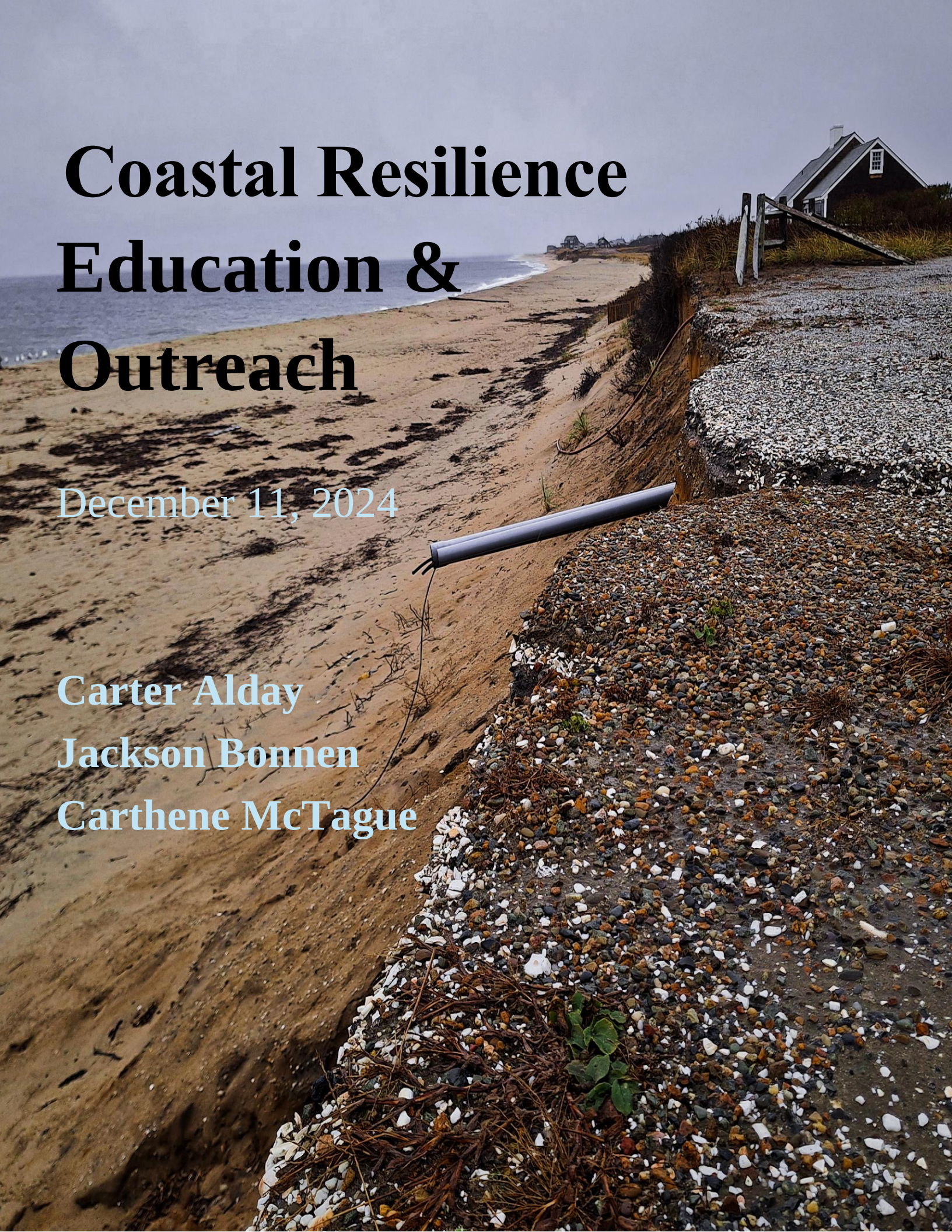


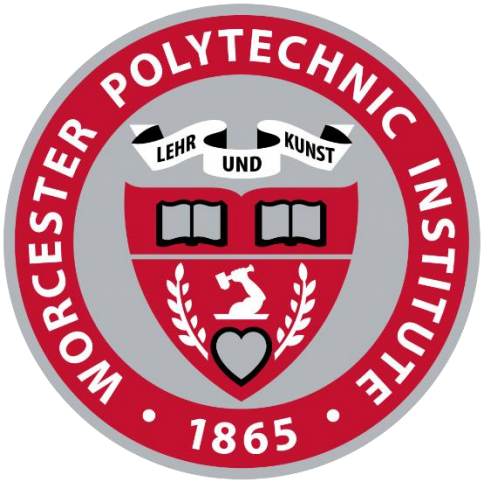
Coastal Resilience Education & Outreach

December 11, 2024

Carter Alday
Jackson Bonnen
Carthene McTague

Development of Education and Outreach Materials for Homeowner Coastal Resiliency

Nantucket Project Center
December 11, 2024



An Interactive Qualifying Project Report
Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the Degree of Bachelor of Science by

Authors
Carter Alday, Civil Engineering, 2026
Jackson Bonnen, Computer Science, 2026
Carthene McTague, Electrical & Computer Engineering, 2026

Submitted to

Sponsor
Nantucket Natural Resources Department

Liaison
Leah Hill

Advisors
Professor Melissa Belz, Ph. D.
Professor Dominic Golding, Ph. D.

Abstract

The Nantucket Natural Resources Department (NNRD) and the Coastal Resiliency Advisory Committee (CRAC) are responsible for increasing coastal resiliency on Nantucket through education and outreach. Through analysis of an island-wide survey and interviews with experts and homeowners, we identified effective outreach strategies and developed materials to inform homeowners of the options available to them in responding to coastal hazards such as erosion and flooding. Based on our findings we created recommendations on how the NNRD can increase the impact and reach of future outreach campaigns.

Executive Summary

Global sea level rise is a concern in coastal communities around the world, even more so in Nantucket, where the rate of sea level rise has exceeded the global average by about 20% over the last 70 years (NNRD, 2021, p. 62). “Over the next 50 years, with sea level rise, coastal flooding and erosion are expected to cause over $3.4 Billion in cumulative damages across the island” (NNRD, 2021, p. 74). Recognizing these risks, Nantucket’s Coastal Resilience Advisory Committee (CRAC) and the Nantucket Natural Resources Department (NNRD) prepared an extensive Coastal Resilience Plan (CRP), that lays out a long-term strategy to improve the island’s resilience to coastal hazards. A current focus of the NNRD is to explore effective outreach options for property owners to encourage them to take individual and collective actions to improve the resilience of their individual houses and the collective resilience of the communities in which they live.

The goal of this project was to develop strategies and materials the Nantucket Natural Resources Department can use to educate Nantucket property owners on the best practices to enhance resilience against coastal hazards. We identified three main objectives necessary to accomplish this goal:

1. Characterize Nantucket homeowner's concerns, attitudes, and opinions about coastal resilience
2. Evaluate current and best educational practices used to promote resilience to coastal hazards in coastal communities in Massachusetts
3. Create outreach strategy recommendations and prototype educational materials for the NNRD to use in promoting resiliency on Nantucket

Background

Coastal flooding is the most pervasive of the hazards faced by Nantucket, resulting in significant damage to homes, businesses, infrastructure, and local ecosystems. With just one inch of flooding, a structure’s flooring can be destroyed along with its walls, foundations, and electrical equipment, rendering that structure unlivable for an extended period of time (NNRD, 2021, p. 58). As seen in Figure A, most coastal flooding on Nantucket occurs on the western side of the island. Flooding impacts are predicted to expand inland as sea levels rise through 2070 (represented by the lighter blue sections in Figure A), resulting in a large increase in the number of structures, miles of roadway, and areas of protected land affected over the same period

Nantucket experiences coastal erosion along its entire coastline, with significant impact along the southern coast and Great Point barrier beach. Storm surges can cause significant changes through "episodic erosion." The erosion of Nantucket’s shores has been accelerated by sea level rise, as well as the increased frequency and intensity of storms due to climate change such that portions of Nantucket, particularly on the southern coast, have eroded over 100 ft inland in just the last ten years (NNRD, 2021, p. 58). As seen in Figure B, this acceleration is only going to continue, with a significant amount of coastline being eroded by 2100.

Figure A - Depicts the Risk and Extent of Coastal Flooding Through 2070 (NNRD, 2021, p. 59)

Figure B - Depicts the Predicted Coastline Recession Through 2100 (NNRD, 2021, p. 71)

The effective communication of coastal hazard risks and mitigation strategies requires overcoming significant barriers, including the complexity of research and public mistrust in government-led outreach (Altinay et al., 2023). This section outlines key strategies for improving education and outreach, with particular emphasis on framing, content delivery methods, and personal engagement.

Framing is a technique for presenting information that significantly impacts public perception and behavior. Two major framing methods are 'risk' and 'gain' framing. Risk-framed messages can induce fear and disengagement, whereas gain-framed messages emphasize the benefits of action and foster hope, certainty, and action. Risk framing has been the standard framing device for decades; however, it is being phased out due to indications that gain-based framing is preferable (Hine et al., 2016).

Having effective materials is an important factor in ensuring that messages reach their audience. There are three main types of educational material styles. 'Passive materials' such as brochures, newsletters, and broadcasts, are informative but rarely drive long-term action (Becker, J.S et al, 2012). 'Experiential events' such as town halls and interactive presentations, are more engaging but require repeated exposure to change perceptions (Becker, J.S et al, 2012). 'Anecdotal lessons' stemming from lived experiences were seen to significantly shape behavior, but often lead to reactive coping strategies rather than proactive adaptation. Blending passive and experiential approaches, created with a basis in the values and experiences of the community, offers the best opportunity to move communities from reactive responses to proactive adaptation (Elrick-Barr & Smith, 2022).

Effective education and outreach require personal engagement to build trust and address community-specific needs. Extension agents play a crucial role as public-facing representatives who provide tailored, one-on-one assistance while acting as bridges between government agencies, non-government organizations (NGOs), and local communities. Failing to understand the community can alienate audiences, limiting behavioral changes. Extension agents assist in keeping outreach campaigns aligned with community values.

By tailoring efforts to community needs and emphasizing collective, locally focused solutions, education programs can build trust, drive engagement, and inspire meaningful action to mitigate coastal hazards.

Methods

The Nantucket Natural Resources Department (NNRD) conducted an island-wide survey of homeowners to gauge public concerns about coastal hazards, determine current homeowner mitigation strategies, and assess how the NNRD might best help homeowners in the future. The survey had a total of 522 respondents. Out of those we focused on the Madaket supergroup (Madaket, Smiths Point, and Fishers Landing, n=77). Additionally, the team interviewed 13 homeowners (including three couples) from the Madaket area, both in person and virtually, to further understand community-specific attitudes and mitigation efforts. We interviewed 16 experts from 11 organizations across Massachusetts and Nantucket. These organizations were either non-government conservation organizations, non-government coastal resiliency focused organizations, or government agencies concerned with coastal resiliency planning.

Findings

Interviews with homeowners, as well as survey data, suggested that a sizable portion of the population of Madaket and Nantucket are concerned about coastal hazards. However, 22% of all survey respondents and 36% of the respondents from Madaket, as well as 8 of our 13 homeowner interviewees, were taking no action. From our interviews, we gleaned this may be, in part, because some believed they were too far inland for coastal hazards to affect them. Others

indicated they were confused about what was legally permissible for them to do to address coastal hazards affecting their properties.

In both our interviews with experts and homeowners as well as our survey analysis, we found that in-person events were the most successful outreach format. Experiential events were conducted by all conservation NGOs we interviewed. The purpose of experiential events is to develop a personal connection with the audience and form a deeper understanding of the work an organization conducts than is provided by passive outreach.

The organizations we interviewed used two main types of physical materials: newsletters and brochures. Brochures are physical materials primarily utilized as supplements to larger events on similar topic areas. Due to their smaller size, brochures are significantly limited in either the depth or breadth of information that can be contained within them. Newsletters are long-form physical materials primarily formatted as a collection of smaller articles. Every organization we interviewed has a newsletter of some kind. Newsletters differ in release cycles from monthly or weekly release cycles, to quarterly, biannual, or annual, and some organizations run short and long cycles simultaneously.

Conducting effective outreach campaigns entails a significant investment in staff time and resources. Our expert interviewees informed us that having an outreach coordinator was essential to their outreach efforts, all eleven organizations we interviewed have at a minimum one full-time staff member whose role is to manage public communications.

Recommendations

Considering that the NNRD needed immediately implementable materials to inform homeowners and that one of the top three most preferred options in the homeowner survey was a “best practices brochure for your home” we therefore created a brochure to convey homeowner options for adapting to coastal hazards. While our findings and background show that passive materials such as these are not as successful as other forms of outreach, particularly when used alone, they were found to be particularly useful in combination with experiential events. Brochures are important supplemental materials and can be used at open houses and tours that the NNRD already hold. Additionally, because the team received feedback from homeowners that the permitting process was complex and unclear, the team designed a permitting flow chart to guide homeowners through the process.

Forming partnerships with other organizations on and off the island would permit the distribution of work in planning an event, increasing the viability. Additionally, partnering with organizations the public already trusts will help bring more trust to the NNRD and increase visibility to the membership of the audience of those organizations.

While the recommendations noted here would significantly bolster the outreach performed by the NNRD, there are presently scarce resources to implement any of these recommendations, as they largely fall outside the purview of any of the NNRD’s current positions. The Coastal Resilience Coordinator at the NNRD is presently operating at her limit generating educational materials as well as organizing open houses.

The responsibilities of an outreach coordinator for the NNRD would include:

- The generation of brochures and newsletters to support outreach on the behalf of all the NNRD's divisions.
- Keeping homeowners informed on the implementation of the CRP.
- Continuing the development of best practices brochures.
- Handling the NNRD's social media.
    - Taking care of routine posts on platforms such as Instagram, Facebook, YouTube,
    - Creating short form media such as TikTok and Instagram Reels.
- Coordinating partnerships with organizations
- The creating content for, and scheduling of in-person events such as informational presentations and experiential events

ACKnowledgements

Dominic Golding

Melissa Belz

Leah Hill

Vincent Murphy

Nantucket Yacht Club

Youngs Bicycle Shop

Walter's Deli

Stubby's

Remain Nantucket

Our House

Roberta and Bill White

All our Homeowner Interviewees

All our Expert Interviewees

The fine people of Nantucket

Table of Contents

Table of Figures

List of Tables

Authorship List

Abstract	Author: Carter Alday	Editor: Carthene McTague
Executive Summary	Author: Carthene McTague & Carter Alday	Editor: All
1. Introduction	Author: Jackson Bonnen & Carter Alday	Editor: All
2.1 Coastal Hazards	Author: Carter Alday	Editor: All
2.2 Enhancing Resiliency	Author: Jackson Bonnen	Editor: All
2.3 Obstacles to Implementing Coastal Resiliency Measures	Author: Carthene McTague	Editor: All
2.4 Education & Outreach	Author: Carthene McTague	Editor: All
2.5 Summary	Author: Jackson Bonnen	Editor: All
3. Methodology	Author: Jackson Bonnen & Carthene McTague	Editor: Carthene McTague & Carter Alday
3.1 Characterize Homeowner Sentiments based on Interviews and Survey Data	Author: Carthene McTague	Editor: Carthene McTague & Carter Alday
3.2 Evaluate Practices Used in Coastal Communities in Massachusetts For Coastal Resiliency Education	Author: All	Editor: All
3.3 Create Prototype Materials and Strategy Recommendations for the NNRD	Author: Jackson Bonnen & Carthene McTague	Editor: Carthene McTague & Carter Alday
4.1 Homeowner Sentiment	Author: All	Editor: All
4.2 Presenting the Message	Author: Jackson Bonnen And Carthene McTague	Editor: All
4.3 Utilizing Different Education Material Formats	Author: Jackson Bonnen	Editor: All
5.1 Prototype Material Design	Author: Carter Alday & Jackson Bonnen	Editor: All
5.2 Hire full-time outreach staff member	Author: Carthene McTague & Carter Alday	Editor: Carthene McTague
5.3 Additional Partnerships with NGOs	Author: Carter Alday & Jackson Bonnen	Editor: Carthene McTague
5.4 Improve Social Media Presence	Author: Carter Alday & Jackson Bonnen	Editor: Carthene McTague
5.5 Create a Newsletter for the NNRD	Author: Carter Alday & Jackson Bonnen	Editor: Carthene McTague
6. Conclusion	Author: Jackson Bonnen	Editor: Carthene McTague
Appendix A: Experts Script	Author: Jackson Bonnen	Editor: Jackson Bonnen
Appendix B: Homeowner Residency Area	Author: Carthene McTague	Editor: Carthene McTague
Appendix C: Homeowner Interview Script	Author: Jackson Bonnen & Carter Alday	Editor: Carter Alday

Appendix D: Experts Interviewed	Author: Jackson Bonnen	Editor: Jackson Bonnen
Appendix E: Survey Community-Seasonality and Supergroup Composition	Author: Carthene McTague	Editor: Carthene McTague

1. Introduction

Global sea level rise is a concern in coastal communities around the world, even more so in Nantucket, where the rate of sea level rise has exceeded the global average by about 20% over the last 70 years (NNRD, 2021, p. 62). “Over the next 50 years, with sea level rise, coastal flooding and erosion are expected to cause over $3.4 Billion in cumulative damages across the island” (NNRD, 2021, p. 74). Recognizing these risks, Nantucket’s Coastal Resilience Advisory Committee (CRAC) and the Nantucket Natural Resources Department (NNRD) prepared an extensive Coastal Resilience Plan (CRP), that lays out a long-term strategy to improve the island’s resilience to coastal hazards. A current focus of the NNRD is to explore effective outreach options for property owners to encourage them to take individual and collective actions to improve the resilience of their individual houses and the collective resilience of the communities in which they live.

