Guardians of the Seascape: Considering the Next Era of Lighthouses in Rural Nova Scotia Communities

by

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CONTENTS

ABSTRACT

This thesis studies ways in which architecture and the coastal infrastructure of lighthouses can help preserve a relationship with the seascape, encouraging rural Nova Scotian communities to engage and respond to their local environment. The intention is to consider our changing climate, explore relevant materials, and introduce supplementary programming related to specific existing communities in order to establish a speculative lighthouse network.

The research identifies existing preservation efforts, but also acknowledges that few efforts have proven successful and in many cases are overrun by future sea levels regardless. Identifying three test sites - Cape Sable Island, Belliveau's Cove, and Parrsboro - the work hopes to generate conversation regarding ways we can rethink the aging infrastructure, and proposes a new approach to navigational aids that activates the memory of the historic maritime culture by looking forward to a new, more inclusive lighthouse.

ACKNOWLEDGEMENTS

Mom, Dad, and the rest of my family that fed and supported me over the last six years, I owe you big time for your patience.

To Cristina, your guidance through this process made this experience exciting and unique. Thank you for your encouragement and friendly approach to learning. To Roger, thank you for your advice and input along the way.

Matt Jones, Matt Bishop, Will, and all others who helped along the way and during the home stretch, your efforts went above and beyond.

To my best pal Ashley, your amazing patience, generosity, and willingness to help proved that two heads are truly better than one.

CHAPTER 1: INTRODUCTION

Nova Scotia's lighthouses are physical points of reference along varied and often hazardous shorelines. Providing seafaring individuals navigational aid, these points of reference often serve as a symbol of refuge and safety for rural Nova Scotia communities. With nearly half of the provinces population still calling rural Nova Scotia home (Canadian Rural Revitalization Foundation 2015), these lights have played and continue to play a large role in Nova Scotia's coastal settlements.

Aging infrastructure and advancements in navigational technology have proven dangerous for the historic yet relevant structures. With countless communities and industries that have relied, and continue to rely on their interactions with the sea, the lighthouse has become a physical expression of a coastal way of life - an expression that is at risk of being lost (Baird 2010). Preservation efforts and community involvement prove as useful means of ensuring many of Nova Scotia's lighthouses have a future, yet difficulty securing, repurposing, and maintaining the delicate and tired structures has been challenging at best (Standing Senate Committee on Fisheries and Oceans 2011a).

With the majority of the few lighthouses that have been successfully handed over to communities or community groups converted into small museums or gift shops, the structures become a means of making a modest income for maintenance and upkeep costs (Fisheries and Oceans Canada 2012). Primarily serving the interests of curious tourists and travelers, the historic buildings become far less about creating spaces for the community to connect with and more about a means to an end.

On top of neglect, lack of funding, and overall lack of direction, Nova Scotia's existing lighthouses face perhaps a decided fate nonetheless. The majority of the existing infrastructure in many cases hovers just several feet above today's high tide, often significantly impacted by storm surge or extreme high tides (Wagstaff 2015). Add future climate change to the mix, and many of the otherwise robust lighthouses are permanently flooded.

Often with exposed sites in varying degrees of isolation, the opportunity exists to address ideas of maintenance, materiality, and program. The goal of this thesis is to explore the lighthouse as a piece of at risk coastal infrastructure, understanding how the structures developed and exist today, with the hopes of creating a more engaging and sustainable intervention, connecting the community and the coastal region at large (Baird 2010).

Cape Sable Island, Belliveau's Cove, and Parrsboro serve as case studies to test a new approach to building navigational aids. All three sites are rural coastal communities at risk of being affected by rising sea levels, offering a spectrum of accessibility and local culture that can be explored and integrated (see Figures 1-3).

Figure 1
Cape Sable Lighthouse

Figure 2
Belliveau's Cove Lighthouse

Figure 3
Parrsboro Lighthouse

CHAPTER 2: HISTORICAL OVERVIEW

The dawn of maritime commerce also gave life to what we recognize today as lighthouses. Navigational aids were introduced in tandem with the development of seafaring merchants and trade between nations. In its near 3000 year history, the practice of lighting the threshold of land and water has come to represent not only navigation in its most visually present form, but a symbol of refuge, warning and courage. Often isolated and exposed to nature's most powerful means, the lighthouse became an object of opposition or protest, serving those at sea regardless of weather or time. Day, night, fog, hurricane, the light was expected to communicate a message of guidance serving the individuals that chose to brave the sea for its bountiful prospects and opportunity.

Global

A simple fire on a platform atop a high point allowed fishermen and merchants to safely navigate the largely uncharted coastlines (Hague and Christie 1975, 1). At the entrance of the ancient city of Troy, it's thought that one such platform existed, guiding safe passage to the city's port between 1700 and 1250 BC (Johnson and Nurminen 2007, 222-223). It were these primitive structures; having existed alongside the earliest documented marine commerce that established light as prominent form of way finding.

The first written record of a lighthouse was the Pharos of Alexandria. Built in Egypt during the third century BC, the tower served as a marker and gatekeeper for the harbor of Alexandria (see Figure 4). Pliny the Elder, a researcher and writer describes in his extensive accounts of the Lighthouse of Alexandria; "the use of this watch-tower is to show light as a lantern, and give direction in the night season for ships to enter the harbor and so avoid sand bars and reefs" (MacLeod 2000, 37).

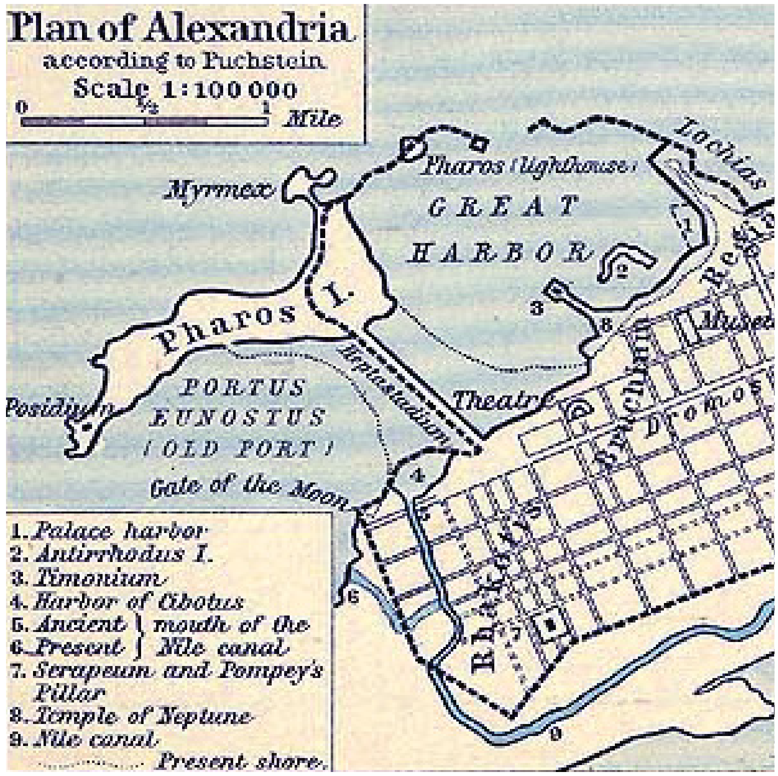


Figure 4
Plan of Alexandria, BCE, (Puchstein, 1890)

Figure 5
Drawing of the Lighthouse (Pharos) of Alexandria, (Thiersch, 909)

Towering at an estimated height of 450' tall, Pharos of Alexandria was one of the tallest man-made structures in the world for many centuries (see Figure 5). Counted among the Seven Wonders of the Ancient World, its construction had long-standing influence on the typology in terms of both material and form outlasting the tower itself, which fell into disrepair following an earthquake around 1200 AD (Stevenson 1959). Constructed of massive local white granite block (see Figure 6), with excavated pieces assumed to have been left behind from the fallen tower weighing upwards of 75 tons and measuring more than 11 meters in length, the structure set a bold precedent for coastal construction (Empereur 2000, 57-58).

With an estimated range of 29 miles, Alexandria's "lamp" was no less impressive, considering the logistics of maintaining such a tall a light and ensuring a continuous supply of fuel. Tasks of securing, moving, and lifting material to be burned were most likely made possible as a result of slavery (Stevenson 1959).

Figure 6
Excavated granite plinths from the Pharos of Alexandria sitting on the breakwater, (Notes from Alex, 2013)

Pliny also makes note of other structures similar to the Pharos of Alexandria, 'like to which there be many beacons burning to the same purpose, and namely at Puteoli and Ravenna' (Hague and Christie 1975, 3). Pliny's writing from the first century AD already suggests the existence of not only an established network, but also a consistency in purpose. It's suggested that the majority of early lights were temporary or used only on occasion. The beacons would serve a greater system, activated in sequence or intervals of season or time. Strategic lights located in areas of importance would be barricaded against the harsh environment to ensure their permanence, complimented by more temporary beacons. Furthermore, monumental markers served the coastlines of cities or ports as significant points of reference (Steil 2010).

The lightkeeper, a role developed alongside the lights themselves became an integral aspect of the network. Operating, maintaining, observing, and regularly rescuing distressed mariners all became everyday tasks of the light attendants. Dwelling in the tower itself or in a separate out-building often posed a life of isolation, routine, and hardship.

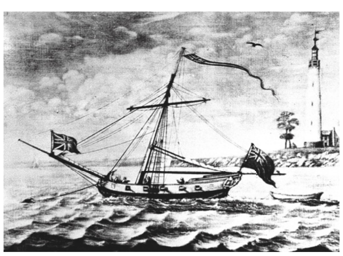


Figure 7
1729 Engraving of Boston Light,
(D'Entremont, 2014)

The first lightkeeper in North America stationed what was also North America's first lighthouse. Built in 1716 at the mouth of the Boston Harbor on Little Brewster Island (see Figure 7), it was commissioned by the British government as a reference point for British ships and vessels (Holland 1988, 69-72). The light was kept by George Worthylake, living on the island with his wife Ann and their five children. It was said that George also maintained a farm on a neighboring island, keeping a flock of sheep in order to offset his £50 a year salary (Smith 1873, 12).

It was only two years after the light had been lit however that an overturned boat traveling back to the island with George, his wife Ann, and their daughter Ruth, left all three drowned in a fatal tragedy. The unfortunate incident, a consequence of rough water and frigid November temperature struck a chord with Boston residents. A poem found in 1940 thought to be that of a young Benjamin Franklin's, recounting the misfortunes of the Boston lightkeeper would have been sold on the city's streets describing a life of difficulty and sanctuary, ending in unfortunate chaos and catastrophe (D'Entremont 2014).

Figure 8
Boston Light, Boston Mass, (Detroit Publishing Co., 1906)

Canada

The lighthouse as we know it today in Canada is very different from the lights of the past. Advances in technology after World War II pushed navigational methods into the modern era. Comparable advancements in automation technology soon led to the obsolescence of light keepers, leaving the watchtowers empty and neglected.

Technology

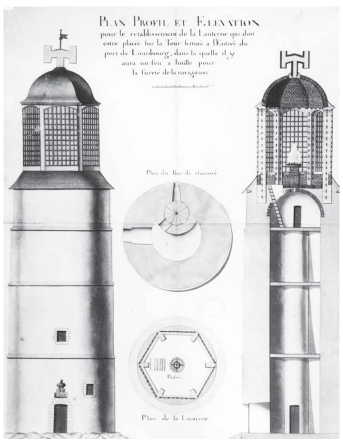


Figure 9
Plans for the first Louisburg Lighthouse built in 1734, (Parks Canada, n.d.)

The history of Canada's lighthouses begins in the province of Nova Scotia. The first known lighthouse was a circular stone tower of large granite blocks at the French occupied fortress of Louisbourg. Constructed in 1734 in order to guide war supply vessels into the harbour's docks (see Figure 9), the light used a circle of wicks set in a copper ring mounted on cork floats that sat in sperm oil. The lantern however caught fire shortly after construction had finished with only the stone shell surviving. Refitted with a larger more accommodating lantern and non-combustible materials including a vaulted brick roof covered with lead, the structure stood guiding the French vessels until its demise in 1758 when it was destroyed by the British Navy (Irwin 2003, 140). Two additional lighthouses were constructed after its destruction; a square wood dwelling with a lantern on top became Louisburg's second lighthouse in 1842 (see Figure 10), while the last and current version is an octagonal white concrete tower built in 1932 (see Figure 11).

Figure 10
The second Louisburg Lighthouse built in 1842, (Parks Canada, n.d.)

Since 1734, advancements in technology and navigational methods have shifted the process of navigation. The advent of radar and corresponding technologies in navigational equipment no longer meant seafaring individuals were at the mercy of fixed points such as lighthouses or buoys when navigating close to shore.

Figure 11
The third Louisburg Lighthouse built in 1932, (Dennis, 1981a)

GPS (Global Positioning System) utilizes satellites to send out signals which, when bounced back correctly, determine locations with a high level of accuracy. However, solar activity, malfunctioning satellites, or individuals can cause GPS "jamming" (blocking or reproducing signals) and create false readings that lead navigators astray ("GPS Jamming," 2013). Enhanced long-range navigation, also known as eLoran, is thought to be the next phase of technology to sweep the world of marine navigation (see Figure 13). Some believe that ground-based eLoran towers emit a much more consistent signal than satellites and could potentially act as replacement or backup to GPS systems ("GPS Jamming," 2013). However, the reliability of eLoran as a substitute for current fixed navigational aids in the context of navigating closer to shore has yet to be tested. The resilience and simplicity of revolving lights on the edges of intricate shorelines have proven quite difficult to replace.

Figure 12
Image of an eLoran Tower during construction, (Loran Tower, 2001)

The Lightkeeper

The lightkeeper has always played an integral role in the network of marine navigation. Today, Canada maintains 51 staffed lighthouses, with only three other developed countries maintaining staffed lights including France, Portugal, and South Africa (Standing Senate Committee on Fisheries and Oceans 2011b, 9). The arrival of electric light, as well as technological advances have left the traditional role of the lightkeeper to become significantly reduced, and in most cases seen as unnecessary (see Figure 13). Lighthouse automation in Canada began in 1948 at Sydney Bar in Cape Breton Nova Scotia. Light sensors capable of determining when the light should be turned on and off replaced the need for full time light keeping (Stephens 1973, 11). Pressure from the federal government in 1968 to decrease operational costs of light stations pushed automation efforts forward (Irwin 2003, viii).

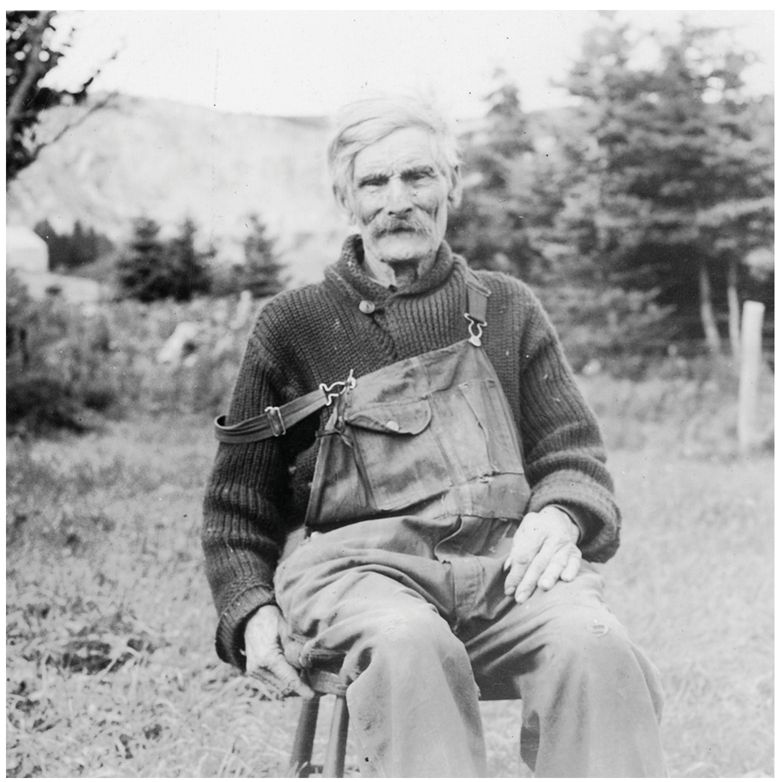


Figure 13
Lightkeeper at Cape North Lighthouse - 1981, (Dennis, 1981b)

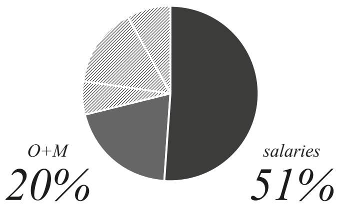


Figure 14
Diagram depicting the cost of operations and management (2.3M) and salaries (5.9M) as a percentage of the total cost of staffed lighthouses in Canada, (Standing Senate Committee on Fisheries and Oceans 2011b, 8)

In 1970, the Coast Guard began the process of systematically automating light stations (Standing Senate Committee on Fisheries and Oceans 2011b, 6). Lights were outfitted not only with light sensors, but fog sensors, weather monitoring equipment, and backup generators. At the beginning of 1970, there were a total of 264 staffed lighthouses in Canada (see Figure 14). Today, of the 51 remaining, 27 exist in northern parts of British Columbia's coast, 23 in Newfoundland, and one in New Brunswick (Standing Senate Committee on Fisheries and Oceans 2011a, 2).

To mixed review, Nova Scotia's lighthouses were completely automated and de-staffed by 1993 (Standing Senate Committee on Fisheries and Oceans 2011b, 3). Residents and local industry to neighboring lights suggested that "the light itself had worked better at staffed stations" (Standing Senate Committee on Fisheries and Oceans 2011b, iii) The senate of Canada at the request of the Department of Fisheries and Oceans was tasked with looking at the staffing of lighthouses back in 2011.

Through talking to community members, fishermen and the remaining staff themselves, the federal government concluded that the role of the lightkeeper served a much greater purpose than just the historical and outdated public perception provided. The suggestion by the senate was to maintain staff at strategic locations as well as consider re-staffing stations of significant importance (Standing Senate Committee on Fisheries and Oceans 2011b, iii).

In Green Island Newfoundland, committee members arrived to tour the lighthouse where a boater described the life-saving shelter from the elements they had received just days before. The committee was also told of the importance of weather and safety reports that seaplane pilots, kayakers, pleasure boaters, ship navigators, and fishermen receive over radio directly from the lightkeepers themselves. They were also told of the assistance they provide for hikers, science expeditions, and research groups (Standing Senate Committee on Fisheries and Oceans 2011b, iii).

Nova Scotia's de-staffing efforts were described as "heavy handed", severely lacking any consultation with the surrounding communities and industry. With fishermen voicing their opinion that select lighthouses should have continued to be staffed by the Coast Guard, they suggested that other "key" locations would benefit from reestablishing lightkeepers (Standing Senate Committee on Fisheries and Oceans 2011b, 10). The Coast Guard however has yet to address government and community concerns, and Nova Scotia's lights continue to remain un-staffed (see Figure 15).

Developing countries with similar intricate coastlines to Nova Scotia such as Chile and Brazil have continued to staff lights in remote, or 'high-risk' areas. Additionally, Ireland is in the process of restaffing their light stations with Australia, England, Portugal, and Denmark employing weather observers, life-saving personnel or technicians with a broader skill set, all in an effort to maintain a coastal presence (Standing Senate Committee on Fisheries and Oceans 2011b, 10).

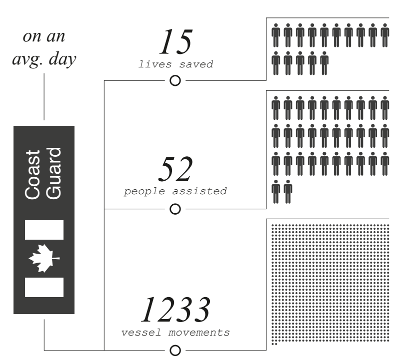


Figure 15
Diagram depicting the lives saved, people assisted and vessels moved by the Coast Guard on an average day in Canada,
(Standing Senate Committee on Fisheries and Oceans, 2011b)

Preservation and Upkeep

Canada's Efforts to automate and de-staff its lighthouses has resulted in neglected maintenance and upkeep. With most structures in various states of disrepair, and numerous cases of lights collapsing under the forces of nature (see Figures 16-17), the scenario places many lighthouses at risk of being lost in the near future (Standing Senate Committee on Fisheries and Oceans 2011a, 2). With the Coast Guard capable of building more cost-effective 'skeleton towers,' cutting down on maintenance and operational costs, most of the remaining infrastructure has been left to the elements until it becomes deemed fit for replacement (Standing Senate Committee on Fisheries and Oceans 2011a, 9).

Figures 16-17
Images depicting the 140 year old wooden Church Point lighthouse before and after a spring storm in the southwestern part of Nova Scotia, (Robichaud, 2014)

Figure 18
Image of members of the Friends of the Yarmouth Light Society fundraising for repairs, (Allen, 2015)

Concerns from community members, other government departments, as well as preservation groups have prompted a number of cases where the ownership of a lighthouse has been handed off, as is the case with Cape Forchu in Yarmouth, the first lighthouse to be passed over to a not-for-profit (see Figure 18). In the majority of these cases, the Coast Guard continues to maintain operations of the light itself while the community group or government department handles all other responsibilities. However, the expensive nature of maintaining the complex and in some cases large and often isolated structures, combined with the cumbersome government red tape process of actually obtaining and converting a lighthouse has proven detrimental to all involved.

In 2010, the Heritage Lighthouse Protection Act (HLPA) came into effect with the hopes of facilitating increased and streamlined community involvement. The effort was aimed at creating opportunities for the protection and preservation of Canada's lighthouses as a direct response to their recognition as historically significant cultural icons. The HLPA was set up to encourage individuals and community groups to nominate any federally owned lighthouse for heritage designation review. The HLPA also laid out a streamlined framework for the adoption process, allowing any lighthouse deemed 'surplus to operational needs' by the Department of Fisheries to be purchased for a nominal fee with the commitment to protect its heritage character (Minister of Justice 2008).

A list drafted by the Department of Fisheries and Oceans in 2010 declared all but the remaining 51 staffed light stations surplus. This dropped the responsibility of some 975 active and inactive lighthouses on the public (Standing Senate Committee on Fisheries and Oceans 2011b, 2-3). At this time is was generally expected that the Coast Guard would maintain ownership of the majority of the more significant and strategic lights. Revisions to the list were made one year later due to inaccuracies, reducing the number of surplus lighthouses to a still staggering 541 (Standing Senate Committee on Fisheries and Oceans 2011a, 21).

Although the interest in preservation and conservation of the structures exists, the ability for community groups or even municipal or provincial governments to step in and provide upkeep has proven difficult, as is the case with the Sambro Light (Nova Scotia's oldest lighthouse) (see Figure 19). With the Department of Fisheries' lack of need for lights with habitable space, they have moved forward installing what the Nova Scotia Lighthouse Preservation Society describes as "lights on a pole" (Joanne Mccormick, pers. comm.). With no clear solution on how to deal with the current stock of lighthouses in Canada, these cultural and historical icons continue to fall further into disrepair.

Figure 19
Picnic at Sambro Island Light,
(Picnic at Sambro, n.d.)

Nova Scotia

Figure 20
Stonehurst, NS in the fog

The day was muggy and spring like, with an overwhelming bout of fog hanging over both the water and land alike. Water that had built up on the spindly trees and wild shrubs from the heavy mist brought the sparse landscape to life. The droplets of water caught the dim glow of the sun trying to push through the heavy blanket of fog.

The road followed the jagged edges of the coarse shoreline, offering glimpses of calm inlets in between the recently sprung foliage. The road, lacking any signs of human life on a Monday afternoon eventually led to a clearing, where modest sized homes were packed tightly together in a surprising density given the long and sporadic drive. The patched wood shingled buildings overlooked a dark narrow inlet that fed into a body of water known as Middle Pass, crowded by patches of sharp island leading into the open Atlantic.

A woman stood in her driveway with her arms crossed talking to her neighbor looking down into the inlet. A Cape Islander boat sat still on the flat water clearly reflecting the blurred surroundings. Past the fishing boat was a fisherman moving lobster traps. The small piers and precarious shacks sitting atop monolithic cribbing on the exposed blue slate were flimsy but settled, as if they had been there from the beginning. The homes were extensions of the fishing infrastructure, relating to the water's edge in a consistent and somewhat ordered way watching over their livelihood. What was very clear about this small and ordinary rural Nova Scotian community was its deep and entangled relationship with the sea.

Not unique to East Stonehurst, the majority of rural Nova Scotia is settled along the coastline. Relying on the sea's bountiful harvest and its economic opportunity, a string of coastal fishing communities serve as the backbone of the rural Nova Scotian landscape. With Nova Scotian agriculture concentrated in what is known as the "agricultural triangle," made up of northern Cumberland, Colchester, Kings, and Hants counties, the area accounts for over 60 percent of agricultural revenue in the province (Nova Scotia Department of Agriculture 2012, 4). The remainder of the rural communities scattered across the province soon realized the inherent lack of favorable farming conditions of the land that they had been given, and naturally came to rely on their relationship with the sea, often serving as the lifeline of the communities (Nova Scotia Archives 2016a).

