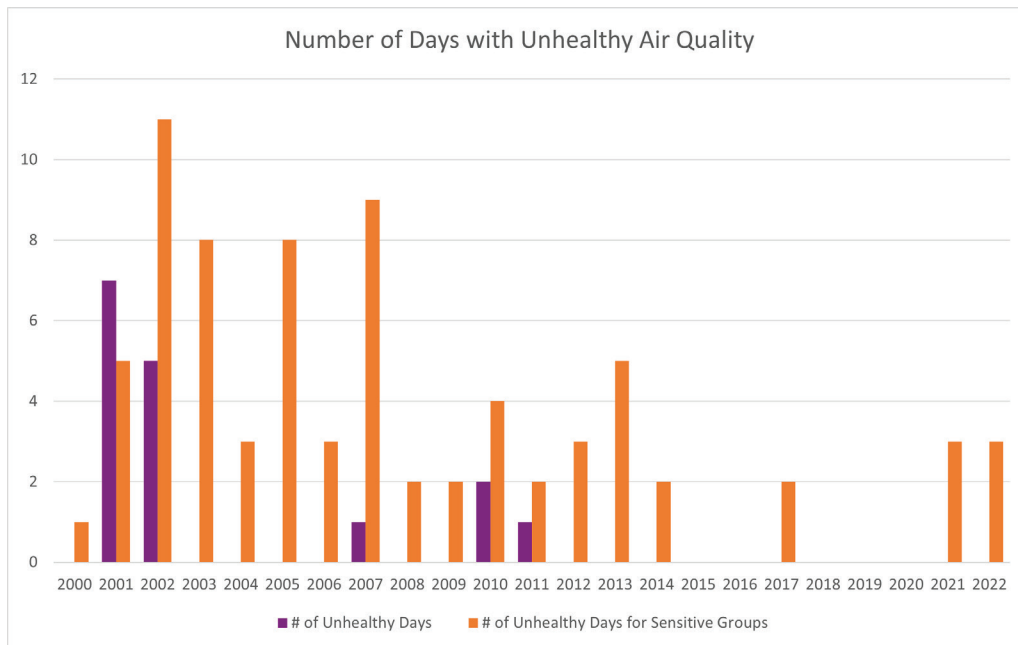


Figure 12: Graph of Number of Days with Unhealthy Air Quality in Cumberland County

DRINKING WATER QUALITY AND QUANTITY

Increased precipitation creates more stormwater runoff, which impairs water systems. Stormwater runoff delivers larger quantities of pollutants such as nutrients, sediment, bacteria, and trash into water bodies. These pollutants increase the likelihood of water-related illnesses.⁴⁶ Combined with higher temperatures, water quality is further degraded by increase in toxic algal blooms due to higher temperatures.

Sea level rise presents the risk of saltwater intrusion—which is where saline water infiltrates groundwater and freshwater aquifers.⁴⁷ Saltwater intrusion contaminates drinking water supplies and can damage underground infrastructure which further leads to degraded water quality.⁴⁸

Conversely, the extended periods of drought brought on by climate change will deplete groundwater sources.⁴⁹ With prolonged periods of droughts and decreased spring snowmelt, groundwater aquifers and wells are at risk of running dry and straining water quantity. In Cumberland County based on the U.S. Drought Monitor, there have been four periods of severe to extreme drought since 2000. These occurred during the summer and fall of 2001–2002, 2016, 2020, and 2022.⁵⁰

In Yarmouth

As mentioned earlier, many households in Yarmouth receive drinking water through the Yarmouth Water District (YWD). YWD regularly tests both the source and treated water. The Maine Drinking Water Program (DWP) evaluates public water supplies as part of the Source Water Assessment Program (SWAP) to assess how likely drinking water sources are to being contaminated by human activities in the future. Water quality testing and limited development in the YWD protection area indicated a low risk for future bacterial contamination and moderate risk for chronic contaminants.⁵¹

In 2022, YWD received a testing violation for failing to test and report on all contaminants by the reporting deadline.⁵² However, 2021 testing results indicate that the YWD's water continuously meets or exceeds all state and federal requirements and has no reportable violations.⁵³

Households which rely on private wells for drinking water are specifically at risk for contaminated water quality. Private wells are not regulated under the Federal Safe Drinking Water Act or state laws which means well owners are responsible for testing and maintaining water quality.⁵⁴ According to the Maine Geological Survey, Yarmouth has approximately 280 wells.⁵⁵ These wells are spread around town, including Cousins and Littlejohn Island. The wells on both islands and along the coast are most susceptible to saltwater intrusion.

As the Town also relies on groundwater for drinking water supplies, prolonged periods of drought have impacted residents. In 2022, the Maine Drought Task Force documented 95 privately owned wells that reportedly ran dry during the year, the majority of which were in Cumberland, York, Kennebec, Lincoln, and Knox Counties and 97% of these wells were residents.⁵⁶

The USGS monitors groundwater levels in Cumberland County at a well in Brunswick and a well in North Windham. Since 2000, the lowest recorded groundwater levels occurred in October 2022 at the Brunswick well and October 2016 at the North Windham well, both corresponding with recent severe drought conditions.⁵⁷ This impacts both town water and private well supply.



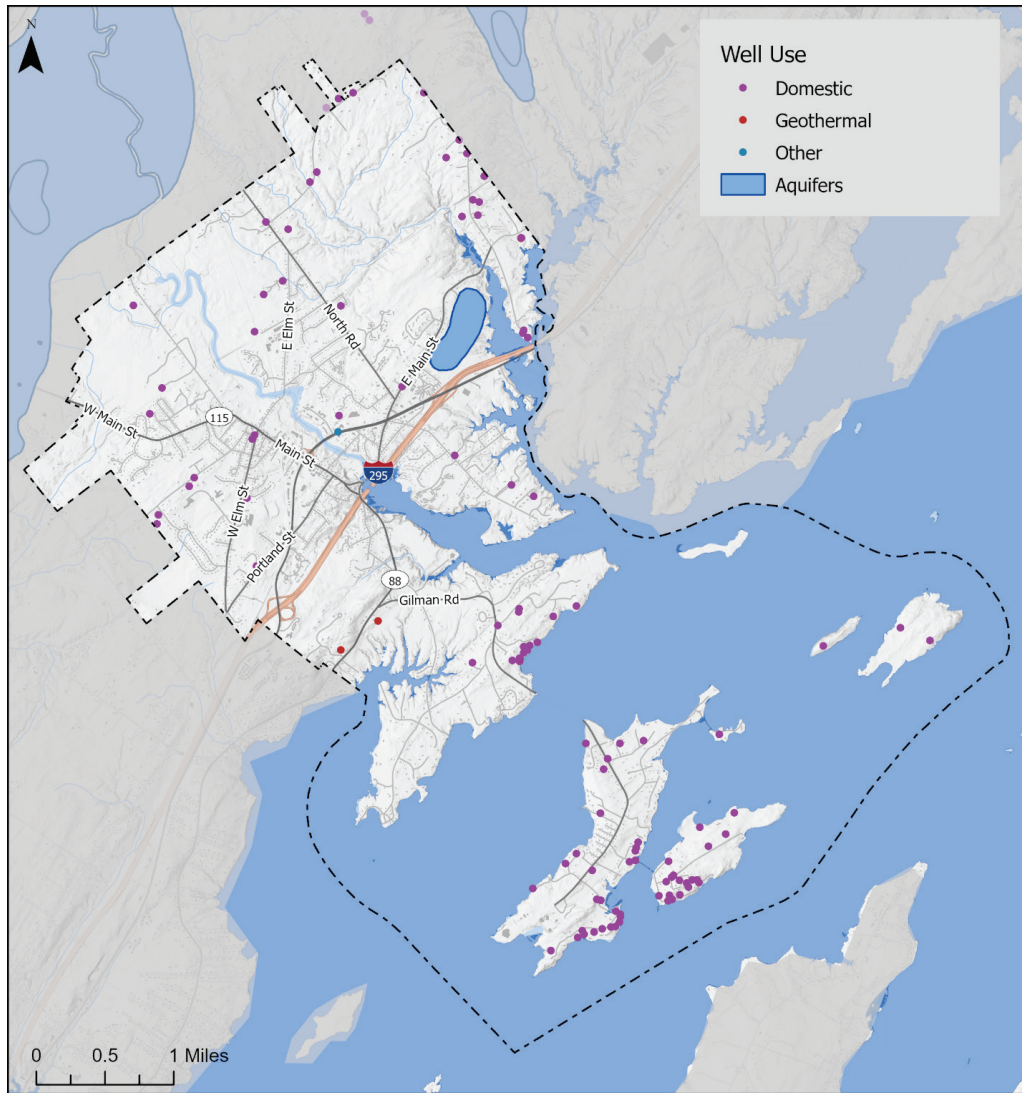


Figure 13: Wells in Yarmouth. Source: Maine Geological Survey

VECTOR-BORNE DISEASES

Warmer winters, higher humidity, and more precipitation impact the breeding and survival rates of ticks and mosquitoes, as well as the pathogens they carry. Nine vector-borne diseases (two mosquito-borne and seven tick-borne) have been identified in Maine. In 2021, Lyme disease, which is spread by black-legged ticks or deer ticks, was the most common vector-borne disease in Maine.⁵⁸ Rates of Lyme disease have increased significantly over the past decades from less than 250 reported cases in 2005 (70 in Cumberland County) to over 2,600 reported cases in 2022 (223 in Cumberland County)- setting a state record.⁵⁹ Two other prevalent tickborne diseases—Anaplasmosis and Babesiosis—also had a record number of cases in 2021 with 841 and 201, respectively.⁶⁰

KEY TERMS

Vector borne diseases are those passed to humans through non-human vectors, such as mosquitoes, ticks, fleas, and bacteria. These vectors pass diseases that are often debilitating and sometimes fatal, and most vector species thrive in high heat and high humidity environments.

In Yarmouth

Like communities across the state, Yarmouth is experiencing a prevalence of tickborne diseases. The Maine CDC tracks three diseases at the town level: Lyme, Babesiosis, and Anaplasmosis. Between 2016 and 2020, Yarmouth had the 6th highest rate of Lyme disease in Cumberland County, and the 9th highest rate of Babesiosis.⁶¹

Table 8: Rate and number of confirmed and probable cases of tick-borne disease in Yarmouth from 2016 to 2020. Source: Maine Tracking Network Data Portal.

2016–2020	Lyme Disease	Babesiosis	Anaplasmosis
Number of confirmed and probable cases	71	3	8
Rate per 100,000 people	168	7.1	18.0
Prevalence in Cumberland County out of 28 communities	7th	9th	18th

EXTREME HEAT

As described earlier, exposure to high heat is linked with a number of health-related concerns. Some populations are at a greater risk of being affected by heat illness, including the elderly, children, individuals with preexisting health conditions, and those who work outside.⁶² To combat heat, officials often recommend staying in air-conditioned buildings. However, many Maine homes and businesses lack air conditioning, making people more vulnerable to heat stroke in the summer. Additionally, those with financial and mobility burdens are less able to afford air conditioning or access cooling centers.

To compound this, “heat islands” (areas of town with more impervious surfaces like buildings, roads, parking lots, etc.) retain more heat and have higher surface temperatures. Residents who live or work in high-impervious areas are at greater risk of heat-related illnesses.⁶³ Areas with more trees and vegetation reduce the effect of heat islands and remain cooler. Historically, the most vulnerable populations within a community have the least access to open, green space.

In Yarmouth

Based on data from the Trust for Public Land, Yarmouth has two prominent areas that are hotter than the average temperature for the town as a whole from the summer of 2021. The maps show heat severity measured on a scale of 1 to 5, with 1 being a relatively mild heat area (slightly above the mean for the town), and 5 being a severe heat area (significantly above the mean for the town).

In Yarmouth, the downtown areas bordering both sides of the Royal River along Route 1 have the highest heat severity. The heat island on the south and west side of the Royal River extends along Main Street. Many community resources, including senior living centers, schools, town hall, and the library, are located within higher-than-average heat areas. There are more vulnerable populations in this area including residents over the age of 65 and living alone, renters, and those who are cost burdened.

