Le Tour de Grand Pré: An Exploration of an UNESCO Heritage Landscape through Avian Ecology

by

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Dalhousie University is located in Mi'kmaq'i,
the ancestral and unceded territory of the Mi'kmaq.
We are all Treaty people.

Contents

Abstract

Every year, millions of birds migrate long distances to find areas with plentiful food reserves and habitat to nest and rear their young. However, human development is rapidly diminishing bird habitat worldwide. This thesis will explore using ecological architecture to harmoniously bring birds and people together without further deteriorating sensitive ecological systems.

The health of bird populations can be used to measure the overall health of our environment. They are also beautiful species to observe and bring humans closer to nature. Thus, the goal of this thesis is to examine the relationship between human activity and nature, not as distinct categories, but rather as mutually impactful. Many projects focus on creating or restoring a "wilderness," a place that is free from human impact. Here, I instead try to build within the landscape of the Annapolis Valley in Nova Scotia, where humans and wildlife have coexisted for centuries.

Acknowledgements

I would like to extend thanks to my supervisor, Christine Macy, and my advisor, Patrick Kelly. Christine always kept me on track and offered honest and supportive feedback. Patrick gave so much of his time to helping me and taught me so much about the birdlife in Nova Scotia. I am so thankful to have two people who were filled with knowledge to assist me during this project.

Chapter 1: Introduction

In this thesis, I propose a variety of constructions in the Grand Pré UNESCO heritage site, located in the Annapolis Valley region of Nova Scotia. These designs are the culmination of research into how the field of design is constantly evolving to reflect and protect natural environments. The designs featured here will be an example of how we can bring humans closer to birds and their habitats, without posing a significant risk to either. To understand the goals of each build, I first explore the threats facing birds today in Grand Pré and beyond, before showcasing similar design attempts from around the globe. Ultimately, this project aims to show that human development and wildlife do not always have to be thought of as distinct and competing; but rather through careful and deliberate design planning, it is possible to create opportunities for humans to get closer to nature while also protecting it.

The Importance of Birds

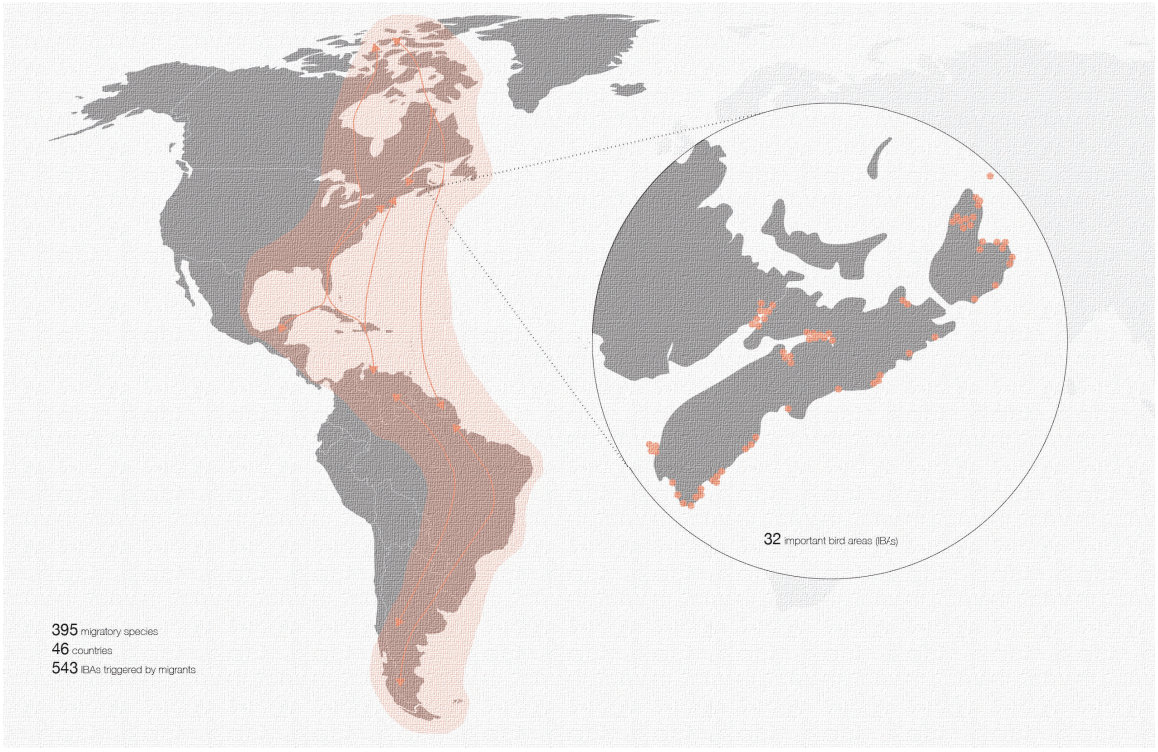
Why should we humans care about birds? Birds are essential characters to a healthy ecosystem. Birds pollinate plants, disperse seed, and control insect numbers. Birds are also great indicators of environmental health because they are easy to study and observe, and have many specific environmental requirements. Finally, birds are fascinating to watch, listen to, and bring people closer to nature (Birds Canada 2020).

Avian Migration Corridors

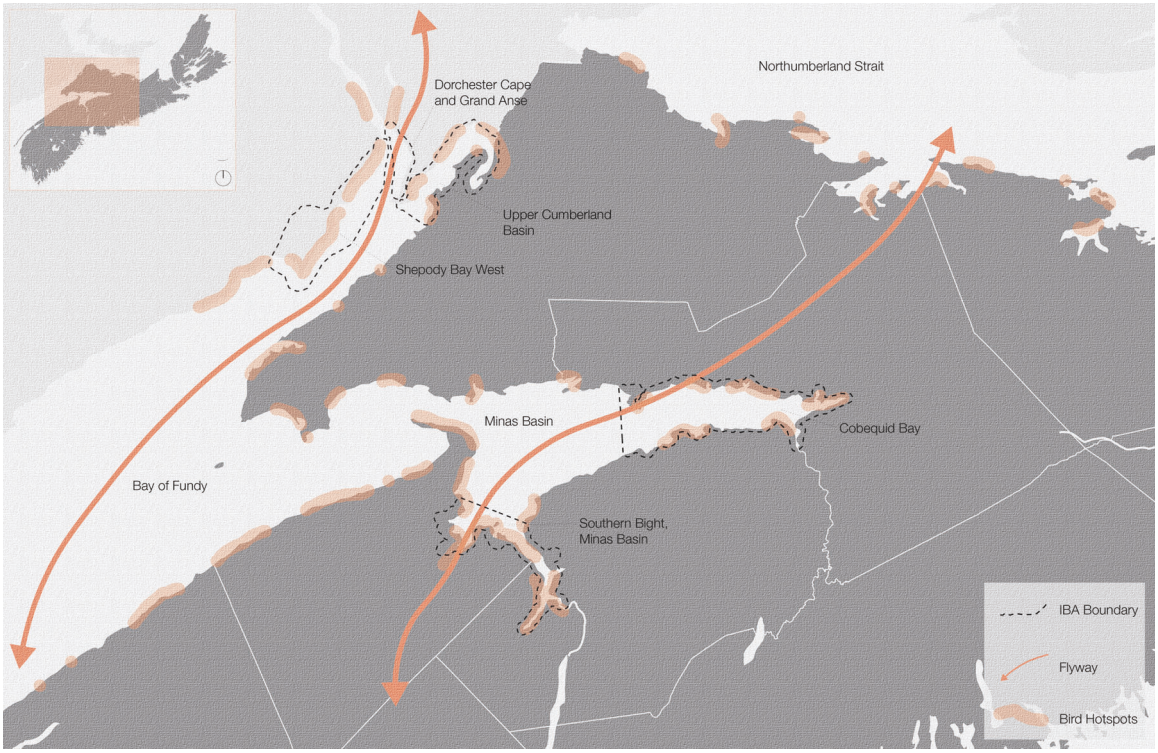
The Atlantic Americas Flyway is one of eight popular migratory routes that connects the Canadian Arctic with the southernmost tip of South America (Birdlife International

n.d.a.). Bird migration is a fascinating avian behaviour that bewilders even the most advanced avian biologists. Twice a year, in the spring and fall, millions of birds migrate thousands of kilometres across the world to find areas with food abundance and habitat for nesting and rearing their young. The Atlantic Americas Flyway spans across 46 countries. However, not every bird is making the journey from Nunavut, Canada down to Argentina, like the Arctic tern. The piping plover winters in the southeast United States and the Caribbean, while migrating to the northeastern United States and the Canadian Maritimes for breeding in the spring. The gray jay similarly migrates regionally to higher elevations and colder temperatures, sometimes only a few kilometres.

Birdlife International developed Important Bird and Biodiversity Areas (IBAs), to mark hotspot areas of particular importance and interest for birds worldwide. IBAs were developed for long-term international conservation (Birdlife International n.d.b.), now with more than 13,000 worldwide. There are a variety of criteria that can make an area an IBA, but notably it is a hotspot for a globally threatened species, a restricted-range species, a biome-restricted species, or an area that holds large congregation of a specific bird species. The Atlantic Americas Flyway crosses a total of 543 IBAs.



Map diagramming the Atlantic Americas Flyway, one of eight well-known bird migration routes worldwide. Zoom in on Nova Scotia, showing the location of 32 Important Bird Areas (IBAs).



Map diagramming bird hotspots and IBAs in the northern and Valley regions of Nova Scotia.

Thesis Description

How can we design in ecologically and historically sensitive areas for people to explore and enjoy, while still maintaining a healthy landscape?

The goal of this project is to respectfully design human-interventions in a sensitive and historic landscape that will allow people to learn about and observe birds, without deteriorating their habitat or interfering with their behaviour.

Chapter 2: Anthropogenic Impacts on the Natural Environment

In order to understand how to ethically design infrastructure that promotes human and bird health, it is important to understand the conditions facing birds in North America today.

Wetland Loss

Wetlands play a crucial role in providing habitat, food, and shelter for birds (Stewart n.d.). Some birds spend the majority of their lives in or near wetlands, while others depend on them only during migration or for breeding purposes (Stewart n.d.). Either way, wetlands are diverse habitat types that are critical to the health of avian ecosystems.

Wetland loss, or the degradation of wetlands, has a huge impact on avian species, as well as on the environment as a whole. Wetlands play huge roles in controlling flooding, reducing water contaminants, and providing habitat for wildlife. Wetlands are the most productive and diverse ecosystems. When wetlands are lost, biodiversity also decreases immensely. Wetlands also provide erosion control, and protects existing infrastructure from storm surges during big weather events (Government of Nova Scotia 2019).

Exact data for the amount of wetland loss in Nova Scotia is limited. However, researchers can say with certainty that certain types of wetland have diminished at increased rates due to human development and land manipulation. 80% of the salt marshes that were once present along the Bay of Fundy in the Annapolis Valley region are estimated to have been lost due to agricultural practices, most notably

from the dyking by the Acadians. There is also thought to be a loss of freshwater wetlands in the Annapolis Valley region, particularly along the floodplains of prominent rivers (Government of Nova Scotia 2019).

The Government of Nova Scotia has implemented strategy plans to manage human activity near wetlands, and prevent the net loss in area and function of existing wetlands. Additionally, in regions where there has already been a large amount of wetland loss, or areas of special wetland significance, management strategies have been put in place to restore or enhance wetlands (Government of Nova Scotia 2019).

Constructed Wetlands

It is simplistic to think of bird habitat as a percentage of land that is "untouched" by anthropogenic influences. Instead, through human development we are often altering habitats. Sometimes these alterations amount to destruction of vital habitat, while sometimes species biodiversity merely shifts. Constructed wetlands are an example of how development can provide necessary habitat instead of harming wildlife.

As mentioned previously, wetlands provide many benefits that range from flooding management and erosion control, to increased habitat and contaminant removal, making them essential parts of ecosystems. Constructed wetlands, although man-made, provide benefits similar to those of natural wetlands. Constructed wetlands are complex systems comprised of water, plants, animals, and microorganisms that work together to treat water (US EPA 2013). A common application of constructed wetlands is for the treatment of domestic sewage effluent (US EPA 2013).

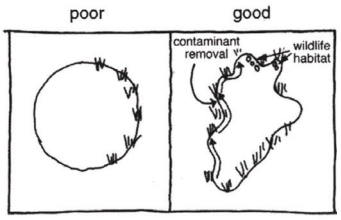
In more recent years, constructed wetlands have also been developed to treat the high organic loads from agricultural runoff.

Constructed wetlands provide more benefits than just treating water. They can provide an aesthetic quality and enhance the landscape. They can also provide an abundance of food sources and habitat for a wide variety of species, notably birds. Wetlands attract many species of waterfowl, making them areas of interest for birders. Constructed wetlands that are accessible to the public also provide opportunities for education and engagement.

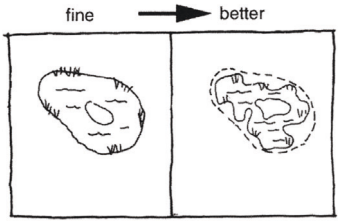
For constructed wetlands to be effective, they must be carefully designed for the effluent input, and take into consideration the local climate and vegetation. Well-designed wetlands can blend into the site and be indistinguishable from natural wetlands.

Wetland vegetation in a key component that aids in the treatment of wastewater. Vascular plants (which conduct water through their structure) aid in bank stabilization, slow water velocity thereby enabling suspended materials to settle, take up carbon and other nutrients, and provide habitat for the microbes that break down nutrients in the water (US EPA 2013).

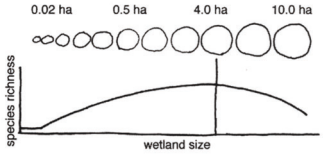
In simple terms, wetlands are comprised of three elements that work to improve water quality: (1) plants (vascular and algae), (2) invertebrates (insect larvae), and (3) microorganisms (bacteria). These three elements work together to slow down, filter, absorb, and break-down the nutrients in the water.



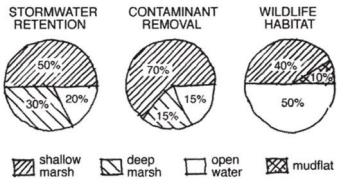
Graphic depicting poor and good wetland shape design (France 2021).



Graphic depicting better shoreline design for wetlands (France 2021).



Graph showing optimal wetland size for species richness (France 2021).



Charts showing ideal wetland composition for different factors (France 2021).

Overall, wetlands are a cost-effective management strategy to treating wastewater, while also providing other numerous benefits such as increased habitat, beautified landscape, and public education. However, because constructed wetlands use a large area, they are not suitable for every setting. They also require extensive planning and careful design, as well as maintenance and upkeep after construction.

