

Getting on Board



Preparing for Sea Level Rise in Camden, Maine



June 2017



**GETTING ON BOARD:
PREPARING FOR SEA LEVEL RISE IN CAMDEN, MAINE**

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Watershed School
Camden, Maine

Contents

Acknowledgments	i
Introduction	1
Why is sea level rising and how much is it expected to rise?	1
Methods	5
How will Camden be affected by sea level rise?	8
Survey results on community attitudes about this issue	18
How can Camden prepare for sea level rise?	18
Conclusion	20
Literature Cited	21
Appendix A: Sea Level Rise Survey Results	23

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Introduction

Where the mountains meet the sea—we think of the ocean off of Camden Harbor and the beautiful backdrop of green hills as constants, but a warming climate will result in profound changes to the Camden area within our lifetime. Scientists say that if we stay in our current emissions path, we have three to four decades until our earth's climate is irreversibly altered. To avoid this we need to keep total warming below 2°C, which means moving away from the business as usual path we're on as quickly as possible and reducing emissions by 80% or more by 2050 (IPCC 2014). For the Camden area, projected changes include snowfall amounts decreasing by 40%, more frequent and intense storms, shifting ranges of plant and animal species, rising sea levels, and many more.

The junior class at Watershed School, a small independent high school located a few streets away from Camden Harbor, decided to explore different sea level rise scenarios and their consequences for the town of Camden. Our goal is to alert town officials and community members about this issue in hopes that the town will act to both prepare for the coming changes and do everything it can to reduce fossil fuel emissions.

For this project, we analyzed sea level rise scenarios and their potential impacts on the Camden coast, and researched what other towns around the Gulf of Maine are doing to prepare for these impacts. We also conducted a survey of Camden residents, students, visitors and workers to find out what community members know about the issue of sea level rise. We hope the town will take heed. Our future is at stake.

Why is sea level rising and how much is it expected to rise?

The two major long-term factors contributing to sea level rise are the thermal expansion of water and the melting of land ice. Other things like storm surges from tropical storms and northeasters, unusually high tides, and seasonal changes in precipitation can affect sea level for short periods.

Since 1880, global mean sea level has risen by about 8 to 9 inches, with about 3 inches of that occurring since 1993 (Sweet et al. 2017). In the Gulf of Maine, where water is warming more quickly than in other parts of the globe, sea level trends have been higher than the global average over the past several decades. This included a several year jump in sea level beginning in 2009 (Goddard et al. 2015; Sweet 2017). Sea level is now rising at a rate of about 3.2 mm per year (Figure 1), which is much faster than any time in the past 5,000 years (Fernandez et al. 2015, Slovinsky 2015). The cause of these higher rates is uncertain, but scientists think it might have to do with changes in the Gulf Stream (Sweet et al. 2017; Kopp et al. 2015).

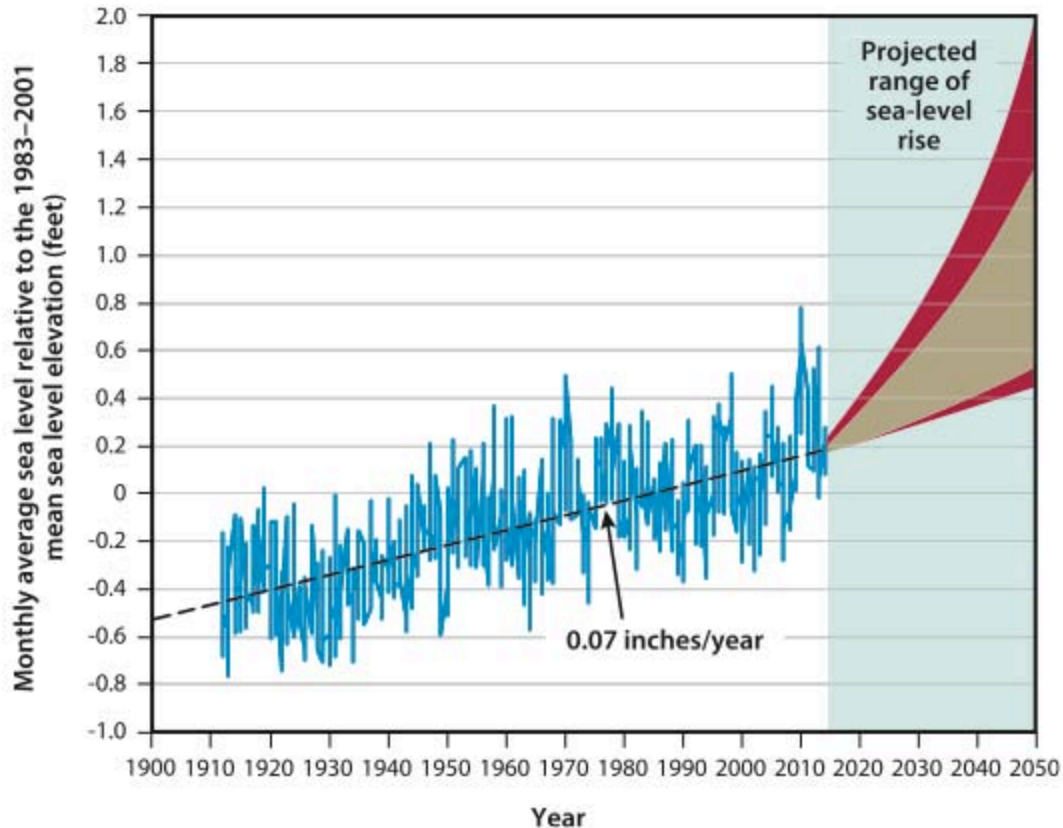


Figure 1. Sea Level Trend at Portland, Maine. Sea level at Portland provided by the National Oceanic and Atmospheric Administration Center for Operational Oceanographic Products and Services. The mean sea level trend is 0.07 inches per year (1.9 mm/year) with a 95% confidence interval of ± 0.006 in/yr (0.16 mm/yr) based on monthly mean sea level data from 1912 to 2013, which is equivalent to a change of 0.62 feet in 100 years. During the period 2003-2014, the average rate of increase has been 3.2 mm/year. The currently projected range of sea-level rise of 1 to 3 feet by 2050 falls within a larger range that incorporates uncertainty about how glaciers and ice sheets will react to the warming ocean, the warming atmosphere, and changing winds and currents (graph and notes from Fernandez et al. 2015). Note that, since this graph was prepared, NOAA has extended the high end scenario from 6 feet to 8.2 feet by the end of this century (Sweet 2017).

In NOAA’s 2017 report entitled *Global and Regional Sea Level Rise Scenarios for the United States*, six different sea level rise scenarios are given that project a sea level increase of between 6 inches (low emissions scenario) and 2 feet (high emissions scenario) by 2050 (Sweet 2017). The report also says that, in the Gulf of Maine, sea level rise is projected to be greater than the global average for almost all future scenarios (e.g., 12-19+ inches higher by the year 2100 under the intermediate scenario, which translates to an increase of 1.5 to 3.5 feet of sea level rise in the Gulf of Maine by midcentury). NOAA’s scenarios are not meant to predict future changes, but are meant to describe realistic future conditions so that towns like Camden can plan ahead (Parris et al. 2012).

Figure 2 shows the six global sea level rise scenarios going to the end of this century. RCP 2.6, RCP 4.5 and RCP 8.5 are three of the different emissions scenarios (representative concentration pathways) given in the most recent IPCC Assessment (IPCC 2014). The RCP numbers refer to the extra “heat” in watts trapped by additional greenhouse gasses in the atmosphere, e.g., RCP 2.6 means a pathway that leads to 2.6 more watts of energy trapped by the atmosphere because of higher amounts of CO₂ (for this scenario, 490 ppm instead of today’s

level of 400 ppm). This would result in a 1.5°C increase in global mean temperature from preindustrial levels (IPCC 2014).

