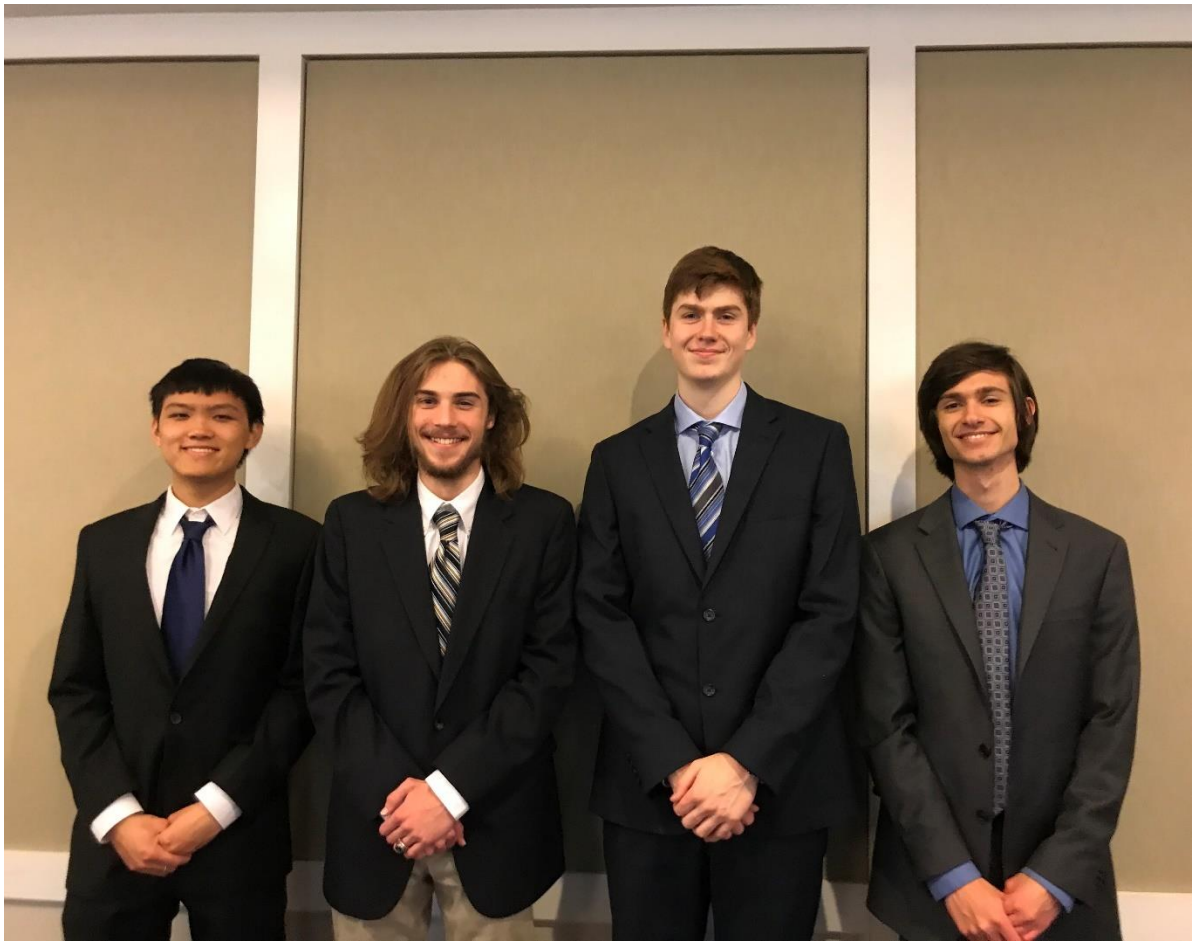
Moby: Addressing Coastal Litter on Nantucket Through Functional Art



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Moby: Addressing Coastal Litter on Nantucket Through Functional Art

An Interactive Qualifying Project
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WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements of the
Degree of Bachelor of Science

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Abstract

Artists around the world have created captivating sculptures to raise awareness of the growing problem of marine litter and pollution. In this vein, we collaborated with the Nantucket Department of Public Works and the Marine Mammal Alliance Nantucket to design a functional public sculpture in the image of a sperm whale called *Moby*. This iconic sculpture will serve as an attractive receptacle for trash and recyclables and encourage people to collect and dispose of coastal litter found on the beach. The *Moby* project will spread awareness of the impact litter has on the marine environment and its wildlife through informational signage, local outreach, and the symbolic image of marine litter filling the body of a whale.

Acknowledgements

We would like to thank the many individuals and groups who helped make this project possible:

- The **Nantucket Department of Public Works**, especially our project liaisons **Rob McNeil** and **Graeme Durovich**, as well **Richard Moore** and **Eric Johnson**.
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- **Evemarie McNeil**, the **Nantucket Intermediate School** teaching staff, **Matthew Liddle**, and the **Nantucket New School** teaching staff for the opportunity to present our project and its message to their students.
- **Amanda Bardsley** of the **Cyrus Peirce Middle School** for advice on educational outreach.
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- **Ilaria Wernick**, who collaborated with the team through the processes of performing background research and writing the project proposal during the first half of the semester.

Executive Summary

Introduction

Litter pollution in the world's oceans is increasingly recognized as an urgent and growing problem. It poses a severe hazard to many kinds of marine wildlife, and potentially humans as well. The island of Nantucket, located off the coast of Massachusetts, faces a significant coastal litter problem. Naturalists and others on Nantucket regularly find seals, whales, and other wildlife suffering from damage caused by plastic entanglement or ingestion. It has become increasingly popular to combine art with activism in order to promote better environmental stewardship. The Nantucket Department of Public Works [DPW] is always looking for innovative and effective ways to better manage waste and recyclables on the island. In keeping with the island's history, the DPW in cooperation with the Marine Mammal Alliance Nantucket [MMAN] proposed the creation and installation of an iconic sculpture in the shape of a sperm whale called *Moby*.

Methodology

The goal of this project was to assist the DPW and MMAN in developing a sculpture that will serve as a litter receptacle and as a means of raising public awareness about coastal litter. We identified five main objectives to accomplish to achieve this goal:

1. Selected an optimal site and position for the installation of the sculpture.
2. Developed and evaluated conceptual designs for the sculpture.
3. Developed an operational plan in cooperation with the DPW to service the receptacle.
4. Created ancillary public education and outreach materials on plastic waste and coastal litter to present to Nantucket elementary school students.

Implementation

We identified the parking lot for Surfside Beach as the optimal location for *Moby* due to its accessibility to the DPW, popularity and public visibility, and the amount of litter that accumulates there.

We developed a series of rough sketches of initial design concepts and consulted our sponsors to determine which ideas they preferred. We also consulted the creators of prior similar sculptures such as the untitled sculpture commonly known as *Yoshi the Fish*, *Treadgold Fish*, and the litter sculpture collection by Keep Golden Isles Beautiful, to identify key factors to consider when designing a sculpture, selecting building materials, and creating informational signage.

Building on the initial concepts, we developed more detailed drawings and design criteria in an iterative process that involved the team, our sponsors, and the sculptor. The final design concept, shown in Figure 1, features a steel mesh-covered head with static displays of coastal litter on the sides and internal removable barrels for collecting deposited litter, a wooden body enclosing eight receptacles for trash, recyclables and compostables, and a steel tail with a static display of litter inside and a fluke. During the development of the design concepts, we learned that the Nantucket Regional Transit Authority was planning to install a bus shelter at Surfside in memory of the late local surfer, David Ozias. We were able to modify our design so that the flukes of the whale will serve as the shelter.

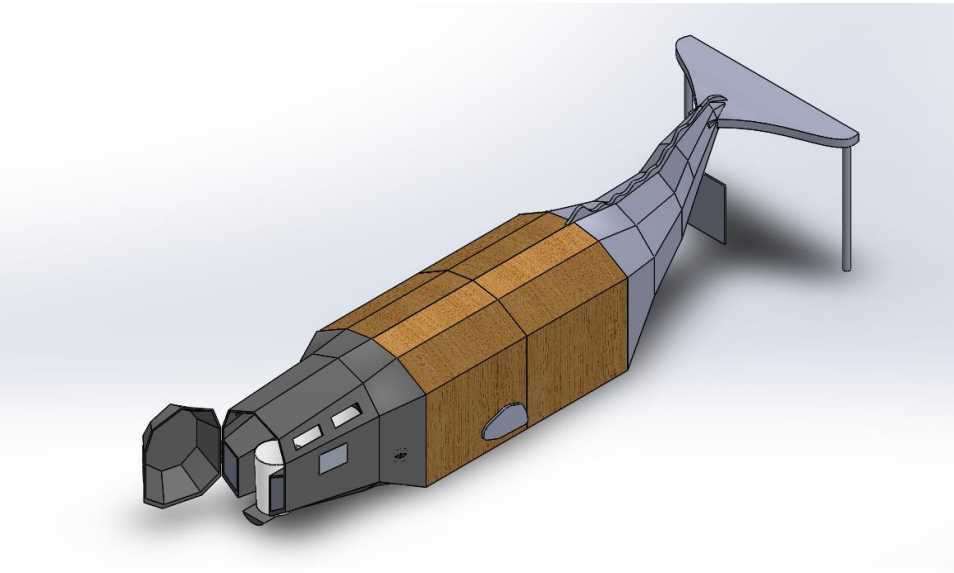

Figure 1. The final design of *Moby*

We also used an iterative process to design instructional signage informing people how to use *Moby* as a beach litter receptacle and informational signage explaining *Moby*, its pro-environmental message, its connection to Nantucket's history, and actions people can take to reduce coastal litter and plastic pollution. The final design for the instructional signage is presented in Figure 2 and the final design for the informational signage is presented in Figure 3.

Figure 2. The final design of *Moby*'s instructional signage.

To address the project objective of public outreach and raising awareness, the team met with local Nantucket schools to encourage their students to get involved in the *Moby* project. We proposed ideas for potential student activities to teachers. The Nantucket Intermediate School and Nantucket New School also allowed us to present to fifth grade students about marine litter, our project, and how students can get involved in keeping the ocean clean. Additionally, we arranged to have our project featured at the and marine wildlife and environmental sustainability-themed New Year's Eve Gala Under the Sea Dinner & Dance Party hosted by the Nantucket Hotel and Resort. This will serve as an opportunity to gain exposure, raise awareness, and obtain donations for the project.

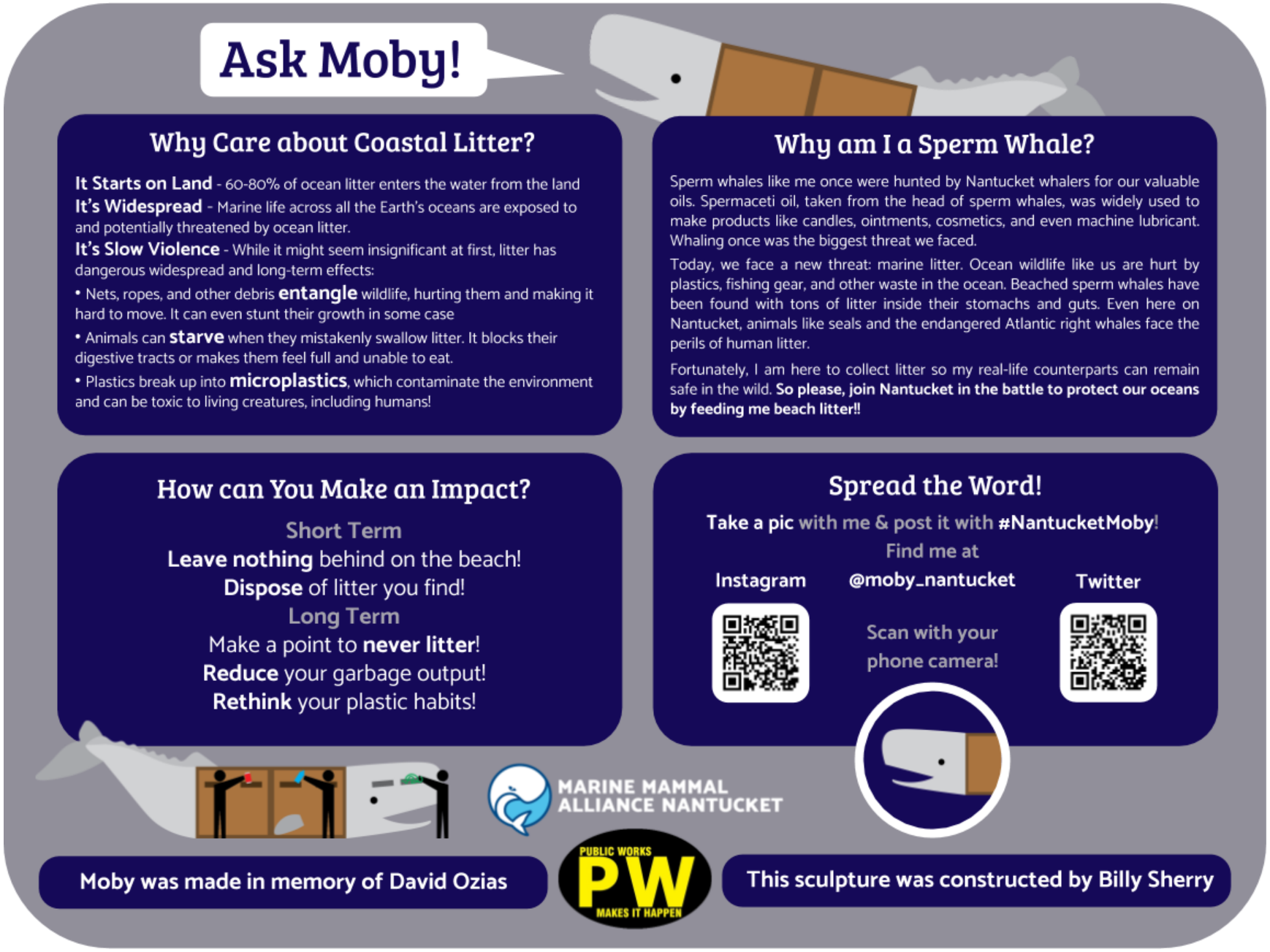

Figure 3. The final design of *Moby*'s informational signage

Conclusions

From our findings the team concluded that there is substantial support on the island for a functional coastal litter sculpture that uses an iconic image from Nantucket's past, the mighty sperm whale, to raise awareness about coastal litter, recycling, waste management, and how it affects the ocean's wildlife. Public art pieces, particularly those that serve other purposes aside from aesthetics and symbolism, can be used as an effective medium to promote public awareness, but the messages need to be reinforced through multiple channels, such as school programs, social media, and informational advertisements and posters. We determined that *Moby*, along with any future beach sculptures that may be created, must balance eye catching imagery with practical considerations, such as usability, ease of access for the DPW staff, materials that minimize costs and maximize durability in a coastal environment, and effectiveness of the sculptures' placement.

While encouraging responsible recycling is laudable, the ultimate goal is to fundamentally shift public perceptions and dramatically minimize the use of plastics in the first place as a way to protect the health of the ocean and its wildlife. The concept of "slow violence", or the damage committed by mankind on the environment in ways that are usually gradual and often unseen, has been a recurring theme in this project. Drawing attention and advocating for a voiceless entity, has been a major topic throughout this project. By creating a sculpture of a sperm whale filled with coastal litter, the project can raise awareness of this act of slow violence in a way that ties into local history and creates a deeper connection with the people who interact with it. Based on these conclusions, we recommend:

- The DPW, MMAN, sculptor, Ozone Surf Classic Fund, and others continue to collaborate in order to complete the construct of the sculpture.
- The DPW continue to collaborate with the MMAN, the sculptor, the Ozone Surf Classic Fund, and others to develop a public outreach/marketing plan for the installation of *Moby* in spring/summer 2020.
- The DPW and MMAN monitor and maintain the *Moby* social media to determine its popularity and adjust messaging as needed.
- The DPW and MMAN work together with the schools to further develop the educational materials prepared by the team.

- The DPW monitor the coastal litter collected in *Moby* to better characterize that stream and adjust signage and informational materials as necessary.
- The DPW and MMAN consider further additions or adaptations to *Moby,* as well as the installation of additional sculptures on other beaches on Nantucket based on the *Moby's* success.

Authorship

Leonardo Go, Cameron LeBlanc, Evan Ryan, and Joseph Stadolnik all contributed heavily to the research and writing of this report. Ilaria Wernick also contributed additional work to the Background section. The breakdown of authorship and editing for the report, as well as other significant project contributions, was as follows:

Leonardo Go was the primary author of the following sections: the Introduction, Background sections 2.1 and 2.1.2, Methods sections 3.2.4 and 3.2.5. He was a primary editor of Findings sections 4.4 and 4.6, Methods, Conclusions and Recommendations. Mr. Go also served as the primary two-dimensional artist on the team, creating most conceptual drawings of sculpture designs and elements as well as graphical elements for signage, presentations, this report, and social media.

Cameron LeBlanc was the primary author of the following sections: Background section 2.3, Methods sections 3.1 and 3.2.3, Findings section 4.4, Conclusions, and Recommendations. He was a primary editor of the Findings and Maintenance Plan. Among Mr. LeBlanc's most critical contributions was the creation of all three-dimensional models of the sculpture, its components, and the many iterations of their designs.

Evan Ryan was the primary author of the following sections: the Introduction, Background sections 2.2.1 and 2.2.2, Methods sections 3.1, 3.4.1, and 3.4.2, Findings sections 4.2, 4.3, and 4.6, and the Conclusions. He also was the primary editor of Findings section 4.4. Mr. Ryan also served as the primary spokesperson of the team during interviews and in many communications with sponsors. In addition, he contributed digital illustrations of some sculpture designs and details, and was the primary author and creator of educational content for the Nantucket school presentations.

Joseph Stadolnik was a primary author of the following sections: Background sections 2.2.2, 2.2.3, and 2.3; Methods sections 3.1, 3.2.1, 3.2.2, 3.3, 3.4.1, and 3.4.3; Findings section 4.5, and the Maintenance Plan. He also served as the primary editor for much of this report, particularly the Background, Methods, Conclusions, and Recommendations sections. In addition, Mr. Stadolnik acted as a primary editor for the presentations and developed all signage for the sculpture. He also handled much of the team's communication with sponsors, collaborators, and other relevant parties.

The Executive Summary was written collaboratively by the team. Likewise, the Appendices, with the exception of the Maintenance Plan (Appendix F), were written by the whole team.

Ilaria Wernick was a primary contributor to section 2.2.1, Impacts on Wildlife, the Environment, and Humans. Ms. Wernick was also involved in the initial planning of the educational outreach portion of the project.

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1. Introduction

Litter pollution in the world's oceans is increasingly recognized as an urgent and growing problem. The oceans are heavily contaminated with plastic litter, which gets carried by currents and washes up on beaches. It poses a severe hazard to many kinds of marine wildlife, and potentially humans as well. The island of Nantucket, located off the coast of Massachusetts, faces a significant coastal litter problem. Naturalists, coastguards, and other individuals on Nantucket regularly find seals, whales, and other wildlife suffering from damage caused by litter entanglement or ingestion. Nantucket is a popular tourist destination and thousands of visitors as well as year-round residents flock to its beaches in the summer. Coastal trash detracts from public enjoyment of the beaches and thus threatens not only the natural wildlife but also the economy of Nantucket (Nantucket History, n.d.).

It has become increasingly popular to combine art with activism in order to promote better environmental stewardship. Large, eye-catching sculptures, such as the untitled sculpture in India commonly known as *Yoshi the Fish* and a similar piece in Indonesia called *Goby the Fish*, have been installed on beaches to serve not only as litter receptacles but also to promote greater awareness about the problem of plastics in the oceans (Menezes, 2019). The Nantucket Department of Public Works [DPW] is always looking for innovative and effective ways to better manage waste and recyclables on the island. In keeping with the island's history, the DPW has recently proposed the creation and installation of a similar art piece called *Moby* in the shape of a sperm whale.

The goal of this project was to assist the DPW in developing and installing a sculpture that will serve as a litter receptacle and as a means of raising public awareness about coastal litter. In order to achieve this goal, we identified four objectives. The team:

1. Selected an optimal site and position for the installation of the sculpture.
2. Developed and evaluated conceptual designs for the sculpture.
3. Develop a maintenance plan to guide the DPW in servicing the sculpture.
4. Create ancillary public education and outreach materials on plastic waste and coastal litter.

These objectives were accomplished by conducting numerous interviews with our sponsors, town personnel, clean-up organizations, artists, and other relevant parties, collaborating with

local artists to design and construct the sculpture, and developing educational materials to promote public awareness and behavioral change.

2. Background

In preparation of fulfilling this goal, we have reviewed the physical and psychological aspects of the problem. This includes the fundamental issues of plastic pollution, the effects of plastic litter on both wildlife and humans, and the psychological and behavioral reasons behind littering, and innovative approaches to promoting pro-environmental behavior. We will then focus on coastal litter and the impacts it specifically has on Nantucket.

2.1. Plastic Waste in the Ocean

Marine pollution is not a new problem, but it is more urgent than ever. Some of the earliest reports of plastic pollution appeared in the 1980s, although these early reports were often dismissed as non-urgent issues (Derraik, 2002; Ritchie & Roser, 2018). The problem has grown at an alarming rate, and only now is the world beginning to realize the scale of the issue and its serious consequences. From the 1950s to the 2010s, the production and usage of plastic has increased by nearly 2000%, and as the production of plastic skyrocketed so has the disposal of plastic, much of which ultimately ends up in the oceans (Li, 2016; Ritchie & Roser, 2018). In 2015, it was estimated that 4.8-12.7 million metric tons of plastic enter the ocean each year (Kandziora et al., 2019). As shown in Figure 4, around 8.3 billion metric tons of plastic were produced globally by 2015, and 6.3 billion metric tons had been discarded, with 79% of the discarded plastics dumped in landfills or the natural environment (Geyer, Jambeck, & Law, 2017).

Aside from its abundance, plastic is also notoriously durable; many plastics are expected to last up to 500 years or more (Derraik, 2002). When plastic finally degrades, it does not decompose like organic materials, but disintegrates into smaller particles, known as microplastics, which contaminate bodies of water and wildlife food chains (Derraik, 2002; Li, 2016; Ritchie & Roser, 2018; Almroth & Eggert, 2019).

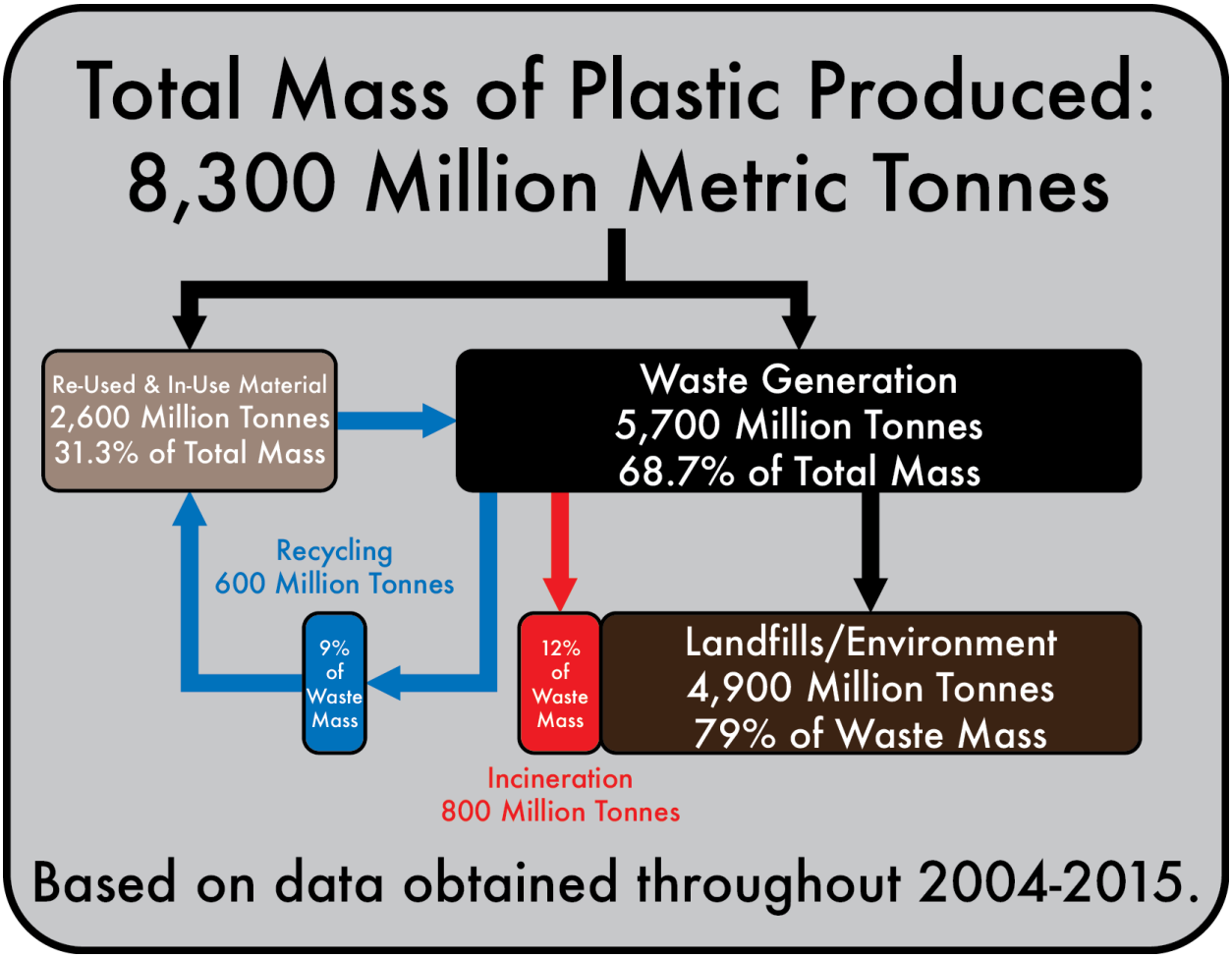

Figure 4. Graphic showing the quantities of plastics that are made, re-used, or end up in the environment or landfills. The weight of generated waste shown does not include the 600 million metric tons that get recycled (US Plastic Waste Streams, 2018).