Constructed wetlands can continue to treat water even during cold winter months. The microbial activity of breaking down nutrients usually generates enough heat to keep subsurface water from freezing. The treatment of water continues under a layer of ice. Rates of microbial decay slow down during months with lower temperatures, which should be taken into consideration when designing the wetlands; for example, they often need to be made larger in areas with colder climates. In some cases, additional storage tanks are added to slow the release of effluent into the wetlands during cold periods.

Wetland Design

Designing a constructed wetland is much like designing anything else, there is more than one way to do it. However, there are common considerations to keep in mind that lead to better designed constructed wetlands.

The design should be simple, and designed for easy maintenance. It is essential to pay attention to the site, and use natural slopes for gravity-fed flow. A well-designed wetland is site sensitive and incorporates existing site features, reducing the amount of environmental disturbance. And, as previously mentioned, climate should be taken into consideration during design. Natural and meandering

banks have proven to be more effective at improving water quality. This means that mimicking natural wetlands is often a good strategy for wetland design (US EPA 2013). Finally, a wetland should be designed for its function. Is the wetland treating stormwater runoff, agricultural pollutants, residential wastewater, or a combination? The type of wastewater and load will determine the size and composition of the constructed wetland. Wetlands can be made up of shallow marsh, deep marsh, open water, and mudflats, all which provide different benefits for water treatment and habitat production. Finally, the size of wetlands have been studied for species richness. If a wetland is too small, or too large, species richness is lower. The optimal size for species richness is four hectares (France 2021). This is a large wetland and will not be plausible for all sites. However size should be a consideration when designing the wetland.

Wetland design provides a valuable backdrop for projects in which humans and wildlife interact.

Agriculture

Agriculture is the largest cause of biodiversity loss worldwide. Over one third of the world's land surface is being used for agricultural purposes, excluding Greenland and Antarctica. However much of the remaining two thirds has not been farmed to do poor climatic and site conditions for agriculture. As human populations grow, so do our farms in order to produce enough food to feed everyone. However, agriculture typically turns once-natural habitats into intensely-managed lands, stripping regions of their natural vegetation and nutrients. Agriculture contributes to environmental pollutants through pesticides and fertilizers,

and through the use of fossil fuels to plant, harvest, and transport crops (Dudley and Alexander 2017).

Agricultural Impact on Bird Life

With the expansion of agriculture comes an increasing threat of habitat loss for birds and other wildlife. This happens directly through land manipulation, such as marshland draining or forest clear cutting, or indirectly through the use of chemical pollutants and pesticides (Murton 1974). Although some bird species, such as European starlings or song sparrows, can thrive on agricultural lands, most such lands lead to a loss of biodiversity. Healthy ecosystems require a range of species, providing different functions to maintain environmental health.

From an ecological point of view, the global expansion of agricultural systems has been a disaster, but farming is also essential to human societies. However, there are strategies to make agriculture more sustainable, and decrease the associated habitat loss. Intensive farming practices such as mono-crop culture leave little room for biodiversity. However, integrating vegetated lands among crop fields can increase wildlife habitat, while also creating healthier agricultural land. Having wetlands, forested areas, or other vegetated areas dispersed amongst acres of crops provides areas for a wider variety of birds to nest and feed. Additionally, many bird species are beneficial to farming. Birds of prey eat pest rodents, smaller passerine species eat pest insects, and birds aid in pollination and seed dispersal. Thus, the integration of bird habitat amongst farmed areas not only benefits the avian ecology of the area, but also the farmers.

Chapter 3: Ecological Design

The case of constructed wetlands shows us how to effectively rebuild habitat for wildlife in areas where development has previously degraded biodiversity. It becomes more complicated however to design structures with both wildlife and humans in mind. This practice falls under the growing field of Ecological Design, an umbrella term that includes ecological architecture and nature-centred design.

Ecological Architecture

Ecological architecture is much more than “green” or “sustainable” architecture. These terms focus more on the direct impact of materials or gadgets that can be used to lower the carbon footprint of a building (Yeang 1995, 1). Ecological architecture can encompass green and sustainable elements, and it often does. Malaysian architect, Ken Yeang, describes ecological architecture as, "a designed system that seeks to minimize and at the same time is responsive to the negative impacts that it has on the earth’s ecosystems and resources” (Yeang 1995, 73). Yeang also says that, “ecological design is an anticipatory approach to design” (Yeang 1995, 83). This means being critical of the site and being able to forecast future natural influences. The architect, or designer, must anticipate the negative impacts that their design could have on the environment, or local ecosystems, and work to mitigate this impact with respectful design.

Nature-Centred Design

“Nature can live without humans, but humans cannot live without nature. Architecture can make this truth transparent

and allow us to experience nature at a deep transformative level" (Van der Ryn 2013, 47).

Nature-centred design encompasses the notion that design should be rooted in the land, climate, and place. It is important for architects and designers to reduce the mindless consumption and unsustainable practices that are often associated with the building sector. Instead architecture should be regenerative, and work to mimic the living and natural systems. Buildings should work to make a landscape healthier, incorporating natural elements of the sun, water, air, and vegetation (Van der Ryn 2013).

Nature-centred design is more than architecture that is simply "green" or "eco-friendly." These terms do not get to the root of unsustainable systems. Using sustainably harvested wood slows the rate of deteriorating the earth, but it fails to look at a building's impact within its greater landscape and wider community. Thus, the term regenerative is a better term to encompass the goal of ecological design. It suggests healing, instead of degradation, which is often associated with development.

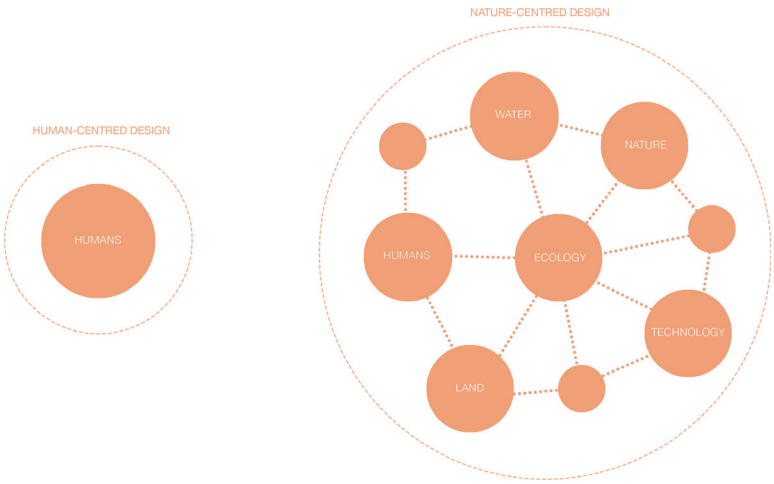


Diagram depicting the complexity of nature-centred design versus the more common, human-centred design.

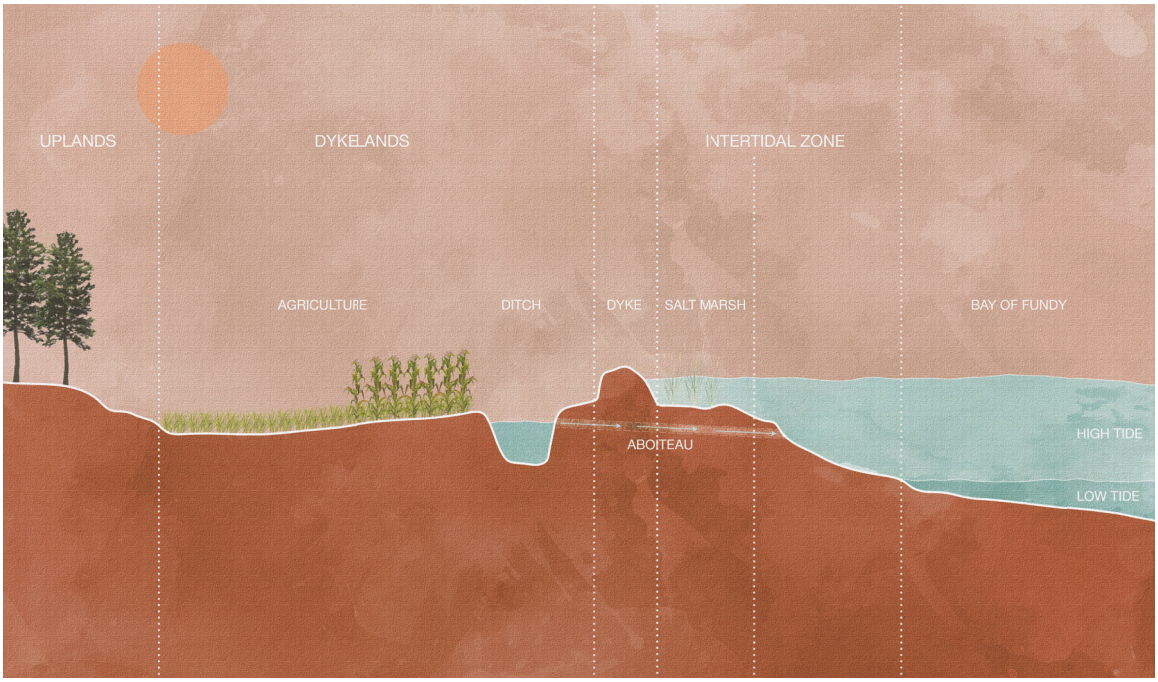
As designers, we can design infrastructure that works to mimic how the natural world works, since it was keeping itself healthy long before the arrival of humans. For example, humans spend billions of dollars and resources designing sewage treatment plants. However, as previously shown, wetland systems are also capable of removing contaminants in water, much like the function of these sewage treatment facilities. Plants naturally filter and absorb nutrients found in wastewater, making them exceptional natural water purifiers.

Chapter 4: The Site

Grand Pré

Grand Pré, a 13-square kilometre agricultural landscape, is located along the Bay of Fundy's Minas Basin in the Annapolis Valley region of Nova Scotia.

In the late 17th century, the Acadian settlers lived in Grand Pré amongst the Mi'kmaq, the indigenous people of Nova Scotia. The Acadians worked to develop the wetlands of Grand Pré using dykes (The Landscape of Grand Pré Inc., n.d.). This dyke technology allowed the settlers to keep the tidal sea water out, and turn the landscape of Grand Pré into fertile land for agriculture (see section diagram of dykelands). If it were not for the dykes, the majority of the land would be completely submerged by the ocean. To this day, many of the dyke systems remain intact, keeping the lands productive for crops and livestock. Kings County, where Grand Pré is located, has the highest number of farms



Section diagram showing dykeland composition in Grand Pré.

per county in Nova Scotia at 565, or 19% of the province's total farms (Government of Nova Scotia, n.d.b.).

However, the history of Grand Pré also has that of turmoil and expulsion, much like the rest of Canadian history. In 1755, the British forced out the Acadian people in the French-British struggle for colonial primacy in North America. The Great Expulsion on August 10, 1755 resulted in the death of many Acadians and the exportation of many to the other British colonies. Thus, beginning in the late 19th century, and continuing to present day, Grand Pré has been recognized as an important memorial in the history of the Acadian people. In 2012, the Landscape of Grand Pré was listed by UNESCO as a World Heritage Site for its cultural significance to Acadian history (The Landscape of Grand Pré Inc., n.d.).

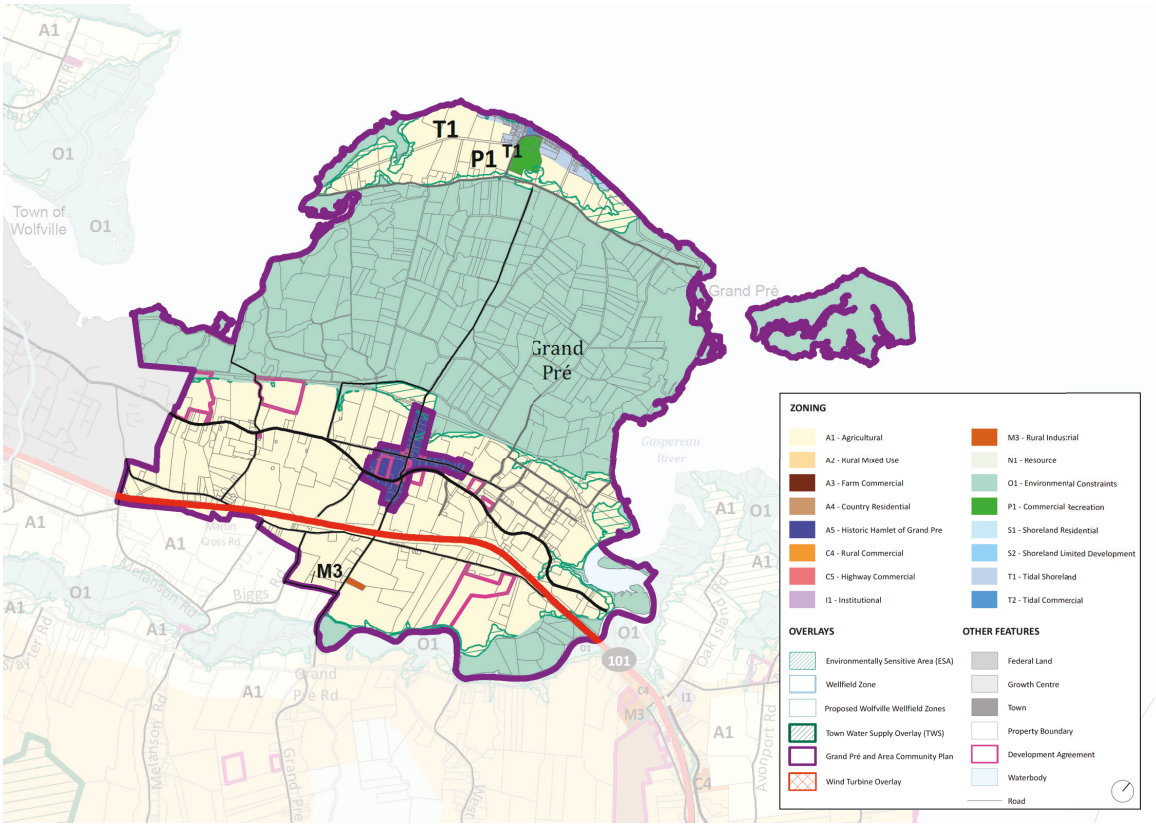
Zoning of Grande Pré

In 2008, the Municipality of the County of Kings began developing a long-term community plan for Grand Pré to protect the area as a unique cultural resource, and to provide tourism opportunities (Municipality of the County of Kings n.d.). The community plan was officially adopted in 2010 and outlines various bylaws and design guidelines to preserve the heritage of the landscape of Grand Pré.