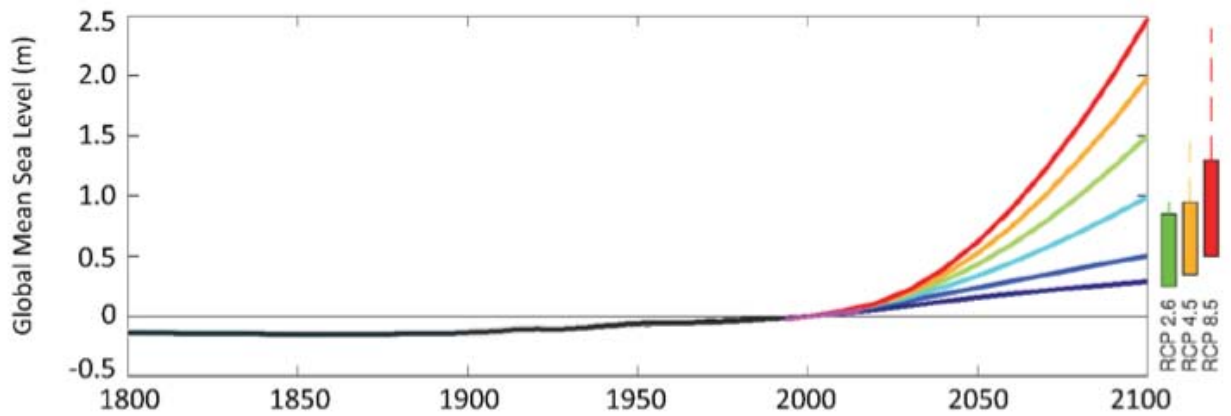


Figure 2. NOAA Global Mean Sea Level Scenarios for 2100. These are the 6 global mean sea level rise scenarios for 2100 (6 colored lines) relative to historical geological, tide gauge and satellite altimeter GMSL reconstructions from 1800–2015 (Sweet 2017).

Global Mean Sea Level Rise for the Different Scenarios in Meters

GMSL Scenario (meters)	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2120	2150	2200
Low	0.03	0.06	0.09	0.13	0.16	0.19	0.22	0.25	0.28	0.30	0.34	0.37	0.39
Intermediate-Low	0.04	0.08	0.13	0.18	0.24	0.29	0.35	0.4	0.45	0.50	0.60	0.73	0.95
Intermediate	0.04	0.10	0.16	0.25	0.34	0.45	0.57	0.71	0.85	1.0	1.3	1.8	2.8
Intermediate-High	0.05	0.10	0.19	0.30	0.44	0.60	0.79	1.0	1.2	1.5	2.0	3.1	5.1
High	0.05	0.11	0.21	0.36	0.54	0.77	1.0	1.3	1.7	2.0	2.8	4.3	7.5
Extreme	0.04	0.11	0.24	0.41	0.63	0.90	1.2	1.6	2.0	2.5	3.6	5.5	9.7

GMSL = global mean sea level. The scenario heights are in meters for 19-year averages centered on decades through 2200 (showing only a subset after 2100) beginning in the year 2000. Only median values are shown (Sweet 2017).

The correlation between CO2 levels, global temperature and sea level is well established (see Fig. 3). As global temperatures rises, so does the sea level. Global warming has a direct cause and effect relationship with rising ocean levels.

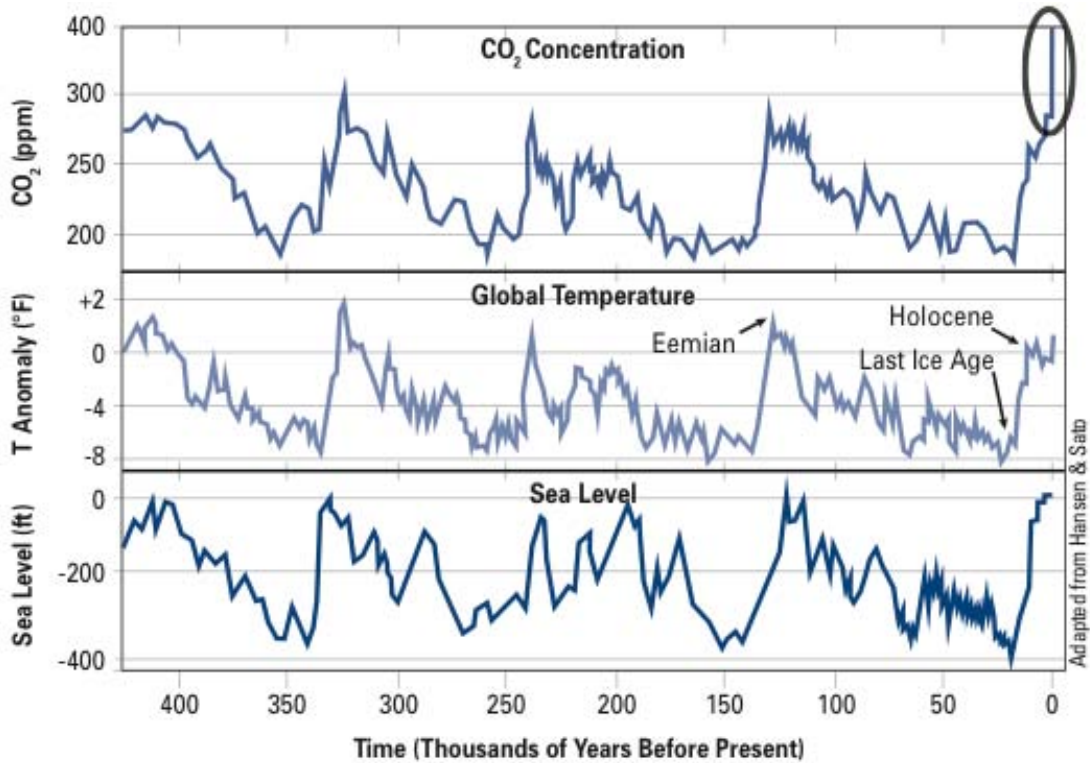


Figure 3. 420,000 Years of Carbon Dioxide (CO₂) Concentrations, Global Temperatures, and Sea Level. This figure, which is based on Vostok ice core data, was taken from King (2016) who attributes it to Englander (2013).

We are now on the high emissions path, and, even if we can achieve the goal of staying below a 2°C increase in global temperature set in the 2015 Paris Agreement, scientists think that sea level will continue to rise throughout the 21st century and beyond. This is because of global warming that has already occurred, the warming that is yet to occur due to the still uncertain amount of future emissions (Sweet et al. 2017), and the time it takes for carbon to cycle out of the atmosphere. According to Sweet and others, the question is not *if* sea levels will rise, but *by when* and *how much*? Angus King, after a trip he took to Greenland with climate scientists in 2015, summarized their predictions for the North Atlantic this way: “a foot of sea level rise in the next 10-15 years and one foot per decade thereafter for the rest of the century” (King 2016).

2050 and 2100 seem like a long way away. Many people alive now will not be around to see these changes come to pass. However, if we don’t start reducing our emissions and preparing now, this rise will forever change the Camden coast that we know and love today.

Methods

We spent six weeks working on this project, which involved the following steps.

Step 1: Analysis of different sea level rise scenarios using the Maine Geological Survey mapping tool on their ArcGIS web application.

This allowed us to analyze the following layers:

- Highest annual tide (for 2015)
- Sea level rise storm surge scenarios
- Maine parcels (shows property lines for organized towns)
- SLOSH (Sea Lake and Overland Surge from Hurricane)

These layers helped us visualize four different projected sea levels (one foot, 2 feet, 3.3 feet and 6 feet) using the highest annual tide for 2015 as a baseline. Highest annual tide (HAT) is an approximation of the landward extent of inundation during the highest predicted tide for a given year. The Maine Geological Survey selected it as a starting point because the HAT along the Maine coastline can be between two and three feet higher than the mean higher high water (MHHW), which is a common starting point for sea level scenario mapping in other states and in web-based mapping tools.