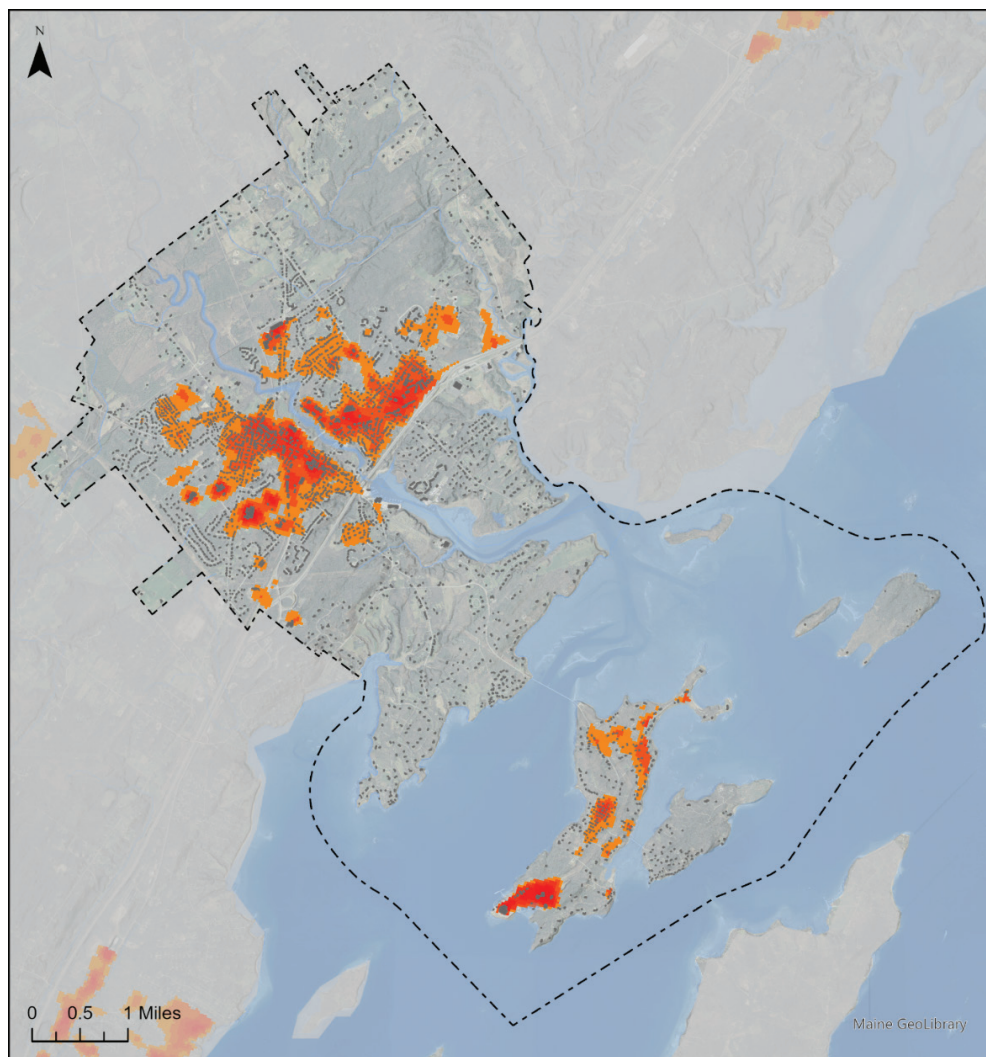


Figure 14: Heat severity in Yarmouth. Darker areas indicate a severe heat area.

Source: The Trust for Public Land

MENTAL HEALTH

Climate change will not only impact people physically, but mentally and emotionally as well. This can include trauma from a climate disaster, stress from changing job industry or increasing financial burdens, or the persistent emotional toll of processing information about climate change.⁶⁴ The mental health impacts can be temporary stress from immediate events to long ranging post-traumatic stress disorder, anxiety, and depression. Those who already face social vulnerabilities, described earlier in the report, are more likely to experience adverse mental health outcomes. This includes people who are economically disadvantaged, the elderly, children, first responders, and those which rely on the natural environment for their livelihood.⁶⁵ Climate change, specifically extreme heat, will also exacerbate impacts for people who experience mental health conditions.

Further, the mental and emotional stress of climate change interacts with factors, such as relationships or jobs, which further strains social and environmental resilience.

In Yarmouth

There is no data or information specific to Yarmouth regarding the impacts of climate change on mental health. However, the Town recently received a grant for a community mental health resource position to share across three neighboring towns.

The Center for Disease Control produces the Behavioral Risk Factor Surveillance System which is a health risk survey aggregated by state that includes questions on mental health. Based on the survey, in 2022 26% of respondents in Maine said they experienced between 1 to 13 days where their mental health was not good, and 16% of Maine respondents said they experienced 14 or more days where their mental health was not good.⁶⁶ These percentages have increased every year since 2019.



Community Resources

Demand for social services and community provided resources will likely increase due to the financial, physical, and emotional stressors created by climate change. Extreme weather will also limit access or strain existing community resources. Southern Maine has seen an influx of migration over the past few years, and this could increase as we see more climate refugees at the national and international scale. There is little data available to predict the scale of climate migration to Maine as a receiving state in the future, however, being prepared for growth is a key resilience strategy for communities. Ensuring access and capacity to increase community resources will be essential to maintaining a healthy and resilient community.

SOCIAL SERVICES

Losing access to key social services such as childcare or schools, libraries, and town services - whether permanently or temporarily - increases the overall vulnerability of the community. Climate disasters can also strain the capacity of these community resources, such as food pantries or financial assistance organizations, as more people experience impacts from climate change. Ensuring these services can handle the capacity is crucial to maintaining a resilient community.

KEY TERMS

Climate refugee:

People who are displaced due to climate hazards

In Yarmouth

Overall, the biggest impact to services in Yarmouth will be restricted access during storm events, due to flooded roads and bridges. Residents often commute outside of Yarmouth for health and social services. As mentioned earlier, flooding along key roadways will limit residents' ability to access resources within Yarmouth and outside of the Town boundary. People may need to find alternative routes to access these services. Flooding along Main Street at Route 1 and Route 88 would make it difficult for people living on the north side of Yarmouth to access the Town Hall or the Yarmouth Food Pantry.

The properties of several community service resources may experience flooding during storm events, but few buildings will be directly impacted.

Concern:

While the town administers great assistance programs, there is a lack of awareness and many people who would qualify don't take advantage of the assistance.

How Yarmouth is resilient:

The Town administers a robust General Assistance Program to help those in need. And the police department helps bring essential items to people in need.

Table 9: Community services impacted by different flooding scenarios.

Service	Resource	Impact
Schools	Yarmouth High School Frank H. Harrison Middle School Yarmouth Elementary School William H. Rowe School	All will experience some degree of flooding on the property, but it will not impact the school buildings
	North Yarmouth Academy	Flooding from the pond behind the American Legion may encroach on Pricilla B. Middle School Building
Municipal Services	Town Hall Merrill Memorial Library	Both buildings could experience direct flooding during a 100-year flood event. The surrounding roads will also be flooded and prevent access.
	Town Landing	The parking lot and access road will be flooded
	Transfer Station Yarmouth Water District	Properties will experience minor flooding during storm events, but it will not impact buildings or operations
Community Resources	Yarmouth History Museum American Legion Yarmouth Community Services	Flooding will impact the building and property

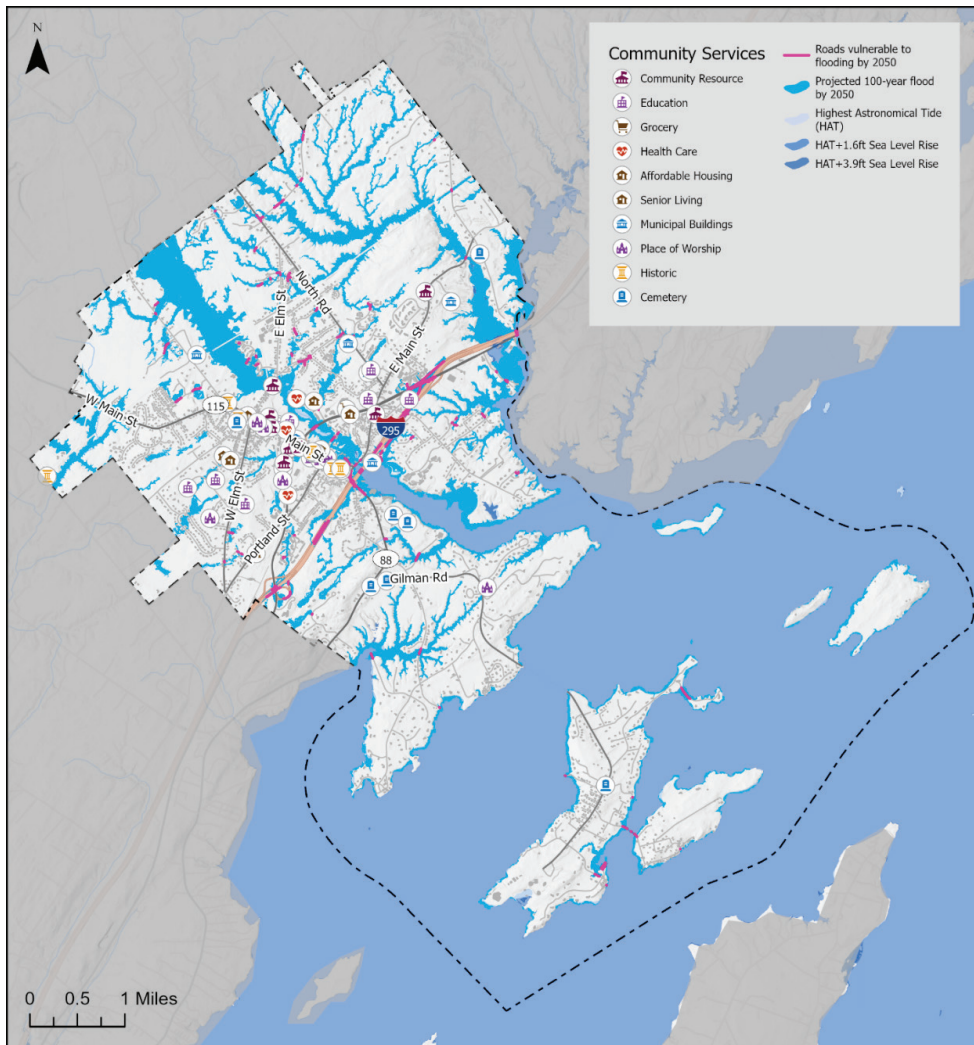


Figure 15: Key community services that are vulnerable to sea level rise or 100-year flooding by 2050.

Source: Town of Yarmouth, Maine Geological Survey, FloodFactor

FOOD SECURITY

Climate change threatens to amplify food insecurity for households. Impacts will occur across the food supply system from growing to distribution. This includes increased food-borne illness from pathogens and contaminated water, disrupted food availability, decreasing access, disruption in shipments, or increasing prices due to fuel or product scarcity.⁶⁷ Reliance on non-domestic food increases households' vulnerability to these climate-induced impacts.

KEY TERMS

Food deserts are geographic areas where residents with lower-incomes or no vehicles do not have access to affordable, healthy food.⁷⁰

In Yarmouth

On average, 90% of food consumed by Mainers comes from outside the state.⁶⁸ Similarly, Yarmouth residents rely heavily on external food sources and will feel impacts from increased pricing, shipping disruptions, or food shortages due to climate impacts. There are no food deserts in Yarmouth.⁶⁹

Yarmouth has one major grocery store—a Hannaford's on Route 1—along with a Rosemont Market, Walgreens, and several convenience stores. None of these food suppliers are expected to be directly impacted by flooding. However, access may be limited due to surrounding flooded roads.

Food security can be worsened for those individuals who are already cost burdened. Yarmouth currently has the following food support services in town:

- **Yarmouth Community Food Pantry**—Located behind First Parish Church on Main Street, this serves residents of Yarmouth, North Yarmouth, Cumberland, Pownal, and Freeport. In addition to providing food for those experiencing food insecurity, it also distributes senior food boxes and holiday food baskets.
- **Meals on Wheels**—Delivers lunch Monday through Friday to those who are over the age of 60 or on disability.
- **Yarmouth Community Garden**—This organic garden is located on two-acres at the entrance to Frank Knight Forest, and consists of a community plot, 132 rental plots for residents to grow their own food, and a children's plot to serve as a living playground.⁷¹ The community plot raises roughly 4,000 pounds of organic vegetables per year. Yarmouth Community is the largest community garden contributor to the Maine Harvest for Hunger program.
- **Yarmouth General Assistance**—assists residents with paying for basic necessities such as food and personal supplies and can assist with applying for food stamps. Yarmouth General Assistance operates from Town Hall.
- **Yarmouth School District** offers free breakfast and lunch to all enrolled students regardless of household income.

Town Hall, where Yarmouth General Assistance is located, may experience flooding from severe storms in 2050. None of the other buildings or garden plots will be directly impacted, however, flooded roads and bridges could make it difficult for organizations to distribute at-home meals.

TRAILS, PARKS, AND PRESERVES

Parks and trails bring many benefits for residents. Green space helps lower surrounding air temperature, promote active living, improve public health, serve as community gathering spots, increase surrounding property values, and provide ecological benefits (see Natural Resources at Risk Section).⁷² Climate hazards disrupt access to the trails, parks, and preserves, but it will also require more maintenance and repair, putting strain on municipal resources. Maintaining and expanding access to these spaces creates a more vibrant community and builds resilience to climate change.

In Yarmouth

Yarmouth hosts a diverse range of outdoor activities and access to natural resources is vital to the community's character. In 2019, the Town completed an Open Space Plan to support the preservation of these resources.⁷³ The Open Space Plan provides an inventory of resources, recommendations for how to maintain and enhance these, and sets goals to ensure these resources remain in the future.

Almost all inventoried open spaces will experience impacts from sea level rise or inland flooding in 2050. The parks and preserves along the Royal River and Pratt's Brook will experience the greatest degree of inland flooding. Sea level rise threatens the Spear Farm Estuary Preserve, Camp SOCI and Sandy Point Beach on Cousins Island, Littlejohn Island Preserve (owned by the Royal River Conservation Trust), and Lanes Island (conserved and managed by the Maine Coast Heritage Trust). Portions of the West End Trail, and trails located within the parks, are all vulnerable to flooding.