The goal of this project was to develop strategies and materials the Nantucket Natural Resources Department can use to educate Nantucket property owners on the best practices to enhance resilience against coastal hazards. We identified three main objectives necessary to accomplish this goal:

1. Characterize Nantucket homeowner's concerns, attitudes, and opinions about coastal resilience
2. Evaluate current and best educational practices used to promote resilience to coastal hazards in coastal communities in Massachusetts
3. Create outreach strategy recommendations and prototype educational materials for the NNRD to use in promoting resiliency on Nantucket

In this report, we discuss the background of the coastal hazards Nantucket faces, the mitigation strategies used to prevent the damage they cause, the obstacles to implementing these strategies, and finally the outreach and education strategies used to inform the public of this information. The methods section outlines our objectives and methods used to complete this project. The findings and recommendations section outlines key findings of homeowner concerns, as well as modern framing devices for coastal resiliency outreach and the importance of partnerships between organizations. The deliverables we produced included a pair of brochures detailing risk areas and viable mitigation strategies for erosion and flooding respectively.

2. Background

2.1 Coastal Hazards

Like many communities along the eastern seaboard of the United States, Nantucket is increasingly concerned with the growing risks of coastal erosion and flooding due to global climate change. In response to these concerns, the town of Nantucket tasked the Coastal Resilience Advisory Committee and the Nantucket Natural Resources Department (NNRD) to produce a strategy document, the Coastal Resilience Plan (CRP). The goal of the CRP is to "create a community-supported roadmap to implementation for a series of layered flood control and adaptation approaches that lessen the loss from storm surges and help the community adapt to rising seas and eroding coastlines" (NNRD, 2021, p. 29). The CRP was developed through extensive community engagement including "detailed project briefings and interviews with 150+ staff and community members across 22 departments, boards, commissions, and organizations" and engaging the Nantucket residents directly through two virtual public open houses, each of which had over 130 attendees (NNRD, 2021, p. 44).

Based on data and projections from the Intergovernmental Panel on Climate Change and the National Oceanic and Atmospheric Administration, the CRP estimates that the Nantucket mean sea level will rise 4.2 feet by 2100 (NNRD, 2021, p. 65). Rising sea levels, increases in storm size, frequency, and intensity, as well as changing tides associated with climate change will significantly increase coastal flooding and erosion.

The CRP estimates that "from now through 2070, 2,373 structures are at risk from coastal flooding and erosion, with the cumulative expected annual damages totaling $3.4 Billion, including direct physical damage to buildings, anticipated direct and induced economic disruption to businesses, direct social disruption, including relocation costs, health costs from injuries and mental stress, and lost income due to health issues, and Federal, State, and local tax impacts" (NNRD, 2021, p. 70). As seen in Figure 1, these impacts are unevenly distributed across the island, with most building damages occurring in the downtown area. Figure 1also shows that while residential properties comprise 84% of the 2,373 structures at risk, they will account for 59% of the damages (NNRD, 2021, p. 70).

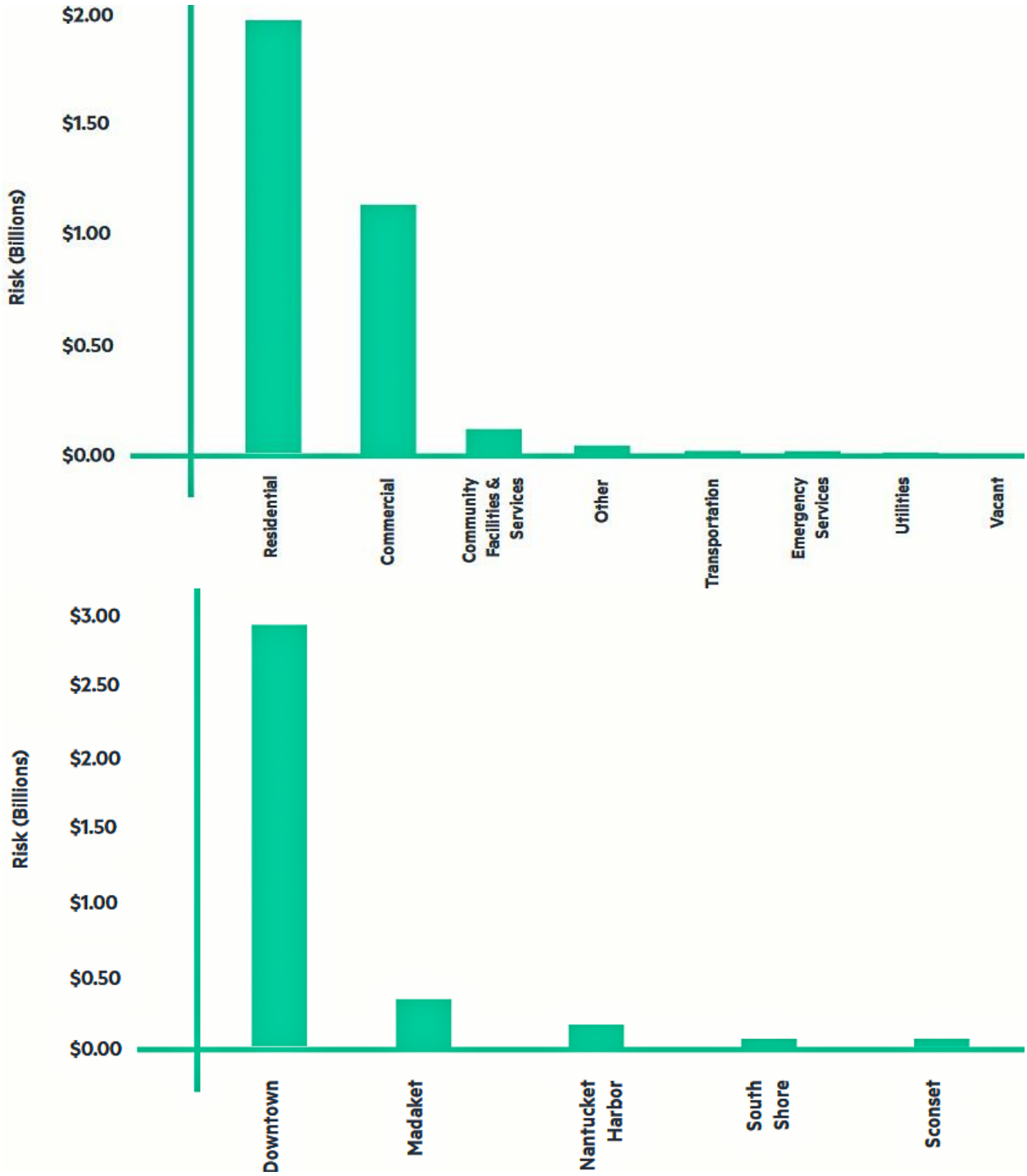


Figure 1 - Value of Buildings and Structures Damaged by Location (top) and Use Category (bottom) (NNRD, 2021, p. 70)

2.1.1 Coastal Flooding

Coastal flooding is defined by the CRP as "The inundation of low-lying land by seawater, often as a result of storm surge" (NNRD, 2021, p. 50). As seen in Figure 2, most of the coastal flooding on Nantucket occurs on the western side of the island. However, there are still large pockets near Polpis and Sconset.

Figure 2 - Depicts the Risk and Extent of Coastal Flooding Through 2070 (NNRD, 2021, p. 59)

Coastal flooding is the most pervasive of the hazards faced by Nantucket, resulting in significant damage to homes, businesses, infrastructure, and local ecosystems. With just one inch of flooding, a structure's flooring can be destroyed along with its walls, foundations, and electrical equipment, rendering that structure unlivable for an extended period (NNRD, 2021, p. 58).

Table 1 - Projected Exposure of the Island to Coastal Flooding in the Years 2030, 2050, and 2070. 2070 (NNRD, 2021, p. 58)

Island-Wide Exposure to 1% Annual Chance Coastal Flood						
	2030*		2050*		2070*	
	# Exposed	% Island-Wide	# Exposed	% Island-Wide	# Exposed	% Island-Wide
Structures	1,051	8%	1,253	10%	1,518	12%
Roadway Loss of Service (miles)	40	15%	46	17%	54	20%
Protected Open Space (acres)	2,871	16%	3,356	18%	3,937	22%

*decades shown based on data availability, not consistent across coastal hazards

Flooding impacts are predicted to expand inland as sea levels rise through 2070 (represented by the lighter blue sections in Figure 2), resulting in a large increase in the number of structures, miles of roadway, and areas of protected land affected over the same period, as seen in Table 1.

2.1.2 Coastal Erosion

Coastal erosion is the gradual loss of land along a shoreline due to the removal of sand, rocks, and other sediment by waves, currents, and tides. As depicted in Figure 3 Nantucket experiences coastal erosion along its entire coastline, with significant impacts especially along the southern coast and Great Point barrier beach.

Figure 3 - Depicts the Predicted Coastline Recession Through 2100 (NNRD, 2021, p. 71)

Storm surges can cause significant changes through "episodic erosion." The erosion of Nantucket's shores has been accelerated by sea level rise, as well as the increased frequency and intensity of storms due to climate change such that portions of Nantucket, particularly on the southern coast, have eroded over 100 ft inland in just the last ten years (NNRD, 2021, p. 58). As seen in Figure 3, this acceleration is only going to continue, with a significant amount of coastline being eroded by 2100. Similarly to coastal flooding, this will result in a significant increase in the number of structures, roadways, and protected land being exposed to erosion risks, as seen in Table 2. In the case of exposed structures, an over seven-fold increase is expected.

Table 2 - Island-Wide Exposure to Coastal Erosion, 2030-2100 (NNRD, 2021, p. 60

Island-Wide Exposure to Coastal Erosion						
	2030*		2050*		2100*	
	# Exposed	% Island-Wide	# Exposed	% Island-Wide	# Exposed	% Island-Wide
Structures	113	1%	329	3%	860	7%
Roadway Loss of Service (miles)	6	2%	12	4%	33	12%
Protected Open Space (acres)	312	2%	678	4%	1,754	10%

2.1.3 High Tide Flooding

High tide flooding (also called nuisance flooding) is a prevalent coastal hazard in downtown Nantucket, an example of which is depicted in Figure 4. Nuisance flooding overwhelms storm drains, leading to the closure of roads and disruption of businesses (NNRD, 2021, p. 58).

Coastal flooding in Downtown Nantucket, December 2020 (photo by Vince Murphy)

Figure 4 - Nuisance Flooding in Downtown Nantucket 2020 (NNRD, 2021, p. 58)

A 2020 town report noted that Easy St. had experienced a sixfold increase in tidal flooding frequency in just the past 40 years. Additionally, the data suggests that a water level of 1.1 feet Mean Higher High Water or greater may occur, on average, every week by 2030, resulting in further nuisance flooding (Larson, 2020).

2.1.4 Groundwater Table Rise

Groundwater is the saturated zone below grade, the surface of which is called the ‘water table’. As depicted in Figure 5, on islands like Nantucket, rising sea levels force the water table to rise to the point that groundwater may saturate the surface and cause ponding.

Figure 5 - Groundwater Emergence on Brant Point, November 2020 (NNRD, 2021, p. 68)

Global sea level rise is a concern in coastal communities around the world, even more so in Nantucket, where the rate of sea level rise has exceeded the global average by ~20% over the last 70 years (NNRD, 2021, p. 62). This, as previously described, will cause a large increase in groundwater table rise. Although groundwater table rise is not as pervasive a problem in Nantucket as coastal and nuisance flooding, it increasingly threatens soil instability, infiltrates underground utilities, and can pose public health threats if sewage backfill and runoff seeps into homes and other public locations, such as schools (NNRD, 2021, p. 62).

2.2 Enhancing Resiliency

As sea level rise continues to increase the risk posed by various coastal hazards, it only becomes more important to take action to reduce the damage these hazards cause. As illustrated in Figure 6, the CRP outlines three approaches to enhance coastal resiliency: Protect (or 'build with the sea'), Adapt (or 'live with the sea'), and Relocate (or 'move away from the sea'). The tools to achieve these strategies range from structural to non-structural.

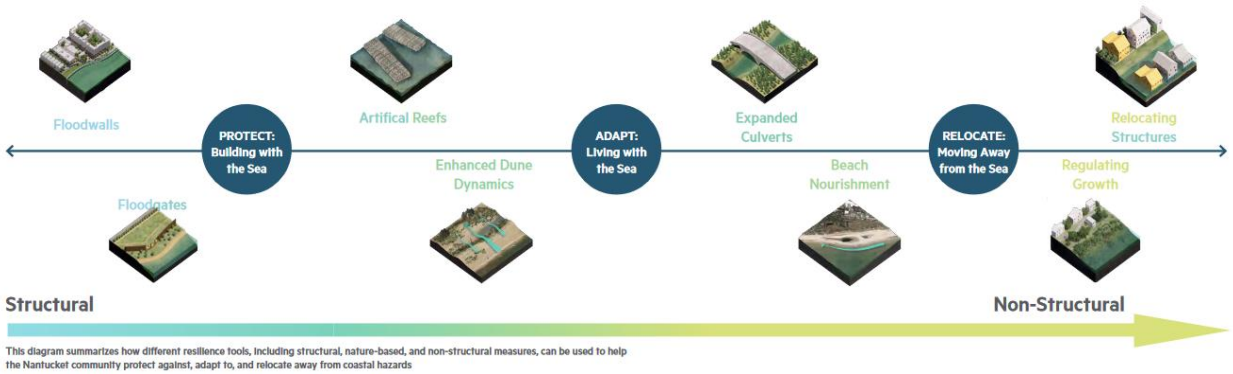


Figure 6 - Diagram of Coastal Resiliency Approaches (NNRD, 2021, p. 15)

2.2.1 Protection Strategies

Protection strategies improve coastal resiliency by "implementing approaches that seek to keep water out, reduce its force, or to minimize erosion" (NNRD, 2021, p. 78). These strategies directly combat coastal hazards, barring floodwaters from entering protected areas, preventing waves from crashing against vulnerable coastlines, etc. The approaches that fall under this distinction are primarily hard structures.

Hard structures have historically been very popular, in part due to Nationwide Permit 13 allowing property owners to establish their own coastal hard structures without requiring notice to the U.S. Army Corps of Engineers (USACE) (Brandon, 2016). This has resulted in an estimated 17,500 hard structure projects completed between 2012-2017 alone (USACE, 2012). The purpose of most hard structures is to protect the coast behind the structure from being severely impacted by flooding and erosion (Kraus, 2024). They accomplish this by dispersing or deflecting coastal forces before they contact the area to be protected. Common approaches include sea walls, sea dikes, and sea groins. While these approaches are relatively effective at protecting the area immediately behind the structures, they have several negative effects.

First, hard structures destroy the beach areas on which they are installed, an effect known as "placement loss" (Brandon, 2016). Second, because hard structures only deflect or disperse coastal forces, improper construction can cause increased damage to neighboring areas. An example of this is "scouring". When wave energy is dispersed by a sea wall, the wave energy impacting neighboring unprotected coastlines may be increased, increasing erosion (Kraus, 2024). This does not mean that hard structures such as seawalls should never be used; however, they require more careful implementation than historically believed (Basco, 2006).

2.2.2 Adaptation Strategies

Adaptation strategies intend to mitigate the effects of coastal hazards by "implementing approaches that reduce or slow the impacts of flooding and erosion" (NNRD, 2021, p. 79). These strategies are most effective when protection strategies are infeasible or unwanted, and thus, the effects of coastal hazards are unavoidable. Adaptation strategies include primarily soft structures and architectural adaptations.

The term 'soft structures' refers to anti-erosion structures formed by the addition of sediment to a coastline (Erisman, n.d.). Soft structures have become more popular in recent times as the deficiencies of hard structures become more apparent (Griggs, 2024). Soft structures can reverse

the previous effects of erosion, unlike hard structures, when the rate of sedimentation outpaces the rate of erosion (Linham & Nicholls, 2010). An illustrative example of a soft structure is dune stabilization.

Dune stabilization functions by artificially promoting the formation of natural dune structures. There are several approaches to accomplish this, including constructing fences to capture sediment blown away by wind, planting native vegetation to stabilize the existing sediment, or simply placing new sediment (Linham & Nicholls, 2010). Dunes are a natural method of storing sediment on a coast to alleviate the effects of erosion, and with proper management, can significantly protect a coastline against erosion. However, if the dunes are not monitored and maintained, the formation will eventually fall apart, so dune stabilization, like most other soft structures, requires consistent maintenance to be an effective method long term (Linham & Nicholls, 2010).

There is a wide variety of coastal resiliency-focused architectural adaptations but comparatively sparse literature covering them (Javeline & Kijewski-Correa, 2019). Because of this, the Massachusetts Homeowner's Handbook and CRP are the primary sources for this section. Architectural adaptations have a few shared benefits, those being their relatively low cost, small scale, and simplicity. These traits allow these approaches to be implemented by individual property owners without external assistance. Architectural approaches are less effective against erosion; however, they primarily focus on mitigating flooding risks. Architectural adaptations focus on one of two resiliency approaches: prevention of water from entering the building (prevention approaches) or mitigation of damage caused by water entering the building (mitigation approaches). Figure 7 provides an overview of these architectural adaptations, delineating them by relative complexity.

Figure 7 - Resiliency Methods Available to Homeowners (NNRD, 2021, p. 130)

There are a diverse variety of prevention approaches available to homeowners; however, they all come with a shared downside. If they fail to prevent floodwater from entering the building, they do nothing to protect the interior and, in some cases, can even trap water inside, increasing the damage done. It is for this reason that it is advisable to combine these approaches with mitigation

approaches. Two common prevention approaches are structural elevation and dry floodproofing.

Structural elevation entails raising a building above the expected elevation of flooding in that area. When done properly, structural elevation can significantly mitigate the effects of flooding if not outright prevent them. There are faults, however. This approach can be very expensive to implement on existing buildings, and as flood elevation increases, the efficacy will decrease. These faults lead to elevation being a more complex method to implement, as seen in Figure 7.

Dry floodproofing is a group of approaches that prevent damage by sealing floodwater outside of the building. This includes building with water-resistant materials, applying waterproof coating to exterior walls, reinforcing walls against pressures induced by floodwater, etc. (Murphy & Taylor, 2020). These approaches are relatively cheap and simple, and in the ideal case, they completely prevent damage from flooding. However, as discussed before, the failure of these approaches can increase flood damage by trapping water in the interior. Thus, it is best to combine these approaches with mitigation approaches. Like structural elevation, these faults lead to an increased implementation complexity, as noted in Figure 7.

Mitigation approaches also vary widely. Mitigation approaches reduce damage caused by flooding but do not prevent it. Two examples of mitigation approaches are appliance elevation and wet floodproofing.