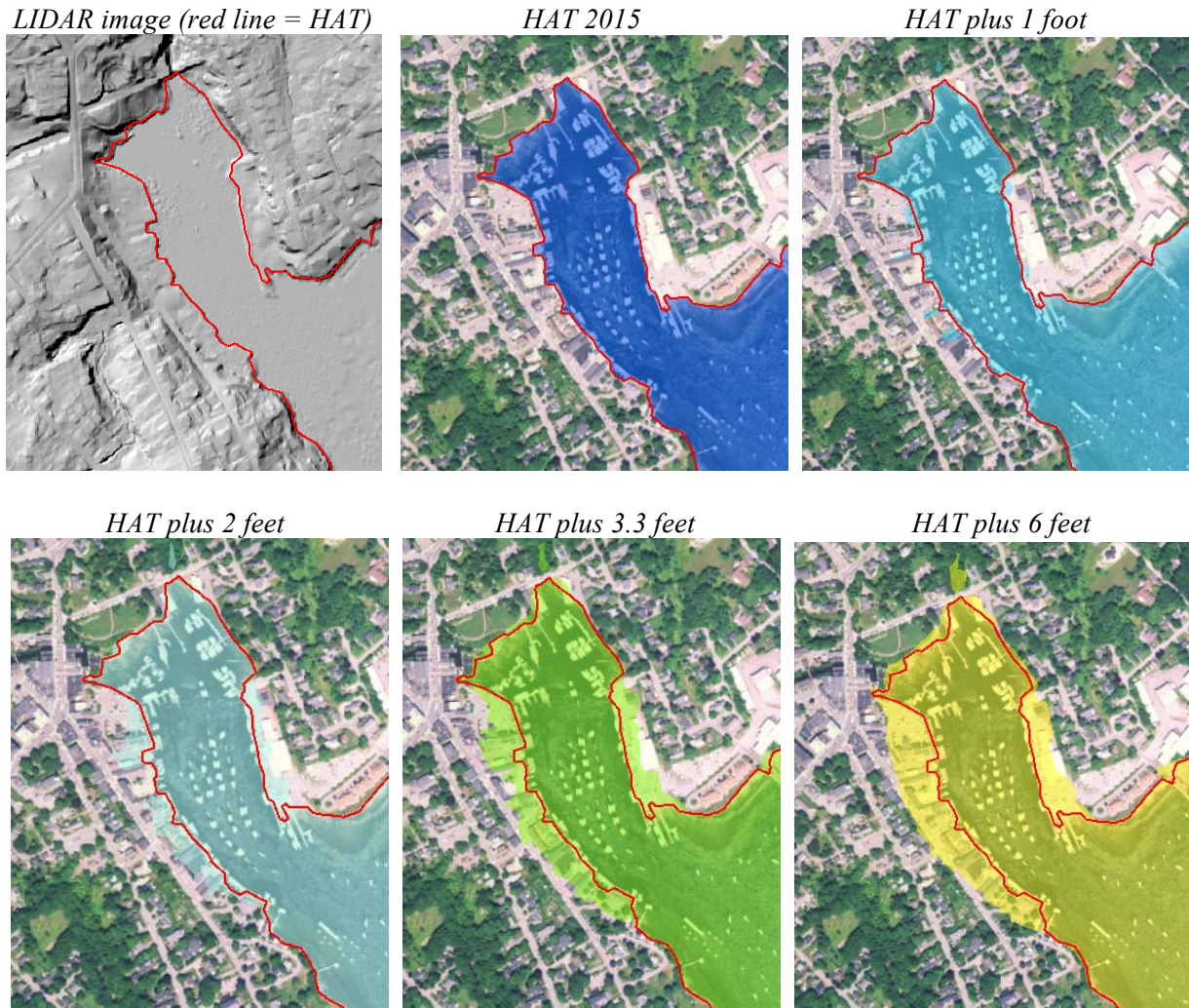
Using the HAT allows for visualizing the worst case flooding scenario. Also, HAT is used as a regulatory boundary as part of Maine's shoreland zoning. Adding sea level rise scenarios to that elevation allows for communities to visualize how boundaries might change in the future. The HAT baseline was mapped using LIDAR (Light Detection and Ranging), which is a very accurate remote sensing method used to examine the surface topography of the earth.



HAT at Camden Harbor on October 29, 2015

The following series of images shows the kind of information available on the Maine Geological Survey website. In addition, there is a hurricane/storm surge layer available.

Figure 4. Maine Geological Survey Mapping Tool Sea Level Scenarios for Camden Harbor



Step 2: On-the-ground analysis

We looked at the entire Camden coastline by boat and walked portions of the inner and outer harbor on foot to identify and photograph vulnerable areas such as stable and unstable bluffs, and road segments, buildings, and other infrastructure that would be affected by flooding.

Step 3: Research on what Camden and other towns around the Gulf of Maine are doing to address sea level rise

We researched what other towns and regions are doing to prepare for sea level rise. Most of these were on the Gulf of Maine, including Damariscotta, Boothbay, Harpswell, Portland, South Portland, York, Gloucester, Massachusetts and the province of Nova Scotia. We also looked at the country of China. This allowed us to compare how other areas are preparing for sea level rise and find out what steps might be relevant for Camden. We then carefully looked downtown again to try to quantify specific impacts such as the number of buildings and parking

spaces that would be flooded at different sea levels. During this whole process we documented each step with photographs for the report and future reference.

Step 4: Simulations of projected sea levels at three locations in town

We created visual simulations of three places around the harbor to give an idea of what future sea levels would look like on the ground. These included the lower part of Harbor Park in front of the library, the Yacht Club, and the Harbormaster's house. To do this, we first measured the HAT, then a six foot level was used to get a reference point. Then we used a ruler to measure down to other sea level heights and took photos to record visual indicators as to where each scenario would fall. To create the visual simulations, we used Adobe Photoshop CS6 to draw horizontal lines at each scenario and overlay a water texture at approximately 80% opacity to show where sea level would be for each scenario.



Measuring projected sea level heights at the Public Landing and the Yacht Club

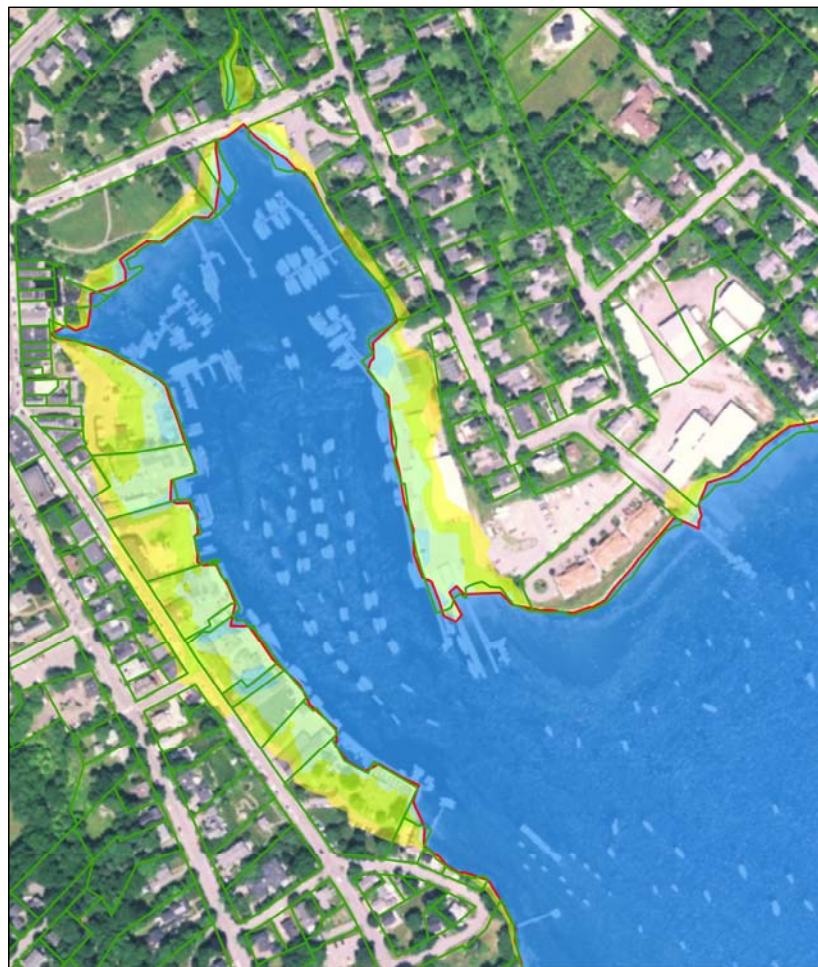
Step 5: Survey

We developed a short 21 question survey on Google Forms to get a better sense of what people actually know about sea level rise, their views on climate change, where they live, and how their age and political affiliation might affect these things. An electronic version of the survey was sent to Camden Hills Regional High School and shared on social media. A paper version was taken to the following locations: Bagel Cafe, Zoot, Camden Town Office, Baptist Church, Camden National Bank, Owl and Turtle Book Shop, Sea Dog, Boynton Mckay, Camden Public Library, Cutting Edge Salon, Barber Shop. We collected results from May 18 to May 29, 2017.

