UNIVERSITY OF NEW BRUNSWICK
FACULTY OF FORESTRY AND ENVIRONMENTAL MANAGEMENT

ENVS 6007

PRACTICUM IN WATER, WILDLIFE, AND FOREST MANAGEMENT

Project Proposal: Determining the presence of Species-At-Risk on the Saltmarsh at Deadman's Cove, New Brunswick

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1.1 PROJECT BACKGROUND

The Deadman's Head Living Laboratory project focuses on examining the saltmarsh near Deadman's Head in the Bay of Fundy. This vital ecosystem plays a crucial role in coastal preservation and supports diverse plant and animal species, which are key to maintaining environmental balance. This project builds on a three-year collaboration between Ernie Edwards, Judy Edwards, and the University of New Brunswick (UNB). Goals include evaluating the health of the saltmarsh, a search for evidence of Species-At-Risk (SAR) and understanding the potential impact of climate change on the saltmarsh. In the Fall of 2022, the Edwards partnered with UNB to investigate the feasibility of creating a living laboratory for ecological research, leading to the project "Identification of Possible Pathways in the Development of a 'Living Laboratory' in Southwest New Brunswick." Since then, this initiative has grown to encompass a thorough evaluation of species at risk within this distinctive ecosystem.

Various floras and faunas mark the Deadman's Head saltmarsh, which is increasingly under pressure with environmental changes linked to climate change. It hosts many species, including migratory birds, different fish species, and invertebrates. The biodiversity of the saltmarsh ecosystem underpins essential ecological functions such as nutrient cycling in water and soil, maintaining the water table, and offering nesting habitats for species crucial to the ecological community and the fishing industry. It is also a wetland that acts as a natural buffer by being able to soak up excess water and dampen the full force of storm surges, certainly an increasingly critical function associated with climate change.

Project Aim:

The project's main goal is to perform an in-depth assessment of SAR within the saltmarsh. The data collected will be compared to already existing historical data and used to predict possible future environmental changes and their effect on species distributions and guide the creation of effective conservation strategies. These findings

would facilitate the protection of the shoreline and preserve existing marshes as they are vital to maintaining the health of these ecosystems. The project's primary goal is to enhance interest in marsh conservation and invasion dynamics, deepen understanding of coastal ecosystems, and encourage environmental stewardship for generations to come.

Objectives of the Current Phase:

1. **Ground Assessments**: Conduct detailed field surveys to identify and document SAR within the saltmarsh, focusing on their distribution, abundance, and ecological roles.
2. **Climate Change Impact Analysis**: Evaluate the potential impacts of climate change on habitat conditions, particularly how climate shifts may influence species composition and overall ecosystem dynamics.

1.2 Location of Deadman's Head Saltmarsh

The saltmarsh (Figure 1) adjacent to Deadman's Head is a significant ecological feature in southwestern New Brunswick, Canada. It encompasses Deadman's Harbour and extends beyond the Marsh Road to Beaver Harbour. This expansive wetland system is situated at approximately 45°03'28"N latitude and 66°45'34"W longitude. With its location in the greater marsh area along the Bay of Fundy coastline, it is an ideal location to research what the impact of climate change is having on coastal ecosystems. Because it is so close to the Deadman's Head peninsula, studies can be conducted in comparison to the terrestrial and aquatic environments.

This saltmarsh is characterized by:

- Exposure to the Bay of Fundy's renowned tidal fluctuations
- A diverse array of habitats supporting unique flora and fauna

This dynamic environment, made fertile by the organic deposits laid down at the heart of the saltmarsh's land and sea intersection, is a particularly sensitive one and is an ideal site for long running ecological research and monitoring.

Figure 1: Various images of the saltmarsh September 2024

Chapter 2: Saltmarshes in New Brunswick: Overview

2.1. Introduction to Saltmarshes

Saltmarshes are coastal wetlands which are located in the intertidal zone between land and salty or brackish waters. They are known for the presence of salt-tolerant plants, such as grasses, sedges, and rushes. Saltmarshes are important ecosystems that support biodiversity, provide flood protection, and mitigate coastal erosion. On a global scale, saltmarshes are recognized as vital habitats, particularly for SAR and play a key role in storing carbon and helping with water quality (Adam, 2002).

In New Brunswick, saltmarshes are primarily found along the Bay of Fundy and the Northumberland Strait, where they experience some of the highest tides in the world. These ecosystems face threats from both natural and human-induced factors, including climate change, rising sea levels, and development pressures. Understanding the definition of saltmarshes in New Brunswick and the conservation efforts in place is crucial for managing and protecting these sensitive habitats.

2.2 Saltmarshes in New Brunswick: Definition and Importance

In New Brunswick, saltmarshes are defined as coastal wetlands dominated by salt-tolerant vegetation, where tidal flooding occurs regularly, usually twice a day. These ecosystems usually are shaped on low-lying coastal areas and are typically classified into two main zones: the low marsh, which is frequently flooded, and the high marsh, which is only occasionally flooded during spring tides or storms (NB Department of Natural Resources and Energy Development, 2010). Saltmarshes in New Brunswick are dynamic environments. They include both freshwater from rivers and the saline waters of the Atlantic Ocean. Ecologically, they provide essential habitat for various species, including migratory birds, invertebrates, and fish. Species like the Nelson's sparrow (Ammospiza nelsoni) and the eastern mudminnow (Umbra pygmaea) rely on saltmarshes for feeding, nesting, and breeding (Crosby et al., 2016).

Additionally, saltmarshes act as natural buffers, by protecting coastal communities from storms and floods by absorbing wave energy and storing excess water during high tides. This flood mitigation capacity is becoming increasingly important as climate change leads to rising sea levels and more frequent extreme weather events (Chmura et al., 2003). Saltmarshes also contribute to carbon capturing and storing carbon dioxide in their plant biomass and soil. This function is valuable in combating global climate change. Economically, the tourism and fisheries sectors in New Brunswick benefit from healthy saltmarsh ecosystems. Saltmarshes support commercially important species such as lobster, flounder, and shellfish, which use these habitats during different stages of their life cycles (Greenberg & Lars, 2013). In addition, saltmarshes provide recreational opportunities, including birdwatching and nature tourism, which contribute to the local economy.

2.3 Conservation of Saltmarshes in New Brunswick

In New Brunswick, the conservation of saltmarshes is managed through a combination of provincial policies, local stewardship programs, and federal regulations. Key players include the New Brunswick Department of Natural Resources and Energy Development (DNRED), Environment and Climate Change Canada (ECCC), and local conservation organizations like the Nature Conservancy of Canada (NCC). There have

been several initiatives taken to protect and restore saltmarshes in the province, considering their ecological significance. The New Brunswick Wetlands Conservation Policy is a major framework guiding the protection of saltmarshes and other wetlands. The policy seeks to prevent wetland loss by regulating development activities in or near these areas. It requires project developers to avoid wetlands or minimize disturbances, and in some cases, compensate for wetland loss by restoring or creating wetlands elsewhere (NB Department of Environment and Local Government, 2002).