Concern:

With the increasing use of trails, there needs to be an increase in staff to maintain the trails.

How Yarmouth is adapting:

There has been an increased use in the town trails. Meaning more people are getting outside and moving. The Town installed lighting along Royal River Trail to ensure safety and continue to encourage use of the trail.

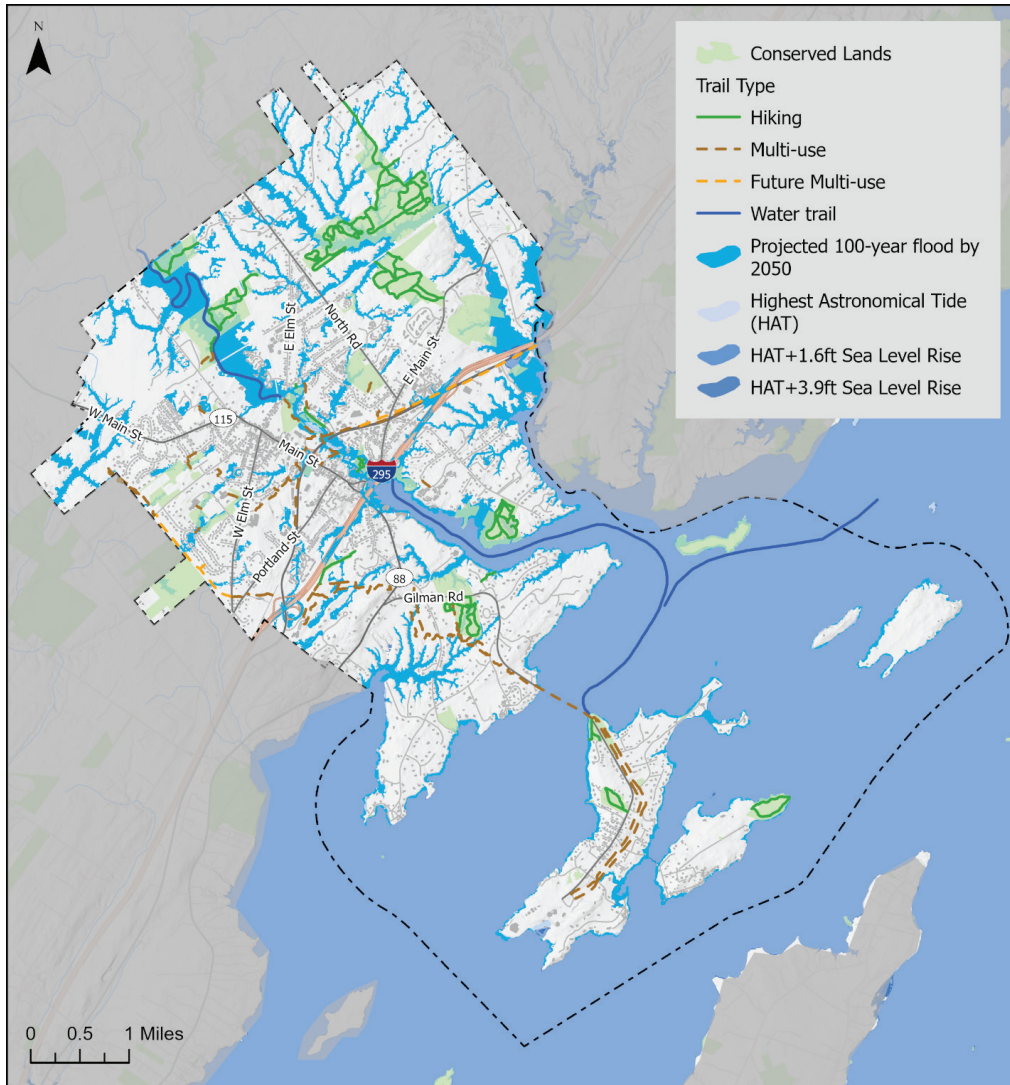


Figure 16: Parks and trails that are vulnerable to sea level rise or 100-year flooding by 2050
 Source: Town of Yarmouth, Maine Geological Survey, FloodFactor

HOUSING

Rising sea levels and storm intensity threaten to directly damage houses, leading to reduced property values and impacts to Yarmouth's tax base and real estate market. Any substantial loss or damage to the housing stock caused by storms or flooding will compound the region's ongoing housing stresses. Yarmouth and the whole region have existing housing security, affordability, and quality issues. This section highlights particularly vulnerable housing communities within Yarmouth.

Access: A lack of available or affordable housing in Yarmouth and the surrounding region means a growing percentage of the labor force will have to commute further for work. As housing prices also rise regionally, workers may commute from outside the Greater Portland area over time, leading to both higher greenhouse gas emissions and greater vulnerability for climate-related transportation interruptions. Similarly, since many Yarmouth residents work outside of Town boundaries, residents run the risk of losing access to their jobs which impacts the regional economy or being unable to get home in case severe weather hits during working hours.

Affordability: Yarmouth’s [cost-burdened homeowners](#) and renters already face financial insecurities. As climate hazards damage properties, force temporary or permanent evacuation, or require increased maintenance it will continue to increase housing costs. Investing in flood insurance, retrofitting buildings, or investing in flood-resistant properties are often unattainable for cost-burdened households. A lack of affordable housing will continue to push people out of town and place financial burdens on those who stay, making responding to climate change difficult. Elderly residents who live on fixed income, those in affordable housing complexes, and people living in manufactured homes are vulnerable to housing impacts from climate change.

In Yarmouth

Yarmouth has several senior living and affordable housing communities, along with a rehab and nursing center, and an in-home care organization. In addition, Yarmouth also has two zoned Mobile Home Overlay Districts. The table below lists the impacts to these resources. Beyond the direct impacts of flooding, the Town needs to consider access issues and communication about climate impacts to these communities.

Table 10: Senior and affordable housing units vulnerable to flooding during flooding events.

Resource	Location	Impacts
Skilled Nursing	Coastal Manor Brentwood Rehab and Nursing Center	No direct impacts
Senior and Affordable Housing	Bartlett Woods Yarmouth Falls Apartments Bartlett Circle	Two buildings on Bartlett Circle are vulnerable to flooding in 2050
Assisted Living	Bay Square at Yarmouth	Vulnerable to flooding in 2050

In 2020, the town established an Affordable Housing Committee to review key issues impacting the quantity, availability, and affordability of housing in the Town, and make recommendations to the Council. The development of the committee will help boost the resiliency for these communities and the committee can work to address existing vulnerabilities while considering the impact of climate change on future housing needs.

Further, in 2023 the town commissioned a [Housing Affordability Market Study](#). This study found that there is a greater need for affordable units at various income levels in Yarmouth than in Cumberland County as a whole. The report found there is an existing need for 1,278 units that are affordable at various income levels—885 ownership and 443 rental options. With the strain that climate change puts on affordability, the need for affordable housing will continue to rise.

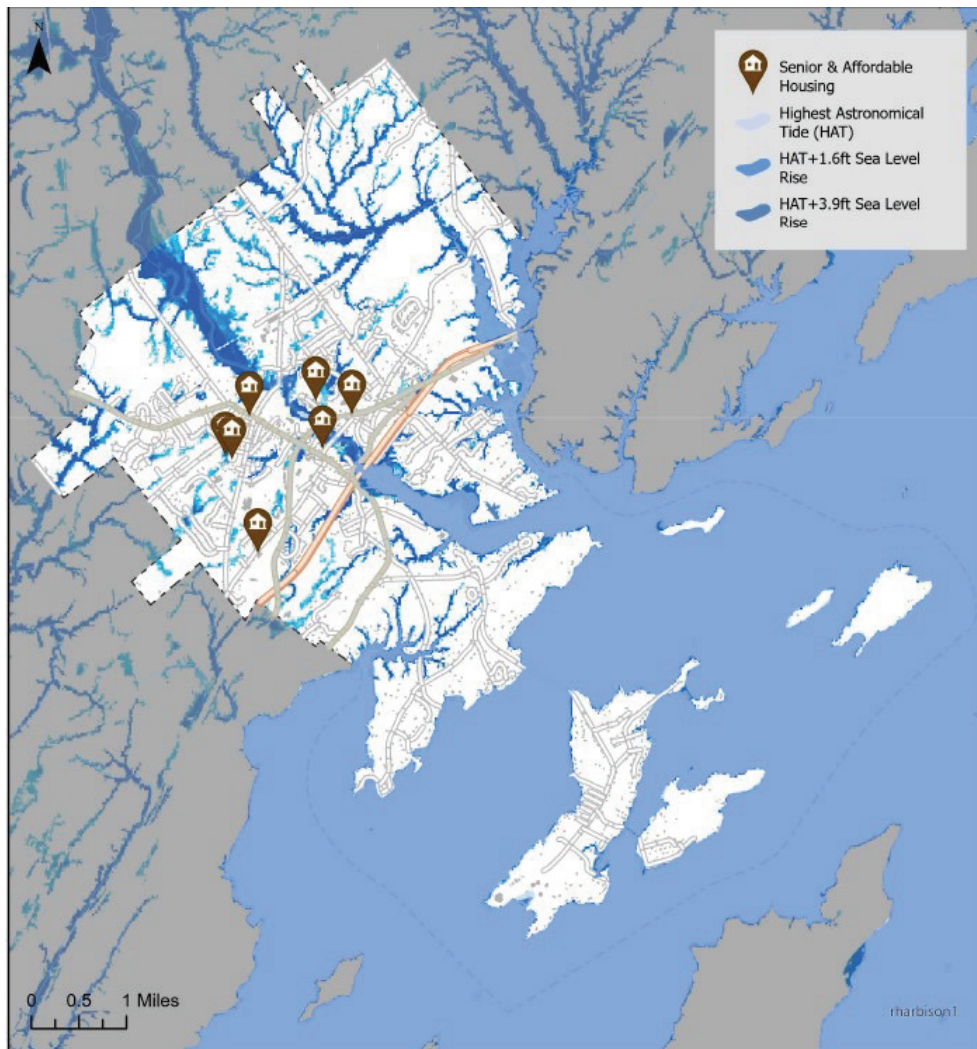


Figure 17: Vulnerable housing communities that are at risk of flooding due to sea level rise or 100-year flooding by 2050. Source: Town of Yarmouth, Maine Geological Survey, FloodFactor

HISTORIC SITES

Climate change threatens the integrity of historic structures and sites. Sea level rise and eroding coastlines can result in permanent loss of historically significant places, while increasing storms and flooding may damage structures. The Maine Historic Preservation Plan cites the challenge of protecting historic and archaeological resources from the effects of climate change.⁷⁴ Rehabilitating historic buildings to be more sustainable can be challenging due to modern building codes, cost and effort to improve energy efficiency, and securing funding. Archaeological sites are also of great concern, especially those along the coasts which may be lost to sea level rise or eroding bluffs.

The State is committed to collaborating with partners to assess the impact of climate change and providing greater protections for particularly vulnerable resources.⁷⁵

In Yarmouth

The town has 11 properties listed on the National Register of Historic Places.⁷⁶ Listing in the National Register indicates that the property is recognized as historically significant at a regional, state and/or national level. Shell middens on Yarmouth's shore are susceptible to the impacts from sea level rise and erosion.

In 2021, Yarmouth Town Council adopted the Historic Preservation Advisory Ordinance which is designed to identify and preserve sites and structures that have historic, cultural, architectural, and archeological significance and to preserve the historic character of the Town. The ordinance designated three local historic districts, 11 local historic landmarks, and 3 local historic objects, as well as the criteria and process for future designations. The ordinance also established the Historic Preservation Committee and outlines its responsibilities, including implementing the advisory review process for exterior alterations to historic resources. A portion of the three historic districts and a number of the contributing resources in these districts are vulnerable to flooding.

Yarmouth has 8 cemeteries, only 4 of which are currently active with plots available. None of these are vulnerable to flooding, however, Riverside Cemetery and Holy Cross Cemetery are situated along a bluff which is a landslide hazard. Currently, none of the plots are vulnerable but sea level rise and storm surge may erode the cliff, placing portions of the cemetery at risk.

Most archaeological site locations are kept confidential to protect the resources, therefore, the vulnerability of archaeological sites has not been identified through this report. The Town should review past surveys and consider conducting additional surveys in areas that are vulnerable to flooding or sea level rise that may contain these resources.

Concern:

"The Yarmouth Historical Society is so close to the river that it will flood during big rain events"

Economy and Livelihoods

Climate change impacts businesses' physical properties, changes the demand and type of employment, affects commuting patterns, and ultimately impacts the overall economy of a community. In a region reliant mainly on private vehicle transportation, both workers and businesses are vulnerable to temporary flooding and long-lasting damage to roads. Changing temperatures and ocean conditions makes the natural resource industry particularly vulnerable to shocks and stressors.

