



Island Structures Potentially Impacted by Sea Level Rise  
in the Land Use Planning Commission's Service Area

Maine Land Use Planning Commission  
October 2024

# Table of Contents

<b>Summary</b> .....	2
<b>Introduction</b> .....	3
<b>Background</b> .....	4
Understanding Development Patterns and Potential Impacts.....	4
NOAA’s Projected Sea Level Rise .....	4
Climate Change and Sea Level Rise Work in Maine.....	4
2023-24 Winter Storms.....	5
<b>Island Structure Analysis</b> .....	5
Methods.....	5
Coastal Island Structure Inventory.....	6
Structures Potentially Affected by Sea Level Rise.....	6
Results.....	6
Island Structure Inventory .....	6
Structures Potentially Affected by Sea Level Rise.....	6
<b>Discussion And Next Steps</b> .....	8
Implications.....	8
Limitations of the Analysis .....	9
Next Steps: .....	10
Outreach .....	10
Maintaining and Updating the Inventory .....	11
<b>Appendices</b> .....	12
Appendix One: Community Resources for Sea Level Rise .....	12
Appendix Two: Maps of Selected Island Communities.....	12
Map 1: Matinicus Isle .....	12
Map 2: Ragged Island.....	13
Map 3: Monhegan Island .....	14
Appendix Three: Images of Storm Damage Due to Coastal Flooding.....	15
Appendix Four: Detailed Methods.....	19
Understanding Island Topography.....	19
Identifying Island Communities and Creating a Structure Inventory .....	19
Applying Sea Level Rise Scenarios.....	20

## Summary

Under current emission levels of greenhouse gases, sea level is predicted to rise an average of ten to fourteen inches by 2050 and two feet by 2100. If emissions continue to climb, sea level rise may be as high as three to seven feet by 2100. The Maine Climate Council recommends that the state manage for 1.5 feet of sea level rise by 2050 and 3.9 feet by 2100 but points out that sea level rise could be as high as 3.0 feet by 2050 and 8.8 feet by 2100. To investigate the potential effects of sea level rise, the Land Use Planning Commission used data from remote sensing (LiDAR) of the Earth's surface and aerial imagery to determine the existence and location of structures on the 321 coastal islands in the Commission's service area.

This Coastal Island Structure Inventory located 854 structures across 42 of the islands. Maps of these islands showing the locations of these structures were overlaid with maps showing the predicted extent of ocean waters under sea level rise scenarios running from 1 foot to 10 feet. Six islands were found to have structures that will potentially be encroached by sea water with 2 feet or less of sea level rise. An additional three islands have structures that will potentially be encroached upon with up to 4 feet of sea level rise. Overall, 24 islands have structures that are predicted to be encroached by sea water with up to 10 feet of sea level rise, and 18 islands are predicted to have no structures that will be encroached by up to 10 feet of sea level rise.

A few points are important to keep in mind about this study:

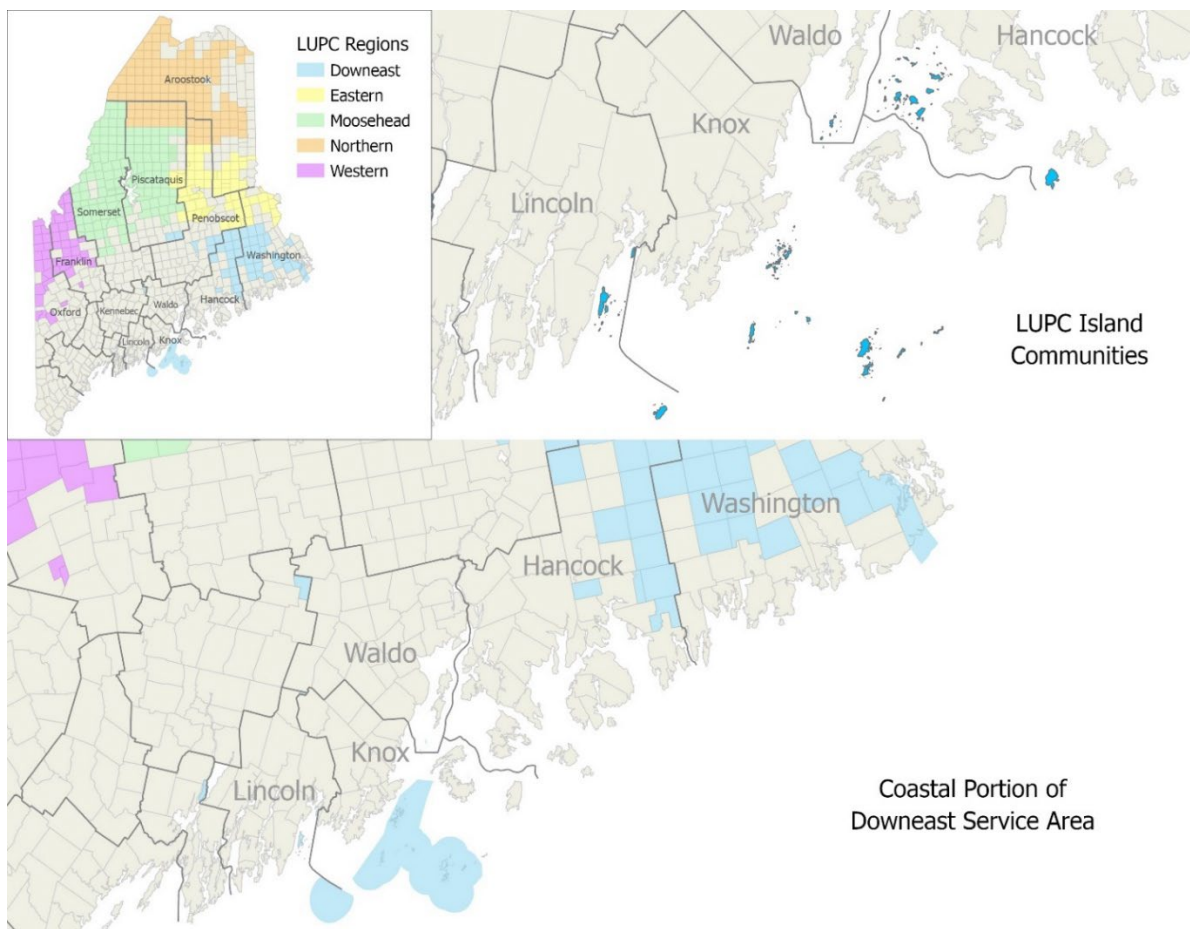
1. Transportation infrastructure such as wharves, piers, airstrips, and roads, which may be vital to island communities, was not included in the study;
2. The study does not account for the greater extent of flooding and more severe effects of storms at higher sea levels; and
3. The structure inventory may not include all island structures.