Appliance elevation is, simply, the elevation of appliances within the building above expected floodwater elevation. This includes the elevation of expensive, important, permanent installations such as washing machines, ovens, and electrical outlets to protect them from damage (Murphy & Taylor, 2020). This targeted protection of the costliest objects to replace is relatively simple and cost-effective. Due to its simplicity in implementation and lack of faults, appliance elevation is considered a relatively simple approach, as represented in Figure 7.

Wet floodproofing is a group of approaches that mitigate damage by directing floodwaters out of or into designated building areas. One such approach is the installation of barriers around appliances, particularly those that may be difficult to elevate. Another wet floodproofing approach is flood vents. Flood vents are designed to allow floodwaters to flow between specific areas, rerouting water away from areas containing valuables or equalizing water pressure on both sides of a barrier to prevent it from being breached (Murphy & Taylor, 2020). Both barrier construction and flood vents are considered simple architectural adaptations, as seen in Figure 7.

2.2.3 Relocation Strategies

Relocation strategies intend to avoid the damage caused by coastal hazards by “retreating from coastal risks” (NNRD, 2021, p. 79). This is accomplished through a policy that stops development in areas affected by hazards or promotes the removal of existing assets in at-risk areas. The most common relocation strategies are coastal setbacks and coastal retreat.

Coastal setbacks are a policy in which a buffer zone is established between an affected coast and human development (Nichols & Bruch, 2008). Setbacks are an inexpensive alternative to other mitigation strategies. Rather than protecting endangered assets, setbacks prevent new development in high-risk areas to avoid the cost of protective measures and repairs in the future. The main downsides of setbacks are the prevention of development in the setback area and the need for periodic re-evaluation of the setback area (Harman et al., 2015). As the coastline erodes,

the distance between the high-water line and human development will shrink, and so setbacks must be re-evaluated to ensure the buffer zone effectively protects developed areas from coastal hazards (Harman et al., 2015).

Coastal retreat, also referred to as managed retreat, is the systematic withdrawal from the coastline through the abandonment or relocation of coastal assets that are endangered by coastal hazards (Alexander 2012). Coastal retreat trades the loss of already existing coastal assets or the cost to relocate them from endangered areas with the future costs of the coastal protection implementations needed to otherwise protect them (Abel et al., 2011). It also, similarly to coastal setbacks, protects the natural habitat and coastline from the negative effects of human development (Harman et al., 2015). However, coastal retreat is still a relatively expensive resiliency method and tends to face pushback from the public (Uiterwyk & Starbuck, 2023).

2.3 Obstacles to Implementing Coastal Resiliency Measures

Many mitigation strategies are available to homeowners to combat the coastal hazards their properties face. However, several obstacles can shrink a dauntingly large array of options to a painfully small one. For example, permitting and zoning laws can restrict the types of mitigation strategies that can be implemented (NNRD, 2021, p. 95). Additional difficulties come in the form of community approval of projects, as well as the willingness of individual homeowners to adopt mitigation strategies that benefit themselves without harming the community. Coastal resiliency projects can become highly unpopular with homeowners due to unsightly structures, significant project costs, or disagreement on best strategies. Awareness of these challenges is required to make feasible recommendations to homeowners.

2.3.1 Permitting and Zoning Constraints

When homeowners undertake construction or renovation, their project may be subject to permits from the town, State, or Federal government (NNRD, 2021, pp. 95–96). These permitting laws may require homeowners to demonstrate that their projects will not negatively impact the surrounding environment (MA CZM, 2021), along with other requirements based on the locality. Acquiring permits can be a significant legal hurdle with no guaranteed success, especially for smaller projects. The possibility of an open-ended legal struggle may outweigh the benefits of undertaking new construction to mitigate coastal hazards in the eyes of homeowners (McGuire, 2017, p. 7).

As mentioned in 2.2.1 Protection Strategies, Nationwide Permit 13, along with Massachusetts Chapter 91, can help ease regulatory burdens on homeowners when constructing hard structures along the waterfront but does not help with other methods such as soft structures or relocation of the personal residence. On Nantucket, homeowners may be required to seek permission from the Conservation Committee, depending on whether their structure exists in a wetlands buffer zone or another protected area (Conservation Commission, 2013). Additional permission will be required from the Nantucket Building Department, Health Department, Historic District Commission, Planning Board, and Zoning Board of Appeal to relocate or remove a structure on a property (Town of Nantucket, 2024).

2.3.2 Impacts of Public Sentiments and Concerns

Ensuring that there is broad and enduring support for projects is essential for their success. The CRP is an all-encompassing plan which greatly impacts the lives of homeowners. Therefore,

maintaining the public's support is imperative to its successful implementation: “By engaging a wide range of community groups in the process, the Town is ensuring that the CRP can move forward to implementation with broad input and support” (NNRD, 2021, pg. 11).

Maintaining public support will be a significant challenge for Nantucket to overcome. The Town of Nantucket must carefully balance several conflicting interests to acquire the necessary support to achieve the public works projects called for in the CRP. These interests include economic incentives, socio-political factors, sentimental attachments, and community engagement (Hanna et al., 2019).

The Town of Nantucket will always be constrained by the amount of money it can secure for its resiliency projects from taxes, grants, and federal or state funds. Projects undertaken by the town need to serve a large swathe of community members to gain support; as a result, they tend to be extremely costly and may take years, if not decades, to complete. Convincing taxpayers that a given resiliency project is more valuable than another police officer or teacher is a challenging proposition and requires a careful approach to the problem (Hanna et al., 2019).

2.4 Education & Outreach

Highly trained professionals perform the vast majority of research on coastal hazards and mitigation strategies, many with post-doctorate education or years of legal or engineering experience. As a result, the results of this research are largely inaccessible to the public in terms of comprehension and lack of familiarity with research databases (Lieske et al., 2014; Sterman, 2011). It is thus often the role of government and non-governmental organizations (NGOs) to disseminate coastal risk and resiliency information to the public. Unfortunately, it is still unclear what the best way to carry out this outreach is, with governments and researchers attempting various methods, from top-down informational campaigns to one-on-one interventions and assistance from extension agents. (Elrick-Barr & Smith, 2022; Lieske et al., 2014). This section provides a broad overview of methods that have shown success across the globe, as well as methods that have been ineffective or counterproductive.

2.4.1 Simplification

Coastal hazards, especially those exacerbated by climate change, are a field of intense and ongoing study. Most of these publications are aimed at engineers, scientists, and policymakers, resulting in publications consisting of dense and complex texts, incomprehensible to those who would benefit most from their findings. Communicators must distill this research into simple, concise, and actionable messages for lay people (Lieske et al., 2014).

While simplification may seem straightforward, many academics and professionals fail to successfully distill their message down to a point where the public can understand. The text needs to be put into simple language; jargon must be omitted or explained. A delicate balance must be made between talking down to the recipients and being too complex for them to grasp (Lieske et al., 2014). Text is not the only form of communication that must be simplified; it is also important to simplify graphics, especially those that assume an understanding of additional subject matter. Many graphs and plots used in research papers are complex and do not display the pertinent results in a self-evident fashion (Lieske et al., 2014).

To improve the intelligibility of simplified materials, Lieske recommends testing educational materials with their intended recipients in focus groups. The materials should be retested until

the language and graphics shown are easy to interpret, sufficiently engaging, and do not omit any important points that may need to be more thoroughly explained (Lieske et al., 2014).

2.4.2 Framing

To frame something is "to dispose, lead, incline (someone) to something" (Oxford English Dictionary, 2024).

Humans are susceptible to a number of inconsistent and emotional behaviors that impact their interpretation of information. "We make different decisions based on the way the data are presented…" (Lieske et al., 2014). Different structuring and presentation styles affect perceptions of its contents and subsequent behaviors. Therefore, communicators must pay close attention to not only what they are trying to share with the public, but also how they go about describing it.

Two main lenses have been found to have a significant impact on the audience's reaction to messaging on coastal resiliency and climate change. Hine found that whether communicators chose to frame coastal hazards in terms of the risks presented or the steps that could be taken to mitigate the hazards had a large impact on whether recipients took action to mitigate the hazards or not. It was observed that when educational materials focused on the risks posed to health, safety or property by coastal hazards, recipients were less inclined to mitigate those risks than they had been before consuming the educational material. This is believed to be the result of risk-centric framing generating a sense of hopelessness and uncertainty, which results in disengaging from educational materials or outright rejection of the risks to retain a sense of control over the situation (Hine et al., 2016).

In contrast, framing the issue in terms of 'gains', what benefits could stem from taking action, increased senses of hopefulness, certainty, and control in recipients of educational materials (Hine et al., 2016). Spence and Pidgeon noted that recipients of educational materials framed in terms of gains adopted the mitigation behaviors that were being recommended, demonstrating preference for "safety-oriented activity"; that is to say, actions directly intended to avoid bad outcomes (Spence & Pidgeon, 2010). While Haer agrees that it is important to put particular emphasis on the options available to the recipient of educational materials, they also made it clear that "…there is a threshold of perceived threat that needs to be overcome before households take protective measures", regardless of how informed they were as to their options (Haer et al., 2016). Taking this into account, it is best to use a strategy that strikes a balance between risk and gain framing, with risk grabbing attention through concern and then later framing around gains, assuaging those concerns in a motivational fashion.

Another framing device that has been shown to impact the behaviors of recipients of educational materials is framing actions through the lens of a collective effort to mitigate or adapt to climate change. As noted by Hine, framing mitigation efforts as a collective action instead of the individual's responsibility improved the audience's receptiveness to undertaking these efforts. "*The Day After Tomorrow* conveyed a sense of collective human responsibility among viewers, along with increased motivation and a sense of responsibility to take personal action" (Hine et al., 2016). While framing education materials around collective action increased its impact, focusing on local hazards and collective action was even more impactful when compared to focusing on actions and hazards at a global scale (Evans et al., 2014; Scannell & Gifford, 2013).

Scannell and Gifford also found that those with greater attachment to their locality demonstrated greater investment in climate change issues (Scannell & Gifford, 2013).

2.4.3 Private-Public Partnerships

Despite the extensive resources and experts at their disposal to disseminate information and encourage hazard mitigation, it is not unusual for interventions by government agencies to be met with distrust (Barra et al., 2020). This suspicion is only enhanced when the government spends meaningful amounts of time and money on measures that are later shown to have been unhelpful or counterproductive (Lorenzoni & Pidgeon, 2006). There are also limitations for how much assistance the government can offer by nature of its role as a neutral actor, such as limits on its ability to connect the public with legal, engineering, and private financial assistance that they will invariably require to implement their mitigation efforts. As a result, partnerships between government agencies and NGOs can expand the breadth of assistance and flexibility an outreach program can provide. NGOs can provide outside experts, positive connections with the public, and perspectives that the government could not recommend impartially (Altinay et al., 2023).

As noted by Lorenzoni and Pidgeon, the efforts of the government to incentivize coastal hazard mitigation and adaptation can be seen in a highly negative light, especially amongst communities that feel ignored or alienated by past actions taken by the government, even if they were made by an entirely separate part of the government regarding an entirely separate issue (Lorenzoni & Pidgeon, 2006). The trust and relationships that have been developed by an organization already embedded in a community cannot be easily reproduced, often requiring decades of concerted effort; thus, partnering with an external organization can greatly expand audiences' engagement with any outreach program the government may undertake (Walton & Swann, 2021).

Additional assistance from NGOs can come in the form of helping to connect homeowners with the legal, engineering, and fiscal resources required to successfully undertake a mitigation project. While there are often engineers and law firms available to file permits, survey plots, and conduct other related tasks, many homeowners feel disconnected from those resources. "Participants identified the social links that they perceived to be lacking among technical and nontechnical stakeholders and suggested the formation of partnerships for these key actors." (Altinay et al., 2023). While many government organizations are barred from directly recommending firms to homeowners by law or ethics, the government can still help facilitate the development of relationships between communities and NGOs.

Even in situations where the scope of outreach efforts is deemed satisfactory, forming partnerships to increase community engagement will result in more effective outreach than a purely government-led top-down outreach campaign of similar size. A 'top-down' or broadcast outreach campaign is where a singular entity, for example, a government department, pushes information outwards and it spreads through a community through its agents, activities, and established communication channels. In contrast, a 'grassroots' or people-centered outreach campaign starts at a wide base of the public, often from a large organization made up of members of the public, which then spreads organically out from there using the social networks of members of the community. Lieske suggests that both grassroots and top-down approaches are needed to engage the public in the process of adaptation to coastal hazards (Lieske et al., 2014). Strengthening the argument for the importance of grassroots or people-centered outreach programs, Haer found that a people-centered campaign where both mitigation and risk were

explained was much more effective in causing recipients to undertake hazard mitigation efforts than a top-down solely government lead approach. It was also found that even if the people-centered outreach campaign reached fewer people, the effectiveness would be greater than a top-down campaign (Haer et al., 2016).

2.4.4 Impacts of Educational Material Content and Styles

While there is a breadth of research into general scientific outreach and disaster communications, "little is known about the efficacy of different types of information in facilitating climate change adaptation, particularly in the coastal zone" (Elrick-Barr & Smith, 2022). While the efficacy of certain educational material contents is not yet substantiated in academic literature, a swathe of research has been undertaken to characterize the impacts of a variety of educational material styles and their content. From these known impacts, it is possible to shape educational materials to have the desired effect on audiences, even if the effectiveness of those materials is unclear.

Education materials can be categorized into one of three categories: 'passive materials', 'experiential events', and 'anecdotal lessons' (Elrick-Barr & Smith, 2022). Passive materials consist of literature that simply states risks, mitigation strategies, and other pieces of information for recipients to consume at their leisure; brochures, newsletters, radio broadcasts, and other forms of top-down media are passive (Becker, J.S et al, 2012). Experiential events consist of experiences, activities, or interactions with another person(s) to acquire information (Becker, J.S et al, 2012); informational presentations, town halls, nature hikes, and meetings with extension agents are experiential. Anecdotal lessons are not a form of outreach that is carried out by an organization, rather it is a result of the experiences of the recipients (Becker, J.S et al, 2012). Anecdotal lessons are the broadest of these categories and can range from seeing a neighbor raise their house to resist flooding, witnessing a house falling off a cliff due to erosion, or recalling that the sand fencing planted at the recommendation of the government was destroyed in a storm causing a large mess (Elrick-Barr & Smith, 2022).

Passive materials, experiential events, and anecdotal lessons affect human behavior differently. Elrick-Barr and Smith investigated the impacts of passive materials, experiential events, and anecdotal lessons to assess whether they had informed past actions, changed perceptions, or might inform future adaptation choices. They discovered that while homeowners found passive education materials valuable, they were not a driver of future adaptation. Elrick-Barr and Smith noted that for a passive information campaign to be broadly applicable, it should not be overly tailored to a specific audience as doing so reduces its applicability to the wider population (Elrick-Barr & Smith, 2022). Conversely, Haer cautions that past outreach campaigns failed to be effective or gain traction due to insufficient attention being paid to local concerns and situations (Haer et al., 2016). The result of these two requirements is a delicate balance in choosing appropriate messaging for an appropriately sized audience to maximize efficacy.

Elrick-Barr and Smith noted that experiential events have gained significant support and shown preliminary success amongst many organizations involved in coastal hazard communication. However, earlier research found that one-time exposure to experiential education activity has been unable to change perceptions of climate change and associated risks (Fernández-Giménez et al, 2015), a critical limitation of this method due to generalized reticence to repeat experiences. This reticence is the result of the increased time commitment, inconvenience, and potential boredom of engaging in an experiential education activity compared to consuming passive media

reduces the likelihood of repeat attendance compared to that of rereading a brochure (Elrick-Barr & Smith, 2022).

Perhaps unsurprisingly, anecdotal lessons also known as lived experiences, were found to be a strong indicator of individual responses to coastal hazards. Responses is used here instead of adaptation as Elrick-Barr and Smith found that the majority of responses to climate-related hazards were not a preemptive adaptation or long-term mitigation practices, but coping strategies that reduced only the most immediate impact of imminent hazards. Many also did not undertake collective action to adapt to their situations, despite noted preferences for materials framed through the lens of collective action, as noted by Hine (Elrick-Barr & Smith, 2022; Hine et al., 2016). As noted by Haer, "...previous studies have shown that there is a threshold of perceived threat that needs to be overcome before households take protective measures", Elrick-Barr and Smith would indicate the majority of that awareness is gained through anecdotal education, and resultantly it will be very hard to effect change in populations that do not regularly experience coastal hazards, even if they are soon to be threatened (Elrick-Barr & Smith, 2022; Haer et al., 2016).

Elrick-Barr and Smith conclude, based on current evidence that the majority of responses to coastal hazards are coping with hazards as they arise, the key to moving recipients of education materials away from coping to adaptation is through an effective balance of passive and experiential educational materials (Elrick-Barr & Smith, 2022).

2.4.5 Personal Connections

While there is immense power in private-public partnerships and in grassroots communication, much of the leg work to educate the public on coastal hazards is carried out by governmental organizations. Almost paradoxically the government is hamstrung in this effort at almost every level ranging from increasingly low public trust (Altinay et al., 2023), overreliance on internal experts to decide the direction of educational campaigns resulting in a mismatch between materials and the needs of the public (Lieske et al., 2014), to an overreliance on passive education materials due to logistical constraints (Haer et al., 2016). While there is no one size fits all solution, having effective and positive connections with the public at the personal and community level has been shown to remedy many of these issues.

A common failing in government outreach programs is not meeting the “[public] where they are at” (Pelletier & Sharp, 2008). This failure spans from fundamental misunderstandings of the beliefs and values of a community, misalignment between governmental objectives and those of the community, or inaccurate estimation of the awareness or engagement of a community on a particular issue. Government outreach programs surrounding coastal hazard risk and mitigation are not immune to these common misjudgments. Lieske found that the government often consults experts when attempting to build a coastal hazard education program, instead of directly interfacing with the public intended to benefit from the program, stunting its effectiveness (Lieske et al., 2014). Elrick-Barr and Smith further state that an outreach program must utilize the beliefs and values of the community to properly acquire their attention and engagement (Elrick-Barr & Smith, 2022). In a field that is still very much under development, a theme has still emerged that a personal connection is required between educators and their audiences. Lieske goes so far as to say, “Risk communication strategies will only be successful when they are informed by a thorough understanding of the public’s beliefs” (Lieske et al., 2014). Further alienation is possible when communication efforts fail due to a lack of engagement with

educational materials on the part of the recipient, and communicators believe the recipient was the cause of the failure, rather than an inability to tailor the messaging, a critical flaw (Hine et al., 2016). These issues can only be solved by both sufficiently integrating educators into the community and integrating the community into the development of outreach materials (Lieske et al., 2014).