Most of the landscape of Grand Pré is designated as O1-Environmental Constraints. This zoning designation restricts new development in areas that are prone to flooding, erosion, slope failure, or other environmentally sensitive features (Municipality of the County of Kings n.d.). Small buildings with a footprint of less than 215 square-feet are permitted, as well as "open air park and recreational structures."

The other prominent zone in Grand Pré is A1-Agriculture. This designates land used for agricultural purposes (farms and farm auxiliary uses), but also allows select residential and community structures (Municipality of the County of Kings n.d.).

The centre of Grand Pré is zoned as A5-Historic Hamlet of Grand Pré. The purpose of this zone is to maintain the historic character of the Heritage Conservation District. A wide variety of uses are allowed in the area, residential, agriculture, community facilities, markets, etc. However all new development needs to follow strict design guidelines put forth by the Municipality of the County of Kings. These design guidelines prescribe permissible building forms, roof pitches, size, facade, materials, and other design parameters.



Map showing the designated zoning areas of Grand Pré (Municipality of the County of Kings n.d.).

These zoning guidelines have informed this design project, comprised of an avian interpretation centre and four birding pavilions linked by a bicycle path. The main public interpretation facility is located in the boundaries of the Historic Hamlet of Grand Pré. The other auxiliary structures (the birding pavilions), which are open-air, and/or less than 215 square-feet will be in areas zoned as O1 or A1, environmental constraints or agriculture respectively.

Agriculture in Grande Pré

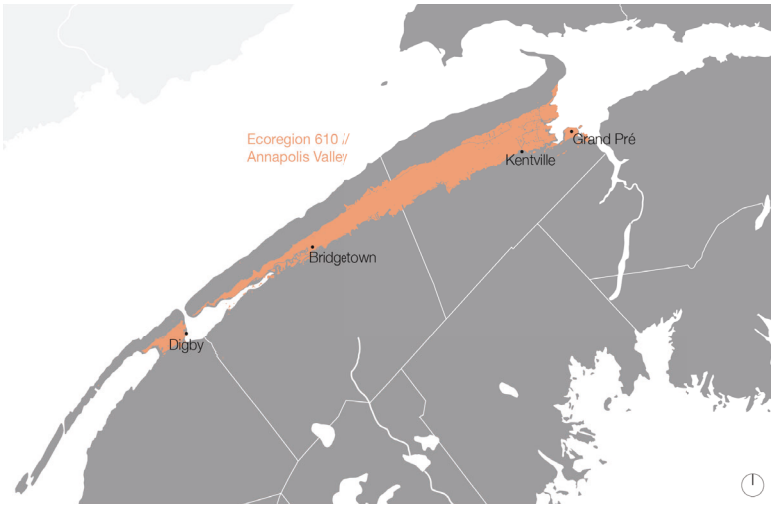
Kings County is responsible for the highest proportion of agricultural land in Nova Scotia, leading to an economy that is built upon the agricultural industry (Nova Scotia Federation of Agriculture 2017). This is largely attributable to the fertility of the soil. The three largest farming types in Kings County are fruit and tree nut, poultry and egg production, and cattle ranching (Statistics Canada 2017).

Agricultural fields in Grand Pré. Photo taken by Jamie Robertson (The Landscape of Grand Pré Inc. n.d.).

Ecology of Grand Pré

Grand Pré lies in a unique ecoregion known as “the valley.” This region, spanning approximately 11-kilometres in width

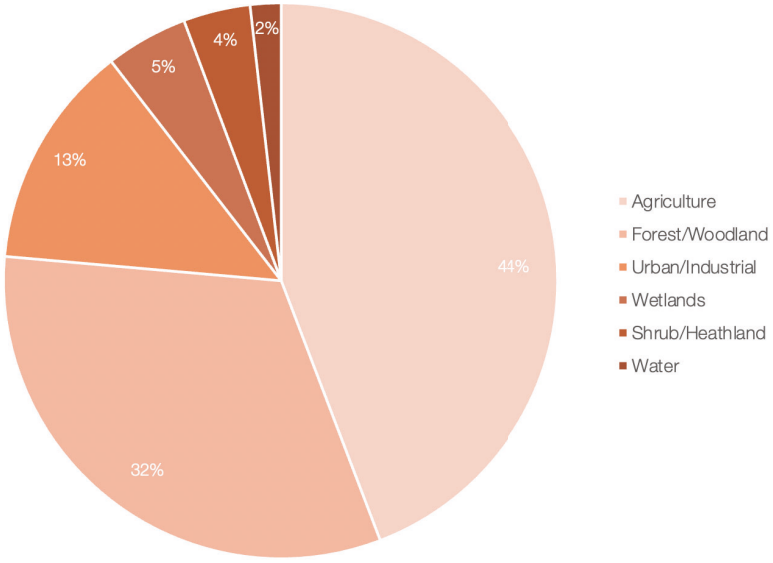
is guarded by the North and South Mountains which shelter the region from coastal fogs of the Bay of Fundy, rendering it warmer and dryer. The region of relatively rock-free soil is the most agriculturally productive area of Nova Scotia. Because of the extensive clearing of the land for agriculture, there are few late-successional forests left. On land that is not suitable for farming, there are black spruce and maple forests. There is some agricultural land that has been converted back to forest that contain aspen, red maple, white ash, and grey and white birch (Government of Nova Scotia n.d.a.).



Map showing the location of Ecoregion 610, commonly known as the Annapolis Valley.

The valley is comprised of land that is mostly farmed, forested, or developed for residential, commercial, and/or industrial use. However despite the extensive land-manipulation, the region encompasses unique biological features. The dykelands of Grand Pré are the largest drained salt marshes in Nova Scotia. On the other side of the dykes, along the Minas Basin, are vast natural salt marshes that are home to rare plant species, such as big-leaved marsh-elder. The floodplains along the Cornwallis River also house a variety of rare vascular plants that are found nowhere

else in the province, such as false nettle and silver maple (Government of Nova Scotia n.d.a.).



Pie chart showing the percentage land cover in Ecodistrict 610. (Data retrieved from Government of Nova Scotia n.d.b.).

Cycling in Grand Pré

Cycling is a popular activity in Grand Pré. Its beautiful natural landscape and lightly trafficked farm roads are perfect for biking. The dykes that surround Grand Pré offer gravel paths that allow visitors to circumnavigate the landscape by while experiencing beautiful views of the Bay of Fundy and salt flats the entire way.

A well-established bike trail, named the Harvest Moon Trailway, begins at the National Historic Site of Grand Pré, and heads West towards the town of Wolfville, continuing for 110-kilometres all the way to Annapolis Royal.

This project builds upon the already existing Harvest Moon Trailway, extending the trail along the dykes through Grand Pré. This allows visitors to take a detour off the main trail, and experience the historic landscape of the region. The new

bike paths will run along the dyke walls and lightly-trafficked farm roads. The majority of the route will take cyclists along the water, capturing beautiful views and allowing visitors to experience the active birdlife in the area.

Cycling along the dykes near Grand Pré. Photo taken by Jodi Delong (Saltscapes n.d.).

Birding in Grand Pré

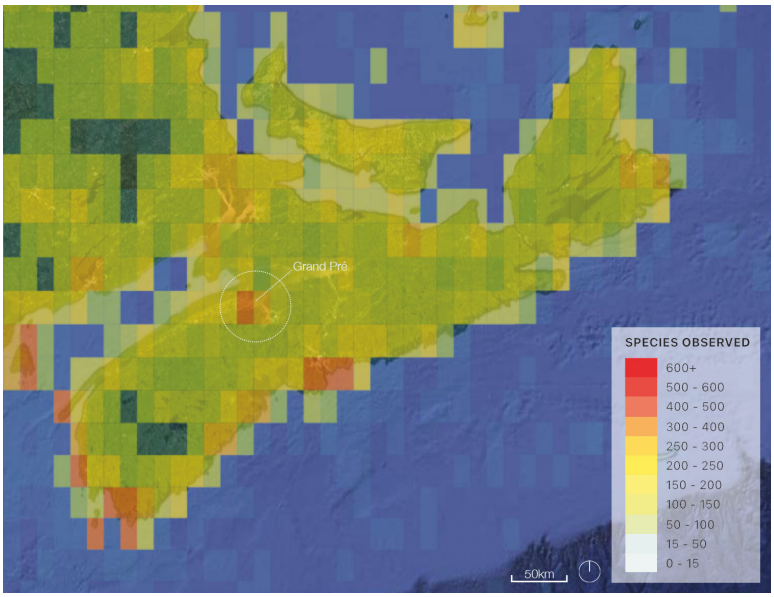
The best birding in Grand Pré occurs from late summer to late fall. Almost the entire world's population of semipalmated sandpipers migrate through the region during late summer, which is an extraordinary site to see (Nova Scotia Bird Society n.d.).

The changing tides of the Bay of Fundy have a huge impact on birds. During times of low tides, vast areas of mudflats are exposed, which present vast expanses for feeding birds.

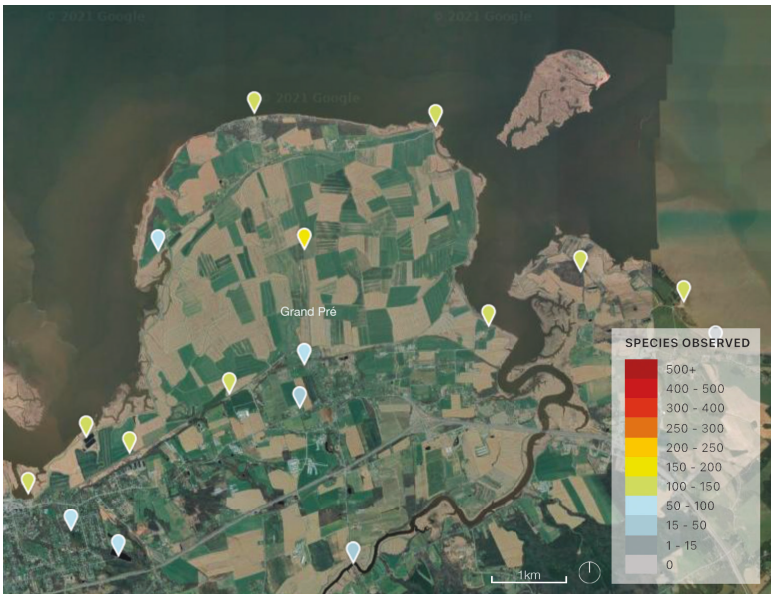
The varying habitat types, salt marshes, agricultural fields, scrub, grasslands, etc. lead to a wide variety of species present in the area. The farm field edges are frequented by bobolinks and sparrows. Various raptors are abundant in the area, such as bald eagles, red-tailed hawks, and peregrine falcons. Since Grand Pré is surrounded by ocean waters, various types of sea-ducks, loons, and sandpipers can also be spotted (Nova Scotia Bird Society n.d.).

Image showing a variety of common bird species found in Grand Pré. Information retrieved from eBird.org (eBird n.d.).

EBird, an online avian database, provides a platform for scientists, researchers, and amateur birders to upload bird observations worldwide. It takes the data and creates a map of hotspot areas with the highest bird counts, and what species are found in particular areas. These birding hotspots will later define the areas of architectural intervention.



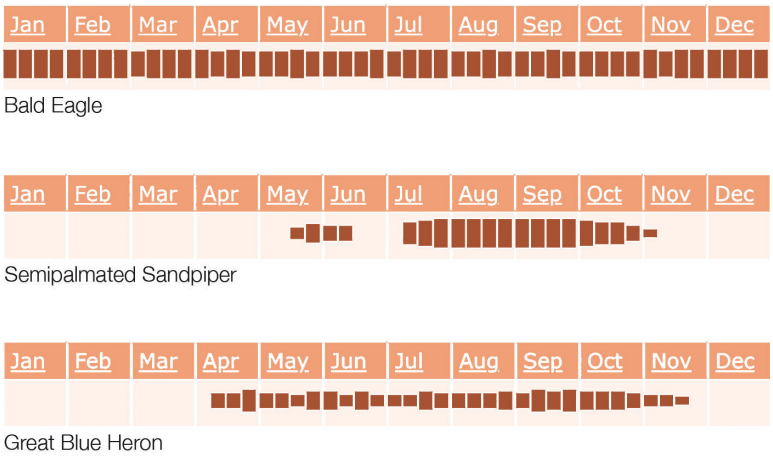
Map from eBird.org showing the number of species observed in regions of Nova Scotia. Grand Pré is one of the highest specie recorded regions in Nova Scotia (eBird n.d.).



Map from eBird.org showing hotspot regions in Grand Pré with the number of species observed (eBird n.d.).

Seasonal Variability

Not all birds migrate, and those that do, do so at different times of the year depending on their species and climactic conditions. The time of year has a large impact on what bird species one will find in Grand Pré. Some birds are known to be observed year-round in the area, such as bald eagles, whereas some spend the majority of the year in Grand Pré and then leave during winter months, such as great blue herons, and some are only seen during their migration at stopover sites, such as the semipalmated sandpiper.



Bar charts showing year-round specie occurrence of bald eagles, semipalmated sandpipers, and great blue herons in Grand Pré (The Cornell Lab of Ornithology n.d.).

Chapter 5: Bird-Friendly Design

Un-Bird-Friendly Design

Each year an estimated 25 million birds die each year from window collisions in Canada. Although this is typically a bigger issue in urban areas with a high concentration of mid- and high-rise glass towers, bird collisions still frequently occur even in sparsely populated areas. Birds' eyes are different than human eyes, in that they cannot perceive reflections in glass as not real. Reflective glass that mirrors nearby trees or the sky is dangerous to birds because it appears real to them, making them think they can fly through it. Clear glass also poses an issue because it is hard for birds to perceive the glass as a solid object. Glass atriums filled with trees are problems because birds are trying to get to the vegetation on the inside of the building, often resulting in death on impact (City of Toronto 2016).

With the rise of “green” architecture comes the implementation of a variety of vegetated architectural features, such as green roofs, courtyards and atriums filled with plants, glass balconies, etc. These can often be “design traps” for birds, luring them to the vegetation that is dangerously close to glass windows and walls that account for many bird collisions. This is not to say these “green” architectural features are bad, in fact they provide many benefits. They should however be designed in a way that accounts for birds getting trapped or colliding with nearby glass (City of Toronto 2016). The following section will outline various design strategies that can be used to create more bird-friendly architecture.

Design Considerations

Eliminate Fly-Through Conditions

Reducing the potential for fly-through conditions in buildings is a key first step to bird-friendly design. Glass bridges, walkways, breezeways, and outdoor railings are all design features that are open in which birds can fly through, greatly increasing the likelihood of a collision (City of Toronto 2016).