Figure 21
Stonehurst, NS fishing shed and coastal landscape in the fog

Industry

It's mid 19th century and the shores of Nova Scotia are alive. Ships are being built across the province at a staggering pace, with schooners, whalers, and fishing vessels being constructed out of the plentiful spruce and pine (see Figure 22) (Sager 1989, 26). In the early 1830s, Lunenburg alone was reported as owning 68 schooners for coastal trade and fishing, 6 brigs designed for crossing the Atlantic, as well as a large three masted ship for extended trade (Nova Scotia Archives 2016).

Nearing the end of the 19th century Nova Scotia was the largest contributor to Canada's Merchant fleet in terms of both number of vessels and total tonnage (see Figures 23-25). On a global scale in 1878, Canada had the fourth largest merchant fleet in the world with the second highest number of vessels (Matthews 1978, 3-18).

Figure 22
Dried cod being unloaded from a fishing schooner, Halifax, NS - 1961, (Lunney 1961)

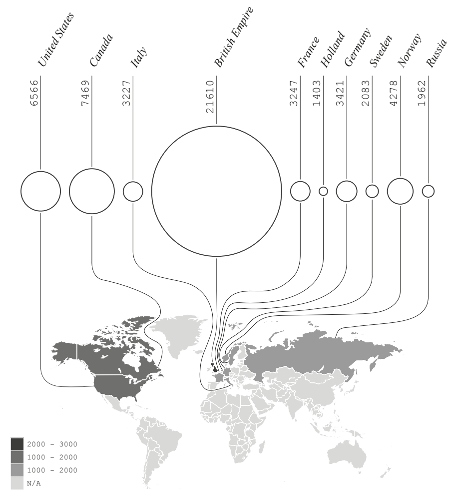


Figure 23
Canada's Position Relative to Other Countries According to Number of Registered Vessels - 1878, (Matthews, 1978)

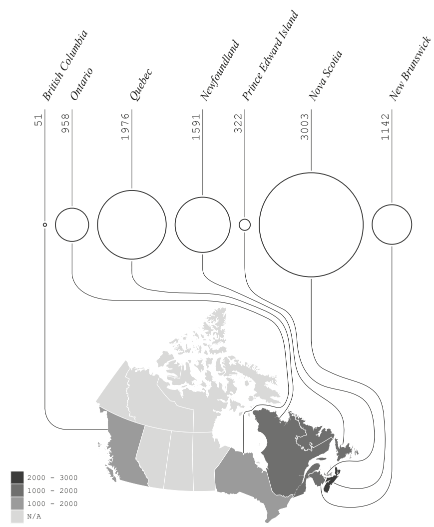


Figure 24
Nova Scotia's Position Relative to Other Provinces According to Number of Registered Vessels - 1878, (Matthews 1978)

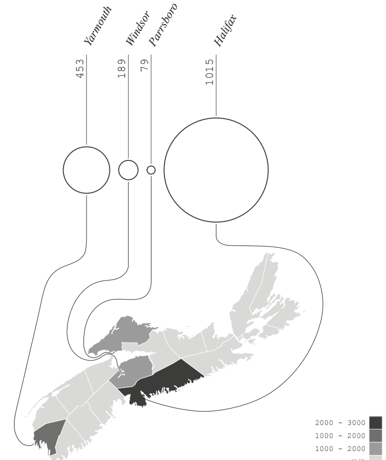


Figure 25
Halifax's Position Relative to Other Nova Scotia Cities According to Number of Registered Vessels - 1878, (Matthews 1978)

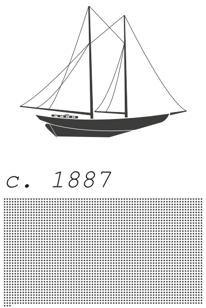


Figure 26
Vessels on the Canadian Register (3003), NS in 1887, (Matthews, 1978)

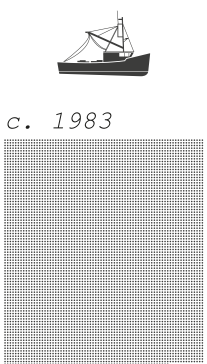


Figure 27
Vessels on the Canadian Register (6362), NS in 1983, (Fisheries and Oceans Canada, 2016b)

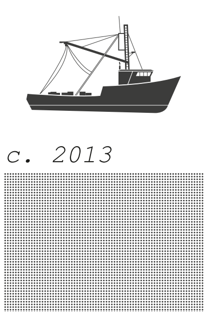


Figure 28
Vessels on the Canadian Register (4043), NS in 2013, (Fisheries and Oceans Canada, 2016c)

Canada had by the end of the 1800s positioned itself as a prominent seafaring nation that depended largely on Nova Scotia to maintain its title. This however was the start of the end for Canada's "age of sail," with the introduction of competent steam powered iron ships (Sager 1989, 74). In Nova Scotia the production of wooden hulled sailing ships however continued to a lesser degree in tandem with the introduction of the newer steamers as there was still a demand for small fishing vessels capable of maneuvering short distances along the shore (Sager 1989, 74).

Where the decline of the wooden shipbuilding industry in Nova Scotia took place at the at the end of the 19^{th} to the early 20^{th} century, the fishing industry lived on (see Figures 26-28). With fishing vessels historically accounting for a major portion of Nova Scotia's merchant fleet, the industry continues to play a large role in the economy of not only rural coastal communities, but the province at large (Gough 2013).

In the past two decades, Nova Scotia has accounted for over a quarter of Canada's total fish landings (see Figure 29-31) (Fisheries and Oceans Canada 2016a). The province's coastal and inland communities have remained largely dependent on its seafaring way of life despite overfishing and government quotas.

Nova Scotia's sea related industries and spinoffs contributed just over twelve percent to the province's total GDP as of 2011. National Defence makes up the majority of employment while the fishing industry accounts for close to 15,000 jobs (Pinfold 2014).

The history that Nova Scotians have with the sea goes beyond economic opportunity however. It's within Nova Scotia's "Canada's Ocean Playground" that 46 percent of Canada's fishing fatalities occurred between 2007 and 2010 (Workers Compensation Board of Nova Scotia 2012).

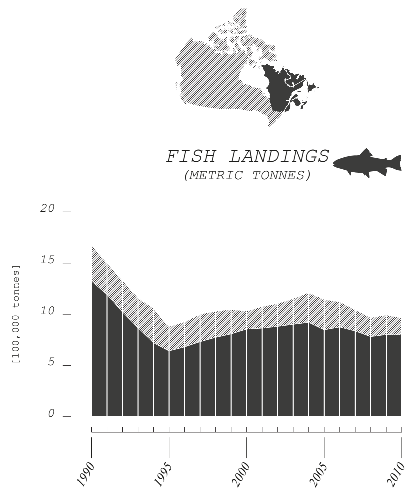


Figure 29
Quantity of Fish Landings in Atlantic Region to Canada, (Fisheries and Oceans Canada, 2016a)

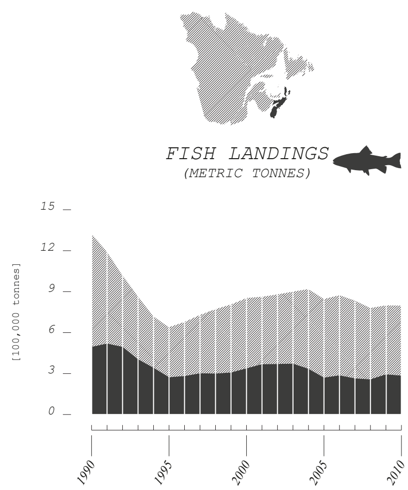


Figure 30
Quantity of Fish Landings in Nova Scotia to Canada, (Fisheries and Oceans Canada, 2016a)

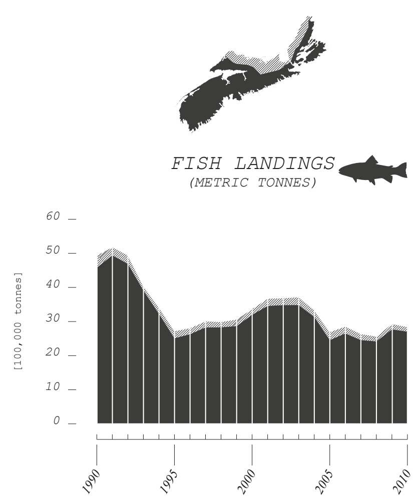


Figure 31
Quantity of Fish Landings in Maritime Region of Nova Scotia to Gulf Region, (Fisheries and Oceans Canada, 2016a)

Comparing Nova Scotia's fishing industry to all others including construction, agriculture, and transport, 40 percent of all acute work related fatalities occurred in the fishing industry alone between 2011 and 2014 (Conlin 2014). It's with the opportunities of gain and prosperity that the ocean paints a picture of grave danger, demanding respect and appreciation from mariners and coastal regions alike.

Figures 32
Diagram comparing the acute fishing fatalties in Nova Scotia to all recorded acute fatalities in Canada - 2011-2014,
(Laroche, 2014)

Tragedy

Nova Scotia's intricate coastlines and unabating seas have never been of the forgiving type. The sleeping giant of the Atlantic has proven to be relentless, sinking a conservative count of up to 5000 ships in the waters of Nova Scotia alone, with many more going unreported or undocumented (Nova Scotia Archives 2016b).

Sable Island, a unique and exposed piece of Nova Scotian landscape, home to a relatively large feral horse population is also consequently home to a large number of shipwrecks (De Villiers and Hirtle 2004, 212). Its low-lying sandy shores often clouded by fog and hidden by waves abruptly welcomes ships that have strayed off course onto its sandy shores (De Villiers and Hirtle 2004, 49-54).

Sailing directions from the early 1900s describe the dangers of the otherwise delicate sandbar:

> At each end of the island are dangerous bars, upon which the sea breaks in bad weather. These bars are extremely difficult to avoid when at a short distance from the north side of the island, and caught with a strong northerly wind; and if to this we add the suddenness of the dense fogs prevalent at some seasons of the year in the vicinity, a sailing vessel under such circumstances is placed in great peril, and nothing but the most careful navigation can extricate it (De Villiers and Hirtle 2004, 52).

Located in the middle of some of the busiest sea-lanes in the world, it sits in the prevailing currents that shape its sandy bars. Its storied past of taking down passing mariners with some 350 documented cases of wrecks occurring on the banks of the island alone has given it the title "graveyard of the Atlantic" (see Figure 33) (Conlin 2014).

By 1801, Lieutenant-governor John Wentworth and politician Joseph Howe oversaw the process of establishing a lifesaving station, the first of its kind in Nova Scotia. Intended only for the purpose of rescuing and housing mariners that ran aground until ships came with supplies and a ride back to mainland, it did little to prevent the ships from actually running aground (Conlin 2014).

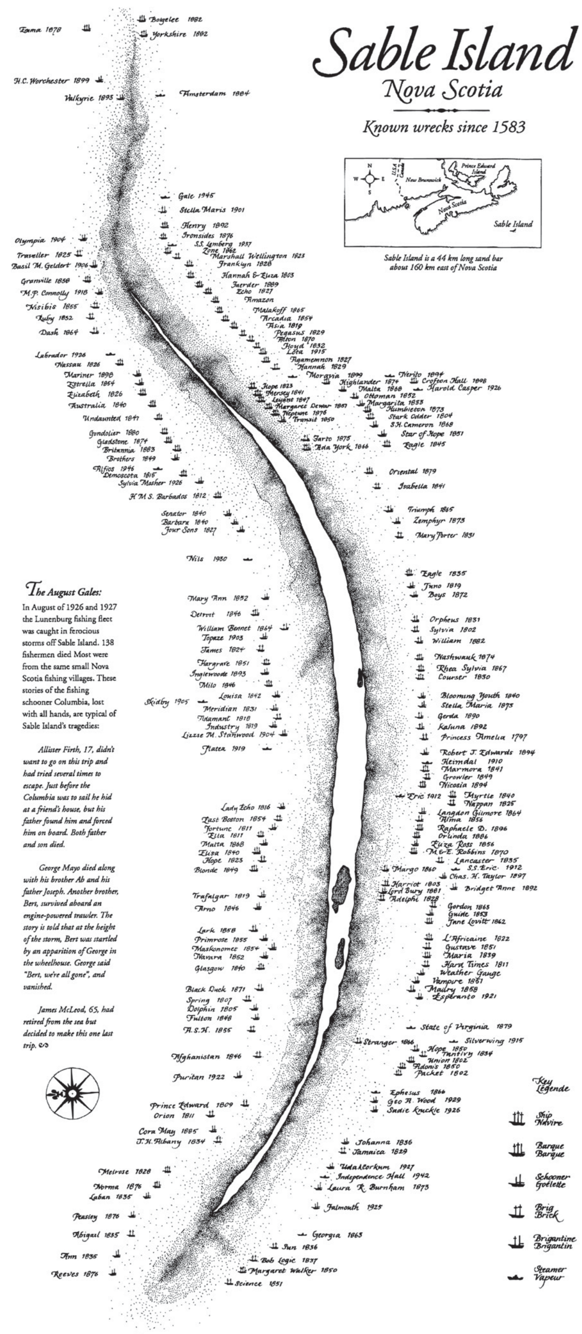


Figure 33
Sable Island known shipwrecks since 1583 organized by type of ship totalling an estimate of 192,
(Nova Scotia Department of Education, 2012)

Response

One year after confederation in 1868, the newly established federal government created the Department of Marine and Fisheries. The department was tasked with the operation of government owned vessels, patrols of waterways and canals, the operation of lifesaving stations, supporting shore infrastructure, as well as operation and maintenance of navigational aids. It wasn't until 1962 however that Canada formed its own national coast guard (Canadian Coast Guard 2014).

Today the Canadian Coast Guard's overarching mandate is marine safety. Among other responsibilities including research, traffic services, and icebreaking, the Canadian Coast Guard continues to carry out search and rescue operations, patrols of the vast Canadian coastline, as well as maintenance and the operations of navigational aids including lighthouses. The Coast Guard's role in Nova Scotia is established and involved, with countless rural areas depending on their services in order to operate industry that depends on marine safety. (Fisheries and Oceans Canada 2014).

With the unforgiving nature of the sea, and its opportunity mixed with a dash of calm, blanketed foggy beauty, we can begin to appreciate the rich relationship coastal Nova Scotian communities have with the ocean. Industry, loss, and landscape begin to inform the identity of these communities, upholding a way of life that contends with the untamable. The communities, resilient by circumstance are a indeed product of their place, rooted in history and the culture of the seascape.

CHAPTER 3: CRITIQUES / ISSUES

Climate

Unfortunately, the world's changing climate has begun to put pressure on the coastal regions of Canada, and in particular the Atlantic Provinces, threatening various aspects of an established shoreline.

Rising Temperatures

The Intergovernmental Panel on Climate Change – the leading global international body on climate change assessment has grave predictions for the future world of ours. As a result of greenhouse gas emissions reaching unprecedented levels in the last 800 000 years, the average global temperature has taken an upswing (IPCC 2014, 4).

According to the National Oceanic and Atmospheric Administration, 2014 is the 38th consecutive year that global temperature was above average (see Figure 34). The year 2014 also marked the warmest year across global land and ocean surfaces in the last 134 years of kept records (NOAA 2015).

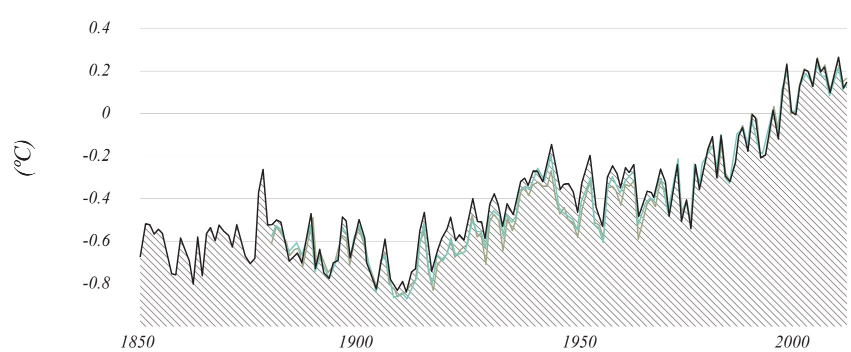


Figure 34
Diagram comparing the globally averaged combined land and ocean surface temperature anomaly, (IPCC, 2015)

Rising Sea Levels

Hand in hand with increases in average global temperature comes rising sea level. Between 1880 and 2012, the global average sea level rose a total of about 21 cm, or an average of 1.6mm/year. Localized regional sea level change can however be drastically different. For example, due to rapid post-glacial rebound – swaths of land that had previously been compressed by receding glaciers, contributed to regional sea level falls of 10mm a year in and around areas of Hudson Bay (Government of Canada 2014, 7).

The Atlantic region however is experiencing regional land subsidence as a result of central Canada's postglacial uplift. While there is variation across Nova Scotia, the province as a whole has consistently experienced higher than average relative sea level rise. Based on records between 1920-2008, Halifax tracks a 32 cm/century relative rise in sea level (see Figure 35). Similarly, Yarmouth between 1967-2008 tracks a 30 cm/century relative sea level rise (CBCL Limited 2009, 160-161).

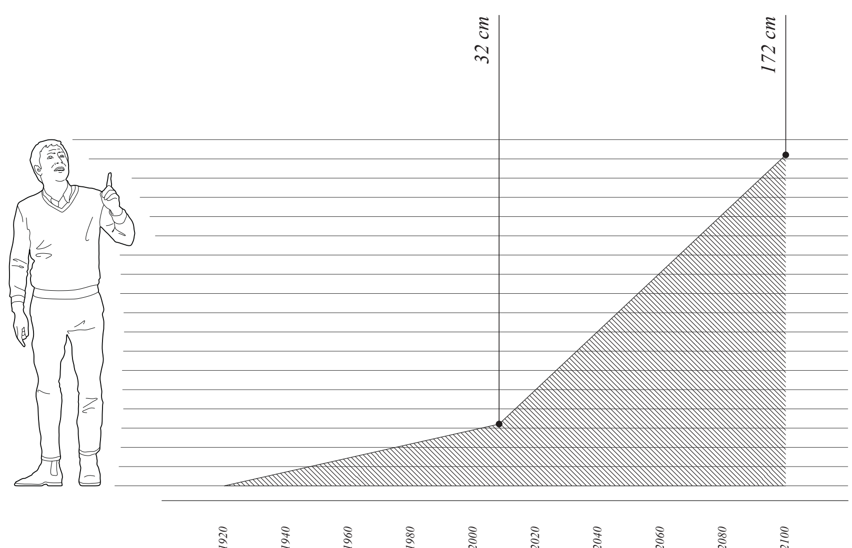


Figure 35
Illustrating the magnitude of sea level rise in Halifax - 1920 to present compared to expected levels in 2100, (CBCL Limited, 2009)

The world's future sea level projections all hinge on how drastically the planet as a whole is able to cut emissions in order to curb global warming trends. The IPCC outlines several scenarios based on possible greenhouse gas predictions by 2100, increasing in severity the higher the concentration of gasses. The best-case scenario results in a predicted global average sea level rise of anywhere between 0.28 - 0.61 m. The worst-case scenario results in a global average sea level rise of anywhere between 0.52 – 0.98 m (IPCC 2015, 1182).

Local Sea Levels

The Nova Scotia government has accounted for a range of 70 – 140 cm in relative sea level rise by the end of the century. The province's prediction takes into account the effects of regional subsidence combined with the expected global average (CBCL Limited 2009, 162). A shift in sea level of 1.40 meters would threaten a significant number of coastal communities flooding coastal roads, wharves, breakwaters, and of course lighthouses.

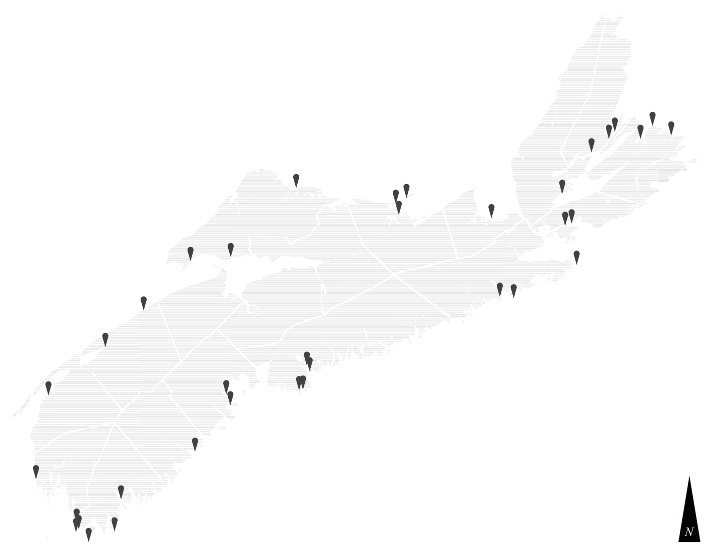


Figure 36
Map depicting Nova Scotia's active lighthouses at risk of future sea level rise over the next 80 years, (Nova Scotia Open Data, 2016)

Out of no fault but the practical need for light beacons to hug the exposed shorelines, many of Nova Scotia's lighthouses face an uncertain future in the next century and onward regardless of preservation efforts (see Figure 36). A total of thirty-six lighthouses have been found to be at risk of a 1.4 m sea level rise, accounting for nearly one fifth of Nova Scotia's existing lights.

Additionally, sea levels will continue to rise regardless of our efforts to curb emissions with even best case scenarios accounting for some degree of continued impact. With more drastic estimates of 7 meters or more accounting for a total melt of the Greenland ice sheet, most existing coastal infrastructure would be submerged more than two stories under water along with the majority of Nova Scotia's coastal communities (National Geographic Society 2016). It's this uncertainty that prompts the need to identify and establish more thoughtful approach to the way we build on the shorelines.

A public conversation has yet to begin that addresses the lights at risk, with focus from government departments directed at wharves, water access, and breakwaters for the most part.

Figure 37
Government wharf in Port Mouton protected by a breakwater

Material

> In some of our light-house localities, the unbroken force of ocean waves must be resisted; in others, the less powerful waves of bays and harbors only take effect; while in others, the sites are entirely withdrawn from watery inroads. Hence the different constructions demand quite different degrees of skill but, in all, the faithful builder…ought in every instance to insure that the costly teachings of past experience are made duly and appropriately effective. (*Lighthouse Construction and Illumination,* 1857, 198)

Rebuilding - Eddystone

Southwest of London, off the shores of the Plymouth harbor, lie the Eddystone rocks, often hidden and a menacing threat to the American trade ships that had found themselves navigating the shores of the English Channel (Hague and Christie 1975, 121).

Suggesting that Eddystone was difficult to build upon would be an understatement. Several attempts to fortify a beacon that would cling to the small footprint of shoal serves as a prime example of the hardship that coastal construction can present. Five versions of lighthouses since 1668 have undertaken the responsibility of alerting passing mariners (Stevenson 1881, 12). Figure 38 depicts all five of the towers built over.

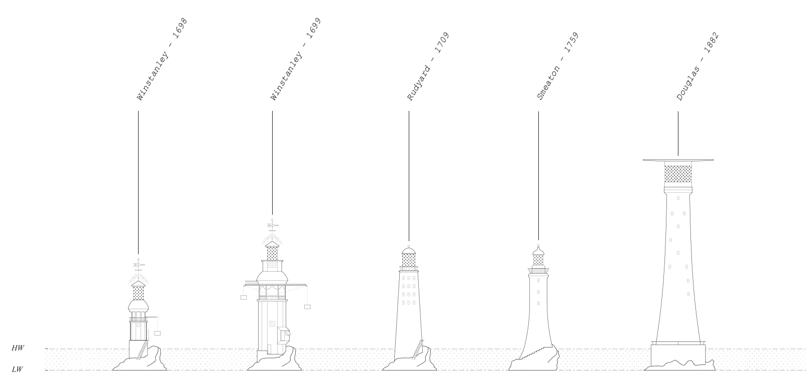


Figure 38
Eddystone's various lighthouses over time, placed at their relative heights above high and low tide, (Stevenson, 1881)

Perhaps the most fascinating aspect of Eddystone was how it developed over time. Winstanley's light was built on a solid granite masonry cylinder 14 feet in diameter with a timber upper portion that sat above the high water mark. It was modified the following year by increasing the foundation by 8 feet and re-portioning the upper timber portion to suit (Stevenson 1881, 12).

Washed away only four years later, silk merchant John Rudyerd constructed a hybrid timber and masonry foundation with a timber upper portion clad in oak planks. The structure stood defiantly for 46 years until it caught fire, burning for several days until it was reduced to rubble (Hague and Christie 1975, 123-125).

Recognizing the urgency for a more stable and durable structure, John Smeaton – recognized today by many as the "father of civil engineering," was recommended by the Royal Society of London to develop a new scheme. Consisting of dovetailed courses of granite masonry, the pattern revolutionized lighthouse construction, allowing a new standard of durability (Gang 2011, 135-136).

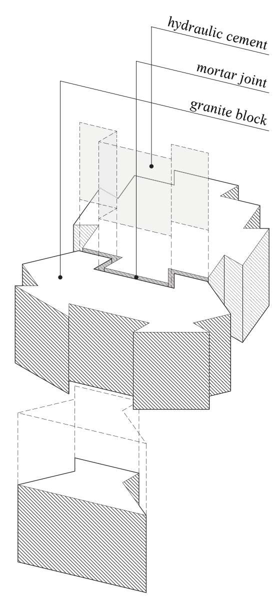


Figure 39
Eddystone's various lighthouses over time, placed at their relative heights above high and low tide, (Stevenson, 1881)

Smeaton’s tower stood until 1877 when natural erosion of the Eddystone reef allowed the 59-foot tower rock in the waves. Outliving the very land it sat upon, the Smeaton tower was disassembled block by block and rebuilt in Plymouth no longer serving as a lighthouse, but as a memorial to John Smeaton’s revolutionary design (see Figure 41).