Litter ends up in our oceans through a variety of different ways. A common point of entry is from people throwing their garbage into the sea or nearby beaches and rivers. Between 60% and 80% of ocean litter originates from land, particularly from coastal cities and towns, and is carried out to sea via rivers. Most of this litter consists of plastic bags, food wrappers, bottles, and cigarettes (Li, 2016; Almroth & Eggert, 2019; Sheavly & Register, 2007). A survey in 2015 showed that more than 80% of the litter carried to the sea through rivers originates in Asia (Ritchie & Roser, 2018).

A considerable amount of litter also originates from large ships, especially fishing boats, that often dump large quantities of trash at a time. Observations from 2003 to 2015 reported more than 10,000 pollution incidents from purse-seine fishing boats in the Pacific; 71%

consisting of purposely dumping waste, 37% of which was plastic waste (Richardson et al., 2017). Fishing boats sometimes leave fishing gear behind, either by accident or as part of the dumping, which further contribute to the pollution problem. The vast size and continuous movement of the ocean means that it is difficult to measure how much waste ships are contributing, but appears that ships getting rid of onboard waste are a major source of plastic pollution. International regulations have been put in place, such as the 1972 London Dumping Convention [LDC] and the 1978 Protocol to the International Convention for the Prevention of Pollution from Ships [MARPOL], but enforcement and compliance remain problematic (Derraik, 2002; Sheavly & Register, 2007; Li, 2016; Richardson et al., 2017).

One other major factor that spreads ocean litter is the constant movement of currents and rivers. The lightweight, buoyant nature of most litter, particularly plastics and fishing gear, allows the debris to float within the water column, and over time the debris is carried across the ocean through the currents, spreading far and wide around the globe. In some cases, the floating debris gathers into huge garbage patches, such as those shown in Figures 5 and 6.

Figure 5. Photo of an ocean garbage patch. Most of the debris consists of lightweight plastic products (Ocean garbage patch, 2018).

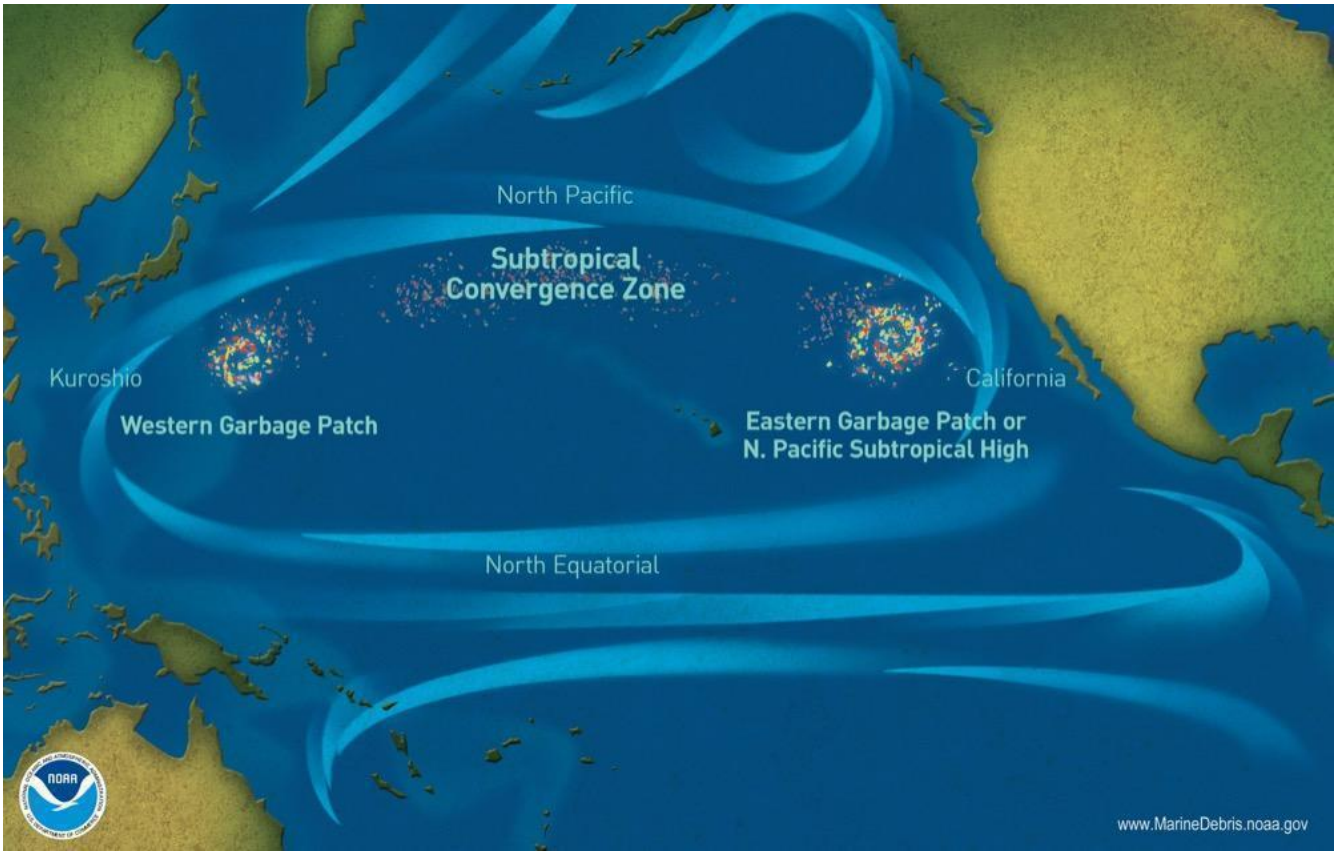

Figure 6. Map of ocean currents showing garbage distribution in the Pacific Ocean (Great Pacific Garbage Patch Vortex, 2018).

2.1.1. Impacts on Wildlife, the Environment, and Humans

Ocean littering has been demonstrated to have a significant adverse impact on marine life. In addition to constituting the majority of oceanic litter, plastics have proven to be a particularly devastating hazard to oceanic life by way of both ingestion and entrapment (Cressey, 2016; Derraik, 2002). The former is oftentimes due to this waste being mistakenly ingested as food by wildlife. Entrapment can also hinder the animal's ability to move, like with the seal shown in Figure 7, and cause severe lacerations, chafing, or death by drowning (Sheavly and Register, 2007; Derraik, 2002). We are now beginning to learn that microplastics can have substantial adverse impacts on wildlife as well. For example, one study of Pacific oysters found a 41% decrease in offspring for the individuals under microplastic exposure. Another study found that consumption of plastics impaired development in fish in terms of size and sense of smell, and this in turn increased their risk of predation (Cressey, 2016). In total, more than 550 animal

species have been definitively impacted by oceanic waste through either ingestion or entrapment, including mammals, birds, and all sea turtle species. Although there are no concrete numbers on how many individuals are affected by plastic, some studies estimate that around 80-90% of all individual seabirds have ingested plastic (Rochman et al., 2016; Almost all seabirds…, 2015). Frequently stated estimates indicate that approximately 100,000 marine mammals and 1,000,000 birds die each year from plastic ingestion, but these numbers are difficult to substantiate (Wilks, 2006). Similarly, there is currently a lack of clear data on the magnitude of threat that oceanic plastic poses to human health (Seltenrich, 2015). However, given the increased awareness of the adverse impacts on wildlife, there is growing concern about the human ingestion of microplastics through contaminated seafood (Barboza, Vethaak, Lavorante, Lundebye, and Guilhermino, 2018).

Figure 7. Entangled juvenile gray seal (Leonard, 2017). Under permit of National Marine Fisheries Service.

Plastic accumulation in oceanic habitats is a major problem that must be addressed promptly in order to minimize the number of living organisms that are placed in harm's way. This includes reducing the quantities of ocean-borne plastics that, inevitably, make their way to the world's coastlines. It is difficult to identify the exact magnitude of this problem, as information cannot be readily found on quantities of coastal litter. S

Some locations do have concrete data, including Chile, Britain, the states comprising America's western coast, and Henderson Island, but this type of information is far from ubiquitous (Kiessling, Salas, Mutafoglu, and Thiel, 2017; Nelms et al., 2017; Hardesty, Wilcox, Schuyler, Lawson, and Opie, 2017; Lavers and Bond, 2017). As such, there is no broad compilation of data on the quantities of coastal litter worldwide, and thus there is no clear measure of the scope of this issue on a global scale.

2.1.2. Coastal Litter

In the locations that do have data about coastal litter, there is serious cause for concern regarding its environmental and societal impacts. Coastal litter comprises of the nonbiodegradable plastics and other materials that wash up on the shores and accumulate in the surf-zones (i.e., the waters where waves begin to break). This debris creates a range of environmental, economic, and health-related issues (Kiessling et al, 2017). A 2017 report by the National Oceanic and Atmospheric Administration (NOAA) established a baseline estimate of the amounts, types, and distribution of coastal litter in the United States (Hardesty et al, 2017). The authors found that, according to four different data sets, there was an average of between 0.2 and 16.5 debris items per meter of coast, indicating a total of between 20 million and 1.8 billion items along the U.S. tidal line (Hardesty et al, 2017, p.6). Coastal litter on beaches and in surf-zones may cause health problems in multiple ways. For instance, litter rotting on the beaches can become health hazards for pets and children, stray glass and other sharp objects can lead to injury, and toxins can be ingested through the consumption of locally-caught seafood that has been contaminated with microplastics. Combating these hazards with clean-up effort tends to be very expensive for local governments, and in most cases is mainly handled by volunteer and non-profit organizations instead. However, failing to address the issue can lead to a decrease in revenue from tourism due to the unappealing appearance of the coast, as well as cause additional damage to aquatic structures such as boats, harbors, and sewage systems (Kiessling et al, 2017).

Fortunately, there is are growing coastal litter efforts to increase public knowledge and action rising to match this threat.

Many communities have engaged in efforts to stop littering through public information, education, and outreach. Some communities have used innovative approaches, such as public art displays. One such display is an untitled sculpture in Karnataka, India often known as *Yoshi the Fish*, shown in Figure 8, which is meant to highlight the harm that litter does to the wildlife while helping clean up the beach. For simplicity, future references to this sculpture will refer to it as *Yoshi*. This project has been so effective that similar art displays have appeared around the world, such as *Goby* in Bali, Indonesia and *Nipsey* in Martha's Vineyard, Massachusetts, shown in Figures 9 and 10, respectively (Menezes, 2019; Pline, 2019). In order to identify more effective means of combating coastal litter, however, it is crucial to first understand why people litter in the first place.

Figure 8. Photograph showing an untitled coastal litter-collecting sculpture, commonly known as *Yoshi*, created by Janardhan Rao Havanje in Karnataka, India (*Yoshi the Fish*, 2018).

Figure 9. Photograph of *Goby the Fish*, a specially-shaped beach trash can at the W Bali - Seminyak hotel in Bali, Indonesia (*Goby the Fish*, 2019).

Figure 10. Photograph of *Nipsey,* a shark sculpture constructed using beach litter on Martha's Vineyard, Massachusetts (Pline, 2019).

2.2. Psychology of Pro-Environmental Behavior

Human psychology and public perception are key factors that help explain littering and other environmentally-harmful behavior. Awareness and understanding of these factors are critical to developing innovative ways to address it. This section will examine the question of who litters and what motivates them to do so, as well as discussing how experiments involving human psychology are used to understand the variables that affect human behavior. Using findings of human psychology and behavior like these, environmentalists across the globe are finding new ways and approaches to aid in the fight against plastic pollution.

2.2.1. Who Litters and Why

In order to address the problem of coastal litter effectively, one must look at why people litter in the first place. A case study in the United Kingdom by Dr. Fiona Campbell found that most people littered and blamed it on "factors outside of their control" such as the lack of recycling bins, not knowing what to do with recyclables or where to put litter, and being in a moving car (Campbell, 2007). This idea that proper accessibility to trash receptacles will lead to a decrease in litter is supported in a study conducted by Bator, Bryan, and Schultz, where a survey found a decrease in litter when trash receptacles were present (Bator, Bryan, & Schultz, 2010). In a later experiment conducted in 2011, Schultz, Bator, and three others found a correlation between trash receptacle placement and a decrease in litter, with the lowest rate of littering happening when the trash receptacle was less than 20 feet away (Schultz, Bator, Large, Bruni, & Tabanico, 2011). Conversely, a 1988 study found that simply adding more receptacles did not correlate to a decrease in litter. These contrasting findings led the researchers to believe that it is important to carefully consider where to place receptacles, as they need to be both convenient to access and in places where people are most likely to dispose of trash, as this should produce the lowest rate of littering (Schultz et al. 2011).

Respondents in the Campbell survey also pointed to other reasonings for their transgressions, notably being in their teenage years or subjected to peer pressure (Campbell, 2007). A number of other studies have supported this notion that youths litter more frequently than older people. For example, Casey and Scott (2006) found that older people are generally more concerned about protecting the environment by disposing of trash appropriately.

Additionally, Bator et al. (2010) determined that younger people are less likely to have "strong antilittering [*sic*] norms." The notion that younger people litter more than older people is a recurring finding in this type of research.

On the other hand, there are also reasons people may choose to avoid littering. In 2001, Vaske and Kobrin studied teenagers aged 14-17 who were involved in environmentally-oriented work programs to observe how personal relationships to nature and places correlate with environmentally responsible behavior. They found that when someone has a reason for interacting with a space regularly they become attached and invested to that place, and this in turn makes them more likely to act environmentally responsibly towards it (Vaske & Kobrin, 2001). As such, littering and other environmentally harmful behaviors may result from a lack of personal emotional connection to the affected location.

It is clear that a complex range of factors are involved in determining whether or not people will litter. Social, societal, situational, and personal influences all apply, and this makes effectively combating littering and promoting pro-environmental behavior a complicated task. In order to successfully tackle littering, one must employ an understanding of human psychology to identify effective methods to affect these factors and change people's outlooks and behaviors.

2.2.2. Human Behavior Analysis

Human psychology is the driving factor in what motivates people's behavior. According to William Fox, behavior cannot be changed simply by demanding someone to act or feel in a certain way, but rather by enforcing a message powerful enough that it serves as a catalyst for them to change their assumptions on their own terms (Fox, 1981, p. 148-149).

Research has demonstrated that a range of methods can achieve such behavioral changes, especially when used in combination. An experiment done in Hong Kong observed how mass media plays a role in affecting attitudes towards environmentally friendly behavior, particularly when addressing the local environmental problems caused by a rapidly growing population. The experiment set out to record behaviors of different families on an affordable housing facility when it comes to recycling. The results of the study support Ajzen's theory of planned behavior, which states that "a person would demonstrate a certain behavior if he or she perceived themselves to have sufficient control over internal and external factors" (Ajzen, 1991). In other words, the subject must be physically able to fulfill this behavior, feel as though they are acting

under their own volition, and also believe their desired outcome will be achieved. In addition, the study found that personal influences such as friends and family were just as impactful as mass media like TV ads, public art, and infographics (Chan, 1998).

On a similar note, a different study in Baton Rouge, Louisiana found that while in-person contact is the most effective, many methods of prompting people to recycle are impactful. Groups of residents at local college apartments were provided with a recycling program and various levels of information about it: one got just an informational flyer, another got a flyer with a pledge card they could use to declare they will take part in the recycling program, and a third got a flyer, a pledge card, and an in-person visit and interview to encourage them to recycle. The researchers found that getting people to pledge to recycle caused no significant increase in actual recycling behavior, but all groups actively recycled to some extent. The third group, which received personal contact from the researchers, recycled on average nearly twice as often as either of the others. Furthermore, when the study was extended but the participants were informed they were no longer obliged to participate, the recycling rates of all groups remained stable or even rose (Reams & Ray, 1992). Based on these findings, it appears that while personal connection and interaction heightens its effectiveness, simply providing an informed opportunity to take part in pro-environmental behavior like recycling can be sufficient to inspire action.

In an attempt to find a correlation between effective signage and decreases in litter, a study in Mt. Field National Park, Tasmania, applied Azjen's theory of planned behavior to create anti-littering message. After placing these signs, shown in Figure 11, the researchers found that the amount of litter people collected increased by 15-20%, and that the second version, which was designed to appeal to people's morals, prompted people to comply 5% more (Brown, Ham, & Hughes, 2010). This shows that the proper signage can decrease cost of litter cleanup while directly helping to protect the natural environment. While providing information and a call to action through signage, flyers, and other sources is demonstrably effective, environmentalists are also turning to more innovative ways to address the litter problem.

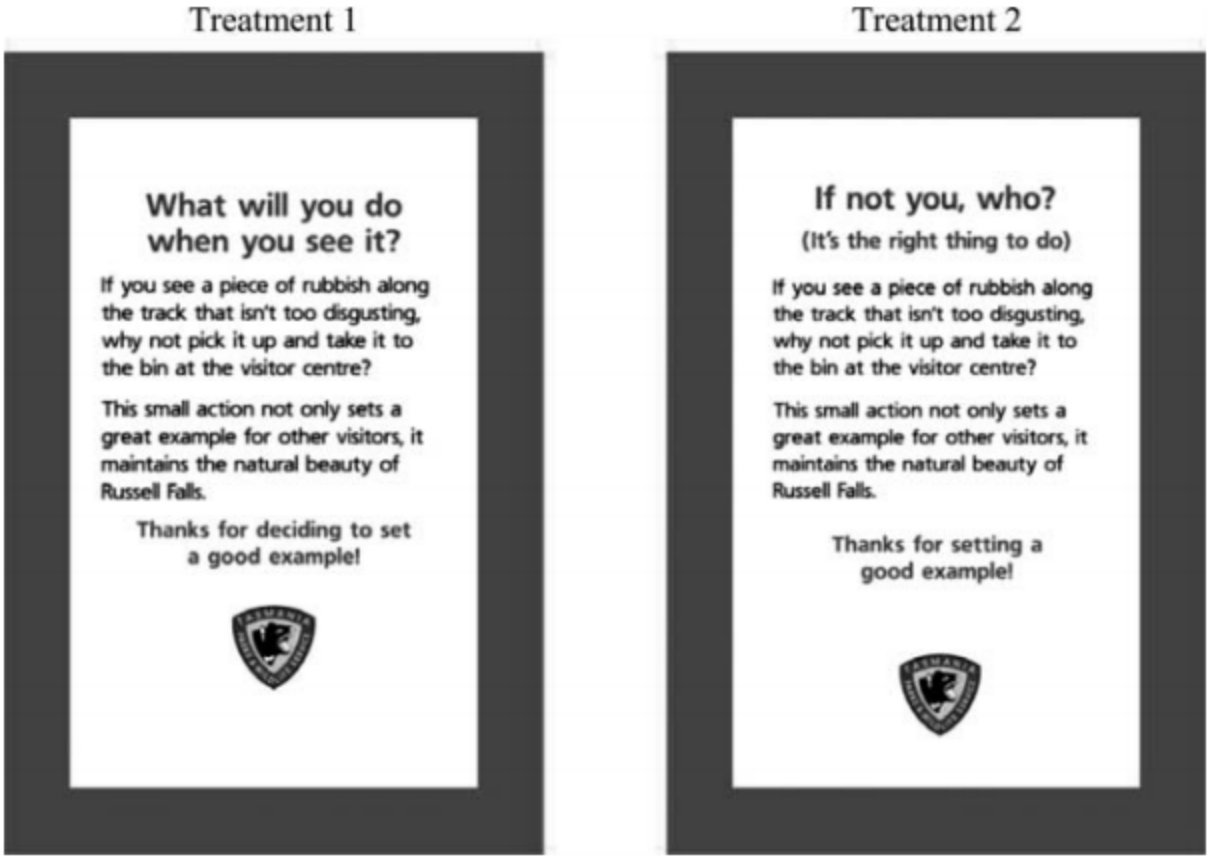

Figure 11. Anti-littering signage placed at Mt. Field National Park, Tasmania from an experiment done to observe the effects of different messages on the amount of litter in the park (Brown, Ham, & Hughes, 2010).

2.2.3. Innovative Approaches to Changing Public Perspectives

While there is no universally applicable or effective approach to encouraging people to change their behavior, attitudes, and actions on environmental issues, a range of additional techniques have been explored that leverage the ideas and methods of more conventional approaches.

In an effort to promote pro-environmental behavior in teens, professors at Utah State University collaborated with Logan City, Utah to host a contest to create posters to promote clean air, mainly by encouraging drivers to turn off the car when in idle. The students created posters incorporating elements teenagers would connect to such as pop culture, humor, and social media. A survey demonstrated that the contest "increased student awareness about local air pollution" (Stafford & Brian, 2015, p. 49) and subsequently led to better understanding about air quality and increased willingness to engage in more eco-friendly driving behavior (Stafford & Brain, 2015). While this article did not detail the long-term effectiveness of the posters as messaging tools, it shows that proactive, self-education is more effective than mere passive reception of a message.

One recurring approach to changing perspectives is to incorporate litter or other waste into artistic pieces that aim to draw attention to issues surrounding the particular types of trash they contain. In Córdoba, Argentina an art studio called Designo Patagonia created a collection of street furniture shaped like tetrominoes that were filled with recyclable items and also featured informational messages, such as the one in Figure 12 (Lisa, 2011). Efforts like the Washed Ashore Project seek to raise awareness of the issue by recycling beach litter in the form of art installations. It is a travelling art exhibit composed of sculptures of marine life, like *Octavia the Octopus* shown in Figure 13, constructed from metal frames and coastal litter (Ocean Ambassadors, 2019; Chung & Brown, 2018). A professor and doctoral student at the University of Houston also created a document of educational activities for students in fourth through eighth grade that focuses on the collection and encourages youth to learn about the issues it highlights (Chung & Brown, 2018). A different approach in a similar vein is a collection of metal sculptures containing static displays of litter that were created by Keep Golden Isles Beautiful, a non-profit organization from the Golden Isles of Georgia that focuses on waste, recycling, and

litter prevention (Keep Golden Isles Beautiful, n.d.). This organization developed six different litter prevention sculptures featuring animals native to their region, as well as signage with facts about litter and information about each animal. Figure 14 shows one of their sculptures, shaped like a right whale, and Figure 15 shows the informational signage that accompanies it. The project hosted a clean-up event the day the sculpture was installed and the litter collected was used to fill the sculpture (King-Badyna, L., personal communication, October 30, 2019). Although pieces like these only directly recycle a relatively small amount of waste, the hope is that the attention they raise will prompt people to reduce their own garbage output.

Figure 12. Photograph of a piece of tetromino street furniture in Córdoba, Argentina which features recyclable materials and an informational message (Designo Patagonia, 2011).

Figure 13. Photograph of *Octavia the Octopus*, a litter sculpture from the Washed Ashore Project (*Octavia the Octopus*…, n.d.).

Figure 14. Photograph of the Right Whale sculpture by Keep Golden Isles Beautiful (King-Badyna, L., personal communication, December 9, 2019).