Awnings and Overhangs

The addition of awnings and overhangs above windows act as visual cues to deter birds from flying too close to windows. However it is important that they are paired in conjunction with other visual markers since they will not completely reduce glass reflections (City of Toronto 2016).

Exterior Screens

Exterior screens on windows provide clear visual markers to deter birds from colliding with the glass. Exterior screens can be made of a wide variety of materials and are a design element of many buildings. They can also provide other benefits such as blocking out sun, keeping the temperature inside cooler during hot periods, or provide privacy (City of Toronto 2016).

Exterior window screen from the Kripalu Housing Project by Peter Rose + Partners (Peter Rose + Partners n.d.).

Visual Markers

The first design goal for bird-friendly architecture is to reduce opportunity of collision. This often means reducing glass wherever possible, and providing visual markers to the glass that remains. Glass is an important architectural element to buildings, providing views out, and letting light in. Although the amount of glass can often be reduced on many new developments, it cannot, and definitely should not, be eliminated altogether. In this case it is about providing visual markers so birds are aware that the glass is there (City of Toronto 2016).

Reflective glass should be avoided at all costs. Low-reflective glass (less than 15% reflectance) is a better option, but to be fully effective at reducing collisions, must also be paired with other visual markers (City of Toronto 2016).

Although birds cannot detect reflections, their eyes have evolved to be able to see ultraviolet (UV) light. Thus any window, or other glass feature, using glass that is able to reflect and/or absorb UV light would appear solid to birds, and thus prevent collision. This option is ideal for glass areas that one would want minimal obstructions on, such as areas encompassing views. Since humans cannot see UV light, the glass would appear as normal translucent glass to us (City of Toronto 2016). Glass manufacturers are able to etch a UV pattern into the glass, which then let the birds know the glass is solid.

Another popular visual cue used is etched or fritted glass. The patterns applied to glass give birds a visual cue that the glass is a solid object, and therefore deter them from flying too close. For the patterns in the glass to be effective, it is important that they are not spaced more than 10 centimetres

apart. Patterns can be as simple as dots spaced evenly apart, or then can represent a more artistic quality. The glass itself becomes a design project and can be an aesthetic feature of a building. Fritted glass also benefits by reducing solar heat gain inside buildings (City of Toronto 2016).

Examples of fritted glass patterns. Above: JIMY Professional Glass Manufacturer (Jimy Glass Co., Ltd. n.d.). Below: Utrecht University Library by Wiel Arets Architects (Architizer. n.d.).

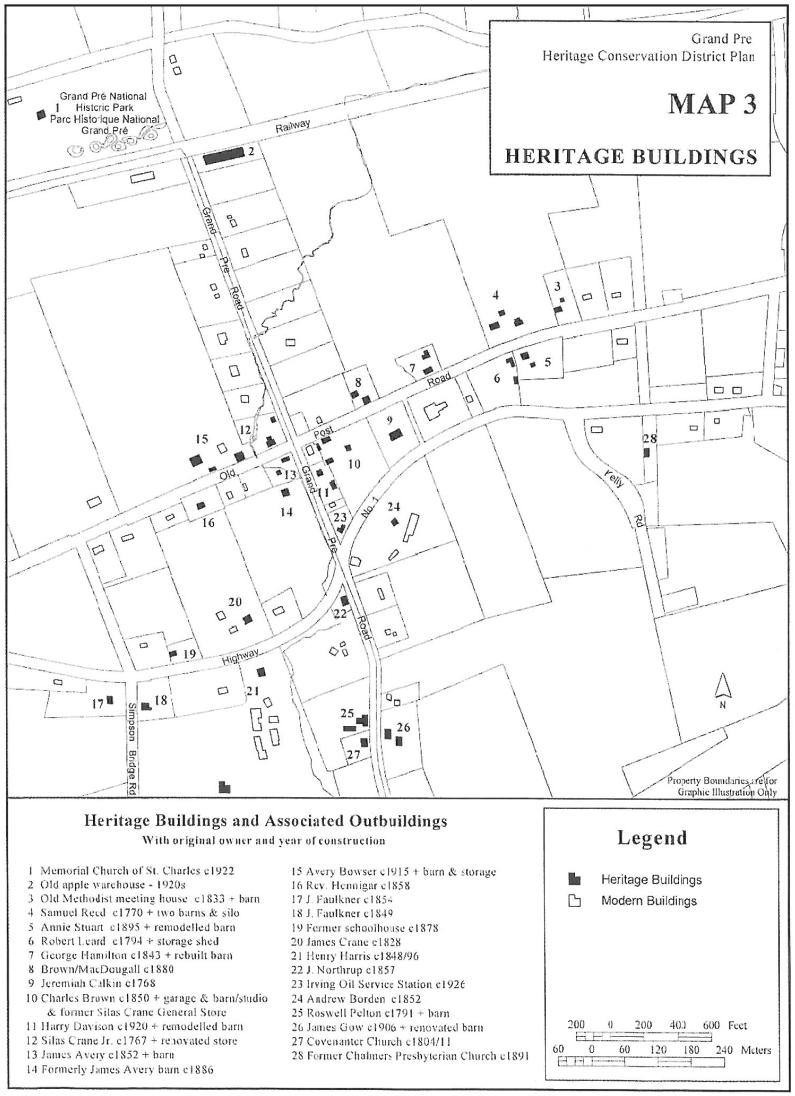
Chapter 6: Le Tour de Grand Pré

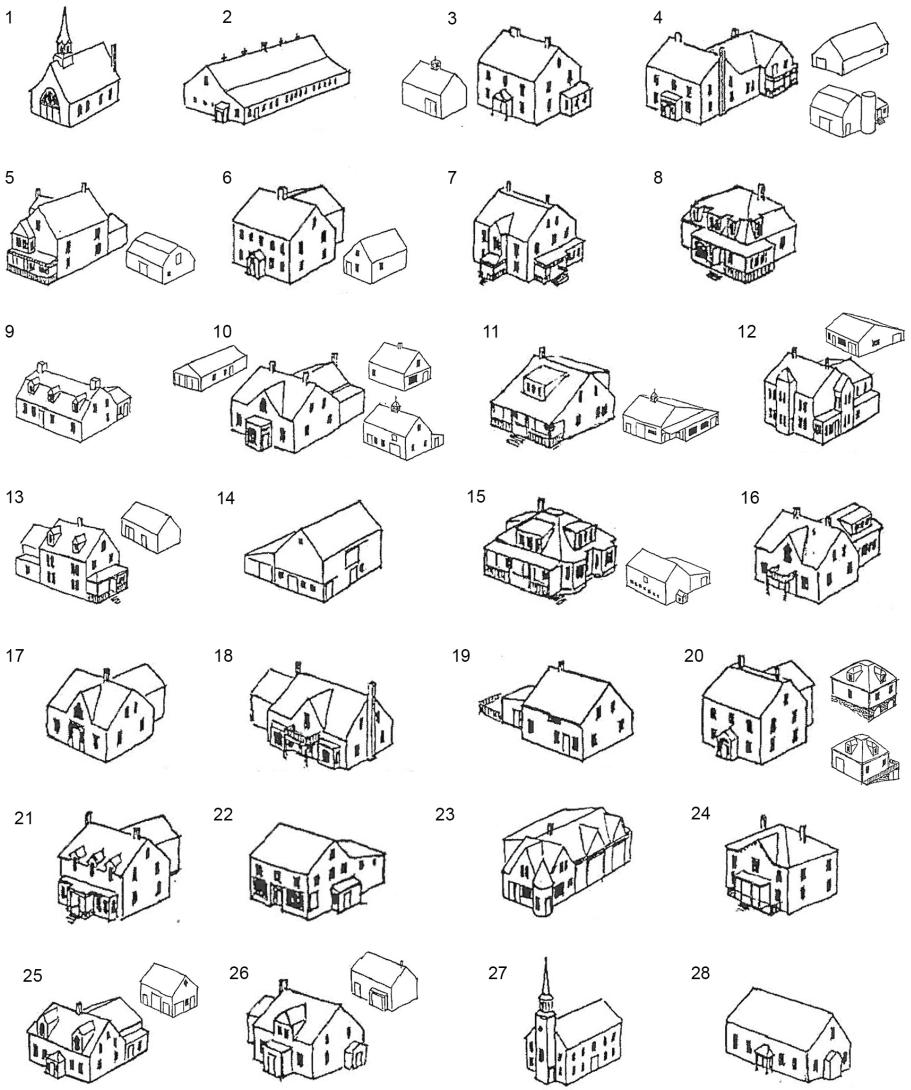
Materials

The balance between modern and heritage architecture is a fine balance in Grand Pré. New development is slow in the region, at approximately one new building a year, over the past 30 years. The number of surviving heritage buildings, from the past 200 years, stand at 27. This means that Grand Pré currently has an equal split of heritage versus new architecture. Current zoning requirements are thus very strict in order to preserve the culture and aesthetic quality of the existing heritage structures (Municipality of the County of Kings n.d.).

According to the Heritage Conservation District Plan of Grand Pré, custom-designed new development that responds to the architectural and visual style of the surrounding historic buildings is preferred (Municipality of the County of Kings n.d.).

In terms of materials, wooden clapboards or shingles is the preferred cladding. Other materials such as vinyl and aluminum cladding are sometimes allowed in specific scenarios if they sympathetically abide by the design guidelines and maintain the historic character. Some financial incentives and rebates are applicable in the conservation district and become void if wooden cladding is not used. For roofing materials on new construction, asphalt or wooden shingles are preferred. Metal roofs are allowed, but must have a painted finish (Municipality of the County of Kings n.d.).





Map and drawings showing the heritage buildings located in the Historic Hamlet of Grand Pré (Municipality of the County of Kings n.d.).

Typical heritage house of Old Town Lunenburg, depicting classic Lunenburg bump above front door (ViewPoint n.d.).

Modern rendition of the Lunenburg bump (Abbott Brown Architects n.d.).

Old Town Lunenburg urban fabric with new B2 Loft building (MacKay-Lyons Sweetapple Architects Ltd. n.d.).

B2 Lofts (MacKay-Lyons Sweetapple Architects Ltd. n.d.).

UNESCO Building Precedents

Since the avian interpretation centre falls within the UNESCO historic hamlet of Grand Pré, I looked at other architectural precedents within UNESCO designated sites.

Designing modern architecture in an UNESCO heritage landscape is a challenging task. Navigating the balance between preserving historic value and cultural aesthetic without purely mimicking the architecture features is important. A building should allude to a temporal quality, acknowledging itself as a modern building if it is being built in the present day. However, it is equally as important to respect the fabric of a heritage district, and design accordingly.

Two Nova Scotian architecture firms, Abbott Brown Architects and MacKay-Lyons Sweetapple Architects, have recently completed projects in Old Town Lunenburg, another UNESCO designated world heritage site in Nova Scotia. The Bump House by Abbott Brown Architects displays a modern interpretation of the classic Lunenburg bump, found on many historic properties in the town. It keeps with the urban fabric by conforming to the classic form of nearby houses, and using traditional wood shingles for cladding. This house does an excellent job emulating its surroundings, while maintaining a modern character. Another building, not far away, is a mixed use residential and commercial development by MacKay-Lyons Sweetapple Architects. From an aerial view, the B2 lofts seamlessly integrate into the urban fabric of Lunenburg with its gambrel and gable roof form, its shingle siding, and bright colours. However crisp and modern detailing has distinguished this building as a modern development on the street.

Sanctuary Architecture Precedents

The following precedents were used to research examples of birding structures, which ultimately informed the bird-viewing pavilions along Le Tour de Grand Pré.

Tower at Tipperne Bird Sanctuary (Johansen Skovsted Arkitekter 2017).

Bird Hide at Tipperne Bird Sanctuary (Johansen Skovsted Arkitekter 2017).

Located along a fjord on the Western side of Denmark, amongst an important stopping point for migratory birds, is a bird sanctuary designed by Danish architecture firm Johansen Skovsted Arkitekter. This sanctuary is home to various structures amongst the landscape, such as a watch tower, a bird hide, workshop, research station, and walking trails. Each structure stands alone in the landscape with its distinct modern character, but also has a subtle relationship to the other nearby structures and the natural surroundings (Johansen Skovsted Arkitekter 2017).

Viewing pavilion in East Point Bird Sanctuary (PLANT Architect Inc. n.d.).

Bird blind in East Point Bird Sanctuary (PLANT Architect Inc. n.d.).

The second example, located in the city of Toronto, are birding pavilions by PLANT Architect in East Point Bird Sanctuary. This sanctuary was developed as part of a citywide initiative to protect bird habitat and increase awareness and education of bird activity in this urban area (PLANT Architect Inc. n.d.). Throughout the park there are architectural interventions such as viewing pavilions, signage, and bird blinds. The form of the structures take shape of a bird in flight, symbolizing the area as an important stopover for birds in migration. The pavilions are compact, occupying only a small footprint in the natural setting, but are beautiful iconic features in the landscape. They lure visitors to them and hold information printed on weathering steel to educate the public about the importance of bird habitat preservation. The bird blind, situated in a treed area, has perforations that allow light to filter in and people to see out. This allows people to stand in the blind and observe birds without disrupting them.

Aerial view of The Big Jeezley eagle building at CWRC (CWRC n.d.).

Interior of The Big Jeezley at CWRC (CWRC n.d.).

Bird Bricks to provide nesting cavities for birds within buildings (Dunkerton n.d).

Wooden boxes to provide areas for nesting on the facades of buildings by MoonWalk Local Collectif d'architectes (Inhabit n.d.).

Avian Architecture

There are a lot of architectural examples of human-made structures that bring humans closer to birds and allow them to better observe their behaviours. However there are also architectural examples of structures built exclusively for the birds. These are often found in rehabilitation centres, that take in injured animals, and work to improve their health to be released back into the wild. A local example is the Cobequid Wildlife Rehabilitation Centre (CWRC), located in Brookfield, Nova Scotia. One of the structures on site was built purely for large raptor species to have an area to safely fly in while they undergo rehabilitation at the centre. It is an oval-shaped building that allows the birds space to fly. Inside are perches and other natural appearing features for the raptors to use. Architecture such as this is unique because it is designed for the birds behaviour in mind. In creating such structures, designers need to work with avian ecologists and other specialists who understand and study bird behaviour.

Bird Bricks

New development often leads to reduced bird habitat. To compensate for this loss, some people are providing habitat for birds as parts of new or existing buildings. An example of this is the Bird Brick, a normal brick with a carved out cavity to allow for birds, such as sparrows, a place to nest within the walls of a structure (Dunkerton n.d.).