The easiest way to combat perceptions of a lack of government understanding or engagement with a community is to have employees who interact directly with the public both in public and in private, on a daily basis. A prime example of such civil servants is ‘extension agents’. Extension agents function as a person who exists in the public sphere to provide both one-on-one and group assistance to homeowners to manage their unique situation, functionally acting as an extension of the department they represent beyond the walls of their office. Additionally, they often serve as the bridge between the public and private sectors, working to foster connections that permit better understanding and cooperation between each side (Altinay et al., 2023).

Extension agents often become the public face of local NGOs or government departments tasked with coastal hazard mitigation, making the government seem more personable and approachable. Trust only extends to the extension agents or departments, because of the personal connection, and does not transfer beyond to the government, serving to insulate grievances from other departments. Extension agents are often trained in effective communication for complex scientific and legal topics to be easily interpreted by a layperson, a key requirement for helping members of the public understand how to adopt mitigation strategies (Altinay et al., 2023; Lieske et al., 2014).

In-person interactions with an extension agent can provide the benefits of both experiential and passive educational materials, first coming from interactions with the agent themself, and then from materials provided by the agent for future reference such as brochures, maps, or charts. Unlike experiential events where audiences may only infrequently engage, homeowners may meet with an agent many times regarding just a singular issue, providing the repeated experiential education mentioned as critical by Elrick-Barr and Smith (Altinay et al., 2023; Elrick-Barr & Smith, 2022).

2.5 Summary

The coastal hazards affecting Nantucket will only worsen as climate change advances, with coastal erosion and flooding increasing the most significantly. While the NNRD understands the effectiveness of the various resilience methods and the path to implement them, individual homeowners remain in the dark. Because of this, education methods are still being refined, with different organizations conducting their own outreach in different manners. Thus, the NNRD tasked us with communicating with these organizations to understand what outreach methods have succeeded, determining what information Nantucket homeowners need to protect their property as well as how to get it to them, and finally synthesizing our findings into actionable recommendations for the NNRD.

3. Methodology

The goal of this project was to develop strategies and materials the Nantucket Natural Resources Department can use to educate Nantucket property owners on the best practices to enhance resilience against coastal hazards. We identified three main objectives necessary to accomplish this goal:

1. Characterize Nantucket homeowner's concerns, attitudes, and opinions about coastal resilience
2. Evaluate current and best educational practices used to promote resilience to coastal hazards in coastal communities in Massachusetts
3. Create outreach strategy recommendations and prototype educational materials for the NNRD to use in promoting resiliency on Nantucket

We used a mixed methods approach, including background research, analysis of existing survey data, and interviews with practitioners, policymakers, homeowners, and other stakeholders on and off Nantucket. Figure 8 summarizes the tasks associated with each of our objectives.

3.1 Characterize Homeowner Sentiments based on Interviews and Survey Data

Prior to arriving on Nantucket, the Nantucket Natural Resources Department (NNRD) conducted the Nantucket Homeowners Resilience Survey to collect data on coastal hazards affecting communities, the planned or implemented mitigation strategies of homeowners, and what assistance the NNRD could provide going forward. The survey initially received responses from November 14, 2023, through September 27, 2024. We then requested the survey be reopened to the public to increase the number of respondents from Madaket. The second period of responses to the survey went from October 23, 2024, through November 30, 2024. We analyzed the survey to provide a broader picture of Madaket and Nantucket's concerns, planned and implemented mitigation strategies, and desired assistance beyond what was discovered in homeowner interviews. Additionally, we investigated if those parameters had correlation with community or seasonality. We assessed the proportions of respondents out of the total sample size for each parameter, along with the conditional probability of relationships between concerns, mitigation strategies, and desired assistance. When working with the survey, we first removed any respondents who had not responded to questions beyond their community and seasonality. This prevented their responses from impacting the proportions of responses. Respondents were then sorted into categories based on their community and then on their seasonality. We ended up using 25 distinct community-seasonality (CS) groups for community-level analysis. Supergroups were also created by aggregating communities located close to each other. This was done to mitigate outliers in the data resulting from low CS group respondent counts with a target of having each Supergroup have at least 10% of the total sample size. This approach resulted in 5 supergroups, the compositions and populations of which can be found in Appendix E: Survey Community-Seasonality and Supergroup Composition. Responses in the other columns for Mitigation strategies and Assistance were then read for each respondent to see if responses were erroneously made there, e.g. 65 respondents wrote a version of “none” into the ‘other’ column for mitigation strategies, despite a provided option for none. Responses such as “?”, “survey

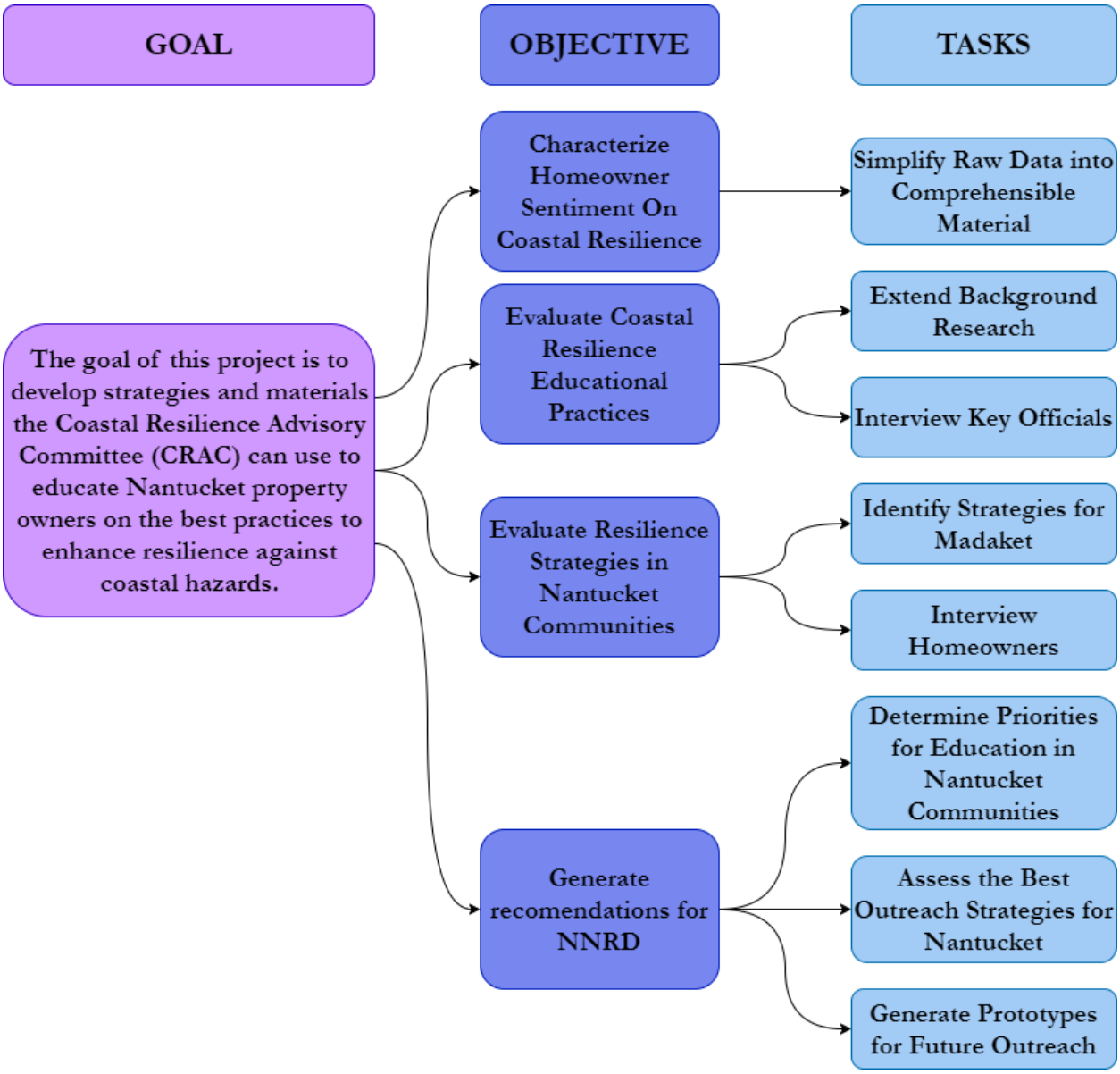


Figure 8 - Goals and Objectives Flowchart

unclear" and unrelated complaints against the NNRD or CRAC were also removed from the dataset to prevent contamination of their respective categories. Records of particularly salient responses in the "Other" columns were taken for quotation in the Findings. From there the team plotted the counts of responses from each CS group into plots of the concerns, mitigation strategies, and desired assistance. The Supergroups were also plotted this way. We then compared the responses of Madaket to those of Nantucket as a whole, as well as the other Supergroups. The team discussed differences in proportions of the population who responded to various categories as potential indicators of specific characteristics of Madaket that may warrant further attention.

When working with the survey, we first removed any respondents who had not responded to questions beyond their community and seasonality. This prevented their responses from impacting the proportions of responses. Respondents were then sorted into categories based on their community and then on their seasonality. We ended up using 25 distinct community-seasonality (CS) groups for community-level analysis. Supergroups were also created by aggregating communities located close to each other. This was done to mitigate outliers in the data resulting from low CS group respondent counts with a target of having each Supergroup have at least 10% of the total sample size. This approach resulted in 5 supergroups, the compositions and populations of which can be found in Appendix E: Survey Community-Seasonality and Supergroup Composition. Responses in the other columns for Mitigation strategies and Assistance were then read for each respondent to see if responses were erroneously made there, e.g. 65 respondents wrote a version of "none" into the 'other' column for mitigation strategies, despite a provided option for none. Responses such as "?", "survey unclear" and unrelated complaints against the NNRD or CRAC were also removed from the dataset to prevent contamination of their respective categories. Records of particularly salient responses in the "Other" columns were taken for quotation in the Findings. From there the team plotted the counts of responses from each CS group into plots of the concerns, mitigation strategies, and desired assistance. The Supergroups were also plotted this way. We then compared the responses of Madaket to those of Nantucket as a whole, as well as the other Supergroups. The team discussed differences in proportions of the population who responded to various categories as potential indicators of specific characteristics of Madaket that may warrant further attention.

We conducted interviews with 13 homeowners from Madaket, Smiths Point, and Fishers Landing covering the majority of the Madaket harbor area (specific area encompassed by Homeowners noted in Appendix B: Homeowner Residency Area), to understand their knowledge, attitude, and opinions surrounding their coastal hazard concerns, what mitigation strategies they may use or have used, their opinions of the Town and other on-island organizations, as well as ways the NNRD could provide information to aid them. These interviews were conducted on the island when possible, however, with a large portion of the island being seasonal, four of the 13 interviews were completed via Zoom or phone call.

Prior to each interview we explained our research and received informed consent to record and potentially quote (Appendix A: Experts Script). As our sponsor asked us to target the outreach materials to Madaket, Fisher's Landing, and Smith's point, we made sure to interview homeowners from each region. In total, we interviewed five Madaket, three Smith's Point, and four Fisher's Landing residents. Interviewing each community helped the team understand the difference in homeowner attitudes towards mitigation strategies as the projected damage to each community varied.

The team organized the data to analyze common trends in attitudes and opinions towards their respective risks and what their options are when mitigating them. We then used this information to synthesize our informational materials and the recommendations we made to the NNRD.

3.2 Evaluate Practices Used in Coastal Communities in Massachusetts for Coastal Resiliency Education

The team extended our background research by searching for education and outreach strategies. We queried Google Scholar for a variety of terms such as “Coastal Hazards”, “Climate Risk Communication”, “Perceptions of Climate Change Adaptation”, “Public Responses”, and “Government Outreach Campaigns”. We then searched for papers that cited the papers we found to be pertinent to more recent studies. The proofing process was then applied to these more modern papers. From papers that were found to be relevant to the project, excerpts were taken to assist in drafting Background 2.4.

We identified useful outreach and education strategies to promote resilience to coastal hazards such as coastal flooding and erosion. The research was then used to aid in the interview process with the experts described below.

To produce our education and outreach recommendations for the NNRD, we sought to understand the current practices of other resiliency organizations. To this end, we conducted interviews with outreach specialists and coastal resilience researchers working on Nantucket as well as in other Massachusetts coastal communities. We asked questions about the processes they followed when designing their outreach efforts, from lower-level questions about the information complexity of short-form materials to higher-level questions on the relationships between the different dissemination methods they use. All of our questions can be found in our interview script in Appendix C: Homeowner Interview Script.

The interviews lasted from 30 minutes to one hour, with one interview requiring a follow-up to continue the discussion. They were conducted in person when possible and on Zoom when necessary. In total, we interviewed 16 different individuals from the 11 organizations we identified.

3.3 Create Prototype Materials and Strategy Recommendations for the NNRD

To create materials relevant to the homeowners of Madaket and useful to the NNRD, we had to understand both what topics homeowners were most concerned about and how to best communicate information on those topics to homeowners. We first had to identify the relevant topics. To accomplish this, we analyzed our simplified data from the Nantucket Homeowners Resilience Survey as well as our homeowner interviews to identify information which was valuable to Madaket homeowners. Next, we had to identify the most effective form factors for disseminating this information. To do this, we analyzed information from our expert interviews and cross-referenced this with our background sources. We also took into consideration our capability to produce materials within the timeframe of IQP and the realistic scope of our project.

To form effective outreach strategy recommendations for the NNRD, we analyzed the practices found in our expert interviews and the public-facing practices of the organizations our experts belonged to. We then compared these with the findings of our background sources, creating a broad, initial set of recommendations. We then revised the recommendations with the NNRD, focusing them more on the particular issues the NNRD faces.

4. Findings

This section describes our findings from analysis of the survey data as well as our interviews with homeowners and experts. These findings are organized by the topics of homeowner sentiment on coastal resilience, common outreach strategies, and the effectiveness of various informational formats.

Our findings from expert interviews strongly influenced many of our findings. We categorized the interviewee organizations based upon area of expertise. ‘Officials’ are interviewees who work in government departments, such as the Town of Chatham and Provincetown, focused on coastal resiliency. ‘Conservationists’ work in conservation-focused non-profits, such as the Nantucket Conservation Foundation and Nantucket Land Bank. ‘Resiliency coordinators’ work in organizations that are not government departments but focus on coastal resilience, such as the Woods Hole Oceanographic Institute and Cape Cod Commission.

4.1 Homeowner Sentiment

Madaket homeowners are the primary audience for the outreach materials and recommendations the team makes to the NNRD. Therefore, it was important to understand their concerns and how they are distinct from other communities on Nantucket.

4.1.1 Homeowner Concerns Regarding Coastal Hazards

Prior to the team's arrival on the island, the NNRD conducted an island-wide survey titled the Nantucket Homeowner Resilience Survey (n=522). The survey inquired about sentiments regarding coastal hazards, mitigation strategies, and future assistance from the NNRD or CRAC, as well as whether they were year-round or seasonal residents, and what community they lived in. These demographics were used to observe whether variations in seasonality and locality affected responses in terms of concerns, mitigation strategies, and desired assistance.

The Nantucket Homeowner Resilience Survey asked respondents “What are your biggest concerns today regarding coastal hazards related to sea level rise on your property or within your neighborhood?” The survey offered 8 named concerns (i.e., erosion, flooding, etc. as shown in Figure 9) to select as many as desired. Respondents could also choose ‘other’ and write in a response or choose ‘none’. Since the survey allowed respondents to select multiple items of concern the total number of responses in Figure 9 is greater than the total number of respondents (n=522) in the sample.

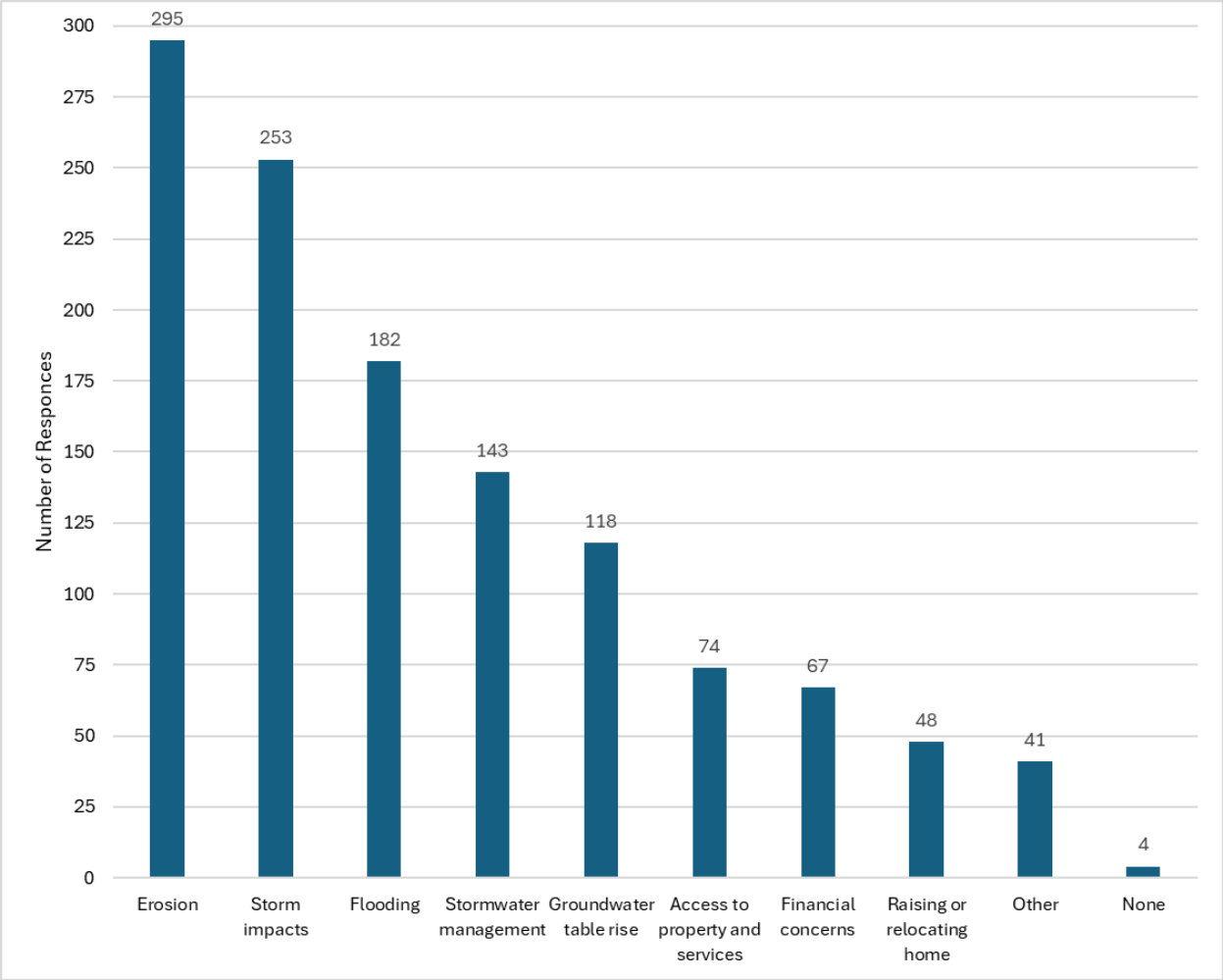


Figure 9 - Plot of all Respondents Expressing Concern about Particular Coastal Hazards (NNRD, 2024)

Figure 9 orders the nine response categories from greatest to least number of responses. Of all respondents (n=295), 57% reported being concerned about erosion, 48% of all respondents (n=253) reported being concerned about storm impacts, and 35% of all respondents (n=182) reported being concerned about flooding. Out of all respondents to the Nantucket Homeowner Resilience Survey, only four respondents reported having no concerns regarding coastal hazards. Figure 10 displays the concerns of respondents (n=77) from Madaket only.