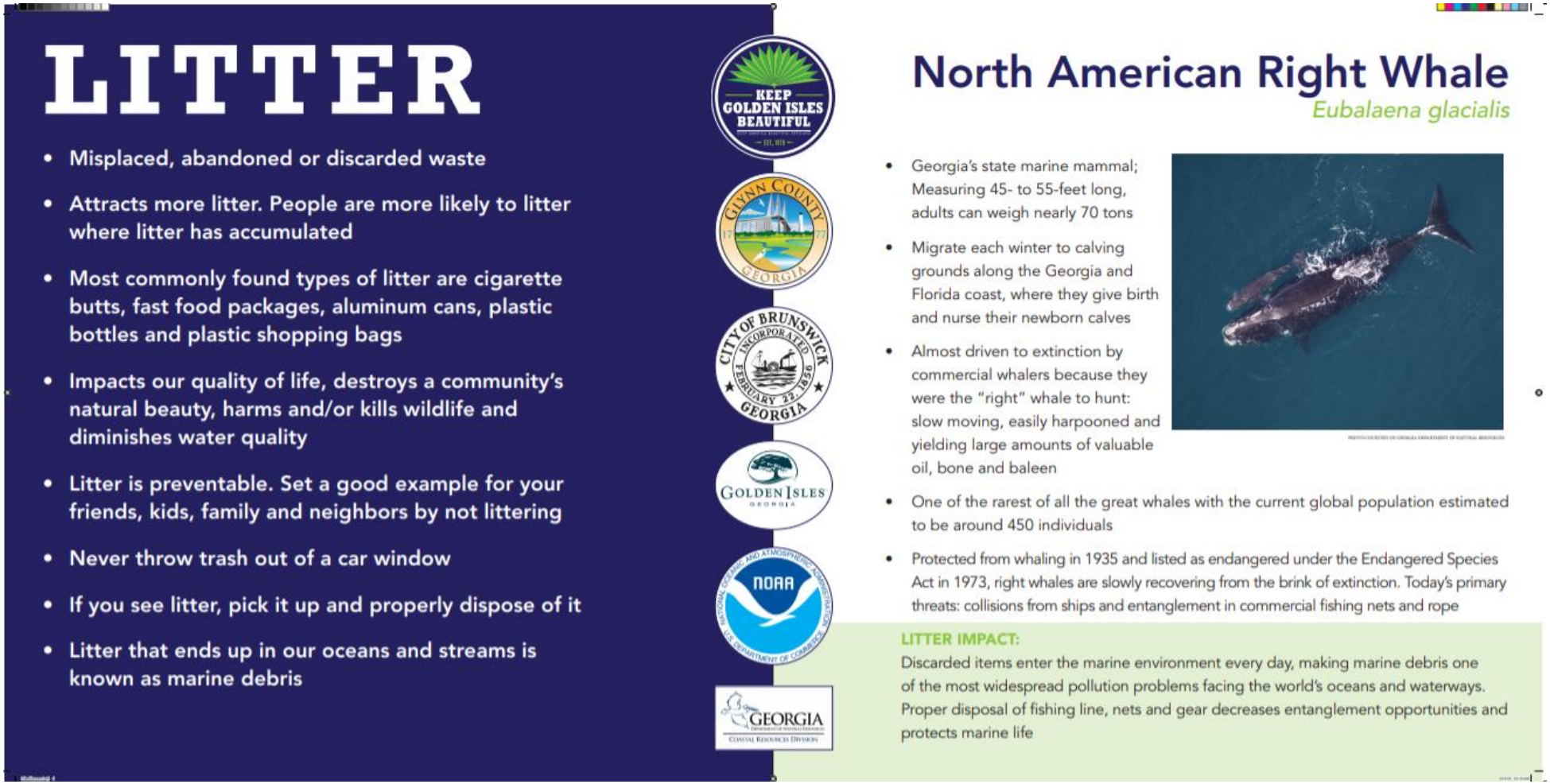

Figure 15. Signage accompanying the Right Whale sculpture by Keep Golden Isles Beautiful (King-Badyna, L., personal communication, December 9, 2019).

Other pieces of art are designed to have a more direct, enduring effect on the communities and environment around them. In June 2018, an artist named Janardhan Rao Havanje created the *Yoshi* fish sculpture in Karnataka, India (Menezes, 2019). As shown in Figure 8, this sculpture was designed to be filled with beach litter and prominently display it through its sides. It was created with the intent of showcasing the environmental and biological harm caused by plastic pollution in the ocean, while also serving as a receptacle for waste to help keep its beach clean (Dsouza, 2018). The W Bali - Seminyak hotel, located in Bali, Indonesia, heard about a similar project online and followed suit in February 2019, creating their own litter-collecting sculpture named *Goby*, shown in Figure 9 (W Bali – Seminyak, 2019). Other recent works have also been inspired by these examples, such as *Nipsey* on Martha's Vineyard. It was constructed in the shape of a shark on the island's State Beach by the local organization Friends of Sengekontacket and, as seen in Figure 10, incorporates beach litter prominently in its design. A shark is an especially fitting choice for the location, as *Nipsey* occupies the same beach that was used for filming the movie *Jaws* (Pline, 2019). This additional local connection makes the sculpture uniquely relevant to residents and tourists alike. *Treadgold Fish*, created in Portsmouth, England by the artist Pete Codling, likewise aims to connect to the local culture. As shown in Figure 16, it is a fish-shaped sculpture designed to collect and display plastic bottles. It has local ties both through its shape, which is reminiscent of the city's star and crescent symbol, and its construction, as it is made of repurposed steel from a former local ironworks, which together make it uniquely representative of Portsmouth (Codling, P., personal communication, October 29, 2019). The attention garnered by these types of functional, environmentally-friendly beach sculptures has inspired the DPW and MMAN on the island of Nantucket to express an interest in installing their own, similar sculptures.

Figure 16. Photograph of *Treadgold Fish*, a sculpture filled with plastic bottles that was built by Pete Codling. "Pompey" is an alternate local name for the city of Portsmouth, England, where the sculpture is located (Van Herck, 2019).

2.3. Littering on Nantucket

While limited data exist on the prevalence of beach litter on Nantucket, it is undoubtedly an ever-present issue. Nantucket has 22 publicly-accessible beaches over 82 miles of coastline, which attract thousands of visitors who expect and demand pristine conditions (Nantucket Beaches, n.d.; Town of Nantucket, n.d.-b). As confirmed by William "Bill" Connell, co-captain of a local cleanup organization called the ACK Clean Team, a significant range of litter makes its way from the ocean onto Nantucket beaches, including drink bottles, fishing equipment, and construction debris. In addition, visitors to the beaches often leave litter like cigarettes, candy

wrappers, picnic debris, and firewood (Connell, W., personal communication, October 25, 2019). Graeme Durovich, the Recycling/Solid Waste Coordinator serving Nantucket's DPW, reports that hour-long beach cleanups "usually fill 2-3 55-gallon contractor bags" (Durovich, G., personal communication, September 2019). One cleanup effort on the southern shore's Cisco Beach and a nearby road gathered 217 pounds of litter in July 2019. However, she notes that the levels of litter can vary dramatically by location: the northern beaches, in particular, are less prone to litter accumulation, as they are more sheltered from the open ocean. UMASS-Boston also began a broader coastal litter study on the island over the summer of 2019, but the results have not been released as of yet (Durovich, G., personal communication, September 2019).

Fortunately, Nantucket has multiple different programs and organizations working to rid the island of litter that ends up on its beaches. The DPW is the primary organization for dealing with waste, recycling, and litter on Nantucket, and they have numerous programs and services that support this goal. A crucial one is the mandatory recycling program, established in July of 1992, which requires all residential and commercial property owners on the island to recycle. This program was updated in January 2019 to require residents to put their waste through another round of sorting, separating compostable and non-compostable materials (Town of Nantucket, 2019). Other initiatives include the Take-It-or-Leave-It, a site where Nantucketers can visit to deposit and collect unused belongings, and the biodigester, which breaks down organic material from waste into compost (Town of Nantucket, 2019; Wright, Gake, Opincaru, & Curtis, 2018). The DPW has previously worked with the Nantucket school system through projects where students created songs, radio spots, and videos on properly sorting waste in order to maximize recycling and composting. Durovich states that "education about waste and litter in the schools [is] an ongoing effort by teachers, non-profits, and myself" but "new perspectives and outreach about this project are certainly welcome and needed" (Durovich, G., personal communication, September 2019).

Other programs on the island play a key role in reducing pollutants in the environment and are implemented quite frequently. #ACKLOCAL is the town's outreach initiative for promoting education and raising awareness of all things environmental. As part of this, many programs have been launched on the island such as the Stop The Straw campaign, the implementation of water bottle refilling stations, and the Single-Use Plastics Ban. Each of these programs are designed to regulate commercial use of plastics by keeping plastic straws, plastic

water bottles, and other unnecessary plastics out of stores and restaurants (Town of Nantucket, n.d.-a). Some featured informational graphics to enhance their message, as seen in Figure 17. Nantucket also has some policies designed to keep the island and its beaches free of litter, like town bylaws that require that individuals with permits for beach events are required to clean up the beach afterwards or risk being fined (Town of Nantucket, 2010).

There are also additional organizations on Nantucket that play a role in keeping the island's environment free from waste. One such group is the ACK Clean Team, which consists of over 400 members across the island committed to keeping Nantucket clean. Founded by Bill Connell, Sarah Oktay, and Grant Sanders in 2009, the Clean Team meets every Saturday between May and November to go out and collect litter strewn across the island and, on average, cleans up over four tons of waste per year just from downtown Nantucket and its beaches (Town of Nantucket, n.d.-a). There are also many other non-profit organizations dedicated to preserving the natural beauty and integrity of the island as well, such as the Nantucket Land Council, the Linda Loring Nature Foundation, and the Nantucket Conservation Foundation (Town of Nantucket, n.d.-c).

Despite the efforts of the DPW and other organizations on Nantucket, there is still a need for raising further awareness about the issue of coastal litter and encouraging people to take more action on it. Our project is intended to help address this need by both providing an engaging way to clean up beach litter and spreading a larger message of what plastic is doing to oceans and the environment. By building upon previous successful projects and drawing from Nantucket history, we intend to design a sculpture that will fulfill this purpose.

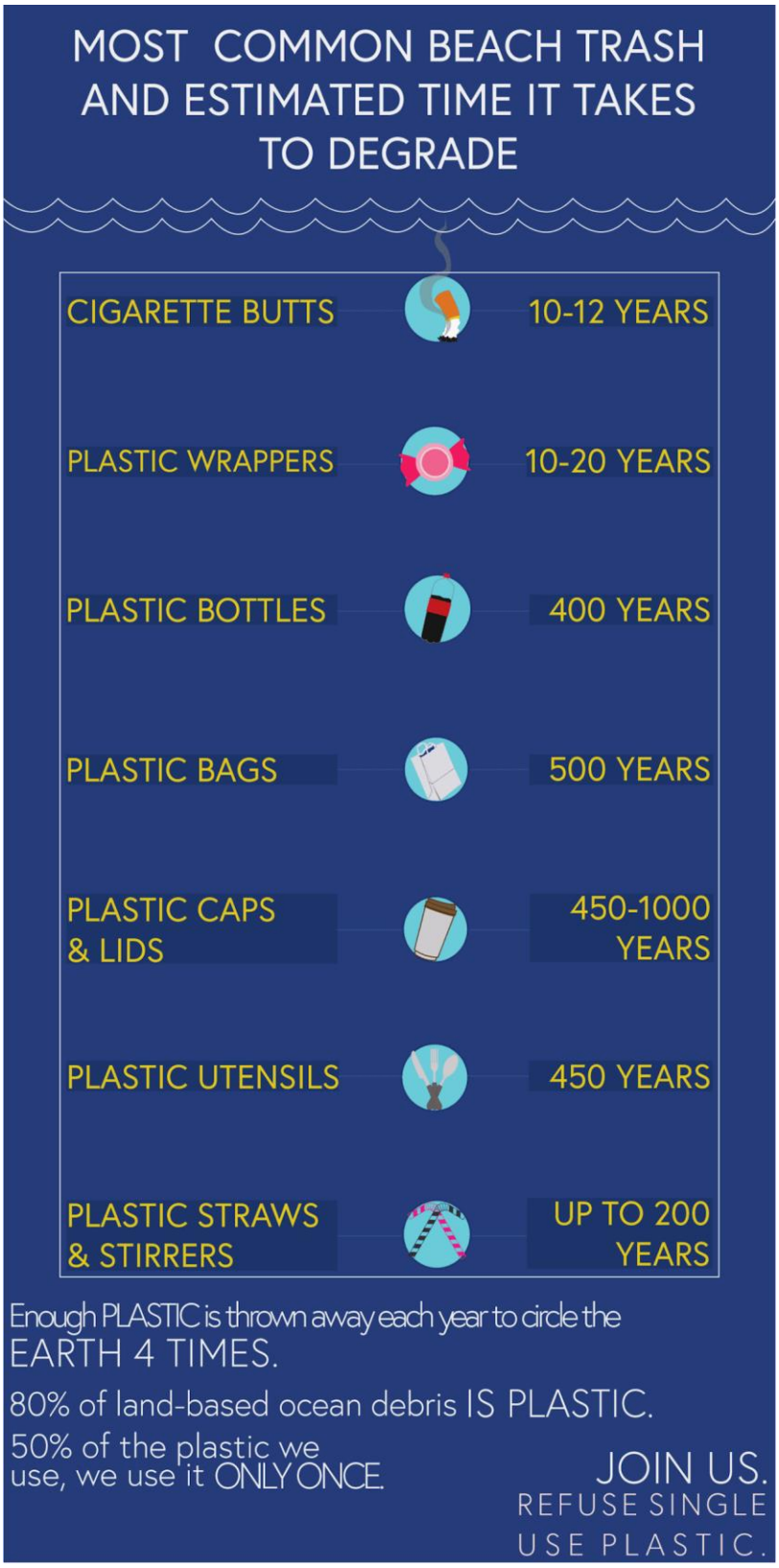

Figure 17. Graphic showing how long it takes for different forms of litter to degrade (Town of Nantucket, n.d.-d).

3. Methods

The goal of this project was to design a sculpture that will serve as a litter receptacle and as a means of raising public awareness about coastal litter. In order to achieve this goal, we:

- Selected an optimal site and position for the installation of the sculpture;
- Worked with our sponsors and a local artist to develop and evaluate conceptual designs for the sculpture;
- Developed maintenance plan to guide the DPW in servicing the sculpture.
- Created ancillary public education and outreach materials on plastic waste and coastal litter.

These objectives and their associated tasks are summarized in Figure 18. In addition, the team's timeline of progress on the specified objectives and tasks is shown in Figure 19.

3.1. Objective 1: Selecting Optimal Location

In order to identify where the sculpture should go to have the desired impact, we took into account the number of people that will see it, the practicality of its location for the DPW, and the amount of litter it will be able to collect. Since the team was on Nantucket during the off-season, we had to rely on secondary sources to obtain the required data regarding beach popularity. According to information from the Town of Nantucket, the island features 21 beaches covering 82 miles of coastline, 8 of which have lifeguards on duty (Nantucket Beaches, n.d.). Our sponsors narrowed this down by recommending a specific set of six beaches to investigate, and the team consulted primarily with DPW staff to identify criteria for determining the optimal location, as they have ample knowledge of the island and would be the ones servicing the sculpture. The main criteria we focused on were the popularity, accessibility, and amount of litter for each beach. Popularity was important as it maximizes the public visibility of *Moby* and may contribute to the levels of litter found there. Accessibility of the sculpture's location to the DPW was critical, as they are the ones who will be servicing the sculpture. The amount of litter found on the beach was also an important consideration in order to maximize the direct impact *Moby* has on cleaning up its environment.

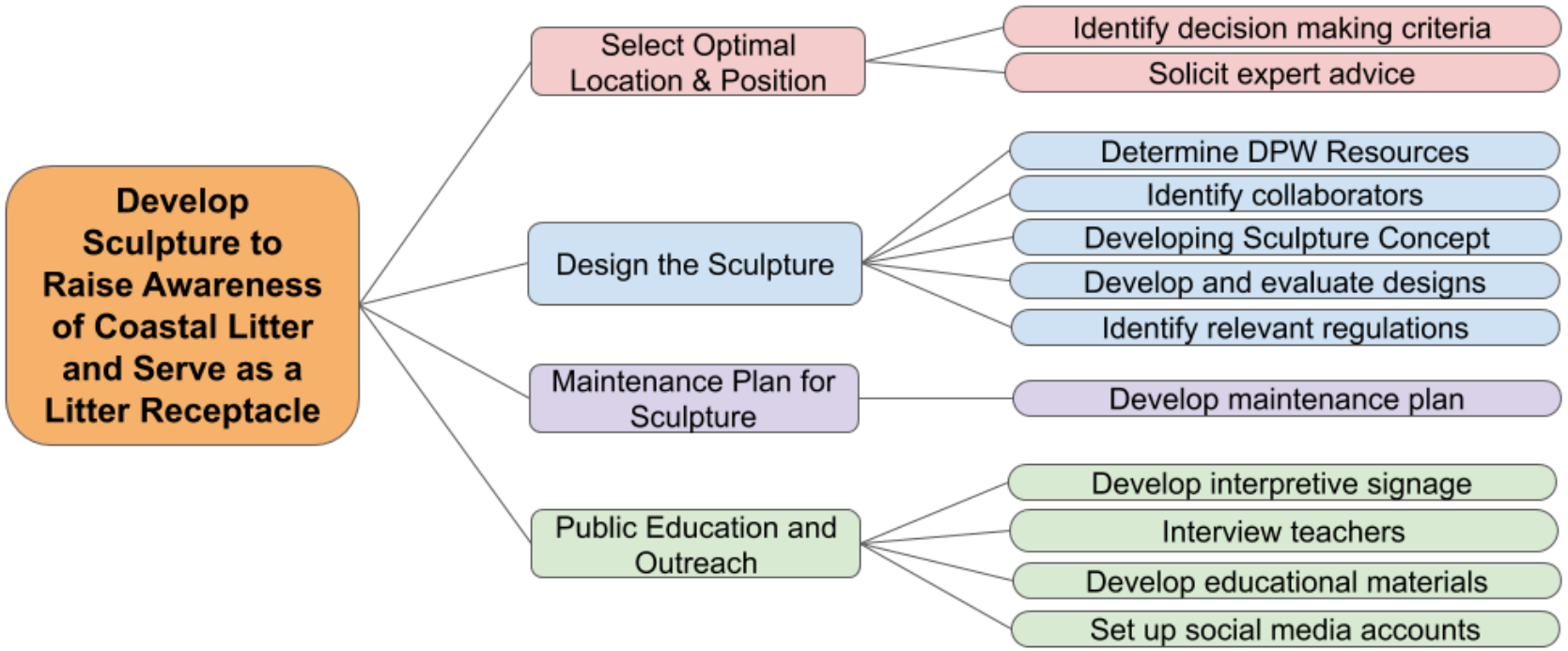

Figure 18. Schematic displaying project objectives and tasks.

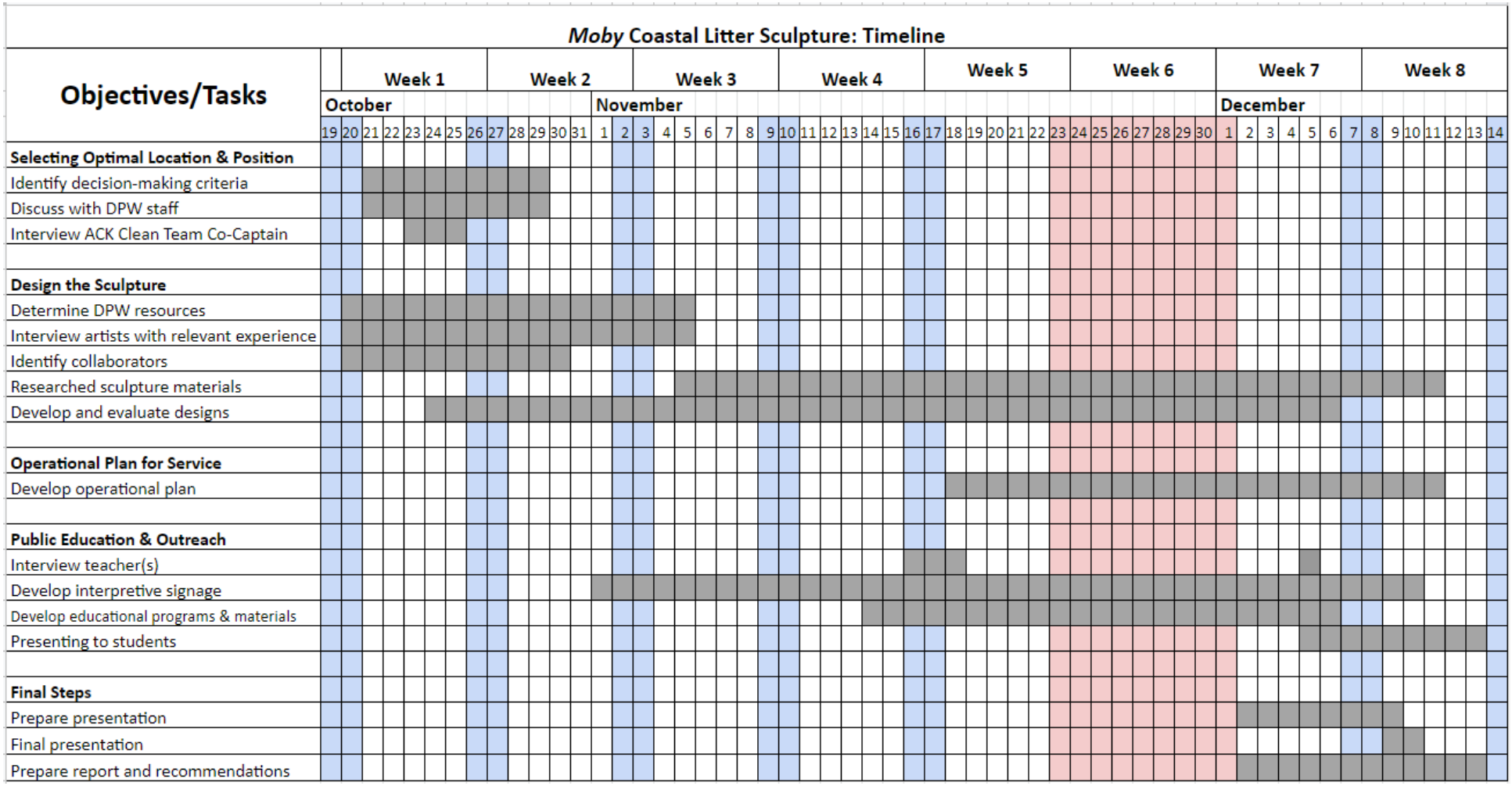

Figure 19. Graphic showing the timeline for our project.

To collect information about the beaches, the team carried out interviews and discussions with relevant individuals and visited the locations in-person. When visiting beaches, we took notes about their features and then rated them on a numerical scale for each criterion. We used information from discussions with our sponsors to further inform these rankings, particularly regarding the accessibility of beaches. The types of questions we asked DPW staff about this can be found in Appendix A. To get a better sense of the litter levels, beach popularity, as well as an additional outside opinion we also interviewed Bill Connell, Co-Captain of the ACK Clean Team. The script used for interviewing him is outlined in Appendix B.

By combining all of this information, the team and our sponsors reached a mutual agreement on the best location for *Moby*.

3.2. Objective 2: Designing the Sculpture

Developing a workable design was a multi-stage process. First, we had to identify good practices to follow and challenges to be aware of from similar projects, the relevant resources and needs of the DPW, and which local artist – or artists – we would collaborate with to create the sculpture. These tasks are detailed in Subsections 3.2.1 through 3.2.3. We aimed to complete them in parallel as much as possible in order to maximize our time efficiency.

With the agreement of our sponsors and the chosen artist, we finalized the overarching design concept of the sculpture, and translated it into more concrete plans and models that allowed us to visualize the design and evaluate its costs and requirements. These tasks are detailed in Subsections 3.2.4, 3.2.5, and 3.2.6 and had to be completed in sequence. After identifying our finalized design, we moved on to the actual construction of the sculpture.

3.2.1. Obtaining Expert Advice

Several litter-collecting sculptures similar to the one we have designed have already been created in other parts of the world. In order to identify good practices to follow, pitfalls to avoid, and other details we might overlook, the team interviewed artists who have designed and built similar works. We reached out to them over email to determine whether they were interested and set up an interview over the phone, a video call, or email depending on their preference. The planned general script for these interviews can be found in Appendix D.

We identified several relevant artists and organizations for this purpose. These include Janardhan Rao Havanje, the creator of India's *Yoshi* sculpture; the W Bali - Seminyak hotel, which installed *Goby* in Bali, Friends of Sengekontacket; who built *Nipsey* in Martha's Vineyard; Pete Codling, who designed *Treadgold Fish* in Portsmouth, England; and Keep Golden Isles Beautiful, a volunteer and community-based organization that installed a collection of litter-prevention sculptures in Georgia's Golden Isles (John Pounds Community Trust, 2019; Menezes, 2019; Pline, 2019; W Bali – Seminyak, 2019). While they did not all respond to us, the range of perspectives we gathered proved useful in getting varied advice and insight for how to approach our own project.

3.2.2. Evaluating DPW Resources

The team interviewed employees of the Nantucket DPW to find more specific information on their capabilities and resources as they pertain to this project. Since they will be responsible for servicing and maintaining the sculpture, it was critical to ensure that it met their needs. This included factors such as how often they will need to service the sculpture, how much litter they can transport when emptying it, and what dimensions and features the structure requires to facilitate its cleaning. This information was gathered through email, phone, and in-person discussions with Robert McNeil, the director of the Nantucket DPW, Graeme Durovich, the DPW's Recycling/Solid Waste Coordinator, and Richard Moore, the Operations Manager. We also spoke with Eric Johnson, the DPW's central fleet manager, regarding materials the DPW could provide us. The questions we asked in these discussions can be found in Appendix A.