Facade Nesting

Other custom examples of nesting are also being developed to integrate into a wide variety of cladding facades. "Bird boxes" can be made out of a wide variety of materials, and

can be prominent architectural features, or blend into the exterior cladding, depending on the desired architectural aesthetic.

These materials and design considerations will form design parameters for the architectural interventions to follow.

The Five Hotspots

The website eBird identifies five bird "hotspots" in Grand Pré: the Harvest Moon Trailway, the Sewage Lagoons, Mosquito Point, Evangeline Beach, and the Guzzle. The first hotspot, the Harvest Moon Trailway, is a reclaimed railway that is now a popular bike path through the Annapolis Valley. The path traverses through stands of deciduous trees, making it a popular spot year-round to see a variety of songbirds. Because it traverses through multiple habitat types, it is common to see birds of prey and waterfowl as well.

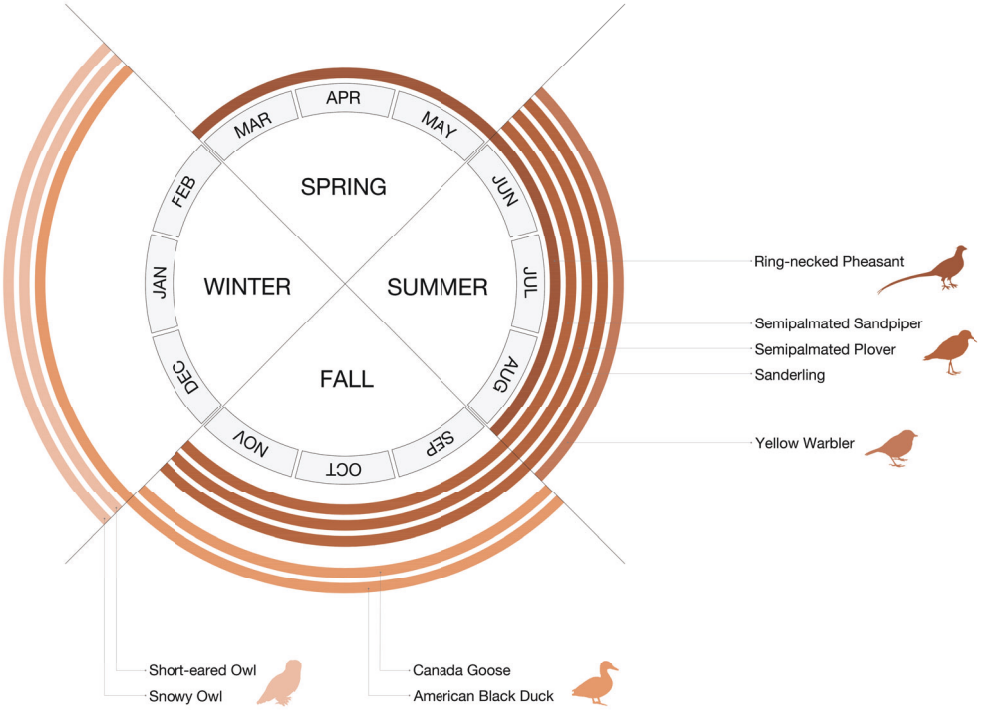
Map showing five birding hotspots in Grand Pré. Information retrieved from eBird.org (eBird n.d.).

The next hotspot, the Sewage Lagoons, is a particularly busy spot for birds feeding on organic matter that enters the lagoons, and on the aquatic insects that breed here. Year-round visitors can see a variety of gulls and waterfowl in the lagoons.

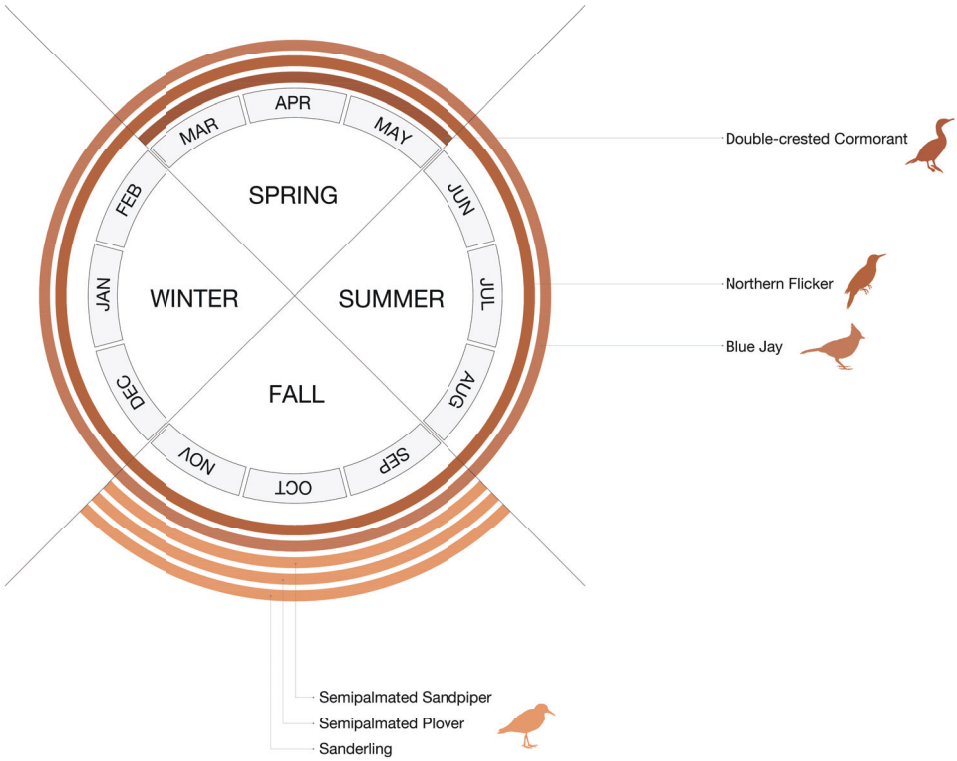
Mosquito Point is located along the Minas Basin near the mouth of the Cornwallis River and Ransom Creek, creating ideal estuary habitat. Waterfowl are common year-round, and during the summer visitors will see an abundance of shorebirds during the migration.

Evangeline Beach is a well-known and much-used location to watch the shorebird migration during late summer. An abundance of shorebirds occupy the vast tidal flats along the rocky shoreline in search for food to fatten up before their journey south.

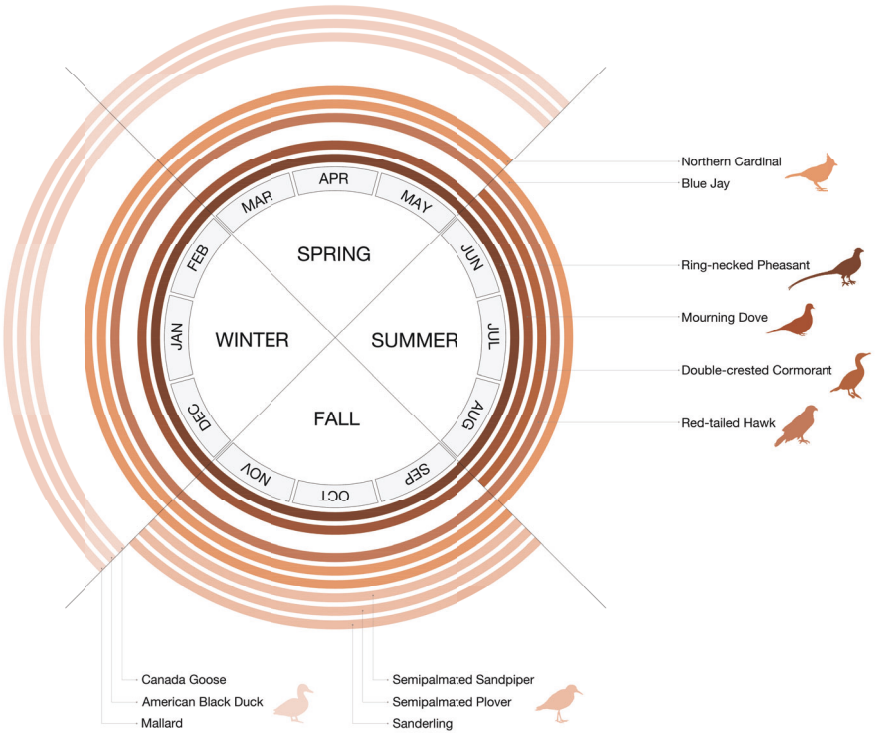
Finally, the Guzzle is a popular hotspot for birds because it lies near the mouth of the Gaspereau River, creating an intersection between salt and freshwater. The high tides expose vast mudflats that provide an abundance of food for a variety of shorebirds, ducks, herons and gulls. A few hundred metres off the tip of the guzzle lies Boot Island, designated as a National Wildlife Area for its importance as a staging and migration site for both waterfowl and shorebirds. In the winter, this is also a popular spot to find snowy and short-eared owls.



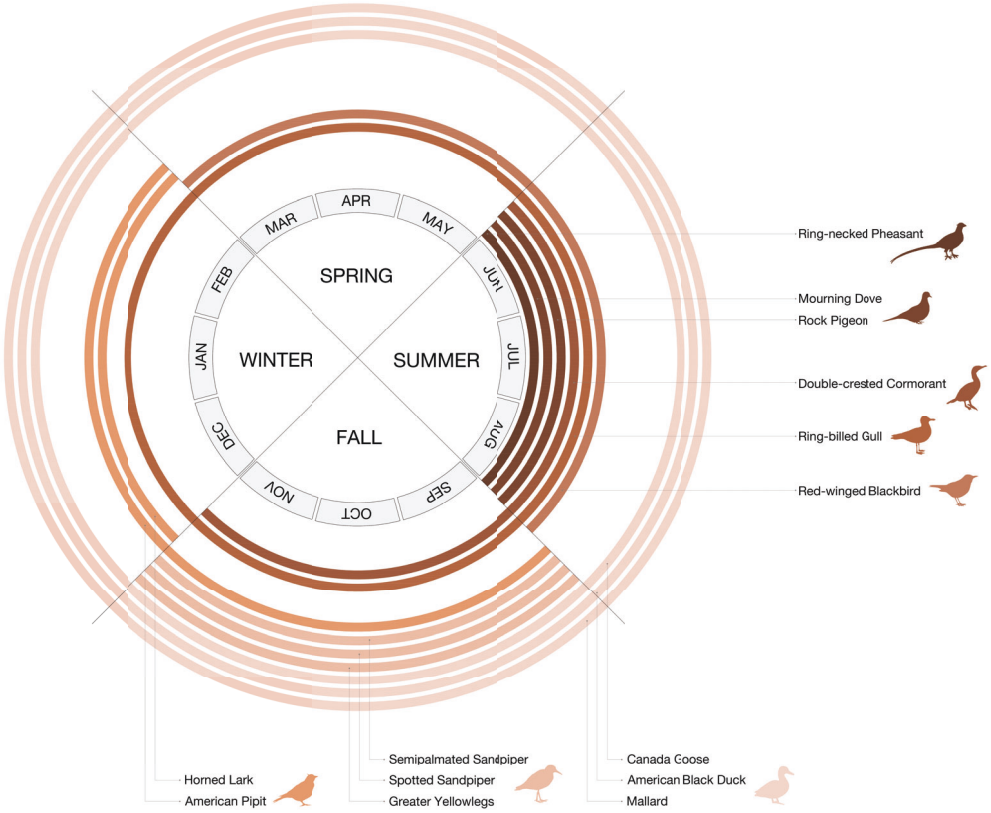
Circular bar chart showing popular bird species found year-round at the Guzzle. Information retrieved from local birder, Patrick Kelly, and eBird.org (eBird n.d.).



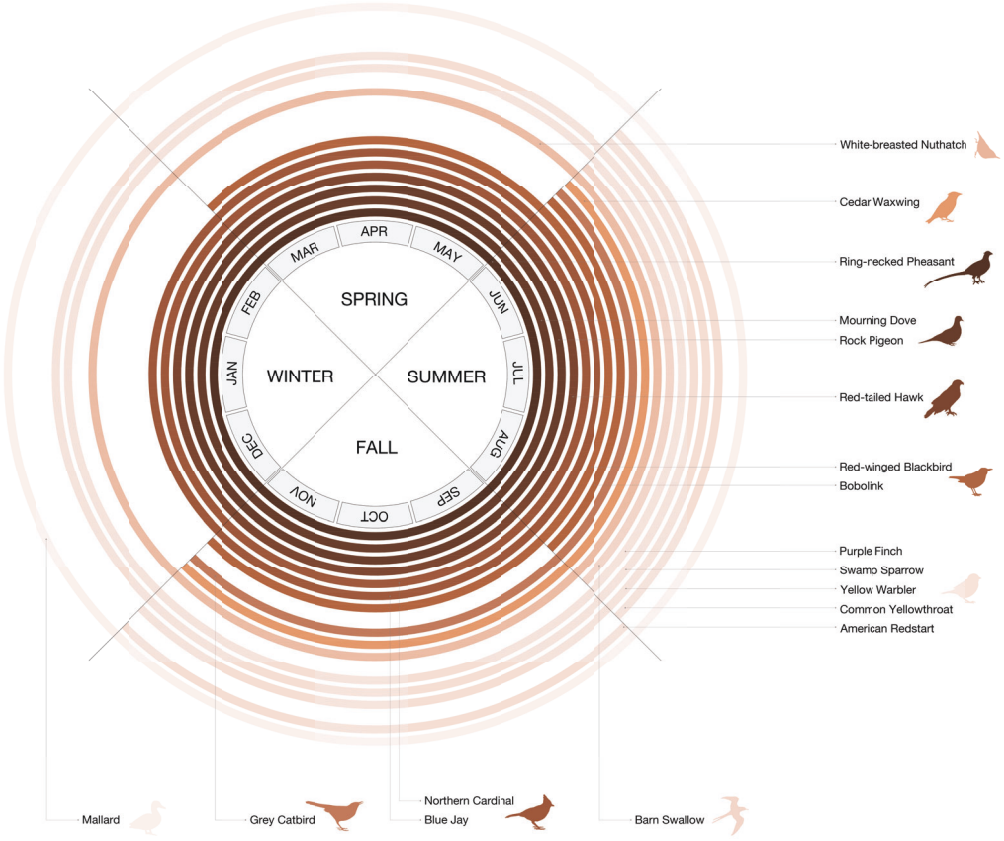
Circular bar chart showing popular bird species found year-round at Evangeline Beach. Information retrieved from local birder, Patrick Kelly, and eBird.org (eBird n.d.).