At the federal level, the Canadian Wetland Conservation Act supports efforts to conserve saltmarshes by funding projects that restore degraded habitats and protect areas of ecological importance. The Ecological Gifts Program also allows landowners to donate their land to conservation organizations. This effort ensures the long-term protection of ecosystems like saltmarshes (Environment and Climate Change Canada, 2021). There have also been restoration projects to recover degraded saltmarshes in New Brunswick which have proven to be crucial in the recent years. One notable project is the Bay of Fundy Saltmarsh Restoration Initiative, which focuses on rehabilitating saltmarshes that have been impacted by agricultural dikes and tidal barriers. These projects help restore the natural functions of saltmarshes, such as nutrient cycling and habitat provision for wildlife by reintroducing tidal flow and planting native vegetation (Nova Scotia Department of Agriculture, 2015).

Another successful initiative is the Musquash Estuary Marine Protected Area, located near Saint John, which includes significant saltmarsh habitat. This area was designated as a marine protected area (MPA) in 2006 and is managed to protect its biodiversity, including saltmarshes, from harmful human activities like industrial development and pollution (Hanson & Locke, 2006).

2.4 Challenges and the Future of Saltmarsh Conservation

Despite ongoing efforts, the conservation of saltmarshes in New Brunswick faces several challenges. Climate change is a significant concern, as rising sea levels and increased storm intensity threaten the stability of saltmarshes. As sea levels rise, saltmarshes are likely to become inundated more frequently, leading to habitat loss and changes in species composition (Kirwan & Megonigal, 2013). Another challenge is the

pressure from coastal development. The rising demand for waterfront property and new development is causing saltmarsh habitats to be destroyed or broken apart. Policies like the provincial wetlands policy are designed to lessen the impact, but enforcement is often inconsistent, especially in areas where there are competing demands for land use.

Looking ahead, protecting saltmarshes in New Brunswick will require a well-rounded approach that includes climate adaptation strategies, better public awareness, and stricter enforcement of regulations. The promotion of living shorelines, which involve the use of natural materials and vegetation to stabilize shorelines, can be an example of an adaptive management strategy that can help protect saltmarshes from erosion. (Bilkovic et al., 2017). Public education and involvement are also key to ensuring the long-term protection of saltmarshes. Engaging local communities in conservation efforts through citizen science programs, educational outreach, and partnerships with Indigenous groups can help with a deeper understanding of the importance of saltmarshes and encourage stewardship.

Chapter 3: Potential Species-At-Risk on the Saltmarsh

Many species, including many that are endangered, find homes in saltmarshes, which are essential coastal ecosystems known for their productivity. Climate change, habitat loss, and human activity pose multiple hazards to New Brunswick's saltmarshes along the Bay of Fundy and the Gulf of St. Lawrence (Environment and Local Government New Brunswick, 2023). The species at danger that are present in these saltmarsh environments are discussed below, which also includes information on their conservation efforts, status, Latin name, common name and efforts to protect them.

1) Saltmarsh Sparrow (*Ammospiza caudacuta*)

- **Common Name**: Saltmarsh Sparrow
- **Latin Name**: *Ammospiza caudacuta*
- **Conservation Status**: Vulnerable (Federally)
- **Description**: According to Environment and Climate Change Canada (2020), the Saltmarsh Sparrow is a little, brownish bird that only lives in saltmarshes. It builds its nests in dense patches of marsh grass. Its habitat is being significantly lost because

to increasing sea levels, which affects its tidal rhythms of reproduction (Environment and Climate Change Canada, 2023). For the species to survive, habitat restoration and sea level rise adaptation are essential. (Figure 2)

Figure 2: Saltmarsh Sparrow (Ammospiza caudacuta)

2) Piping Plover *(Charadrius melodus)*

- **Common Name**: Piping Plover

- **Latin Name**: *Charadrius melodus*
- **Conservation Status**: Endangered (Federally and Provincially in New Brunswick)
- **Description**: The Piping Plover is a tiny shorebird that has a black band across its neck and across its forehead. For breeding, it needs sandy beach habitats, which frequently overlap with saltmarsh habitats during migratory, particularly in the Bay of Fundy (Environment and Climate Change Canada, 2020). Predation, disturbance by humans, and habitat loss have all led to the species' decrease. Predator control, habitat restoration initiatives, and nest site monitoring are all part of conservation efforts (Environment and Climate Change Canada, 2023). (Figure 3)

Figure 3: Piping Plover (Charadrius melodus)

3) Eastern Baccharis (*Baccharis halimifolia*)

- **Common Name**: Eastern Baccharis
- **Latin Name**: Baccharis halimifolia
- **Conservation Status:** At Risk (Provincial)
- **Description**: The shrub known as Eastern Baccharis, which grows in saltmarshes along the coast, is identified by its grayish-green foliage and white, brush-like blooms. It is uncommon in Canada; its northern range reaches the saltmarshes of New Brunswick. Rising sea levels and habitat degradation from coastal development pose

the biggest threats to this species (Environment and Local Government New Brunswick, 2023). Protection of habitat and population monitoring are the main goals of conservation initiatives. (Figure 4)

Figure 4: Eastern Baccharis (Baccharis halimifolia)

4) American Eel (*Anguilla rostrata*)

- **Common Name**: American Eel
- **Latin Name**: Anguilla rostrata
- **Conservation Status**: Threatened (Federally and Provincially)
- **Description**: Saltmarshes are essential feeding and developing environments for the migratory American eel throughout its life cycle (Environment and Climate Change Canada, 2020). Population decreases are a result of threats like pollution, habitat fragmentation, and overfishing. This species is being conserved by reduced harvesting, enhanced fish passage, and habitat restoration. (Environment and Climate Change Canada, 2023) (Figure 5)

Figure 5: American Eel (Anguilla rostrata)

5) Eastern Ribbon Snake (*Thamnophis sauritus*)

- **Common Name**: Eastern Ribbon Snake
- **Latin Name**: *Thamnophis sauritus*
- **Conservation Status**: Special Concern (Federally)
- **Description**: Wetlands and saltmarshes are home to the semi-aquatic Eastern Ribbon Snake. It has a narrow body and a recognizable yellow stripe. Pollution and the lack of habitat are two threats. Preserving wetlands and reducing human influence on the hydrology of saltmarshes are the primary goals of conservation strategies. (Government of New Brunswick, 2023) (Figure 6)

6) **Short - eared Owl (*Asio flammeus*)**

- **Common Name:** Short-eared Owl
- **Latin Name:** *Asio flammeus*
- **Description:** The Short-eared Owl is a medium-sized owl with long wings, a round head, and striking yellow eyes. Its brown back and streaked cream chest provide excellent camouflage. It is most active during dusk and dawn (crepuscular). This

Figure 6: Eastern Ribbon Snake (Thamnophis sauritus)

species relies on open habitats like grasslands, marshes, and coastal saltmarshes for breeding and feeding. (Figure 7)

Conservation Status: Special Concern (Federally) (Environment and Climate Change Canada, 2020).

Threats: Habitat loss due to urban development, agriculture, and the degradation of open spaces.

Conservation Efforts: Protection of open habitats, including saltmarshes, and public awareness campaigns about habitat conservation are key (Government of Canada, 2018).