The Land Use Planning Commission will use the results of this study to guide outreach to property owners, residents, and regional organizations providing assistance to coastal island communities. Outreach efforts may include sharing the information in this report, and perhaps further analysis where helpful, but would primarily focus on learning from local and regional partners what strategies they hope to pursue to mitigate the effects of sea level rise and the associated increase in damage from storms and flooding.

## Introduction

Sea level rise affects coastal communities and offshore islands in the Maine Land Use Planning Commission’s (LUPC or the Commission) service area. To better understand these effects, LUPC staff completed an inventory of structures on coastal islands and compared this inventory with maps of predicted sea level rise. This report presents the results of this analysis. Commission staff hope to use this report in outreach and discussion with residents and property owners, with the idea of identifying strategies to mitigate the impacts of sea level rise and identifying potential regulatory barriers to implementing those strategies. It is important to keep in mind that this analysis reflects potential effects of sea level rise alone and does not account for the greater effects of storms at higher sea levels.

The Maine Land Use Planning Commission is part of the Bureau of Resource Information and Land Use Planning within the Department of Agriculture, Conservation and Forestry.<sup>1</sup> The LUPC is responsible for planning, zoning, permitting, and code enforcement for unorganized and deorganized areas of the state. The LUPC serves just under half of the state, encompassing approximately 10.5 million acres and including numerous coastal islands. Planning for such a large area is challenging, especially when considering the effects of climate change.



<sup>1</sup> Maine Land Use Planning Commission: [www.maine.gov/dacf/lupc/](http://www.maine.gov/dacf/lupc/)

## Background

### Understanding Development Patterns and Potential Impacts

In the summer and fall of 2023, the Commission, in partnership with the Margaret Chase Smith Policy Center at the University of Maine, hosted an internship to create a structure and infrastructure inventory (the inventory) for coastal islands in the LUPC's service area. Commission staff sought to better understand which islands have structural development and whether that development might be impacted by predicted sea level rise. The resulting maps include approximate structure locations on all coastal islands in the LUPC's service area and depict which structures will experience some level of encroachment based on sea level rise projections (but not reflecting potential vulnerability resulting from storms at higher sea levels). Commission staff hope to use this information to help prioritize outreach and collaborative efforts with local partners to mitigate the effects of sea level rise.

### NOAA's Projected Sea Level Rise

The National Oceanic and Atmospheric Administration (NOAA) is a federal agency providing data, tools, and services that support work to protect environments and increase community resilience in the face of climate change. NOAA has developed sea level rise predictions based on current and increased greenhouse gas emissions.<sup>2</sup> Under current emission levels, sea level is predicted to rise an average of ten to fourteen inches by 2050 and two feet by 2100. If emissions continue to climb, sea level rise may be as high as three to seven feet by 2100.<sup>3</sup>

### Climate Change and Sea Level Rise Work in Maine

Due to the significant impacts that climate change is projected to have on communities and the environment, the Maine Climate Council (the Council) was created in 2019 by Governor Janet Mills and the Maine Legislature. The Council, made up of scientists, industry leaders, bipartisan state and local officials, and citizens, produced a report describing the impacts of climate change and providing strategies and plans for building community resilience. The Council recommends that the state commit to managing for 1.5 feet of relative sea level rise by 2050 and 3.9 feet by 2100 but also suggests that sea level rise could be as high as 3.0 feet by 2050 and 8.8 feet by 2100.<sup>4</sup>

In addition to NOAA and the Council, many public and private organizations provide support to communities planning for sea level rise. Some examples include the Federal Emergency Management Agency (FEMA), Maine Island Coalition, the Island Institute, The Nature Conservancy, Regional Planning Organizations, the Maine Department of Environmental Protection, the Maine Municipal Assistance Program, and the Maine Geological Survey (see [Appendix One](#) for a more comprehensive list). The Maine Emergency Management Agency and individual counties have also developed hazard mitigation

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<sup>2</sup> NOAA Sea Level Rise Portal: <https://oceanservice.noaa.gov/hazards/sealevelrise/>

<sup>3</sup> NOAA Sea Level Rise Technical Report: <https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>

<sup>4</sup> The Maine Climate Council and Maine Won't Wait Four Year Plan: [www.maine.gov/future/climate/council](http://www.maine.gov/future/climate/council)

plans to help communities prepare for and cope with hazards such as sea level rise.<sup>5</sup> The LUPC can contribute to managing projected sea level rise by engaging with Maine people and communities about climate impacts. The Commission can also work collaboratively with local communities to identify and permit projects that improve resiliency (e.g., improvements to infrastructure like wharves or breakwaters).

## 2023-24 Winter Storms

In the winter of 2023-2024, storms along the entire coast of Maine resulted in high winds, high tides, and significant stormwater runoff. The resulting flooding and other effects were enormously destructive to public and private property, businesses, homes, and infrastructure (roads, utilities, wharves, breakwaters, etc.) and necessitated a Presidential declaration of a major disaster.