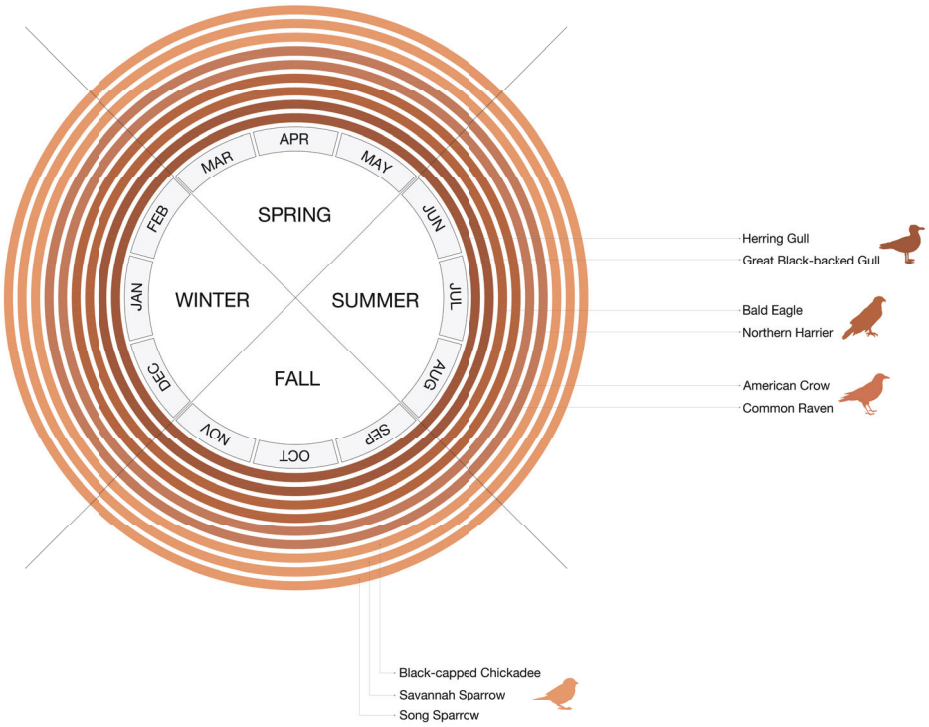
Circular bar chart showing popular bird species found year-round at Mosquito Point. Information retrieved from local birder, Patrick Kelly, and eBird.org (eBird n.d.).



Circular bar chart showing popular bird species found year-round at the Sewage Lagoons. Information retrieved from local birder, Patrick Kelly, and eBird.org (eBird n.d.).



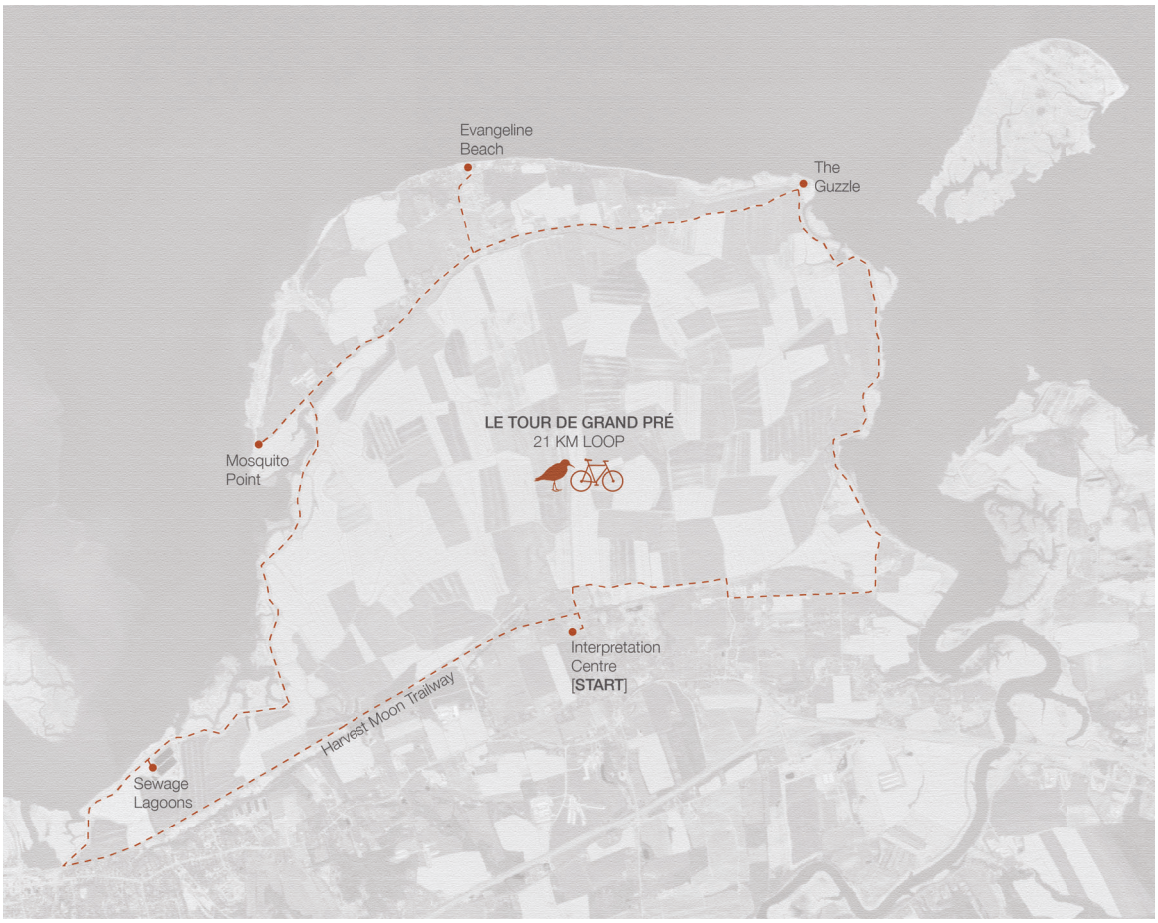
Circular bar chart showing popular bird species found year-round at the Harvest Moon Trailway. Information retrieved from local birder, Patrick Kelly, and eBird.org (eBird n.d.).



Circular bar chart showing popular bird species found year-round at all five birding hotspots. Information retrieved from local birder, Patrick Kelly, and eBird.org (eBird n.d.).

The Route

The design begins with Le Tour de Grand Pré, a 21-kilometre bike route, that leads visitors through the landscape of Grand Pré, highlighting the five bird hotspots along the way. The route begins at the Interpretation Centre, where guests learn about the local avian species, their migration patterns, threats and disturbances, and other important ecological information. They can rent bikes here to experience birdlife in Grand Pré first hand at the various bird hotspots, noted on the map below. Small viewing stations at each birding hotspot offer an opportunity to slow down and watch the birds, perhaps picnic, or rest out of the wind or under the shade.



Map showing Le Tour de Grand Pré, a 21-kilometre bike route.

Harvest Moon Trailway

After renting a bike at the interpretation centre, or bringing a bike of their own, visitors begin the route along the Harvest Moon Trailway. Formerly a railroad, this well-groomed gravel path allows bikers to traverse through the agricultural landscape of the region. Stands of deciduous trees make this trail a popular spot to see songbirds year-round. However, the trail spans through a multitude of habitat types, meaning waterfowl, birds of prey and other avian species are common throughout.

Render of bird and human activity on the Harvest Moon Trailway.

Wolfville Sewage Lagoons: The Cormorant

The first architectural intervention is located at the Wolfville Sewage Lagoons, located along the Minas Basin near the mouth of the Cornwallis River. The shape was inspired by the double-crested cormorant. The main design parameter for this site was limited views of the lagoons due to the large dykes that encapsulate the ponds, and the high fence that surrounds the dykes. This makes it difficult for people to get a good view to the birds in the lagoons. A new birding tower here allows visitors to climb up for a better view to birds in the lagoons and the nearby estuary. Three levels can be occupied, depending on the desired height and views of the birder. Even in winter, many species can be seen here such as gulls, waterfowl, and horned larks. For those that are adventurous during the colder months, these paths can be accessed by foot or car as well.

The use of corten steel is inspired by the history of agriculture in the area, and by the similarly coloured red mud that is unique to this region of Nova Scotia. Corten steel is the main

Site section showing viewing lines over the fence and dyke to the birdlife inhabiting the lagoons.

Location, bird species present, and wind direction for the cormorant pavilion located at the Wolfville Sewage Lagoons.

Cormorant pavilion: plan, unfolded elevations, and perspective.

Cormorant pavilion, showing the perforations in the corten panels, and the viewing slots looking towards the lagoons.

material of all the birding pavilions, establishing material continuity amongst them.

Mosquito Point: The Cardinal

The second stop is Mosquito Point. This form of this pavilion was inspired by a northern cardinal in flight, a bird that is commonly seen here fall through spring. This site is near the mouth of the Cornwallis River, a tidal estuary much frequented by birds. The area is also filled with sporadic stands of deciduous trees, and plentiful tall grasses for a variety of songbirds and other passerines. Strong winds blow off the water at this site, so providing shelter from the wind was key.

This pavilion appears to emerge out of the rolling landscape while providing an area to sit and watch the waterfowl in

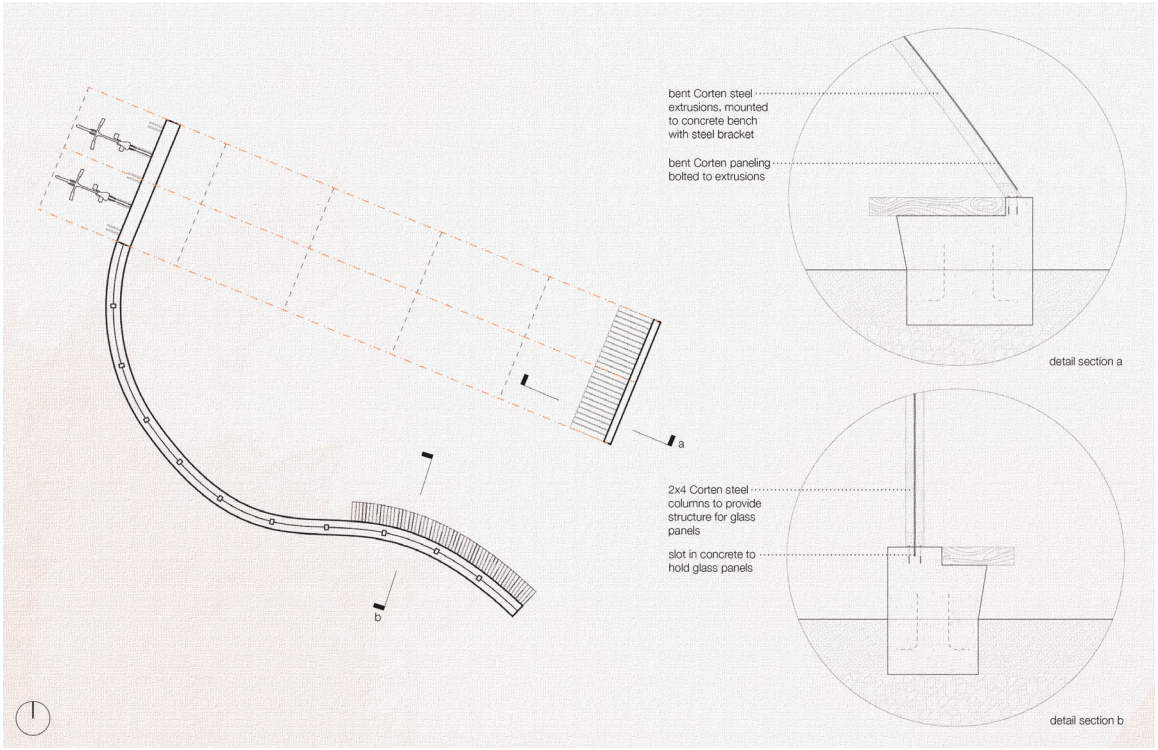
Location, bird species present, and wind direction for the cardinal pavilion located at Mosquito Point.

Cardinal pavilion: site plan and perspective view.

the estuaries against the stunning backdrop of Blomidon. A glass-paneled wall completed with a fritted pattern allows for people to enjoy the view while being protected from the wind. The treatment of the glass prevents bird collisions. Bent-steel extrusions hold up the curved corten roof, providing shelter from rain and snow. These steel extrusions are mounted to poured concrete footings that double as benches for people to sit and enjoy the birdlife. The northwest concrete footing extends high enough to secure bikes to.

These pavilions do not provide sufficient protection from extreme wind and rain. However during weather events such as these, birds themselves take shelter since flying in heavy wind and rain can be difficult and dangerous to them.

Concrete footings that double as structure which the corten roof is mounted to, and space to park bikes.



Zoomed-in plan, and section details.

Site section showing the gradual slope from the cardinal pavilion towards the salt flats and estuary. Glass panels and a metal roof provide shelter from the elements, such as wind and rain.

Evangeline Beach: The Sandpiper

The next stop is Evangeline Beach, which is most popular during late summer, when millions of shorebirds populate the area in search of food before heading South. Birds of prey, like peregrine falcons, are also common, hoping to feast on one of the many flying sandpipers.

This birding pavilion was inspired by a crouching semipalmated sandpiper, the most popular migrating shorebird in the region. Although this beach is warm and lovely to visit during the summer months, wind coming off the Bay of Fundy makes this area frigid during winter months. Thus, this pavilion needed to provide protection from the harsh wind.

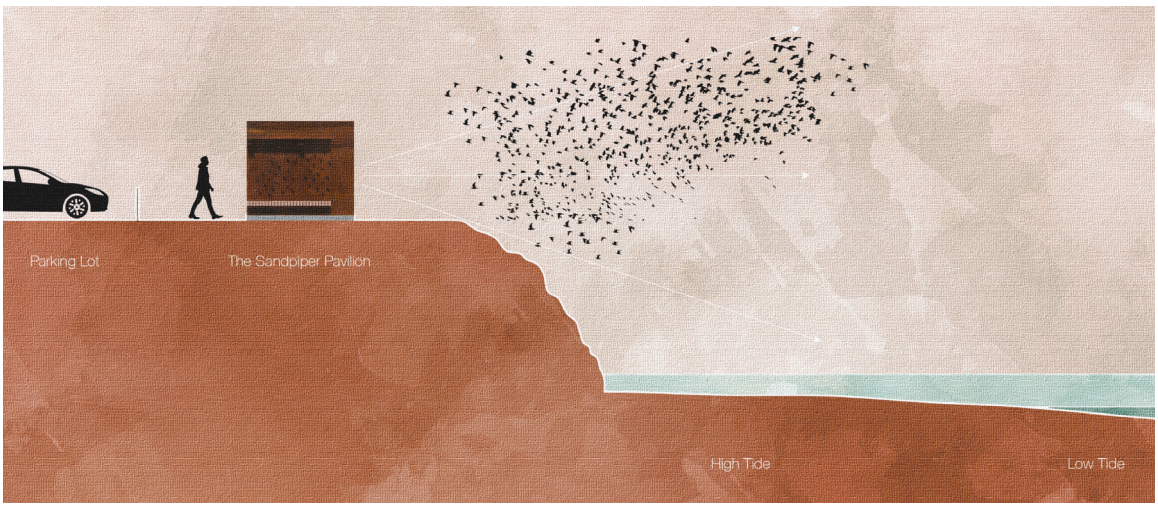
Just past the parking lot at Evangeline beach, at the top of the rocky shoreline, lies an existing concrete slab approximately 26-feet by 10-feet. This concrete slab was once occupied

Location, bird species present, and wind direction for the sandpiper pavilion located at Evangeline Beach.