Figure 40
Smeaton’s foundation remains standing next to the new light, (Matthews, 1978)

Figure 41
Postcard showing Smeaton’s tower in its final resting spot after having been disassembled and reassembled in Hoe Park, Plymouth, (Hinde, n.d.)

The final chapter of Eddystone’s long history of building and re-building ends with James Douglass’s lighthouse which was built next to the remaining courses of Smeaton’s foundation (see figure 40). Using a similar dovetail approach of granite block, the Douglass tower adopts a taller foundation, thicker walls, and much taller overall height (Stevenson 1881, 15-17).

This somewhat opportune example of the intense building climate that coastal infrastructure exists within highlights both the developments over a relatively short amount of time, and the high frequency of failing structure as a result of the harsh environment.

Rebuilding - Nova Scotia

Although built of durable materials in every scenario, each iteration of Eddystone lighthouse fell victim to the relentless conditions of the sea in one way or another. This cycle of building and re-building can be observed throughout the history of lighthouses across the board, including Nova Scotia.

Of Nova Scotia's estimated 128 operating lighthouses, only 37 are as they stood when the light was first established. Many lights have been replaced three or four times (see Figure 43) often changing in materials and form. Of all of Nova Scotia's lights that have been replaced or moved, Sable Island holds an impressive record.

Much like the shorelines of the island itself (see Figure 42), the lighthouses of Sable Island have shifted many times since the western light was first established in 1872. Both the west and eastern towers have been reassembled or completely rebuilt a total of eight times, adopting a bolted modular steel structure in 1916 and later in 1935 on the east side in anticipation of moving (Irwin 2003, 100-103).

Figure 42
Eddystone's various lighthouses over time, placed at their relative heights above high and low tide, (Stevenson, 1881)

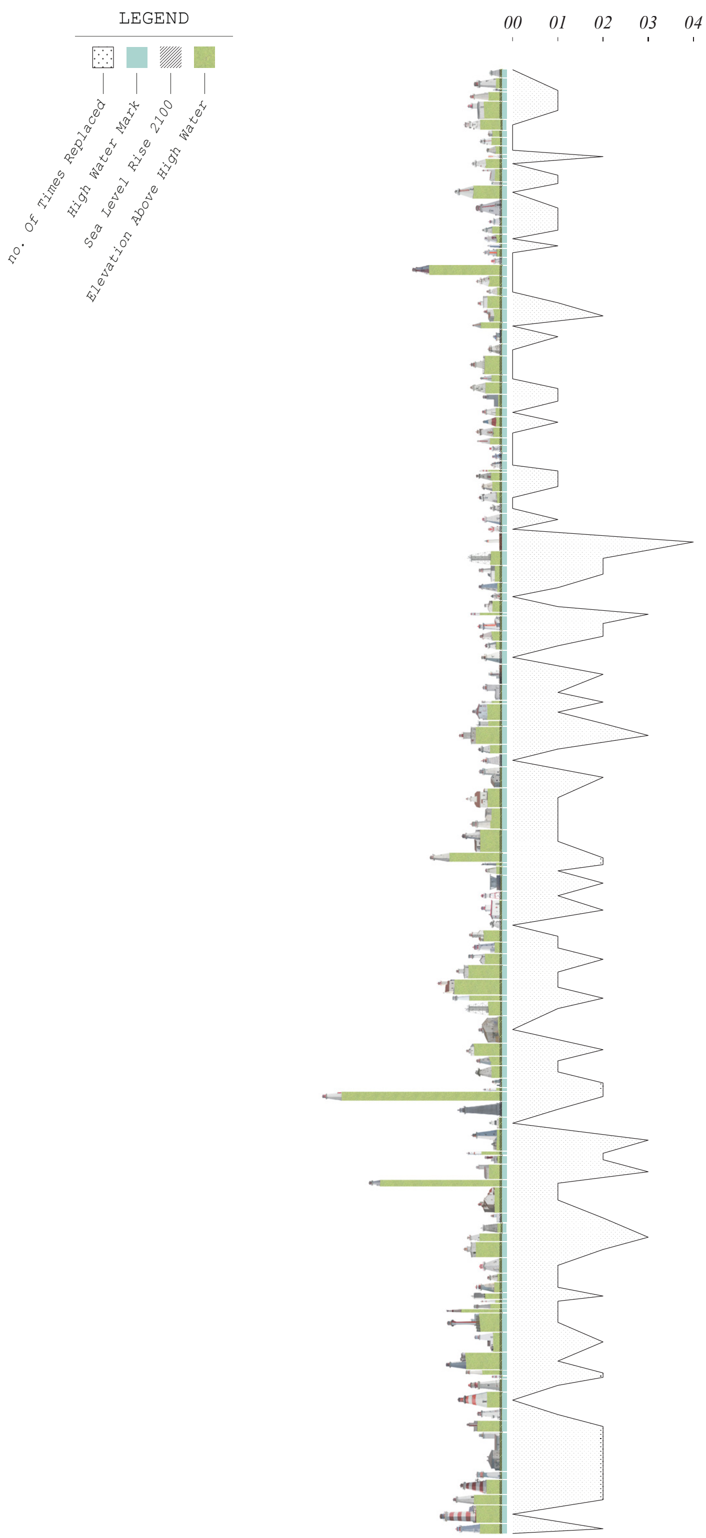


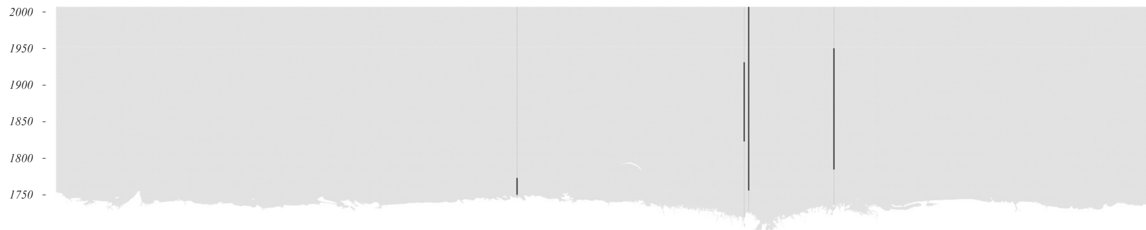
Figure 43
Diagram of lighthouses in Nova Scotia showing how many times each has been replaced,
(Irwin, 2003, Nova Scotia Lighthouse Preservation Society, 2016)

Material Qualities

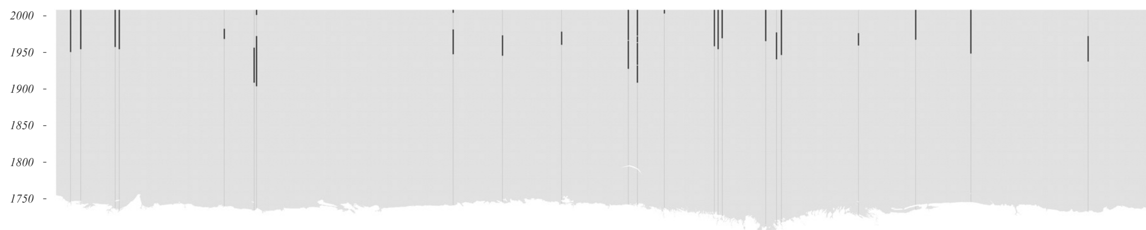
With so many materials in the world, lighthouses in many ways have remained similar throughout time, adopting new materials or techniques that were thought to be more robust as they were developed. From the primal wooden platforms of ancient times, to Smeaton's tower of highly crafted jigsaw pieces, lighthouses have throughout history been a product of their time. Most often reflecting the local building culture, the materials available, and the particularities of the site, engineers have pushed lighthouse construction through hundreds of years of development.

In Nova Scotia, there are numerous examples of four dominant materials that have been used throughout for lighthouse construction – granite, wood, steel, and concrete (see Figure 45). All are not without their faults but are worthy of thorough investigation.

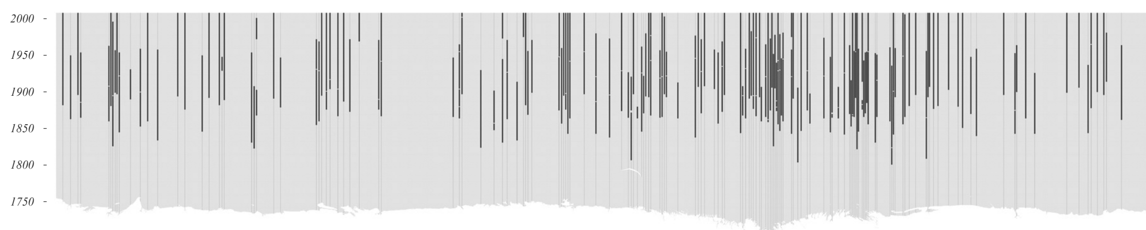
Figure 44
Image of wooden fishing shed in Peggy's Cove, N.S. - 2016



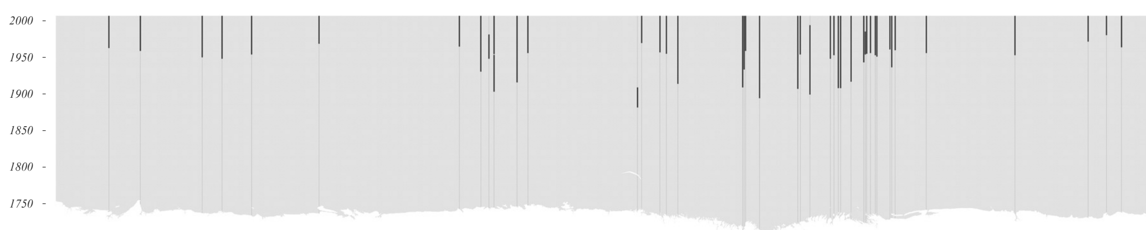
Stone



Steel



Wood



Concrete

Figure 45
Graphs showing the use of stone, steel, wood, and concrete over time in lighthouses for Nova Scotia, (Irwin, 2003)

Granite - A Resilient Module

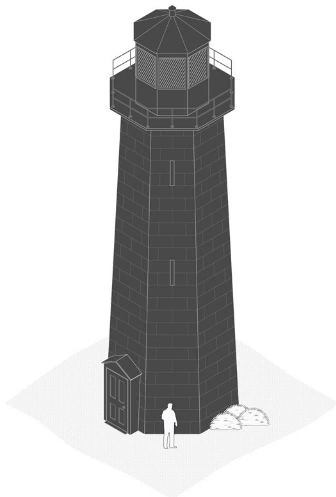


Figure 46
Diagram of a typical masonry lighthouse found in NS today

Used as the structural material in the Lighthouse of Alexandria, 75-ton blocks of granite set a precedent for coastal construction that influenced the generations of lights to come (Empereur 2000, 58). Used for its strength in compression and its natural fire resistance, Smeaton adopted the material for his design of the fourth Eddystone lighthouse detailing its assembly in a way that had yet to be done.

In order to increase its tensile strength against powerful storm waves, Smeaton dovetailed the granite in an effort to create a structure that behaved as if it were one solid piece of stone (see Figure 47). Each course of stone was a slightly different pattern, becoming smaller in diameter as you moved up allowing the tower to take on its iconic truncated figure that was intended to lessen its resistance to wind the higher the elevation (see Figure 46) (Hague and Christie 1975, 125).

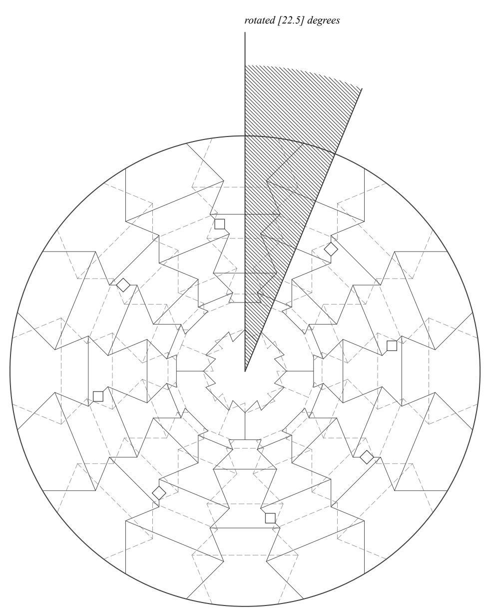
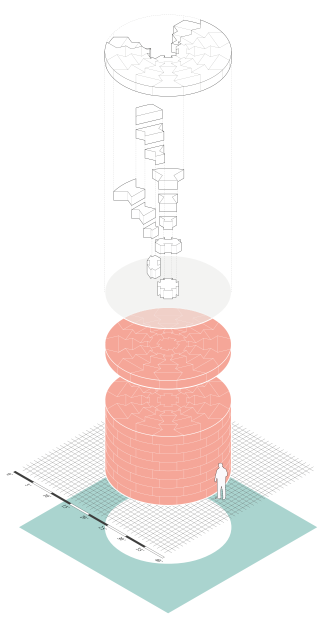


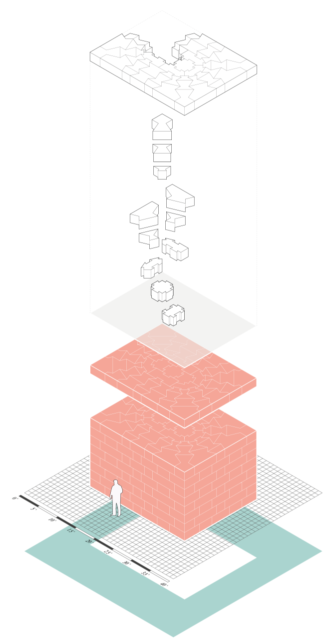
Figure 47
Interpretive plan diagram of Smeaton’s dovetail granite pattern, (Hague and Christie, 1975, 126)

Capable of handling the shear stress of waves, the chunk made up of individual hand cut granite blocks totaled several tons as a mass. Each course was inset with marble dowels (see Figure 47) to reduce the tendency for slippage set with hydraulic lime – developed and used by Smeaton for the first time in the construction of the Eddystone light and capable of setting underwater (Hague and Christie 1975, 126).

Perhaps the most interesting and overlooked opportunity for the application of Smeaton's dovetail design is its modular aspect, where forms that are extruded rather than truncated use the same pattern through each course (see Figure 48-49). Rotating every other course 22.5 degrees allows the joints to stagger without the need to cut a different pattern (see Figure 47).

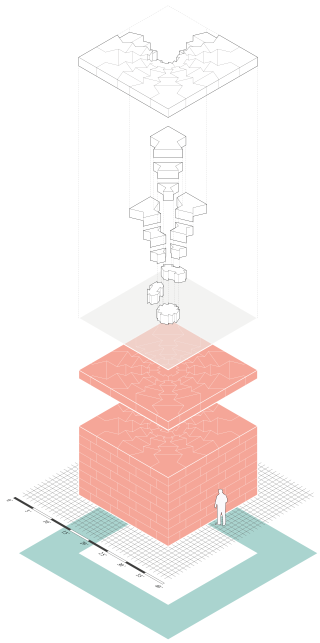


Granite Dovetail Pattern
Circle

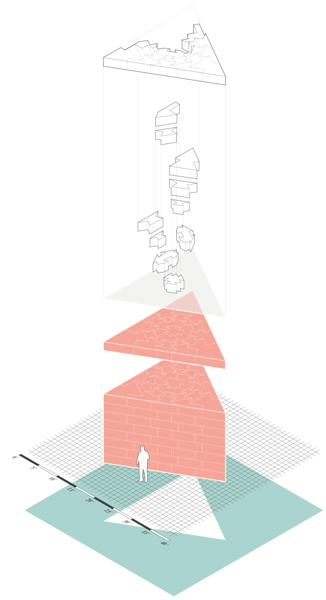


Granite Dovetail Pattern
Rectangle

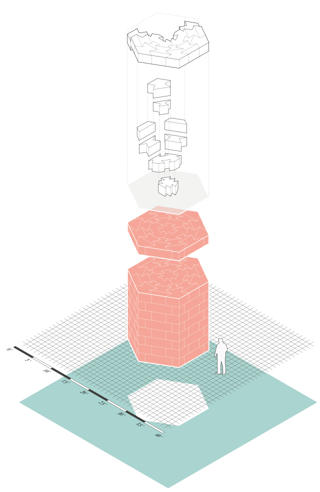
Figures 48-49
Diagrams exploring dovetail patterns based on John Smeaton's original granite dovetail detail



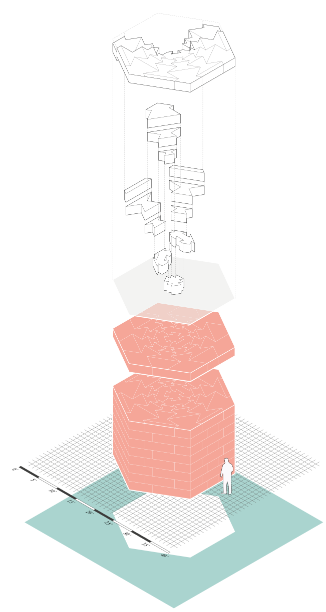
Granite Dovetail Pattern
Square



Granite Dovetail Pattern
Triangle



Granite Dovetail Pattern
Pentagon - Small



Granite Dovetail Pattern
Pentagon - Large

Figures 50-53
Diagrams exploring dovetail patterns based on John Smeaton's original granite dovetail detail

Other geometries, including pentagons, squares, triangles and rectangles are possible with minor adjustments to the overall pattern and have the ability to grow in area by interchanging the face blocks with blocks that continue to interlock. Its ability to expand is of course limited by the size as the further the pattern radiates from the centre, the larger the size of the block (see Figures 48-53).

The most promising geometry of the forms explored is the rectilinear form, offering the opportunity of length by inserting blocks in the middle to grow in a linear way (see Figure 54). Able to withstand the same magnitude of shear force, the area of the mass when elevated in the air would most likely prove problematic compared to the slim figure of Smeaton's original design.

With the opportunity for a modular set of blocks that are consistent throughout multiple instances, structures could be disassembled and reassembled, added to and subtracted from based on future or current needs, providing an adaptable and robust foundation that considers time and uncertainty.

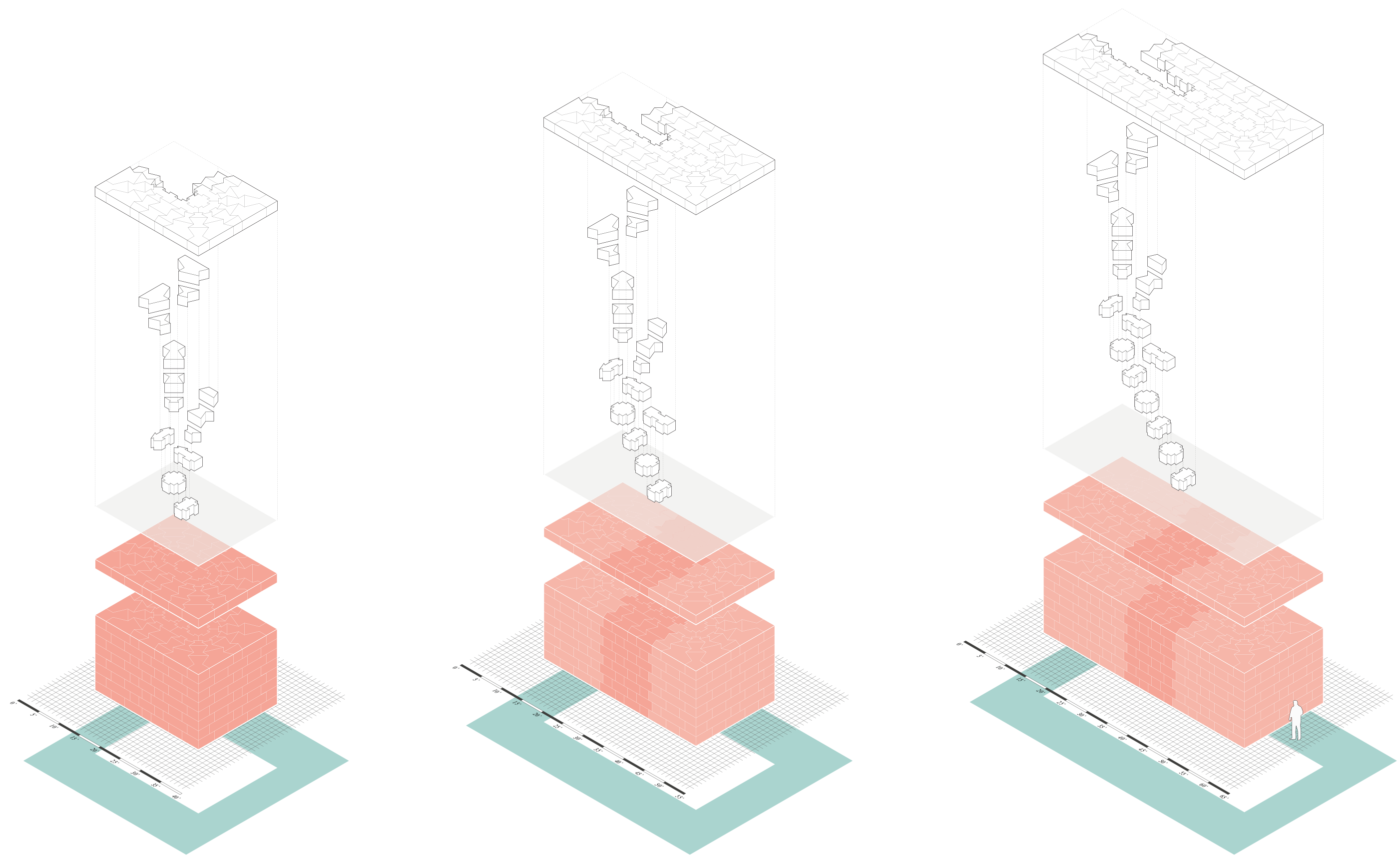


Figure 54
Diagrams exploring the expandability of a rectilinear dovetail pattern

Steel - A Flexible Structure

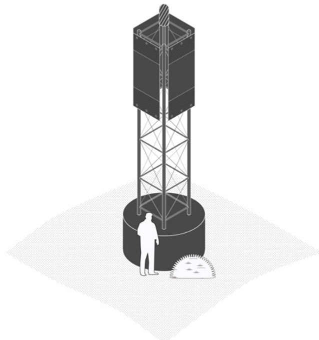


Figure 55
Diagram of the typical skeleton lights found in NS today

The introduction of the iron lighthouse didn't appear in North America until around until the 1840's with the introduction of plants capable of producing quality iron plate and piles (Wermiel 2006, 39-40). With the increasing use of Iron as a building material, the British developed several examples of cast iron lighthouses with many attempts failing and eventually replaced with traditional masonry towers. One example south of Wales – Whiteford lighthouse still stands today, derelict and rusted but nonetheless depicts the modular nature of the bolted iron plates (see Figure 56) (Hague and Christie 1975, 132).

Figure 56
Whitford lighthouse steel structure,
(Emmanuel, 1985)

Figure 57
Detail image of the Whitford modular bolted plates rusting (Emmanuel, 1985)

The U.S. was more successful at adopting the new material, with its reduced weight, durability, and ability to be pre-fabricated. Bolt connections also allowed assembly and reassembly, as well as replacement of worn or damaged parts.

Iron skeleton lights were also developed to accommodate shifting ocean bottoms. An open frame allowed waves to wash through the legs with the habitable spaces placed well above the high water mark (see Figure 59). The spindly legs did little however to combat ice build up.

Similar versions of iron plate lighthouses existed in Canada, with one such notable example being the Cape North light. Originally fabricated in England and shipped to Cape Race Newfoundland, it was disassembled and shipped to Nova Scotia in 1908 after 52 years of service (Irwin 2003, 122-125).