Efforts to recover from these storms and repair vital infrastructure are ongoing. Commission staff are assisting residents and officials of Monhegan Island Plantation and Matinicus Isle Plantation with permitting repairs from storm damage and planning development projects that increase community resiliency. [Appendix Three](#) includes pictures gathered by the Monhegan Volunteer Fire Department that show some of the damage on Monhegan.

While the analysis in this report does not account for the projected effects of storms at higher sea levels, there is a relationship between the two: the higher the sea level, the more structures are likely to be damaged by storms and the more severe that damage is likely to be.

## Island Structure Analysis

### Methods

Commission staff, with assistance from the Margret Chase Smith intern, used ArcGIS Pro to develop maps displaying the overlap between areas projected to be affected by sea level rise and the locations of structures on coastal islands in the LUPC's service area.<sup>6</sup> Data were obtained from NOAA's Digital Coast: Data Access Viewer<sup>7</sup>, United States Geological Survey's (USGS) LiDAR Explorer Map<sup>8</sup>, Microsoft's Bing Maps Building Footprints<sup>9</sup>, and the USDA's National Agriculture Imagery Program (NAIP).<sup>10</sup> The Commission's permitting data, some additional data collected as part of past planning projects, and

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<sup>5</sup> State Hazard Mitigation Plan: [www.maine.gov/mema/hazards/natural-hazard-mitigation](http://www.maine.gov/mema/hazards/natural-hazard-mitigation); e.g., Knox County Hazard Mitigation Plan:

[www.knoxcountymaine.gov/county\\_departments/emergency\\_management\\_agency/hazard\\_mitigation\\_plan\\_page.php](http://www.knoxcountymaine.gov/county_departments/emergency_management_agency/hazard_mitigation_plan_page.php)

<sup>6</sup> Maps throughout this report were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit [www.esri.com](http://www.esri.com).

<sup>7</sup> NOAA Office for Coastal Management. Sea Level Rise Inundation-1 – 10 ft. (2024). NOAA office for Coastal Management. Available at: <https://coast.noaa.gov/digitalcoast/data/slr.html>

<sup>8</sup> U.S. Geological Survey. ME MidCoast (2021). Department of the Interior. Available at: [Index of /vdelivery/Datasets/Staged/Elevation/metadata/ME\\_MidCoast\\_2021\\_B21](#)

<sup>9</sup> Microsoft. Building Footprints – Feature (2022). Esri. Available at: <https://hub.arcgis.com/datasets/esri::microsoft-building-footprints-features/about>

<sup>10</sup> U.S. Department of Agriculture. ME NAIP Imagery (2023). U.S. Department of Agriculture. Available at: <https://nrsc.app.box.com/v/naip/folder/242446943225>

other information available through sources such as the Maine Office of GIS (MEGIS) helped inform the inventory. The most valuable information available for completing the inventory was aerial imagery.

See [Appendix Four](#) for more detailed information on analysis methods. LiDAR is a remote sensing method that uses light energy to measure the Earth's surface.

### Coastal Island Structure Inventory

LiDAR data were used to generate detailed maps of island terrain to locate structures, roads, and other development. The locations of structures and infrastructure were then refined by comparing them with structures and infrastructure shown on aerial imagery of the islands. Ultimately, this inventory of development identified:

- Islands in the LUPC's service area with structures;
- The number and location of structures on each island;
- The elevation of each structure; and
- Each structure's proximity to the coastline.

### Structures Potentially Affected by Sea Level Rise

The locations of island structures and infrastructure were overlaid on NOAA's maps of sea level rise. The sea level rise maps show how far inland sea level is projected to rise above the mean high-water mark along coastlines. Maps are available for zero to ten feet of sea level rise in one-foot increments.<sup>11</sup>

On islands with significant amounts of development, or significant overlap between the inventory and NOAA's projections, the staff further refined the locations of structures by mapping the footprints of buildings rather than treating buildings as single points. Building footprints allow for more accurate analysis because they show the space a building occupies and therefore may overlap with a projected sea level rise scenario before a point. (See [Appendix Four](#) for more information.)

## Results

### Island Structure Inventory

There are 321 coastal islands in the LUPC's service area ranging in size from approximately 400 square feet to over two square miles. 53% of these islands are under 1 acre in size, and 83% are under 10 acres. The inventory identified 854 structures on 42 of these islands. The islands with the highest number of structures are Monhegan Island (271) and Matinicus Isle (260). Islands and island groups with less than 100 structures include the Hancock County group of islands (79), Lincoln County group of islands (84), Muscle Ridge Township (70), Ragged Island (57), and the Knox County group of islands (28).

### Structures Potentially Affected by Sea Level Rise

Of the 854 structures mapped on coastal islands, 156 structures (18%) are likely to experience some level of encroachment by sea water between one and ten feet of sea level rise (Table 1). Twenty-four coastal islands contain structures that will potentially experience encroachment, and eighteen coastal

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<sup>11</sup> NOAA Digital Coast Sea Level Rise Viewer Frequently Asked Questions:  
<https://coast.noaa.gov/data/digitalcoast/pdf/slr-faq.pdf>

islands contain structures that are not projected to experience encroachment with up to 10 feet of sea level rise (Tables 1 through 4).

Islands with the largest number of potentially affected structures include Matinicus Isle (35), Ragged Island (28), and Monhegan Island (22) (see detailed structure maps in [Appendix Two](#)). Structures on each of these islands are projected to be affected by relatively small amounts of sea level rise. On Ragged Island, for example, four structures are likely to be affected by a sea level increase of one to two feet, and 15 structures are likely to be affected by a sea level increase of three to four feet. As sea level rises, the proportion of structures expected to experience encroachment generally increases significantly. On Matinicus Isle, for example, 29 of the 35 potentially affected structures (83%) are projected to first experience encroachment between five and ten feet of sea level rise. On Monhegan, the number is 19 out of 22 (86%). Because Ragged Island is relatively low lying, a greater proportion of structures is expected to be first affected by up to four feet of sea level rise (15 out of 28, 54%) than by five to ten feet of sea level rise (13 out of 28, 46%).