BUSINESSES AND INDUSTRIES

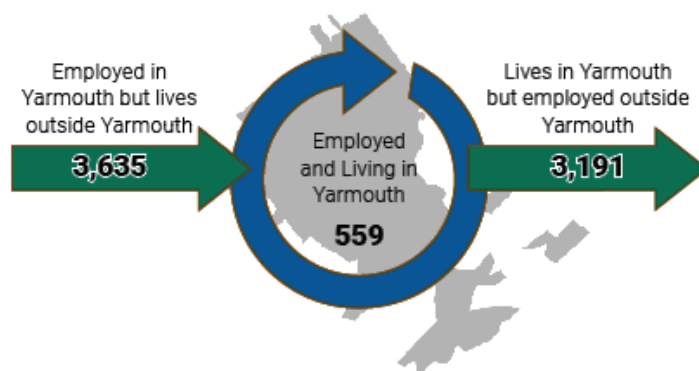
Sea level rise threatens waterfront restaurants and businesses and access to critical working waterfront points of entry, including the loss of docks limits recreational sailing and marine tourism. Food service and hospitality businesses will experience changes as the number and visiting days for tourists shift due to the changing seasons. With Maine winters becoming shorter, recreational activities like ice skating and skiing will be limited by less snowfall. Not only will climate change impact the physical properties but it can shift industry demand.

In Yarmouth

In 2022, the major industries of employment in Yarmouth were Professional, Scientific, and Technical Services; Health Care and Social Assistance; Retail Trade; Educational Services; and Accommodation and Food Services. These top five industries made up 68% of employment in town.⁷⁷ The Maine Department of Labor shows 574 establishments which employ almost 4,500 people. Yarmouth does not have a large tourism sector, which could be most impacted by climate change. However, changes in the seasons can still impact the retail and food industries.

In 2019, the Town of Yarmouth commissioned an economic impact study of its commercial harbor. Through data collected from the National Ocean Economics Program (NOEP), the Maine Department of Labor, and surveys collected from its water-oriented businesses, Yarmouth's harbor generated \$15.9 million annually to the local economy. Future impacts from climate change will almost certainly have an impact on the community's future working waterfront opportunities.

The biggest threat to businesses will be access and damage during flooding events. A vast majority of Yarmouth's labor force (including Town staff) live in neighboring communities, while most employed Yarmouth residents commute out of town to work, primarily by car. The Town of Yarmouth commissioned a Real Estate Market Analysis for the Comprehensive Plan Update which provides insight into potential developments for the town. This study found that limited availability for development combined with rising housing costs restricts the potential workforce.⁷⁸ Continued reliance on attracting workers who live outside of town not only increases greenhouse gas emissions, but also increases the vulnerability of businesses to bounce back during a climate event.



ESSENTIAL SERVICES

Access to supermarkets, health care, emergency services, schools and municipal buildings may be cut off due to flooding of roads and bridges. This prevents people from getting to their jobs or receiving those services. In addition to physical access, the increase in impacts to public health will strain the healthcare system and limit healthcare availability. Similarly, rising costs and financial constraints will overwhelm critical resources. The indirect strain placed on essential services will impact the overall system as much or more than the physical impacts of climate change.

In Yarmouth

Most municipal staff, including first responders, commute to work in Yarmouth. During a severe weather event first responders will face difficulty coming to the Town to provide support, and once in town could face difficulty getting resources to residents and businesses. While there are several health services within the town, Yarmouth residents would rely on hospitals in Portland or Brunswick for emergency care. Roads projected to flood in 2050 could limit access to these communities. To date the town emergency services (police, fire, EMS) have not experienced any difficulty in access.

NATURAL RESOURCE ECONOMY

Maine's economy is heavily reliant on natural resources from fishing to forestry. As temperatures rise these sectors are increasingly under threat. Individuals who rely on these fisheries for their livelihoods, especially lobster, may experience economic impacts as species' ranges shift with climate change. Recreational fishing opportunities for non-commercial license holders may also be impacted, representing a significant cultural loss for the community. In addition, the loss of docks from sea level rise threatens access to the waterfront.

Concern:

"I'm concerned about the decline in working waterfront and access points for shellfish harvesters." (quote from resident)

In Yarmouth

Only 1% of Yarmouth's population is employed in agriculture, forestry, fishing, or hunting. However, Yarmouth's primary natural resource economy relies on marine industry—both commercial fishing and aquaculture and employs people from outside of town boundaries. In 2022, the Maine Department of Marine Resources issued 140 licenses to Yarmouth.⁷⁹ This includes 7 aquaculture licenses, 51 commercial fishing licenses, and 82 non-commercial licenses. Most commercial licenses are for "Lobster/Crab". In addition, there are 9 NOAA Vessel Permits⁸⁰ and the town issued 4 resident and 1 nonresident municipal license.

The total landings in Yarmouth equated to almost 324,000 pounds valued at over \$560,000.⁸¹ In the last two years, Oysters brought in the most money. During the last decade, softshell clam brought in the most value to the port and prior to 2010 lobster had the highest value. Changes in ocean conditions are already impacting the type of species harvested. Continued changes will impact both individual livelihoods but also the town's earnings. Water quality in Casco Bay is already a challenge and impacts the shellfish industry, flats are often restricted in Yarmouth due to maintenance at the wastewater treatment facility or other water quality issues. More information on closures due to water quality challenges can be found in the Natural Resources at Risk section.

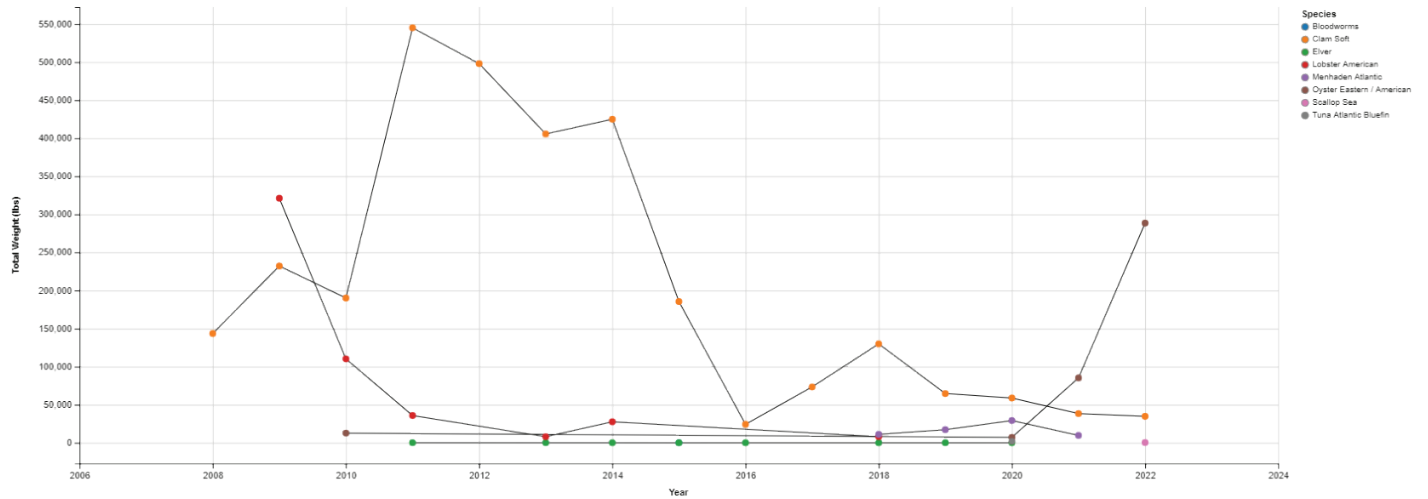


Figure 18: Total weight (lbs.) per species for Yarmouth port from 2008 to 2022. Source: Maine DMR

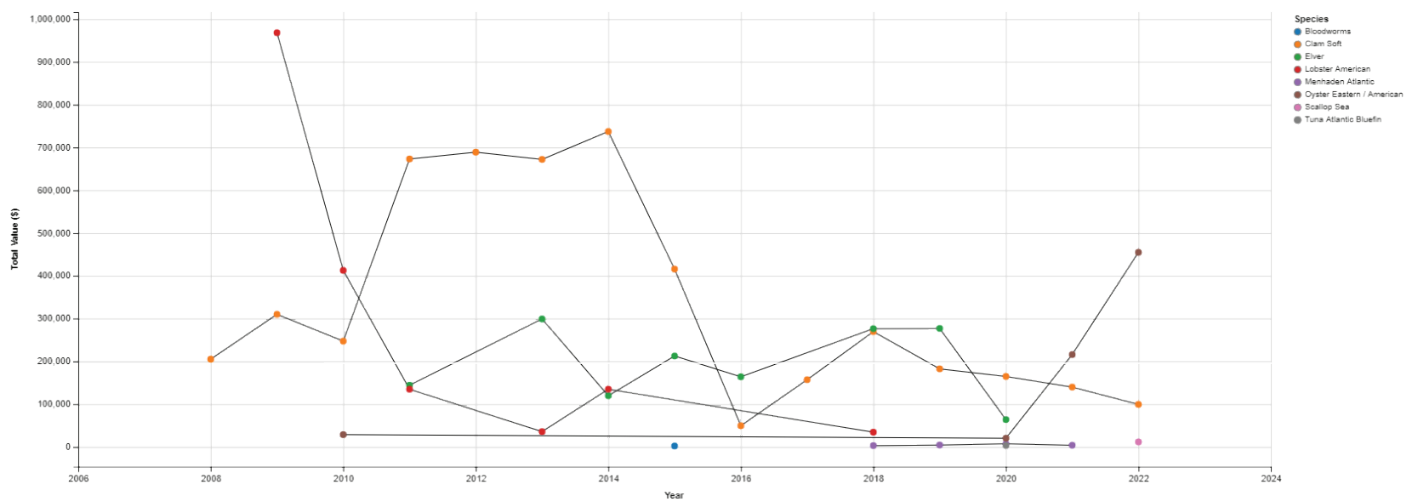


Figure 19: Total Value (\$) per species for Yarmouth port from 2008 to 2022. Source: Maine DMR

PROPERTY VALUES/TAX BASE

In addition to the economic costs of property damage, climate change is impacting property values. Property values are higher for land on higher elevations due to their lower risk of flooding. As properties become increasingly exposed to flooding, their market and assessed values could decline, reducing local tax revenues from affected parcels and potentially straining municipal fiscal health. Similarly, as climate change degrades water quality, property values are lower on lakes with poor water clarity and increased algal blooms.⁸²

Tidal flooding caused by sea level rise has been estimated to have eroded more than \$70 million in Maine coastal real estate value, with most of that occurring in southern Maine.⁸³ Substantial loss or damage to housing will reduce a town's tax base, impacting municipal budgets. The municipal tax base will also be affected by increased damage and frequency of repairs needed to infrastructure. It is also possible that federal and state taxes will increase due to emergency management services and government flood insurance programs requiring higher capacity.

In Yarmouth

Climate impacts in Yarmouth will affect overall property values and the municipal tax base. Almost 1,200 parcels would experience flooding during a severe event by 2050. Analysis estimates that this could equate to an assessed value of almost \$67.5 million or approximately 9% of Yarmouth's assessed land value.

These values were calculated using the following method:

1. Parcels were selected based on intersection with the sea level rise layers from the Maine Geological Survey and 100-year flood in 2050 from Flood Factor as described in the methodology section.
2. For parcels which intersected any of the layers, the value affected was calculated based on the percent of flooding on parcel (e.g., if 30% of parcel is flooded, then 30% of land value is affected)

Building values were not assessed since it is difficult to determine whether the whole building would be impacted from flooding and therefore the whole building value would be lost, or if only a portion of the building's value would be impacted.

	Acres	Assessed Land Value
Total in Yarmouth	7,722	\$749,054,600
Total Parcels in flooded area	4,500	\$393,441,900
Flooded Area within parcels	357	\$67,408,644

Flood insurance

As the risk of flooding increases, the chances of flood-related expenses go up. As the risk of damage and expenses increases so will the cost of flood insurance. In April 2023, FEMA fully implemented Risk Rating 2.0, National Flood Insurance Program's (NFIP) pricing methodology. This methodology addresses rating disparities by incorporating more flood risk variables to equitably distribute premiums across policyholders based on home value and a property's flood risk.⁸⁴ However, in 2021, First Street Foundation calculated the average expected annual damage per Maine property within a special flood hazard area to be \$4,381 while the average insurance premium was only \$1,285.⁸⁵ This suggests that even with insurance, it does not meet the full cost of flooding impacts. First Street Foundation also found that the risk and cost of those living outside of FEMA designated flood areas have been historically underestimated. Properties outside of FEMA's designated special flood hazard areas account for only 2% of flood insurance policies but account for 20% of all claims and receive 33% of federal disaster assistance for flooding.⁸⁶ Even with the updated Risk Rating 2.0, it is likely that flood insurance will only cover a portion of the properties and impacts.

NATURAL RESOURCES AT RISK

Climate hazards strain the health of marine and terrestrial ecosystems. Climate change has already begun to strain ecosystems and has the potential to lead to long-term impacts. Changes in temperature and precipitation are expected to increase stress and disturbances in forests. As ecosystems are transformed, species will migrate to more desirable habitats. The Gulf of Maine and Casco Bay exchange nutrients and support marine species important to southern Maine's coastal economy and identity. Understanding how and where the environment is vulnerable can guide decision-making to conserve and protect Yarmouth's natural resources.