3.2.3. Identifying Collaborators

Our sponsors had identified a couple of local artists with whom they recommended working with in designing and constructing the sculpture: Jared Strang and Billy Sherry. Although we kept these names in mind, we also conducted our own research to identify additional options for collaborating artists. We had prepared a script for interviewing potential artists in order to choose between them, which can be found in Appendix E.

3.2.4. Developing the Sculpture Concept

The general idea for the sculpture was a sperm whale called *Moby*. We chose this particular animal for the sculpture's design because the sperm whale is an iconic symbol of Nantucket's past (Nantucket History, n.d.). The name *Moby* is inspired by Herman Melville's classic novel *Moby-Dick,* which was based on the tragedy of the Essex, a Nantucket whaling ship sunk by a sperm whale. Furthermore, there have been several reports of sperm whales dying from plastic ingestion, indicating that sperm whales are more vulnerable to plastic pollution than most other great whale species (Unger et al., 2016). We brainstormed several distinct concepts for *Moby*'s overall design, and ultimately found a direction that our sponsors approved of which combined concepts of ours with ideas they proposed.

Throughout this process, we needed to identify any relevant regulations to ensure that the final sculpture complies with them. Due to local coastal dynamics and winter storms, our sponsors decided the sculpture would be a seasonally deployed structure rather than a permanent installation, and therefore did not require special permitting (Durovich, G., personal communication, September 2019). We also needed to identify any regulations that limit the size of the sculpture, what materials it could be made from, and what areas we were allowed to place it in, as well as any safety regulations that must be followed.

3.2.5. Designing and Evaluating the Sculpture

Once an artist and direction was selected, the team worked with them, the DPW, and the MMAN to plan multiple variations of the design concept. This included defining the sculpture's appearance, deciding on its dimensions, determining how it would be emptied, and determining other necessary specifications.

- Refining design specifications

  Based on our artist interviews and discussions with our sponsors, collaborators, and others, the team developed a more concrete understanding of which materials could be used to build *Moby*, as well as what dimensions it needs to be to accommodate any potential physical constraints. Another factor we took into account was the amount of funding and materials that would be provided by collaborators and other organizations. This affected the parameters in which we

have to work with as we design the sculpture concepts, particularly in terms of what materials would be feasible to use.

- Developing models and renderings

  Once the team had outlined all variables that will affect how we build the sculpture, we produced computer-aided models and renderings of the designs. These aided in visualizing and communicating the details of the sculpture and served as the plans and guidelines for the collaborating artist to use during the construction process. We also created a small cardboard and wire model of the sculpture to help visualize it and develop methods of emptying the sculpture.

- Estimating materials and costs

  The materials that we used needed to satisfy a number of requirements for the sculpture in terms of design, durability, and functionality. The sculpture needed to survive the harsh outdoor weather and elements, especially strong winds, rain, and moisture and salt from the sea. The sculpture was also designed to be transported off the beach site during emergencies, for special events, and seasonally. Therefore, the materials we chose had to be both long-lasting and resistant to the elements, and also the right density to withstand most wind speeds while being light enough to transport easily. An additional possibility was to treat the material to make it last longer against corrosion and rusting, such as galvanizing or otherwise coating metal. The sculpture's body walls also needed to be wholly or partially see-through, such as being made of metal mesh or wireframe, to allow people to see the litter building up inside and create a striking image of a whale literally filled with litter. After creating the computer-aided model of the final design of the sculpture, the team calculated the surface area and lengths of its components to get estimates on how much material will be required. Several different price estimates were then calculated based on the costs of different possible materials.

Once we created and modeled a set of design possibilities, we consulted with our project liaisons from the DPW and MMAN as well as the artist to identify the best design in terms of ease of use, practicality for servicing, aesthetic appeal, and any other relevant constraints that are identified. This will become our final design.

The next task was to create physical prototypes to ensure that the construction would go as planned. We began by creating smaller prototypes of specific parts of the sculpture we wanted to test, such as the system for emptying and filling the coastal litter from its head. These gave us a chance to receive additional feedback from our sponsors so we could make timely and necessary changes to the sculpture. After we have revised and improved our final design based on feedback from the physical prototypes, we worked with the artist to construct the full sculpture.

3.3. Objective 3: Developing a Maintenance Plan for Servicing the Sculpture

Once the sculpture design was finalized, we formulated a document to instruct the DPW on how and when to service the receptacle and keep it in working condition. This took into account the resources they have available to work with and aim to minimize the time and costs required to maintain it. The DPW was provided with a copy of this document for their own use, and it can also be found in Appendix F.

This document includes:

- How to remove collected litter from the sculpture.
- How to access and fill the static litter displays in the sculpture.
- Recommendations for maintenance to reduce rust and decay.
- Recommendations for assembly and disassembly for transport based on our design.

If this project proves to be successful, the DPW may potentially build additional litter receptacle sculptures on other beaches. In this case, assuming that these additional sculptures follow a similar structure to the first, the initial maintenance plan may be useful for future installations.

3.4. Objective 4: Public Education and Outreach Materials

In this section, the team highlights the methods we used to communicate our message to the public. First, we will create signage located on or near *Moby* that will effectively communicate the message of the sculpture and instruct people in its proper use. Next, the team will develop an educational plan incorporating the sculpture, and all information contained in its message, to present to local schools. Finally, for broader outreach we will create social media pages about *Moby* and produce a video summarizing our efforts over the course of this project, specifically including details about our overall progress, relevant background information, and the reasoning behind the project.

3.4.1. Creating Educational Signage

The team designed and developed informational signage to be attached on the sculpture. In addition to reviewing the literature on how to construct an effective and appealing message and examples of previous efforts to do so, we consulted with the DPW and Marine Mammal Alliance Nantucket. The questions the team asked are outlined in Appendix A. Based on our review of the literature on persuasive signage and the feedback from our sponsors, the team determined the content of the signs, the number of signs, the materials to use for them, and the locations and mounting methods for them. It was also important for the signage to be sufficiently eye-catching, in order to spark interest to the viewer and grasp their attention long enough to get the message across.

When considering the specific content on the signage, a critical need was to differentiate what kind of litter should be deposited where using instructional; signage. Since children and adults alike comprise part of the intended audience of the signage, we needed to communicate this information in a clear, accessible, and ideally engaging manner. We proposed several variations with different wording, levels of information, and use of icons and photographs, and refined our designs iteratively with sponsor feedback.

To ensure the clarity of its message and link the project more to Nantucket, we decided to have a separate, information-rich sign containing messages that connect the issues further to Nantucket history and beach visitors. As seen in the Background section, previous studies have

observed how attachment to a certain place can affect behavior. We implemented this strategy through referencing the history of whaling on Nantucket, highlighting the importance of the relationship between sperm whales and the island, and discussing how sperm whales and other marine animals are instead affected by the slow violence of ocean litter today.

3.4.2. Developing a Local Educational Program

Before displaying our content to students, we visited local schools and interviewed teachers and staff to discuss criteria for the educational content and get their opinion on effective approaches. Our sponsors recommended several teachers for us to reach out to at various Nantucket schools. With them, we discussed what age group our educational materials should be directed towards, what subjects we should base them around, whether the team or the teacher will deliver the material, what types of educational activities were appropriate, and what programs had been taught in the past that we could potentially build upon in our lesson plan. The list of the questions that we prepared for the interview are found in Appendix E. Any content we developed needed to be intended to tie into the Massachusetts curriculum, particularly clause 5-ESS3-1 of the Massachusetts Department of Elementary and Secondary Education curriculum framework which requires students to "obtain and combine information about ways communities reduce human impact on the Earth's resources and environment" (Massachusetts Department of Elementary and Secondary Education, 2016).

3.4.3. Creating Social Media Pages

As an additional way to promote the sculpture and encourage engagement with it, we set up social media pages for *Moby* on Instagram and Twitter. This included:

- Reserving relevant, fitting usernames.
- Creating QR codes that linked to the respective profiles and placing them on the informational signage for the sculpture.
- Creating relevant avatar icons for these profiles.
- Providing the DPW and MMAN with the information required to access these accounts.
- Identifying possible hashtags that could be used to encourage people to share photographs of the sculpture.

4. Findings

This section discusses key information the team gathered, our design processes for the sculpture and its signage, and the approaches we took to engage in public outreach about the project.

4.1. Identifying the Sculpture's Location

The team determined the location for *Moby* by evaluating beaches recommended by the DPW and MMAN in terms of their accessibility to the DPW, their visibility to the public, and the amount of litter present there. Scott Leonard took us on a tour of the recommended Nantucket beaches, which were Brant Point, Children's Beach, Cisco Beach, Jetties Beach, Sconset Beach, and Surfside Beach, shown in Figure 20. Our project liaisons at the DPW recommended Surfside beach in particular due to its popularity and easy accessibility from its large parking lot. We also interviewed Bill Connell, Co-Captain of the ACK Clean Team, a local volunteer clean-up group. Mr. Connell gave insight into the types of litter that occur on Nantucket, confirmed that beaches on the southern shore receive significantly more litter, and provided his opinions on the beach locations. He was a strong proponent of Cisco Beach due to its popularity with surfers and young people and the limited number of existing waste receptacles there, but he also viewed Surfside Beach and Nobadeer Beach as good candidates given how visible the sculpture would be in their parking lots. Mr. Connell expressed concern that Jetties Beach would be too 'visually' crowded due to the restaurant and playground already present there, so *Moby* would not stand out (Connell, W., personal communication, October 25, 2019). It also became clear from our conversations with our sponsors, residents, and other stakeholders that putting the sculpture on a beach itself would be problematic, as it would not only require special permitting, but it would also interfere with the natural beauty of the location and present problems of access for emptying and maintenance. Instead, we determined it would be far more effective and practical to put the sculpture on a beach parking lot instead. Taking all these considerations into account, we rated the proposed locations as shown in Table 1 and determined Surfside Beach's parking lot to be the preferred location for *Moby*.

Figure 20. Map of Nantucket with different beach locations considered for the placement of *Moby*.

Table 1. Suitability Ratings of Selected Beaches

Beach (in ranked order)	Ratings (5 is High, 1 is Low)			
	Accessibility	Visibility	Observed Litter Level	Connell's Opinion
1. Surfside Beach*	5	5	4	4
2. Cisco Beach*	4 (lot), 2 (beach)	4	3	5
3. Jetties Beach	5	5	2	3
4. Sconset Beach	4	3	3	N/A
5. Brant Point	2	5	2	N/A
6. Children's Beach	3	4	1	N/A

*Located on Nantucket's southern shore, which receives more coastal litter from the ocean.

4.2. Identifying Relevant Regulations

The team was concerned that local regulations would impact how we could create *Moby* and where we could place it, but as a seasonal sculpture on the parking lot instead of a beach our sponsors informed us that there were no relevant regulations we would need to take special action to comply with. There was a restriction on how close the sculpture could come to a nearby powerline, but the design was well within the constraints. Any other regulations regarding placement and design will be handled by the DPW during implementation.

4.3. Finding a Local Artist

Our sponsors had recommended two artists on the island: Jared Strang and Billy Sherry. We tried to find additional options through research and interviews, asking people like Courtney Bridges, the Executive Director of the Artists Association of Nantucket who they would recommend. However, these independent searches failed to turn up other artists who would be appropriate and available. We contacted both Mr. Strang and Mr. Sherry. After talking to Mr. Sherry about his metalworking experience and examining his workshop, we realized that he was clearly our best choice for the project. We ultimately decided to move ahead with Mr. Sherry as our collaborator.

4.4. Designing the Sculpture

Early on in the design process, we spoke with several artists and organizations who had created similar sculptures elsewhere in the world. The first person we contacted was Janardan Rao Havanje, the creator of the *Yoshi* sculpture, shown in Figure 8 in the Background section. He answered many questions about his sculpture's size, volume, serviceability, materials, and coatings which helped us develop our design criteria. Of particular note to us were the measures taken to protect the sculpture from environmental conditions: the sculpture was repainted annually with polyurethane paint to protect against rust, and it was closed during the monsoon season (Havanje, J. R., personal communication, October 28 - November 5, 2019). This prompted us to look into alternate, more enduring methods of protecting against rust in order to minimize the maintenance work required for *Moby*, and highlighted the importance of making a design that could be readily relocated in preparation for intense weather. Also significant was the

fact that the sculpture had to be emptied manually from the mouth and a hatch on the underside, which was a more labor-intensive system than we wanted in our own design (Havanje, J. R., personal communication, October 28, 2019). Another artist we interviewed was Pete Codling, creator of the *Treadgold Fish* sculpture in the UK (Figure 16). He provided a wealth of information and advice beyond our initial set of questions, including recommending that we ensure the design had the support of the local government, suggesting ways to make sure it is safe for the public like minimizing sharp edges, advising that we take measures to ensure people only put the desired types of litter inside, and emphasizing the importance of linking functional sculptures symbolically with the community around them to increase their impact. Lastly, we interviewed Lea King-Badyna, the executive director of Keep Golden Isles Beautiful, about the organization's collection of litter prevention sculptures. One such sculpture is the Right Whale shown in Figure 14. While these sculptures were static displays rather than active receptacles, Ms. King-Badyna still had much to offer in terms of advice, including affirmation of our ideas on creating a social media page for *Moby,* including a QR code on our informational signage, and getting local students involved. She also provided information on ways to raise awareness of events through other local organizations, ways to obtain funding such as government and privatized grants, and demonstrating that even a non-interactive sculpture in this vein can successfully draw attention and encourage people to read signage about it (King-Badyna, L., personal communication, October 30, 2019).

The first step of designing the sculpture was to decide on the overall appearance of the main body. When we first met with the DPW's liaisons to our project, Director Rob McNeil and the Recycling/Solid Waste Coordinator Graeme Durovich, on-island to discuss it, Director McNeil informed us that they have wooden waste enclosures, as shown in Figure 21, each of which contain two 50-gallon drums used as waste or recycling bins. The DPW had already installed these enclosures at some beaches and planned to install several more at others. These enclosures not only provided a more appealing way to house waste barrels, but also shielded them from the elements and wildlife. Director McNeil noted that our sculpture should likewise prevent animals like seagulls from getting into the sculpture.

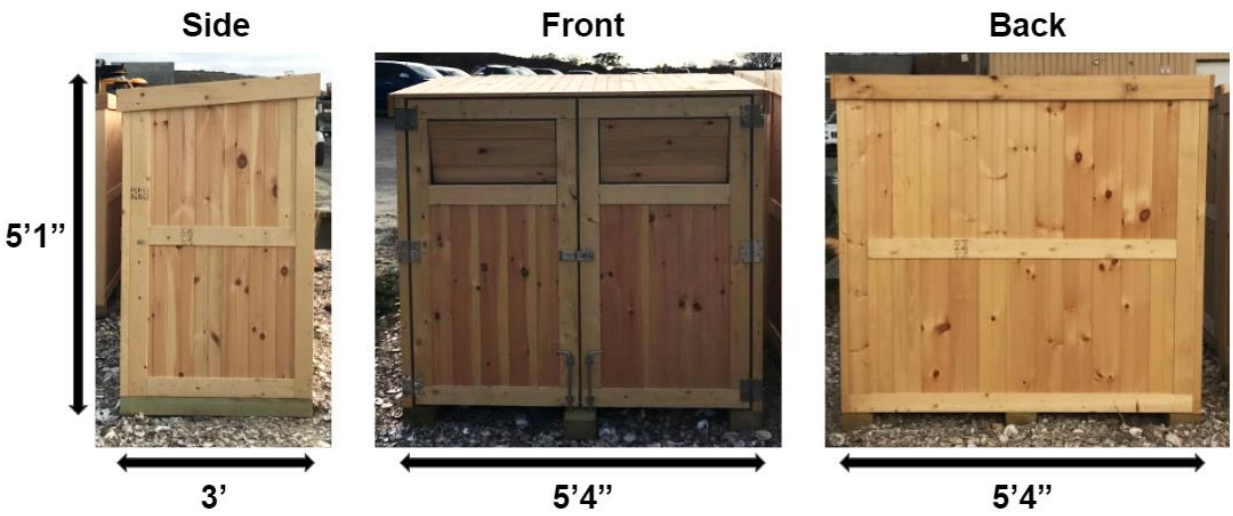

Figure 21. Photographs of the DPW’s waste bin enclosures with dimensions.

Director McNeil also proposed the idea of constructing *Moby* out of wood and incorporating these enclosures in the body, which would be a more aesthetically-pleasing way to display them. Building on the examples of *Yoshi* and *Goby*, however, we were keen to include wireframe elements that would incorporate articles of beach trash as integral, eye-catching elements of the entire sculpture. We developed a range of initial rough sketches for Moby (Figure 22). One such early sketch was based on Director McNeil’s suggestion, and featured a body incorporating the DPW’s pre-built beach enclosures and a raised tail, with a person sitting at a table underneath the whale’s flukes (the right image in Figure 22).

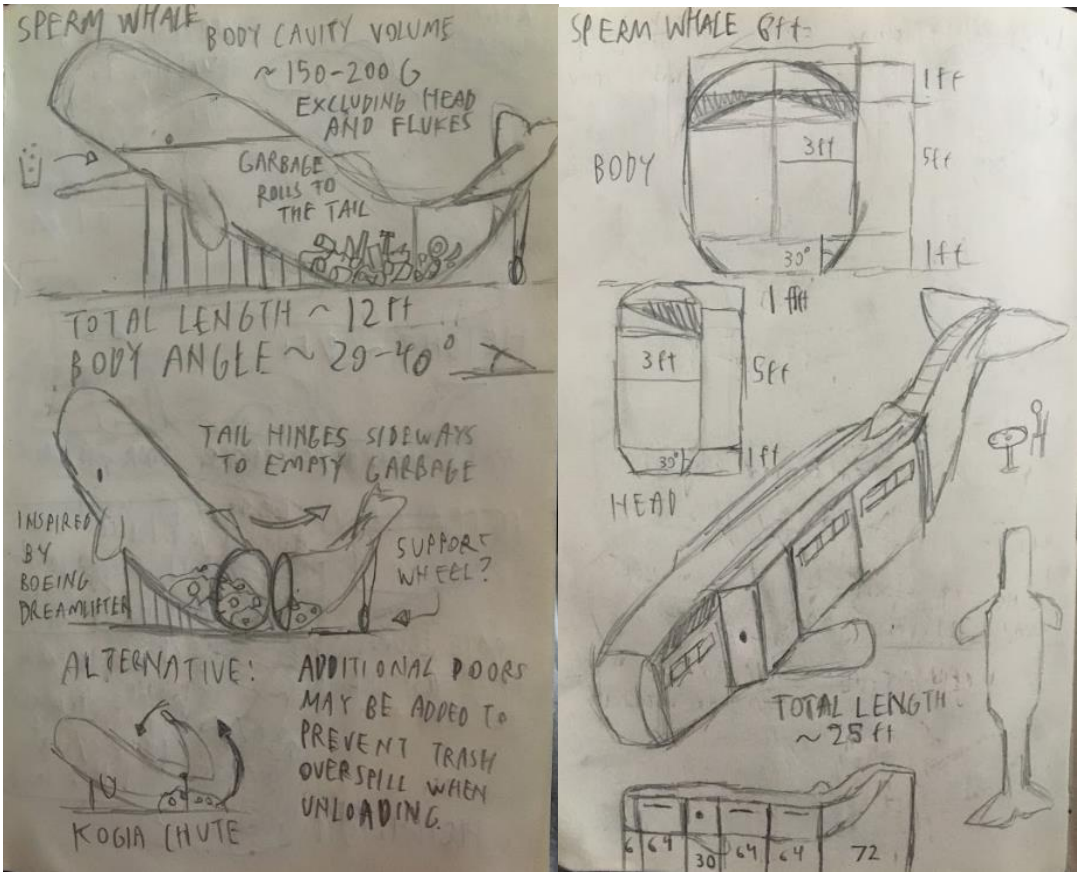

Figure 22. Original sketches of *Moby* designs. The left concept is inspired by previous sculptures, while the right concept is based on the suggestion to use waste enclosures.

After this discussion we proposed a hybrid design, with the head and tail as metal litter enclosures and a wooden body incorporating the DPW's waste bin enclosures, which our sponsors all approved. Director McNeil informed us that a group of residents were negotiating with the Nantucket Rapid Transit Authority (NRTA) to install a bus shelter at Surfside Beach directly adjacent to where we planned to place *Moby*. The Ozone Surf Classic Fund generously offered to fund this bus shelter proposal in honor and memory of their dear friend David "Ozone" Ozias, a surfer and advocate for beach and ocean protection. We discussed the implications of the shelter for the sculpture in terms of available space, aesthetics, and access. During this conversation it became clear that one innovative approach might be to use the flukes of the sculpture as a roof for a bus shelter. The rough sketch of the hybrid design incorporating this can be seen in Figure 23, and consists of the following segments:

1. A wireframe head serving as the refillable chamber to regularly collect coastal litter that people bring from the beach.
2. A wooden body consisting of four DPW enclosures with customized roofs to match the profile of the whale's back.
3. A wireframe tail permanently filled with litter to maintain the striking image of a whale filled with litter at all times.
4. A pair of flukes serving as the roof for the bus shelter.

These segments were also designed to be modular units that are detachable from each other, which would make transporting the sculpture much easier. This would meet the DPW's requests for the sculpture to be moved on and off the beach for seasonal display.

Our sponsors concurred with this approach, so we developed several renderings using computer-aided design software (shown in Figures 24, 25, and 26).

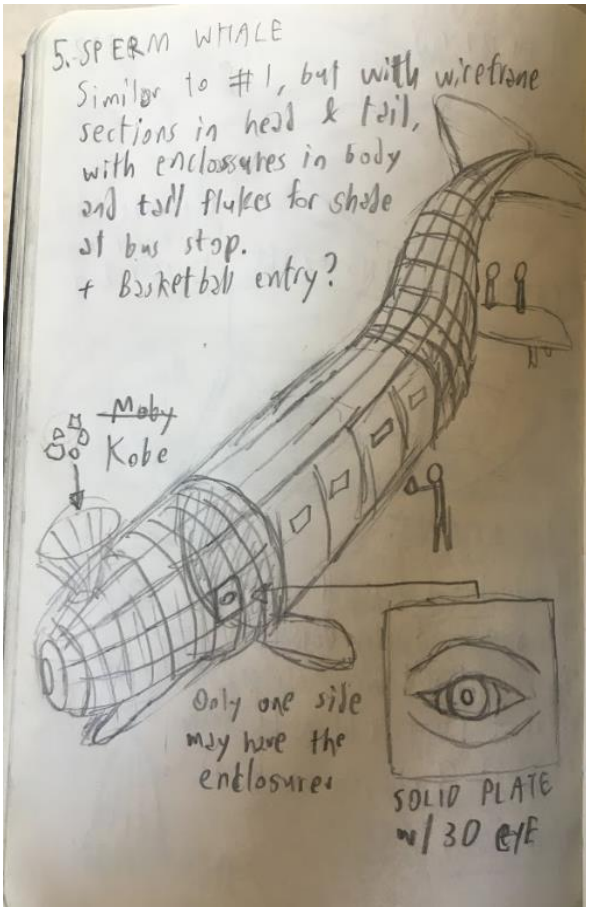

Figure 23. Original sketch of the hybrid *Moby* design featuring the litter receptacle, waste enclosure, tail display, and bus stop shelter.

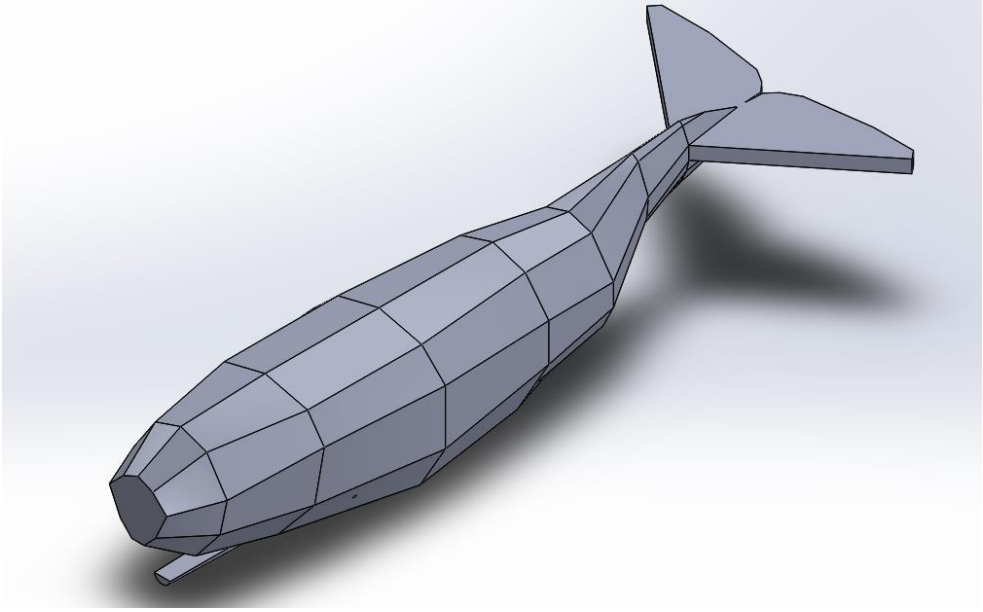

Figure 24. Computer-aided design of the first iteration of *Moby*, loosely based on the dimensions of an actual sperm whale.