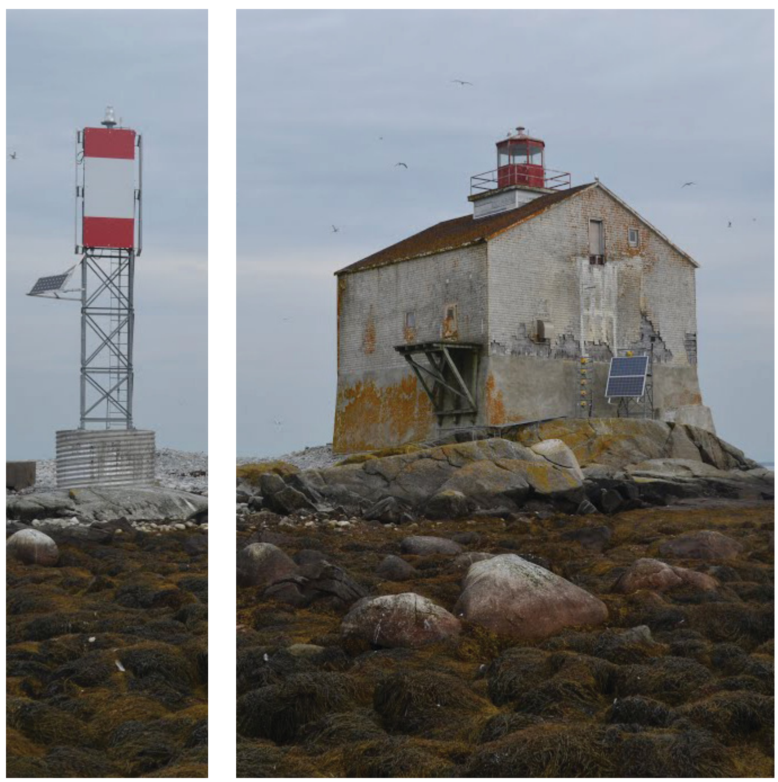


Figure 58
The Salvages lighthouse established in 1965 and neighbouring skeleton tower built in 2014, (The Salvages, 2016)

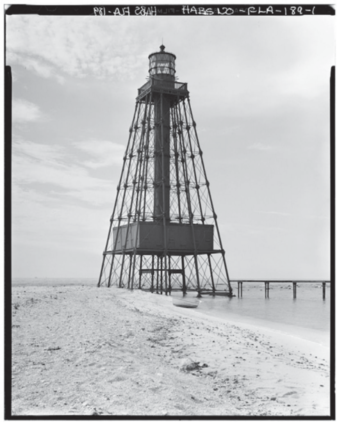


Figure 59
An example of light iron frame lighthouse in Sand Keys, FL, (Historic American Buildings Survey, 1933)

Bolted back together with 800 bolts, the 32 plates of iron weighing nearly ¾ of a ton each were reassembled in one of the most remote areas of northern Cape Breton. Cape North's journey doesn't end there however, with demolition of the then leaking structure planned for 1978, the director of the Ottawa Museum of Science and Technology was in the market for acquiring such a light. Once again, the structure was disassembled into its 32 plates, shipped to Ottawa and reassembled on the front lawn in if the museum (Irwin 2003, 122-125).

Current efforts by the Coast Guard to replace aging lighthouses include steel skeletons offering low maintenance and ease of assembly (see Figure 58). The replacement skeletons can be seen in several instances along Nova Scotia's coastline much to the dismay of preservation groups.

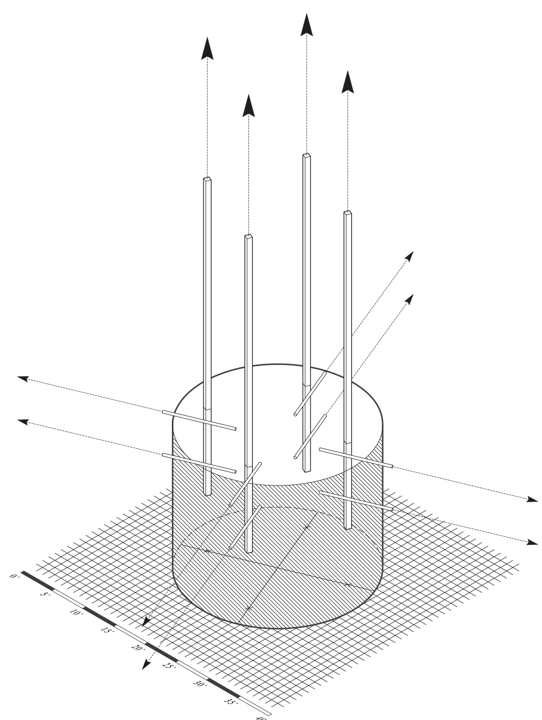


Figure 60
Interpretive diagram of steel connecting to block foundation

Wood - An Existing Material Culture

Figure 61
Diagram of a typical wooden lighthouse found in NS today

Although not the most robust when it came to large towers in harms way, the majority of Nova Scotia's lighthouses are constructed using traditional light-frame construction. With a high demand from shipbuilders for safer navigation along Nova Scotia's shores in the mid 1800's, a large number of lighthouses needed to be built in a relatively short time (Irwin 2003, viii).

Readily available, cheap, and well suited to Atlantic Canada's climate, the material culture that was already well established as a result of shipbuilding embraced the wooden lighthouse which went on to become the mainstay up until only recent times (Stephens 1973, 10). With an estimated 229 wooden lighthouses built across Nova Scotia, it's beyond a doubt one of the most recognizable structures related to Nova Scotian culture (see Figure 61).

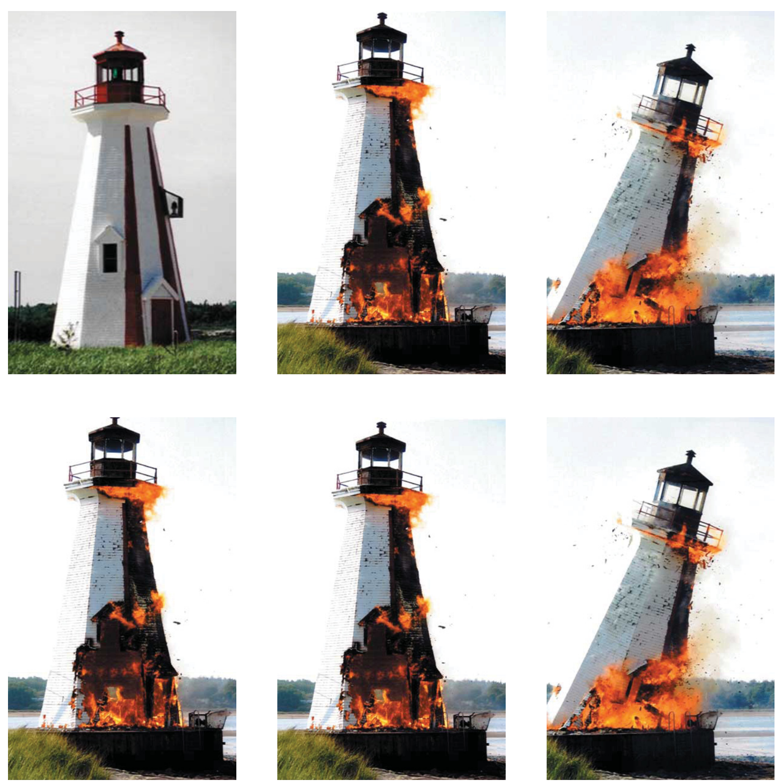


Figure 62
Fire destroying wood lighthouse at Pictou Bar - 2004, (Irwin, 2004)

In America, few examples of wooden lighthouses remain as most were replaced by towers of more durable and less combustible materials (Wermiel 2006, 37). Wooden lighthouses are particularly vulnerable to fire and difficult to save as they aren't inhabited to the degree they once were (see Figure 62). Although it could be argued that Rudyard's exterior oak sheathing was just as fragile, easily affected by marine worms and ware, it was also easily replaced and could be done by relatively unskilled labor (see Figure 63) (Hague and Christie 1975, 124).

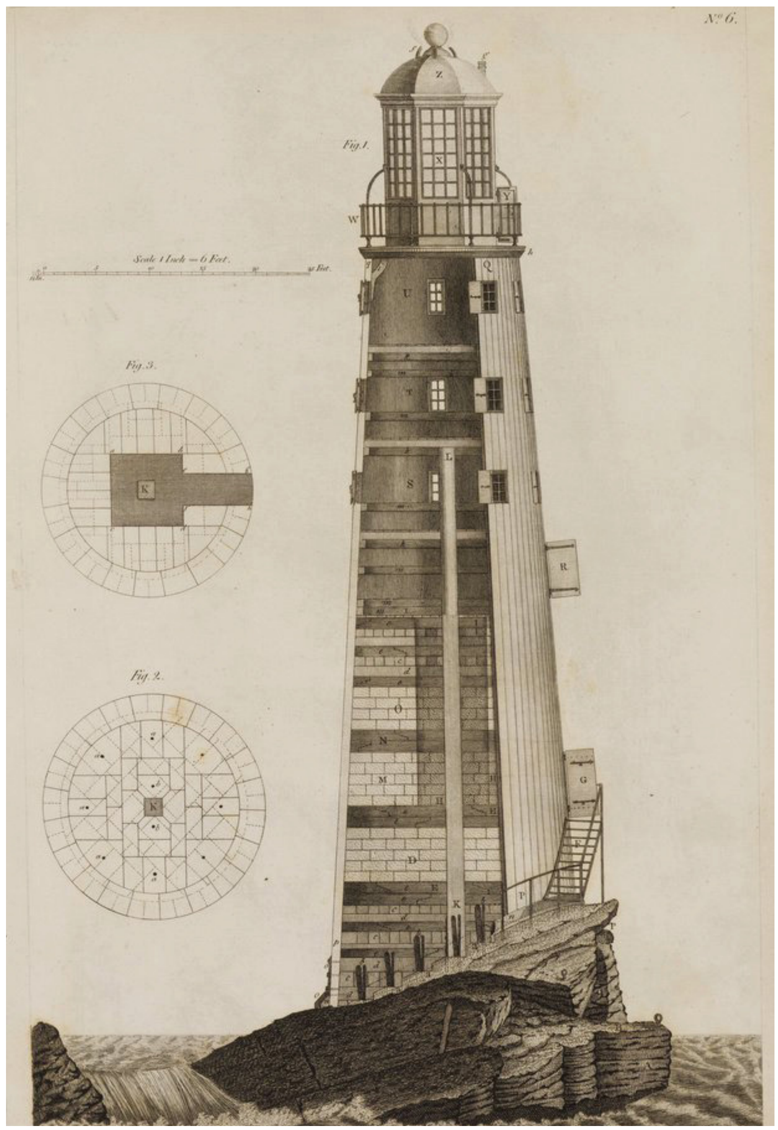


Figure 63
Rudyard's Lighthouse on the Eddystone Rocks,
(Record, 1784)

Concrete - A Pioneering Country

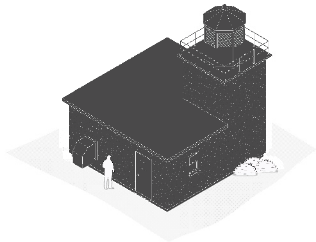


Figure 64
Diagram of a typical concrete lighthouse found in NS today

The introduction of reinforced structural concrete at the end of the 19th century led to a new wave of massive towering lights, cutting costs of labor compared to hand cut granite and rivaling in capability. Used initially in conjunction with iron caissons during the 1850's, Canada later adopted the material, which played a prominent role in shaping the Atlantic shores (see Figure 64).

Canada, a leader in developing concrete towers at the time was responsible for elegant examples such as the flying buttress design developed by Lieutenant-Colonel Anderson (see Figure 65). With an estimated 46 Concrete lights built in Nova Scotia, many examples still stand today.

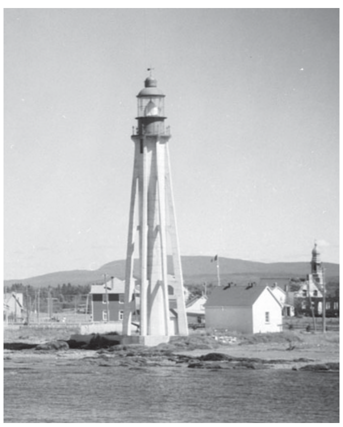


Figure 65
Flying buttress concrete lighthouse
(Johnston, 1933)

Figure 66
Concrete lighthouse at Goderich, Ontario,
(Boyd, 1916)

Figure 67
Little Hope lighthouse before and after collapse,
(Canada Coast Guard, 2004, Tutty, 2003)

However, difficult to mix in remote locations with only seawater available, and proven impossible to move or relocate, the structures in many ways are cumbersome and permanent. With examples such as Little Hope lighthouse, an example of Anderson's flying buttress design falling into the sea in 2003, little could have been done to save the failing structure (see Figure 67) (Irwin 2003, 47-48).

Possibilities however exist in rethinking the use of concrete, where instead of cast-in-place, a precast block approach adopting Smeaton's dovetailed pattern would allow similar assembly methods and a degree of reusability.

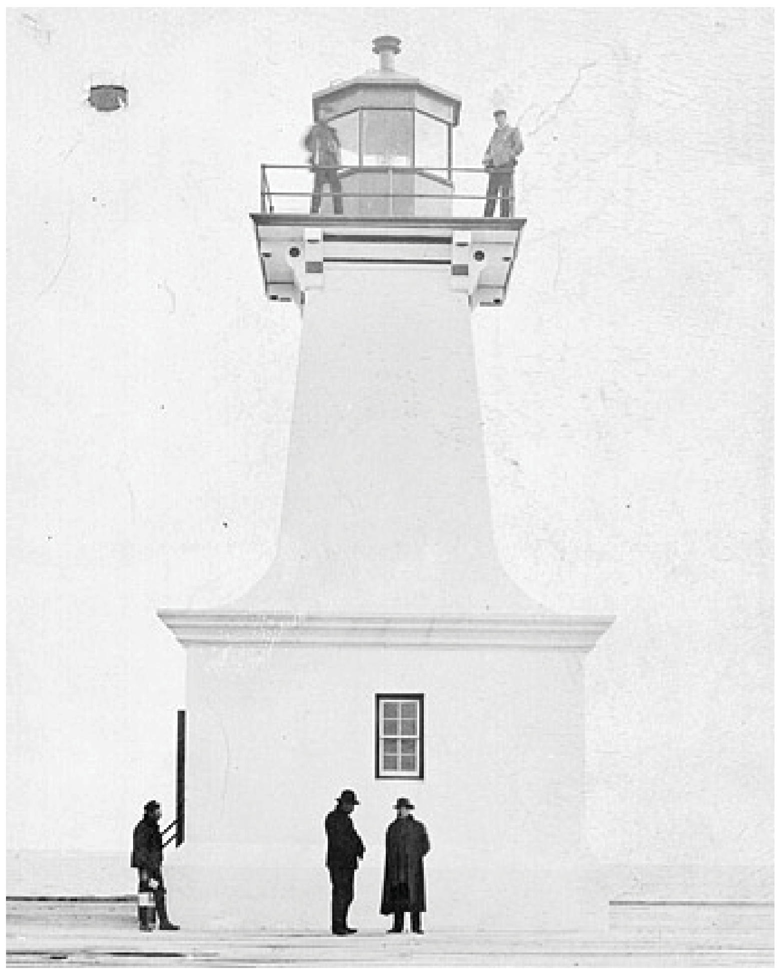


Figure 68
Image of a concrete lighthouse in Port Colborne, Ontario,
(Concrete lighthouse, 1904)

Community

The majority of Nova Scotia's coastal regions have various types relationships with the lighthouses in their communities and to varied capacities – perhaps they depend on the draw of a converted museum light to boost tourism, or preserve the heritage qualities for the sake of its aesthetic value, or directly rely on its intended purpose of guiding mariners away from potential dangers, the network of lights play a significant role in nearly every rural Nova Scotian coastal community (see Figures 69-72).

The opportunity however to tap into the particularities of the diverse areas across the province creates a dynamic network rooted in the existing culture. In order to study how the lighthouse can impact a community, it's imperative that multiple sites are tested to truly understand the scalability of such an intervention.

Figure 69
Image of a group of tourists eating lunch on the shores of Colborne Ontario, (Lund, 1952c)

Figure 70
Keeping watch at St. Paul's Lighthouse, NS,
(Taylor, 1954)

The opportunity to engage with the communities and provide public space allows the light to exist as a space and not just as a structure. Fostering a more participatory relationship with the surrounding area in the form of relevant programming relating directly to existing systems pushes the infrastructure to serve a greater purpose.

Figure 73 shows several basic systems at the scale of the province relating to the existing network of lighthouses, including density of settlement, specific geology, variation in topography, water runoff, as well as road networks. The density of settlement suggests areas of more urban settings, while the road network helps us better understand the isolation of other areas.

Figure 71
Gathering for the blessing of the fishing boats in Digby, NS,
(Brooks, 1961)

Figures 74-76 show several other systems of activity describing densities of fish landings, search and rescue incidents, as well as shipping routes allowing a better understanding of the areas that are more active.

Many of these systems have the ability to inform program or strategies that allow the public to engage with the infrastructure in ways that have yet to be explored through the form of lighthouses. With the community benefitting from the public space and the light benefitting from the community engagement, a more sustainable approach to constructing new lights becomes accessible.

Figure 72
Sharing knowledge of the at Louisbourg National Park, NS,
(Lund, 1952b)

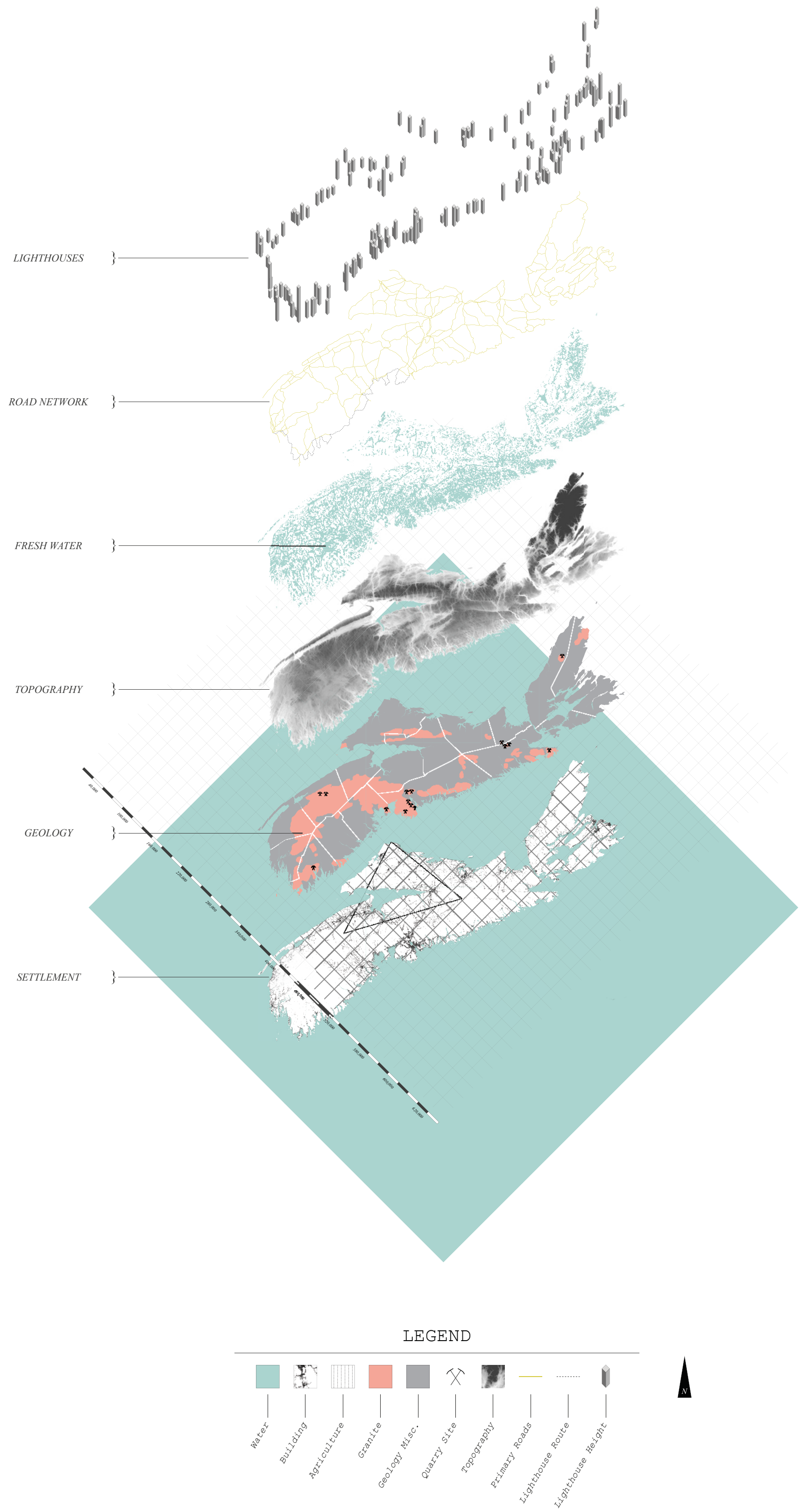


Figure 73
Axo showing layers of networks in Nova Scotia including density of settlement, specific geology, variation in topography, water runoff, road networks, as well as existing lighthouses, (Nova Scotia Open Data, 2016)

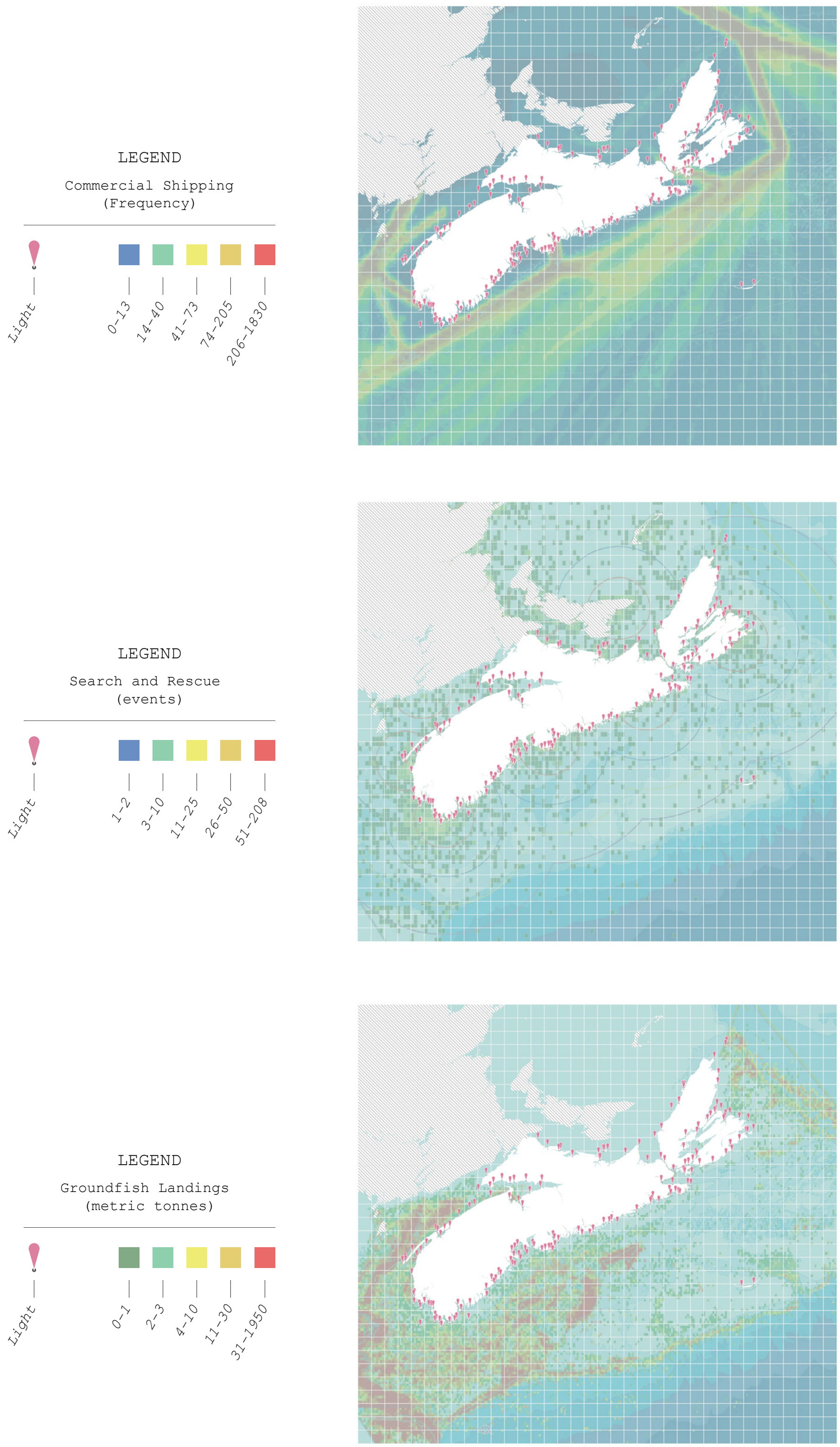


Figure 74-76
Maps identifying commercial fishing traffic density, search and rescue incidents, and ground fish landings relative to Nova Scotia's lighthouse network - 1999-2004, (Fisheries and Oceans Canada, 2005)

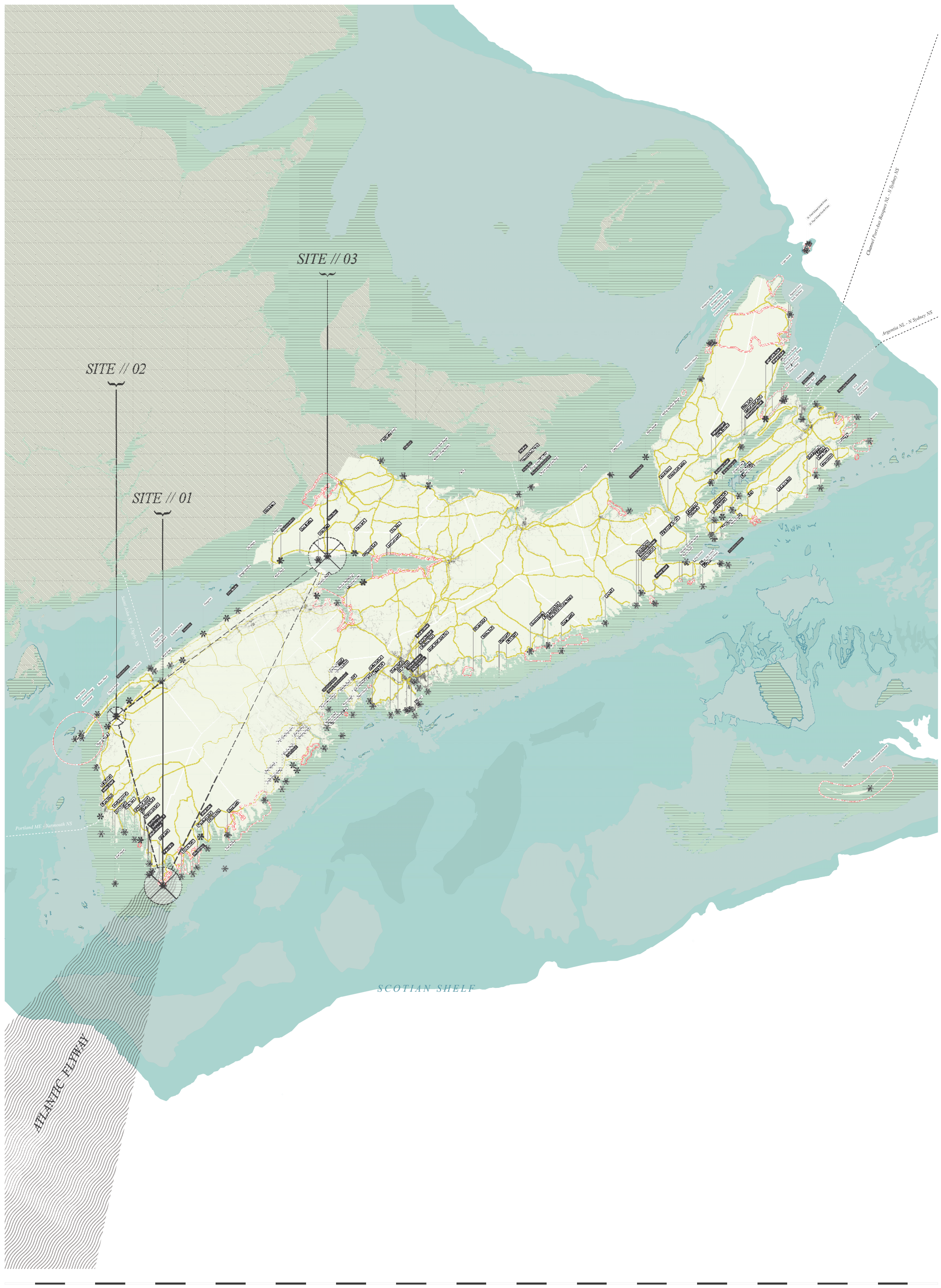
CHAPTER 4: SITE

Coastal Network

Nova Scotia's lighthouses total an estimated 172, with many records unable to keep up with the rapid changes in conditions or community involvement. The vast network however serves both rural areas and the province as a whole, underlining the importance of not only the individual light, but the entire system as an integral piece of marine navigation. Choreographing unique signals and site specific qualities, the network of lights enables distinct movement across the coastal shores.