Key Takeaways

- Yarmouth is seeing an increase in pests and invasive species due to warming temperatures and changing precipitation patterns. These changes put pressure on native ecosystems and disrupt the health of natural resources.
- The town currently has sufficient open space that will allow for marsh migration but the ability to conserve additional land around these sites to support future migration will be critical.
- Although Yarmouth is relatively protected from sea level rise due to its elevated shoreline, erosion of coastal bluffs is impacting coastal properties and natural systems. Armoring shorelines with hard infrastructure can compound these issues and impact adjacent properties. Nature-based solutions like living shorelines should be explored where appropriate.
- Maintaining inland and coastal water quality will be key to supporting the health of aquatic resources.
- The town only has approximately 10% of land conserved.⁸⁷ Increasing the amount of dedicated conserved land will support water and air quality, future marsh migration, and contribute to carbon sequestration.

Concern:

Two of the top concerns residents expressed on the community survey was pollution of the ocean and rivers; and the reduction in biodiversity.

How Yarmouth is resilient:

Along with the development of an Open Space Plan, the Town of Yarmouth has partnered with organizations, such as the Royal River Conservation Trust, to conserve lands and conduct research on natural resource protection.

Shifting Ecosystems

Warmer air and water temperatures cause shifts in species' geographic ranges, leading to declines in native marine and terrestrial life, and increases in invasive species, pathogens, and pests. These shifts make ecosystems more vulnerable to stressors such as invasive species and habitat destruction. Rising sea levels and increased flooding may eliminate habitats for sea bird species. These changes put even greater pressure on already threatened or endangered species.

Maine's fishing industry is particularly susceptible to species migration due to warming water temperatures and ocean acidification. Recent research predicts that lobster populations are likely to shift 200 miles further north because of climate change.⁸⁸ However, other research suggests that Gulf of Maine waters may remain resilient and suitable for lobster populations.⁸⁹ Atlantic Cod populations in the Gulf of Maine have been declining since before 1990, and recent research suggests that the remaining habitat for the species in the North Atlantic could shrink by over 90% by 2100 due to warming waters.⁹⁰

In addition to forcing native species to shift further north, new climate-induced conditions in marine and terrestrial ecosystems are causing invasive, non-native species to migrate into Maine. Invasive plant and marine species disrupt ecosystems by developing self-sustaining populations that are dominant or disruptive to native species by outcompeting them for resources.

IMPACTS IN YARMOUTH

In Cumberland County, with a 2C (3.6F) increase in temperature, 3 birds are highly vulnerable, and 57 bird species are moderately vulnerable to changing habitat conditions.⁹¹ Yarmouth has areas that are home to vulnerable wildlife such as the Roseate Turn and Saltmarsh Sparrow. The largest habitat area is along the Cousins River.

Yarmouth's coastal waters play home to a range of shellfish and marine species that are at risk from rising temperatures and acidification. One important marine resource that has seen a decline due to warming temperatures is eelgrass. Eelgrass is a native seagrass that provides critical habitat and food for other marine species, supports healthy water quality by managing nutrients in the water and stabilizing sediment, and can sequester carbon. Between 2013 and 2021, the waters around Yarmouth lost over 100 acres of eelgrass.

Invasive Species: Yarmouth is already seeing invasive species throughout town. Several areas are being monitored for invasive species including Pratt's Brook Park, Frank Knight Forest, the Riverfront Preserve, and the Spear Farm Estuary Preserve. However, monitoring across town is still limited and there are likely invasive species present on private properties.

KEY TERMS

Invasive species are plants and wildlife that spread to the point that they can cause harm to ecosystems, usually out-competing local species for resources or hunting prey down to dangerously low populations.

Yarmouth is also not immune to invasive marine species. Research by Casco Bay Estuary Partnership found that at two sample locations in Casco Bay, between one-fifth and one-third of all identified marine species were not native.⁹² One example is the European green crab, which damages local shellfish population and habitat. The green crab disturbs the sediment and uproots beds while foraging.⁹³

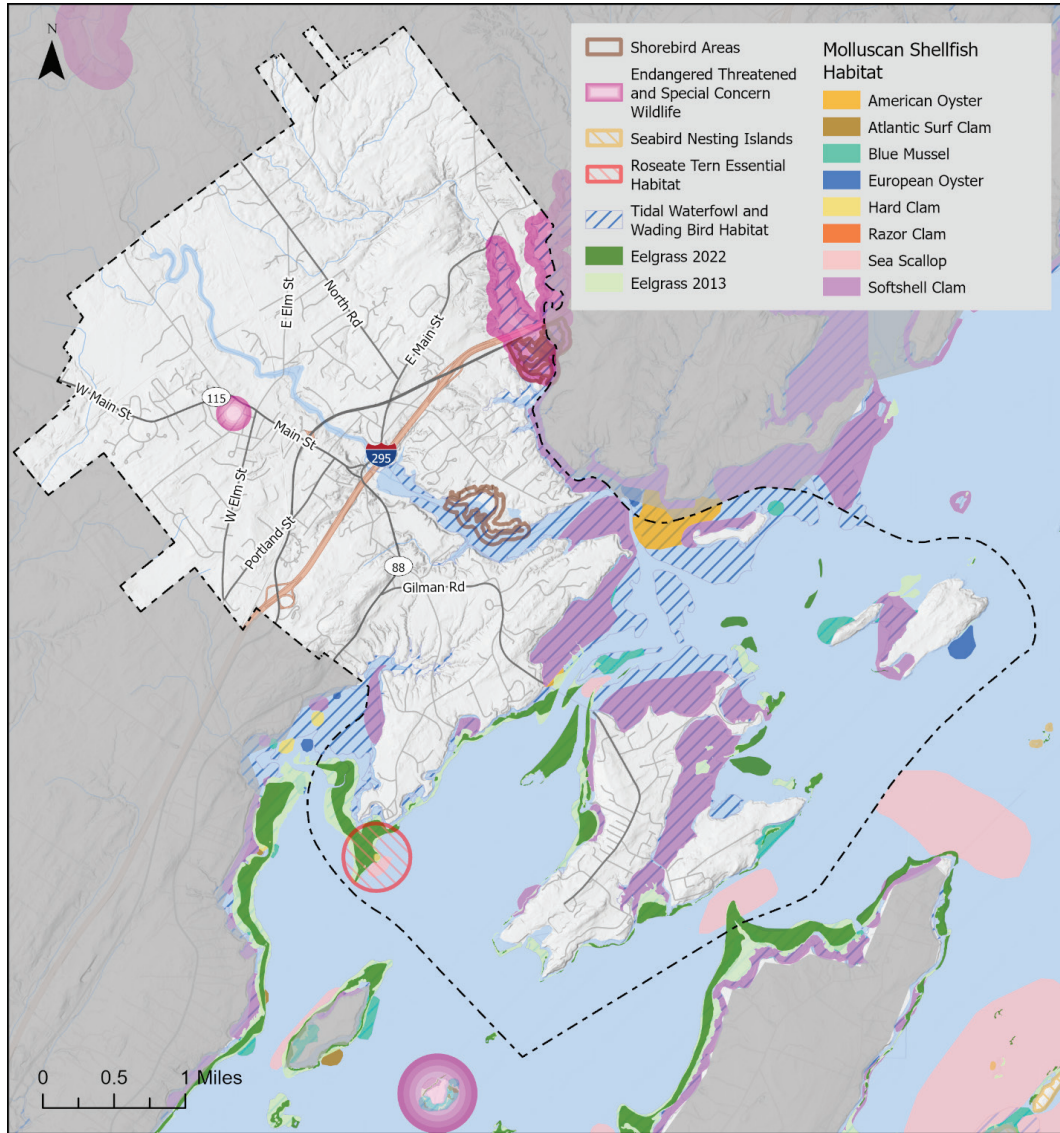


Figure 20: Aquatic and sensitive species habitat in Yarmouth. Source: Town of Yarmouth, Maine DEP, Maine Inland Fisheries and Wildlife, Maine Geological Survey, FloodFactor

Marsh Migration

Tidal areas such as marshes and wetlands are particularly sensitive to climate change. These ecosystems provide tremendous benefit to wildlife, plant species, and the surrounding built environment by serving as habitat and a protective barrier against storm surge and rising sea levels. Marshes also have the natural ability to filter pollution and slow the impacts of erosion, as well as sequester carbon from the atmosphere. Preserving and protecting marsh and wetland areas improve the resiliency of surrounding coastal communities.

As sea levels rise, tidal marshes gradually shift inland onto formerly dry land or nontidal areas. This process, known as marsh migration, is possible only as long as there are no constraints from the built environment or steep slopes in the area. In areas where marshes border development such as roads or buildings, migration may not be possible, resulting in the loss of marshes and an increased risk to the developed area of future storms.

IMPACTS IN YARMOUTH

Maine Geological Survey has mapped potential marsh migration for 1 ft, 2ft, and 3.3 feet of sea level rise. Table # shows the potential additional marsh migration acreage in Yarmouth for each of these scenarios. There are three main areas in Yarmouth identified as able to support marsh migration: (1) Broad Cove, (2) mouth of the Royal River, and (3) Cousins River.

Table 11: Acres of current tidal marshes and how many square miles are needed under different sea level rise scenarios to accommodate marsh migration. Source: Maine DEP

Scenario	Current	1 ft Sea Level Rise	2 ft Sea Level Rise	3.3ft Sea Level Rise
Potential Marsh Migration in Yarmouth (acres)	191.1	19.5	36.4	56.8

- **Broad Cove:** Most of this area is currently surrounded by forested and undeveloped land which would support marsh migration. However, much of the land is not conserved. As sea level rises, tidal marshes could extend past Princess Point Road. Future development in this area could impede migration.
- **Royal River:** There are several existing marsh areas along the mouth of the Royal River that could migrate inland as sea level rises. This area is already largely conserved as part of the Spear Farm Estuary Preserve, which will help to prevent any future loss.
- **Cousins River:** The most significant area of tidal marshes in Yarmouth is along Cousins River and Pratts Brook. Most of the existing tidal marshes are surrounded by forested and undeveloped blocks of land which would support future migration. However, very little of this land is conserved. Along Pratt's Brook the Town has some land conserved by the Transfer and Recycling Center. While this area is currently low-density residential, significant development along the waterways or at the mouth of the river could impact tidal marshes.

The [Community Intertidal Data Portal](#),⁹⁴ developed by Tidal Bay Consulting and the Greater Portland Council of Governments, is an interactive online mapping tool that allows users to more easily zoom in and out of these areas to get a better understanding of tidal marshes that may be impacted near them.

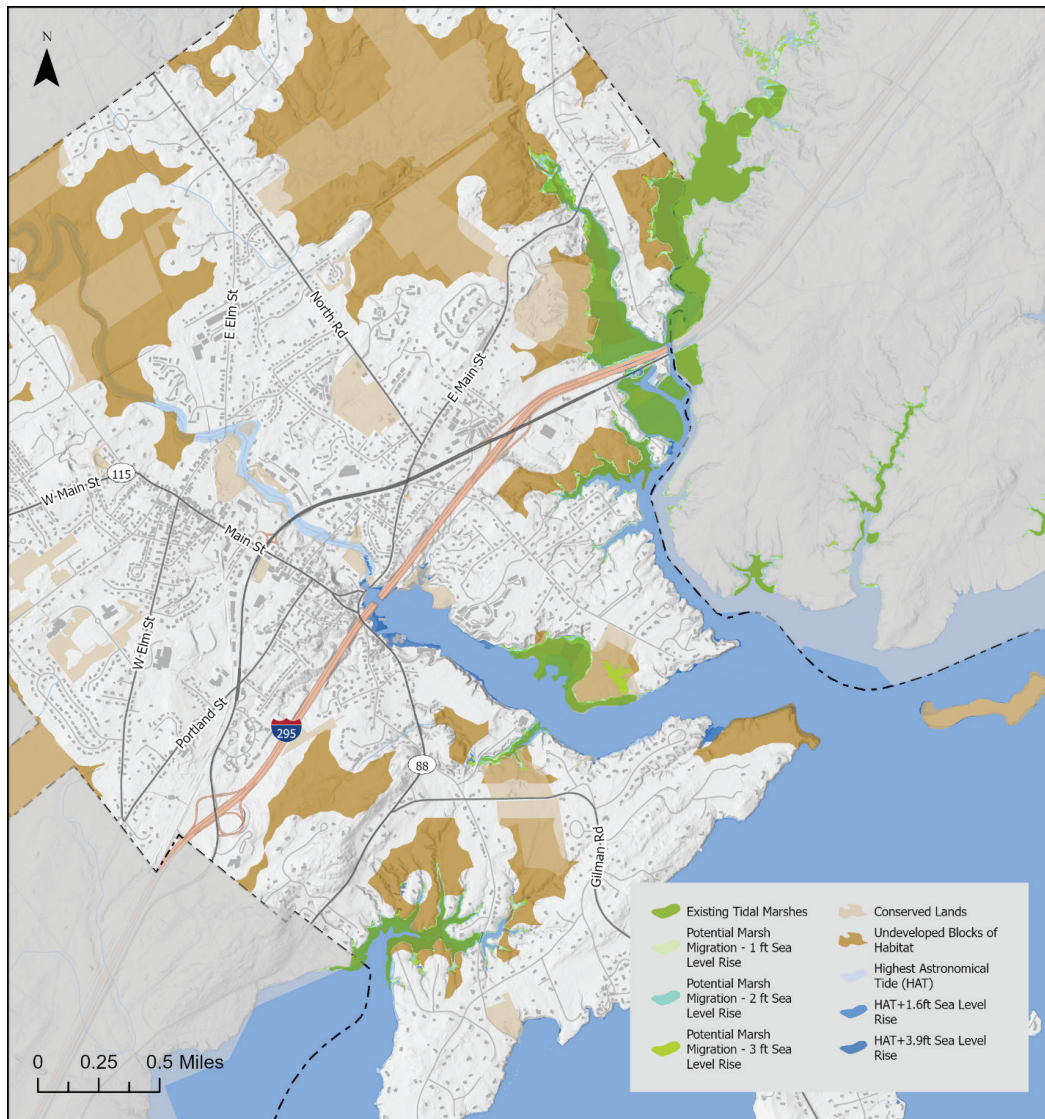


Figure 21: Existing tidal marshes and potential tidal marsh migration under 1 ft, 2ft, and 3ft of sea level rise. Source: Town of Yarmouth, Maine DEP

Coastal and Inland Erosion

Coastal erosion is a process by which severe storms, flooding, sea level rise, and human-related activities wear away beaches, dunes or coastal bluffs. Erosion of the shoreline increases risk of coastal flooding, decreases habitat, and removes natural storm and flood barriers, making adjacent infrastructure more vulnerable. In addition to coastal erosion, increased precipitation threatens the integrity of inland waterways and makes them prone to landslides. Inland flooding can change the composition of soil along riverbanks and compromise the integrity of pre-existing structures built along inland waterways. In the 2022 Cumberland County Hazard Mitigation Plan,⁹⁵ erosion and coastal flooding were among the most prevalent hazards in the county. The slope of the land, sediment type, vegetation, bedrock, and surrounding upland land use can all impact the vulnerability of coastal and inland erosion.