How Will Camden Be Affected by Sea Level Rise?

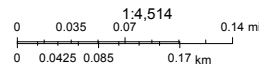
Mid-range sea level rise projections put future sea levels in the Gulf of Maine at about three feet above where they are now by 2100 (Sweet et al. 2017, Maine Geological Survey). If you add this to the current highest annual tides which are two to three feet above the normal high tide, even low-end projections will have an impact on buildings, roads and infrastructure in Camden. The areas that will be most affected include the inner harbor, especially the buildings on the shore side of Bayview Street, and Sherman Point. Three maps follow. The first is of the inner harbor, showing the four sea level rise scenarios (HAT + 1 foot, 2 feet, 3.3 feet and 6 feet). The second shows the inner and outer harbors. And the third shows the inner and outer harbors with the storm surge layer added.

Sea Level Rise Scenarios for Camden's Inner Harbor



May 19, 2017

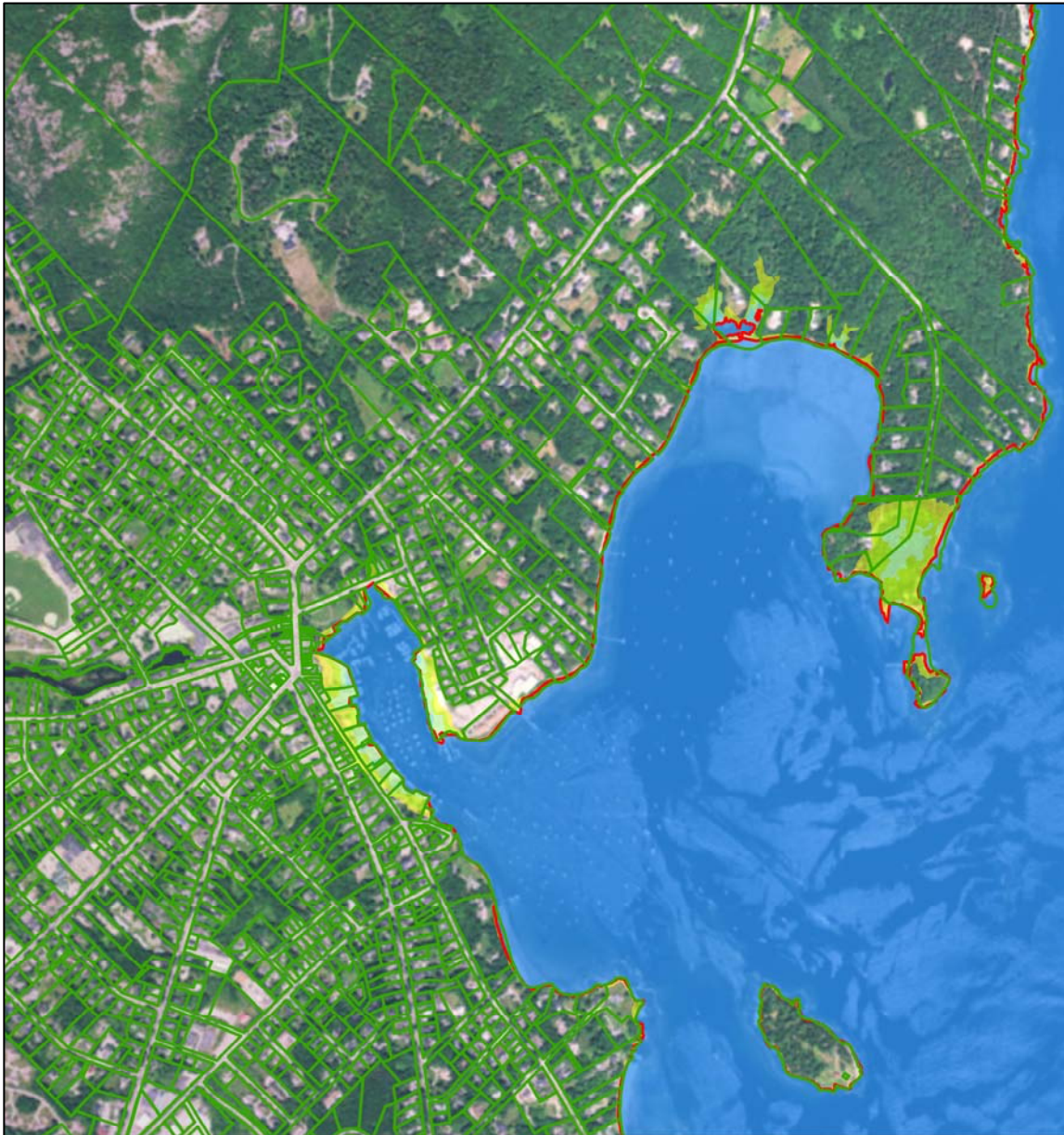
- Parcels - Maine
- Tide_Stations
- Highest_Annual_Tide_Line_2015
- Highest Annual Tide 2015
- Highest Annual Tide 2015 Plus 1 Foot
- Highest Annual Tide 2015 Plus 2 Feet
- Highest Annual Tide 2015 Plus 3.3 Feet
- Highest Annual Tide 2015 Plus 6 Feet



Maine Geological Survey
Maine GeoLibrary, MEGIS
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

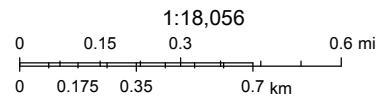
Maine Geological Survey
2016

Sea Level Rise Scenarios for Camden's Inner and Outer Harbors



May 19, 2017

- Parcels - Maine
- Tide_Stations
- Highest_Annual_Tide_Line_2015
- Highest Annual Tide 2015
- Highest Annual Tide 2015 Plus 1 Foot
- Highest Annual Tide 2015 Plus 2 Feet
- Highest Annual Tide 2015 Plus 3.3 Feet
- Highest Annual Tide 2015 Plus 6 Feet



Maine Geological Survey
 Maine GeoLibrary, MEGIS
 Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
 DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

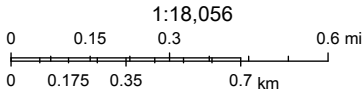
Maine Geological Survey
 2016

Sea Level Rise/Storm Surge Scenarios for Camden's Inner & Outer Harbors



May 19, 2017

- Parcels - Maine
 - Tide_Stations
 - Highest_Annual_Tide_Line_2015
 - Highest Annual Tide 2015
 - Highest Annual Tide 2015 Plus 1 Foot
 - Highest Annual Tide 2015 Plus 2 Feet
 - Highest Annual Tide 2015 Plus 3.3 Feet
 - Highest Annual Tide 2015 Plus 6 Feet
- SLOSH_Inundation_Areas**
- 1
 - 2
 - 3
 - 4



Maine Geological Survey
 Maine GeoLibrary, MEGIS
 Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
 DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Maine Geological Survey
 2016

The impacts of rising seas are not only environmental, they are economic and cultural. Sea level rise will not only cause shoreline erosion and eliminate beaches, it will eventually flood businesses and residences, impact roads, and could cost the town hundreds of thousands in tax dollars. In addition, sea level rise will affect valuable local industries such as fishing, lobstering, and tourism. Below are some of the most obvious impacts identified during this study.

Buildings

We used the Maine Geological Survey sea level rise scenario maps of the inner and outer harbor to count the numbers of buildings that would be affected by different sea levels. The high emissions path we are now on could result in a 6 foot rise in sea level, which would affect 50 commercial and residential buildings, a majority of which house small local businesses. These include practically every building on the shore side of Bayview Street, as well properties owned by the town, including the Yacht Club and buildings on the Public Landing. These numbers would be even higher if we took storm surges from hurricanes into account.