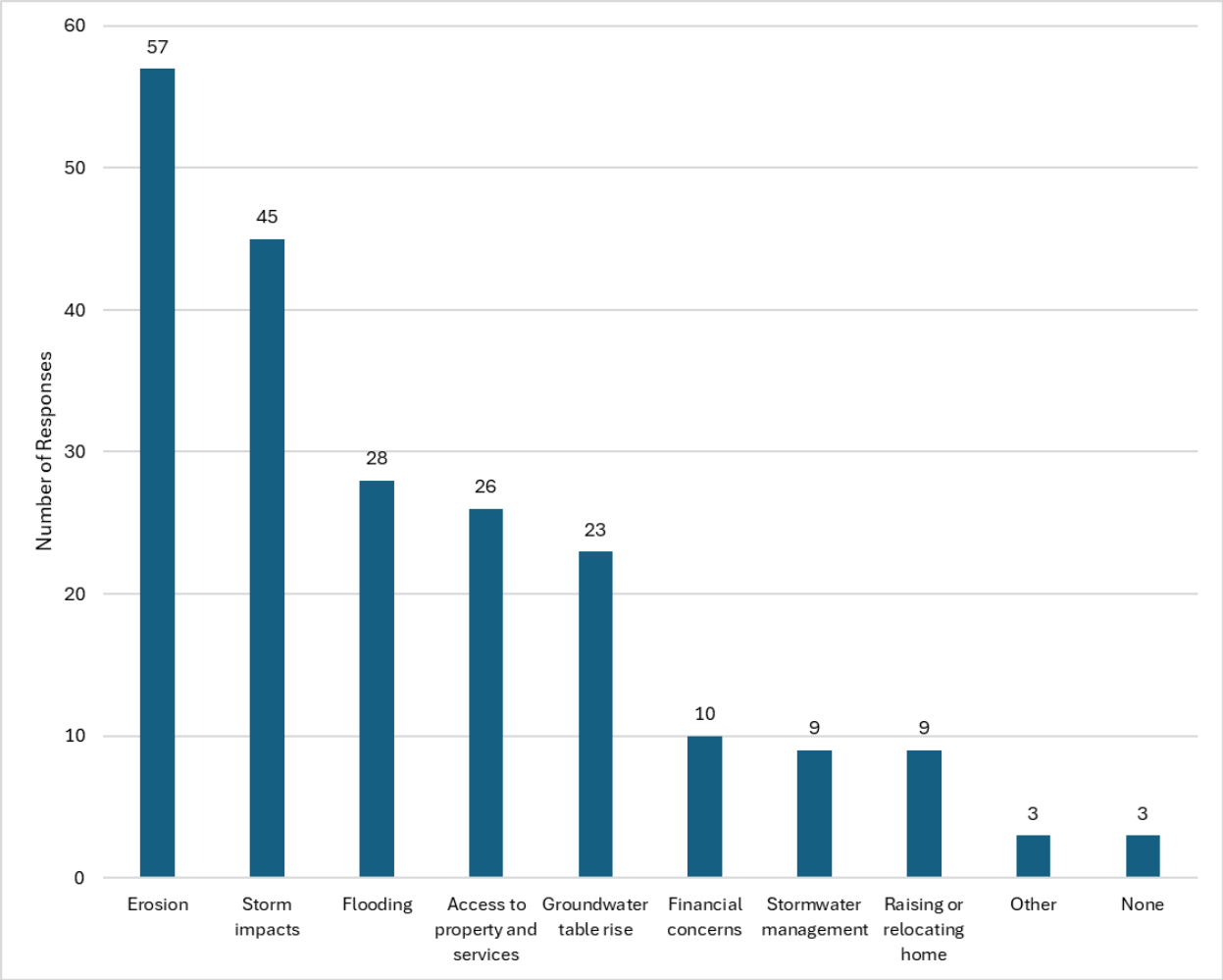


Figure 10 - Plot of Respondents from Madaket Expressing Concerns about Particular Coastal Hazards (NNRD, 2024)

Figure 10 orders the nine response categories from greatest to least number of responses. Of the respondents from Madaket (n=77) more than 74% of all respondents (n=57) reported being concerned about erosion, 58% of all respondents (n=45) reported being concerned about storm impacts. Additionally, at least 30% of respondents were concerned about flooding, access to property, and groundwater table rise. Of those who noted they had no concerns; they were all seasonal Madaket homeowners.

In our homeowner interviews, we found that the main driver of the elevated concern surrounding coastal hazards is a result of the lived experiences of Madaket homeowners. Becker and others noted in their research that anecdotal lessons, i.e. lived experiences or those they studied, also tended to be a principal driver in their awareness of risks, and thus concern for their own situation (Becker, J.S et al, 2012). Of the 13 homeowners we interviewed, all have been living on or visiting Nantucket for over 20 years. During this time, they have observed the effects of coastal hazards including receding shorelines, flooding during historic storms, having to replace utilities such as septic systems due to groundwater table rise, and loss of access to their property during storms. One major difference between the concerns of all respondents and those of

Madaket is the increased concern about access to properties and services. Figure 11 illustrates the weakness of the road links from Madaket to Mid-Island.

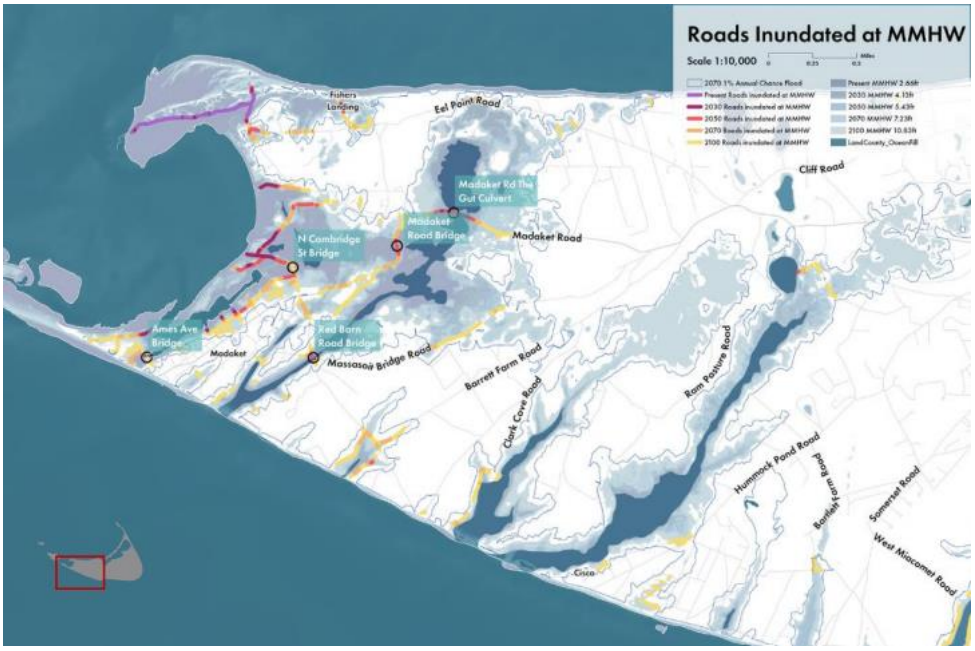


Figure 11 - Map of Roads inundated at Mean Monthly High Water in Madaket (NNRD, 2021, p. 71)

Table 3 - Expected year of loss of use due to MMHW, 1% AEP, and Erosion (NNRD, 2021, p. 72)

Bridge/Culvert	Loss of Service at Monthly High Tide	Loss of Service during 1% Annual Chance Storm	Loss of Service due to Erosion
Ames Ave Bridge	2100	2020	2050
Madaket Rd Bridge	2050	2020	N/A
Madaket Rd Culvert at the Gut	2030	2020	N/A
N Cambridge St Culvert	2050	2020	N/A
Red Barn Rd Bridge	2050	2020	N/A

As depicted in Figure 11, five crossings in Madaket are under threat of being impassable during Mean Monthly High Water. Table 3 specifies the years that MMHW is expected to inundate these crossings. With the Madaket Rd. Culvert expected to be impassable at MMHW by the end of the decade. All of these crossings are routinely submerged for days at a time during storms.

Vince Murphy, Sustainability Programs Manager, indicated in our first meeting that the inundation of crossings was an issue of particular severity in Madaket. Roberta White, a Madaket homeowner said, “We did get trapped during a crazy snowstorm…We didn’t have power for 2 days, we were literally stuck because you couldn’t cross over that [Madaket Road] bridge”. When the Madaket Road bridge is out, Madaket residents, emergency crews, and utility companies lose critical access to and from Madaket. In general, we found that the coastal hazards previously identified by the NNRD, FEMA, and other organizations, were the hazards the residents of Madaket were most concerned about.

4.1.2 Homeowner Mitigation Strategies

Based upon homeowner interviews and results from the Nantucket Homeowner Resilience Survey, we found that there is a measurable difference between what steps residents of Nantucket have or intend to implement, and those taken or intended by residents of Madaket. Figure 12 notes the implementation of Mitigation strategies by all respondents to the Nantucket Homeowner Resilience Survey.

Nantucket Homeowner Resilience Survey asked respondents “Are you currently planning/implementing coastal resiliency measures?” The survey offered 12 named mitigation and adaptation strategies (i.e., planting with native vegetation, flood vents, etc. as shown in Figure 12) to select as many as desired. Respondents could also choose ‘other’ and write in a response or choose ‘none’. Since the survey allowed respondents to select multiple items of concern the total number of responses in Figure 12 is greater than the total number of respondents (n=522) in the sample.

Across all respondents to the Nantucket Homeowner Resilience Survey, planting native vegetation was by far the most popular, with more than 35% of respondents (n=184) indicating its current or planned use, which is ~22% more than the next most prevalent mitigation strategy, redirecting stormwater (n=69). Given the lived experience of respondents and their apparent awareness of coastal risks, it is perhaps initially surprising that 115 respondents indicated they were taking no action to mitigate coastal hazards, nor were they planning to do so in the future. Of those who provided a reason for taking no action, many indicated they believed they were too far inland for coastal hazards to affect them. Survey respondent # 210 stated they planned to do

“Nothing as we are above sea level”.

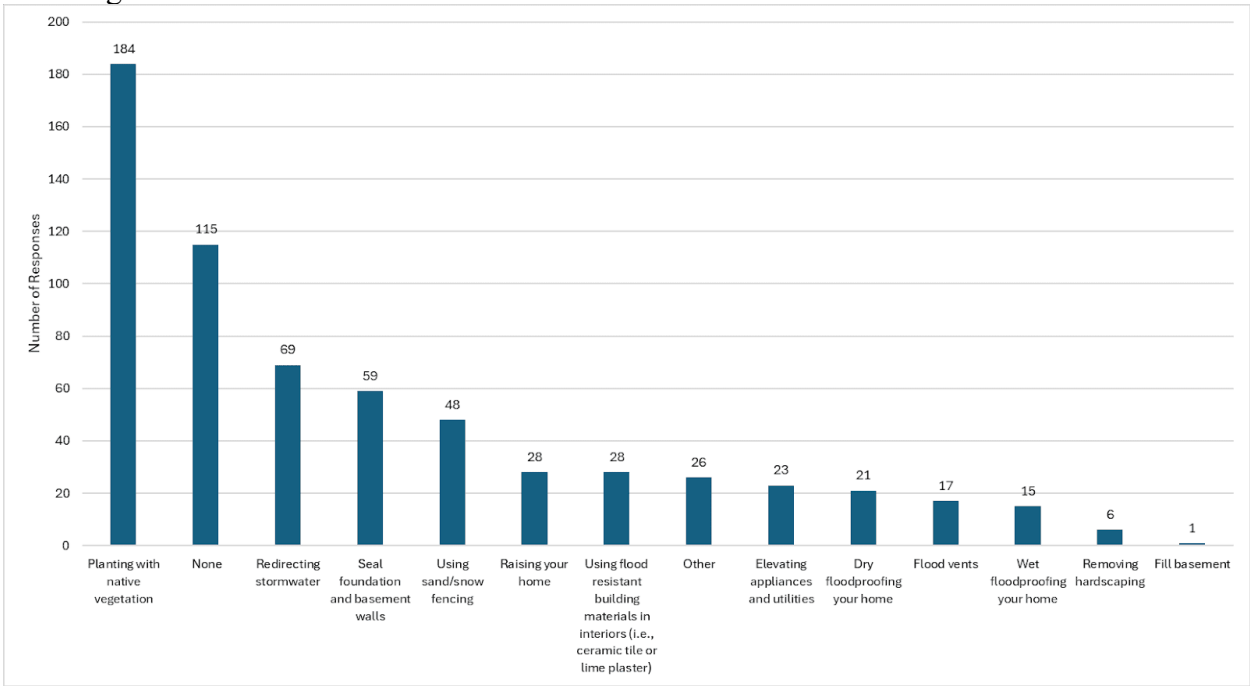


Figure 12 - Plot of all Respondents Using Particular Mitigation Strategies (NNRD, 2024)

While the vast majority of the respondents from Madaket indicated concerns about the coastal hazards they face, this did not result in a comparable segment of the respondents taking action to mitigate their perceived coastal hazards. Of respondents from Madaket, 36% (n=28) reported taking no action. A greater proportion of Madaket residents are taking no action than any other community on Nantucket other than Tom Nevers (n=12)[1]. The survey did not offer an opportunity to express their reasoning for the implementation of a mitigation strategy or lack thereof. We did draw a possible explanation from our homeowner interviews. In eight of our 13 interviews, it was made clear that more time and cost-intensive options, such as the implementation of fiber rolls or raising a home, would only be considered once the property is at a higher visible risk. These eight homeowners' properties were not at an immediate risk of damage from flooding, however five of these homeowners will be within a FEMA floodplain as soon as 2050.

[1] While there is a greater proportion of respondents from Tom Nevers who were taking no action than in Madaket, the number of total respondents from Tom Nevers is only (n=19). Due to the small sample size, the sample of Tom Nevers residents in the survey is less likely to represent the rate of inaction in the population of Tom Nevers than the sample of residents of Madaket.

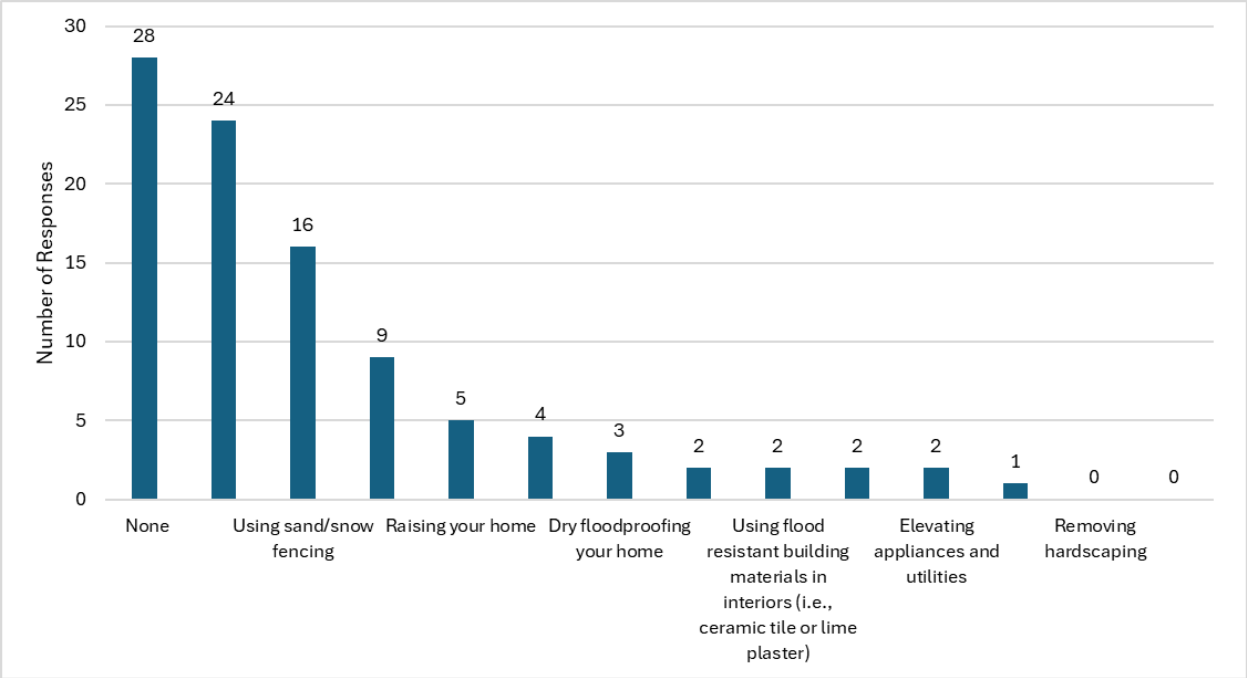


Figure 13 - Plot of Respondents from Madaket Using Particular Mitigation Strategies (NNRD, 2024)

As noted in the background, the majority of responses to climate hazards are coping measures intended to give the practitioner a sense of control. An imminent, experienced, visible risk most often prompts these coping methods rather than the adoption of more long-term methods of mitigation. This mindset is observable in responses to the survey, where solutions that more effectively mitigate structural damage from flooding and erosion, such as floodproofing and raising the home, received few responses, while methods that are designed to merely delay erosion or flooding such as planting native vegetation received a comparatively higher proportion of respondents.