IMPACTS IN YARMOUTH

According to data from the Maine Geological Survey, a large portion of the coastline are on unstable or highly unstable bluffs, while other areas are at risk for a landslide. Some of this data is out of date and coastal bluffs should be monitored locally to track changes. Historically, there are records of coastal landslides along the mainland and both Cousins Island and Little John Island.⁹⁶ There are also beaches and sand dunes on the west side of Lanes Island and at Dead Mans Cove on Cousins Island that are subject to erosion and overtopping. Beach and dune health should be monitored and evaluated for potential stabilization and restoration efforts.

Inland Yarmouth has relatively stable waterways. There are no historic recorded landslides in Yarmouth,⁹⁷ however, landslides have occurred upstream along the Royal River in North Yarmouth. Climate change can increase the likelihood of landslides in susceptible areas and should be monitored. Further studies may be necessary to better understand the risks of Yarmouth's riverbanks.

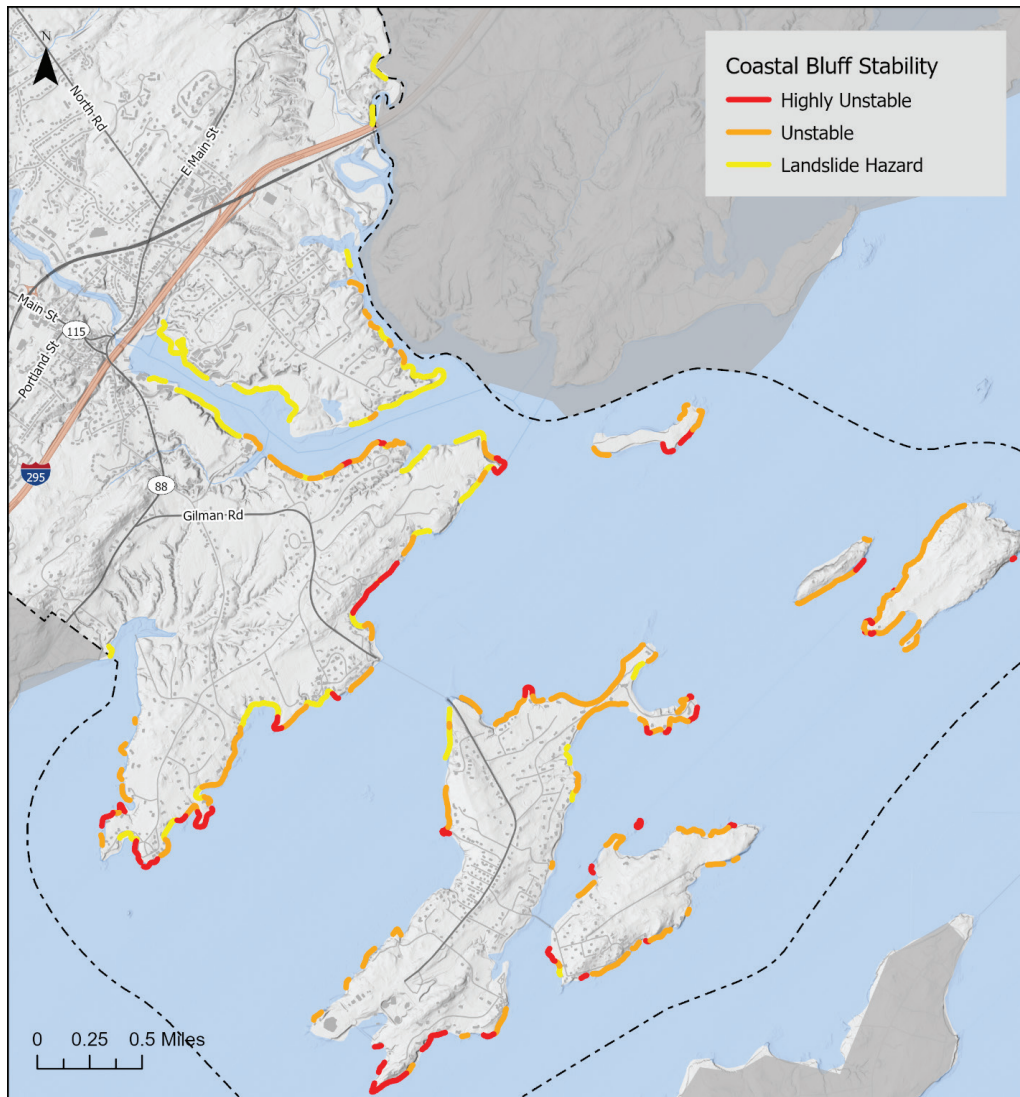


Figure 22: Coastal bluff stability. Source: Town of Yarmouth, Maine Geological Survey

Conserved Lands

Conserved lands, particularly forests and ecologically important areas can assist with habitat retention, as well as flood mitigation by allowing water to infiltrate below ground. Maintaining natural areas also helps maintain good water and air quality. Additionally, these areas act as carbon sinks to help remove carbon dioxide from the atmosphere and help mitigate the effects of climate change. However, warming temperatures put these natural resources at risk by shifting the ecosystem and increasing the presence of invasive species.

IMPACTS IN YARMOUTH

The Town has 934 acres of conserved land, accounting for approximately 10% of the Town's total land area. The largest area, with over 200 acres, is at Pratt's Brook. Pratt's Brook Park, the Riverfront Woods Preserve, and Royal River Park will experience the greatest impact from inland flooding in 2050.

There are several undeveloped blocks of land that have the potential to be conserved which would help maintain open space and preserve areas for marsh migration. Most parcels of undeveloped land are privately owned.

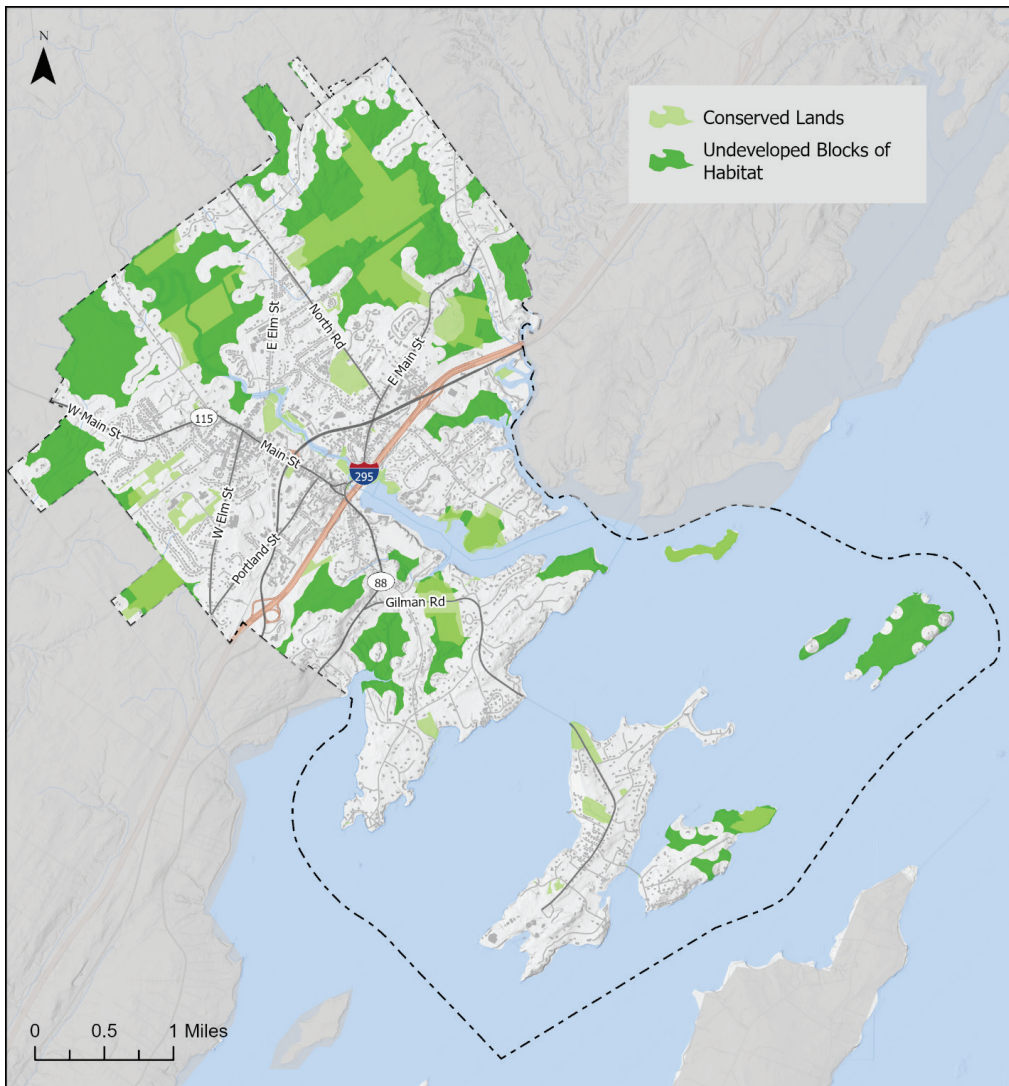


Figure 23: Conserved lands and undeveloped block of habitat.

Source: Town of Yarmouth, Maine DEP, Maine Inland Fisheries and Wildlife

Water Resources

As mentioned earlier, increased precipitation and more intense storms create a greater volume of stormwater runoff, which delivers pollutants such as nutrients, sediment, bacteria, and trash into water bodies. These pollutants and excess nutrients impair rivers, streams, lakes, and coastal waters. Combined with warming temperatures, climate change negatively impacts water resources by harming aquatic life, promoting shifts in invasive species, and increasing algal blooms.⁹⁸

Water bodies must have sufficient dissolved oxygen to support healthy aquatic communities. Low levels of dissolved oxygen cause stress, and at very low levels aquatic organisms may suffocate.⁹⁹ Warming waters lead to lower dissolved oxygen levels and strain aquatic ecosystems. See earlier sections for how changes in water resources from climate hazards impact human health and the economy.

IN YARMOUTH

Royal River, Cousins River, Pratt's Brook, and the coastal waters running through Yarmouth offer important locations for wetland ecosystems, recreation, and critical species habitat. Maintaining and supporting these water resources is vital to preserving the community character. Overall, Yarmouth has relatively healthy water resources.

Inland waterways

All rivers and streams in Yarmouth meet water quality standards and there are no designated impaired waterways in town. The Royal River currently has two dams which restrict habitat and impact water quality. Warmer waters and the construction of dams, roads, and railways cause a severe decline in fish population.¹⁰⁰ Testing in 2022 by the Maine Department of Environmental Protection found that several testing events showed dissolved oxygen levels below required standard.¹⁰¹ As waters continue to warm, the Royal River will see a decrease in dissolved oxygen that will further stress fish species. A free-flowing river is cooler and more oxygenated. The U.S. Army Corps of Engineers is currently conducting an assessment for the removal of the Bridge Street and Elm Street dams along the Royal River.