	HAT 2015 Plus 1 Foot	HAT 2015 Plus 2 Feet	HAT 2015 Plus 3.3 Feet	HAT 2015 Plus 6 Feet
Number of buildings affected	15	27	38	50
Number of lots affected	12	18	20	24

Impact on Property Values and Tax Revenues

Almost every coastal property around Camden Harbor, as well as properties on Sherman Cove, would be impacted by a sea level rise of 6 feet and most would be affected by a rise of 3 feet. The total value of these properties is nearly \$38 million. Damage or loss from sea level rise would impact many Camden business owners and landlords. Additionally, a steadily rising sea might deter many potential real estate investors from buying waterfront property.

Based on the current Camden tax commitment book, many of Camden’s waterfront properties are valued at \$1 million or more. Camden’s waterfront properties bring in a large portion of the town’s annual tax revenue. Loss or damage to these properties due to sea level rise and storm surges would have a significant impact on property values and taxes.

Sea level rise projection	Valuation	Annual property tax lost
HAT + 6 feet	\$38,962,900	\$619,256
HAT + 3 feet	\$32,831,300	\$528,444
HAT + 2 feet	\$25,466,000	\$413,638
HAT + 1 foot	\$16,054,100	\$259,880

In addition, flooding, property damage, and injuries due to more frequent storm surges will significantly raise insurance rates for many waterfront properties in Camden, even at the low-end sea level rise scenarios. Insurance companies have raised their rates and even dropped policyholders with waterfront properties after past storms such as Hurricane Irene and Hurricane Sandy. This could lower the value of waterfront buildings or make people not want to buy them as flood insurance costs rise (Englander 2013).



Low lying property on Northeast Point above and new construction on Dillingham Point below



Roads, the Public Landing, and parking

Based on our analysis, four commercial and residential roadways would be flooded by a 2 foot sea level rise and five would be affected by a 3 foot rise. Other damage could occur from culverts that are too small. We did not look at culverts in this study.

Street Name	Length of street affected (in feet)		
	HAT + 2 feet	HAT + 3.3 feet	HAT + 6 feet
Wayfarer Drive	90	140	158
Sherman Point Road	500	550	686
Bayview Street	0	120	739
Commercial Street	35	135	264
Steamboat Landing Road	60	96	106

Even more vulnerable than these roads is the town's Public Landing. This area is a huge draw for tourists. It has the harbormaster's office, restrooms, a boardwalk, the Chamber of Commerce building, as well as parking for 96 vehicles and 5 motorcycles (TYLIN International 2013). Even a 1 foot rise in sea level would flood the boardwalk portion of the Landing and it would be completely flooded by a 6 foot increase (see Fig 8). In addition to the Public Landing, other private parking areas all along Camden Harbor would be affected. We were surprised that the 2013 proposal to redesign the Public Landing, does not address sea level rise.

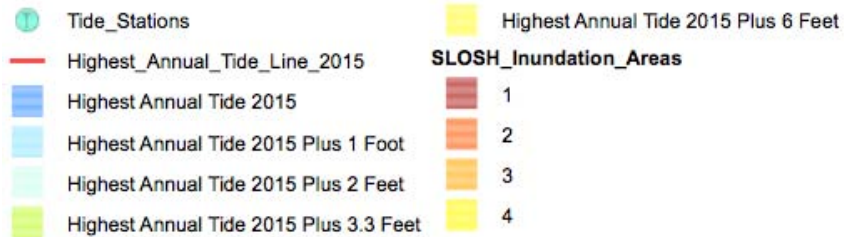
Figure 5. Sea Level Scenarios at the Camden Public Landing



Access to Camden from the north

In addition to town roads, access into Camden from the north on Route One could be a problem in the future. Storm surges and sea level rise are already causing problems in Lincolnville Beach. Figure 6 shows the portion of Route One that would be flooded by different sea levels. This could affect Camden if a big storm hits and residents need to evacuate. Even a sea level rise of one foot would render an evacuation route via Route One impossible and a 6 foot rise would flood more than ¼ mile of road. Coastal communities will need to work together on issues like this.

Figure 6. Lincolnville Beach Showing Sea level Rise and Storm Surge (SLOSH Projections)



Wastewater and other infrastructure

While Camden is fortunate that its wastewater treatment plant is not on near the ocean as is the case in many coastal towns, flooding of the town's wastewater treatment infrastructure and

septic systems and increased storm water runoff could have a major impact on water quality in the harbor. We did not look at this issue in detail. But we did notice that at least one pump station (Bayview Street) would be affected by rising sea levels. Overflow of sewage is already a problem at some pump stations. Also, the problem the town has where groundwater leaks into old sewer pipes and joints will be made even worse if sewer lines are under land and roads that are flooded. These things should be considered as the town makes improvements to the sewer system.

The Maine Geological Survey mapping tool shows 11 private wells that could be impacted by a six foot rise in sea level. These mostly bedrock wells, ranging from 92 feet to 350 feet in depth, could be contaminated by salt water as sea level rises. Fortunately, most of the harbor and village area is on town water.

Coastal Erosion

The Maine Geological Survey defines coastal bluffs as “steep shoreline slopes that are formed in sediment (loose materials such as clay, sand and gravel) that have three feet or more of vertical elevation just above the high tide line” (Bryant et al. 2002). Because these are soft shores, they are easily eroded by storm surges and wave action compared to rocky shores or areas that have been artificially hardened with riprap or rock. Of Camden’s 8.1 miles of shoreline, 2.7 miles are classified as unstable coastal bluffs, 0.2 miles are classified as highly unstable, and 3.9 miles are classified as stable (Fig. 7). Much of the remaining shoreline is bedrock or has been artificially “hardened” with seawalls or riprap.

Figure 7. Coastal Bluffs Map for the Camden Quadrangle
Grey is rocky shore, Green is stable Yellow is unstable and red is highly unstable.



Erosion can result in landward shift of the top edge of the shore, which can be a problem if buildings or other structures are near the edge (Bryant et al. 2002). Sea level rise is expected to make these shorelines even less stable. Highly unstable areas include the land across from Dillingham Ledge and the eastern side of Sherman Cove. Unstable areas include the land across from Eaton Point, the west side of Sherman Cove, the land across from Curtis island, most of the Camden coastline north of Sherman Cove, land across from Goose Rock, and land south of Ogier Point.

Another vulnerable area is Laite Beach, which, based on our walk along the shore, looks like it would not exist between mid and high tide with a two to three feet rise in sea level, or it may be washed away completely.



Unstable shore near head of Sherman Cove on left and outlet of Spring Brook on right





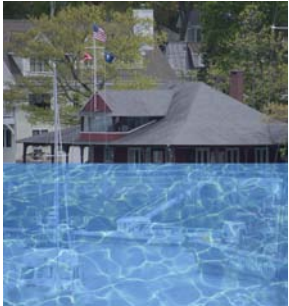






Eroding and hardened bluffs south of Dillingham Point



Laite Beach with rock work in places to protect shore from erosion

The following simulations give a sense of what three locations around the harbor would actually look like under one foot, three foot and six foot sea level rise scenarios. They are approximations.

Location	HAT + 1 Foot	HAT + 3 Feet	HAT + 6 Feet
Walk in front of Camden Library			
Camden Yacht Club			
Harbormaster Office			

Survey results on community attitudes about this issue

In all, 284 people responded to our survey on sea level rise. We were surprised to see that a large majority are aware of the issue and would like to see it addressed by the town. Highlights are included below. The complete survey results are included in Appendix A.

- 54% of respondents were 18 years old or under
- 92% of the people believe that global climate change is happening. Of these, 61% thought it was caused mostly by human activities and 34% believed it is caused by human activities and natural changes
- 73% are concerned about sea level rise and 32% of respondents have noticed a rise in sea level in their lifetime
- 45% of respondents think that there will be an increase of more than 6 feet by 2100 and 33% think there will be a 3 to 6 foot increase
- 68% said that Camden should take measures to adapt to sea level rise
- 75% said that Camden should include a section about the impacts and possible mitigation of sea level rise in the town's comprehensive plan
- The majority of respondents (about 51%) were Democrats, 29% were Independents and about 12% were Republicans. The remainder were unaffiliated. Attitudes toward taking action on this issue varied with political affiliation, with 95% of Democrats, 52% of Independents, and 30% of Republicans in favor of the town taking steps to prepare for climate change.
- Attitudes toward action also varied slightly with age. The oldest (71+) and youngest (<18) were 75% in favor of taking action on climate change. Majorities of all of the other age groups were still in favor of taking action, but to a lesser degree.