7) Bank Swallow (*Riparia riparia*)

- **Common Name:** Bank Swallow
- **Latin Name:** *Riparia riparia*

Description: The Bank Swallow is a small bird with a white underside and a distinct dark chest band. It nests in colonies within sandy or eroding banks near water, including saltmarshes during migration. (Figure 8)

Figure 7: Short - eared Owl (Asio flammeus)

Conservation Status: Threatened (Federally) (Environment and Climate Change Canada, 2021).

Threats: Loss of nesting sites due to shoreline stabilization and erosion control, as well as reduced insect prey populations.

Conservation Efforts: Maintaining natural erosion patterns and reducing pesticide use to bolster insect populations are critical strategies (Government of Canada, 2021).

8) Barn Swallow (*Hirundo rustica*)

- **Common Name:** Barn Swallow
- **Latin Name:** *Hirundo rustica*

- **Description:** This bird is identifiable by its deep blue back, cinnamon underparts, and long, forked tail. It often nests on human-made structures and forages over open habitats like marshes. (Figure 9)
  Conservation Status: Threatened (Federally) (COSEWIC, 2021).
  Threats: Reduced insect populations, loss of nesting sites, and changes in agricultural practices have caused declines.
  Conservation Efforts: Efforts include creating artificial nesting structures and implementing habitat enhancement projects (Environment Canada, 2020).

Figure 8: Bank Swallow (Riparia riparia)

9) Common Nighthawk (*Chordeiles minor*)

- **Common Name:** Common Nighthawk
- **Latin Name:** *Chordeiles minor*
- **Description:** This nocturnal bird is known for its mottled brown plumage, slender body, and distinctive "peent" call. It feeds on flying insects and utilizes open areas, such as saltmarshes, during migration. (Figure 10)
  Conservation Status: Threatened (Federally) (Environment and Local Government

New Brunswick, 2023).

Threats: Declines in insect prey, habitat loss, and increased urbanization.

Conservation Efforts: Promoting insect-friendly agricultural practices and preserving open areas are priority actions (Government of Canada, 2021).

Figure 9: Barn Swallow (Hirundo rustica)

10) Peregrine Falcon (*Falco peregrinus anatum/tundrius*)

- **Common Name:** Peregrine Falcon
- **Latin Name:** *Falco peregrinus anatum/tundrius*
- **Description:** Known as one of the world's fastest birds, the Peregrine Falcon has a slate-gray back, barred underparts, and a black "moustache" marking. Saltmarshes serve as important hunting grounds for this predator. (Figure 11)

  Conservation Status: Special Concern (Federally) (Government of Canada, 2023).

  Threats: Pesticide exposure, habitat disturbance, and illegal hunting.

  Conservation Efforts: Successful reintroduction programs, pesticide regulations, and nest monitoring have bolstered populations (Environment and Climate Change Canada, 2020).

Figure 10: Common Nighthawk (Chordeiles minor)

Figure 11: Peregrine Falcon (Falco peregrinus anatum/tundrius)

11) Monarch Butterfly (*Danaus plexippus*)

- **Common Name:** Monarch Butterfly
- **Latin Name:** *Danaus plexippus*
- **Description:** This iconic orange-and-black butterfly is celebrated for its remarkable migrations between Canada and Mexico. Saltmarshes provide essential nectar sources during migration. (Figure 12)

  Conservation Status: Endangered (Federally) (COSEWIC, 2022).

  Threats: Habitat loss, climate change, and pesticide use pose major threats to its survival.

  Conservation Efforts: Planting milkweed, safeguarding migratory corridors, and reducing pesticide use are central to recovery plans (Government of Canada, 2022).

Figure 12: Monarch Butterfly (Danaus plexippus)

Field Data Surveys

4.1 Survey Details

The basic methodology for determining species-at-risk utilizing the saltmarsh was broken into two questions: 1) given the current Canadian Species-At-Risk Act (SARA) registry, which species have a habitat range that overlaps the saltmarsh and 2) could any SARA species be observed first-hand within the boundaries of the saltmarsh? A

literature review was conducted to answer the first question (see Chapter 3). For the second question, it was decided to conduct a presence / absence survey of the saltmarsh. Since the primary goal of the project was not to determine quantity but rather

Figure 13: Saltmarsh at Deadmans Harbour, New Brunswick

the presence / potential presence of SARA species, abundance surveys were not considered necessary. Taking the results from Chapter 3, it was concluded that there are no SARA aquatic species to search for that would use the saltmarsh. This eliminates approximately 90% of the area of the saltmarsh (Figure 13) for the purposes of species field surveying. What remains is the buffer zone between the forest edge (i.e.

the high marsh), causeway and the hightide mark of the braided channel system connected to the Bay of Fundy (Figure 14). This buffer zone area is predominantly flat and accessible for walking. It varies approximately in width from between a few meters to 30 meters from the forest edge to the various marine water channels. The perimeter length of this buffer zone is approximately 3.4 kms. A walking transect was chosen as the survey technique so that the entire buffer area could be explored. Observations were taken every few meters of any species present using the iNaturalist application (https://inaturalist.ca/). This particular application was chosen for sampling because A) it is FREE of charge to use, B) it allows for real-time sample analysis in the field to help expediate correct sample identification and C) it facilitates the sharing of sample data electronically across the Internet.

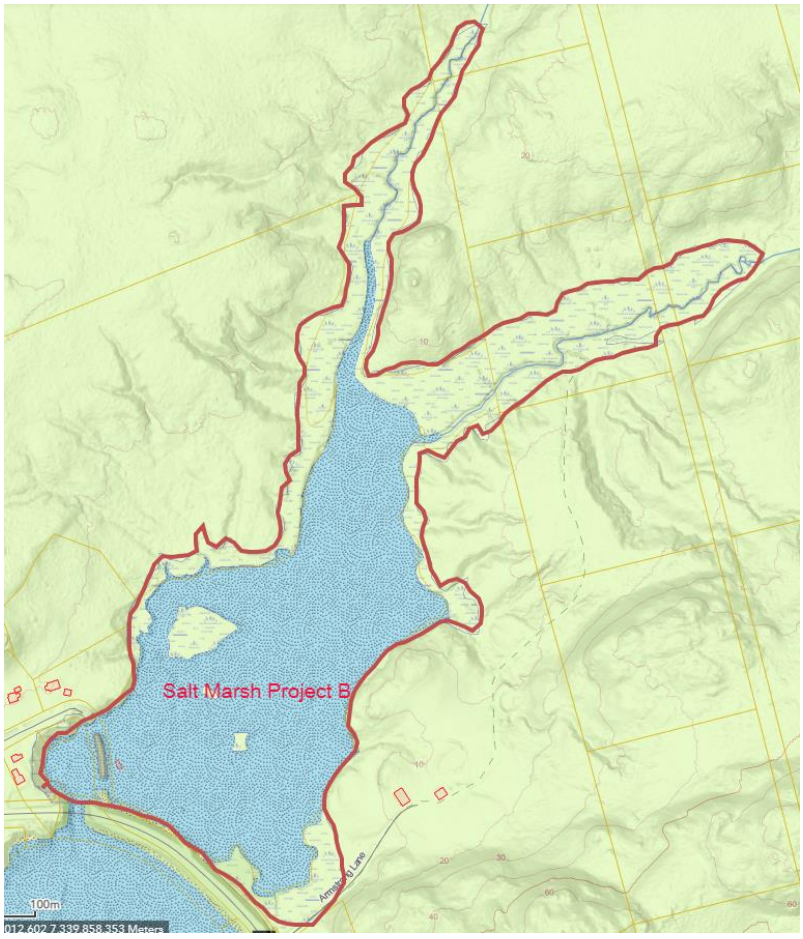


Figure 14: Saltmarsh with buffer zone outlined.