**Table 1.** Islands with structures that will potentially be affected under current sea level rise projections.

County	Island	Jurisdiction	Total Structures	Number of Structures First Affected at Sea Level Rise					Total Affected
				1-2 ft.	3-4 ft.	5-6 ft.	7-8 ft.	9-10 ft.	
Hancock	Bear Island	Hancock County Island	9	1		1	1		3
Hancock	Eagle Island	Hancock County Island	40	1	1	2		1	5
Hancock	Great Spruce Head Island	Hancock County Island	20			1	1		2
Hancock	Pumpkin Island	Hancock County Island	4			1			1
Hancock	Scott Island	Hancock County Island	2			1			1
Hancock	Scrag Island	Hancock County Island	4		1		2		3
Knox	Andrews Island	Muscle Ridge Twp	10	1	1	1	4	2	9
Knox	Dix Island	Muscle Ridge Twp	10			1		2	3
Knox	Flag Island	Muscle Ridge Twp	1				1		1
Knox	Great Pond Island	Muscle Ridge Twp	3				1	2	3
Knox	Hewett Island	Muscle Ridge Twp	22			3	1	1	5
Knox	Lasells Island	Knox County Island	10		1		2	1	4
Knox	Little Green Island	Muscle Ridge Twp	1					1	1
Knox	Matinicus	Matinicus Isle Plt	260	2	4	9	10	10	35
Knox	Metinic Island	Knox County Island	18			1	5	1	7
Knox	Mink Island	Muscle Ridge Twp	4					2	2
Knox	Pleasant Island	Muscle Ridge Twp	12				1	2	3
Knox	Ragged Island	Criehaven Twp	57	4	11	8	2	3	28
Knox	The Neck	Muscle Ridge Twp	7				1	3	4
Knox	Wheaton Island	Matinicus Isle Plt	5				1	1	2
Lincoln	Indian Island	Lincoln County Island	1				1		1
Lincoln	Louds Island	Lincoln County Island	73		1	4	1	1	7
Lincoln	Marsh Island	Lincoln County Island	10			1	1	2	4
Lincoln	Monhegan Island	Monhegan Island Plt	271	1	2	4	10	5	22

**Table 2.** Islands on which 100 percent of the structures are predicted to be vulnerable with up to 10-foot sea level rise.

County	Island	Jurisdiction	Total Structures	Number of Structures First Affected at Sea Level Rise					Total Affected
				1-2 ft.	3-4 ft.	5-6 ft.	7-8 ft.	9-10 ft.	
Knox	Flag Island	Muscle Ridge Twp	1				1		1
Knox	Great Pond Island	Muscle Ridge Twp	3				1	2	3
Knox	Little Green Island	Muscle Ridge Twp	1					1	1
Lincoln	Indian Island	Lincoln County Island	1				1		1

**Table 3.** Islands with structures that experience encroachment with four feet or less of projected sea level rise.

County	Island	Jurisdiction	Total Structures	Number of Structures affected at Sea Level Rise					Total Affected
				1-2 ft.	3-4 ft.	5-6 ft.	7-8 ft.	9-10 ft.	
Hancock	Bear Island	Hancock County Island	9	1		1	1		3
Hancock	Eagle Island	Hancock County Island	40	1	1	2		1	5
Hancock	Scrag Island	Hancock County Island	4		1		2		3
Knox	Andrews Island	Muscle Ridge Twp	10	1	1	1	4	2	9
Knox	Lasells Island	Knox County Island	10		1		1	1	3
Knox	Matinicus	Matinicus Isle Plt	260	2	4	9	10	10	35
Knox	Ragged Island	Criehaven Twp	57	4	11	8	2	3	28
Lincoln	Louds Island	Lincoln County Island	73		1	3	1	1	6
Lincoln	Monhegan Island	Monhegan Island Plt	271	1	2	4	10	5	22

**Table 4.** Islands on which all known structures are unlikely to be affected by projected sea level rise.

Island	County	Jurisdiction	Total Structures
Bar Island	Hancock	Hancock County Island	2
Barred Island	Hancock	Hancock County Island	2
Beach Island	Hancock	Hancock County Island	7
Birch Island	Hancock	Hancock County Island	1
Butter Island	Hancock	Hancock County Island	6
Eaton Island	Hancock	Hancock County Island	1
Hog Island	Hancock	Hancock County Island	4
Horse Head Island	Hancock	Hancock County Island	1
Little Spruce Head Island	Hancock	Hancock County Island	5
Fisherman's Island	Knox	Muscle Ridge Twp	1
Graffam Island	Knox	Muscle Ridge Twp	1
Large Green Island	Knox	Knox County Island	15
Little Green Island 2	Knox	Knox County Island	1
Matinicus Rock	Knox	Matinicus Isle Plt	4
Otter Island	Knox	Muscle Ridge Twp	3
Two Bush Island	Knox	Muscle Ridge Twp	2
Manana Island	Lincoln	Monhegan Island Plt	2
Swan Island	Sagadahoc	Perkins Twp Swan Island	10

## Discussion And Next Steps

### Implications

The Coastal Islands Structure Inventory identifies the islands in the LUPC's service area with structural development. It can also be used to determine which structures are likely to be encroached by rising seas. For example, Ragged Island, Bear Island, Eagle Island, Matinicus Isle, and Monhegan Island all have at least one structure that will be vulnerable to sea level rise of 1-2 feet (Table 3), which is predicted by 2050 (26 years) under current emission levels. If sea level rises to three feet by 2050, additional structures and islands will be affected (see Table 1). In creating the inventory, the staff also noted infrastructure that may be at risk, such as airstrips, breakwaters, wharves, or vulnerable road segments, but that information has not yet been incorporated into the inventory.