How can Camden prepare for sea level rise?

With regard to dealing with sea level rise, the Camden town government is not yet fully on board, even though this may be the biggest issue the town will face in the coming decades. There are many steps the town can take to address this, but first the town needs to acknowledge and understand the magnitude of the problem. The town's 2017 Comprehensive Plan acknowledges that a warming climate will affect the town, but there are no concrete actions with respect to sea level rise. Our research suggests that much more needs to happen. Here are our recommendations:

Planning ahead

- Learn from other more experienced towns and regions. Many towns around the Gulf of Maine have done detailed analyses of ways they will be vulnerable to rising sea level and some have also started to figure out ways to adapt (Schauffler 2014). Camden can look at studies done in Boothbay Harbor, Damariscotta, Harpswell, and other towns to see what's possible. For example, the town of Damariscotta has a public landing that is very

similar to Camden's. They have developed a plan that figures out how to redesign the landing to deal with rising sea level (Milone and Macbroom, Inc. 2015). Boothbay, which has a harbor that is critically important to the economy and culture of the town also has a detailed study Camden could refer to (Slovinsky 2016).

- Find funding to pay for a vulnerability assessment and implement climate adaptation strategies. Many Maine towns have applied for Coastal Community Grants to do this. The Maine Geological Survey has a staff marine geologist (Peter Slovinsky) who has helped many towns evaluate potential impacts.
- Stay informed on the current state of climate change science and update storm surge, sea-level rise, extreme precipitation, and other relevant climate projections. Maine Geological Survey's mapping tool is being updated and has other features that the town may want to look at.
- Consider using the intermediate-high scenario (HAT + 2 foot rise by midcentury) as a baseline for figuring out ways to adapt for the next two to three decades.
- Address sea level rise and other impacts of climate change in detail in Camden's Comprehensive Plan. This will require a vote to add a section or chapter, since the 2017 plan was just voted on and accepted by the town. The town of York has an entire chapter of their Comprehensive Plan devoted to this issue (Planning Board of York 2013), and many towns in Casco Bay, the entire New Hampshire coast, the province of Nova Scotia, and towns like Gloucester in Massachusetts have done detailed studies.

Adaptations other towns are considering (there are many more)

- Amend ordinances, the comprehensive plan, and other policies so they reflect the best available science and vulnerability information. Shoreland zoning laws and building codes need to align with projections. Camden land that will be underwater by mid to late century should not be built on now. The town could consider acquiring land in high risk areas. Projects in vulnerable areas like the Public Landing and Riverwalk should take sea level into account.
- Set aside money each year to pay for current and future adaptations.
- Protect and restore vulnerable natural resources, and consider how natural resources reduce the impacts of flooding. This study did not examine how heavy rains would affect the Megunticook River, but high flows will add to the impacts of sea level rise and storm surges.
- Make existing buildings and structures more resilient to flooding. Some ideas are to raise structures and harbor infrastructure and to floodproof buildings by installing gates at doors and windows, temporary floodwalls, abandoning lowest floors, or painting with waterproof paint.

- Relocate vulnerable infrastructure such as certain stretches of roads, wells, sewage drains, boardwalks and walking paths.
- Designate evacuation routes that can be used if there is a storm surge. Have businesses create preparedness plans so that disruption from sea level rise and storm surges can be minimized.
- Study the effectiveness of breakwaters, seawalls, or permanent flood walls.

Prevention

Reducing emissions is as important as taking actions to adapt to sea level rise. The town needs to do its part to transition to non-carbon energy. The amount we reduce emissions will determine whether we will face a two to three foot increase or a six foot or greater increase in sea level by the end of the century. Some recommendations for Camden are:

- Educate the community about this issue. Some possible ways to do this are to: provide easy access to the scenario maps and other data on the town website; hold informational town meetings; and developing other ways to help people visualize the impact. For example, Watershed School and other groups could raise awareness by creating installations down by the harbor or a 3D model of Camden that shows a future sea level.
- Switch to renewables such as solar and wind.
- Work with homeowners to make their houses more energy efficient.
- Plan and develop transportation so that residents can reduce car driving by car sharing, switching to public transport, cycling or walking for short distance, and remote working. Install EV charging stations. Purchase more efficient vehicles for the town.
- Work with legislators in Maine and Washington on legislation that helps towns reduce their nonrenewable energy use and adapt to the impacts of climate change.

Conclusion

Everyone in Watershed's junior class was born after the year 2000. Nearly every year we have been alive has gone on record as being the warmest year yet, and glaciers in Greenland and Antarctica are melting at an ever-increasing rate. We know the future will be incredibly challenging, but we are willing to work to be the first generation that figures out how to live on this planet in a sustainable way. We hope that this report will serve as a catalyst for the Camden community to come together and address the issue of climate change as fully and quickly as it can. We are here to help.

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Appendix A: Sea Level Rise Survey Results

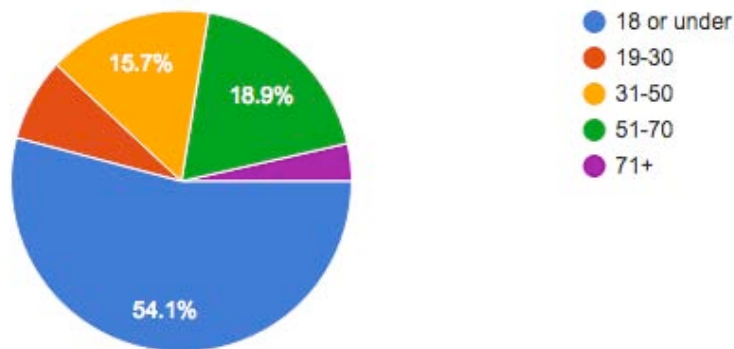
Rising Seas in Camden - A Survey



This survey is being conducted by juniors at Watershed School in Camden. Many coastal towns in Maine and elsewhere in the Northeast are actively analyzing the potential impacts of sea level rise on their waterfronts. We are interested in how aware people in the Camden area are about this issue. We would like to have your comments back by May 29, 2017. We will summarize the survey results in a report that we will share with Camden town officials. Thank you!

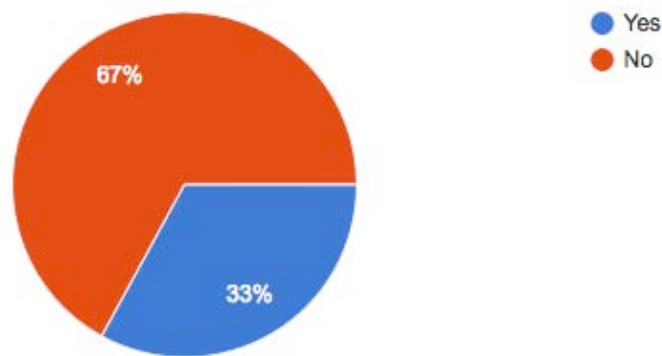
How old are you?

281 responses



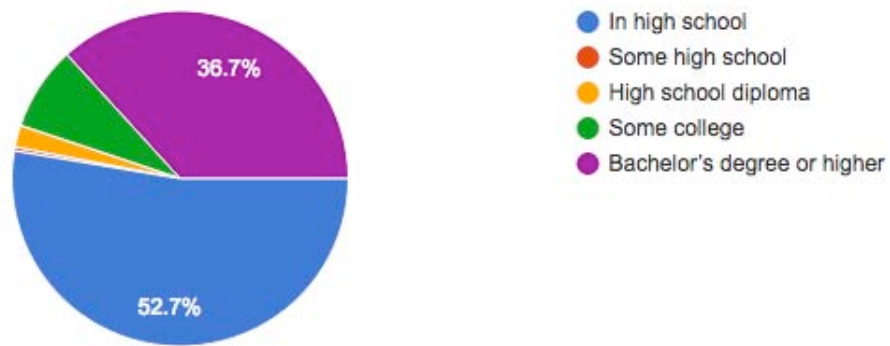
Do you have children?