The network of established points across the province provides a starting point in identifying key sites. By layering basic information such as current height above high tide, we can begin to identify existing sites at risk of sea-level rise. By layering information based on community interest and involvement, we can begin to understand the relationship neighboring areas have with existing lights.

In an effort to identify unique opportunities for relevant interventions, additional layers of networks or activities can used as a tool to single out individual sites that overlap with existing systems or networks. Figure 77 locates Important Bird Areas identifying swaths of land with unique bird habitats that in many cases are studied and observed by organizations and communities alike - identified as site 1, Cape Sable Island. The mapping of the road network depicts lights accessible by tourists and communities - identified as site 2, Belliveau's Cove. Finally, the map depicts areas of dense settlement in an effort to identify larger communities or more urban settings - identified as site 3, Parrsboro.



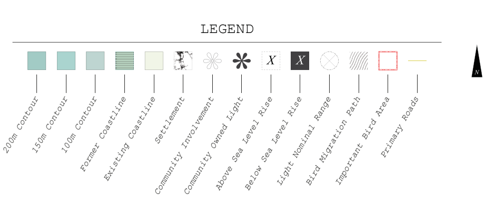


Figure 77 - Map of NS,
(Nova Scotia Open Data, 2016)

Cape Sable Island

Cape Sable Island lighthouse, located at the southern most tip of Nova Scotia serves as an important part of the province's navigational network. The First and Last light visible from the southern Atlantic waters, it overlooks the plentiful halibut and cod fishing grounds that support the well established fishing communities of the south shore. The same area supports a significant shore bird population and serves as a prominent point along the migratory path for a variety of other bird species feeding on the dunes and intertidal mud flats during the spring and fall.

Designated as an Important Bird and Biodiversity Area, the shores are frequented by bird watching enthusiasts and campers alike, with the Maritime Shorebird Survey having conducted volunteer research on the local bird population since 1977 (Important Bird Area Canada 2015).

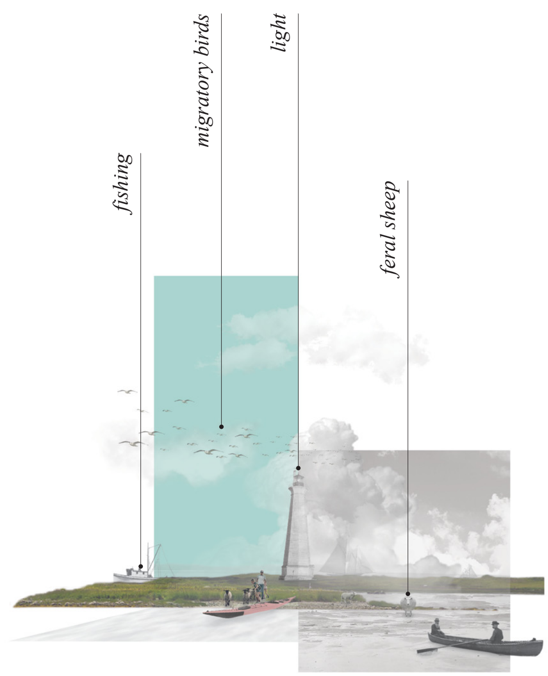


Figure 78
Collage of Cape Sable Island Lighthouse and surrounding site

Wild sheep graze the inland on the relatively flat and low lying grasslands that surround the salt marshes and windswept sand dunes. Accessible from the mainland by kayak or local water taxi during high tide, the sheltered waters protected by the natural grassy breakwater makes for a pleasant excursion.

The low lying grasslands however do little to resist the impact of sea-level rise, with much of the southern point of both the mainland and Cape Sable to the south under the high tide mark in the coming years. Cape Sable's lighthouse, the tallest in Nova Scotia constructed of reinforced concrete would be completely submerged at its foundation during high tide.

In the centuries following 2100, much of the island would be divided into smaller sections, separating at high tide and rejoining as the tide goes out.

Figure 79
Image of Cape Sable's grassy landscape during an early spring morning with a flock of birds in background

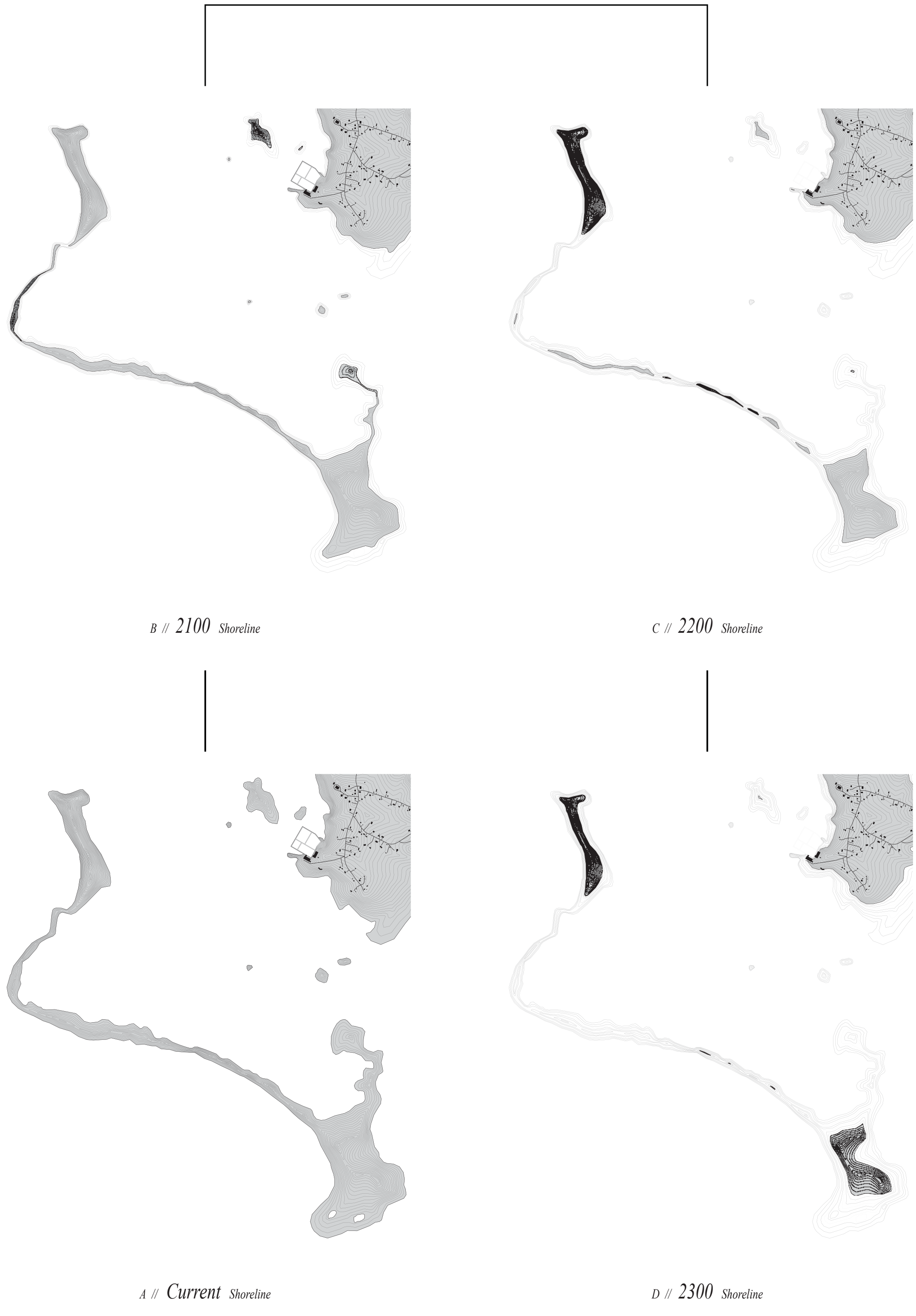


Figure 80
Map showing existing network of lighthouses in Nova Scotia including density of settlement, specific geology, variation in topography, water runoff, as well as road networks, (Nova Scotia Open Data, 2016)

Belliveau's Cove

Belliveau's Cove lighthouse looks out over St. Mary's Bay at the end of a wharf, protecting a small cove of fishing vessels of the French Acadian village that's strung out along the shores of The Bay of Fundy waters. The lighthouse, reconstructed by the community in the 1980's after falling into the ocean during a storm is now maintained as a private light kept by locals.

During the summer months on Friday evenings, the community holds "Beaux Vendredis," where both the community and visitors are invited to share in a seafood dinner. The catch caught by local fishermen, and off loaded in the local harbour has become an integral part of the community's willingness to entertain and gather. Neighbouring a community park that hosts a Saturday farmers market, the area serves as one of the only public spaces for many miles in either direction.

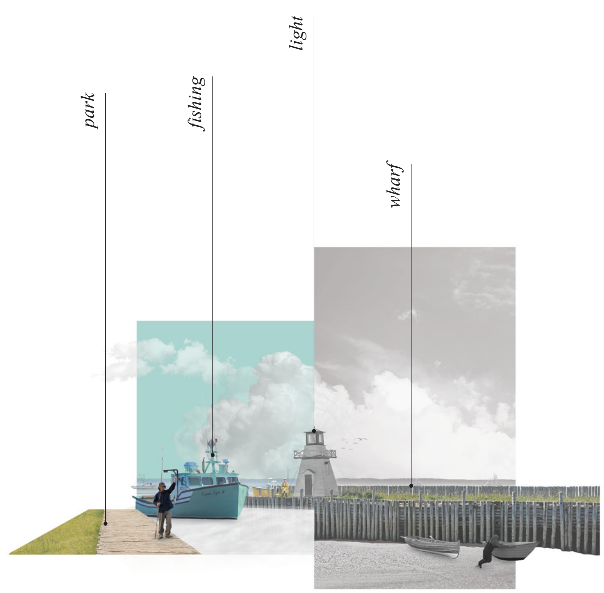


Figure 81
Collage of Belliveau's Cove Lighthouse and surrounding site

The park, frequented by dog walkers, families and tourists spills into the “Piau Trail” boardwalk maintained by the community that wraps up and around the windswept rocky shores to the municipal nature trails that lead to the province’s first Acadian cemetery.

Much of Belliveau’s Cove exists only several feet above high tide, with the two wharves and the majority of the park at risk of being lost in the coming years. Belliveuas lighthouse, sitting at the end of one of the finger wharves will most likely be washed away during a storm surge as a result of high tide marks before the end of this century.

In the centuries following 2100, the majority of the park and trail would be submerged along with several homes and large portions of the existing low lying road.

Figure 82
Image of Belliveau’s Cove’s “Piau Trail” that stretches along the shores of the rocky beach leading to the first French Acadian cemetery

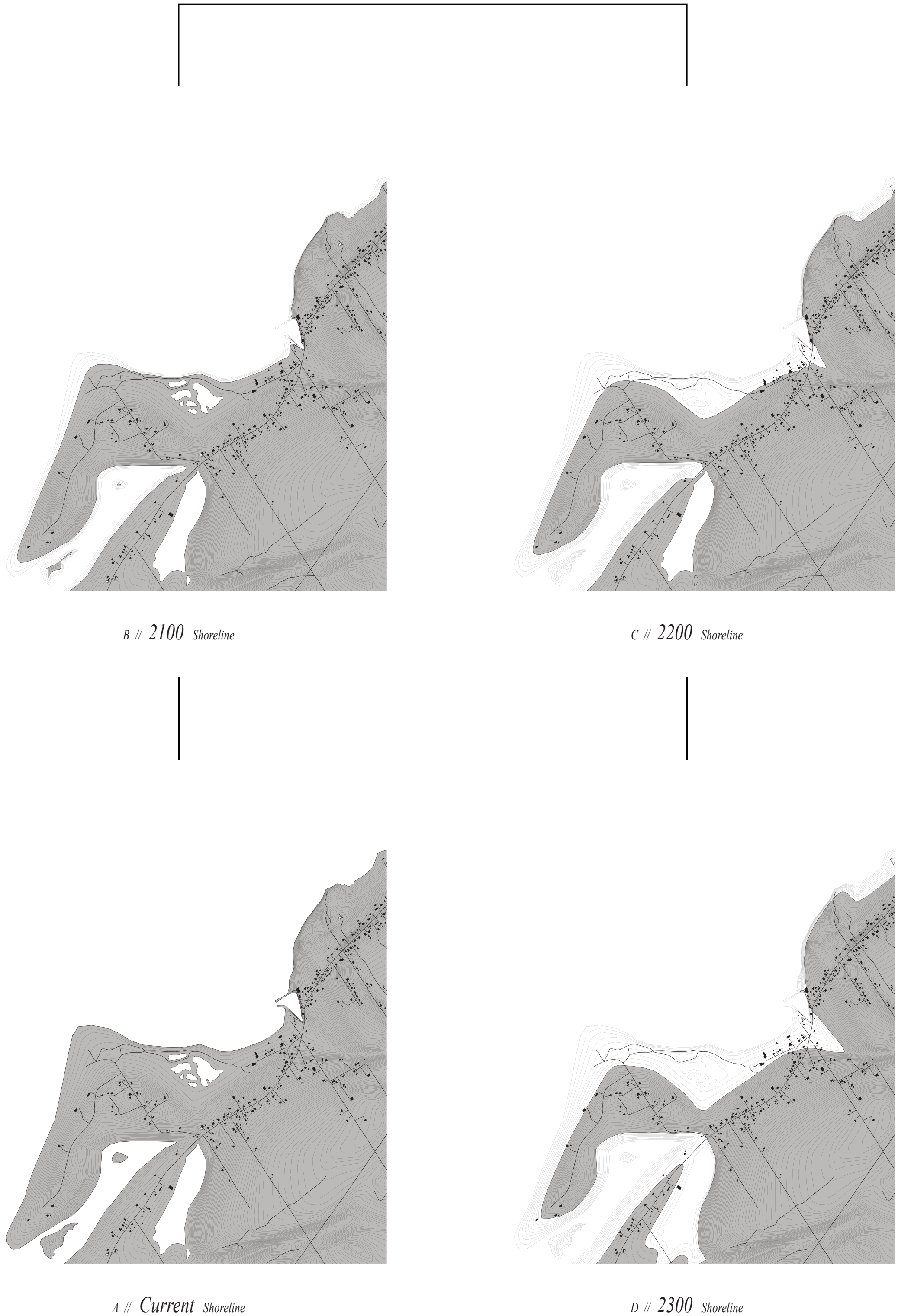


Figure 83
Map showing existing network of lighthouses in Nova Scotia including density of settlement, specific geology, variation in topography, water runoff, as well as road networks, (Nova Scotia Open Data, 2016)

Parrsboro

Parrsboro lighthouse guides local fishermen into the brackish harbour at the end of a breakwater, protecting the monumental wharf and low-lying town of Parrsboro from the seas of the adjacent Minas Basin. Fresh water feeds into the harbour from the man-made-lake - Parrsboro Aboiteau, that is frequented by canoes and kayaks that often spill out into the estuary at high tide.

The estuary, rich with wildlife of many sorts scouring the mud flats and marsh lands at low tide relies on the breakwater at the mouth of the harbour to remain intact. Playing host to a seasonal theatre company on the banks of the estuary as well as three museums, a local radio station and a community centre for music venues and local events, the town is rich with an overwhelming sense of culture and identity, with the town's Main St. filling with local street art every year in June to celebrate local artists' work.

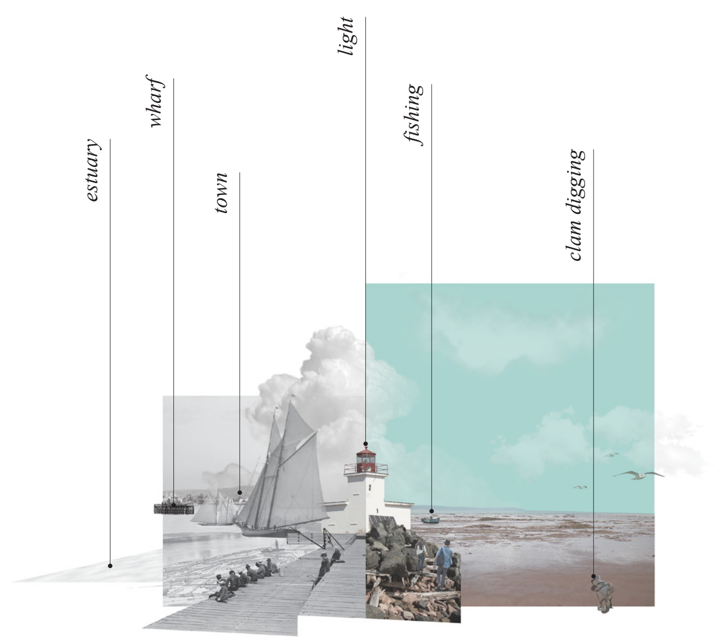


Figure 84
Collage of Parrsboro Breakwater Lighthouse and surrounding site

The breakwater, acting as a makeshift park that exposes itself during low tide is frequented by dog walkers, sun seekers and clam diggers. Serving as the gateway to the harbour, fending off imposing waves and storm surge year round, both industry and community depend on the simple jetty of land that acts as an impromptu place to share and explore.

Unfortunately the breakwater within the next century will only exist as a submerged mass of stone under high tide as rising sea-levels start breach the man-made landmass in the coming years.

In the following centuries, much of shores of Parrsboro will be flooded, pushing the mammoth wharf below the high water mark as well as several homes and businesses.

Figure 85
Image of Parrsboro's government wharf with several fishing boats tied up with Harbour View fish and chips in the background at low tide

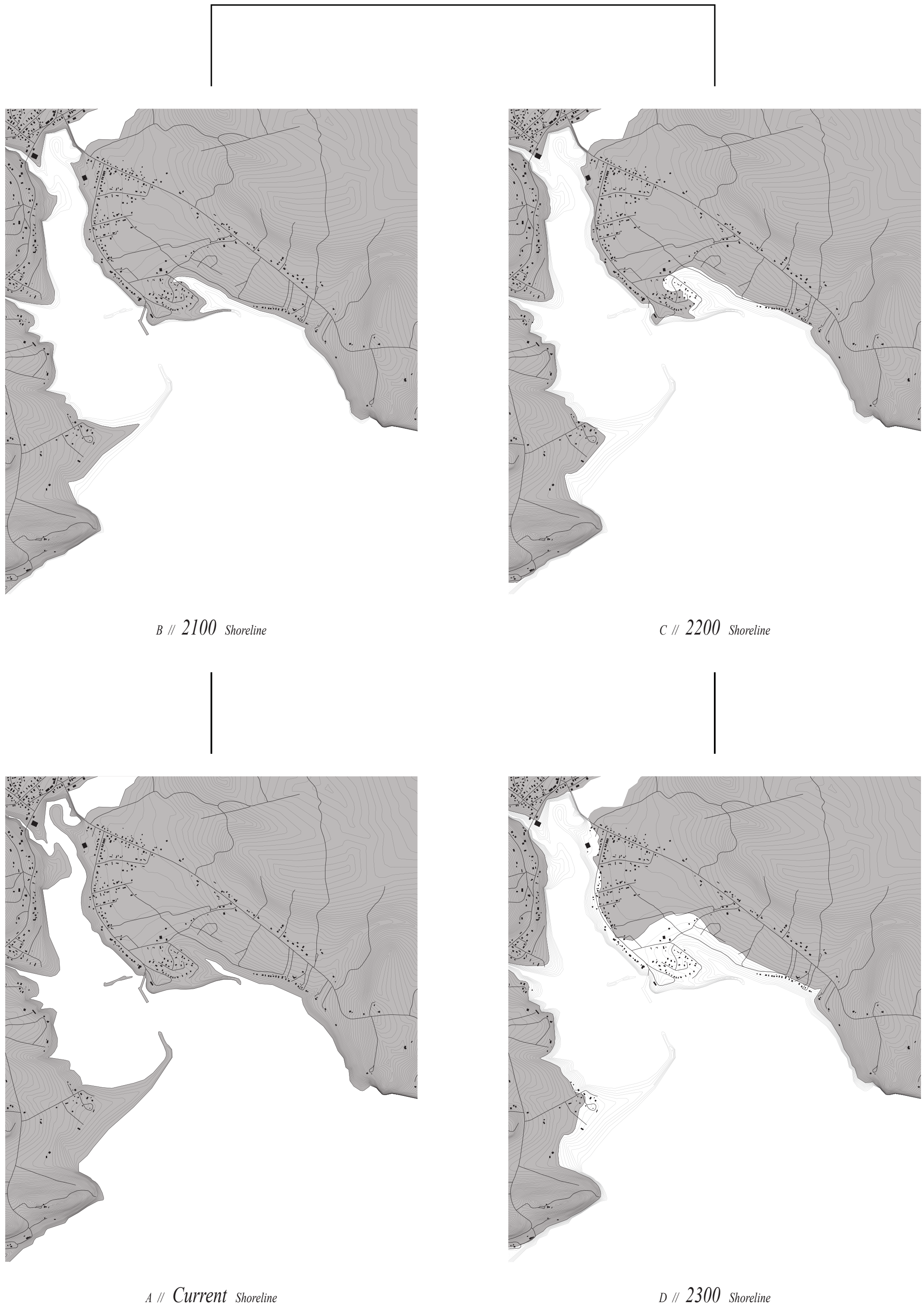


Figure 86
Map showing existing network of lighthouses in Nova Scotia including density of settlement, specific geology, variation in topography, water runoff, as well as road networks, (Nova Scotia Open Data, 2016)

CHAPTER 5: DESIGN

Overview

Drawing from the three site's individual particularities chosen as examples based on the impact of rising sea-level and community involvement, the architectural designs utilize a modular system of materials paired with additional public program relating to the surrounding community. The intention is that through creating a public space in the form of a lighthouse, the community gains a social space, while the lighthouse is reformatted to preserve the function in a more engaging form.

Architectural Strategies

The architecture responds to the urgency of a changing climate in the form of a modular design, adapting materials based on their ability to perform in the harsh coastal environment while providing opportunity for growth, disassembly, and reassembly to adapt to rising sea levels.

The intention is that in the short term life of the building, a wood sleeve serves as the envelope and can be easily repaired or replaced by local trades. A bolted steel structure allows for flexibility in form while ensuring disassembly or reconfiguration in the long term life of the building, while a modular masonry foundation allows for a flexible and reusable mass capable of withstanding the test of time in the form of multiple iterations of the building itself.