Table 12: Current and historical amounts of sea-run fish habitat along the Royal River. Source: Casco Bay Estuary Partnership

Species	Current	Historical
Alewife (acres)	0	460
Blueback Gerring (miles)	0.3	60
American Shad (miles)	0.3	60
Sea-Run Rainbow smelt (sites)	2	2

In addition to the two dams mentioned above, there are 3 barriers in Broad Cove, and an additional dam at the mouth of the Royal River along Spear Farm Estuary Preserve.¹⁰²

Coastal Waters

Changing ocean conditions will create challenges for the region.¹⁰³ The shellfish industry in Casco Bay has seen repeated and continuous closures due to related water quality challenges. Waters around Casco Bay are often classified as prohibited by the Maine Department of Marine Resources and closed to shellfish harvesting due to either water quality testing showing elevated levels of fecal bacteria, or when an area is near a wastewater treatment plant outfall or other source of pathogens.¹⁰⁴

Closures can also reach beyond Casco Bay. In the winter of 2017, a harvesting ban stretched from Portland to Harpswell when shellfish showed elevated domoic acid levels, a biotoxin produced by a large phytoplankton bloom.¹⁰⁵ These closures impact shellfish harvesting, fisheries operations, local jobs, and the economy. In the summer of 2023, the Gulf of Maine saw a widespread bloom of brown algae. Although this type does not produce harmful toxins, the decomposing matter could create low-oxygen conditions that negatively impact aquatic species.¹⁰⁶

Agriculture

The local agriculture industry is at risk due to warming temperatures and changing precipitation patterns. While the longer growing season due to warming temperatures could benefit farmers, increasing drought conditions, pests, and intense storms that damage crops or erode soil may offset any of the benefits and challenge the needed expansion of at-home food production and local agriculture.

According to the 2017 Census of Agriculture prepared by the United States Department of Agriculture, there are a total of 50,021 acres used for farm operations in Cumberland County, resulting in commodity totals of \$25,644,000, or \$512 per acre.¹⁰⁷ In 2020, the Farm Services Administration issued an emergency declaration for Cumberland County as a result of prolonged, severe drought conditions, resulting in increased operational costs due to increased irrigation.¹⁰⁸

IMPACTS IN YARMOUTH

Yarmouth has over 300 acres of farmland. The Greely Farm is located on the west side of town in a permanent agricultural conservation easement held with the Royal River Conservation Trust. Several agricultural parcels will experience an increase in inland flooding in 2050, however, the flooding will be minimal.

Although there will be little direct impact on Yarmouth since agriculture represents a small part of Yarmouth's land use and economy, the climate impacts to state, national, and international agriculture will be felt in town. This includes disruption to services, increase in cost, and an increase in food insecurity (discussed in further detail in the Community Services section). Yarmouth also has Community Gardens which residents may use to grow their own food.

Forests and Carbon Sinks

Forests are key in combating the impacts of climate change as they sequester carbon dioxide through photosynthesis and improve air quality. However, as temperatures rise, precipitation events become more extreme, and invasive pests spread, Maine’s forests face increasing challenges. Changes in temperature and precipitation are expected to increase stress and disturbances in forests. Disturbances such as flooding, ice storms and wildfires can open forest canopies, expose mineral soil, and reduce tree cover, providing greater opportunities for invasion.¹⁰⁹

Forests currently cover nearly 89% of Maine and sequester over 60% of the state’s annual carbon emissions, in addition to supporting the state-wide economy.¹¹⁰ The full impacts of climate change on forests are variable as the longer spring and summer season will help spur growth, but warmer winters and decreased snowmelt will harm some forest species, particularly the spruce-fir forests.¹¹¹ Forests are not the only land cover to sequester carbon. Open grasslands, wetlands, and agricultural lands all store carbon. Particularly in Maine, coastal wetlands serve as a large natural carbon sink.

It will be important for towns to retain these natural areas to sequester carbon and minimize the impacts of climate change.

IMPACTS IN YARMOUTH

According to the NOAA Coastal Change Analysis Program Land Cover Atlas, between 1996 and 2016 Cumberland County lost 2.6% of forest land cover with almost 6 acres of loss being converted to developed land.¹¹² Based on NOAA’s map, Yarmouth has similarly seen areas converted from forest cover to developed areas.¹¹³

Table 13: Land cover change in Cumberland County from 1996 to 2016. Source: NOAA

Land Cover Class	1996 Area (Sq Miles)	2016 Area (sq Miles)	Change in area (sq miles)
Emergent Wetland	15.65	15.39	-0.26
Woody Wetland	84.55	83.71	-0.84
Forested	549.63	535.42	-14.21
Agriculture	55.31	52.45	-2.86
Scrub/Shrub	15.41	21.09	5.68
Grassland	6.65	7.31	0.66

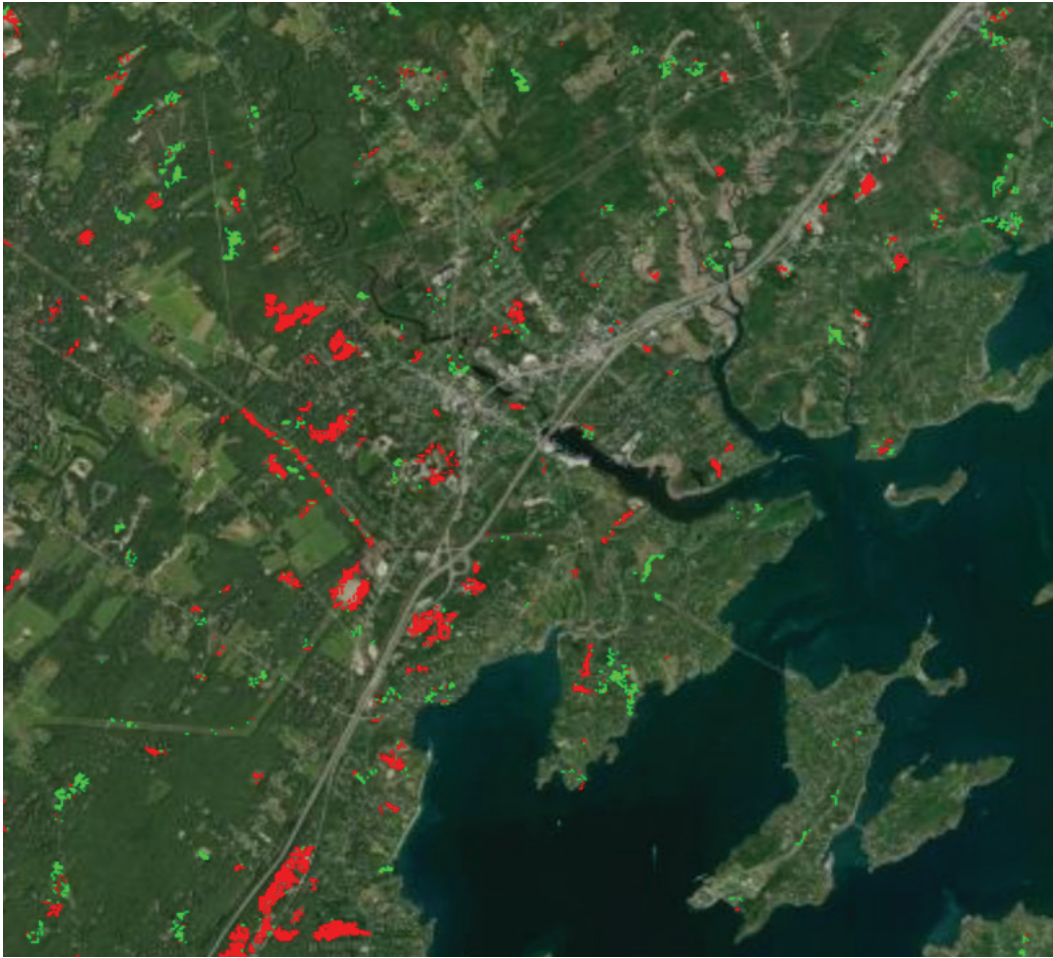


Figure 24: Change in forest cover where red symbolizes a loss of forest cover and green symbolizes an increase in forest cover. Source: NOAA



LAND COVER

Climate vulnerability, resilience, and the ability to adapt are influenced by how we build and where we build. Existing development patterns and town regulations impact where the community may experience climate impacts today and, in the future. Areas of town with more impervious surface will experience higher temperatures, create more stormwater runoff, and decrease water quality.¹¹⁴ Some of this can be offset by conserving open space and tree canopy. Creating “urban forests” such as planting street trees or maintaining pocket parks are effective ways to offset the urban heat island effect and reduce stormwater runoff.¹¹⁵

Zoning ordinances are another tool town’s use to impact how the community develops. Zoning may be used to control building density, limit sprawl, or maintain green space in ways that reduce vulnerability or maximize the utility of resilient infrastructure.¹¹⁶ For example, setting a shoreland overlay district creates restrictions on what and how close development can occur around bodies of water to protect water quality.

What people are concerned about:

- Due to the increased disruption in the supply chain, residents want to have more access to local food. This could mean reserving large plots of land for farming or making a local farmers market (with good parking).
- There is tension in the town between housing, development, and preserving vegetation that is difficult to navigate.
- The conversion of seasonal and rental housing to year-round housing that is only habited part of the year is decreasing affordability.
- A lot of shoreland is being converted to private property which makes it difficult to protect the coast.
- The shoreland zoning ordinance does not go above and beyond the state minimum

How Yarmouth is adapting:

- The town is adopting Low Impact Development standards to reduce impact on the environment
- A new Comprehensive Plan update is underway which will help set the vision and goals for a more sustainable Yarmouth
- The town does not plan to change the growth areas designated in the previous comprehensive plan which will help to prevent sprawl.

KEY TERMS

Land Cover: The vegetative characteristics of the land such as forest, wetland, impervious

Land Use: Reflects how people use the land such as recreational, mixed use, or conservation

Zoning: Zoning ordinances impacts land use by limiting what developers and landowners can do with their properties

Urban Forest: All trees within a densely populated area, including trees in parks, on streetways, and on private property

IN YARMOUTH:

Yarmouth has a compact and walkable center of town focused on Main Street and Route 1. From the Village Center, the town is more rural with pockets of development focused on other major arterials through town. As a result, there are areas of high impervious surface but also large areas of tree canopy. The maps of impervious surface and tree canopy provide a proxy for understanding which areas of town may be most at risk.

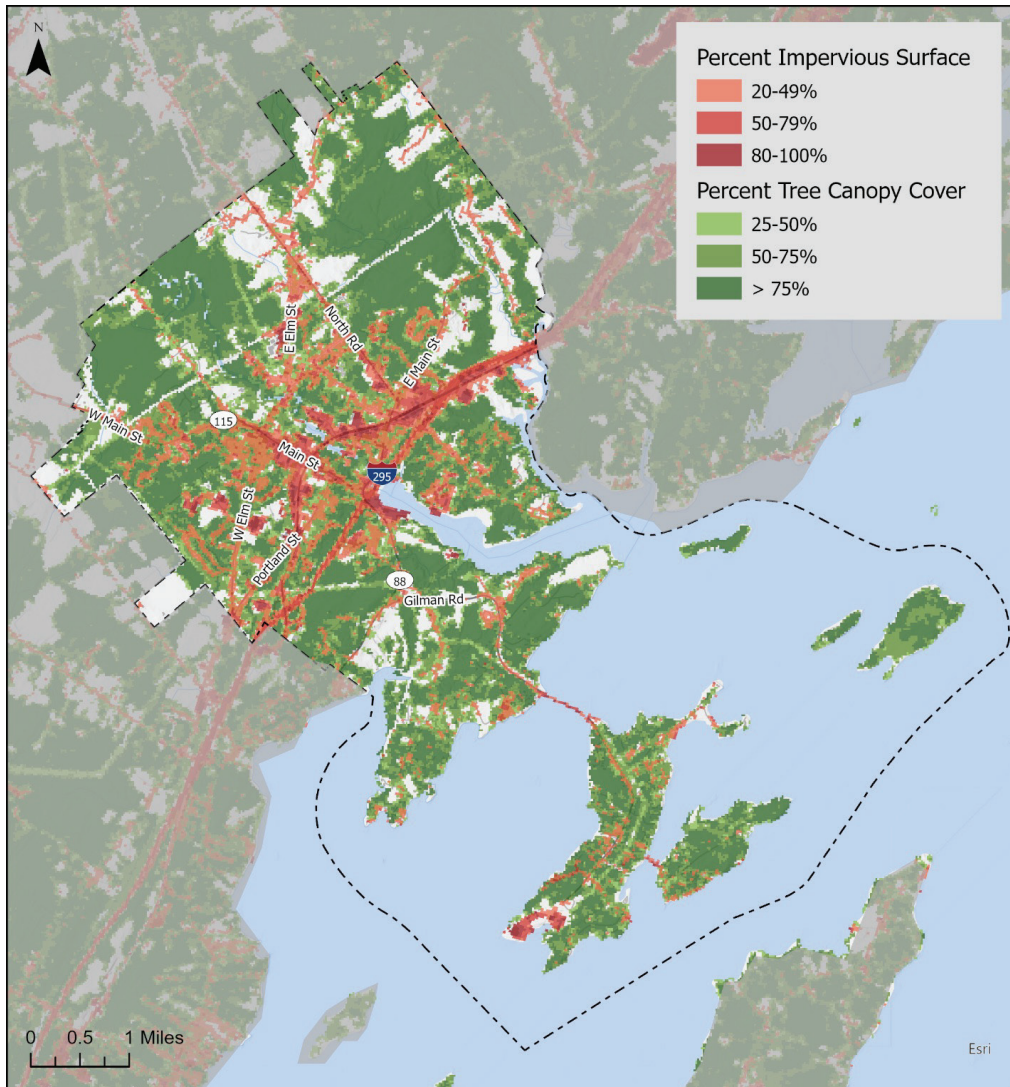


Figure 25: Percent coverage of tree canopy and impervious surface.