Commission staff will use the information in this report to help prioritize outreach and assistance to people who live and work on these coastal islands as they upgrade buildings and infrastructure and take actions to mitigate the effects of sea level rise. The report may also be useful background for local or regional partners seeking resources from federal and state government, or other private foundations or funding sources, to complete projects that may increase a community's resiliency to the effects of climate change.

Ultimately, various adaptation and mitigation strategies may be needed, depending on location and circumstances. Some examples of adaptation strategies that could occur on coastal islands include:

- Natural or green infrastructure projects<sup>12</sup> (such as establishing or re-establishing dunes and wetlands);
- Shoreline stabilization or living shoreline projects;
- Upgrading transportation infrastructure (culverts, bridges, wharves, breakwaters, roads, airstrips, etc.);
- Elevating structures; and
- The managed retreat of structures to higher ground.

### Limitations of the Analysis

The inventory and accompanying maps showing sea level rise scenarios are useful in identifying where structures are located on coastal islands in the LUPC's service area and in understanding which structures may be vulnerable to sea level rise under certain scenarios. However, the analysis is limited in these ways:

- Coastal events and hazards such as storm surge, wave action, king-tides, and stormwater runoff are not included. Such events can have destructive effects beyond those predicted from sea level rise alone. The analysis does not show which structures may be affected by these events. The interaction between sea level rise and weather is already being felt by island communities during significant storms such as those that occurred during the winter of 2023-2024.
- Marine infrastructure such as breakwaters and wharves have not yet been included in the inventory unless a building also existed in the same location. The staff have noted where there appear to be significant implications for marine infrastructure but will ultimately rely on local knowledge and expertise to characterize the risk from sea level rise, especially when identifying necessary upgrades. For example, some wharves may already be elevated above predicted higher sea levels and may not be as vulnerable to inundation as indicated by mapped sea level rise scenarios.
- For many islands, points were used to represent the locations of structures and sometimes infrastructure. Consequently, whether a particular amount of sea level rise encroaches on a structure is dependent on when the sea level rise map overlaps with a structure's location point, not the footprint of an actual building. In a few example locations (e.g., islands like Monhegan or Matinicus, where there is significant existing development), building footprint maps were generated to improve the accuracy of the results.
- Aerial imagery is an imperfect tool for locating structures because it is dependent on what can be seen from above. The results of the inventory have not been verified on the ground. For example, vegetation or image imperfections can "hide" a structure, preventing it from being included. There are likely structures that were obscured in this way. Conversely, some activities, such as the storage of fishing gear, can resemble a structure when seen in aerial imagery. Finally, aerial imagery only captures conditions when the photo was taken. As we work with

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<sup>12</sup> NOAA's description of natural infrastructure: <https://coast.noaa.gov/data/nationalfacts/pdf/hand-out-natural-infrastructure.pdf>.

communities, we may discover additional structures. These will be added to the Coastal Islands Structures Inventory as time allows.

- It is impossible to determine the land use of a particular structure based on its appearance from above. Therefore, the inventory only shows where structures are located and does not capture their use.

## Next Steps:

### Outreach

The staff will use the results of this report to guide outreach over the next year to property owners, residents, and regional organizations providing assistance to coastal island communities. Outreach efforts may include sharing the information in this report, and perhaps further analysis where helpful, but would primarily focus on learning from local and regional partners what strategies they hope to pursue to mitigate the effects of sea level rise and the associated increase in damage from storms and flooding.

Questions LUPC staff have for property owners or local leaders on coastal islands include:

1. What effects of sea level rise are people most concerned about in your community? (e.g., intensifying storms, flooding, erosion, power outages, etc.)
2. Which structures or infrastructure are most at risk?
3. Where should the community focus its resources to build resilience and mitigate the effects of sea level rise and storms?
4. How best can the LUPC provide assistance?

The answers to these questions will help identify if there are potential regulatory barriers or other considerations for a particular approach. For example, some communities have already indicated that they intend to work on raising the height of common marine infrastructure such as wharves and breakwaters. Because this may be a common issue for multiple islands, the Commission staff plans to develop materials covering permitting procedures, best practices, and other helpful topics.

The staff seeks to focus outreach efforts on Ragged Island because of the potential effects of sea level rise on marine and transportation infrastructure on the island (see Appendix 2, Map 2), and on Matinicus Isle and Monhegan Island due to the large number of structures potentially affected. Matinicus and Monhegan are plantations, and their local governments provide a mechanism for engaging with residents and property owners. Working with property owners on islands that lack local government, such as Ragged, Louds, Bear, Eagle, and Scrag may be more difficult. These islands have structures that will experience some level of encroachment with a sea level rise of up to four feet, which is likely to occur within 20 years.

Structures represent one aspect of community infrastructure that should be considered for potential impacts from sea level rise. Also of concern is the potential effect on transportation infrastructure (roads, bridges, airstrips, wharves), community water supplies, and natural resources that protect communities from flooding (wetlands, sand dunes). This work is only the first step in understanding potential impacts and engaging island communities in planning for sea level rise.

Due to limited time and resources, coastal island communities were the focus of this report, but the Commission staff plan to conduct similar analyses for other coastal communities using the methods described in this report.

#### Maintaining and Updating the Inventory

The inventory currently focuses on structures. Commission staff may update the inventory as additional information becomes available and as time and staff resources allow. This information could come from the community and stakeholder outreach described above or through improved access to data. Beyond updating the location of structures, new types of information could be added to the inventory which would be helpful in analyzing potential vulnerabilities and planning for the future. Some examples include:

- Locations of roads;
- Ferry facilities and airstrips or landing areas;
- Utilities such as electrical distribution lines, water lines, and sewer lines; and
- Expanding the structure inventory and mapping to mainland communities in Trescott Township and Edmunds Township.