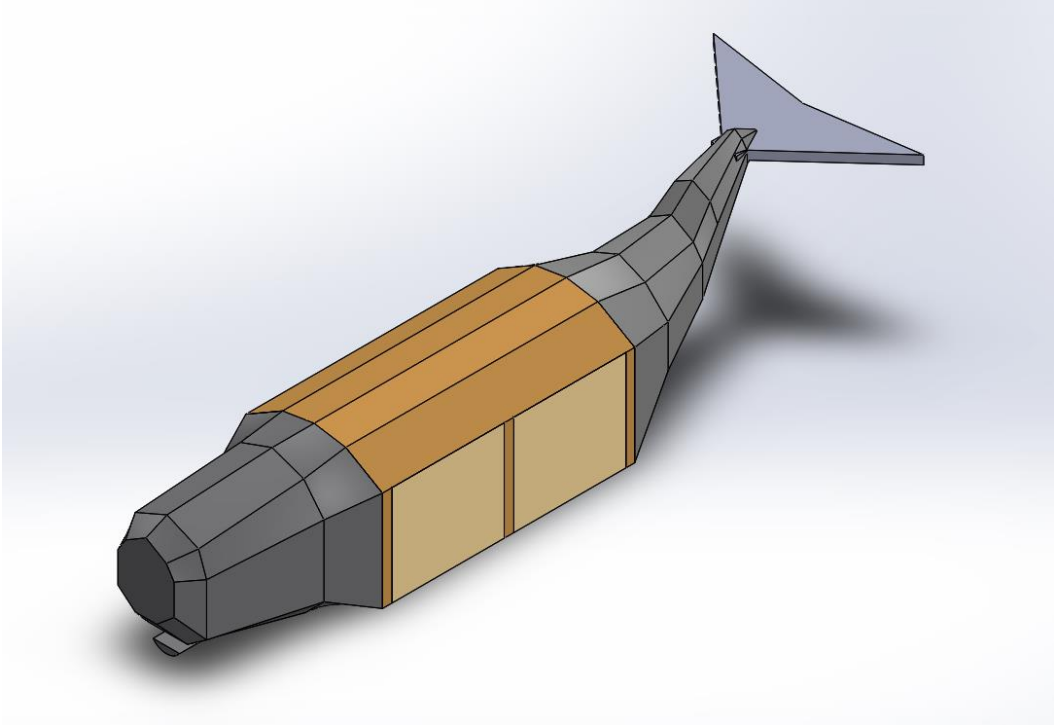

Figure 25. Computer-aided design of the second iteration of *Moby*, featuring the waste receptacles in the central body trunk.

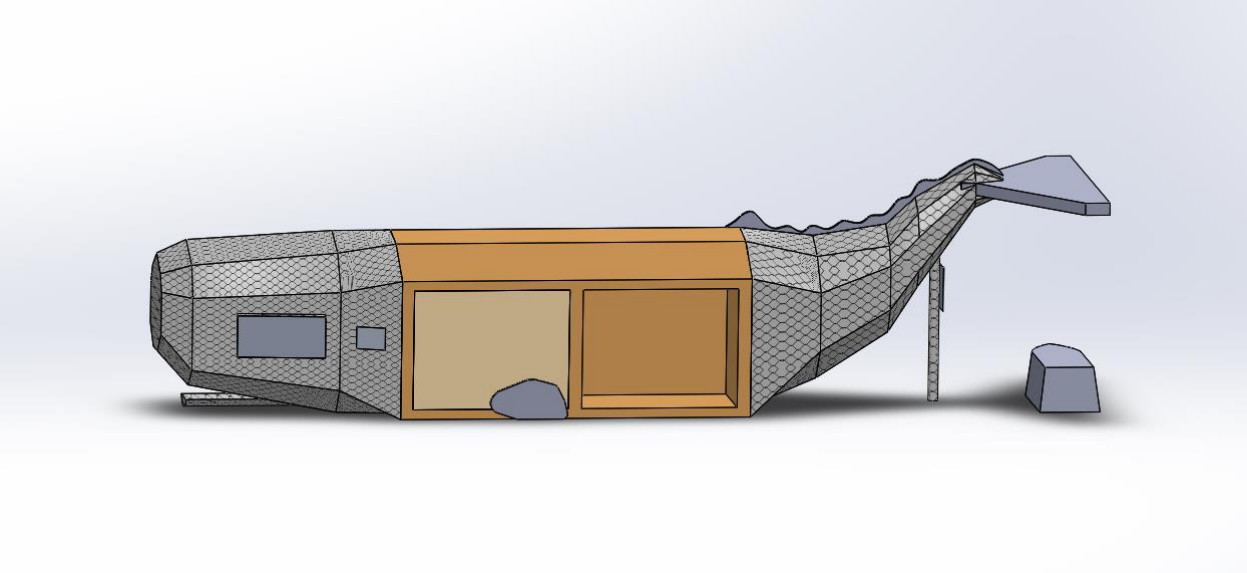

Figure 26. Computer-aided design of the third iteration of *Moby*, featuring the waste enclosures as the central body trunk, and additional details such as doors, flippers, and signs.

Regarding the dimensions of the sculpture, we had to consider the size of the DPW enclosures and the constraints of our chosen location. Each enclosure was a rectangular prism, 64 inches wide, 36 inches deep, and 61 inches tall. At Surfside Beach's parking lot (Figure 27), the available land area was 25 feet wide (from the asphalt path to the first permanent bike rack) and 36 feet long (from the paved parking area to the beach fence). We also had to ensure that there was enough room around the sculpture to allow people to walk between the bike racks and the asphalt path. One complicating factor was the telephone pole located near the corner of the work area with power and network lines (Figure 27, on the right side of the upper image and the left side of the lower image). It is unsafe to build anything within 10 feet of the power line, but we determined that this would not be a problem since the line at Surfside Beach was located more than 30 feet off the ground. This meant there was enough room to allow the tail to be high enough off the ground for people to sit on the bench underneath. To accommodate the DPW wooden enclosures back-to-back, we designed the body to be 6 feet wide at its widest point. Based on our assessment of other local bus shelters, we set the flukes 7 feet off the ground. The highest point of the sculpture would be the tip of the dorsal ridge at 7.5 feet off the ground. The overall length of the sculpture from the tip of the snout to the end of the flukes was 33 feet, allowing a 3-foot-wide path in front for people to walk between the bikes and the beach entrance. A mock-up of the sculpture in place can be seen in Figure 28.

Figure 27. The planned location of *Moby* at the Surfside Beach parking lot.

Figure 28. Mock-up of *Moby* placed at the Surfside Beach parking lot.

Designing the Head and Collection Chamber

After deciding on the overall appearance, dimensions, and location, we explored different options for the design of the head to allow the public to deposit beach litter and for the DPW staff to empty the bins. We also explored different options for the shelter bench and for supporting the flukes. We came up with several ideas to address this situation, many of which consisted of a single collection chamber with holes near the top for adding litter and at least one door or chute for emptying litter, located on the sides, front, or bottom of the collection chamber (Figure 29). Some of these also placed the exit point of the litter too close to the ground, which would make it difficult to transfer the litter to the truck (Figure 29). One design that would avoid used doors on the sides paired with slopes in the middle that push the litter towards them but would still require manual shoveling to empty the sculpture (Figure 30).

The DPW expressed interest in us exploring more avenues, suggesting to incorporate their fifty-gallon barrels into the sculpture. We developed additional designs in response to this proposal, namely a concept in which fifty-gallon barrels, similar to those being used in the wooden enclosures, would be stored inside the head (left image of Figure 31, Figure 32). We included a door on the front of the head to access the barrels for easy maintenance and emptying. To maintain the image of a whale filled with garbage, the barrels would be hidden by a double-walled wire mesh façade that contained static displays of coastal litter.

When we presented these designs alongside refined versions of the internal slope designs, the DPW expressed interest in thee barrel design but raised concerns that the barrels could become impractical to move if they filled with rainwater. To prevent the barrels from being filled with rainwater, we recommended installing a solid roof on the top of the sculpture's head to block the rain. We also developed an alternative design (right image of Figure 31, Figure 33) that included custom-made rectangular baskets instead of barrels, with doors on the sides of the head instead of the front. These baskets would not have solid walls, thereby eliminating the need for façade walls of litter or rainwater protection. The DPW was concerned, however, that such baskets would be difficult to empty, so we settled on the barrel design (Figure 33), as the most efficient way to service the sculpture, and would constantly display the image of a whale filled with litter. The DPW also pointed out that it would be possible to implement drainage holes at the bottom of the barrels to prevent rainwater accumulation.

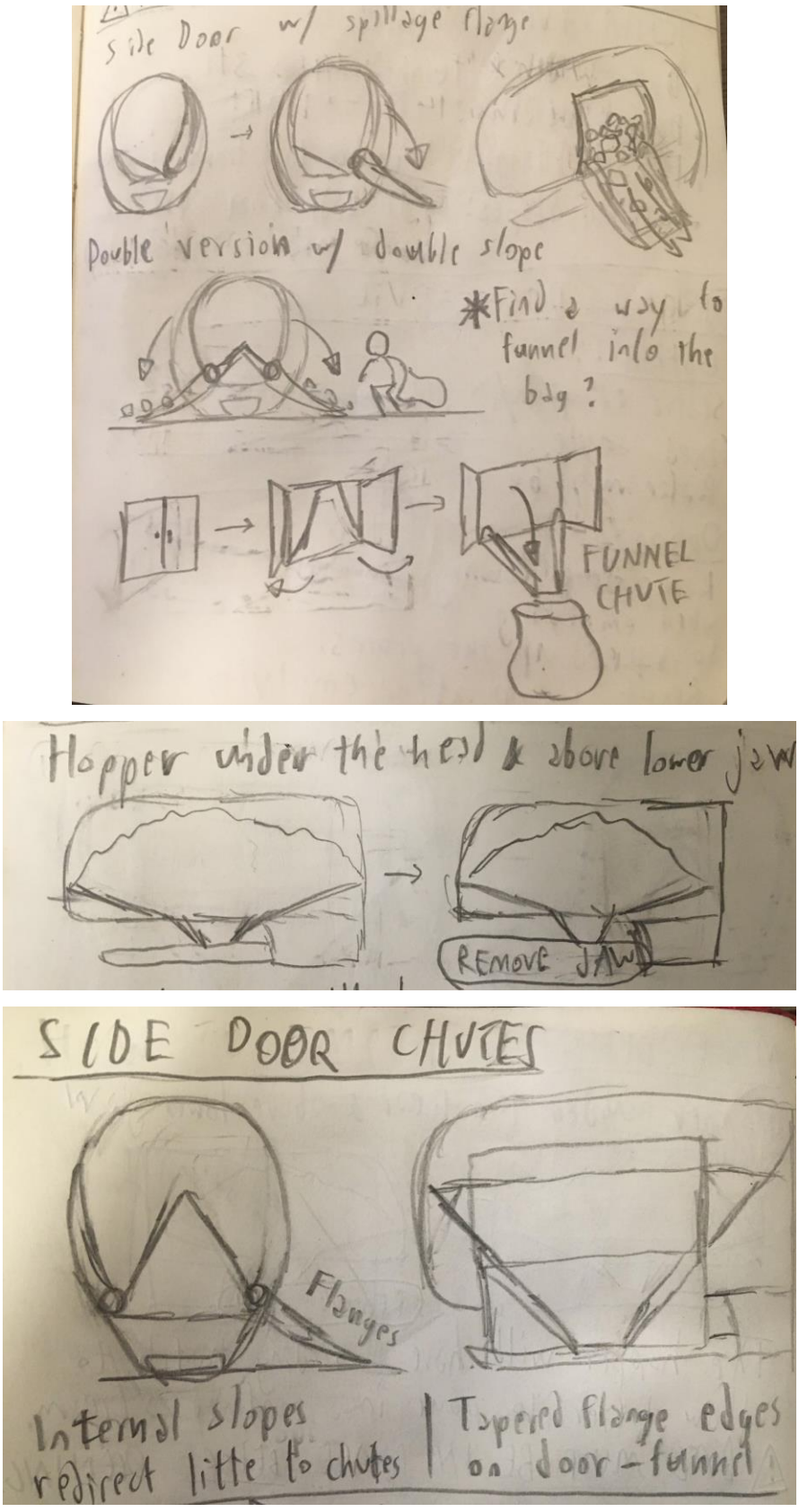

Figure 29. Early sketches for emptying mechanisms with chutes and doors.

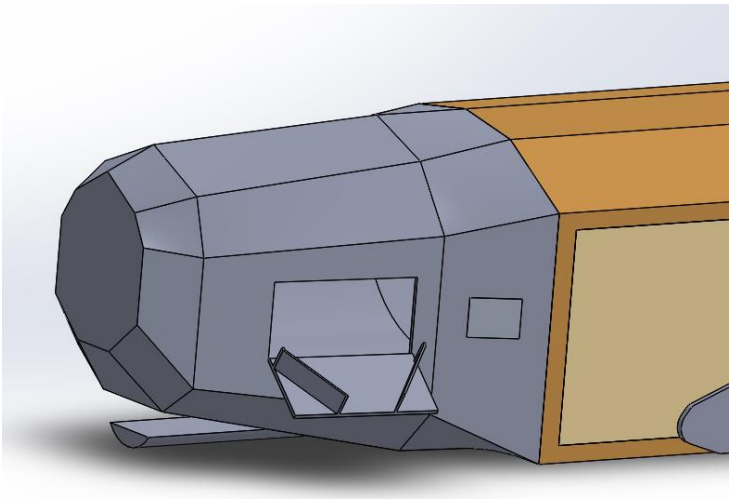

Figure 30. 3D model of a chute door on the head.

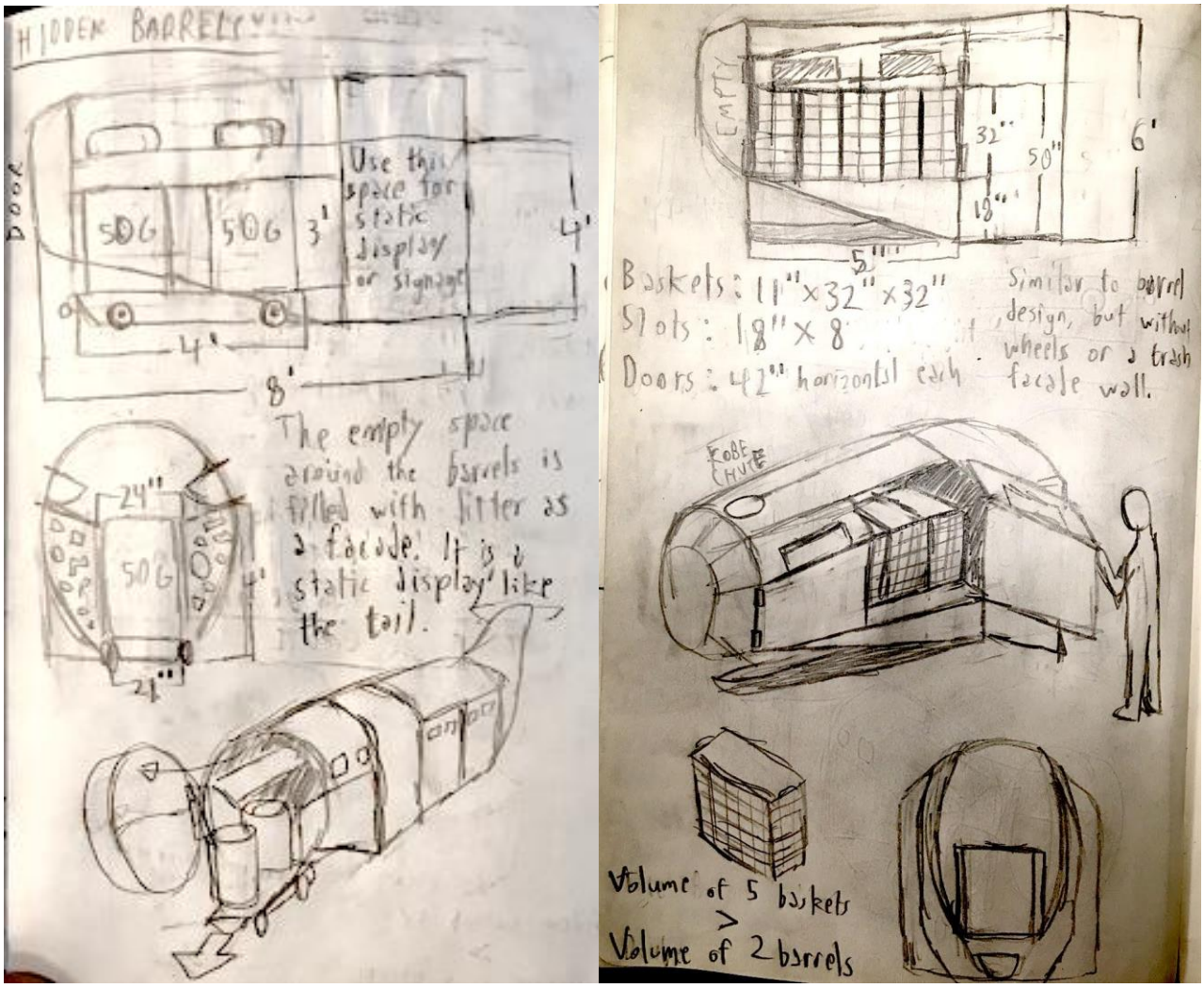

Figure 31. Early sketches of the head containing modular baskets (left) and barrels (right).

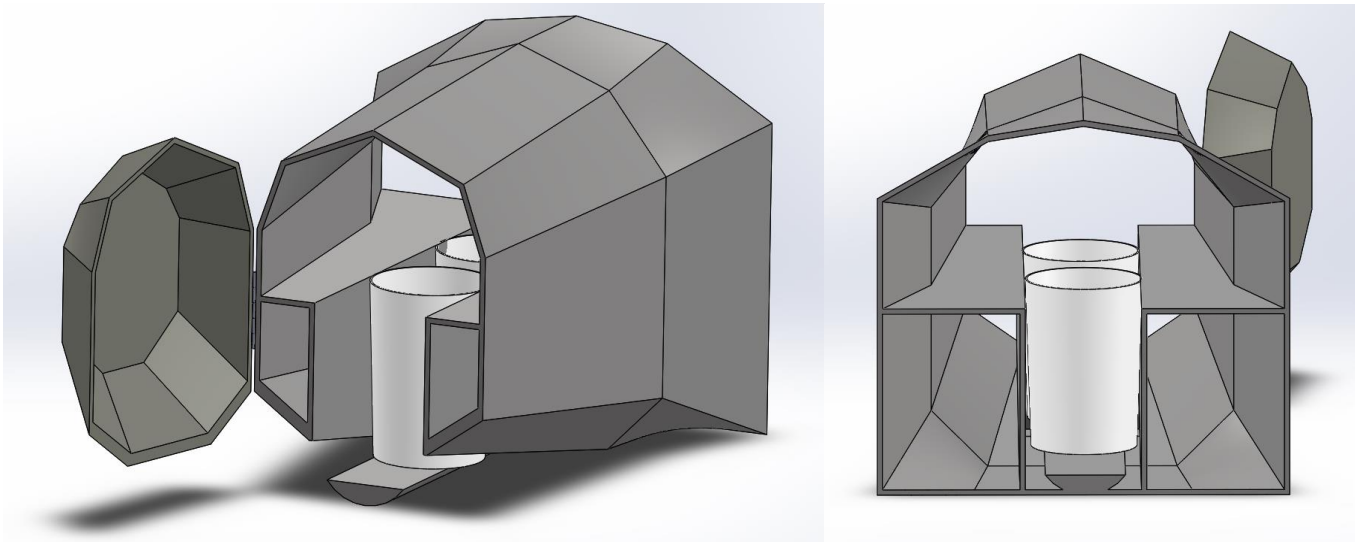

Figure 32. 3D models of the barrels hidden by pockets of litter. This was the chosen design.

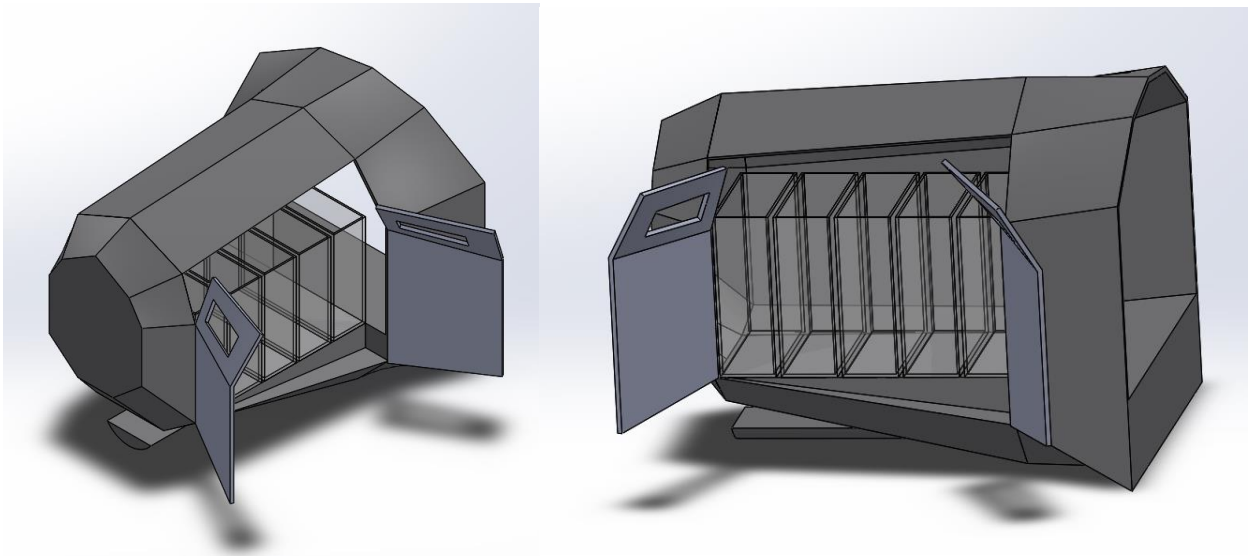

Figure 33. 3D models of the modular baskets.

Designing the Tail and Bus Shelter

We explored many options for supporting the tail, most of which used a central vertical pole (Figures 34 and 35). To make the structure fit the theme of a whale, we discussed different ways to dress the pole, including a harpoon in reference to Nantucket's whaling history, a rope in reference to the current concerns about entanglement, a vertically-standing rowboat that could also serve as a seat, a wave-like shape covered in garbage, and even a surfboard as part of the memorial aspect of the sculpture. We also considered using two separate support poles at the tips of the whale's flukes (Figure 35). This would provide greater stability for the flukes, which are quite large (10 feet across) and heavy as they would be made of solid sheets rather than mesh. To disguise the poles, the edges of the flukes would curve downwards and decorated with wavy wire to resemble water dripping off them.

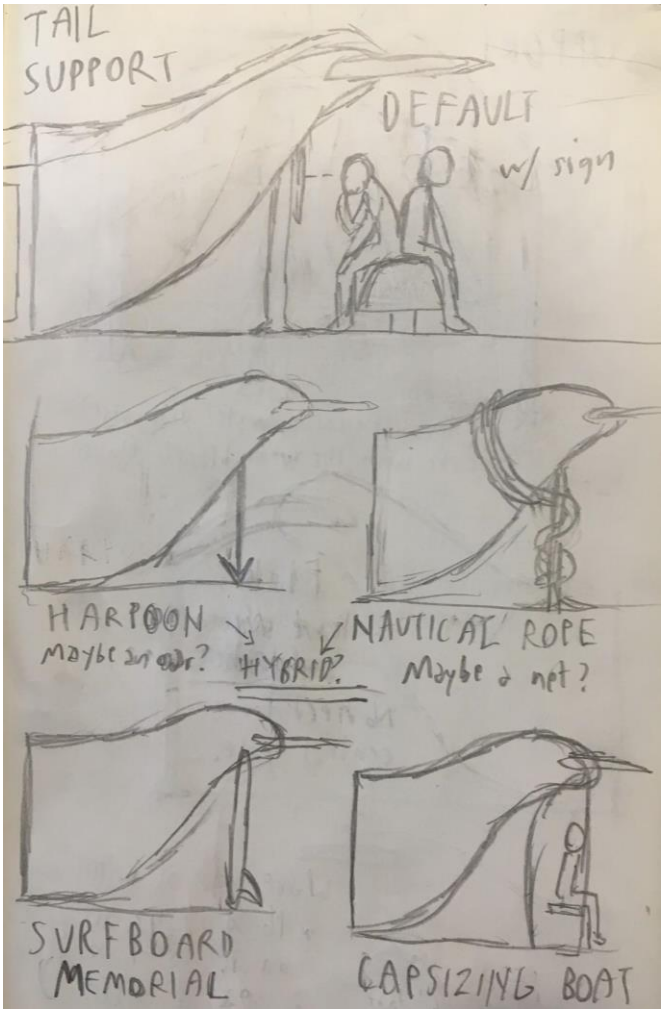

Figure 34. Sketches of ways to dress the central support pole.