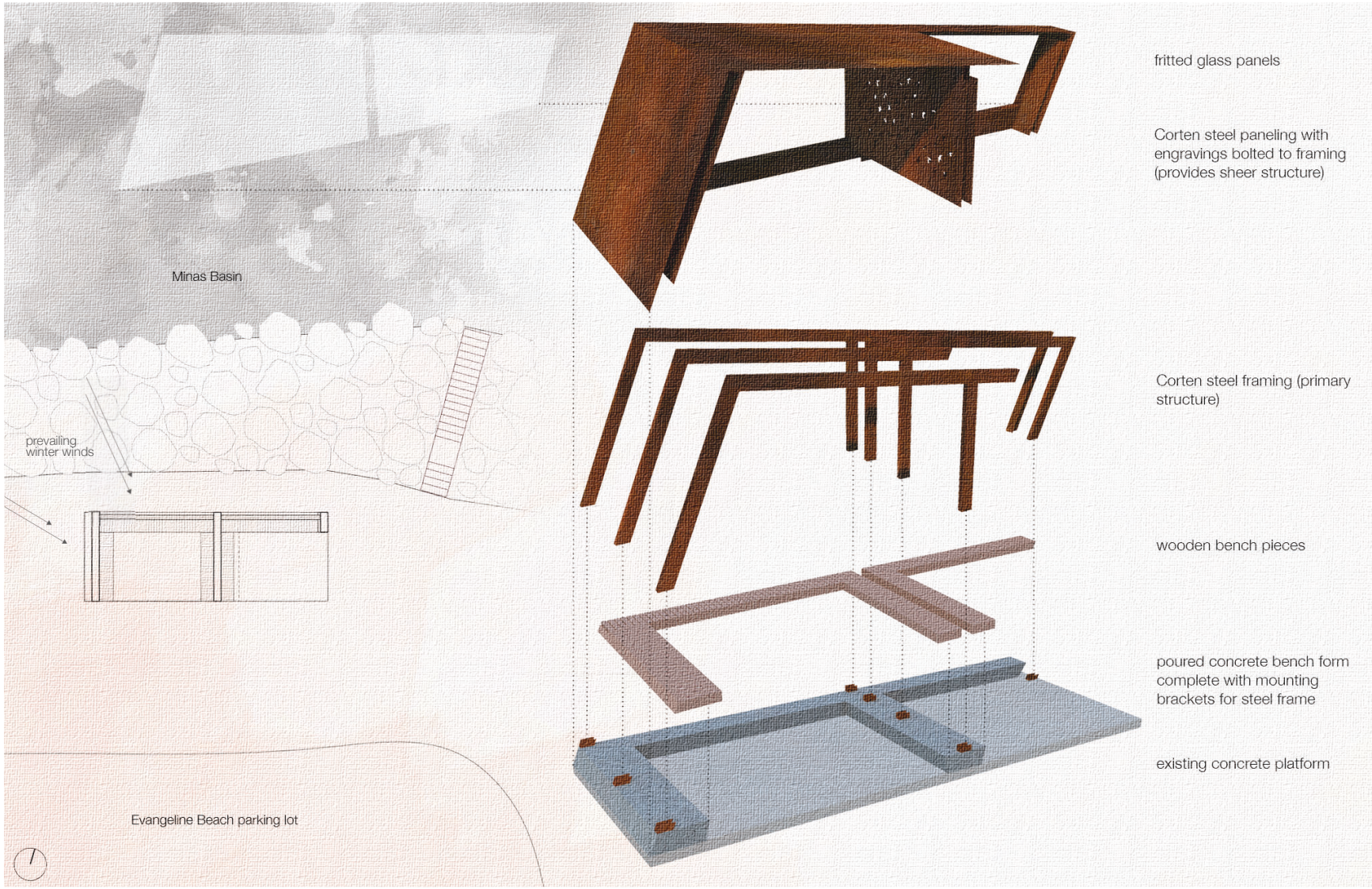
by a previous birding pavilion, that over time weathered beyond repair. Thus, this concrete slab presented as the ideal location for a new pavilion.

The primary structure of the pavilion is steel, completed with corten steel panelling to provide sheer structure. Concrete bench forms will be poured atop of the already existing concrete slab, and be complete with steel mounting brackets for the corten frame. The glass panels are ultra-violet coated to prevent bird collisions. Birds have a wider vision spectrum than humans, allowing them to see UV light. This means we can fabricate glass with UV patterns, making it appear solid for birds, but transparent to the human eye. Inside the pavilion the panelling is engraved with flying sandpipers, depicting their migration that flocks birders and visitors to the area every summer.

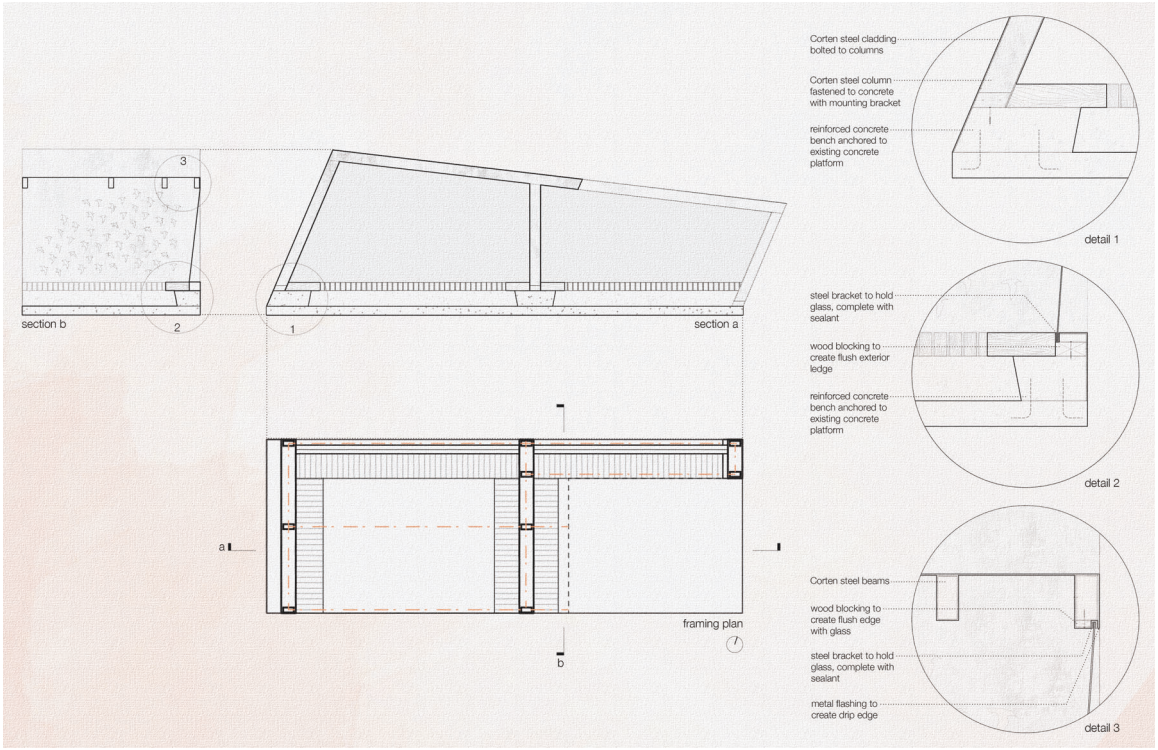
The location of the pavilion keeps visitors off the beach during peak migration season. Sandpipers are easily disturbed by people and other animals, such as dogs. Thus, providing a pavilion for people to be able to observe these birds from a safe distance in turn allows the sandpipers to feed and nest safely without being scared away.



Site section showing the steep, rocky slope from the pavilion towards the beach, and the viewing lines from the pavilion across the water.



Sandpiper pavilion: site plan and exploded structural axo.



Zoomed-in framing plan, sections, and structural details.

Sandpiper pavilion, showing the engraved corten wall and benches for visitors to sit and observe birdlife.

The Guzzle: The Heron

The final stop of the tour is the Guzzle. The shape of the roof of the pavilion is inspired by the majestic blue heron in flight. This site, as with the others near the water, needed to provide protection from the wind.

The corten steel shards that protrude out of the ground are arranged in a bow shape to provide a guarded wall to protect from the cold winds off the water. Viewing slots are cut at various heights in the walls to highlight views out to the water to see the active birdlife in the area. These slots were cut at varying heights to allow for views to be accessible to a range of visitors.

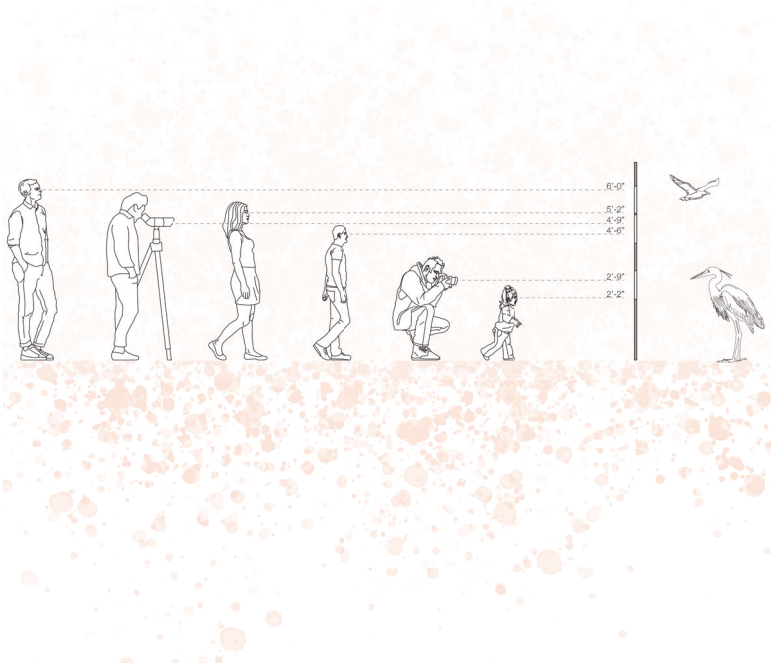
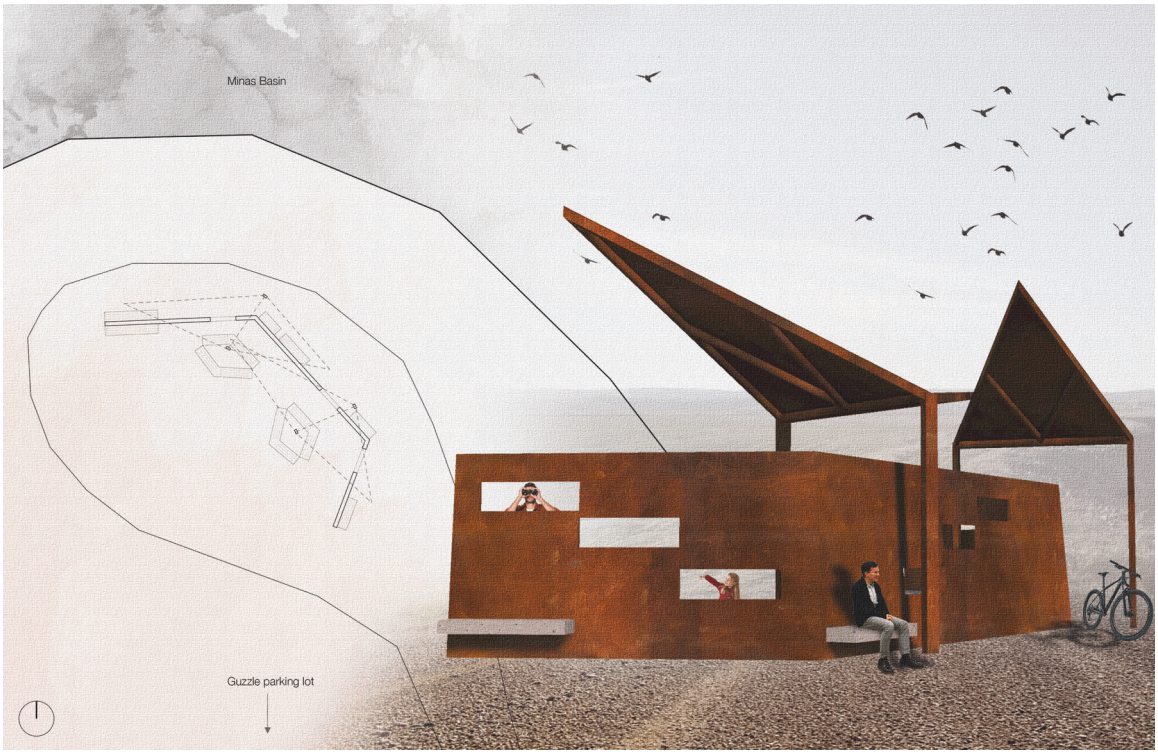


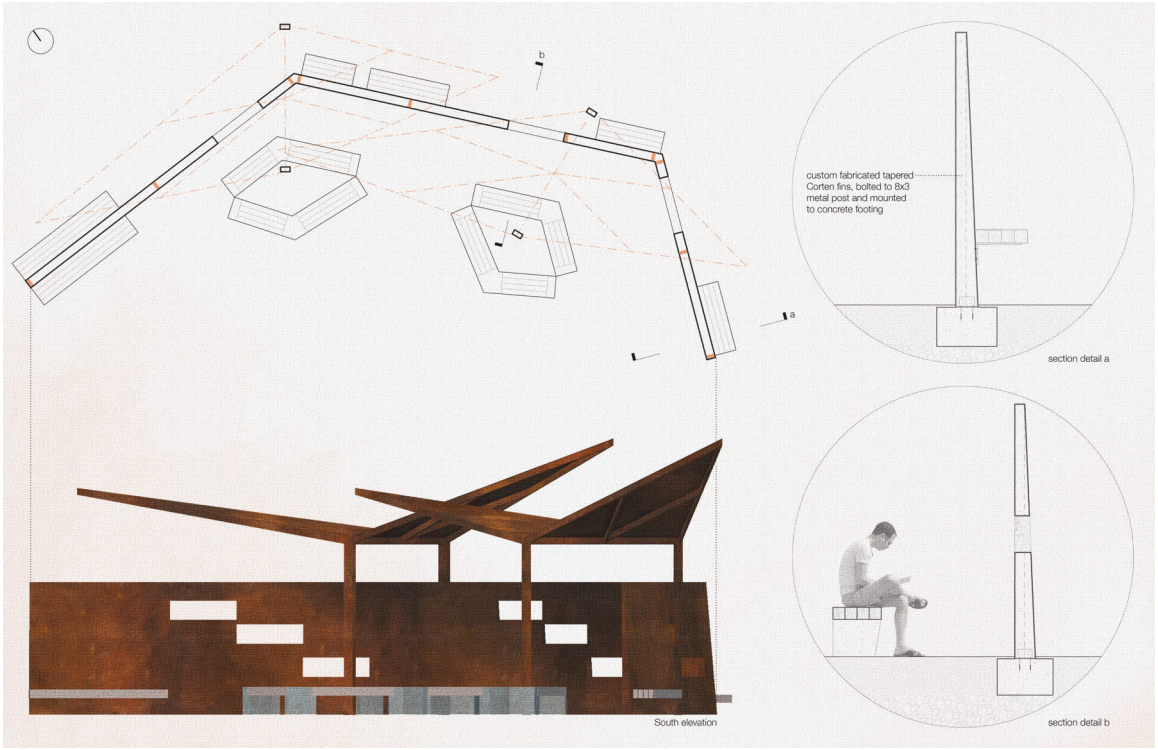
Diagram showing the height of viewing slots to accommodate various visitor heights.