## Appendices

### Appendix One: Community Resources for Sea Level Rise

#### **Gulf of Maine Research Institute**

[Helping Coastal Maine Communities Adapt](#)

#### **Knox County**

[Hazard Mitigation Plan](#)

#### **Lincoln County**

[Hazard Mitigation Plan](#)

#### **Maine Coastal Program**

[Tidal Restriction Areas](#)

#### **Maine Department of Environmental Protection**

[Maine Climate Hub](#)

[Maine Adaptation Toolkit](#)

#### **Maine Geological Survey**

[Sea Level Rise Viewer](#)

[Property Owners Guide to Erosion, Flooding, and other Coastal Hazards](#)

#### **Maine Municipal Planning Assistance Program**

[Planning for Climate Variability](#)

[Municipal Climate Adaptation Guidance Series](#)

#### **Maine Natural Areas Program**

[Potential Tidal Marsh Migration Map](#)

#### **Maine Sea Grant**

[Coastal Community Resilience](#)

#### **NOAA**

[Sea Level Rise and Coastal Flooding Risk](#)

#### **The Island Institute**

[Sea Level Rise Resources](#)

#### **State of Maine Governor's Office of Policy and Innovation**

[Community Resilience Partnership](#)

[Grant Opportunities](#)

[Maine Climate Council](#)

#### **The Nature Conservancy**

[Coastal Resilience Tool](#)

#### **United States Federal Government**

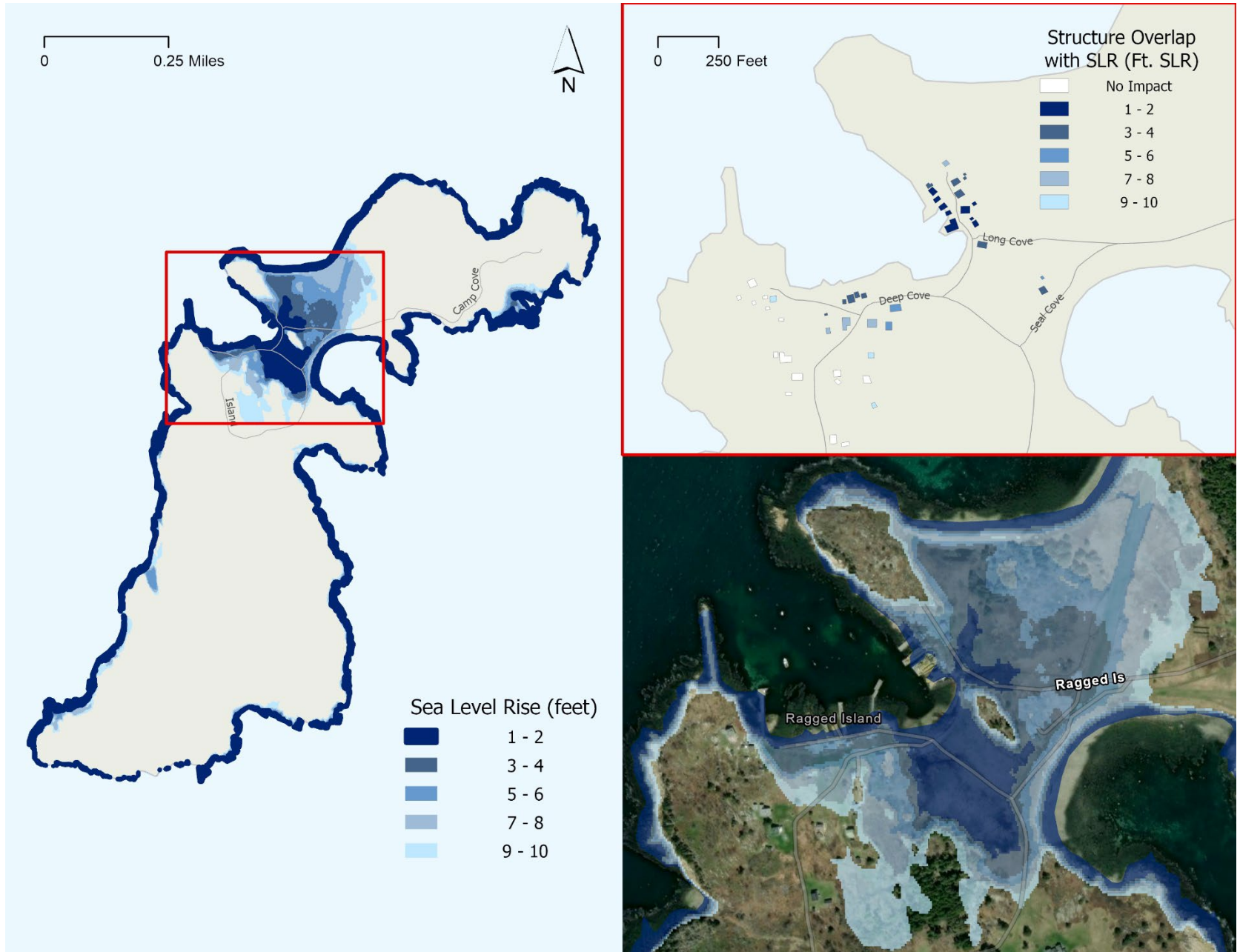
[U.S. Climate Resilience Toolkit](#)