It is important to note that all species observed were sampled not just SAR species. This was done to build an initial species inventory of what is inhabiting the

saltmarsh that could be used in future years to help researchers track empirically current occupation. It might come to pass that a given species not on the SAR registry during the field surveys may, at a later time, be added to / removed from the registry. Being able to re-create a presence-absence temporal model may help determine what factor(s) led to the shift in species abundance.

The buffer-zone transect was fully walked twice: first on September 10th, 2024 and the second on September 20th, 2024 (Figure 15). A total of 148 observations were taken using an iPhone XR (iOS Version 17.5.1) hosting iNaturalist version 3.3.5, build 720. Observations were taken initially every few meters until the observer had a representative collection of the species in-situ. Following this, observations were taken for net new species or to re-confirm a given species or to re-confirm observation location along the transect. This was considered the most practical technique for ensuring the maximum number of individual species were recorded over the entire area of the saltmarsh.

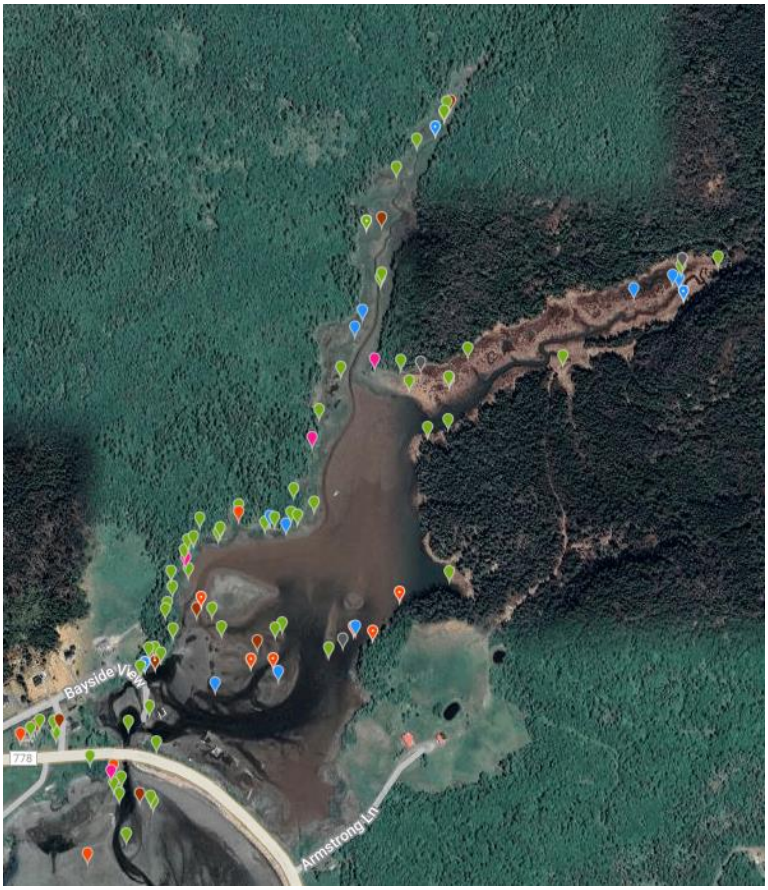


Figure 15: Saltmarsh iNaturalist observation geolocations.

4.2 Field Survey Data Processing

Field observations have been downloaded from iNaturalist and summarized in Table 1. These represent the “best estimate” at accurate identification. Data validation was a three-step process:

Table 1: Saltmarsh Raw Data Field Observations

Group	Common Name	Scientific Name	# of Obs.
Animalia	Atlantic Lion's Mane Jelly	Cyanea fulva	1
Animalia	European Green Crab	Carcinus maenas	5
Animalia	Lake Sponge	Spongilla lacustris	1
Animalia	Northern Acorn Barnacle	Semibalanus balanoides	3
Animalia	Vertebrates	Vertebrata	1
Arachnida	Cross Orbweaver	Araneus diadematus	1
Arachnida	Spiders	Araneae	1
Arachnida	Yellow Garden Spider	Argiope aurantia	1
Aves	Gulls	Larinae	1
Aves	Large White-headed Gulls	Larus	2
Chromista	bladder wrack	Fucus vesiculosus	2
Chromista	Knotted Wrack	Ascophyllum nodosum	4
Chromista	Rockweed	Fucus distichus	2
Chromista	Spiral Wrack	Fucus spiralis	1
Chromista	vesicled rockweeds	Fucus	1
Fungi	Bristly Beard Lichen	Usnea hirta	1
Fungi	Common Sunburst Lichen	Xanthoria parietina	1
Fungi	grey reindeer lichen	Cladonia rangiferina	1
Fungi	shield lichen	Parmelia sulcata	2
Insecta	Hickory Tussock Moth	Lophocampa caryae	1
Mammalia	Bobcat	Lynx rufus	2
Mammalia	Coyote	Canis latrans	1
Mammalia	Red Fox	Vulpes vulpes	1
Mammalia	White-tailed Deer	Odocoileus virginianus	1
Mollusca	Atlantic Jackknife	Ensis leei	3
Mollusca	Blue Mussel	Mytilus edulis	3
Mollusca	Common Periwinkle	Littorina littorea	4
Mollusca	Soft-shelled Clam	Mya arenaria	2
Plantae	alders	Alnus	1
Plantae	American asters	Symphyotrichum	2
Plantae	American dune grass	Leymus mollis	1
Plantae	balsam fir	Abies balsamea	5
Plantae	big red stem moss	Pleurozium	1
Plantae	black spruce	Picea mariana	4
Plantae	Carolina Sea Lavender	Limonium carolinianum	2
Plantae	chaffy sedge	Carex paleacea	2