Finally the form of the public space is based on the function of the light, responding to existing heights while relating to community needs and the surrounding site. The hybrid of infrastructure / public space responds to future high tides as well as the material strategies in order to create a dynamic network of buildings.

Watch - Birding Tower

Although relatively isolated, Cape Sable is frequented by bird watchers and campers eager to explore the southern most Nova Scotian landscape the province has to offer. A walk down Hawk Beach leads to a point of intertidal mud flats populated by piping plovers, sandpipers and a variety of seasonal migrating bird populations.

Across the intertidal mud flats, a path along Cape Sable's grassy terrain leads to a subtle amphitheatre carved into the landscape that the proposed tower watches over. Providing a plinth with an uninterrupted view in all directions, the lighthouse sits atop the stone mass far above any future storm surge situated between the two peaks of the island, a calm and protected area relative to the rest of the exposed landscape.

The light provides researchers and the volunteers of the Maritime Bird Survey group a space to work and store tools, while an observation deck allows for a new perspective for all visitors of the island.

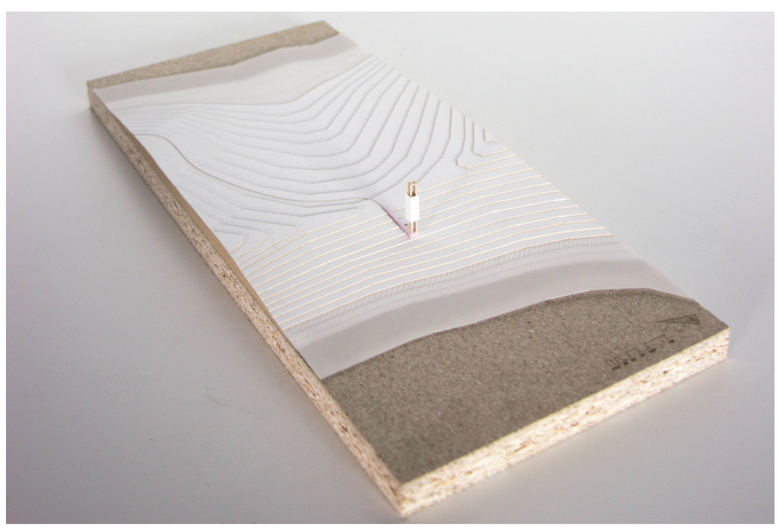
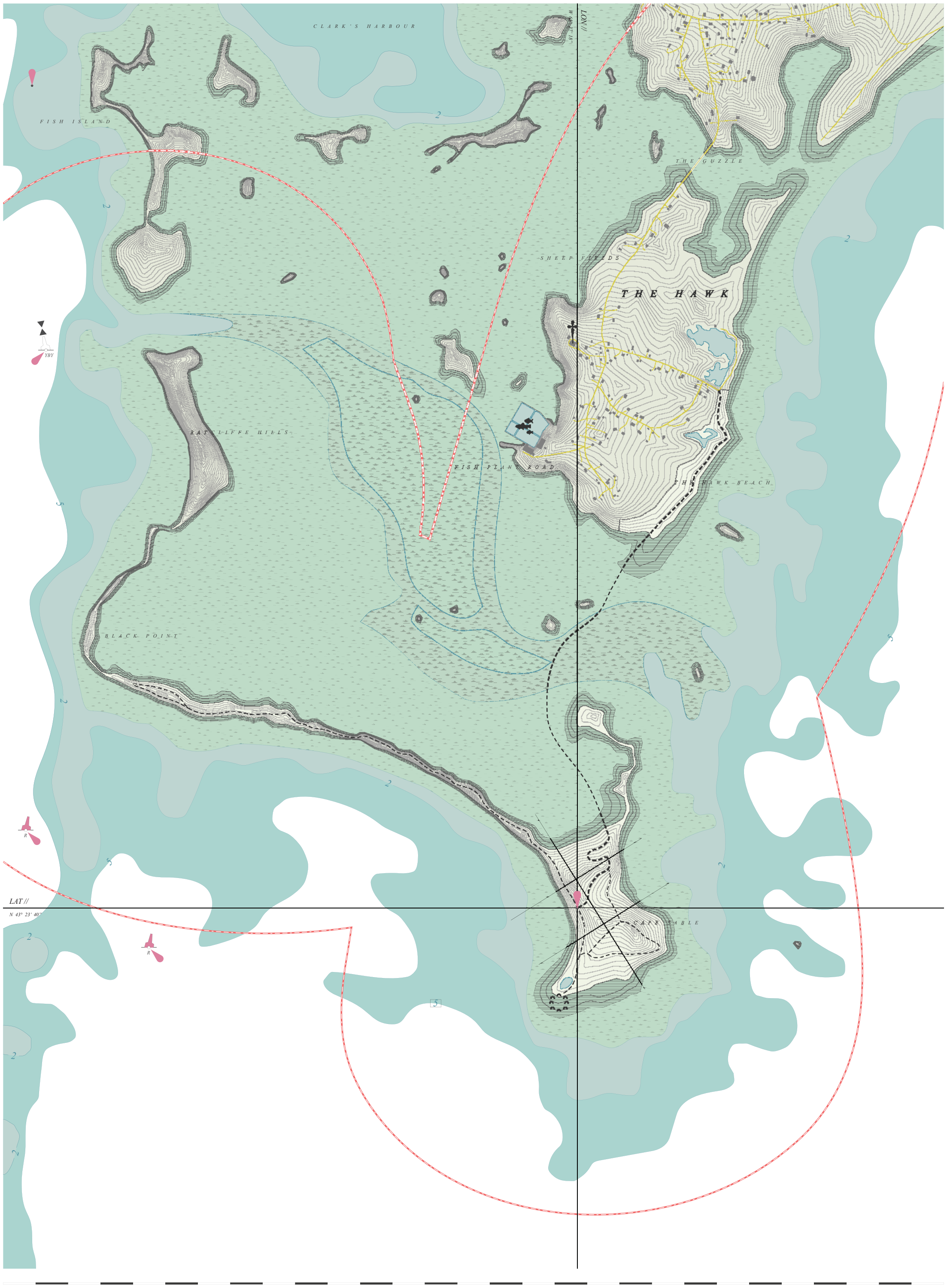


Figure 87
Site model of proposed birding tower lighthouse on Cape Sable Island



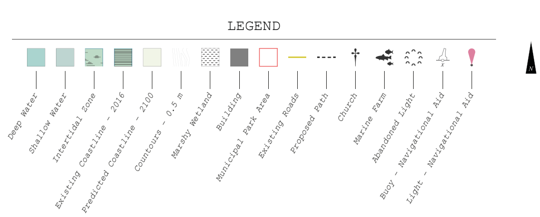


Figure 88 - Map of Cape Sable,
(Nova Scotia Open Data, 2016)

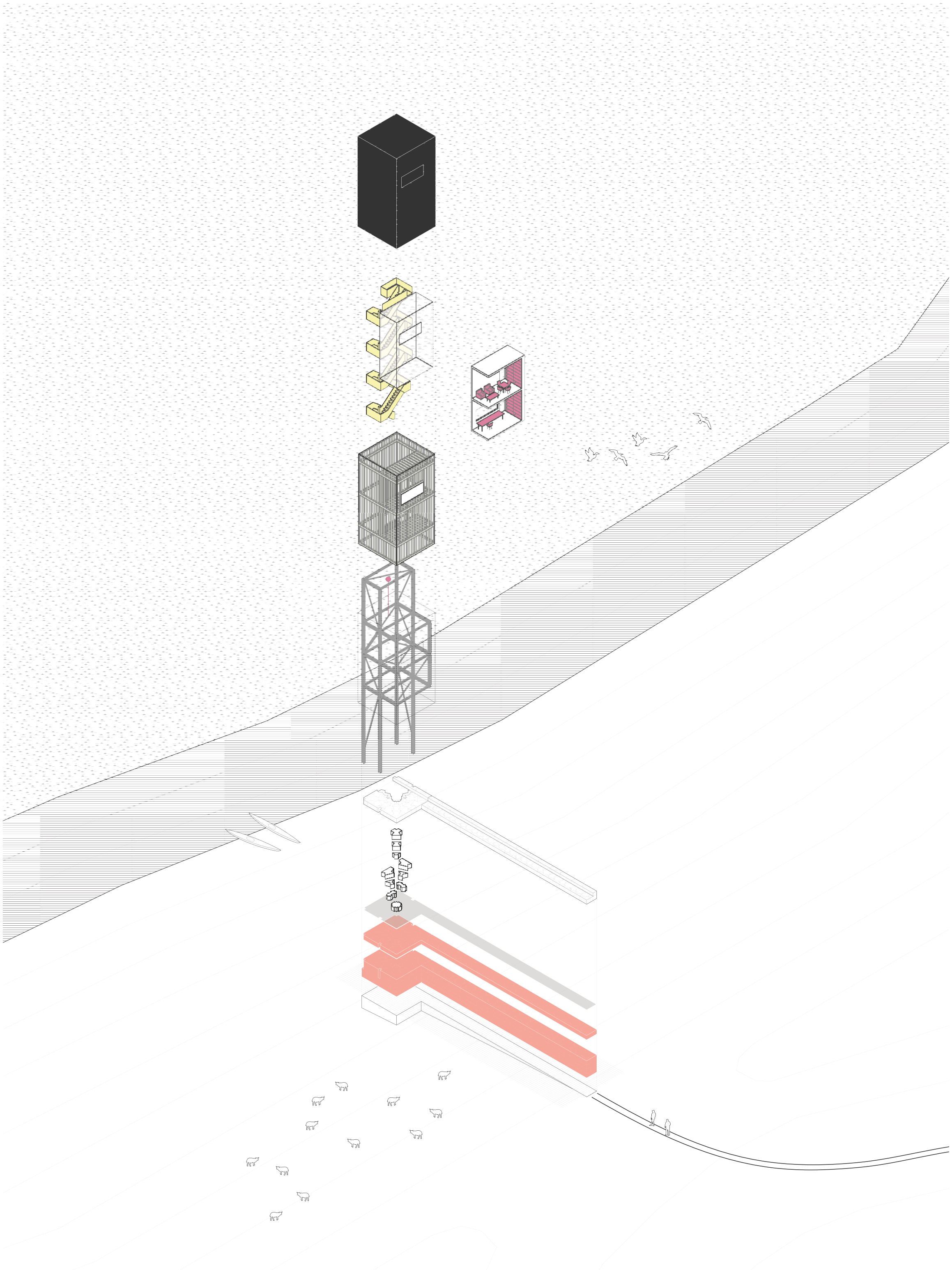


Figure 89
Exploded isometric of birding tower showing the modular foundation, steel structure and wood sleeve that houses the work spaces for the volunteer surveyors and researchers between the two high points of land

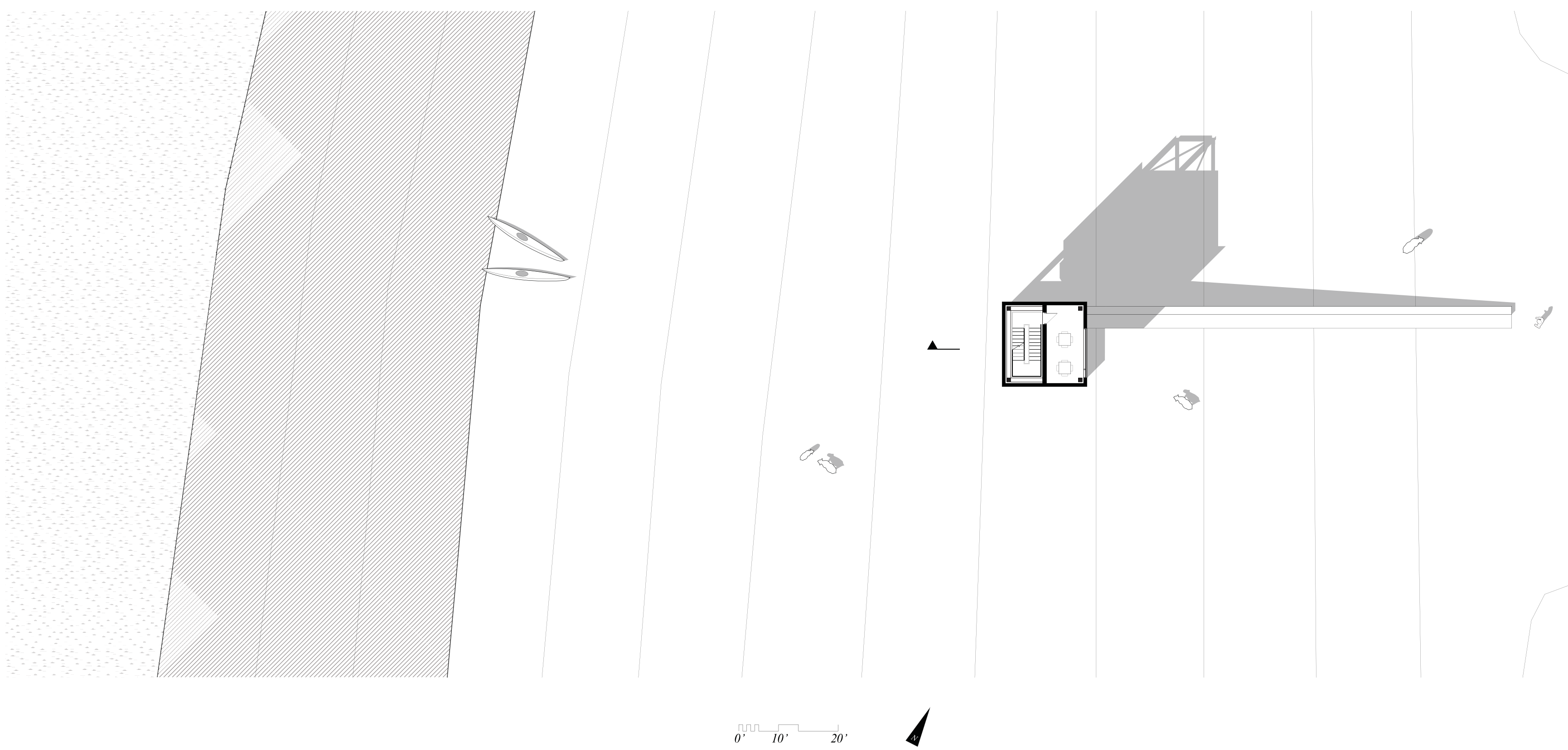


Figure 90
Plan of birding tower illustrating relationship with current and future sea levels

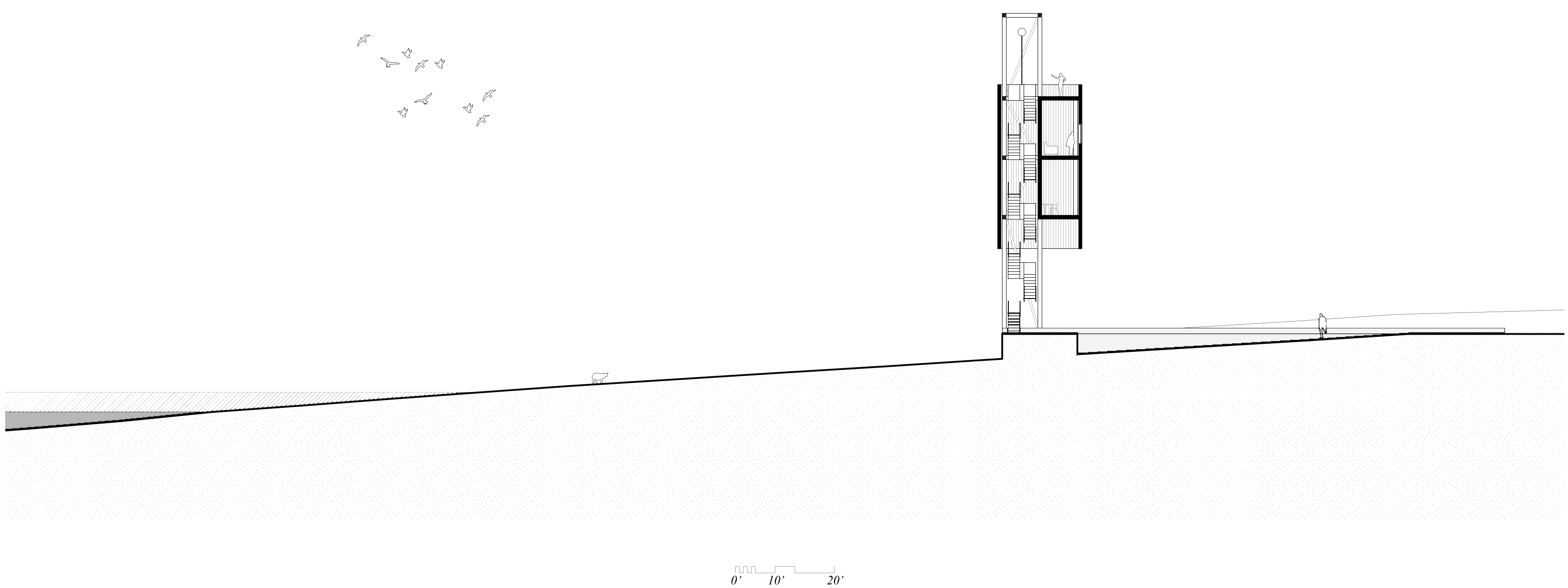


Figure 91
Section of birding tower illustrating relationship with current and future sea levels