282 responses



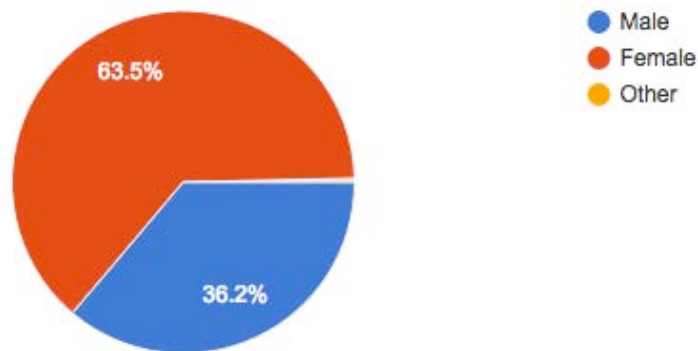
Education level

283 responses



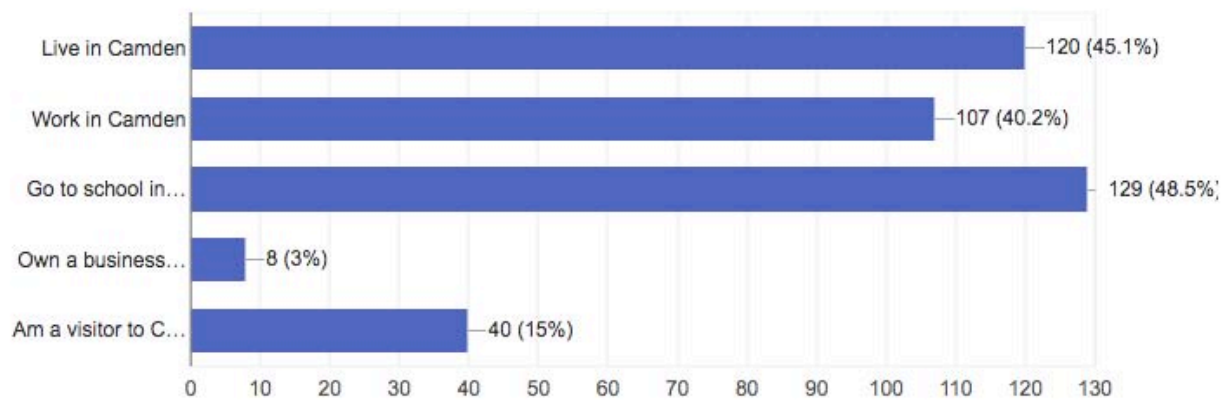
Gender

282 responses



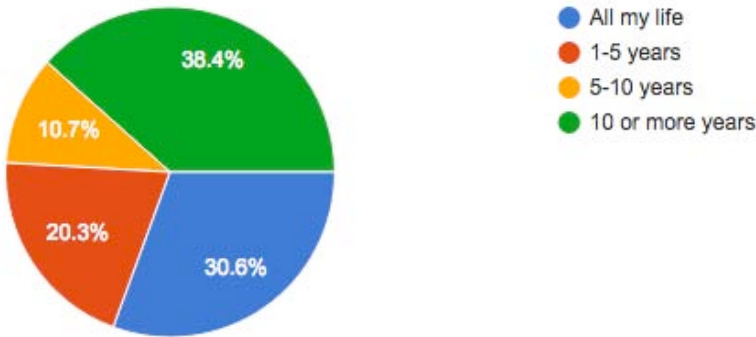
Check all that apply, I . . .

266 responses



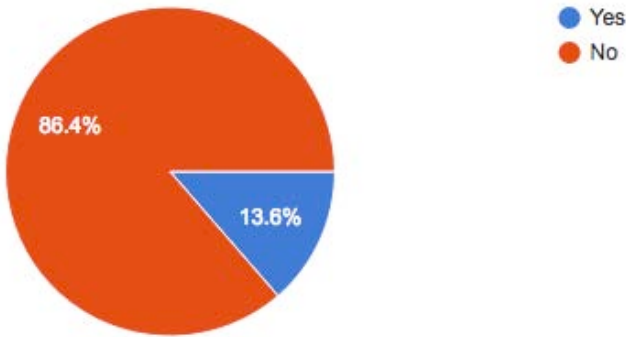
How long have you lived or spent time in the Camden area?

281 responses



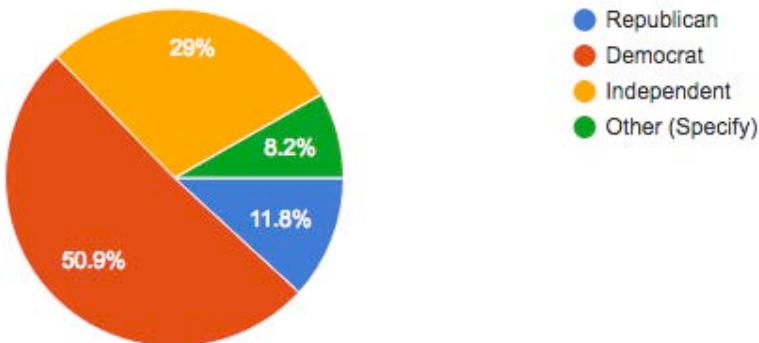
Do you have waterfront property?

279 responses



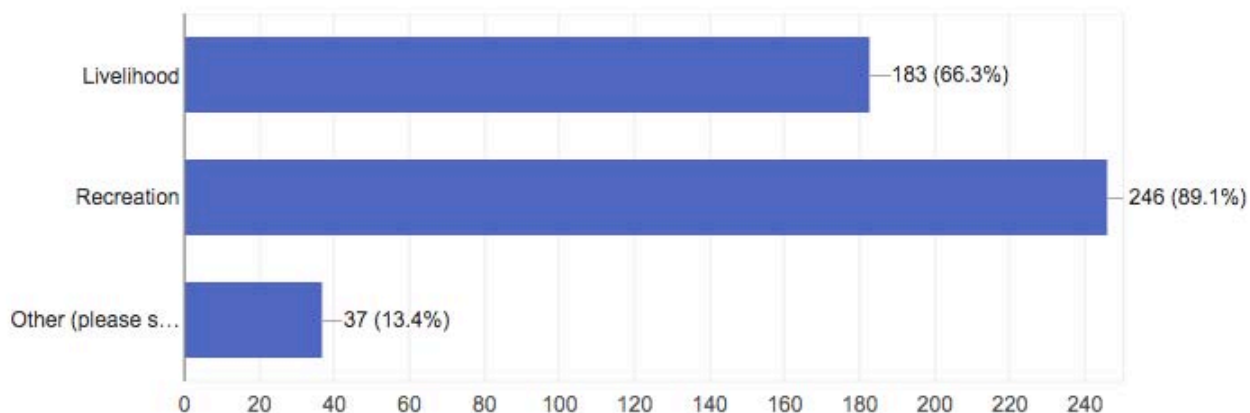
Political Alignment

279 responses



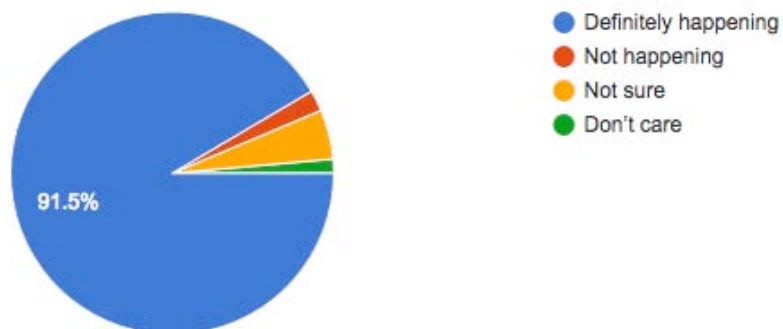
The waterfront provides a source of . . . (Check all that apply)

276 responses



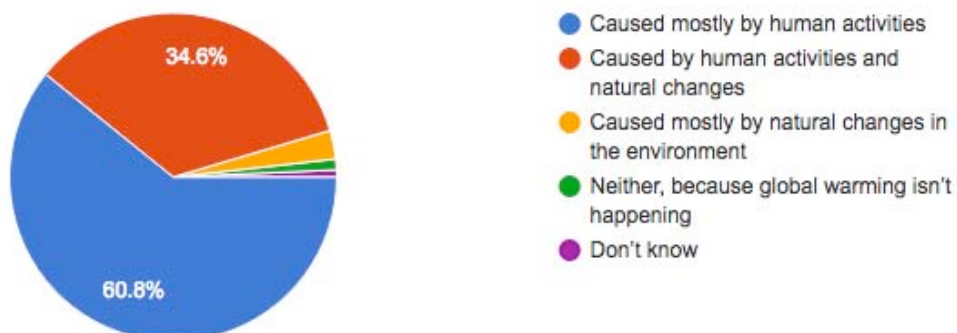
What are your views on global climate change?