Plantae	Common Glasswort	Salicornia europaea	2
Plantae	common yarrow	Achillea millefolium	1
Plantae	Creeping Bent	Agrostis stolonifera	1
Plantae	Creeping Saltbush	Atriplex prostrata	2
Plantae	docks and sorrels	Rumex	1
Plantae	dropseeds, cordgrasses,	Sporobolus	1
Plantae	Eelgrass	Zostera marina	1
Plantae	grasses	Poaceae	1
Plantae	heartleaf paper birch	Betula cordifolia	2
Plantae	Herbaceous Seepweed	Suaeda maritima	4
Plantae	Irish Moss	Chondrus crispus	1
Plantae	Loosestrifes	Lysimachia	1
Plantae	Marsh Hay Cordgrass	Sporobolus pumilus	3
Plantae	New York aster	Symphyotrichum novi-belgii	2
Plantae	pickleweeds	Salicornia	2
Plantae	red fescue	Festuca rubra	3
Plantae	Reedgrasses	Calamagrostis	1
Plantae	Rowans and Mountain	Sorbus	1
Plantae	Saltmarsh Cordgrass	Sporobolus alterniflorus	20
Plantae	Sea Lettuces	Ulva	1
Plantae	Sea Milkwort	Lysimachia maritima	4
Plantae	Sea Plantain	Plantago maritima	5
Plantae	Sea-Lavenders	Limonium	3
Plantae	swamp aster	Symphyotrichum puniceum	1
Plantae	true sedges	Carex	3
Plantae	Virginia Glasswort	Salicornia depressa	3
Plantae	Virginia wildrye	Elymus virginicus	2
Plantae	white bog violet	Viola lanceolata	1
Plantae	white spruce	Picea glauca	1
Plantae	Whitetops	Doellingeria	2

Step 1: Take initial observation photo with iNaturalist iPhone application (Figure 16). Data captured includes date and time in the local time zone as well as the latitude + longitude co-ordinates at sufficient precision to allow a geospatial address to be assigned. Connection to the iCloud iNaturalist platform is essential for real-time observation location capture and species identification. Otherwise, field observations have to be processed manually at a later time. Data observation accuracy is facilitated if real-time processing can be achieved since not all photos taken are of sufficient quality for identification. Often, the observer may have to photograph a specimen several times

from different angles to capture an image of sufficient quality for analysis. It is a trial-and-error exercise made simpler by immediate feedback from the iNaturalist platform.

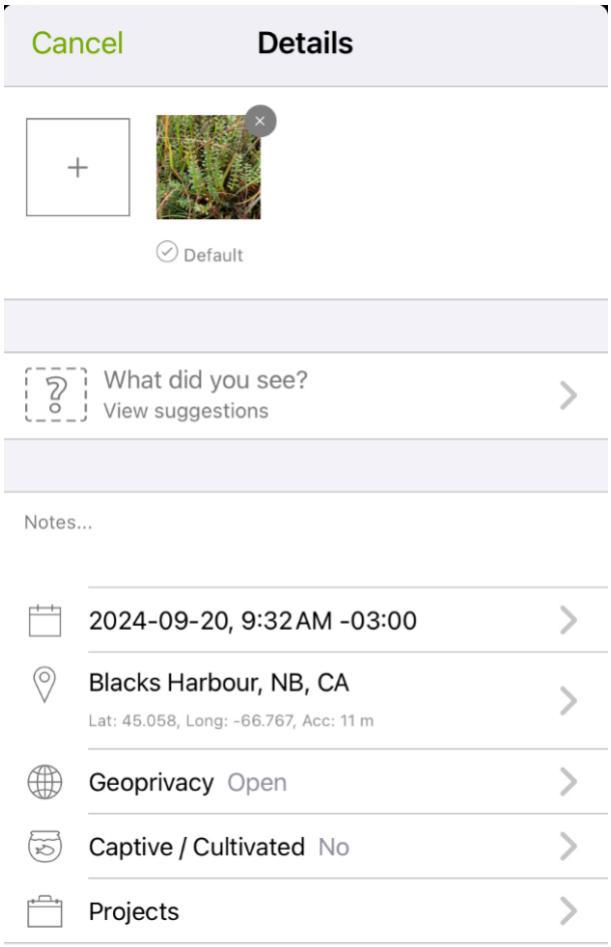


Figure 16: iNaturalist Initial Field Observation

Once the observation has been geolocated, iNaturalist will try to analyze the image to make a conclusive identification. The field observer uses the “What did you see?” functionality to review what the iNaturalist cloud platform has prepared for a possible species candidates.

Step 2: Select “best guess” identification from an iNaturalist list of potential species (Figure 17). Here, the application tries to generate a list of matches based on the photograph taken. In most instances, a set of specie’s photos is presented to the observer allowing the observer to scroll through the list and make a selection they feel

matches their field observation. All field observations were assigned the first “Top Suggestion” from this iNaturalist suggestions.

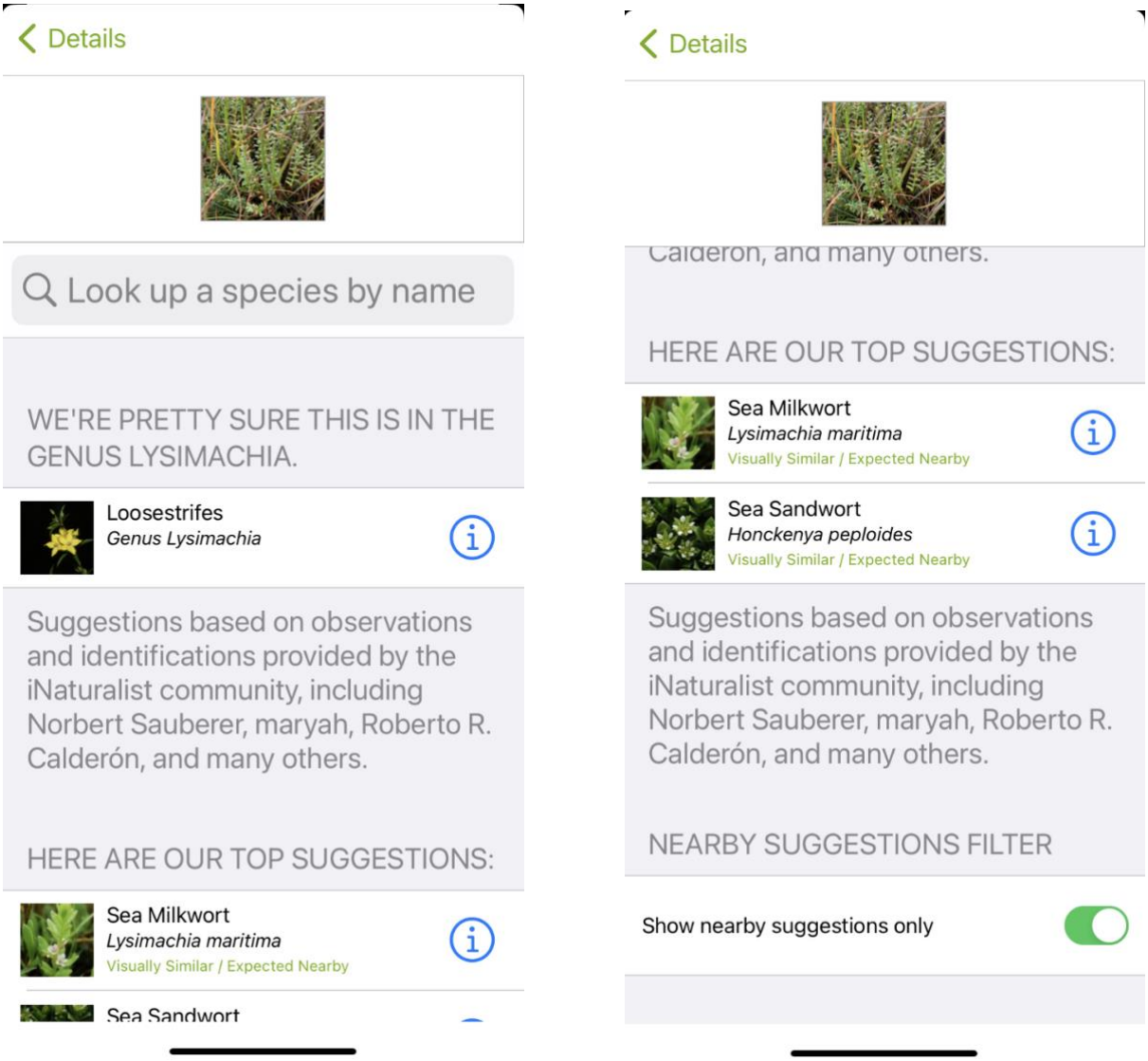


Figure 17: iNaturalist analysis of the field observation & recommendations for ID.