Planting with native vegetation and sand/snow fencing are two strategies intended to regenerate natural dune structures and delay the impacts of coastal hazards and are the only mitigation strategies reported to be used by greater than 20% of respondents from Madaket, as seen in Figure 13. The preference for soft structures was substantiated by responses to the Nantucket Homeowner Resilience Survey, where soft structures were most often used to mitigate damage from the most reported concern, erosion. Two other common traits of soft structures which may have influenced homeowner decisions are their ease of implementation and affordability. As reported by 12 of the 13 homeowners, a lack of clarity on the permitting process for coastal hazard mitigation projects, such as planting native vegetation and sand/snow fencing, was a common obstacle. Homeowners also reported confusion on how to acquire the permit necessary to implement sand/snow fencing and planting native vegetation or in some cases were unaware that such permits were available, instead believing implementation to be impossible.

Another topic of concern that came up frequently in our interviews was compliance with 310 CMR 15.212, colloquially known as Title V, which regulates the distance between a septic system and the high-groundwater table (*310 CMR 15.000, Title 5 of the State Environmental Code*, 2023). On July 7, 2023, Title V was updated to reduce nitrogen pollution from septic

systems. A portion of this amendment enacted changes to 15.212, which stipulates the minimum distance from the high groundwater table. This change then triggered high groundwater table tests by the Nantucket Board of Health pursuant to Chapter 303 § 9-10. Because Madaket is subject to significant groundwater table rise, most homeowners we interviewed have septic systems that have fallen out of compliance and must now be updated or replaced. Five of the 13 homeowners reported confusion with the process, stating that they felt there was a lack of available information on how to proceed in meeting compliance.

A common throughline of those we interviewed was confusion about what strategies were legally permissible to use in addressing coastal hazards affecting their properties. This left our interviewed homeowners feeling disheartened and confused, resulting in minimal action beyond what was required by law to mitigate coastal hazards on their properties.

4.1.3 Homeowner Sentiment on Town Assistance

The preferences of Madaket homeowners' for NNRD and CRAC assistance in addressing coastal hazards were very similar to the island-wide sentiment. As seen in Figure 14, the survey primarily asked which methods of information dissemination were preferred.

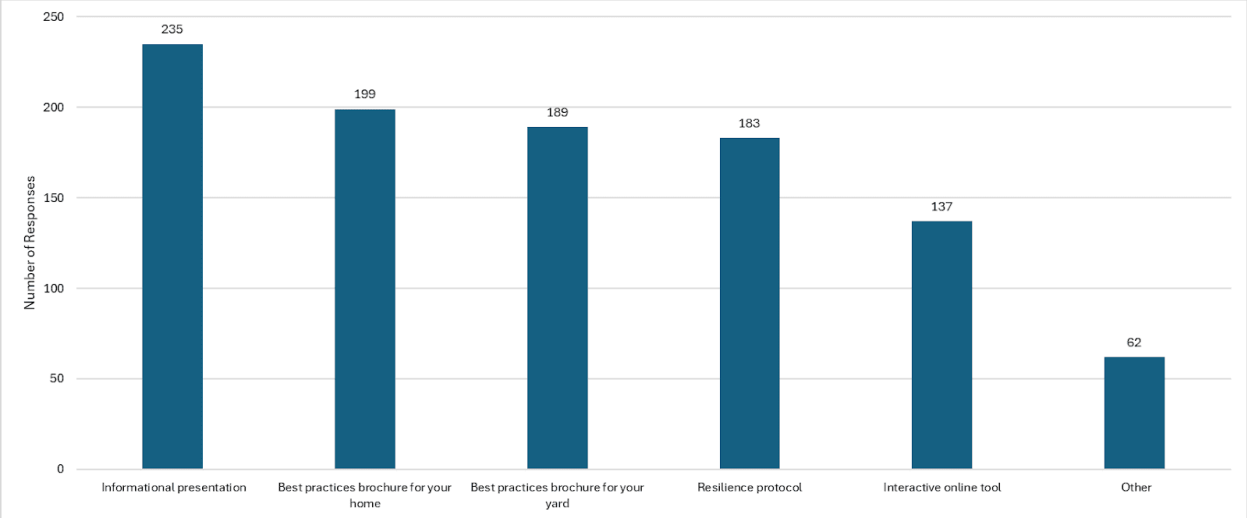


Figure 14 - Plot of All Respondents' Preference in Assistance from NNRD or CRAC (NNRD, 2024)

Informational presentations received the most support of all options with 45% of all respondents requesting an increase by the NNRD and the CRAC. The only responses selected by less than 35% of all respondents were "other" and "interactive online tools". The survey does not give an option for elaboration on the respondent's answer, and thus we are unsure why these two options received markedly less support. Comparison of the preferences of respondents from Madaket to the preferences of all respondents provides a useful contrast in the preferences of Madaket residents.

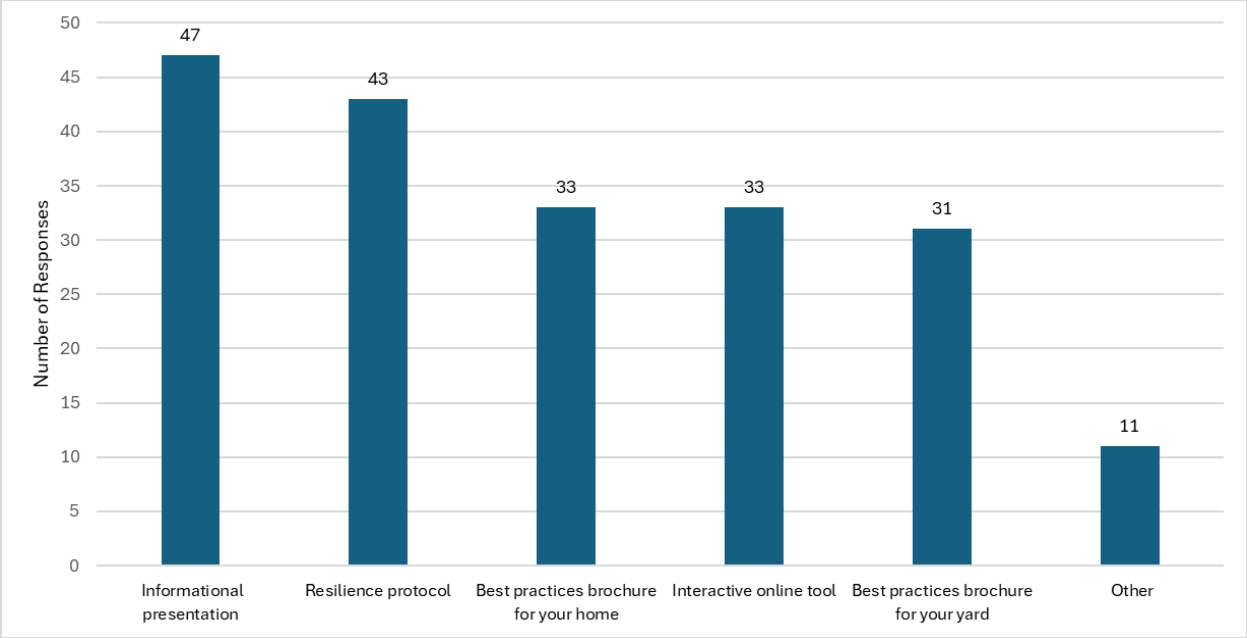


Figure 15 - Plot of Respondents from Madaket Preferences in Assistance from NNRD or CRAC (NNRD, 2024)

Figure 15 shows that respondents from Madaket had similar preferences for additional assistance from the NNRD and the CRAC as did all respondents, with a few key differences. In the responses of Madaket homeowners, interactive online tools saw an increase in the proportion of respondents requesting it by 20% relative to all respondents, and informational presentation saw a 15% increase. This brought the preference for online tools more in line with the other outreach methods while informational presentation's level of representation became further emphasized compared to the other methods. This result is congruent with both our homeowner interviews as well as our expert interviews. Madaket homeowners stated a preference for in-person, discussion-based outreach methods, such as information presentations. The other survey choices for outreach methods are neither in-person nor discussion-based, explaining their comparatively lower numbers of Madaket respondents requesting their increased use.

In all but one of our interviews with experts, in person presentations were stated as an integral part of their outreach process. In terms of outreach method effectiveness, in-person events were consistently found to be the most effective type of outreach method. Outside of informational presentations, the number of respondents from Madaket requesting outreach methods was similar for each option. The survey results align with both our homeowner and expert interviews. From the homeowner's perspective, there was minimal concern about the form factor of the educational material. They were instead primarily concerned with the relevance of the information received to their situation and method of dissemination, such as personal preferences for email, social media, or mailings. Our expert interviewers further support this finding with the vast majority highlighting the importance of conducting outreach using as many methods and formats as possible.

Of the options for additional assistance from the NNRD or the CRAC, "resilience protocol" was the only option that was not an outreach method. The resilience protocol was requested by a 20% greater proportion of the respondents in Madaket relative to those from all respondents. This

trend continued in our homeowner interviews, with many homeowners stating a desire for more information on the current progress of implementation of the CRP as well as an increased speed of implementation.

4.2 Presenting the Message

When conducting outreach, the way information is conveyed is critical. Even if the message and supporting facts are sound, it is crucial that they are explained effectively, or the audience may not be receptive. Effective coastal resilience outreach relies heavily on these concepts, whether it be to simplify the many complex sub-topics or to convey the risks posed by coastal hazards without disheartening the audience.

4.2.1 Framing

As discussed in our background, the framing of coastal hazard mitigation strategies is an important technique to increase homeowners' receptiveness to the implementation of mitigation strategies as well as their understanding of risks associated with coastal hazards. Nine of eleven organizations found success in framing mitigation strategies primarily through a non-risk-focused lens, either by framing strategies around the safety they provide rather than the damage they prevent or by framing the strategies around the secondary benefits, such as maintaining access to boating or recreational fishing, that may have greater personal connections to the audience. A benefit-focused lens also increases the recipient's sense of hopefulness, certainty, and control, making them more inclined to act (Hine et al., 2016; Spence & Pidgeon, 2010).

For example, the Nantucket Conservation Foundation (NCF) observed that emphasizing the importance of salt marshes to recreational fishing on Nantucket was an effective way to connect with their target audiences and promote salt marsh restoration. We asked Jennifer M. Karberg, Director of Research & Partnerships at the NCF how she would go about designing a presentation about dune restoration. She indicated that one important facet of the design would be partially framing dune restoration around secondary benefits, such as habitat restoration, in addition to the primary benefit, coastal resilience. After asking Bala Balachandran, director of the UMass Boston Sustainable Solutions Lab, how he would go about framing messaging about Retreat and Relocation, he provided an example of using gain-centric framing. He emphasized explaining to people "You're not moving because your house is going to fall, you're moving to protect [your house]". This emphasizes protecting your property rather than running from risk.

4.2.2 Distilling Complex Information

Coastal resilience is an incredibly complex topic with significant informational depth. It is important to distill this information into only the components most necessary for the audience's understanding. When information is distilled properly, the lack of extraneous details allows the audience to easily process the essential information. Every expert we interviewed recommended the same strategy for accomplishing this.

The first and most important step is always to identify a primary topic or theme. Eight organizations recommended this theme be somewhat narrow, for example focusing on a single mitigation strategy. When attempting to convey a large depth of information, any increase in breadth becomes more difficult to manage and hinders the audience's ability to understand. By focusing on a narrower topic area, you can commit more space to more detailed information which can provide the audience with a deeper understanding of the subject.

The next step is to identify the information necessary to convey an understanding of the subject. For instance, the mechanisms by which dunes form and how they improve coastal resilience are important to discuss when looking at dune restoration. However, this also includes any secondary information that may be important, such as the importance of dunes as habitats.

These steps identify the bounds of information you desire to work within. Once these boundaries are defined, the strategies for designing a specific material format should be used. These are described later, in 4.3 Utilizing Different Education Material Formats.

4.2.3 Dedicated Outreach Personnel

From our interviews with experts, we found that to conduct a significant and effective outreach campaign there is a large amount of associated overhead. To handle this, all eleven organizations we interviewed have at a minimum, one full-time staff member whose role is to manage the outreach and education conducted by the organization. For example, the process of editing a single video can take multiple hours on its own; “The image and text posts I can knock out pretty quickly, but if I want to make a video it takes five times, ten times as long” said Isaac Hersh, Environmental Educator at the Nantucket Conservation Foundation (NCF). Designing physical materials such as brochures and newsletters also takes a significant amount of time; Neil Foley, Interpretive Education Coordinator at the NCF, explained that because his team was releasing materials in the summer, during the busy season, the extra time and energy to write, plan and layout the materials was a lot in addition to the daily obligations. Without a staff member dedicated to outreach, important aspects such as informational distillation and material cohesion can fall behind without the organization necessarily realizing; “nobody thinks it’s worth putting dedicated resources into this until you’re churning out random pamphlets that people aren’t taking or don’t have the staff to send to an event” explained Poonam Narotam, Communications & Outreach Specialist at the Woods Hole Oceanographic Institute.

4.2.4 Organizational Partnerships

While not often mentioned as an integral component of most organizations’ outreach, organizational partnerships can be a valuable addition to an educational campaign. Partnerships between organizations can supplement knowledge in areas where one organization may lack specialists on a topic or simply want to collaborate. For example, the Nantucket Conservation Foundation (NCF) partners with the Linda Loring Nature Foundation (LLNF) on ornithology-focused events where the LLNF has a greater level of expertise. Another benefit of organizational partnerships is that they help avoid the issue of audiences being split between multiple events occurring in a similar time frame. The problem of splitting audiences, and lowering overall attendance, was primarily encountered by conservationists. To avoid this, conservationists often partner together when they would otherwise have adjacent events, consolidating their collective audiences. These collaborations manifest in events where both organizations work together in areas where they have similar skills, such as co-guided nature walks, or in work where they take advantage of each other’s unique skills or access, such as a collaboration between the LLNF, NCF, and Egan Maritime Institute on a birding excursion which brought together the nature foundations ornithologists and Egan’s knowledge of maritime history.

Partnership can also be a means to reduce competition for resources. For example, the LLNF made a significant change during the COVID-19 pandemic to cut the majority of their summer

classes, instead opting to create partnerships with other NGOs already running summer programs, such as their partnership with the Nantucket Boys and Girls Club. The reasoning for this was two-fold: the LLNF's primary issues when hosting events were lack of transportation, low capacity, and their audience being split between the abundance of other summer programs on similar topics. Whereas the Nantucket Boys and Girls Club had none of those issues, but lacked staff experienced enough in ecological research to create summer programming on those topics. "Sometimes you have to be strategic… there are other organizations on Nantucket like the Boys and Girls Club that already have… full registration, staffing, [and] parking", explained Seth Engelbourg, Program Manager at the LLNF. Because of their complementary needs and capabilities, this partnership was very successful for both organizations and helped reduce the overhead of the LLNF's summer programming.

4.3 Utilizing Different Education Material Formats

Outreach can be done in many forms, with each format for delivering information having different pros, cons, and best practices for design. There are multiple effective outreach formats not mentioned in this section. We chose to focus on the formats consistently used by the experts we interviewed.

4.3.1 Format Combination

A major theme across all organizations we interviewed was the importance of using multiple methods of outreach simultaneously. Homeowners have different preferences for how they receive information. For example, four of the twelve homeowners we interviewed were above the age of 60 and each stated that they have a greater preference for paper media and long-form written materials than short-form digital formats, such as social media posts. Younger audiences, such as the other eight homeowners we interviewed, are more comfortable receiving information digitally and engaging with shorter formats. It is important to capture all audience demographics, so using as wide a variety of outreach methods as possible is recommended to increase the accessibility of information.

4.3.2 In-Person Events

In both our interviews with experts and homeowners as well as our survey analysis, we found that in-person events were the most successful outreach format. There are two main types of in-person events commonly conducted by the organizations we interviewed: experiential events, and informational events.

An important trend we identified, particularly across nature-based organizations, is a focus on experiential events. This trend aligns with the findings of Elrick-Barr and Smith that experiential events are gaining support (Elrick-Barr & Smith, 2022). These are in-person events that emphasize immersing the audience in the work of the organization. In the case of nature-based organizations, guided property walks, kayak tours, or exercises in research work such as bird banding, all with researchers and educators present explaining their work and its relation to what the audience is experiencing. In coastal resilience-focused organizations, this manifests as guided tours of high-risk areas, as well as workshops with property owners, policymakers, and industry professionals present. There may also be planning exercises in which the audience, such as homeowners, collaborate with resiliency planners to explore the design process of community-level mitigation projects.

The purpose of these outreach methods is to develop a personal relationship with the audience and deepen their understanding of the organization's work. While only four of the seven officials and resiliency coordinators used this method, compared to all four conservationists, those four officials saw success in their experiential events with high attendance and anecdotes of enjoying the experience from attendees.