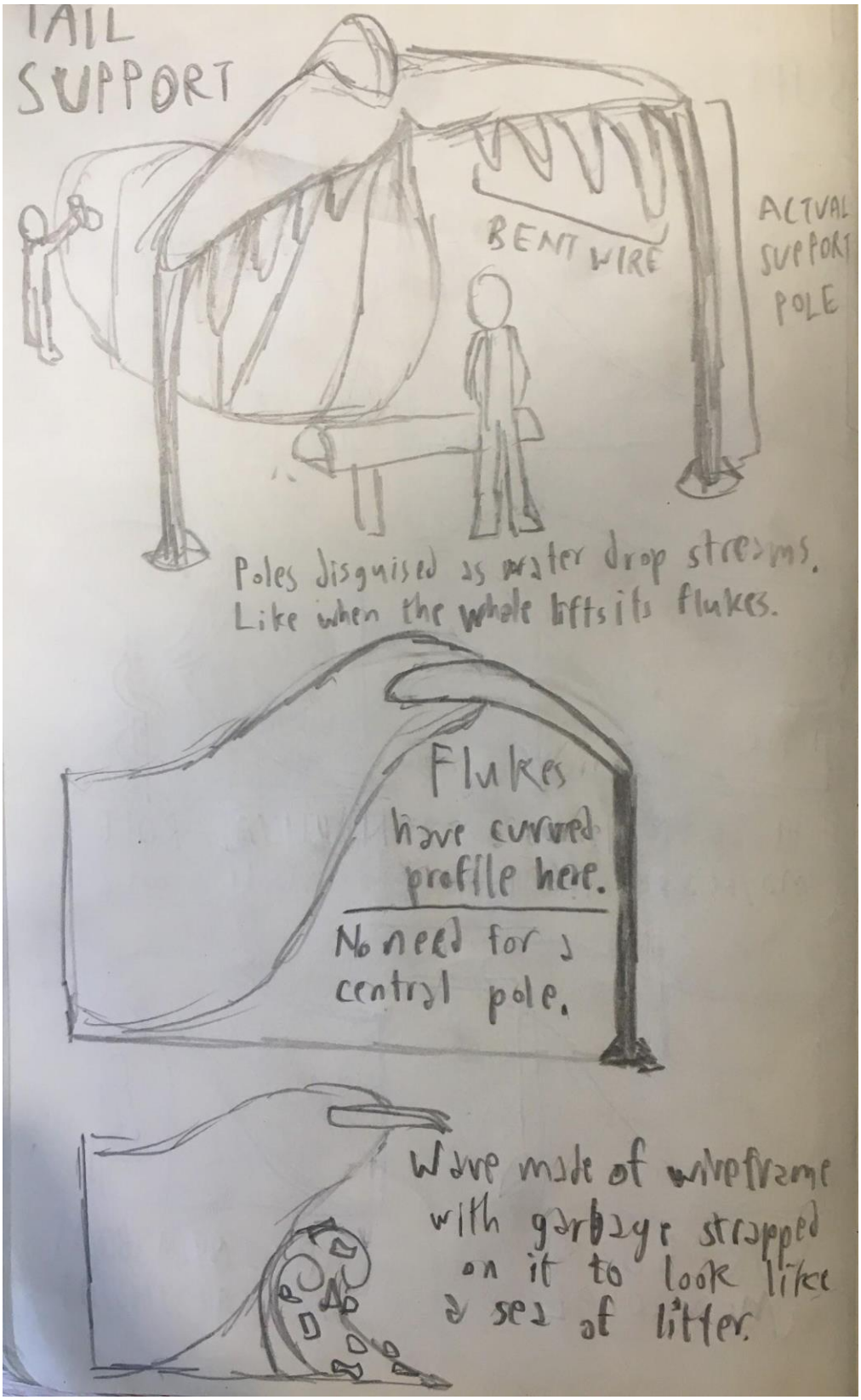

Figure 35. Sketches of the dual-pole design, plus the wave-based design.

The existing benches at the Surfside bus stop are very basic in appearance: each consists of a horizontal wooden board, approximately 5 feet long, mounted on two wooden posts (Figure 27). We explored various options for a bench that would fit with the overall theme and aesthetics of whales. A number of these ideas were based on Director McNeil's suggestion to make the bench resemble an overturned or capsizing whaleboat or rowboat. A vertical rowboat (Figures 34 and 36, bottom right) could also serve as both a seat and support for the tail. One other idea was to make the bench a surfboard, as part of the memorial to David Ozias (Figure 36, bottom left).

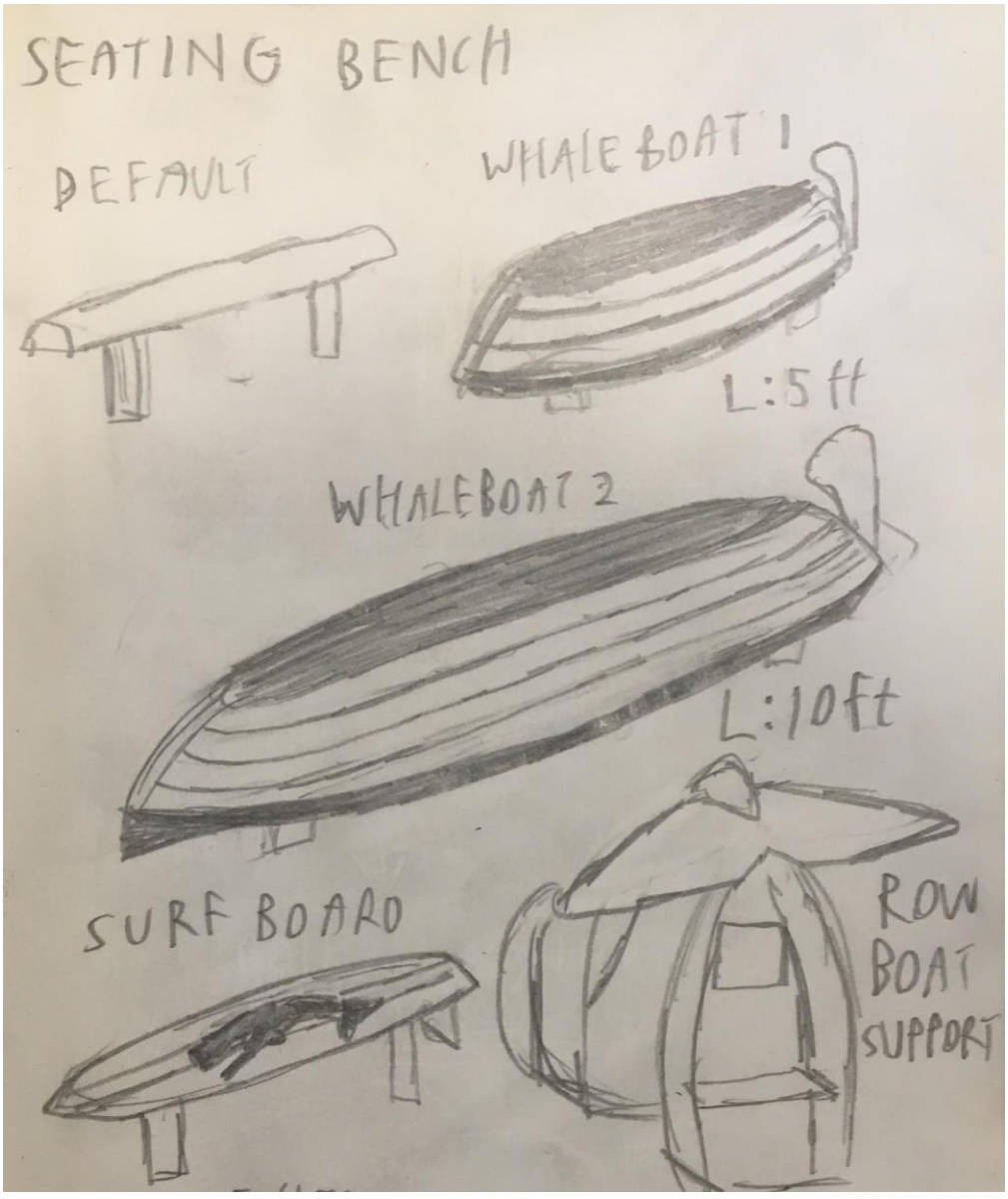

Figure 36. Sketches of bench options.

We presented these ideas at a group meeting on December 2, which included the chosen artist Billy Sherry and John Jordin of the Ozone Surf Classic Fund. Scott Leonard indicated that he and the other members of MMAN were opposed to designs depicting deliberate aggression between humans and whales, including harpoons and whaleboats. The idea of using a surfboard as a support or a bench was rejected on the grounds that it was not in keeping with the overall themes and may not meet public approval. This left three options to support the tail and flukes:

1. Dressing up a single pole to look like a rope entangling the tail (Figure 34, middle right)
2. Using a wave with embedded trash to support the tail (Figure 35, bottom center)
3. Using two poles to support the flukes (Figure 35)

The primary advantages of the first two were that they clearly represent the issues at hand (i.e., marine pollution, entanglement, and coastal litter). The rope option is reminiscent of the current MMAN display at the Nantucket Whaling Museum, which depicts photographs of whales entangled in stray fishing gear. While this can be construed as violence against whales, the group considered this as "slow violence" in contrast to direct intentional violence like that associated with harpoons. The rope is essentially a symbol of the real-world problem of entanglement that is one of the motivating factors behind the creation of the sculpture. The wave option would be symbolic of an ocean filled with garbage. On the other hand, the double-pole option had the advantage of providing more structural stability than all the other designs. With the decorative drops and a unique curvature to the flukes, Mr. Sherry thought it could be aesthetically pleasing and add character and motion to the sculpture. The consensus at the meeting was that the double-pole design might be the best compromise, although the final design could include other elements, such as the rope appearing to be wrapped around *Moby*.

Ultimately, the DPW approved of the double-pole design to maximize the structural stability of the sculpture. No clear consensus was reached regarding the bench, although this is not of great concern as this was a minor element separate from the main sculpture and a standard bench like the ones already present at the location could be used.

Material Choices

The choice for materials to use in the sculpture evolved during the course of discussion about the different design options. To minimize costs and remain in consort with the pro-environmental theme of the sculpture, we explored using salvaged materials to construct *Moby*. The DPW was already building receptacle enclosures from wood, but had substantial amounts of used galvanized chain link fence that might be used to cover the frame of the sculpture. We consulted the artist, Billy Sherry, who recommended using round-stock or flat-stock steel for the frame of the sculpture and some sort of wire mesh to cover the frame. While he agreed that galvanized fencing might work well, he also pointed out that the fencing would be easy to climb and therefore presents a safety hazard. He also suggested that the steel would need to be coated to minimize corrosion. We contacted Wirefab Inc., a well-known company in Worcester, Massachusetts that manufactures steel wire products, to discuss the feasibility of different methods to protect the metal. Jim Hall, Vice President of Operations indicated that coatings, such as powder coatings, would be very expensive. He suggested that stainless steel, which does not corrode and can also come in a variety of different shapes and sizes, might be the best option. Additionally, he offered to provide materials at a discounted price, as well as to have their shop manufacture parts of the sculpture we would need such as the wire mesh for the head and tail sections and the sheet metal for the flukes.

Funding Options:

At the start of this project, we were aware that we needed to get funding on the island, but were unsure if this would be supplied by the DPW or if we had to obtain funding from independent sources. Once we met with our sponsors, we learned that we needed to search for our own funding sources, but the DPW was willing to provide a sizable amount of recycled materials to construct the sculpture, effectively reducing the cost of the sculpture. We discussed our project with the concierge and general manager of the Nantucket Hotel and Resort at the recommendation of Scott Leonard, and they believed it would fit in well with the marine life and environmental sustainability theme of their Gala Under the Sea Dinner & Dance Party, which takes place on December 30 and 31, 2019. They provided an opportunity for us to present our project for their guests and ask for donations towards it. We also explored options for donated or reduced-cost materials. Fortuitously, it appears that Wirefab Inc. of Worcester Massachusetts may be willing to supply many of the metal materials free or at a substantial discount (Hall, J.,

personal communication, November 25, 2019) Part way into the project, Rob McNeil informed us that the proposed location of *Moby* at Surfside Beach's parking lot was directly adjacent to the Ozone Surf Classic Fund's proposed bus shelter, and suggested we find a way to combine the two projects. We presented our project ideas to John Jordin from the Ozone Surf Classic Fund at a subsequent sponsor meeting, and he indicated that the organization would be willing to contribute to the construction and installation of the sculpture in honor and memory of Mr. Ozias.

4.5. Developing Signage

To ensure *Moby* served its purposes as effectively as possible, we developed several ideas for signage that was both instructional, ensuring that people understand how to use the sculpture, and informative on the issues *Moby* aims to raise awareness about. Overall we took a content-centric approach to the signage, focusing on refining the content before perfecting the final layout and aesthetics. We did, however, decide from early on that we wanted a color scheme that reflected the project and Nantucket, and so opted for a combination of gray, reminiscent of a sperm whale's skin, navy blue, reflecting the ocean and Nantucket's flag, and white, further representing the flag and offering a strong contrast. It became clear from our initial approach (Figure 37) that attempting to cover all this information in the same sign would be too wordy and the instructions would be difficult to identify, rendering them ineffective.

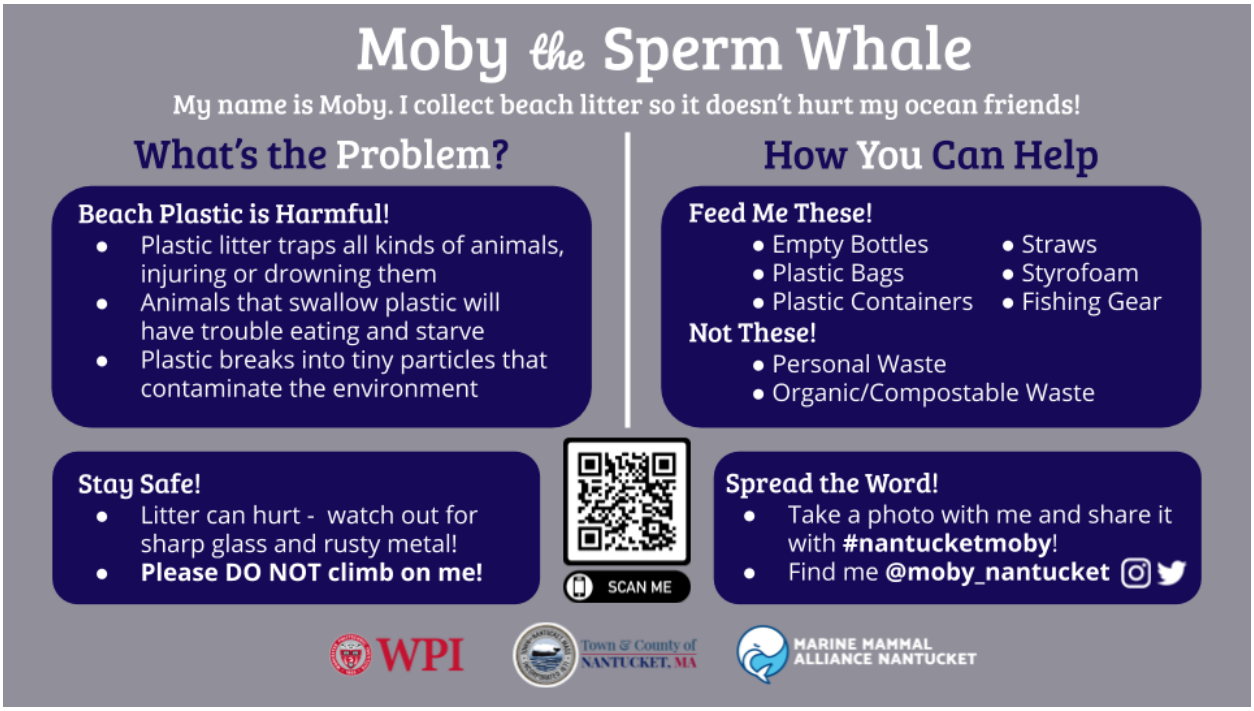

Figure 37. Our initial unified concept for *Moby*'s signage.

To ensure the effectiveness of the messages, we decided to design two separate types of signs. One type, the instructional signage, would display instructions on how to use *Moby* to dispose of coastal litter. The other type, the informational signage, would present more information about the following:

1. The issues of coastal and oceanic litter.
2. Ways that people can take action on these issues.
3. Moby's appearance and purpose.
4. Social media info about *Moby*.

The initial instructional signage designs focused on informing readers about what specific types of items to put in the sculpture and which ones to put elsewhere. We developed numerous variations, most notably a simpler one that just listed items in text and another with labeled icons (Figures 38 and 39). Though they provided visuals to the viewers, they also were relatively wordy, and the images may not have been easy to understand at a glance.

Figure 38. The text-based version of the first iteration of *Moby*'s instructional signage.

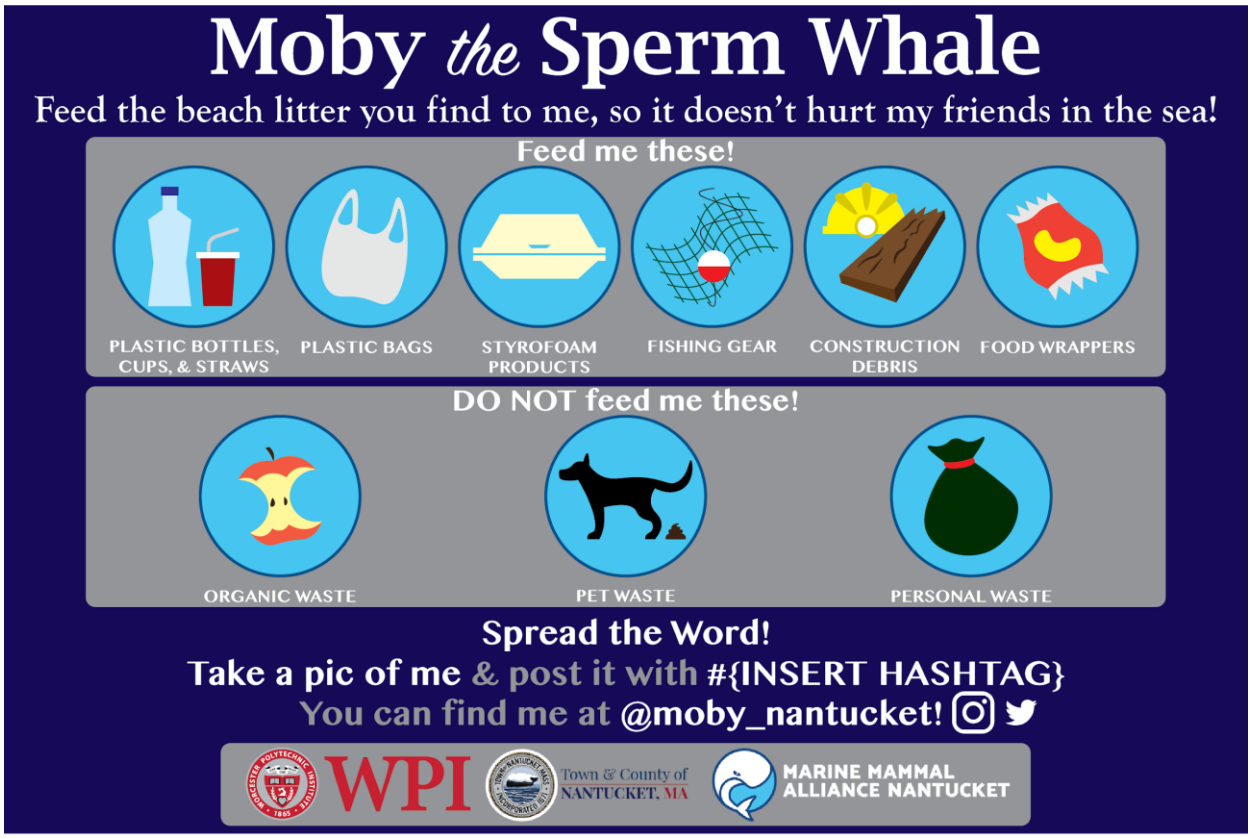

Figure 39. The icon-based version of the first iteration of *Moby*'s instructional signage.

Feedback from the DPW indicated that the sign should be significantly more concise, that photographs would be more broadly recognizable than icons, and that the sign needed to more clearly and generally specify what categories of things were and were not appropriate to put in *Moby*. For the next major iteration we presented a range of designs, on a spectrum from photo-based designs simplified from the previous iteration (Figure 40), to the minimalist extreme of existing DPW signage (Figure 41) which featured just printed arrows and a single simple label (Figure 42). These signs were intended to be either 12" by 18" to maximize visibility, or 9" by 12" to align with the existing DPW signage.

Figure 40. Simplified, photograph-centric version of *Moby*'s instructional signage.

Figure 41. Examples of the DPW's existing signage in context.

Figure 42. Version of *Moby*'s instructional signage based on existing DPW signage.

The DPW informed us that they wanted the coastal litter collected in *Moby*'s head to specifically be Non-Recyclable Non-Compostable [NRNC] waste, as the receptacles housed in its body would provide places for the other types and prevent them from sorting. The DPW approved of the simple version of the instructional sign based on their existing signs and proposed that we

color it black to tie in with the NRNC color designation. This would also go along with their plan to update their signs to color-coded 12” by 18” versions. They also informed the team that they have their own sign maker who would be able to handle the creation of this design of the instructional sign due to its simplistic design. This feedback and information led to the final version of the instructional sign, shown in Figure 43, which would be 12” by 18” and mounted on both sides of *Moby*’s head.

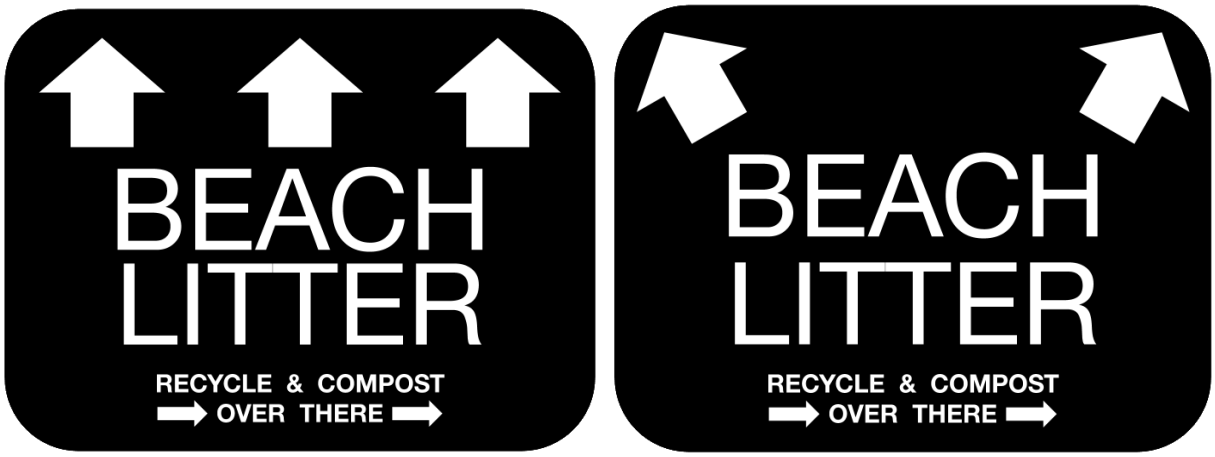

Figure 43. The final iteration of *Moby*’s instructional signage. The two variations are based on the placement of the sign relative to the entry slots where litter is introduced. Both variations come with versions where the bottom arrows point to the left or right.