Step 3: Other members of the iNaturalist community can comment on the observations and their selected identifications to either agree or to suggest an alternate identification. In some instances, a given observation may be marked “Research Grade” from an independent observer authorized to qualify data in this regard (Figure 18). These research grade identifications are the highest form of validation within the iNaturalist data enterprise. Practically speaking, researchers should try to obtain research grade

confirmation for each field observation they have made. The caveat is that this is a voluntary exercise and there is no way to compel iNaturalist experts to certify any given

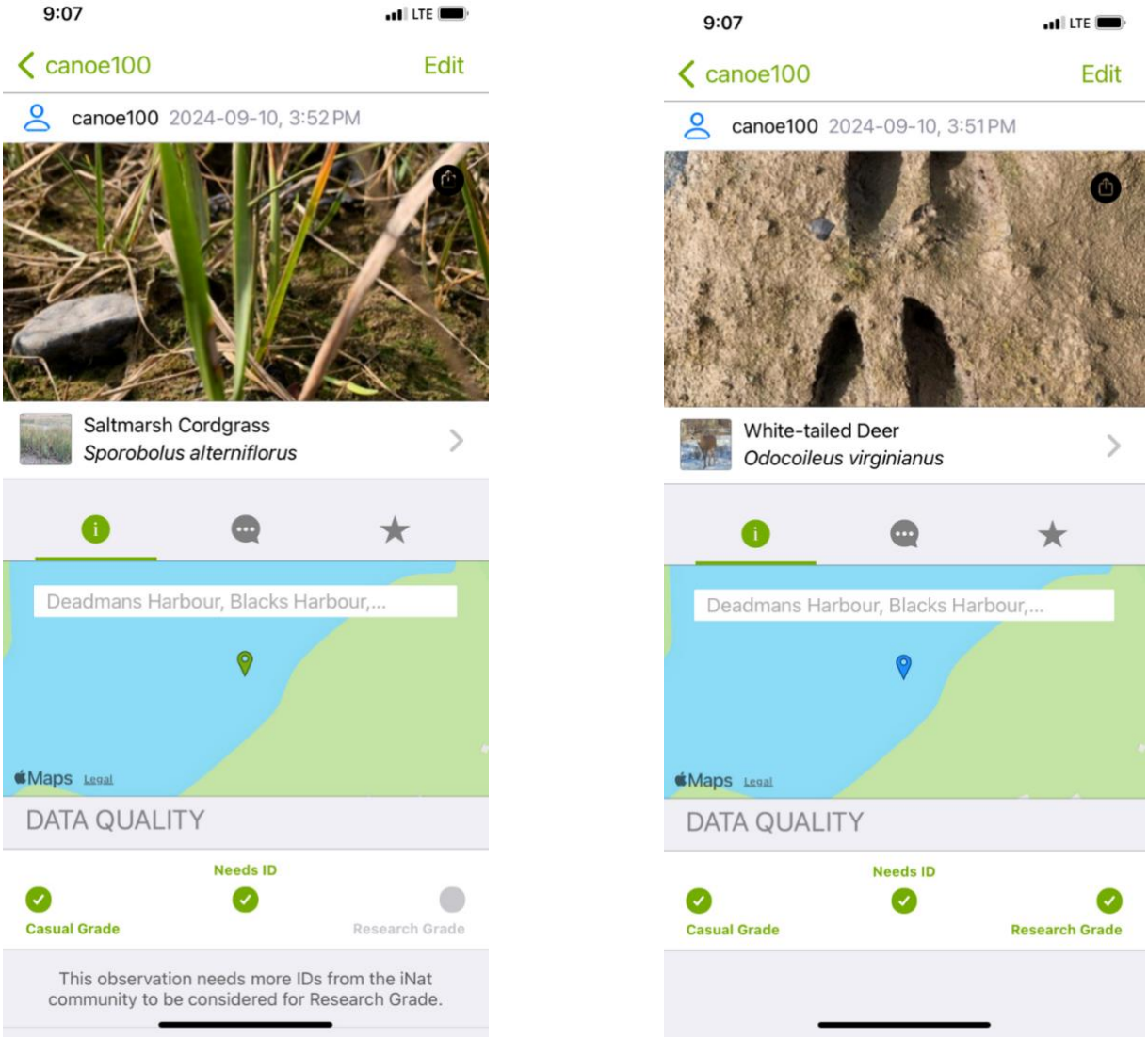


Figure 18: iNaturalist data quality overview.

field observation. This is both the strength (FREE of charge) and weakness (non-obligatory) of this identification technique.

Chapter 5: Data Analysis

5.1 Analysis and Discussion

The purpose of the field surveys at Deadman's Head saltmarsh was to find any SAR in the buffer zone between the high tide mark and the forest edge. On September

10th and September 20th, 2024, two walking transects were conducted in order to collect sample data using the iNaturalist application. In all, 66 species from different taxonomic groups including plants, birds, mammals, and invertebrates were found.

No animal listed under the Government of New Brunswick SAR registry was directly observed in spite of the extensive fieldwork. Even though they were not seen during this survey period, there were a number of animal species that were recorded, including the common glasswort (Salicornia europaea) and saltmarsh cordgrass (Sporobolus alterniflorus), which are typical elements of habitats known to support SAR, indicating that the saltmarsh may offer favorable conditions for such species (Crosby et al.,2016). The other species listed are common native plants and animals in Canada, while some (like Common Periwinkle) are non-native species.

In order to find species whose habitat ranges overlap with the saltmarsh, the second SAR detection method used a comparative analysis. The analysis focuses on species that depend on saltmarshes and are either known to live in similar ecosystems in New Brunswick or are currently listed as SAR based on their preferred habitats. Several species, such as the eastern mudminnow (Umbra pygmaea) and Nelson's sparrow (Ammospiza nelsoni), were identified as possibly utilizing the saltmarsh. Marshes and wetland habitats are essential to the feeding, nesting, and spawning of both species (Environment and Climate Change Canada, 2023). Even if they were not seen during the fieldwork, the likelihood of these and other SAR using the area is increased by the presence of typical saltmarsh vegetation and a largely intact marsh ecosystem.