#### **University of Maine Cooperative Extension**

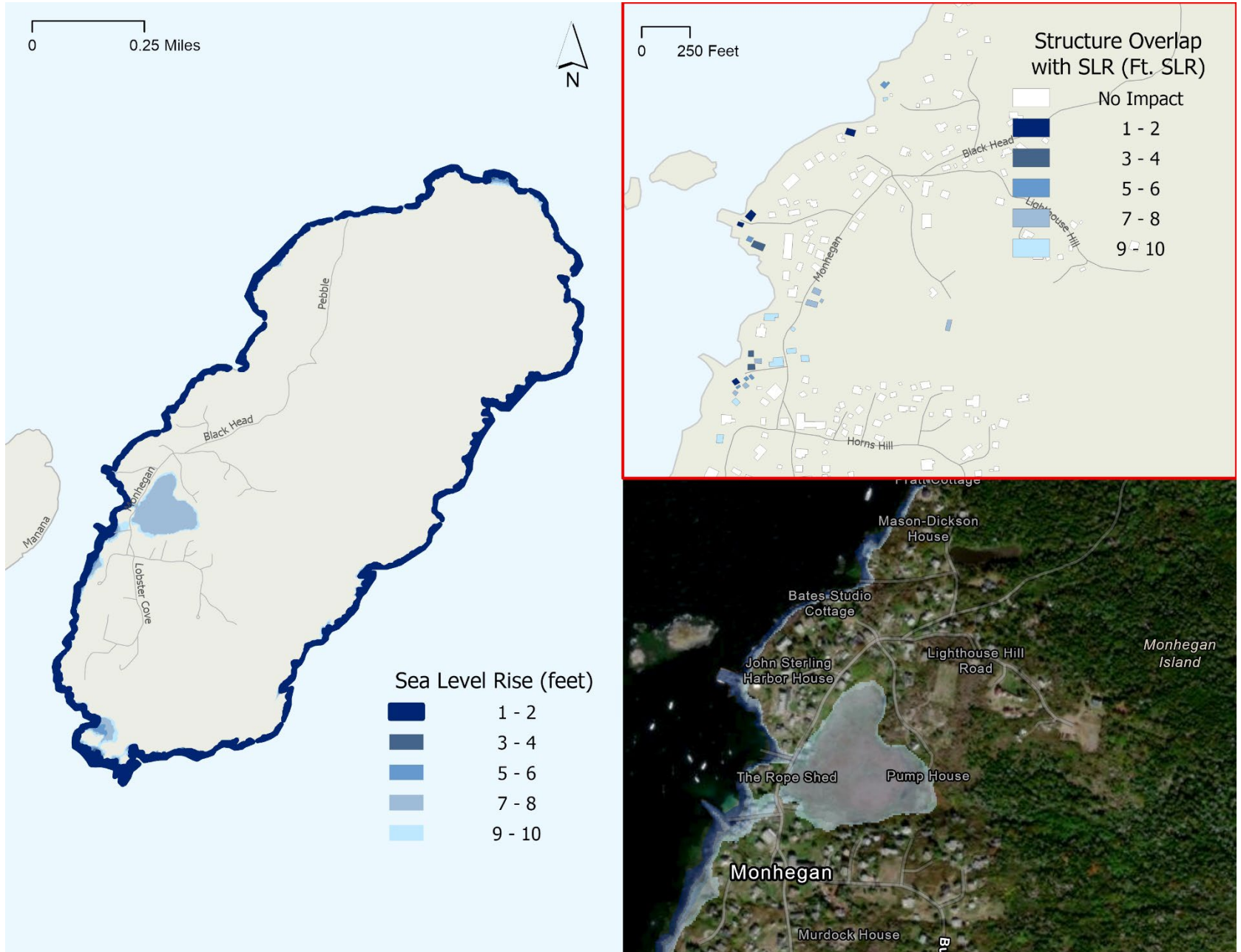
[Maine Community Resilience Workbook](#)



Map 2: Ragged Island



Map 3: Monhegan Island



Appendix Three: Images of Storm Damage Due to Coastal Flooding<sup>13</sup>



*Fish Beach, Monhegan Island*



*Harbor Breakwater and Damaged Building, Monhegan Island*

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<sup>13</sup> Photos courtesy of the Island Institute and Jes Stevens (Monhegan Volunteer Fire Department)



*Public Wharf and Freight Shed, Monhegan Island*



*Public Wharf and Freight Shed, Monhegan Island*



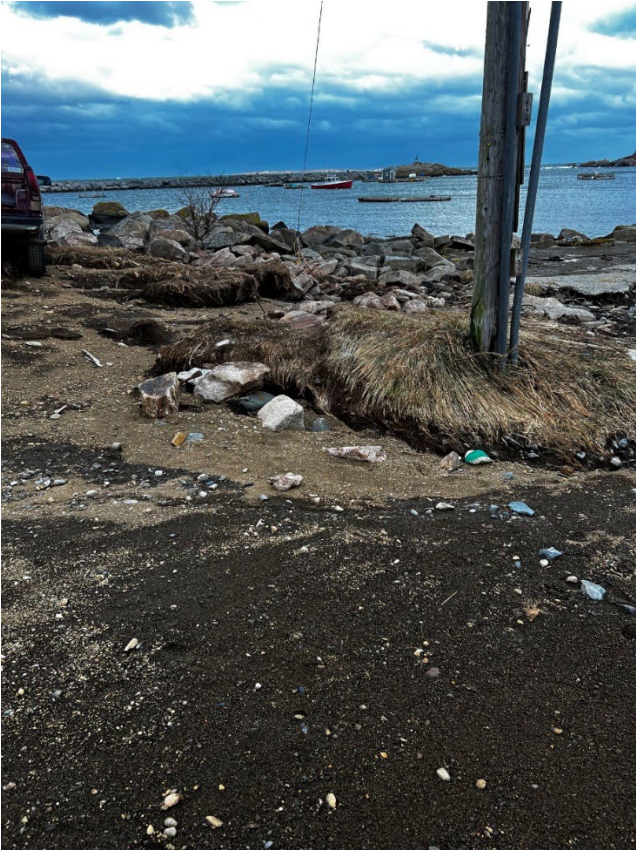
*Airstrip Erosion, Matinicus Isle*



*Shoreland Erosion, Matinicus Isle*



*Shoreland Erosion, Matinicus Isle*



*Shoreland Erosion (with Utility Pole), Matinicus Isle*

## Appendix Four: Detailed Methods

### Understanding Island Topography

Light Detection and Ranging (LiDAR) data are helpful in visualizing topography and land cover. These point cloud data contain the information necessary to create a three-dimensional representation of objects and surfaces. The analysis in the report utilized USGS's 2020 LiDAR data in LiDAR Aerial Survey (LAS) format.<sup>14</sup> These high-density data contain billions of LAS points that were filtered into different LAS datasets and then classified into their respective land cover types based on return values.