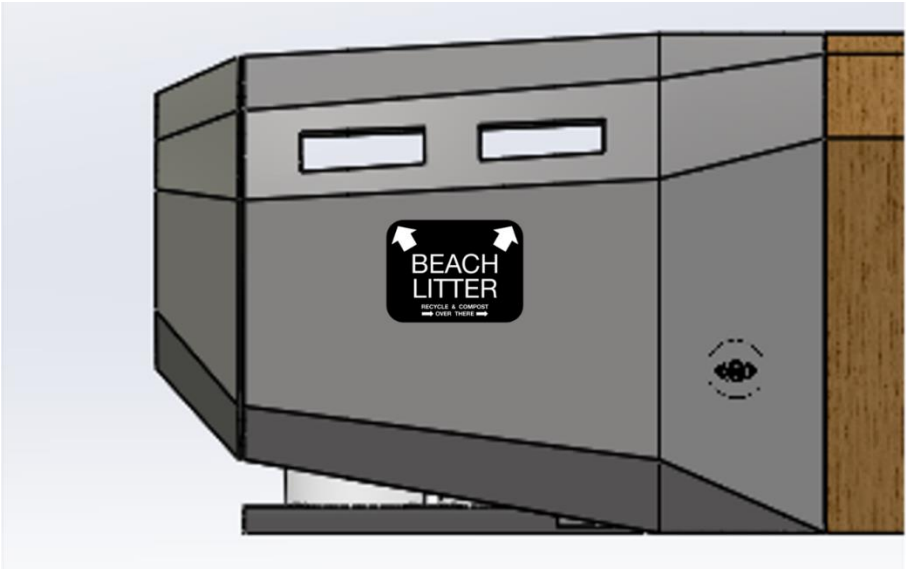

Figure 44. Mock-up of an instructional sign displayed on *Moby*'s head.

The informational signage had a somewhat different iterative process, as it contained complicated content that needed to meet the objectives and goals not only of the project, but of the DPW, the MMAN, and later the Ozone Surf Classic Fund. The initial version of the informational signage, seen in Figure 45, displays information from the four categories noted previously (i.e., issues, actions, *Moby*'s appearance, social media), but did so in generic detail and only provided advice for helping the public address the issues in the short term.

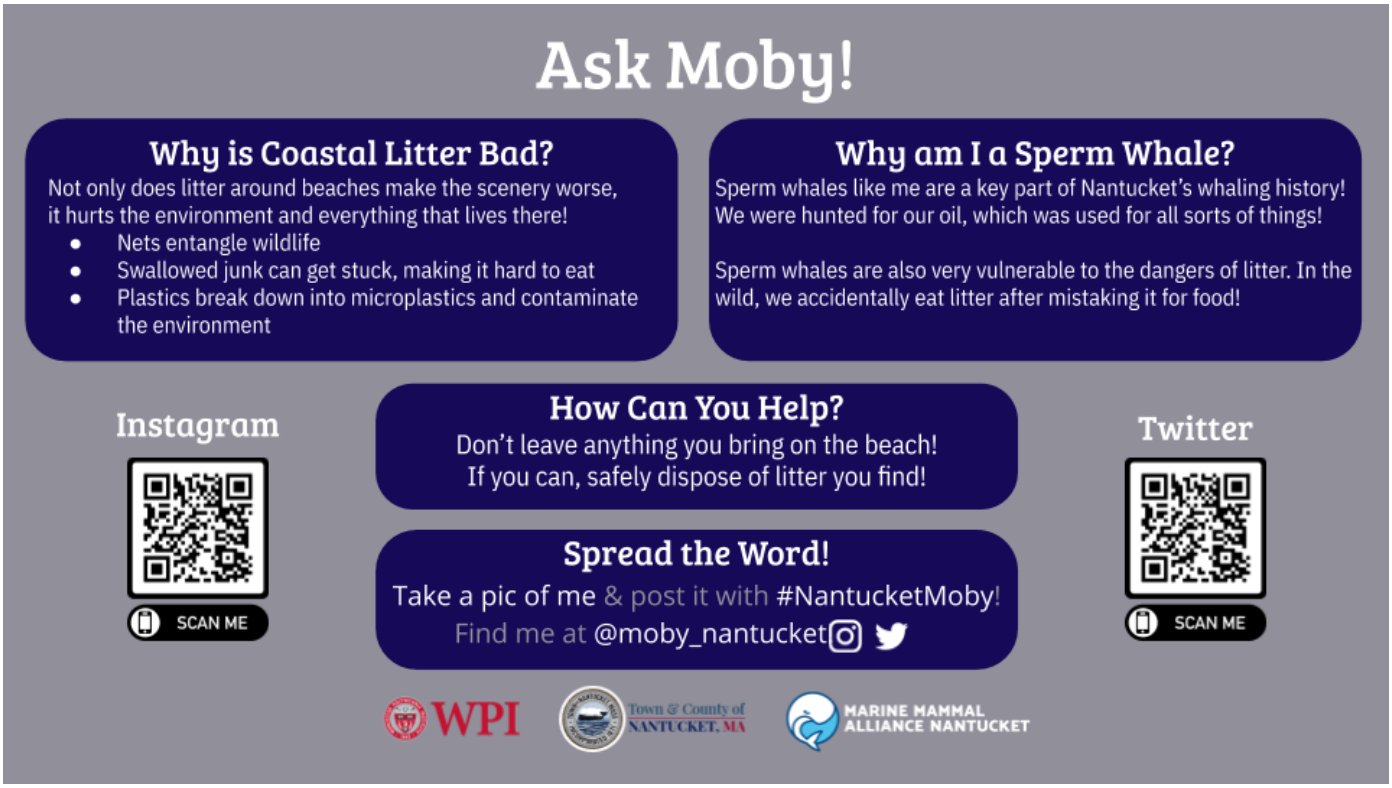

Figure 45. The initial version of the informational signage.

The main feedback we received on this stage of the informational signage was that the sign should aim to encourage not just short term low-impact pro-environmental behavior like cleaning up pieces of litter, but to drive people to do what they can to bring about systemic change to address the issues of plastic waste and recycling. Once the decision was made to make *Moby*'s fluke serve as a bus stop shelter, the sculpture also became a memorial to David Ozias in addition to its other roles, and this also needed to be noted on the sign. We intentionally designed the informational signage to be rich in content, since we anticipated that people would have substantial time to peruse the information while waiting for the bus. We included advice on both

short and long-term ways people can make a difference, compelling facts and statistics about marine litter, and added a note explaining the sculpture's role as a memorial for Mr. Ozias. We tried to present all the information in a visually attractive and engaging format. This version is shown in Figure 46 and was initially planned to be 18" by 24".

Figure 46. The second major revision to the informational sign. [Note: the statistics are from Li, 2016, and Rochman et al., 2016.]

The team continued iterating on the informational sign incrementally with new feedback from both the DPW and MMAN. The sponsors requested that the sign should emphasize the slow violence aspect of litter and how it poses a modern threat for marine life. It was also determined that the DPW would like the sign to be significantly larger than we imagined, recommending a full size of 3 by 4 feet. We discovered that an advantage of increasing the size of the sign was that we were able to feature images and more text while having the freedom to explore more aesthetically-pleasing layouts. To add a bit more life to the sign and build a more personal and social connection between the sculpture and people reading the sign, we decided to include stylized images of the sculpture, demonstrating how to dispose of litter and give *Moby* more of a personality. We also included a note crediting Mr. Sherry as the sculpture's creator, with his permission. The finalized version resulting from this is shown in Figures 47 and 48.

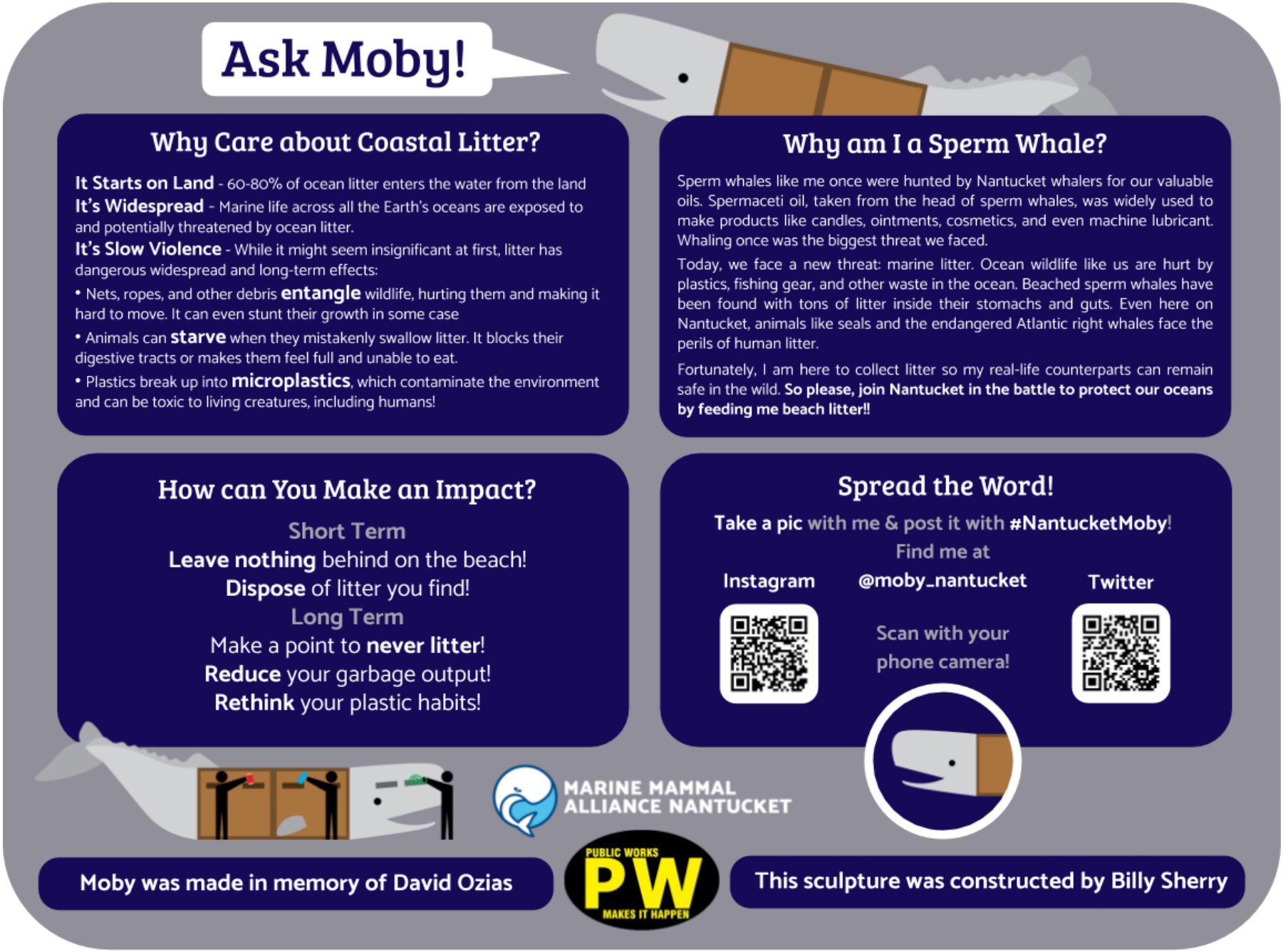

Figure 47. The final version of *Moby*'s informational signage. [Note: The 60-80% figure is from Derraik, 2002, while the spermaceti information is from Encyclopaedia Britannica, 2011.]

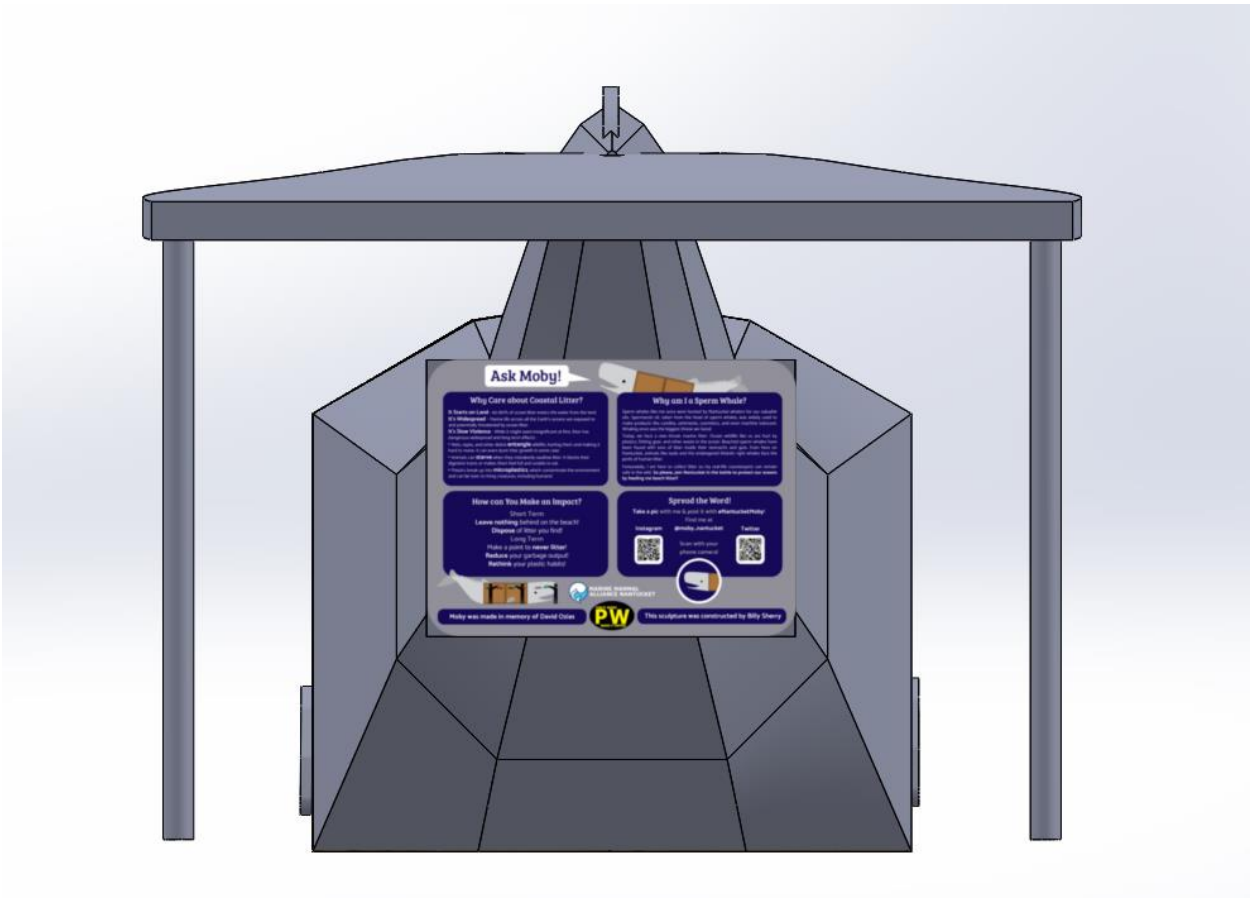

Figure 48. Mock-up of the informational sign displayed at its location under the tail.

4.6. Educational Outreach

The team reached out to Nantucket schools to set up times to interview relevant personnel to get a better understanding of what type of educational content would be both effective and suitable for their students. Graeme Durovich informed the team that she has collaborated with the Nantucket Intermediate School in the past, working with 5th graders to create PSA radio spots for the changes that were made to the mandatory recycling statute. Based on this information and recommendations from our sponsors, the team chose to contact; the Nantucket New School, a private school for grades Pre-K to 8th; the Nantucket Intermediate School, which is the public school for grades 3-5; and the Cyprus Pierce Middle School, which is Nantucket's public school for grades 6-8. We met with Evemarie McNeil, Jessica Held, and Francie Baskett of the Nantucket Intermediate School and Dr. Amanda Bardsley from the Cyprus Pierce Middle School to discuss and formulate an outreach programs in their respective schools.

During the meeting with the Nantucket Intermediate School, we learned more about the previous projects carried out at the school, some of which may be brought back for this year, including PSA broadcasts and various art activities. This lead to the development of other ideas such as students creating their own miniature litter sculptures, Stroll holiday ornaments made out of found objects, a contest for posters or designs and names of potential future sculptures. We established that a teacher would oversee all interactions between the project team members and the students at all times.

During our meeting with Dr. Bardsley, we informed her of what we discussed with the Intermediate School to see if any of the ideas generated with them would be of interest to their middle schoolers. Similarly, we met with Matthew Liddle, a science teacher at the Nantucket New School, and he was very interested in the team presenting in front of their middle schoolers about our project information on coastal litter. The schools we spoke to did not express interest in the team creating material for future use, as that future content would be developed in the teacher's own time and fashion. Since every teacher has their own unique teaching style, it would be more appropriate for them to develop their own lesson plans and content as they see fit.

With this in mind, we worked on a presentation about the project, which focused on conveying our project details, explaining the issue of oceanic litter, and relevant questions for them to consider. The presentation contained images of *Yoshi, Goby, Treadgold Fish,* and digital

models of *Moby*, as well as information about coastal litter and the ongoing debate on the use of plastic. We visited two schools in Nantucket and modified our educational content and presentation for each location and age group accordingly. One presentation was shown to the fifth-grade students of Nantucket Intermediate School in three groups. The second presentation was shown to a group of students, grades 5-8, from the Nantucket New School. Some adjustments were made to the second presentation, as our initial content was developed for a fifth grade audience. Changes were made to the overall wording of the presentation, as well as the terminology used and a more comprehensive discussion on pertinent topics to cater to a larger age-range audience. This allowed the team to interact with the students by introducing them to the problem of coastal litter and answering any questions they might have about the problem we are addressing. It also gave us the chance to answer any questions they had about our project in general and to give them base knowledge that will be useful if they are to participate in supplemental activities later in the school year pertaining to *Moby*.

5. Conclusions and Recommendations

From our findings the team concluded that there is substantial support on the island for a functional coastal litter sculpture that uses an iconic image from Nantucket's past, the mighty sperm whale, to raise awareness about coastal litter, recycling, waste management, and how it affects the ocean's wildlife. Public art pieces, particularly those that serve other purposes aside from aesthetics and symbolism, can be used as an effective medium to promote public awareness, but the messages need to be reinforced through multiple channels, such as school programs, social media, and informational advertisements and posters. We determined that *Moby*, along with any future beach sculptures that may be created, must balance eye catching imagery with practical considerations, such as usability, ease of access for the DPW staff, materials that minimize costs and maximize durability in a coastal environment, and effectiveness of the sculptures' placement.

While encouraging responsible recycling is laudable, the ultimate goal is to fundamentally shift public perceptions and dramatically minimize the use of plastics in the first place as a way to protect the health of the ocean and its wildlife. The concept of "slow violence", or the damage committed by mankind on the environment in ways that are usually gradual and often unseen, has been a recurring theme in this project. Drawing attention and advocating for a voiceless entity, has been a major topic throughout this project. By creating a sculpture of a sperm whale filled with coastal litter, the project can raise awareness of this act of slow violence in a way that ties into local history and creates a deeper connection with the people who interact with it.

In the seven weeks we were on Nantucket, we did not have the time to build the sculpture, but we have several recommendations about how to bring this project to fruition in the near future.

We recommend that the DPW, MMAN, the sculptor Billy Sherry, and the Ozone Surf Classic Fund continue collaborating to finalize, construct, and install the sculpture. While the team developed detailed concepts and plans for the sculpture design, proposed materials, and the potential costs, the details of the final product will be realized by the DPW,

MMAN, and other stakeholders. To facilitate this process and ensure that the needs of all individuals and groups involved are met, we recommend that close collaboration and communication continues between these parties until the sculpture is installed.

We recommend the DPW continues to collaborate with the MMAN, the sculptor, the Ozone Surf Classic Fund and others to develop a public outreach and marketing plan for the installation of *Moby* in spring/summer 2020. While we have created the design and social media pages for *Moby*, presented about the project at schools, and set up plans to present it at the Nantucket Hotel and Resort's Gala Under the Sea Dinner & Dance Party, we currently have no long-term plans for promoting the project and informing the public of its existence or purpose closer to its installation date at the start of the summer. We suggest creating posters, rack cards, and other materials for display at the town hall, on the ferries, and other suitable venues. These materials should include the social media pages and hashtags on them to help ensure that the word on *Moby* gets spread throughout the community. We also recommend reaching out to news sources like the Inquirer and Mirror, 97.7ACK FM and NCTV18 to get coverage of the sculpture's unveiling.

We recommend the DPW and MMAN monitor and maintain the *Moby* social media to determine its popularity and adjust messaging as needed. Since the team will not be present on the island or actively involved in the project after December 2019, it will have to be the responsibility of either the DPW or MMAN to manage and post on the *Moby* social media accounts, @moby_nantucket on Twitter and Instagram. We suggest promoting the sculpture with the hashtags #nantucketmoby, #ackmoby, and #feedmoby, as these are directly relevant and currently receive little to no use. We advise using these platforms to share images of *Moby*, especially those submitted by other users, as well as spreading information related to the mission and objectives of the project, such as what ocean litter does to animals like sperm whales and the amount of litter that *Moby* has collected. Additionally, the MMAN could provide any new images they obtain of marine wildlife entanglements. If the DPW and MMAN wish to include icons for Instagram and Twitter on the sculpture's informational signage, we recommend they acquire permission to do so. We also recommend following up with schools to see if they are interested in having their students design posts for the *Moby* social media pages.

We recommend the DPW and MMAN work together with the schools to further develop the educational materials prepared by the team. When we interviewed the Nantucket Intermediate School faculty and they said our message came at just the right time, as they were going to get into these topics with the students very soon and a presentation about our project would be a good introduction to their unit. After our presentations with the students we recommend that the DPW and MMAN work with local schools to further reinforce how important protecting the environment is and how great an impact coastal and oceanic litter has on it.

We recommend the DPW monitor the coastal litter collected in *Moby* to better characterize that stream and adjust signage and informational materials as necessary. Monitoring the amounts and types of litter collected would be a good indicator of the success of the sculpture as a receptacle for coastal litter. While we believe the indicators for where each waste stream goes are quite clear, if the head of *Moby* begins to be filled with many non-NRNC materials then the instructional signage may require modification. Additionally, if the informational sign at the tail end of *Moby* does not appear to draw the attention of beach-goers then it could be modified or repositioned to a different location on or near the sculpture, such as a freestanding position directly next to the beach entrance or the side of the tail facing the beach entrance.

We recommend the DPW and MMAN consider further additions or adaptations to *Moby,* as well as the installation of additional sculptures on other beaches on Nantucket based on the *Moby's* success. It was suggested by a community member that there be some kind of reward system to encourage further engagement with the sculpture, such as a measurement of how much litter has been collected to date. One idea was to have solar panels placed on the top of the whale's flukes, to power a few electronics in the sculpture, such lighting for the bus shelter under the tail, or device measuring the amount of litter is collected, or a speaker with a digital voiceover that would give more information about the problem writ large. Depending on how well *Moby* is received and how much litter it collects daily after it has been deployed, the DPW and MMAN can use the resources and additional concepts we have developed to create more

coastal litter sculptures at other beachside locations. For consistency and design convenience, *Moby*'s design can be duplicated into more sperm whale sculptures and create "*Moby's* Pod" around the island. These sculptures might feature other iconic wildlife affected by coastal litter such as seals and turtles, as illustrated in Figure 49. As part of the public outreach effort, the DPW and MMAN might engage school students in the choice of animals portrayed, the sculpture designs, and the selection of appropriate names.

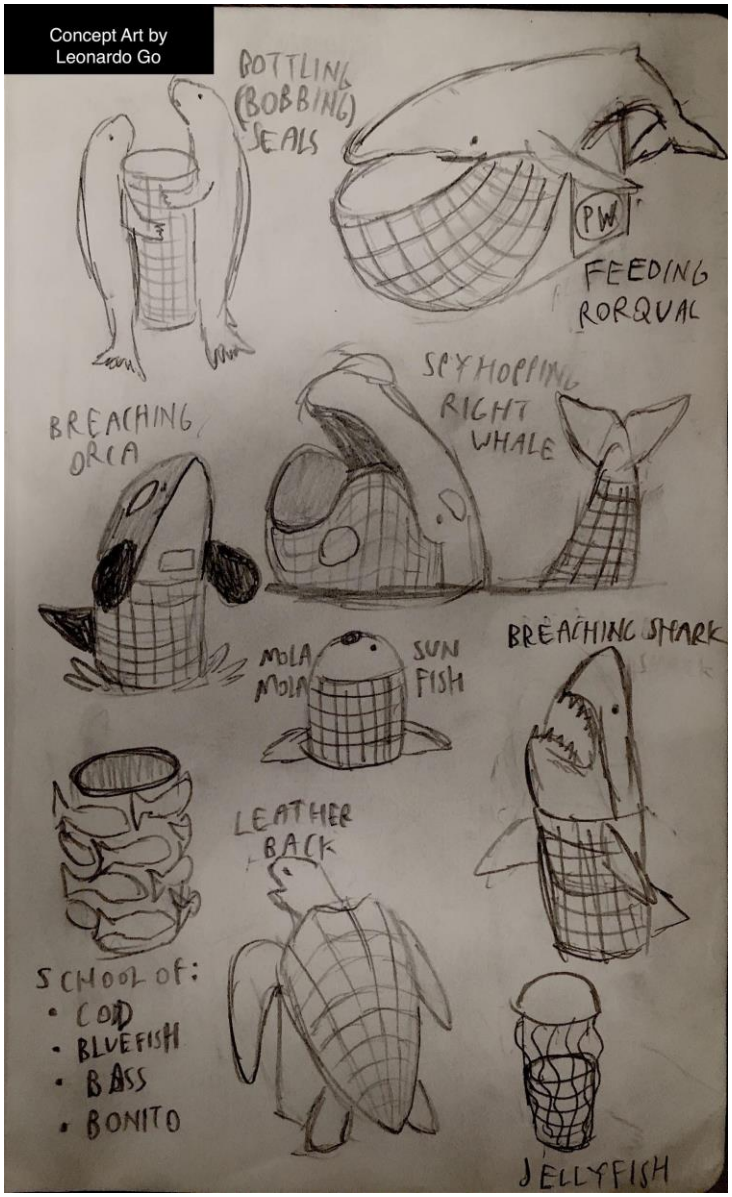

Figure 49. Sketches of possible future sculptures based on Nantucket marine wildlife.