5.1.1 Invasive species

The European Green Crab was identified among the wildlife in the saltmarsh. In Canada, the European Green Crab (Carcinus maenas) is regarded as an invasive species rather than a threatened one. Instead of being threatened, it threatens native species and ecosystems (Greenberg & Lars, 2013). Protecting native Canadian wildlife species that face extinction or extirpation is the goal of the Species at Risk Act. SARA does not provide protection for invasive species, such as the European Green Crab (COSEWIC, 2022). Because of its detrimental effects on native species and habitats,

the European Green Crab is actually being controlled and managed in Canadian waters.

5.2 Impacts of Climate Change on Saltmarsh Habitat

Current Conditions:

The Deadman's Head saltmarsh is characterized by:

- Location along the Bay of Fundy coastline
- Exposure to significant tidal fluctuations
- Diverse habitats supporting unique flora and fauna
- Regular tidal flooding, typically twice daily

Potential Future Changes

1. Sea Level Rise
    - Increased inundation frequency of saltmarshes
    - Potential habitat loss for species like the Saltmarsh Sparrow and Eastern Baccharis
    - Shifts in vegetation zones and species composition
2. Temperature Changes
    - Alterations in species distribution and migration patterns
    - Potential changes in breeding and nesting cycles of birds like the Piping Plover
3. Precipitation Patterns
    - Changes in freshwater input could affect salinity levels
    - Impacts on habitat suitability for species like the American Eel
4. Extreme Weather Events
    - Increased storm intensity may lead to erosion and habitat degradation
    - Potential disruption of nesting sites for shorebirds

5.3 Key Findings

5.3.1 Climate trends and future projections for the Bay of Fundy region and Southwestern New Brunswick

Table 2: Climate projections for the saltmarsh

Climate Factor	Current Measurement	Projection 2050	Projection 2100
Tidal Range	Up to 16m	16-17m	17m+
Average Winter Temperature	1.5°C - 2°C increase	2.5°C increase	3.5°C increase
Average Summer Temperature	1°C increase	1.5°C increase	2°C increase
Annual Precipitation	10% increase	15% increase	20% increase
Sea Level Rise	0.2m rise	0.5m rise	1m rise

Table 2 and Figure 19 provide a summary of current climate measurements and projections for 2050 and 2100, covering key factors such as tidal range, temperature, precipitation, and sea level rise. These trends show the potential impacts on the saltmarsh habitat and associated species at risk.

5.3.2 Analysis of The Bay of Fundy Climate Trends

The Bay of Fundy has some of the highest tides in the world (up to 16 meters) according to its tidal patterns (Bay of Fundy Tourism Partnership, n.d). Current measurements highlight a slow rise in sea level, which is consistent with the global trend of rising sea levels linked to climate change (Daigle, 2020). It is anticipated that this increase will continue, with major ramifications for infrastructure and coastal resilience. Temperature trends show a distinct warming trend in southwestern New Brunswick (Figure 19). Over the past 50 years, average annual temperatures have increased, with the most noticeable increase occurring during the winter months (roughly 1.5°C to 2°C). The increase in heatwave frequency during the summer months further emphasizes the region's shifting climate, which could stress local ecosystems, agriculture, and public health systems (Environment and Climate Change Canada, 2020).

Precipitation trends in Southwestern New Brunswick show a steady increase in annual rainfall, characterized by more frequent and intense rainfall events (IPCC, 2021). This shift, especially evident in the fall and winter, raises the risk of seasonal flooding,

affecting infrastructure and emphasizing the need for improved flood management strategies. Additionally, the growing number of days with heavy precipitation adds further pressure on water management systems (Environment and Climate Change Canada, 2019).

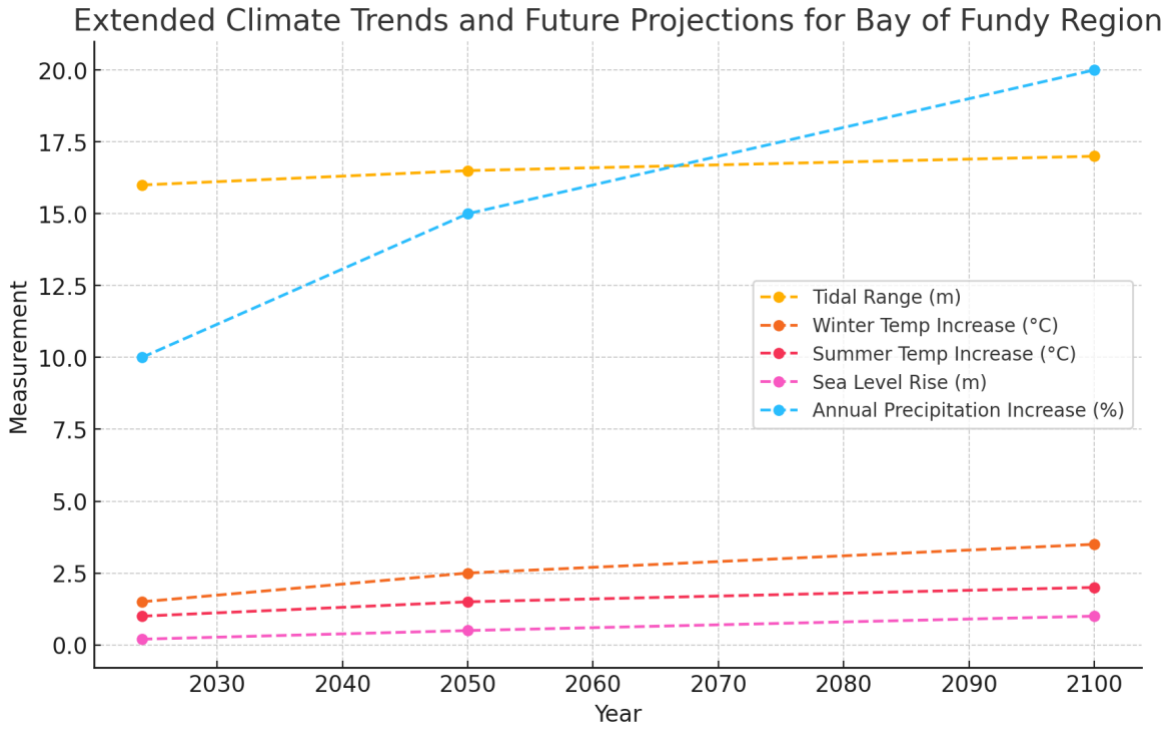


Figure 19: Graph showing summary of climate data.

By the century's end, projections for the Bay of Fundy forecast a sea level rise of 0.5 to 1 meter (Daigle, 2020). The result is an escalating risk of coastal flooding and erosion, combined with a projected increase in both the frequency and intensity of storms. These projections stress the need for proactive measures to mitigate the impacts of climate change (IPCC, 2021).

5.3.3 Effects of Climate Change on the Potentially Present Species at Risk

Table 3 : Species and Potential Climate Change Effects

Species	Common Name	Latin Name	Status	Potential Climate Change Effects
1)Piping Plover	Piping Plover	Charadrius melodus	Endangered	- Loss of nesting habitat due to sea level rise - Increased flooding from storms - Altered food availability due to changes in prey populations.