Figure 92
On Hawk Beach looking out across the inlet to Cape Sable light

Figure 93
On Cape Sable looking across the path inlet to the proposed light

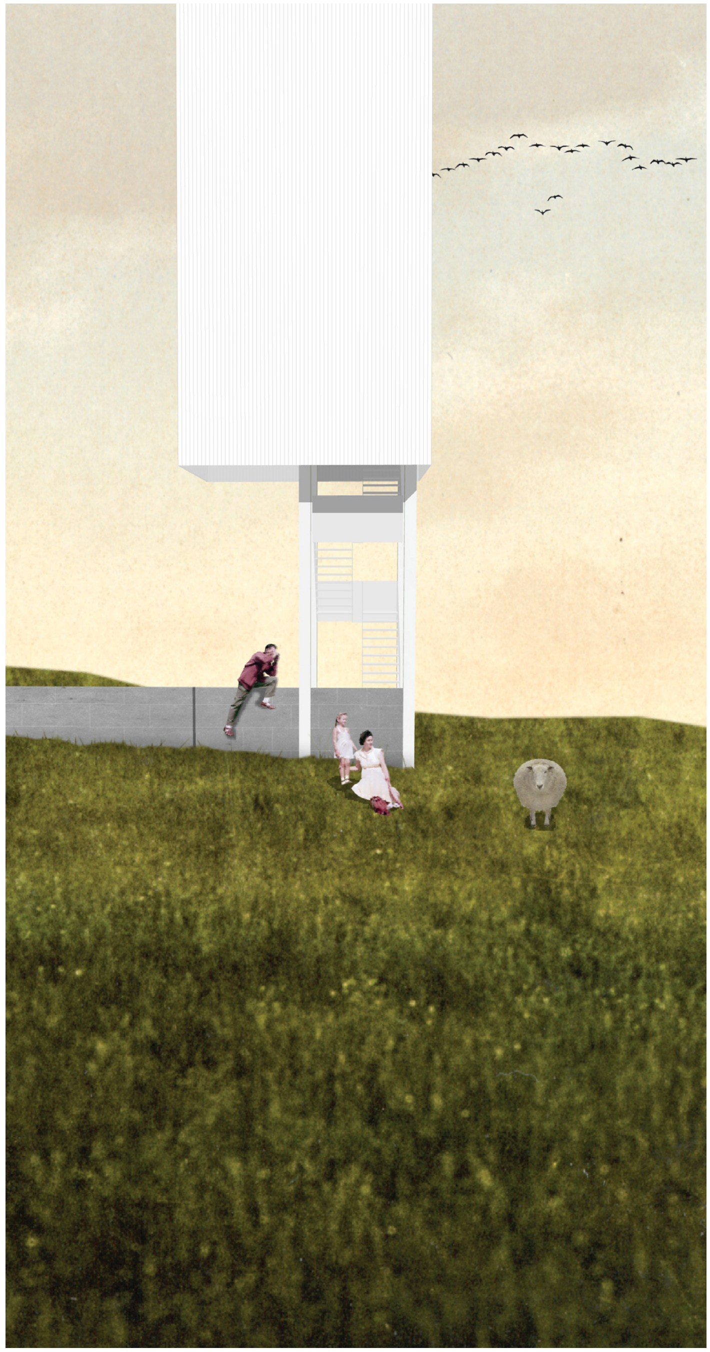


Figure 94
Sitting on the masonry foundation observing wild grazing sheep

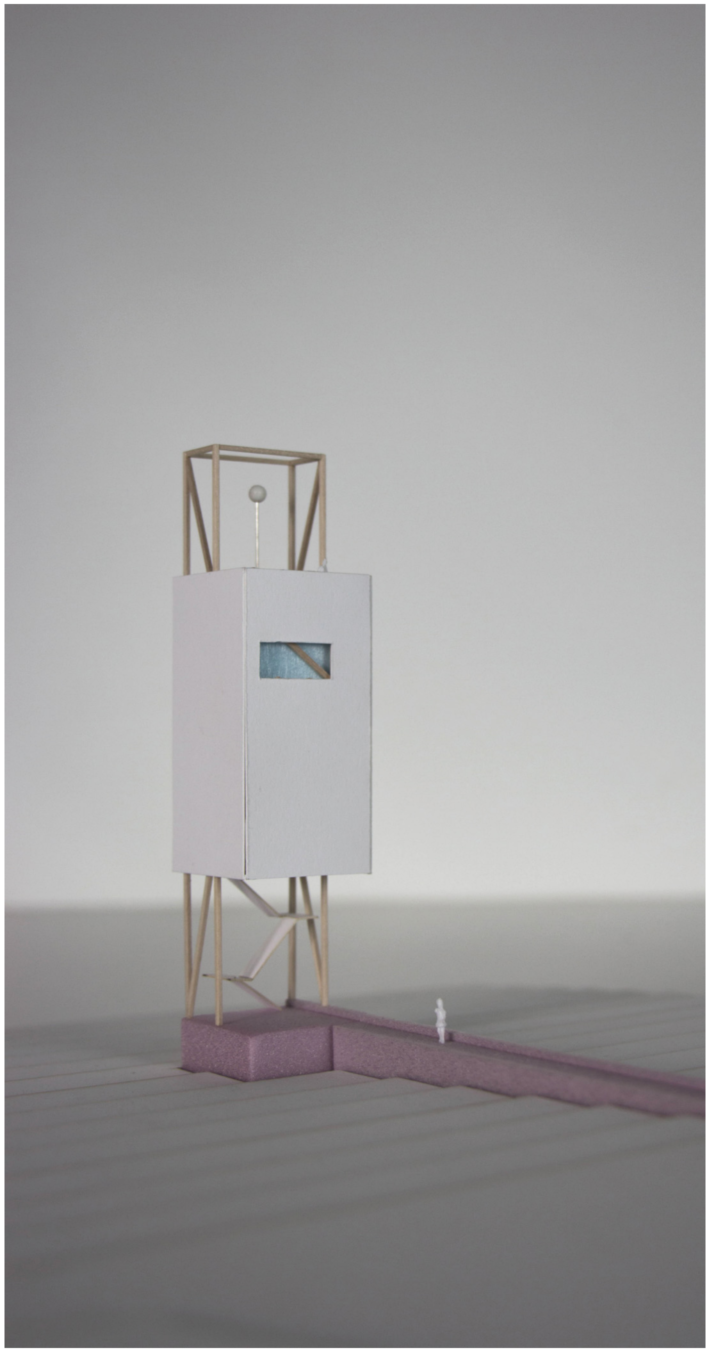


Figure 95
Model of birding tower showing approach to plinth and stair

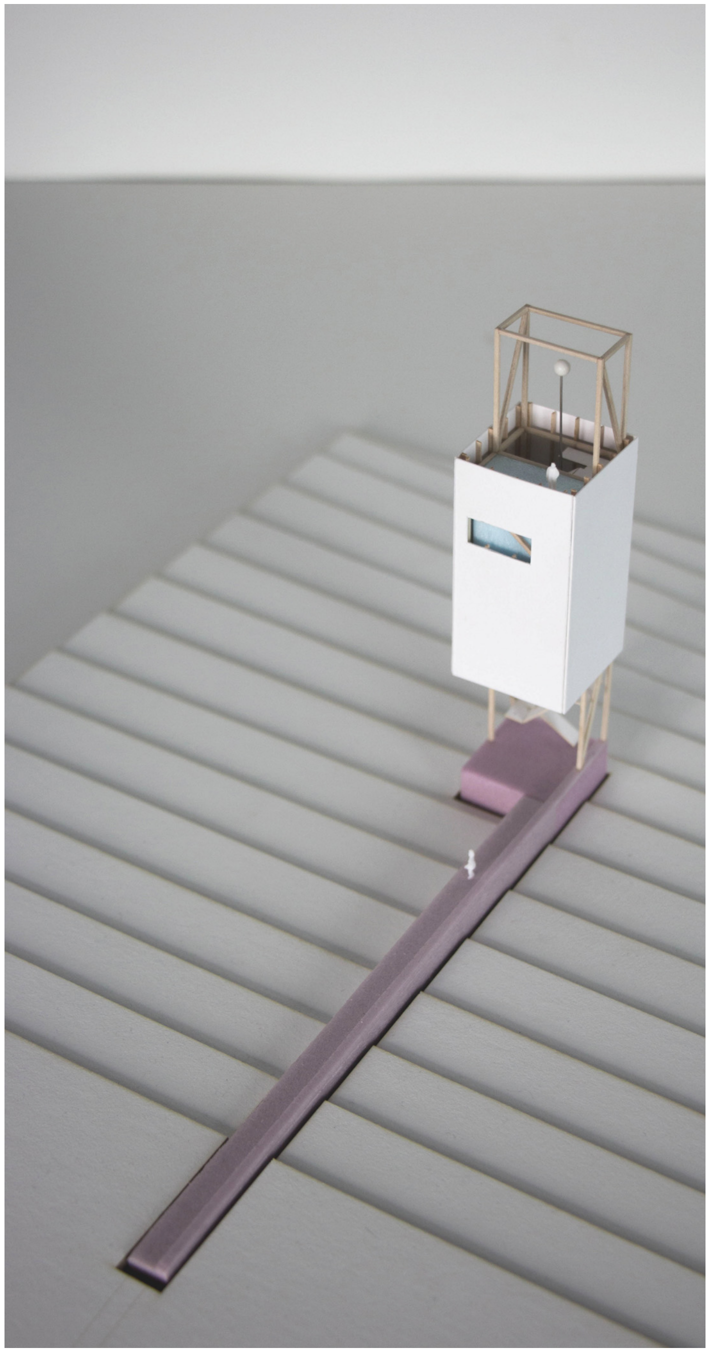


Figure 96
Model of birding tower showing approach to plinth and stair

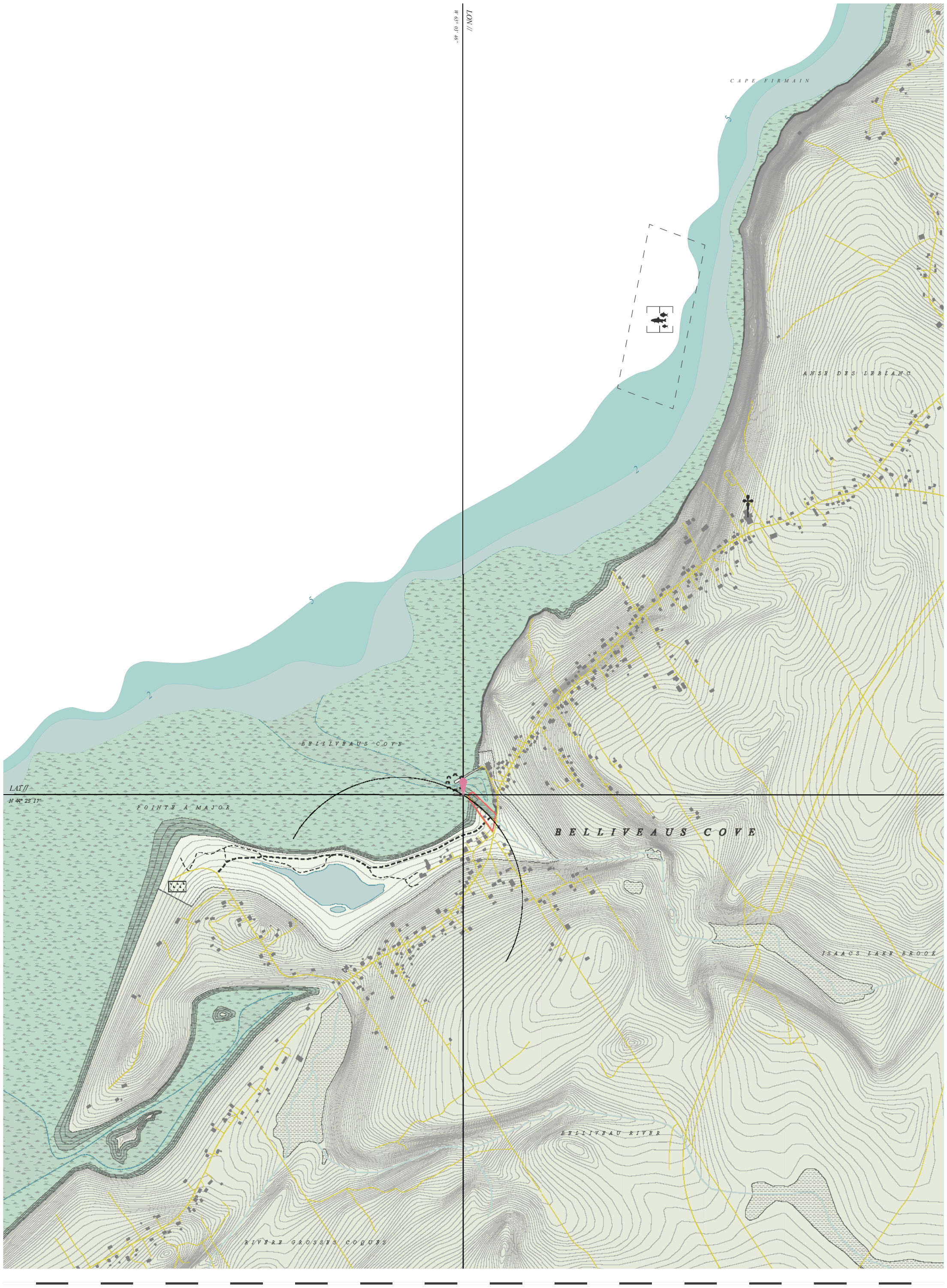
Gather - Dining Hall

In the heart of Belliveau's Cove, the wharf and neighboring park serve as integral pieces of the French Acadian community providing space to host and entertain. In a community largely dependent on both the fishing industry and tourism, the proposed light builds off the end of a new wharf, replacing the current one soon to be flooded.

Bookending the coastal trail, a cradle protects a dining hall from strong maritime winds looking out and back towards the beach and nearby park. Protecting the fishing boats and small harbour that supports a fish processing plant, the wharf plays an essential role in the region supporting both industry and community events.

Providing a space to cook and a boom derrick to load and off-load fishing vessels at various water heights, the light provides open space for gathering - plugging directly into the existing fishing industry. The upper floor provides a large observation deck for extra dining space and uninterrupted views of both the quaint Acadian community and Fundy's massive tidal range.

Figure 97
Site model of the proposed dining hall lighthouse in Belliveau's Cove



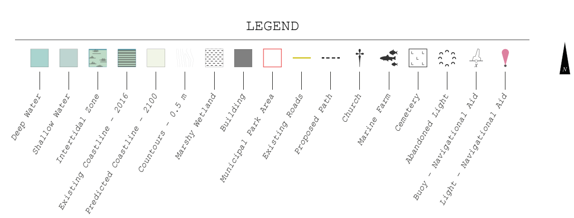


Figure 98 - Map of Belliveau's,
(Nova Scotia Open Data, 2016)

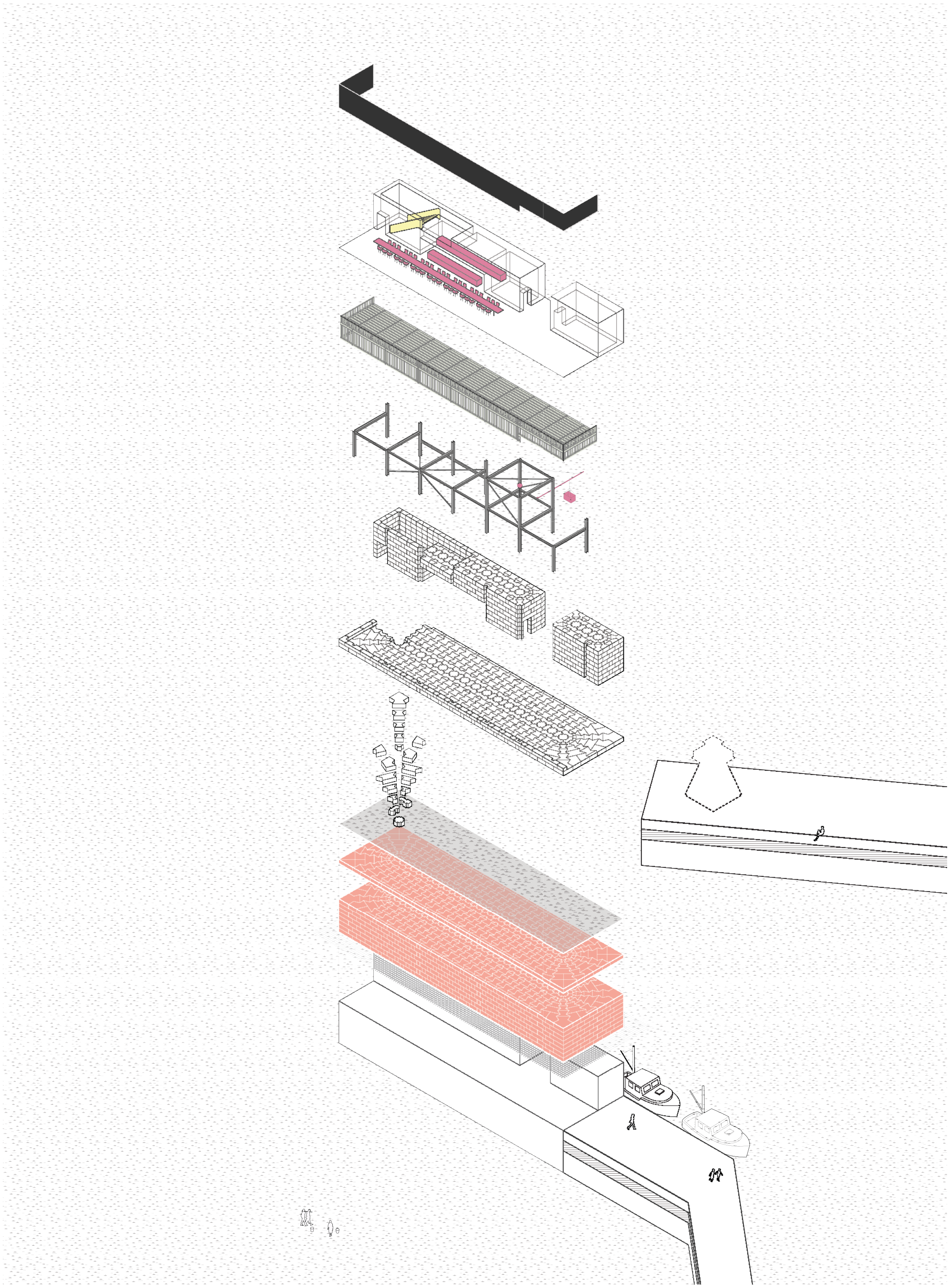


Figure 99
Exploded isometric of the dining hall showing the modular foundation, steel structure and wood sleeve that houses the dining space for gathering both the community and visitors at the end of the wharf

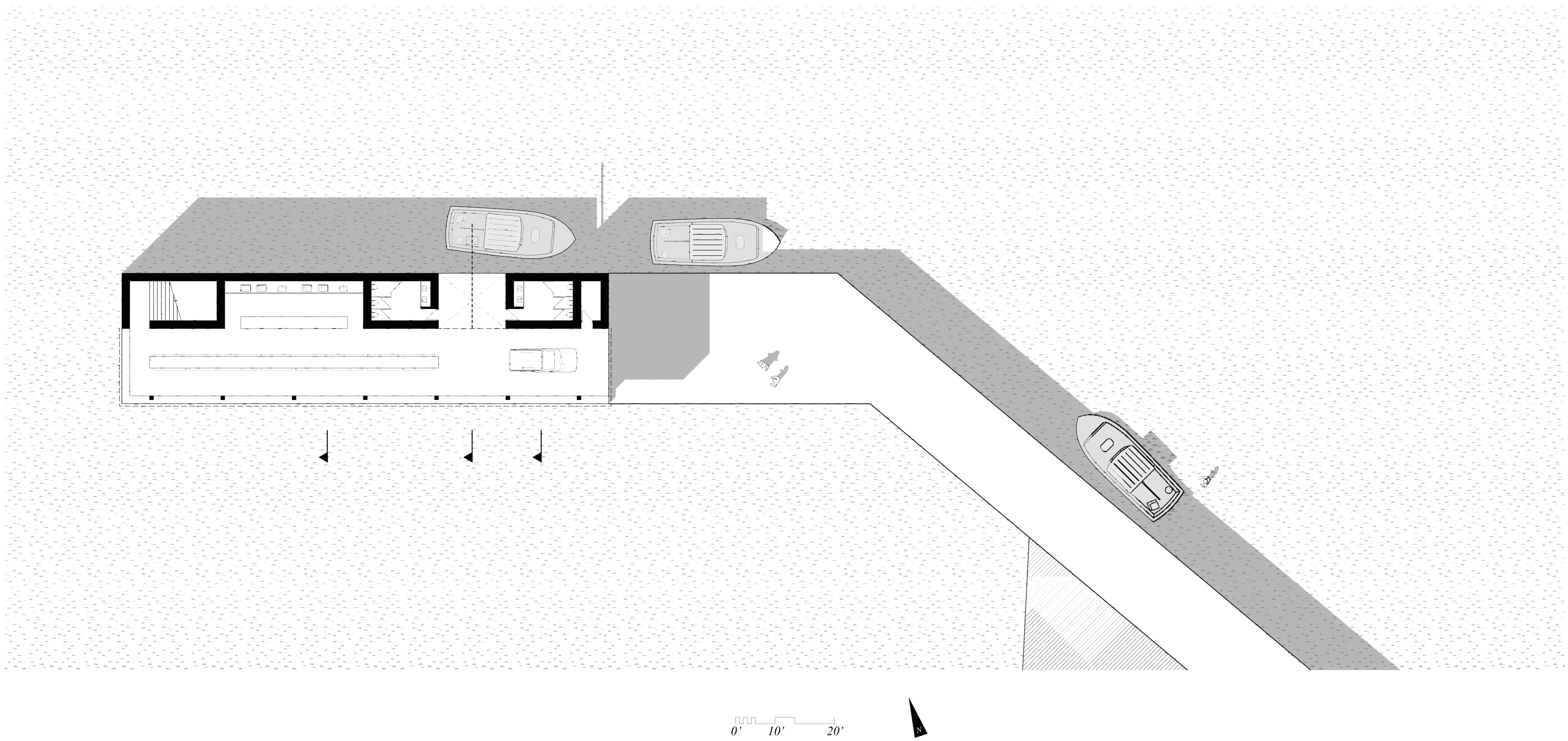


Figure 100
Plan of the dining hall illustrating relationship with current and future sea levels

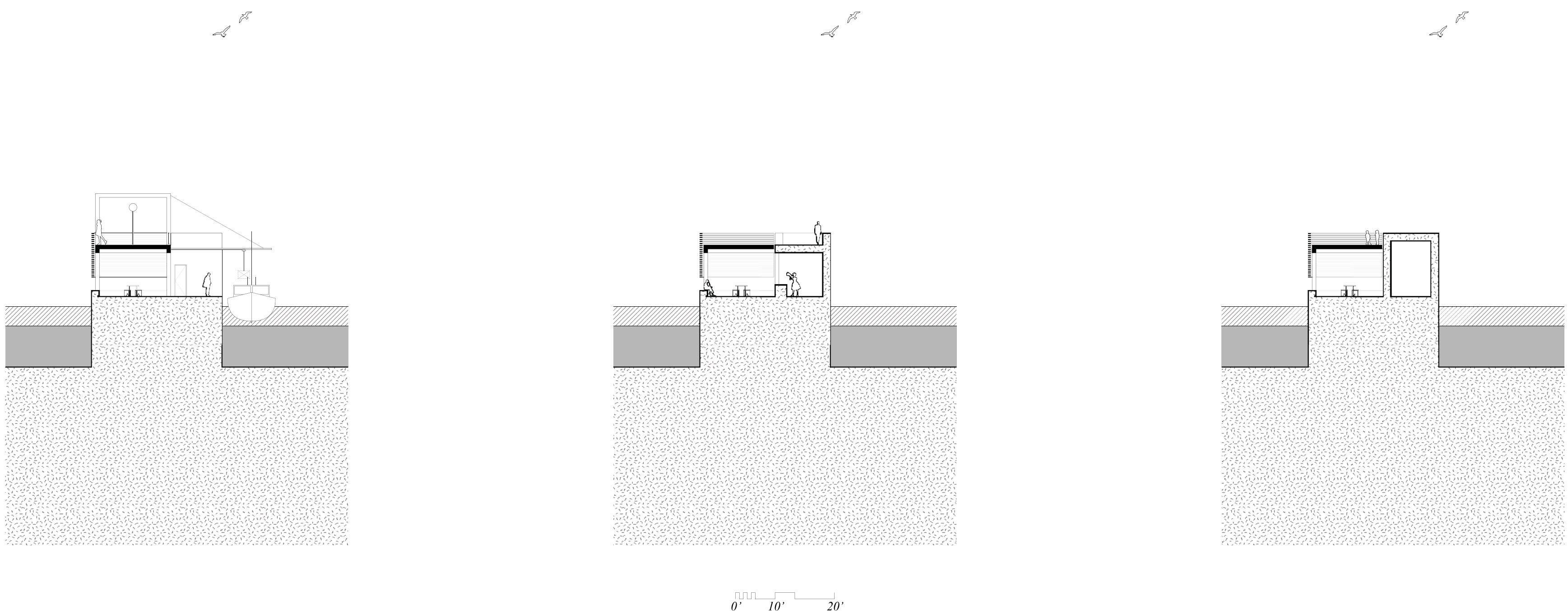


Figure 101
Section of the dining hall illustrating relationship with current and future sea levels

Figure 102
Standing on the beach looking back towards the dining hall

Figure 103
Walking on the wharf towards the dining hall for Beax Vendridis

Figure 104
Fisherman preparing his boat in the harbour mud flats at low tide

Figure 105
Model of dining hall showing approach from wharf to the entry

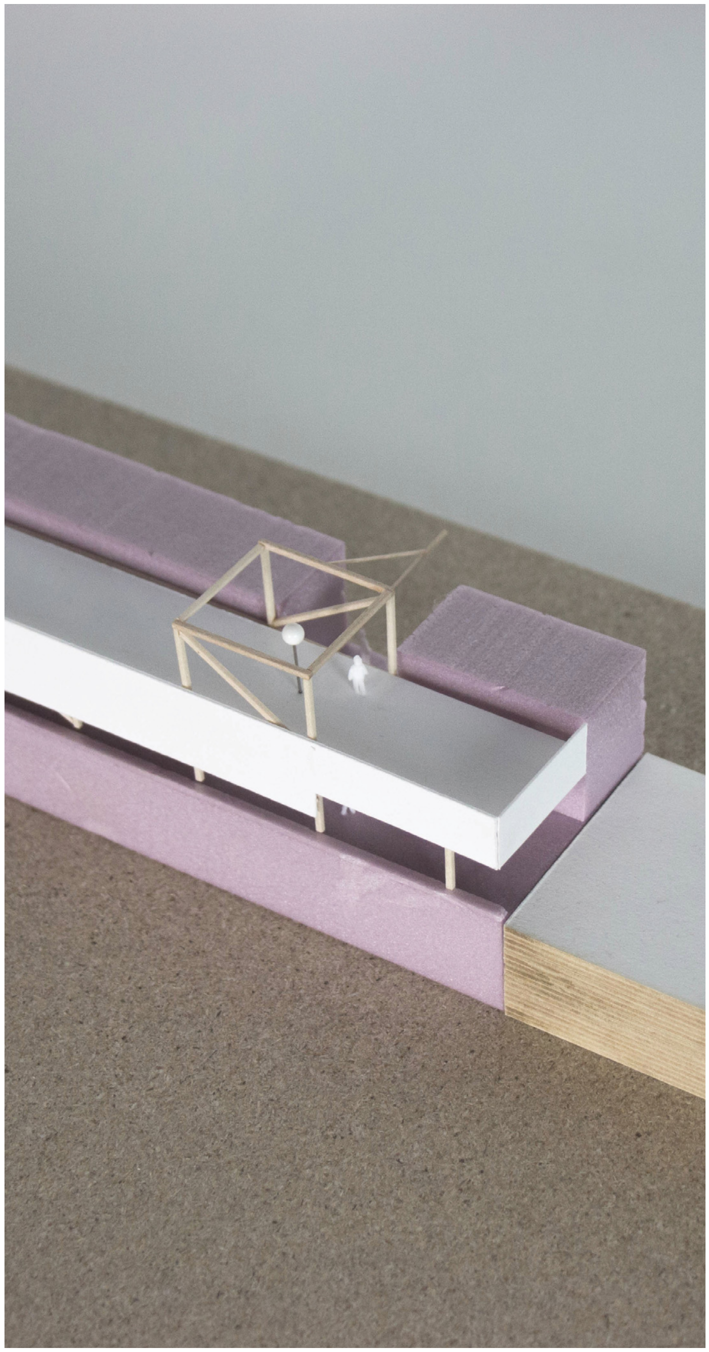


Figure 106
Model of dining hall showing second floor and lantern overhead

Figure 107
Model of dining hall showing boom derrick for unloading boats

Share - Library

At the mouth of the Parrsboro harbour, a breakwater and wharf form a threshold separating estuary from ocean, protecting the fragile shores of the town from damaging storm surge. Like Belliveau's Cove and Cape Sable, Parrsboro depends on its fishing industry as part of its economy, propping up a large part of the 1500 resident town that also relies heavily on blueberry farming and tourism.

Next to the wharf, a busy fish and chips shop serves locals and visitors local battered fish while looking out towards the lighthouse at the end of the breakwater, accessible from the beach at low tide. Extruded out from the southern point of harbour, the new breakwater doubles as a path that sits above high tide leading to the lighthouse that provides a space for sharing in the form of a library.

Protecting the books in the massive masonry walls, with the public space sandwiched between and floating above high tide, the library looks both back at the town and out towards the Fundy tides providing calm spaces to collaborate and learn.