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Appendix A: DPW Discussion Questions

Over the course of our discussions with our DPW sponsors, we intended to find the answers to these questions:

DPW Resources:

1. What equipment do you regularly use for repair and preservation of town properties?
2. What equipment do you use for clean-up and trash collecting services?
    a. How large is the piece of equipment you would use for transporting litter away from the sculpture when emptying it?
    b. What is the procedure for loading that equipment?
3. How frequently would you expect to be able to send people out to the sculpture to empty it?

Sculpture Design Specifications:

4. Are there any specific features you would prefer the sculpture to have in order to ensure it can be easily serviced by the DPW?
5. If you would need to transport the sculpture to another location, such as in an emergency situation, are there any limitations on how large or heavy it can be?
6. Are there any regulations you know of that may impact the design of the sculpture?

Sculpture Location Specifications:

7. Are there any major beaches you would have special concerns about putting the sculpture on, such as having a layout that would make reaching the sculpture to service it difficult?
8. Is the distance between the beach we choose and the DPW facilities a concern?
9. Do you think it would matter if the beach typically has a lifeguard in summer?
10. Is the amount of accessible area above the high water mark a concern at any beaches?

Miscellaneous:

11. Do you have any other concerns, questions, or pieces of advice regarding our project?
12. Is there anyone else you recommend we ask about the types of information we have discussed here?

Appendix B: ACK Clean Team Interview

This interview procedure was used to collect data from the ACK Clean Team about their knowledge and determine which of the beaches and areas tend to have the most litter. The interview was carried out with two team members present, and the team relied on recording the interview rather than taking notes during the course of it as the subject had the team help clean litter from a beach during the course of it.

Preamble:

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a clean-up and education project in collaboration with the Nantucket Department of Public Works. We intend to create a beach sculpture that will help clean up the beach while also educating the public on the effects of littering.

We very much appreciate you taking the time to answer some of our questions about your organization's activities and findings. Your participation in this interview is completely voluntary and you may stop at any time. May we record this interview in video so that we may return to it for reference and possibly use it in a video showcasing our project? We shall also be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your participation in our project.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at gr-ACK19DPW@wpi.edu or our faculty advisor, Dominic Golding, at golding@wpi.edu.

Questions

1. Which beaches on the island are the most popular?
2. What is the most common type of litter you pick up on the beaches?
3. Which beaches do you find collect the most litter on it?

    a. Do you believe that the popularity of the beach is a significant factor in how much litter accumulates there?
    b. How quickly does litter tend to accumulate on these beaches?
    c. Are there distinct regional differences in litter accumulation, such as there being different amounts on the northern and southern shores?
4. Where do you believe the sculpture would have the greatest impact?
5. Do you have any other concerns, questions, or pieces of advice regarding our project?

Appendix C: Prior Litter Sculpture Artist Interview

This interview procedure was used to collect information from artists who have previous experience creating similar litter-collecting sculptures to the one we intend to make. Depending on their availability it was either carried out through a video or audio call, through email, or through another method of text-based digital communication. These were intended to be semi-structured interviews to allow us to cover more points than just the ones we specifically plan to ask about. When carried out over a call, at least two team members took part: one guiding the conversation and the other taking notes. The exact questions asked were adapted slightly to each subject.

Preamble:

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a clean-up and education project in collaboration with the Nantucket Department of Public Works to create a beach sculpture that will help clean up the beach while also educating the public on the effects of littering.

We very much appreciate you taking the time to answer some of our questions about your organization's activities and findings. Your participation in this interview is completely voluntary and you may stop at any time. May we record this interview in video so that we may return to it for reference and possibly use it in a video showcasing our project? We shall also be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your participation in our project.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at gr-ACK19DPW@wpi.edu or our faculty advisor, Dominic Golding, at golding@wpi.edu.

Questions

1. What are some other sculptures have you have created in the past? We would be particularly interested in hearing about ones related to cleaning up or raising awareness about coastal litter or similar issues.
2. How long did it take to build your litter collecting sculpture?
3. How much litter can your sculpture hold?
    a. What types of litter can it hold?
    b. How big is it, approximately?
4. How is your sculpture emptied and how frequently?
5. What materials did you use in building the sculpture?
6. Is the sculpture seasonally deployed or outside for the whole year?
7. What measures did you take to protect the sculpture from the elements, like sand and saltwater?
8. Do you have any other advice for us regarding this type of project?

Appendix D. Collaborating Artist Interview

This interview procedure was designed to be used to evaluate which local artist(s) we wished to collaborate with for the project. Interviewees would be individuals recommended to us by our sponsors and other knowledgeable sources. This type of interview was carried out in person, with at least two group members present: one conducting the interview, and a second taking notes.

Preamble:

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a clean-up and education project in collaboration with the Nantucket Department of Public Works to create a beach sculpture that will help clean up the beach while also educating the public on the effects of littering.

We very much appreciate you taking the time to answer some of our questions about your organization's activities and findings. Your participation in this interview is completely voluntary and you may stop at any time. May we record this interview in video so that we may return to it for reference and possibly use it in a video showcasing our project? We shall also be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your participation in our project.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at gr-ACK19DPW@wpi.edu or our faculty advisor, Dominic Golding, at golding@wpi.edu.

Questions:

1. What makes you interested in this project?
2. What materials do you have experience working with?
3. What is your availability to work on this project?
4. Would you be open to collaborating with other local artists on this project?

Appendix E. Teacher Interview

This interview was used to identify the optimal educational strategy to use with the Nantucket students. The team wanted to determine specifically which age group to design materials for and how to incorporate art and science into the educational information and activities we produce. Additionally, the team aimed to identify previous littering educational content that has been taught to the students in order to avoid repetition, identify effective or ineffective methods of educating on the subject, and potentially have the opportunity to follow-up or continue previous lessons of relevance to the project. These interviews were carried out with two team members present.

Preamble:

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a clean-up and education project in collaboration with the Nantucket Department of Public Works. We intend to create a beach sculpture that will help clean up the beach while also educating the public on the effects of littering.

We very much appreciate you taking the time to answer some of our questions about your organization's activities and findings. Your participation in this interview is completely voluntary and you may stop at any time. May we record this interview in video so that we may return to it for reference and possibly use it in a video showcasing our project? We shall also be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your participation in our project.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at gr-ACK19DPW@wpi.edu or our faculty advisor, Dominic Golding, at golding@wpi.edu.

Questions:

1. What age group of students do you believe would be optimal for an educational program on coastal litter?
2. Currently our team had these ideas educational programs and activities, which could be combined in various ways: [discuss our ideas]
3. What kinds of previous educational content was taught to the students pertaining to plastic litter and pollution?
    a. What school subject or subjects was that content based around? Art, Science, Social Studies?
    b. Are their particular types of activities have you seen to be the most effective at teaching students of [the recommended age group]?
    c. We heard about 5th grade students making videos, songs, social media materials, and radio spots about sorting waste. To avoid repetition, were there any additional programs done with the students on litter or plastics?
    d. Are there any previous lessons that would be appropriate for us to expand or elaborate more on?
4. Are there any particular aspects of the issues of coastal and ocean litter that you believe students would benefit from learning more about?
5. We might like to create a lesson plan including activities that inform and engage students about pro-environmental behavior with an emphasis on coastal litter. We have several questions regarding this:
    a. Given the education students already receive on Nantucket about this subject, do you think this is a useful avenue for us to pursue? If not, do you have any alternative suggestions for ways we can help educate people on this subject?
    b. How does the curriculum affect what we can and cannot do with the lesson plan?
    c. How much time should we plan for our lesson to take?
    d. What restrictions are there on the types of activities students can participate in as part of educational lessons?
    e. Are there any other requirements that a school lesson plan must fulfill?

    f. If we create a lesson plan and it meets the necessary requirements, would teachers at the school have an interest in presenting it to the students, or alternatively giving us permission to present it to them directly with teacher supervision?
6. Is there another idea that we have not mentioned that you believe would be a better alternative to increase student involvement and education?
7. If the team ended up directly working with the kids, would we need to get a CORI background check? If so, it may be out of the question at this point due to time constraints.

Appendix F. Maintenance Plan

Assembling and Disassembling *Moby*

As a seasonal enclosure, *Moby* is designed to be disassembled and relocated as needed. The sculpture is subdivided into sections that can be separately transported. As these are bulky and have substantial weight, the use of equipment like a forklift will be very important for this task. The separate sections of *Moby* are as follows:

- Head Section (approximately 8'x 6'x 6')
- 4 wooden Body Sections (each approximately 6'x 3'x 6')
- Tail Section (approximately 12'x 7.5'x 10')

These are arranged according to Figure 1.

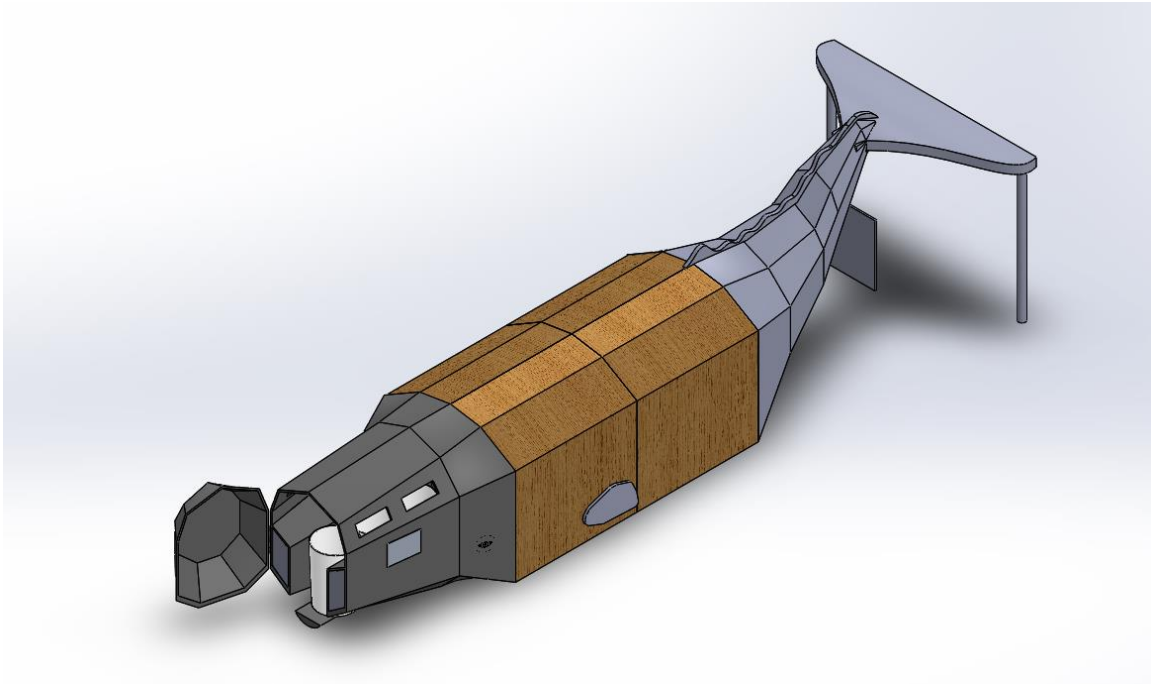

Figure 1. Diagram of *Moby*'s layout

Emptying the Body Section Waste Barrels

Shown in Figure 2, the four wooden Body Sections that make up the body portion of *Moby* are almost identical to the regular wooden waste bin enclosures, with the only difference being a modified roof to match the contour of *Moby* and a slightly longer frame. The waste barrels within these are the same ones that would ordinarily be placed on Surfside Beach, and have the same volume as the barrels in regular beach enclosures. Therefore, these enclosures require no special maintenance procedures besides those already used by the DPW, and should be emptied in the usual manner and frequency as follows:

1. Unlock and open the appropriate wooden door on the Body Section.
2. Remove and empty the waste barrel inside.
3. Return the waste barrel.
4. Close and lock the Body Section door.

Figure 2. Diagram of a wooden Body Section

Emptying the Head Section of Collected Litter

The Head Section of *Moby*, shown in Figure 3, contains three barrels in the head, which collect the non-recyclable and non-compostable beach litter. The three have a shared capacity of 150 gallons, so they are not expected to fill up faster than the waste barrels in the body. However, they should be emptied on an as-needed basis along with the waste barrels in the body. Fortunately, this process should be nearly as easy as emptying the DPW's regular wooden waste bin enclosures.

1. Unlock and open the front of the Head Section.
2. Pull out the barrels one at a time.
3. Empty the barrels into the service truck.
4. Return barrels to the Head Section one at a time.
5. Close and lock the front of the Head Section.

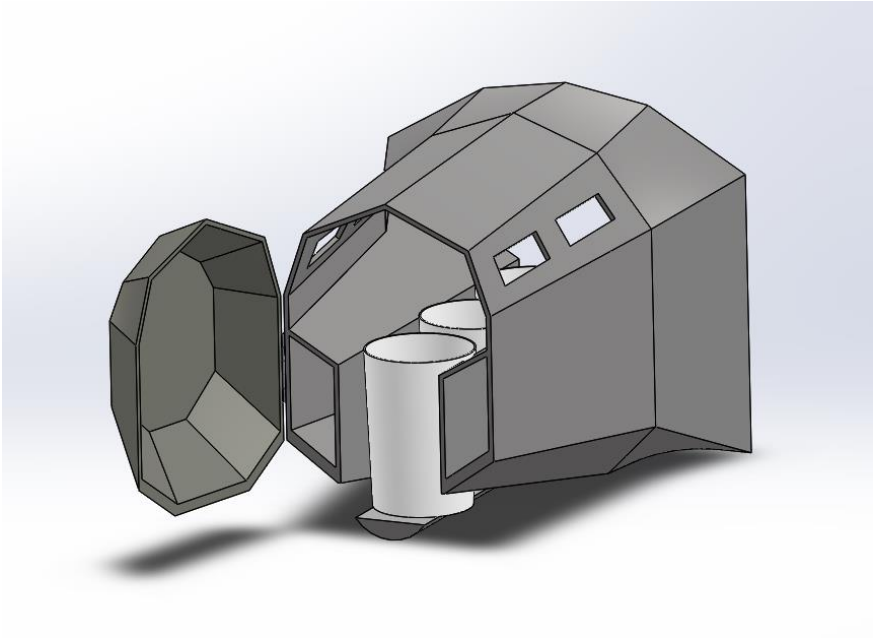

Figure 3. Diagram of the Head Section

Servicing the Static Litter Displays in *Moby*'s Head Section

To access from the front:

1. Unlock and open the front of the Head Section.
2. Open the front hatch doors of the display chamber (see Figure 4).
3. Insert or remove litter from the space inside.
4. Close and lock the static display chamber hatch doors and the front of the head.

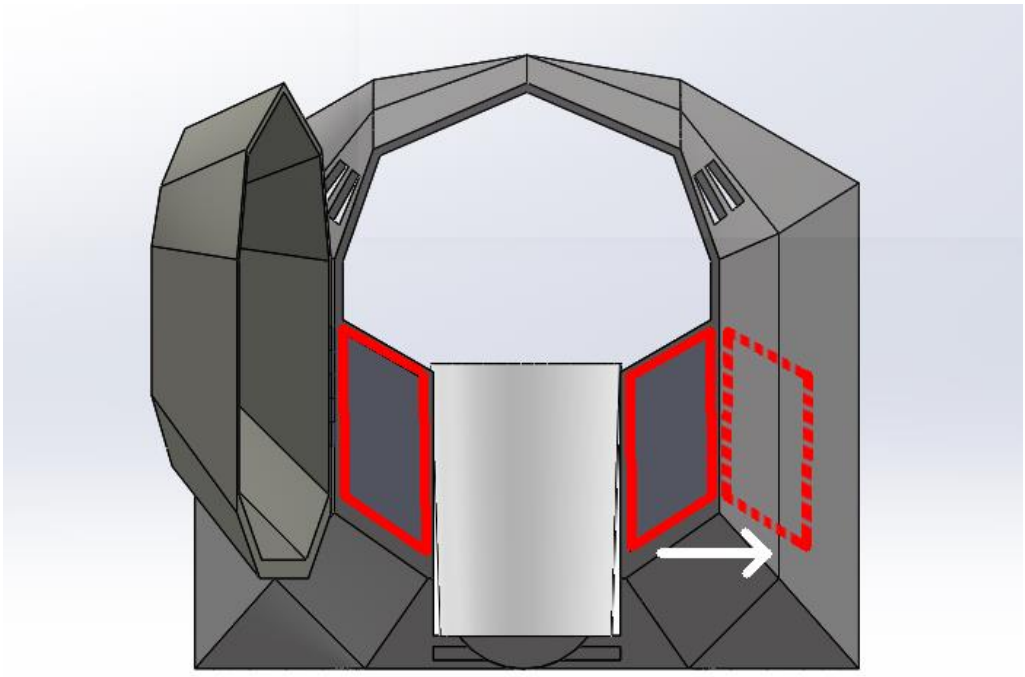

Figure 4. Diagram showing the Head Section's front hatches (indicated in red).

To access from the rear:

This option requires moving wooden enclosures, and is not recommended unless something needs to be removed that is too far inside to reach.

1. Remove the wooden body enclosure box closest to the sculpture's head on the appropriate side.
2. Open the rear hatch doors of the static display pockets (see Figure 5).
3. Insert or remove litter from the space inside.
4. Close and lock the static display chamber hatch doors.
5. Return the wooden enclosures to their original positions.

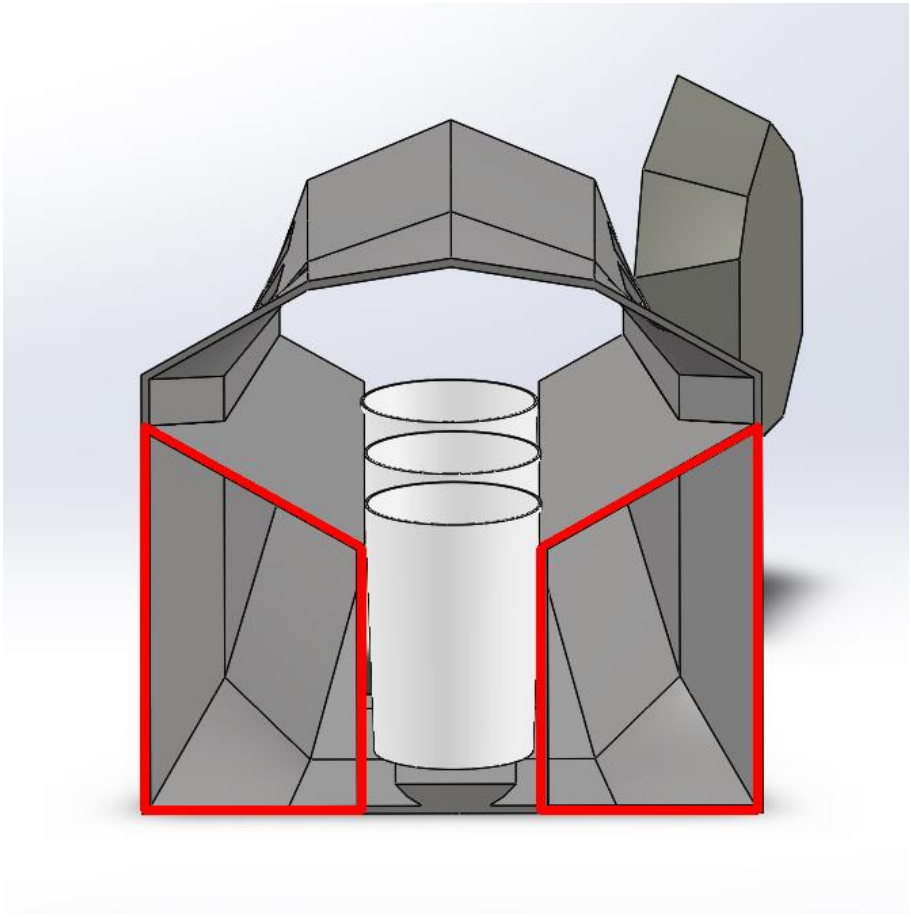

Figure 5. Diagram showing the Head Section's rear hatches (indicated in red).

Servicing the Static Litter Display in *Moby*'s Tail Section

Moby's tail section, shown in Figure 6, only has a static litter display inside and so should not require regular servicing or access. In order to fill or empty the display, it should be accessed as follows:

1. Remove the two wooden body enclosure boxes adjacent to the sculpture's tail.
2. Unlock and open the hatch door on the flat side of the tail.
3. Insert or remove litter from the space inside.
4. Close and lock the hatch door.
5. Return the wooden enclosures to their original positions.

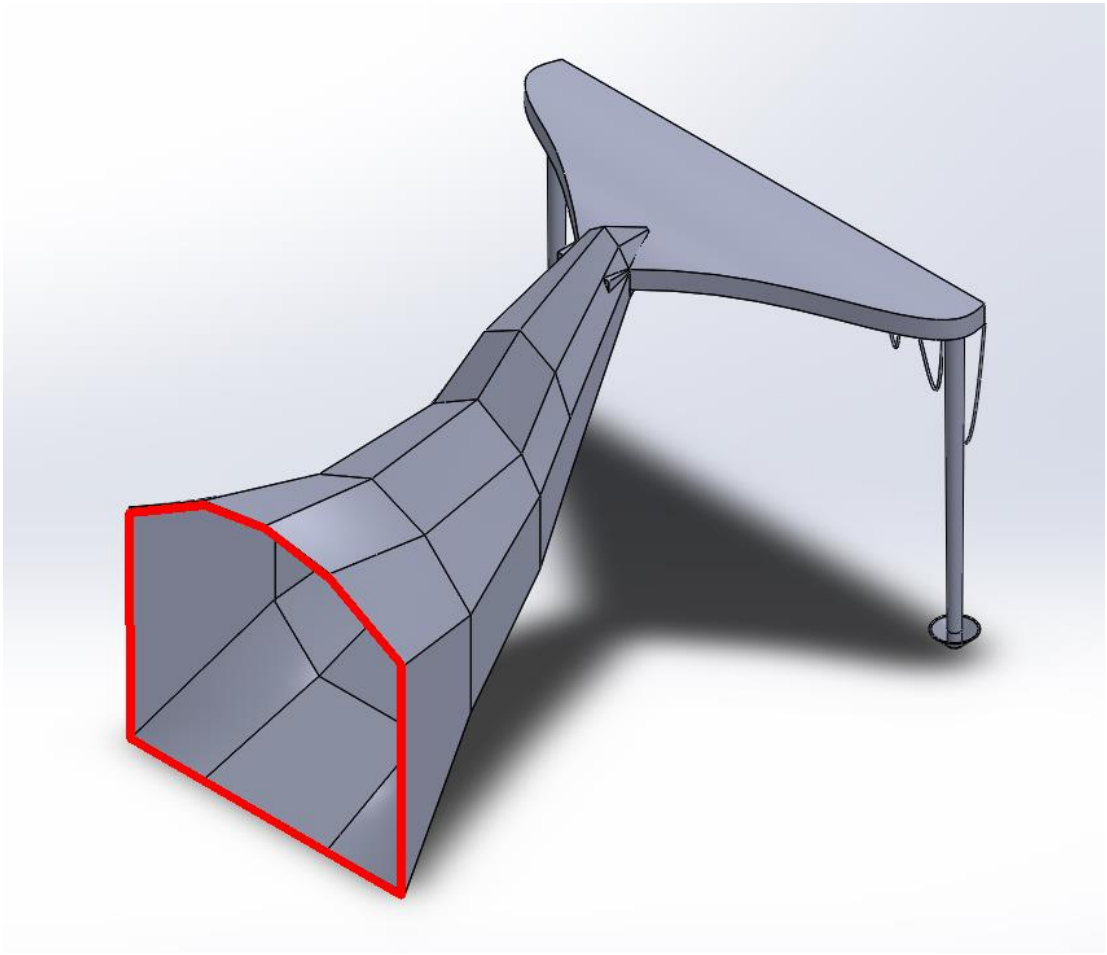

Figure 6. Diagram of the Tail Section, with the access hatch indicated in red.