All eleven organizations we interviewed used informational presentations, which are events designed to convey a large amount of complex information to the audience with varying degrees of audience participation and opportunity for questions. Four organizations expressed concern with the relative lack of audience interfacing. They were concerned that the only interactions between the audience and presenter in these presentations are the questions which are commonly sequestered until the end of the presentation. Because of this, it can be difficult to keep the audience engaged with the subject matter.

Town halls are another form of informational presentation. Only four organizations reported the use of town hall events, however all these organizations stated the format was successful. Town hall events are a format focused on the audience's perspective. Rather than having a presenter convey information, members of the organization conducting the event will field questions from the audience on a topic area. An example of this format is the Nantucket Conservation Foundation’s town hall during which they fielded questions from the public on the direction of their Coskata-Coatue Wildlife Refuge project. Another example of the success of town halls comes from Provincetown. As a part of their Coastal Resilience Plan, Provincetown planned three community engagement events in a town hall or open house style, two of which have already occurred. In our interview with Melyssa Nickerson, Provincetown Environmental Planner, she explained that the two events which have been completed were very successful at engaging the community of Provincetown.

4.3.3 Social Media

Short form social media posts are a format best used to direct audiences towards other forms of outreach, such as articles or excursions, rather than being used as a primary method of outreach. Every organization we interviewed utilizes social media in some way, with Instagram being the most used and most successful platform. Nine of the eleven organizations we interviewed use their social media for at least one of the following four purposes: short updates on either relevant local events or project progress, calling attention to other relevant events occurring in the future, showcasing experiential events with either photos or edited videos from these events, or content specifically designed for social media, such as edited testimonials or fieldwork. Of these purposes, social media posts showcasing experiential events or specifically designed materials were the most successful, as they had the highest engagement.

4.3.4 Print Materials

In our interviews, there were two main types of physical materials commonly used by our interviewee organizations: newsletters and brochures. These physical materials have different strengths, weaknesses, and use cases associated with them.

Brochures are physical materials primarily utilized as supplements to larger events on similar topic areas. Due to their smaller size, brochures are significantly limited in either the depth or breadth of information that can be contained within them. As a result, all organizations the team interviewed use brochures in tandem with larger, more information-dense outreach formats. The

organizations we interviewed explained that they bring general materials to events without a particular topic like handouts, such as table sittings. Brochures are also used as targeted materials to give to audience members who would like more information after events, containing directions to find more information on the subjects discussed. An example of this is the erosion and flooding risk brochure by the NNRD, which provides QR codes linking to interactive coastal hazard maps.

Newsletters are long-form physical materials primarily formatted as a collection of smaller articles. Every organization we interviewed has a newsletter of some kind, however, they were used differently between organizations. Five of the organizations interviewed released newsletters on a long-term cycle, such as annual, bi-annual, or quarterly releases. These newsletters were stand-alone, providing articles on overarching project progress sometimes spanning multiple years, large accomplishments by the organization, and highlights of relevant community events. An example of this is the Land and Water Council's bi-annual newsletters. A recent edition, *Water News* 2023, contained sections on relevant community events such as the Cisco Brewers Trashion Show, project updates on their PFAS cleanup, and research updates on eelgrass-friendly mooring. Four of the five organizations using these long-cycle newsletters print them physically to provide audiences with physical materials to show to friends, raising awareness of the organization's work through the personal social networks of audience members. All eleven organizations implement a monthly or weekly newsletter. These newsletters are smaller in scope, primarily focusing on imminent events being held in the time before the next release and smaller project or research updates. Of the organizations we interviewed, all monthly and weekly newsletters were digital. The reason for their digital format was due to a combination of the cost of printing materials so frequently and the increase in ease of access provided by being digital. An example of a monthly newsletter is the Cape Cod Cooperative Extension's monthly e-newsletter, which gives small updates on sustainability topics such as waste, buying local food, and local vegetation.

5. Recommendations

5.1 Further Develop Prototype Material Design

Considering that the NNRD needed immediately implementable materials to inform homeowners and that one of the top three most preferred options in the homeowner survey was a “best practices brochure for your home” we recommend that the NNRD further develop our sample brochure to convey homeowner options for adapting to coastal hazards. While our findings and background show that passive materials such as these are not as successful as other forms of outreach, particularly when used alone, they were found to be particularly useful in combination with experiential events. Brochures are important supplemental materials and can be used at open houses and tours that the NNRD already holds.

Our review of the literature and the homeowner survey both showed that coastal erosion and flooding are the most severe hazards affecting homeowners and the most reported hazards. For these reasons the team decided to create two brochures respectively.

The research literature and our organizational interviews revealed that it is critical to distill information for the audience. As seen in Figure 16 we chose to focus on the subtopic of mitigation strategies to reduce the breadth of information in the materials and better utilize gain-centric framing. The breadth comes at a cost to informational depth, though, so we provided QR codes which direct homeowners to more in–depth resources, such as the Coastal Resilience Plan and the Massachusetts Homeowner’s Handbook.

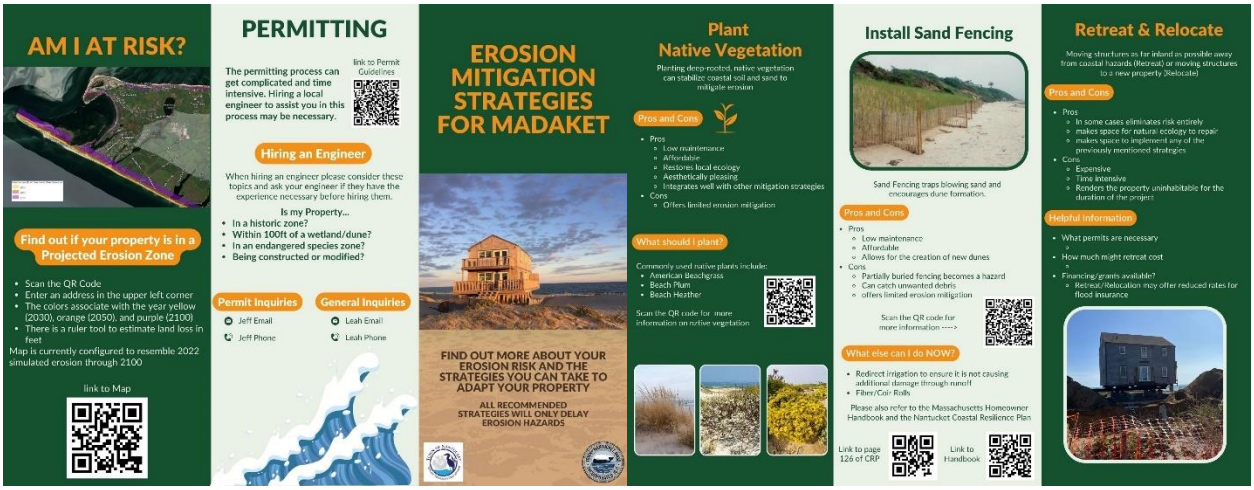


Figure 16 - Brochure of Erosion Mitigation Strategies

The cover page of the erosion mitigation brochure includes a simple explanation of the brochure and a disclaimer that the mitigation methods detailed in the brochure will only delay and not prevent erosion. When first opening the brochure there is a section on risk. We decided to include this because, as detailed in our background, there is a magnitude of perceived threat that needs to be observed before households implement adaptation strategies (Haer et al., 2016). The panel includes instructions on how to use the FEMA projection site which can be accessed by

scanning the QR code located at the bottom of the panel. Homeowners can use this website to determine if their property is in current or projected coastal erosion or flooding zone respectively.

The internal panels contain three mitigation strategies. Outlined are Native Vegetation, Sand Fencing, and Retreat & Relocation. Understanding that relocation, although the most effective option may be unattainable to homeowners, we wanted to include two additional options that most homeowners could implement. All options are displayed graphically with a listing of their pros and cons. We chose to focus on the three mitigation strategies displayed in the brochure (i.e., planting vegetation, sand fencing, and retreat and relocation) based on our background research, the results of the homeowner survey, and discussions with our sponsors.

The flooding brochure is essentially the same design with a cover page, permitting panel, and risk panel. As seen in Figure 17, rather than focusing on three mitigation strategies, we covered many strategies under three distinct categories: immediate actions, retrofitting structures, and structural elevation. These categories separate strategies based on ease of implementation, providing a large breadth of options with different pros and cons.

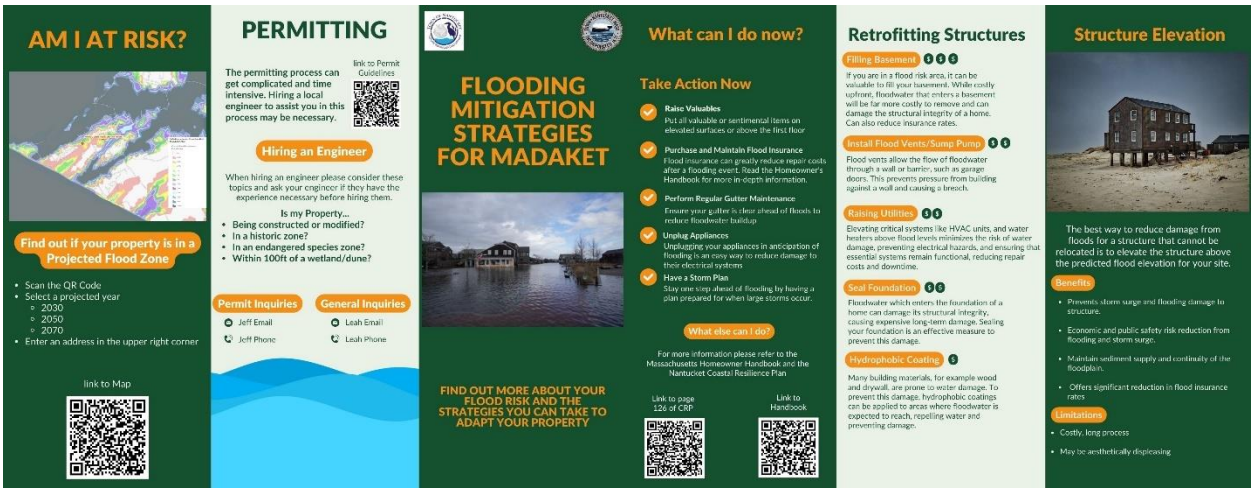


Figure 17 - Flooding Mitigation Strategies for Madaket

On the back panel of both brochures we include an engineer hiring guide, informing homeowners that they should make sure engineers are familiar with the homeowners' particular issues. For example, if a homeowner property is in a historical district zone or within 100 ft of a protected wetland, they should hire an engineer with wetlands expertise with experience in historical commission permitting.

Permitting is an incredibly important topic to understand for any homeowner implementing mitigation strategies. We found in our homeowner interviews there was confusion around the permitting process, both regarding when permits were necessary or obtainable and the process to acquire them. We decided to create an informational graphic providing an overview of the permitting process as seen in Figure 18

Figure 18 - Illustrated Flowchart of the Permitting Process for Coastal Resiliency Projects

The permitting flow chart as shown in Figure 18 outlines three restricted zones that would require permitting, these being: the property is located within 100 ft of a wetland, within a priority or estimated habitat (where an endangered species may inhabit), and within the historical district. Unfortunately, most of these steps cannot be completed without a property survey, so while they are permissible, they will require skilled assistance. The Permitting flow chart was created by interviewing both the director of the NNRD (Jeff Carlson) and a reputable engineer on-island. This graphic is intended to be hosted on the NNRD's website. Both the flooding and erosion brochures also contain QR codes linking to this graphic.

5.2 Hire full-time outreach staff member

During the team's interviews with organizations on and off the island, we found unanimous agreement that at least one outreach coordinator was essential in bringing their organization's goals to fruition. The areas these organizations noted as those most improved by having a full-time employee devoted to outreach are those same areas the NNRD currently struggles most with. Disseminating information surrounding conservation and resiliency efforts was also an area where well-developed, consistent and widespread outreach was only viable with the assistance of an outreach coordinator.

The homeowner survey showed that approximately 80% of respondents wanted some form of assistance from the Town, with the top three preferred assistance methods shown in Figure 14 as: informational presentations, a best practices brochure for homeowner's properties, and a best practices brochure for homeowners' lawns. Twelve of the 13 homeowners interviewed wanted to see more materials, it is therefore clear that there is a high demand for the production of more

materials. The creation of new materials that are not currently in the NNRD's inventory is a significant time commitment. Creating content for informational presentations is particularly taxing, due to their length, and technical thought process that would need to go into concepts like framing and distilling information. As a result of the additional overhead that our recommendations will require of the NNRD's existing staff, the team recommends the allocation of funds for the creation of a new position at the NNRD to handle outreach on behalf of the entire department.

The responsibilities of an outreach coordinator for the NNRD would include:

- the generation of brochures and newsletters to support outreach on behalf of all the NNRD's divisions.
- Keeping homeowners informed on the implementation of the CRP.
- Continuing the development of best practices brochures.
- Handling the NNRD's social media.
    - Taking care of routine posts on platforms such as Instagram, Facebook, YouTube,
    - Creating short form media such as TikTok and Instagram Reels.
- Coordinating partnerships with organizations
- The creating content for, and scheduling of in-person events such as informational presentations and experiential events.

5.3 Pursue Additional Partnerships with Organizations

From our research, experiential educational strategies are particularly effective in changing behavior. Experiential outreach methods were a common tactic used by Nantucket conservation organizations as well as those off-island that we interviewed. Unfortunately, these require significant resources to plan, organize, and run consistently. Forming partnerships with other NGOs on and off the island would permit the distribution of work in planning an event, increasing the viability. Additionally, partnering with organizations the public already trusts will help bring more trust to the NNRD and increase visibility of those organizations. The NNRD has already done a kayak tour in collaboration with the Land and Water Council and a marsh walk with the Nantucket Conservation Foundation. An example for possible partnerships could be collaborating with the Linda Loring Nature Foundation to discuss how certain resiliency measures such as dune restoration can also develop local bird habitats, due to the common natured-based goals of both the NNRD and the Linda Loring Nature Foundation, collaborating will bring in a larger audience that would be willing to learn from both organizations.

5.4 Improve Social Media Presence

Social media presence is an effective way for an organization to keep the public apprised and engaged with its activities. Showing the community what you are working on a regular basis, in short-form media such as Instagram reels or posting updates is a fantastic way to engage with the community. Additionally, it allows for another point of contact with your audience.

Create a Newsletter for the NNRD

This recommendation has a variety of possible options due to its long-form nature. There is enough demand from the public and information/news to share from the coastal resiliency portion of the NNRD and CRAC to create a newsletter only for these programs. Especially with the rising concern we have observed in Madaket, Smith's Point, and Fishers Landing, we believe this is a great next step for the NNRD. It would be necessary for someone to design and implement this newsletter and unfortunately, with the limited capacity of the NNRD it may not be possible without hiring an outreach staff member. We recommend that the newsletter is sent out on a bi-yearly basis at the minimum. The intended topic of the newsletter is project updates from across all divisions of the NNRD. Splitting the workload between multiple programs may be a more sustainable way of continuing this newsletter in the future. We heard anecdotally from 12 of the 13 homeowners interviewed that there was a lack of updates on the progress of the coastal resiliency plan. Additionally multiple Nantucket organizations that we interviewed such as the Nantucket Conservation Foundation, Land and Water Council, and The Land bank all have their own print newsletters with focuses on long form articles highlighting their work. Because of Nantucket communities' current familiarity with this format we believe that it will be better received by the public.

6. Conclusion

Coastal Resilience education and outreach is a complex subject, and a priority for the NNRD and CRAC. Through a qualitative analysis of literature, survey data, and interviews, we generated prototype materials and outreach strategy recommendations for use by the NNRD. While our materials are currently aimed primarily at Madaket homeowners, they are designed to be easily reconfigured to make their content relevant in other communities. Our outreach strategy recommendations are primarily based on what has succeeded for other coastal Massachusetts organizations. We hope that our recommendations will be useful in the Nantucket Natural Resources Department's continuing efforts to improve education and outreach surrounding Coastal Resiliency and will advise the NNRD in future decisions regarding the generation and planning of materials and events.

Works Cited

Abel, N., Gorddard, R., Harman, B., Leitch, A., Langridge, J., Ryan, A., & Heyenga, S. (2011). Sea level rise, coastal development and planned retreat: Analytical framework, governance principles and an Australian case study. *Environmental Science & Policy*, *14*(3), 279–288. https://doi.org/10.1016/j.envsci.2010.12.002

Altinay, Z., Morris, L. L., & Reams, M. A. (2023). Information Needs of Coastal Residents in Louisiana, U.S.A.: Implications for Risk Communication. *Journal of Coastal Research*, *39*(6). https://doi.org/10.2112/JCOASTRES-D-22-00125.1

Barra, M. P., Hemmerling, S. A., & Baustian, M. M. (2020). A Model Controversy: Using Environmental Competency Groups to Inform Coastal Restoration Planning in Louisiana. *The Professional Geographer*, *72*(4), 511–520. https://doi.org/10.1080/00330124.2020.1777574

Basco, D. R. (2006). Seawall Impacts on Adjacent Beaches: Separating Fact from Fiction. *Journal of Coastal Research*, *39*.

Becker, J.S., Paton, D., Johnston, D.M. et al. A model of household preparedness for earthquakes: how individuals make meaning of earthquake information and how this influences preparedness. Nat Hazards 64, 107–137 (2012). https://doi.org/10.1007/s11069-012-0238-x

Brandon, T. O. (2016). Nationwide Permit 13, Shoreline Armoring, and the Important Role of the U.S. Army Corps of Engineers in Coastal Climate Change Adaptation. *Environmental Law*, *46*(3), 537–576.

Conservation Commission. (2013). *WETLAND PROTECTION REGULATIONS* [Town Regulation]. Town of Nantucket Conservation Commission. https://www.nantucket-ma.gov/DocumentCenter/View/1008/Conservation-Commission-Wetland-Regulations-2013-PDF

Elrick-Barr, C. E., & Smith, T. F. (2022). Current Information Provision Rarely Helps Coastal Households Adapt to Climate Change. *Sustainability*, *14*(5), 2904. https://doi.org/10.3390/su14052904

Erisman, A. (n.d.). *EROSION CONTROL, SUSTAINABILITY, AND SEA LEVEL RISE: A CRITICAL EVALUATION OF NANTUCKET'S PLANNING FOR COASTAL RESILIENCE*.