283 responses



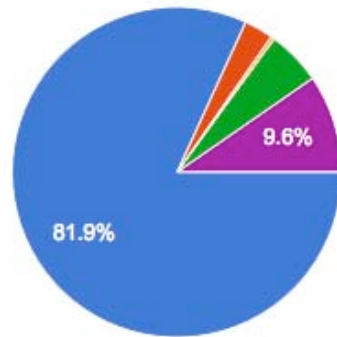
Assuming climate change is happening, do you think it is

283 responses



Which comes closer to your own view?

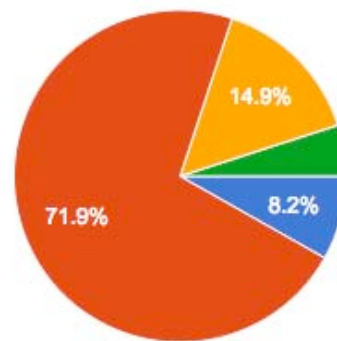
281 responses



- Most scientists think global warming is happening
- There is a lot of disagreement
- Most scientists think global warming is not happening
- Don't know enough to say
- There are a lot of disagreements

Which comes closer to your own view?

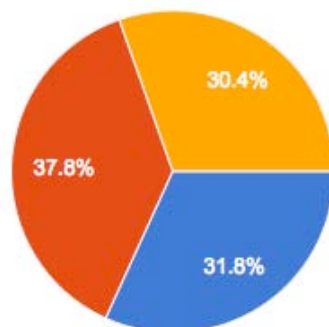
281 responses



- Humans can reduce global warming and will do so successfully
- Humans could reduce global warming, but it is unclear whether we will do what is needed
- Humans could reduce global warming, but people aren't going to change their behavior, so we're not...
- Humans aren't going to reduce global warming, even if it's happening

Have you noticed a change in sea level in your lifetime?

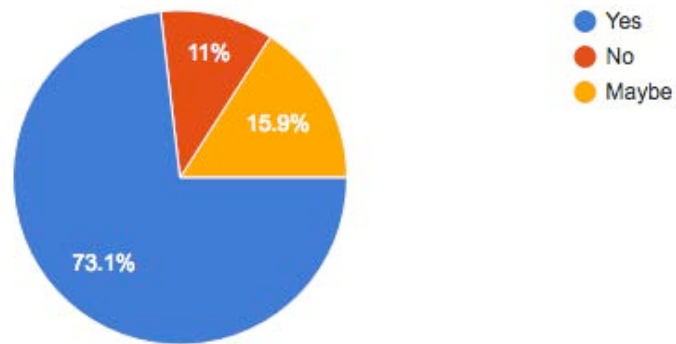
283 responses



- Yes
- No
- Maybe

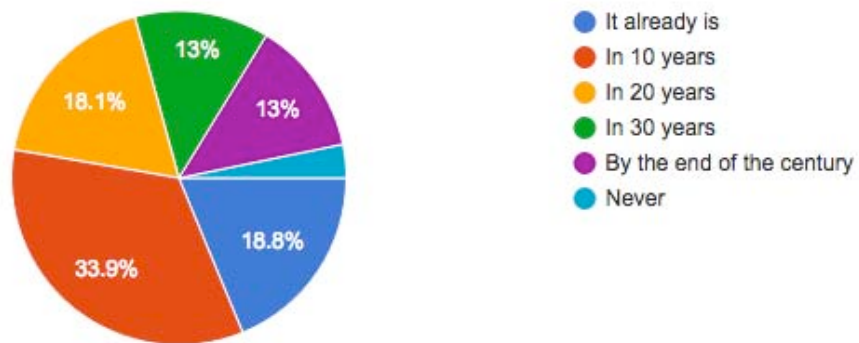
Are you concerned about sea level rise?

283 responses



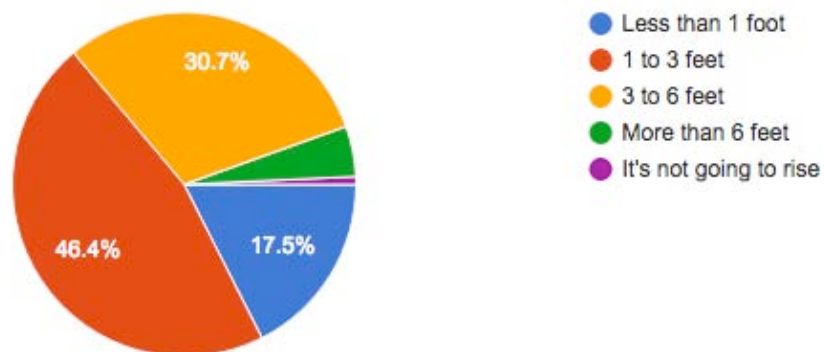
When do you think sea level rise will be a problem for Camden?

277 responses



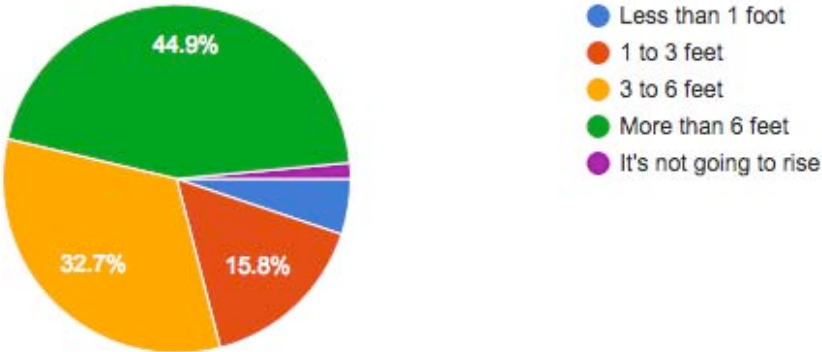
How much do you think sea level could rise in Camden by 2050?

274 responses



How much do you think sea level could rise in Camden by 2100?

272 responses



What do you think is causing sea level rise?

228 responses

This was a write in answer. Of the 228 responses,

177 (78%) said some combination of global warming, melting glaciers and ice caps and thermal expansion

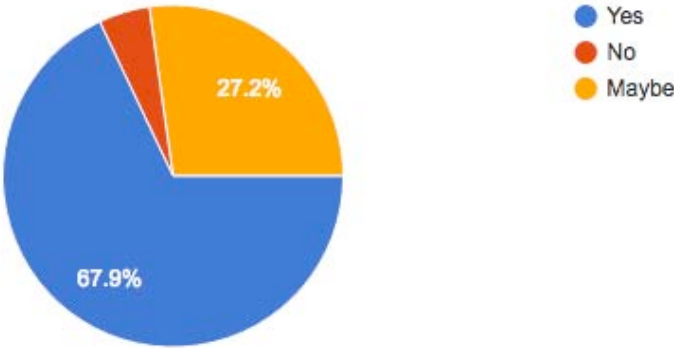
29 attributed it to other factors such as ozone, shifting continents, trash, ocean acidification, sunspots, earthquakes and pollution.

2 did not think the sea level was rising

14 didn't know or weren't sure

Do you think Camden should take measures to adapt to sea level rise?

268 responses



Do you think Camden should address the impacts of sea level rise and ways to adapt to it in the town's comprehensive plan?

267 responses