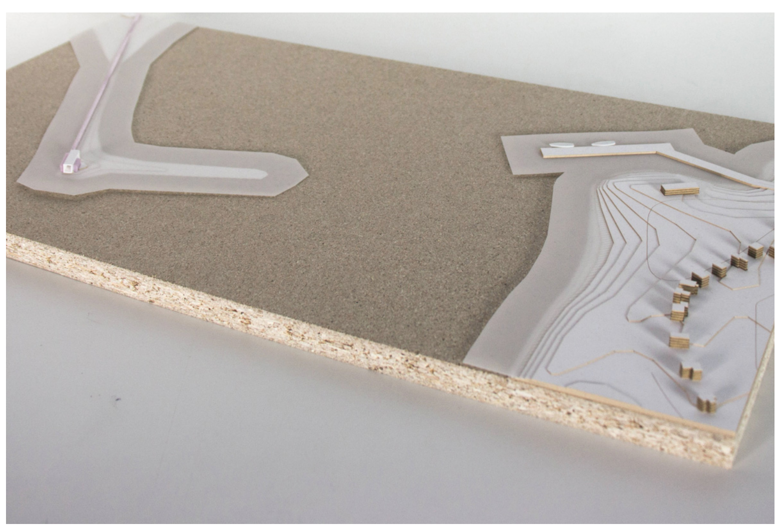
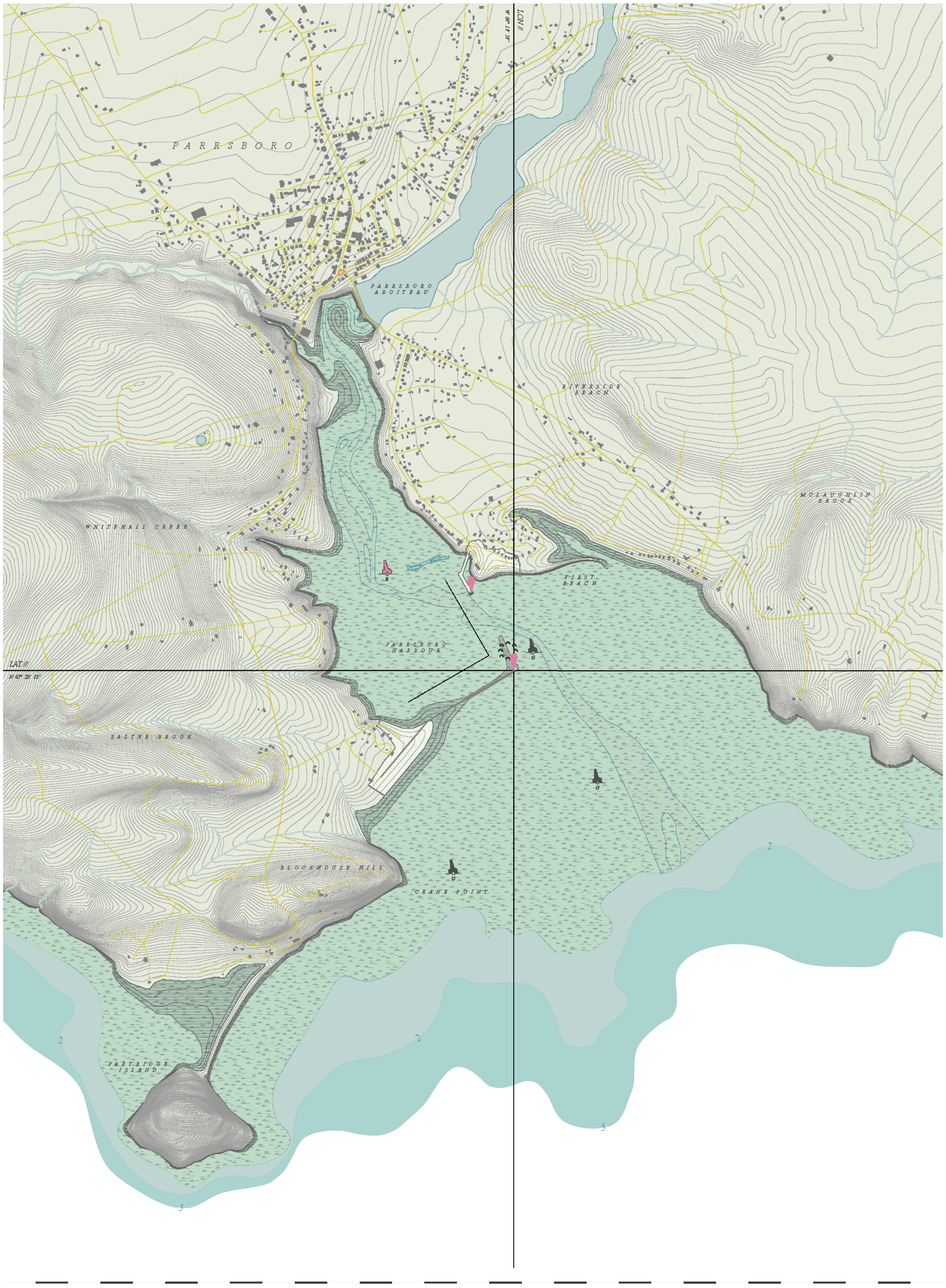


Figure 108
Site model of the proposed library lighthouse in Parrsboro harbour



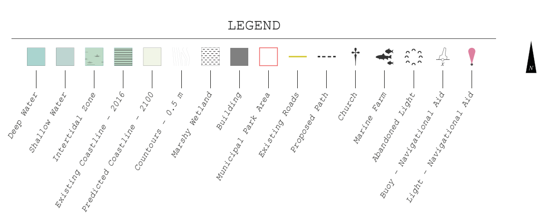


Figure 109 - Map of Parrsboro,
(Nova Scotia Open Data, 2016)

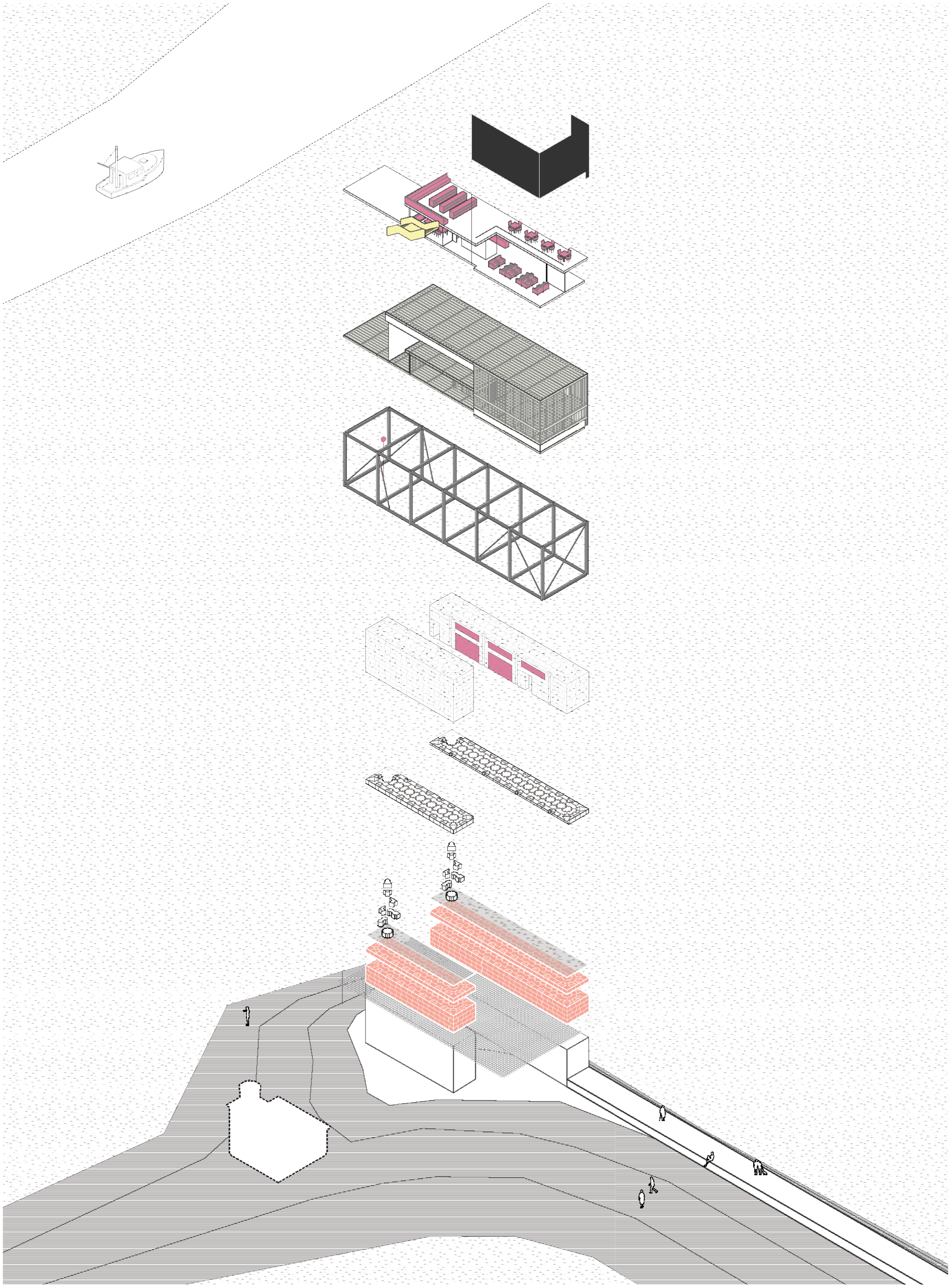


Figure 110
Exploded isometric of the library showing the modular foundation, steel structure and wood sleeve that houses the public space for sharing and learning at the end of the breakwater

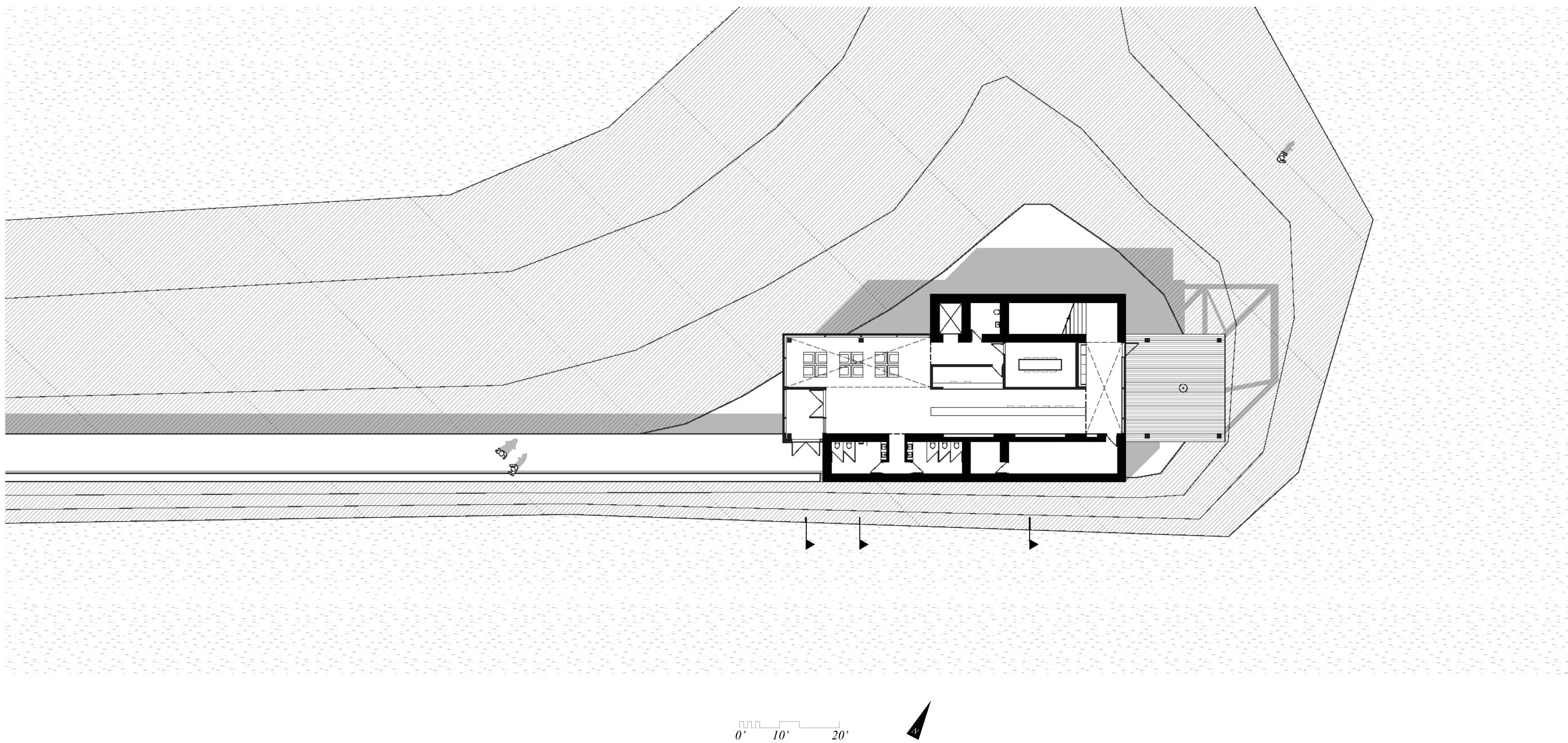


Figure 111
Plan of the dining hall illustrating relationship with current and future sea levels

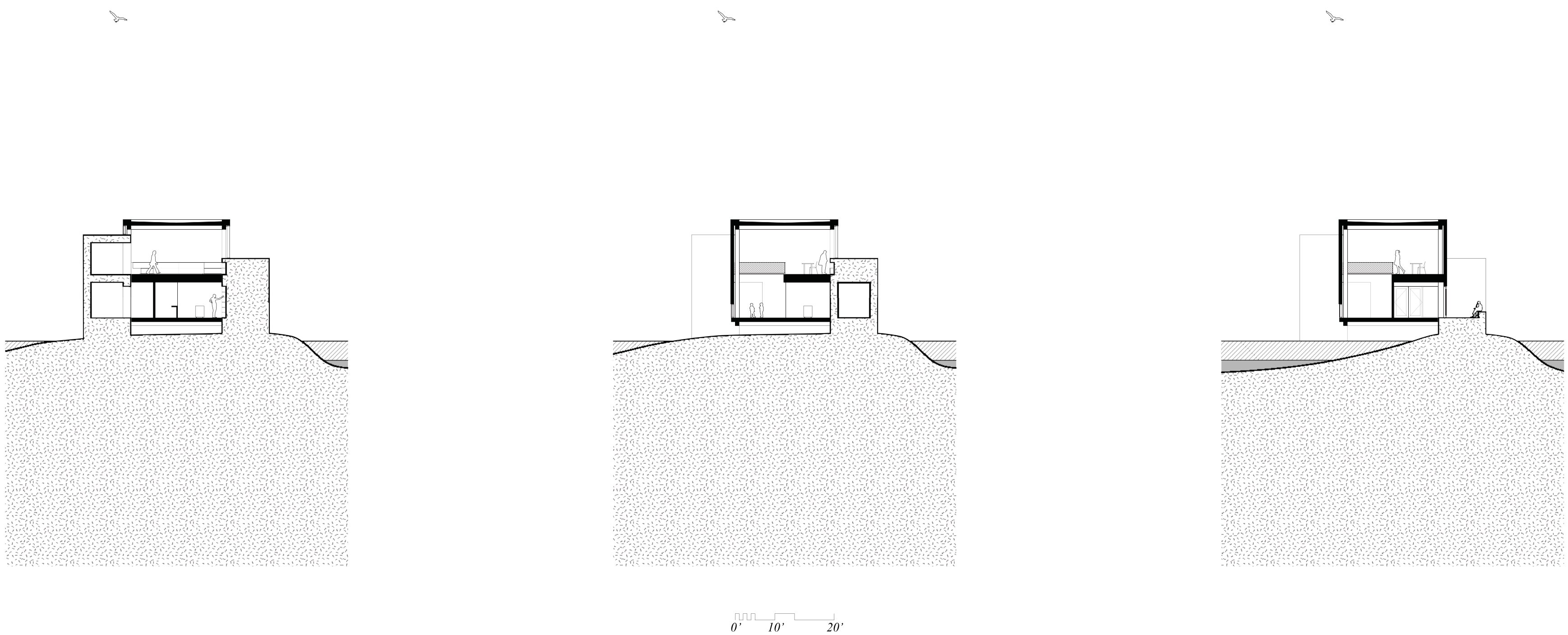


Figure 112
Section of the dining hall illustrating relationship with current and future sea levels

Figure 113
Low tide on First Beach looking out towards the breakwater

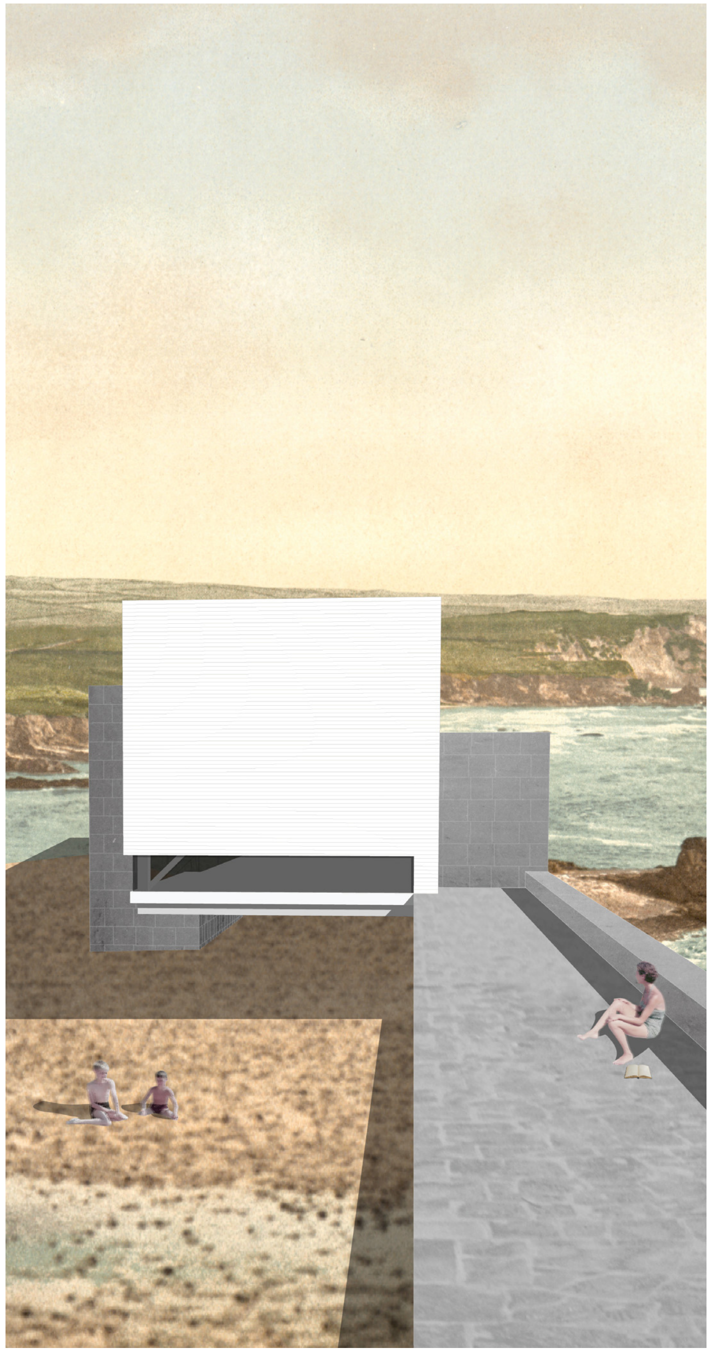


Figure 114
Sitting on the breakwater overlooking the beach at low tide

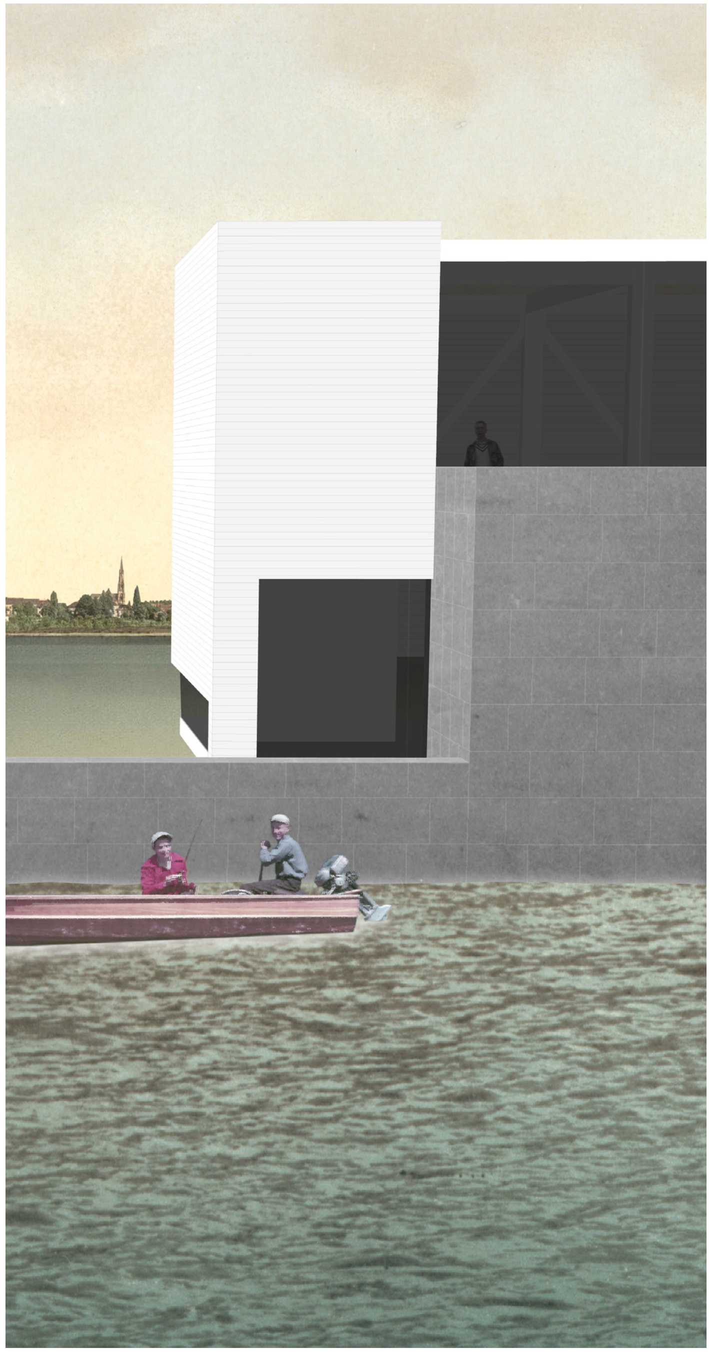


Figure 115
Looking out over the masonry walls at a couple fishing at high tide

Figure 116
Model of library showing the breakwater and north elevation

Figure 117
Model of library showing the breakwater and south elevation

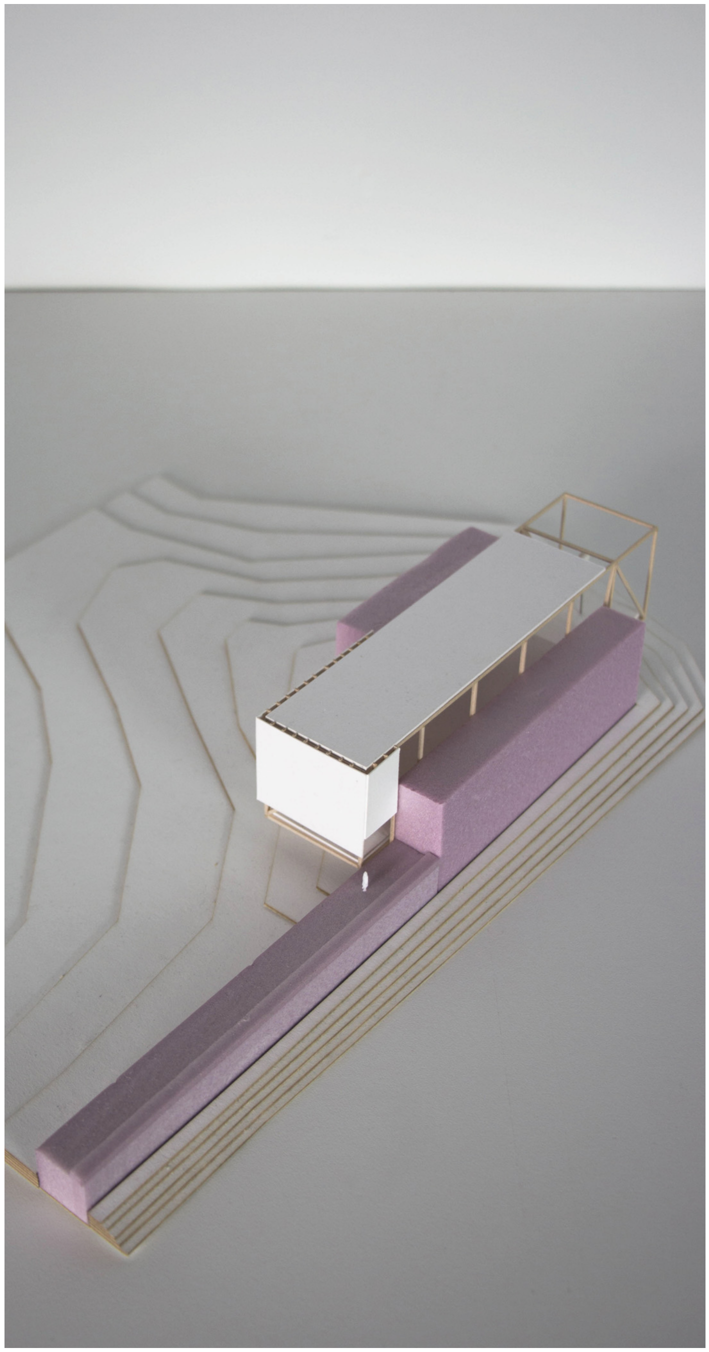


Figure 118
Model of library showing a bird's-eye view of the south elevation

CHAPTER 5: CONCLUSION

This thesis began by evaluating the lighthouse as an endangered coastal infrastructure, a building type at risk of being lost and in many cases in the process of already being replaced by simpler uninhabitable structures. The intent of the thesis is to show a forward thinking approach to a more relevant and inclusive lighthouse by considering ideas of climate, materiality, and community, in an effort to preserve what has come to symbolize the core values and hardships of rural maritime life in Nova Scotia.

The design projects demonstrates three examples that relate to community in a more responsive way, draw from the modular qualities of historical materials, and address the urgency of future climate conditions seeking out the opportunity that current preservation efforts lack.

The architecture adapts the material strategy to relate to site, community needs, as well as current and future environment allowing the approach the flexibility and open-endedness to be applied to all sites within the existing network.

Additionally this approach is not limited to Nova Scotia, with many coastal Canadian provinces and countless other nations having developed similar relationships with at-risk lighthouses. The hope is that the work creates a platform for any coastal region or organization to start considering a reimagined network of lighthouses, all in an effort of providing a means of preserving a relationship with the seascape through a symbol of maritime identity.

APPENDIX: THE LIGHTHOUSE TRAGEDY

Oh! George. This wild November
We must not pass with you
For Ruth, our fragile daughter,
Its chilly gales will rue.

So, home to Lovell's Island
Take us when fails the sea
To the old house where comfort
And better shelter be.

Comes the long weary winter
With its storms of driving snow;
I can only watch the beacon
Sure that you are near its glow.

Yes, dear wife, my constant service
Binds me to this narrow isle,
Love must ever yield to duty
Though the heart be sad the while.

Only grant that on the morrow
We may safely pass the sea,
I can bravely bear my sorrow
You and Ruth here will not be.

With wild nor'wester came this morning,
Cold and clear the hearless sky.
Come wife, take Ruth. The pull will be long.
So – into the boat I will row you home.

Nestled within her mother's cloak
Frail Ruth is sheltered from the blast,
While Anne looks into George's face
With quick, strong strokes they leave the shore.

Though starting in the Brewster's lea,
Rough and empty rolls the sea.
Low the boat – too deeply laden
Heavy hearts make heavy burden.

Now they reach the open channel
Where the flood tide breasts the gale
Rears a toppling wall of water.
Making Anne's cheeks grow pale.

Quick the prow is upward borne
George in Ann's arms is thrown
Husband, wife and child together
To the chilly waves have gone.

Frenzied clasp of wife and daughter
Bears the sturdy swimmer down,
Save the boat upon the water
Nothing of their fate is known.

- Benjamin Franklin
(Celebrate Boston, 2016)

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