Evans, L., Milfont, T. L., & Lawrence, J. (2014). Considering local adaptation increases willingness to mitigate. *Global Environmental Change*, *25*, 69–75. https://doi.org/10.1016/j.gloenvcha.2013.12.013

Griggs, G. (2024). Beach Nourishment: A Critical Look. *Journal of Coastal Research*, *40*(5). https://doi.org/10.2112/JCOASTRES-D-24A-00004.1

Haer, T., Botzen, W. J. W., & Aerts, J. C. J. H. (2016). The effectiveness of flood risk communication strategies and the influence of social networks—Insights from an agent-based model. *Environmental Science & Policy*, *60*, 44–52. https://doi.org/10.1016/j.envsci.2016.03.006

Hanna, C., White, I., & Glavovic, B. (2019). Managed Retreat in Practice: Mechanisms and Challenges for Implementation. In C. Hanna, I. White, & B. Glavovic, *Oxford Research Encyclopedia of Natural Hazard Science*. Oxford University Press. https://doi.org/10.1093/acrefore/9780199389407.013.350

Harman, B. P., Heyenga, S., Taylor, B. M., & Fletcher, C. S. (2015). Global Lessons for Adapting Coastal Communities to Protect against Storm Surge Inundation. *Journal of Coastal Research*, *314*, 790–801. https://doi.org/10.2112/JCOASTRES-D-13-00095.1

Hine, D. W., Phillips, W. J., Cooksey, R., Reser, J. P., Nunn, P., Marks, A. D. G., Loi, N. M., & Watt, S. E. (2016). Preaching to different choirs: How to motivate dismissive, uncommitted, and alarmed audiences to adapt to climate change? *Global Environmental Change*, *36*, 1–11. https://doi.org/10.1016/j.gloenvcha.2015.11.002

Javeline, D., & Kijewski-Correa, T. (2019). Coastal homeowners in a changing climate. *Climatic Change*, *152*(2), 259–274. https://doi.org/10.1007/s10584-018-2257-4

Kraus, N. C. (2024). *The Effects of Seawalls on the Beach: An Extended Literature Review*.

Larson, C. D. (2020). *High-Tides and Flooding on Easy Street* (p. 11). Manager of Strategic Projects. https://nantucket-ma.gov/DocumentCenter/View/41178/Easy-St-2020-0710-Final-Draft-PDF

Lieske, D. J., Wade, T., & Roness, L. A. (2014). Climate change awareness and strategies for communicating the risk of coastal flooding: A Canadian Maritime case example. *Estuarine, Coastal and Shelf Science*, *140*, 83–94. https://doi.org/10.1016/j.ecss.2013.04.017

Linham, M. M., & Nicholls, R. J. (2010). *Technologies for climate change adaptation: Coastal erosion and flooding*. UNEP Riso Centre on Energy, Climate and Sustainable Development.

Lorenzoni, I., & Pidgeon, N. F. (2006). Public Views on Climate Change: European and USA Perspectives. *Climatic Change*, *77*(1), 73–95. https://doi.org/10.1007/s10584-006-9072-z

MA CZM. (2021). *ENVIRONMENTAL PERMITTING in COASTAL MASSACHUSETTS* (p. 80). Massachusetts Office of Coastal Zone Management. https://www.mass.gov/doc/environmental-permitting-in-coastal-massachusetts-0

María E. Fernández-Giménez, Baival Batkhishig, Batjav Batbuyan, Tungalag Ulambayar, Lessons from the Dzud: Community-Based Rangeland Management Increases the Adaptive Capacity of Mongolian Herders to Winter Disasters, World Development, Volume 68, 2015, Pages 48-65, ISSN 0305-750X, https://doi.org/10.1016/j.worlddev.2014.11.015. (https://www.sciencedirect.com/science/article/pii/S0305750X14003738)

McGuire, C. J. (2017). Armoring Against Coastal Climate Adaptation in the US: A Massachusetts Perspective. *Coastal Management*, *45*(4), 271–276. https://doi.org/10.1080/08920753.2017.1327342

Murphy, S., & Taylor, E. (2020). *Massachusetts Homeowner's Handbook To Prepare For Coastal Hazards*. *3rd*, 47.

Nichols, S. S., & Bruch, C. (2008). New Frameworks for Managing Dynamic Coasts: Legal and Policy Tools for Adapting U.S. Coastal Zone Management to Climate Change. *Sea Grant Law and Policy Journal*, *1*(1), 162.

NNRD. (2021). *Coastal Resilience Plan* (p. 286) [Government plan]. Nantucket Department of Natural Resources. https://ma-nantucket.civicplus.com/2962/Coastal-Resilience-Plan

Pelletier, L. G., & Sharp, E. (2008). Persuasive communication and proenvironmental behaviours: How message tailoring and message framing can improve the integration of behaviours through self-determined motivation. *Canadian Psychology / Psychologie Canadienne*, *49*(3), 210–217. https://doi.org/10.1037/a0012755

Scannell, L., & Gifford, R. (2013). Personally Relevant Climate Change: The Role of Place Attachment and Local Versus Global Message Framing in Engagement. *Environment and Behavior*, *45*(1), 60–85. https://doi.org/10.1177/0013916511421196

Spence, A., & Pidgeon, N. (2010). Framing and communicating climate change: The effects of distance and outcome frame manipulations. *Global Environmental Change*, *20*(4), 656–667. https://doi.org/10.1016/j.gloenvcha.2010.07.002

Sterman, J. D. (2011). Communicating climate change risks in a skeptical world. *Climatic Change*, *108*(4), 811. https://doi.org/10.1007/s10584-011-0189-3

Town of Nantucket. (2024, November 5). *FAQs • What permits are required to build / alter / move / demolish a structure?* [Government FAQ]. Town & County of Nantucket Massachusetts. https://nantucket-ma.gov/FAQ.aspx?QID=185

Uiterwyk, K., & Starbuck, K. (2023). *Municipal Perspectives on Managed Retreat* (Research Report 51; p. 36). UMass Boston. https://scholarworks.umb.edu/uhi_pubs/51

USACE. (2012). *Decision Document Nationwide Permit 13*. US Army Corps of Engineers. https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/6784

Walton, W. C., & Swann, L. (2021). Role of Sea Grant in Establishing Commercial Oyster Aquaculture through Applied Research and Extension. *Journal of Contemporary Water Research & Education*, *174*(1), 171–179. https://doi.org/10.1111/j.1936-704X.2021.3367.x

Appendices

Appendix A: Experts Script

Preamble:

We're a group of students from the Worcester Polytechnic Institute (WPI) conducting a research project in collaboration with the Nantucket Natural Resources Department (NNRD) and Coastal Resiliency Advisory Committee (CRAC) to develop informational materials for use in outreach to homeowners.

It would be incredibly helpful to our research if you could take half an hour to an hour of your time to answer some questions regarding outreach methods you've utilized in your community. Your participation in this interview is entirely voluntary, you can stop at any time or choose not to answer certain questions. We'll be taking notes during the interview. Additionally, with your consent, we will record our conversation. We may wish to quote you in our final report. If you are quoted, you will dictate what, if any, identifying information we can include such as your name and job title. We will also be happy to provide a copy of the completed report at your request. Thank you very much for being willing to help us with this work. We'll be sure to remind you at the end, but if you have any questions after we're done feel free to email us at gr-ack24-resiliency@wpi.edu.

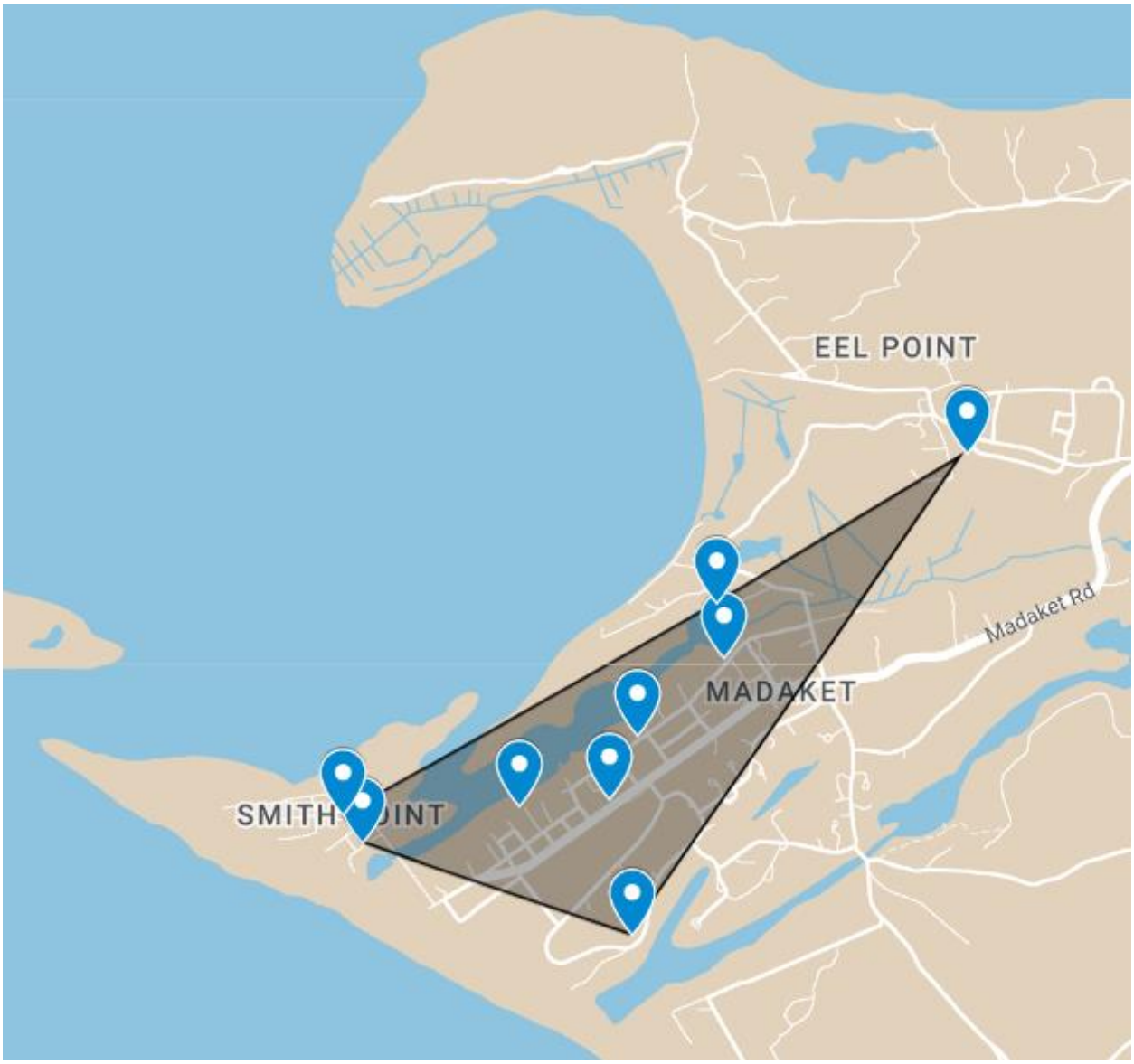
Questions:

These questions cover all topics we discussed; however, the order would shift in accordance with the flow of conversation.

1. What are the main responsibilities of your position?
2. What is your involvement in your organization's outreach?
3. Are there any outreach efforts in which you have or have had a large involvement in? And if so, could you describe them to me?
    1. *If Yes*: What was the reason for your large involvement?
4. Could you describe the strategies your organization follows when designing outreach campaigns? For example, how do you determine who you're reaching out to, what media types you will use, and how you will distribute the outreach materials/information?
    1. *If Yes*: What is the reasoning for the use of these strategies in particular?
5. What types of media has your organization used in outreach campaigns?
6. Were there any media types that were particularly effective, and if so, what made them so successful?
7. Were there any media types that were particularly ineffective, and if so, what made them so ineffective?
8. Are there any types of media that your organization has not yet used but is considering in the future?
    1. *If Yes*: What are the reasons you are considering this media type?
9. What methods have your organization used to distribute your outreach materials?
10. Were there any particularly effective methods used, and if so, why were they so successful?
11. Were there any particularly ineffective means used, and if so, why were they so ineffective?

12. Are there any distribution methods that your organization has not yet used but is considering for the future? And if so, what are the reasons you're considering it?
13. Broadly, what is the best advice you can give us that you feel hasn't come up yet?

Appendix B: Homeowner Residency Area



:

Appendix C: Homeowner Interview Script

Preamble:

We're a group of students from Worcester Polytechnic Institute (WPI) conducting a research project in collaboration with the Nantucket Natural Resources Department (NNRD) to develop informational materials for use in outreach to homeowners.

We would greatly appreciate it if you could take about 45 minutes of your time to answer some questions regarding any concerns you may have regarding the risks of coastal [erosion/flooding] in your area and what information would be valuable to you in that regard. Your participation in this interview is entirely voluntary, you can stop at any time or choose not to answer certain questions. We'll be taking notes during the interview. Additionally, with your consent, we will record our conversation. If you are quoted, is it alright with you to quote you by name or would you prefer it to be anonymous? We will be happy to provide a copy of the completed report if you would like one. Thank you very much for being willing to help us with this work. Do you have any questions before we start? I'll be sure to remind you at the end, but if you have any questions after we're done feel free to email us at gr-ack24-resiliency@wpi.edu.

Questions:

These questions cover all topics we intend to discuss; however, the order may shift in accordance with the flow of conversation.

1. How long have you been visiting/lived on Nantucket?
2. How much of the year do you spend on-island?
3. What is your Nantucket address?
4. How do you keep up with the local news?
5. Do you use any social media, and if so, what?
6. Do you read any newsletters on-island?
7. Have you taken the anonymous survey put out by the Coastal Resilience Advisory Committee?
8. Do you have any concerns regarding the effects of coastal hazards on your property?
    1. If Yes: Are there any particular concerns, you have?
    2. If No: What would you say informs your lack of concern?
9. Are you planning on implementing or have you already implemented any resiliency measures to protect your property?
    1. If Yes: What measures have/are you taking?
    2. If Yes: Have you referred to any informational materials to aid you?
    3. If yes, was it easy to implement or did you have difficulty?
    4. If not, why not?
10. Are you familiar with the Town's Coastal Resilience Plan?
    1. If not, explain what it is: Community driven and support island-wide plans to mitigate flooding and erosion out to 2070. There are 40 recommendations that are split up for each geographic area ex. Madaket, Sconset, Downtown and Brant Point.
11. Are you aware of any informational materials regarding coastal resilience produced by the Coastal Resilience Advisory Committee or Nantucket Natural Resources Department of the Town of Nantucket?
    1. If yes, what were the materials?

    2. If Yes: Would you say these materials have helped inform you of the coastal hazards relevant to you?
    3. If Yes: Would you say these materials have helped inform you of any resiliency methods relevant to you? [MB3]
12. In your opinion, how effective are the town's education and outreach efforts on coastal resiliency? What steps they can take to improve these efforts?
13. Are you aware of any informational materials regarding coastal resilience produced by other organizations?
    1. If Yes: How would you say these materials helped inform you on their subject matter?
14. How capable do you find the town government to be when suggesting best resilience practices?
15. Which outreach materials do you prefer and why?
16. What resiliency information would be helpful to you that you aren't already aware of?
17. What is the best way to get relevant resiliency information to you? This could mean emails, magazine placements, community town halls, etc.
18. What makes those communication methods preferable to you?
19. Anything else you would like to share?

Appendix D: Experts Interviewed

Name	Job Title	Organization	Date(s) of Interview
Jennifer M. Karberg	Director of Research & Partnerships	Nantucket Conservation Foundation	10/30
Neil Foley	Interpretive Education Coordinator/Ecologist	Nantucket Conservation Foundation	10/30, 11/13
Isaac Hersh	Environmental Educator	Nantucket Conservation Foundation	10/30, 11/13
Shelly McComb	Coastal Resilience Specialist	Cape Cod Cooperative Extension	10/31
Erin Perry	Deputy Director	Cape Cod Commission	11/6
Heather McElroy	Natural Resources Program Manager	Cape Cod Commission	11/6
Elizabeth Phelps	Environmental Permitting Coordinator	Nantucket Land Bank	11/6
Seth Engelbourg	Naturalist Educator and Program Manager	Linda Loring Nature Foundation	11/8
RJ Turcotte	Nantucket Waterkeeper	Nantucket Land and Water Council	11/13
Anna Day	Communications Manager	Nantucket Land and Water Council	11/13
Poonam Narotam	Communications & Outreach Specialist	Woods Hole Oceanographic Institution	11/18
Balakrishnan Balachandran	Executive Director	UMass Boston Sustainable Solutions Lab	11/19
Irina Polunina-Proulx	Project Coordinator	ResilientWoodsHole	11/20
Theodore Keon	Director of Coastal Resources	Town of Chatham	11/25

Greg Berman	Director of Natural Resources	Town of Chatham	11/25
Melyssa Nickerson	Environmental Planner & Conservation Agent	Town of Provincetown	11/26

Appendix E: Survey Community-Seasonality and Supergroup Composition

Community-Seasonality	Community-Seasonality Counts	Supergroup Counts
All Respondents	522	
Brant Point - Seasonal	52	62
Brant Point - Year-round	10	
Fishers Landing - Seasonal	1	77
Fishers Landing - Year-round	1	
Madaket Residents - Seasonal	42	
Madaket Residents - Year-round	26	
Smith Point - Seasonal	7	
Mid-Island - Seasonal	1	89
Mid-Island - Year-round	2	
Nantucket Town - Seasonal	32	
Nantucket Town - Year-round	35	
Shimmo - Seasonal	19	
Pocomo - Year-round	1	88
Polpis - Seasonal	1	
Polpis - Year-round	5	
Quidnet Squam - Year-round	3	
Siasconset - Seasonal	55	
Siasconset - Year-round	23	
Cisco - Seasonal	4	206
Cisco - Year-round	2	
Hummock Pond - Seasonal	10	
Hummock Pond - Year-round	5	
Surfside - Seasonal	114	

Surfside - Year-round	52	
Tom Nevers - Seasonal	13	