The walls of the pavilion are tapered, creating a nice angle for people to sit against, while also making the form thinner and more elegant. To achieve this, custom fabricated tapered corten fins will be bolted to steel extrusions, and mounted to the concrete footings.

Location, bird species present, and wind direction for the heron pavilion located at the Guzzle.



Heron pavilion: site plan and perspective.



Plan, south elevation, and section details.

Site section showing the rocky slope from the heron pavilion towards Minas Basin, and the various viewing lines towards the water to observe the birdlife.

After visitors are done at this location, they continue along the rest of the loop to bring them back to the interpretation centre.

The Interpretation Centre

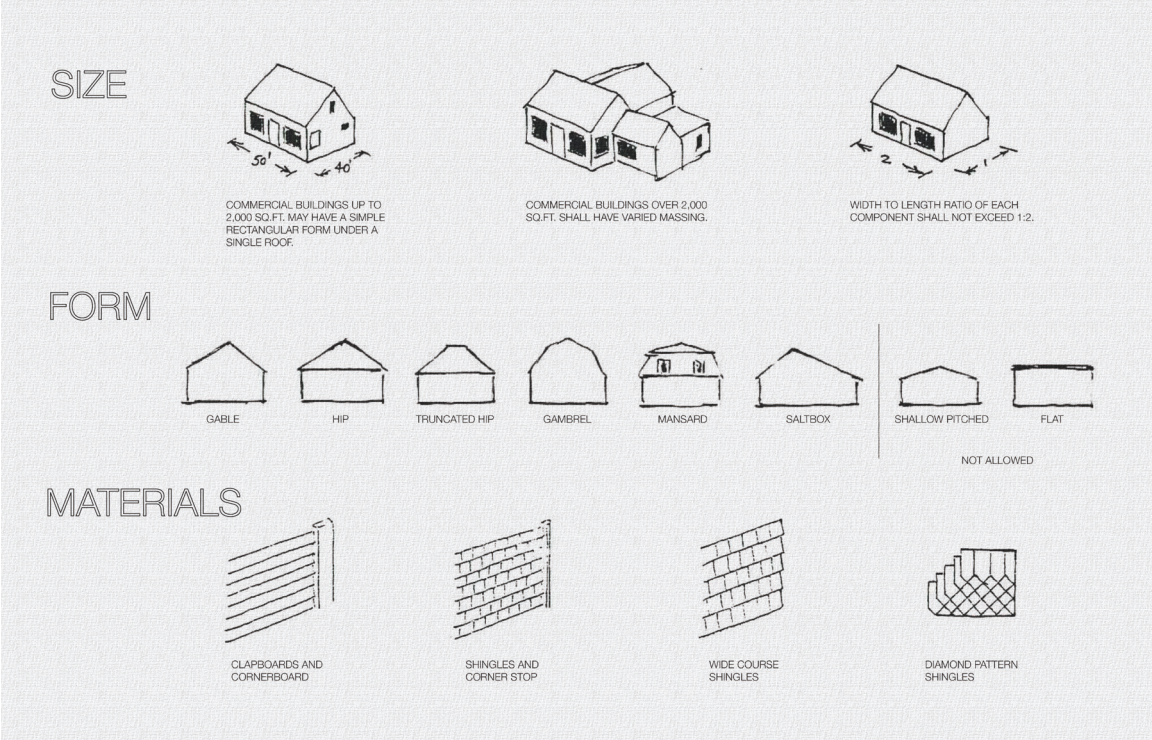
Located in the heart of Grand Pré, the interpretation centre will be the starting and ending point of the tour. The centre will be placed next-door to the already existing Parks Canada Grand Pré Visiting Centre. This will utilize the already heavily trafficked area for visitors interested in learning more about the area. This will also negate the need to develop existing avian habitat into a parking lot, since a sizable one already exists for the visiting centre.

Aerial view of the Grand Pré Visiting Centre. Photo taken by Jamie Robertson (The Landscape of Grand Pré Inc. n.d.).

Aerial view of the Grand Pré visiting centre with the new Interpretation Centre and constructed wetland to the south.

Design Guidelines

Kings County adopted a heritage conservation plan for central Grand Pré in the 1990s. Its purpose was to preserve the historic buildings in the area, and to provide guidelines for new construction to be “architecturally compatible” with the existing historic vernacular. These guidelines outline various criteria, such as the form, shape, size, and materials that must be used for new construction within the central heritage district, which the interpretation centre is located. In response to the design of the Interpretation Centre, these heritage guidelines defined parameters that guided the form and character of the building. Specifically, size, form, and materials were the prominent guiding parameters that defined the interpretation centre design. According to the Kings County design guidelines, commercial buildings under one form can only be up to 2,000 square-feet in size



Diagrams depicting size, form, and material parameters as stated in the Grand Pré design guidelines (Municipality of the County of Kings n.d.).

Parks Canada museum building at Grand Pré Heritage Site (Hay 2021).

Barn in Grand Pré (Phillips n.d.).

Old barn on the way to The Guzzle (Hay 2021).

North Grand Pré community church (Saunders 2019).

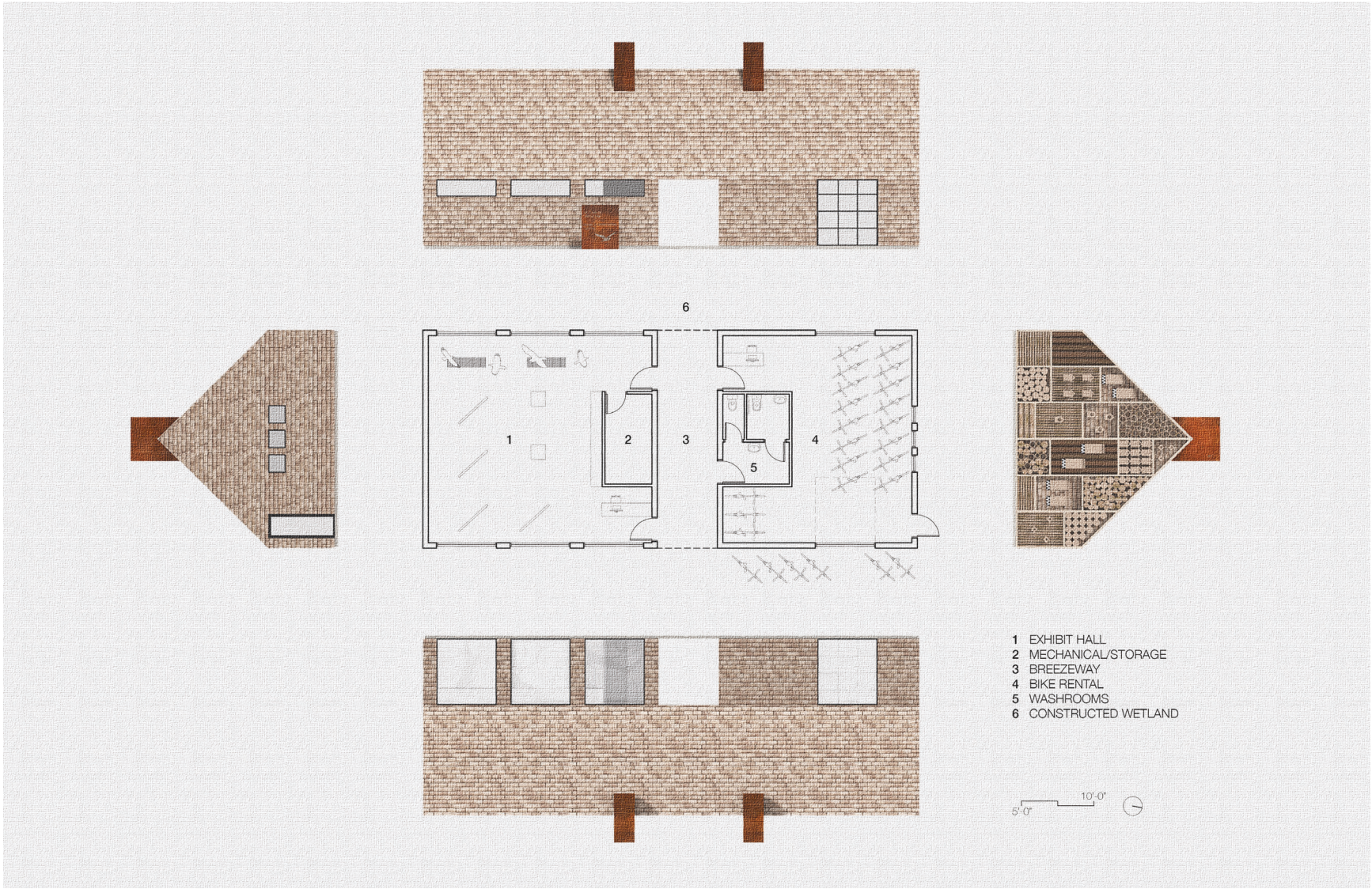
with a maximum 1:2 width to length ratio (Municipality of the County of Kings n.d.). In terms of the roof form, new commercial construction had to be in line with existing roof forms in the area. There was a variety to choose from, gable, hip, gambrel, saltbox, just to name a view. After visiting the area, I noticed an abundance of barn vernacular with a simple gable roof form. The gable roof is a timeless shape, and was used for the interpretation centre. Finally in terms of materials, wood is the preferred choice according to the design guidelines. This includes wood clapboard cladding, as well as a variety of wood shingles. Again I witnessed a number of older structures in the area cladded with wood shingles. This material too has been used for centuries, but also provides a nice modern aesthetic when used on a simple gable form.

Layout

The interpretation in a 2,000 square-foot rectangle, complete with a simple gable form roof and a breezeway through the centre, dividing the structure into two spaces for the two adjacent programs: the exhibit hall and the bike rental. The core of the building holds areas for mechanical and washrooms.

Bird-Friendly Materials

Since this project centres around birds, materials were chosen with birds' well-being in mind. The south wall is clad in a "habitat wall," complete with bird houses, bat boxes, and bee hotels. Since human development is often known to disrupt or destroy habitat, it was the intention to create a human structure that intentionally provided habitat for local species.



Floorplan and elevations of the interpretation centre.

The “chimneys” are not actually functioning chimneys, but instead caverns to provide habitat for the local endangered chimney swift. Chimney swifts once nested in tree caverns, but with the increase in logging, adapted to live inside chimneys. However, we are now seeing many old and abandoned structures with chimneys being taken down, further reducing the habitat of the endangered chimney swift.

Finally, all the windows on the building will be complete with fritted glass, in order to prevent any unnecessary bird collisions.

Exhibit Hall

Inside the interpretation centre, visitors will be able to learn about local avian species before heading on the biking tour to experience the birdlife firsthand. A variety of interactive

The exhibit hall in the interpretation centre.

Entrance of the interpretation centre, showing the "habitat wall" on the north wall.

exhibits will attract people of all ages in order to learn about the importance of birds on the natural environment.

Bike Rental

After visitors take a stroll through the exhibit hall and learn about the local birdlife in the area, they can cross the breezeway to the bike rental. Here visitors are encouraged to rent a bike and ride Le Tour de Grand Pré to experience the birdlife Nova Scotia has to offer firsthand.

Constructed Wetland

Through the breezeway will be a constructed wetland. This wetland will provide a multitude of functions. First the constructed wetland will be used to treat wastewater produced by the building, along with the neighbouring visitor centre. Second, wetlands are essential ecosystems for a variety of species, notably birds. This wetland will be an interactive piece of the interpretation centre that allows visitors to learn about sustainable wastewater management, while also being able to observe birds close up in their natural habitat.

Back side of the interpretation centre, showing the constructed wetland.

Chapter 7: Conclusion

The goal of this project is to respectfully design human-interventions in a sensitive and historic landscape that allow people to learn about and observe birds, without deteriorating their habitat or interfering with their behavior. It is about bringing people closer to birds, to enjoy their beauty, and allow people to engage and learn about all the incredible things that birds do for the environment.

Through a curated bike tour, visitors will be able to experience the beautiful heritage landscape Grand Pré. The architectural interventions include carefully placed birding pavilions along the route, that will suggest bikers stop along the way to experience the amazing birdlife that the area has to offer. The Interpretation Centre, located in the heart of Grand Pré, will be an area of immersive education about avian ecology, as well as a spot to rent a bike before embarking on Le Tour de Grand Pré. Materials play a role in conforming with local vernacular, while also keeping birds' well-being in mind.

This architectural thesis is based on a groundwork of avian research in Grand Pré. Species' migration patterns and popular bird hotspots defined the route of Le Tour de Grand Pré, and ultimately the location and form of the architectural interventions. These structures act as places to attract people to the area to learn about and respectfully experience the birdlife that Grand Pré has to offer.

Elevations of the interpretation centre and the four birding pavilions: the cormorant, the cardinal, the sandpiper, and the heron.

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