This LiDAR analysis allowed the creation of a Digital Elevation Model (DEM) referencing ground points and a Digital Surface Model (DSM) referencing first return points. Creating these models required converting the LAS dataset to a raster layer, creating a mosaic image, which allowed for faster data processing. The interpolation of the two LAS datasets resulted in two separate layers representing the bare-earth elevation (DEM) and the elevation of both natural and man-made features on the islands (DSM).

### Identifying Island Communities and Creating a Structure Inventory

To be certain that the analysis examined all the coastal islands in the LUPC's service area, staff checked the LUPC's Official Land Use Guidance Maps of coastal islands and other LUPC records against records from the Maine Revenue Service, records from the Federal Emergency Management Agency, and aerial imagery. No additional islands in the LUPC's service area were discovered in these other sources of data.

Given the large number of coastal islands in the LUPC's service area, more intensive spatial analysis was focused on those islands with numerous structures potentially affected by sea level rise. Information from 2021 NAIP imagery and from 2024 Google satellite imagery was used in combination with the DSM layer to identify the locations of structures.<sup>15</sup> All island structures are

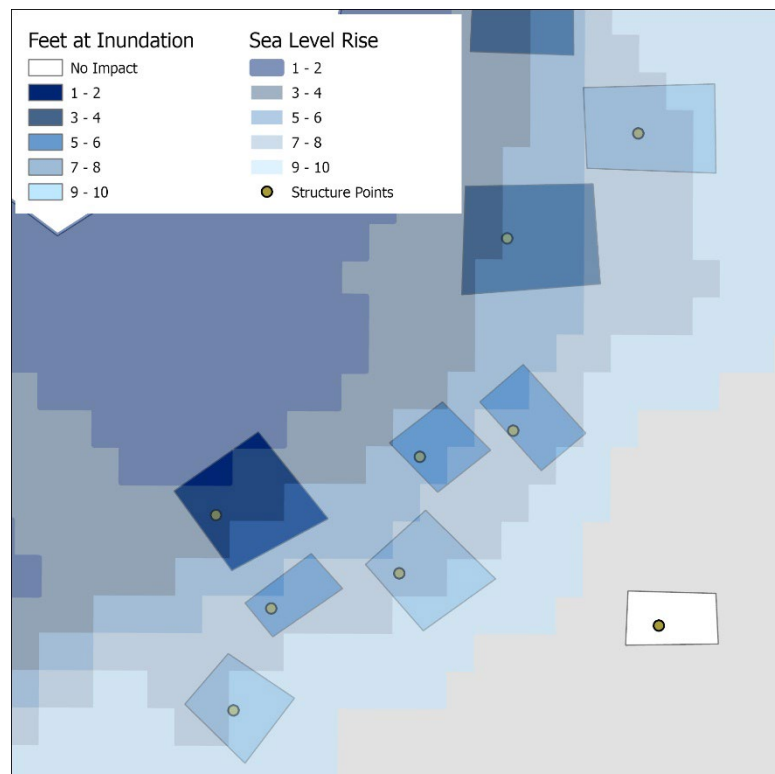


Figure 4.1. Depiction of point and polygon structure layers and point of intersection with sea level rise layers.

<sup>14</sup> U.S. Geological Survey. ME MidCoast (2021). Department of the Interior. Available at: [Index of /vdelivery/Datasets/Staged/Elevation/metadata/ME\\_MidCoast\\_2021\\_B21](#)

<sup>15</sup> U.S. Department of Agriculture. ME NAIP Imagery (2023). U.S. Department of Agriculture. Available at: <https://nrsc.app.box.com/v/naip/folder/242446943225>

represented in a point feature class containing the following information:

1. The number of structure-containing islands;
2. The number of structures on each island and their location;
3. The elevation of each structure; and
4. The nearest straight-line distance from each structure to the coast (“proximity”).

This Structure Inventory point layer provided adequate information to help staff understand the extent of structures vulnerable to sea level rise; however, the point model did not capture the actual area each structure occupies on the island. To address this issue, staff extracted Maine’s building footprint data from a national dataset created by Microsoft, and then modified it further to produce a new, more accurate structure footprint polygon layer.<sup>16</sup>

#### Applying Sea Level Rise Scenarios

The final step of the analysis involved overlaying NOAA’s Sea level rise data on the map of structures.<sup>17</sup> The sea level rise projections range from 1 foot to 10 feet, displaying levels of ground inundation based on elevation. Sea level rise projections were mapped using consecutive paired measurements of the data (i.e., 1-2 feet, 3-4 feet, etc.) and applying a monochromatic color scheme to display each scenario. As a result, staff can identify inundated areas and vulnerable structures by filtering layers and analyzing areas where sea level rise intersects with building footprints.

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<sup>16</sup> Microsoft. Building Footprints – Feature (2022). Esri. Available at: <https://hub.arcgis.com/datasets/esri::microsoft-building-footprints-features/about>

<sup>17</sup> NOAA Office for Coastal Management. Sea Level Rise Inundation-1 – 10 ft. (2024). NOAA office for Coastal Management. Available at: <https://coast.noaa.gov/digitalcoast/data/slr.html>