Source: US National Land Cover Database

Yarmouth has two land use ordinances, the Zoning Ordinance (Chapter 701) and the Character Based Development Code (Chapter 703). In addition, Yarmouth has adopted a Site Plan Review Ordinance (Chapter 702) and a Subdivision Ordinance (Chapter 601). These ordinances do not account for existing or projected climate hazards on a macro level. The town is currently undertaking a Comprehensive Plan update, which will look at land use policy for the town and make recommendations to implement the plans Future Land Use Plan. To align with the Climate Action Plan, it is recommended that any zoning updates consider how future development will influence and be impacted by climate change. For example, a coastal resilience overlay ordinance would help protect critical assets from climate change threats such as sea level rise, flooding, and coastal erosion.

The existing land use ordinances do incorporate the municipal shoreland zoning requirements of the DEP's Chapter 1000 and other best practices as shown in Table 14:

Table 14: Example zoning code ordinances that align that increase resiliency to climate change

Zoning Code	Purpose
Resource Protection District	The inclusion of the Resource Protection District (RPD) is a requirement of a municipal shoreland zoning program. The RPD applies to fresh water and coastal wetlands, the 100-year flood plain as designated by FEMA, and areas in which development would adversely affect water quality, productive habitat, biological ecosystems, or scenic and natural values. This district sets limits and standards on the types of uses and development within the boundaries.
Shoreland Overlay District	The Shoreland Overlay District (SOD) is also a requirement of a municipal shoreland zoning program. The SOD applies to areas within 250 feet of water bodies or wetlands, establishes a 75-foot area surrounding protected streams, and all lands within the Resource Protection District. The intent of the SOD is to further the maintenance of safe and healthful conditions; prevent and control water pollution; protect fish spawning grounds, aquatic life, bird and other wildlife habitat; protect buildings and lands from flooding and accelerated erosion; protect archaeological and historic resources; protect commercial fishing and maritime industries; protect Freshwater and Coastal Wetlands; control building sites and placement of Structures and land uses to conserve shore cover, and visual as well as actual points of access to inland and coastal waters; conserve natural beauty and open space; and anticipate and respond to the impacts of development in Shoreland areas.
Water Oriented Commercial (I, II, and III)	The three Water Oriented Commercial Districts provide areas that serve recreational and commercial marine interest, which allows for a diversity of activities that enhances the interest and economic viability of the harbor and water-oriented activities.
Open Space Residential Development	Open Space Residential Development is an alternative to conventional subdivision that creates a mechanism to allow reduced lot sizes by requiring the preservation of open space, forests, wildlife habitat, contiguous protected areas, natural topography, and the rural character of the town.
Lot Coverage Requirements	These standards are only found in the Character Based Development Code and therefore only apply to those areas. Lot coverage requirements limit the amount of impervious surfaces on a lot.
Site Plan and Subdivision Review Criteria	Both the Site Plan Review and Subdivision Ordinances include review criteria that cover floodplains, soil erosion and sedimentation, stormwater, surface and ground water, wetlands, and other waterbodies, among other items. The Planning Board reviews projects subject to these ordinance and makes a determination on consistency before a project is reviewed.
Neighborhood Connectedness	The Character Based Development Code, Site Plan Review, and the Subdivision Ordinances require that new roads and thoroughfares are connected to the existing network of streets, paths, sidewalks, and trails supporting moving around without the use of a car.
Parking Reductions	The Zoning Ordinance and the Character Based Development Code allow the Planning Board to reduce the parking requirement through shared parking arrangements and other conditions and methods to reduce the vehicular demand.
Street Tree Requirements	The Subdivision Ordinance and the Character Based Development Code require street trees along new roads and thoroughfares.

In addition to the land use ordinances, Yarmouth has multiple ordinances that support resilience in the community—including Floodplain Management, Stormwater Discharge, and Sewerage Ordinances. However, similar to the land use ordinances, these ordinances don't include climate considerations. Future planning documents and ordinances should consider going above baseline regulations and incorporate climate considerations. Specific recommendations will be included in the Climate Action Plan and Comprehensive Plan.

PRIORITY FOCUSES AND AREAS

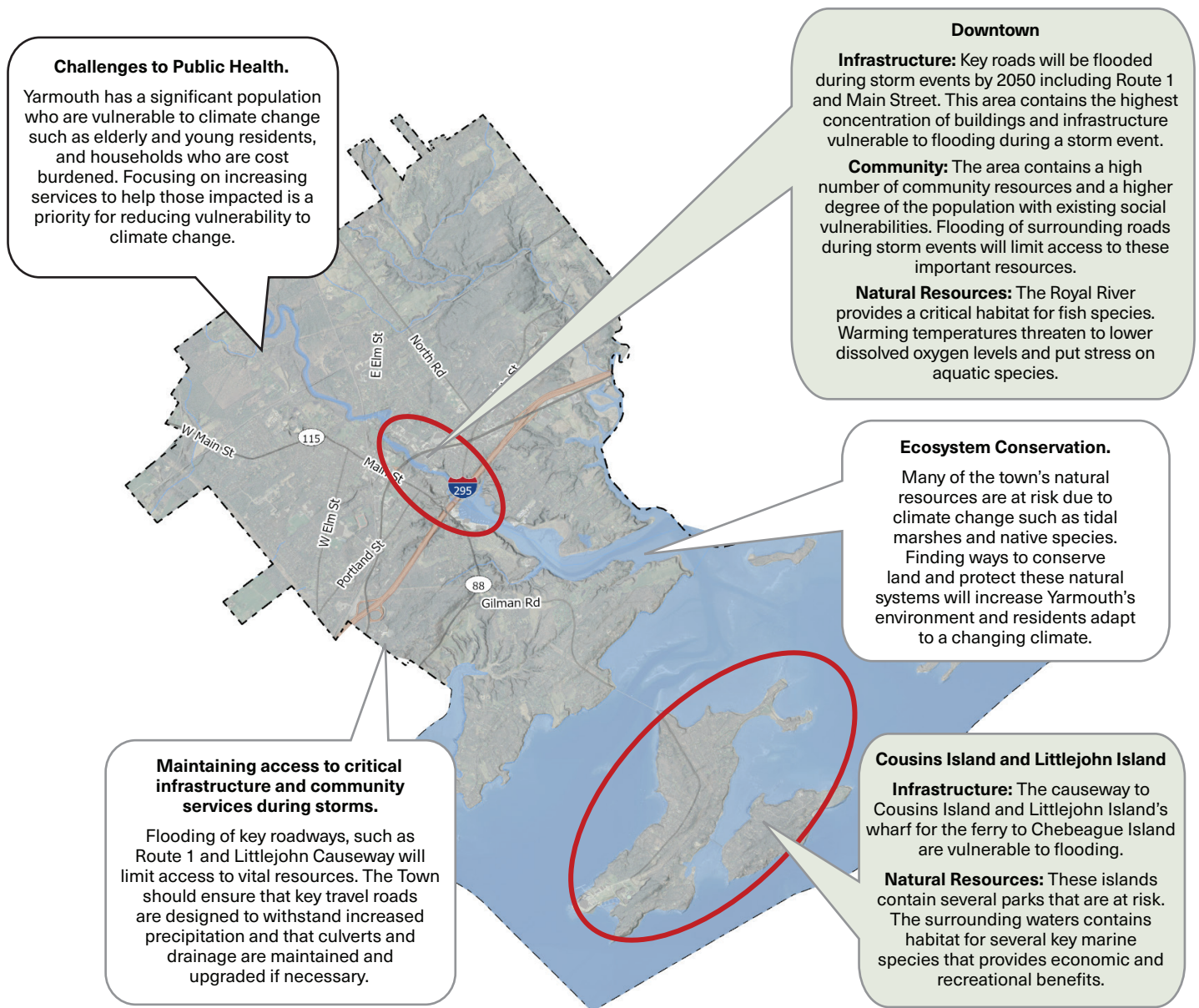


Figure 26: Priority areas of focus for addressing climate vulnerabilities

Yarmouth's elevated coastline and relatively low social vulnerability provides resilience to climate change. However, there are hazards and impacts that should be prioritized to enhance resilience to climate shocks. In this section those assets, communities, and geographic areas are highlighted.

1. **Maintaining access to critical infrastructure and community services during storms**– Currently, the town does not experience flooding that restricts travel, however, with the increase in intense storms roads are more likely to experience flooding and restrict mobility. Flooded or damaged transportation infrastructure can cut off emergency vehicles, limit access to important community resources, and prevent access to important wastewater systems for maintenance and repair. In addition, flooded infrastructure increases costs for maintenance and repair, disrupts supply chains, and creates barriers for habitat migration. In Yarmouth, access to major roadways such as Route 1 during or in the aftermath of a storm, could greatly hinder Yarmouth's ability to respond. The Town should ensure that key travel roads are designed to withstand increased precipitation and that culverts and drainage are maintained and upgraded if necessary. Specific actions are highlighted in the Climate Action Plan.
2. **Challenges to Public Health** -- Climate change, particularly rising temperatures, is likely to exacerbate human-health impacts. Heat-related illnesses, asthma from worsened air quality, and vector-borne diseases are all likely to increase in the future. This will stress the healthcare system and impact people's mental health. Yarmouth has a significant population who are vulnerable to these changes such as elderly and young residents, and households who are cost burdened. Combined with rising unaffordability, these populations will have trouble adapting to future climate disasters. Focusing on increasing services to help those impacted is a priority for reducing vulnerability to climate change.
3. **Ecosystem Conservation** – Yarmouth's unique character depends on access to parks, open space, and clean water. Many of these natural resources are at risk due to climate change—changing ocean temperatures and acidity strain the marine environment, warming temperatures will shift the terrestrial ecosystem, and sea level rise threatens tidal marshes and the surrounding development. Finding ways to conserve land and protect these natural systems will increase Yarmouth's environment and residents adapt to a changing climate.

Geographic Priority Areas

This report presented information on how different assets are at risk from climate hazards. This section will look at how all of the resources interact within a geographic area to assess the areas of Yarmouth most vulnerable in Yarmouth. Identification and assessment of these areas included the following factors:

- Number of climate hazards threatening the area
- Number of assets in a specific area that are vulnerable to identified climate hazards
- Time before a hazard will significantly impact a geographic area's community, infrastructure, and natural resources
- Chance of natural system degradation
- Overlapping social vulnerability in observed neighborhoods

This assessment can guide prioritization of areas for future climate adaptation planning strategies.

DOWNTOWN

The most vulnerable area in Yarmouth is downtown, along the Royal River from roughly I-295 to the Elm Street Bridge. The combination of exposure to climate hazards, and infrastructure and social vulnerabilities puts this area at risk.

Climate Hazards: Warming Temperatures—the area is more impervious than other neighborhoods putting it at risk of locally high temperatures compared to other greener areas. Changing Precipitation—the area is at risk of flooding during 100-year storms at 2050. Sea Level Rise—the Royal River is tidally influenced and will be impacted by storm surges as the high tide water levels rise.

Infrastructure: Several key roads will be flooded during storm events by 2050 including Route 1 and Main Street. This area also contains vulnerable pump stations which if impacted will strain the wastewater system. The east side of I-295 contains several marinas and businesses, including the town landing, which is vulnerable to the impacts of sea level rise. This area also contains the highest concentration of buildings vulnerable to flooding during a storm event.

Community: The downtown area contains a high number of community resources, including the town hall, the library, the food pantry, and several schools. Flooding of surrounding roads during storm events will limit access to these important resources.

Social: The downtown area has a higher degree of people with existing social vulnerabilities – particularly those who are cost burdened, older housing stock, and older residents who live alone. Higher impervious surface will impact the older population and intense storms can damage older housing.

Natural Resources: The Royal River provides a critical habitat for fish species. Warming temperatures threaten to lower dissolved oxygen levels and put stress on aquatic species. In addition, the Royal River provides recreational access for the community. Flooding and changing riverine conditions could limit access.

COUSINS ISLAND AND LITTLEJOHN ISLAND

The islands of Yarmouth are home to residential properties and parks and recreation. Although the islands don't contain many town assets, there are transportation services and infrastructure tied to them, and the loss of access to the islands is important for consideration.

Climate Hazards: Sea Level Rise—Buildings, beaches, and roadways are at risk from sea level rise. Changing ocean conditions—the waters around the islands are habitat for a range of aquatic species. Warming temperatures—portions of Cousins Islands have a higher degree of heat sensitivity.

Infrastructure: The causeway to Littlejohn Island and Cousin Island's wharf for the ferry to Chebeague Island are vulnerable to flooding. Climate hazards could cut off the island from town resources. Several buildings on both islands are at risk of flooding due to storms and sea level rise in the future.

Natural Resources: These islands contain several parks such as Sandy Point Beach and Littlejohn Island preserve that are at risk. In addition, the surrounding waters contains habitat for several key marine species that provides economic and recreational benefits.

ENDNOTES

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