2)Bank Swallow	Bank Swallow	Riparia riparia	Threatened	- Erosion of nesting banks from extreme weather - Changes in insect populations affecting foraging success.
3)Barn Swallow	Barn Swallow	Hirundo rustica	Threatened	- Shifts in insect prey availability due to temperature changes - Damage to nesting structures from severe weather.
4)Common Nighthawk	Common Nighthawk	Chordeiles minor	Threatened	- Changes in insect populations affecting foraging success - Habitat alterations impacting nesting and foraging areas.
5)Peregrine Falcon	Peregrine Falcon	Falco peregrinus anatum / tundrius	Special Concern	- Changes in prey availability (shorebirds and waterfowl) - Potential loss of nesting sites due to coastal erosion and habitat changes.
6)Short-eared Owl	Short-eared Owl	Asio flammeus	Special Concern	- Habitat alterations affecting hunting grounds - Changes in small mammal and bird populations impacting prey availability.
7)Monarch Butterfly	Monarch Butterfly	Danaus plexippus	Special Concern	- Changes in flowering plant phenology affecting nectar availability - Altered migration patterns due to temperature and wind shifts impacting survival rates.
8)Eastern Ribbon Snake	Eastern Ribbon Snake	Thamnophis sauritus	Special Concern	- Habitat loss from wetland changes - Altered prey availability due to ecosystem shifts caused by rising temperatures.
9)American Eel	American Eel	Anguilla rostrata	Threatened	- Changes in ocean currents affecting migration - Altered freshwater habitats due to rising sea levels and salinity.
10)Eastern Baccharis	Eastern Baccharis	Baccharis halimifolia	Special Concern	- Coastal habitat loss due to sea level rise - Changes in competitive plant dynamics due to shifting climate zones.
11)Saltmarsh Sparrow	Saltmarsh Sparrow	Ammospiza caudacuta	Endangered	- Loss of saltmarsh habitats from sea level rise - Increased flooding of nesting areas - Altered prey availability.

5.4 Broader Ecological Impacts of Climate Change on Saltmarshes

Places like the saltmarsh are critical ecosystems for ecological, economic, and social benefits. In turn, the impacts of rising sea levels, temperature rises, extreme weather, and changes in precipitation patterns challenge its functionality and resilience. Given this, the following wide ranging ecological implications:

1. Disruption of Nutrient Cycling

Saltmarshes also provide the critical transition zones controlling the exchange of nutrients like nitrogen and phosphorus between terrestrial and aquatic systems that help maintain healthy ecosystems with good water quality. Climate change is now altering

the salinity and flow patterns disrupting the marsh's capacity to absorb and release these nutrients. This in turn can result in the eutrophication of contiguous water bodies, which may have devastating impacts on marine life.

2. Reduced Carbon Sequestration

Saltmarshes are good carbon sinks, storing carbon dioxide in both plant biomass and the soil. This function is being undermined by rising sea levels and erosion: when marsh vegetation is either drowned or uprooted, the carbon stored within is released into the atmosphere, adding to emissions of greenhouse gases. This lost sequestration potential lessens the marsh's ability to mitigate climate change.

3. Biodiversity Decline

Saltmarshes are highly important habitats to a broad variety of species including SAR. Such areas are being reduced by increased sea levels, habitat fragmentation, and extreme weather conditions. This will not only have impacts on SAR but also on the broader food web and a decrease in overall genetic diversity to weaken ecosystem’s health.

4. Loss of Ecosystem Resilience

The potential or capability of either resistance or recovery by a system after disturbances, while keeping at least its essential functions intact, is resilience. The human encroachment upon the marsh continuously weakens its growing capacity to adapt to each and every disturbance caused by climate stressors from storms to rising temperatures. It, therefore, makes this system more vulnerable to invasive species such as the European Green Crab which degrades the native biodiversity and ecological balance.

5. Economic and Social Impacts

Saltmarsh degradation has direct and indirect consequences for human communities.

Fisheries and Livelihoods: Many species of commercial importance depend on saltmarshes either for spawning or feeding. Thus, saltmarsh habitat loss could negatively impact fisheries and its economy.

Storm Protection and Flooding: Healthy marshes protect the coast from storm surges and erosion. With their reduced protective function, the possibility of flooding and infrastructural damage increases.

Tourism and Recreation: The degradation of biodiversity and scenic values diminishes the opportunities for bird watching, eco-tourism, and recreation, affecting the regional economy negatively.

5.5 Ecological Significance of The Saltmarsh

The saltmarsh demonstrates several key ecological functions:

1. Biodiversity Support: The diverse species inventory indicates that the saltmarsh provides habitat for a wide range of organisms, contributing to local and regional biodiversity.
2. Coastal Protection: As noted in Chapter 2, saltmarshes play a crucial role in protecting coastlines from erosion and storm surges. The presence of a healthy saltmarsh at Deadmans Cove likely provides this ecosystem service to the local area.
3. Carbon Sequestration: Saltmarshes are known for their capacity to sequester carbon. The vegetation observed during the surveys suggests that this saltmarsh is actively contributing to carbon storage, though quantitative measurements would be needed to assess its full potential.
4. Nutrient Cycling: The interaction between terrestrial and marine environments in the saltmarsh facilitates important nutrient cycling processes, supporting both aquatic and terrestrial ecosystems.

5.6 Survey Methodology Effectiveness and Limitations

The use of iNaturalist for species identification proved effective for creating a broad inventory but has limitations:

1. Identification Accuracy: While the three-step validation process improves accuracy, some identifications may still be subject to error, especially for less common or difficult-to-identify species.
2. Temporal Limitations: The surveys were conducted on two dates in September, which may not capture seasonal variations in species presence.
3. Spatial Coverage: The focus on the buffer zone, while practical, means that some species utilizing the aquatic portions of the saltmarsh may have been overlooked.

5.6 Conservation and Management Recommendations

- **Habitat Conservation**: Implement adaptive management strategies to allow for saltmarsh migration inland and establish buffer zones to protect critical habitats from development.
- **Species-Specific Interventions**: Develop targeted conservation plans for each identified species at risk and monitor population trends and habitat use.
- **Climate Change Adaptation**: Incorporate sea level rise projections into long-term conservation planning and explore the potential for creating “living shorelines” to enhance coastal resilience.
- **Research and Monitoring**: Establish long-term monitoring programs to track changes in species distribution and abundance and conduct further studies on the impacts of climate change on saltmarsh ecosystems.
- **Stakeholder Engagement**: Collaborate with local communities, Indigenous groups, and conservation organizations, and develop public education programs to raise awareness about the importance of saltmarshes and SAR.

These findings underscore the critical role of the Deadmans Head Saltmarsh in supporting biodiversity, protecting coastal areas, and mitigating climate change impacts. The report highlights the need for continued conservation efforts and adaptive management strategies to ensure the long-term health and resilience of this vital ecosystem.

Chapter 6: Saltmarsh and Legal Instrument Implications

6.1 Introduction.

In terms of the living laboratory and its future, part of understanding what it could evolve to be is bounded by many factors such as potential usage for scientific purposes, benefits to the general public, benefits to nature, usage by private and public ventures, etc. However, all of these various ideas have one common element: they must conform to what the current legal / judicial framework will allow. Both the topic of SAR and usage have complex legal restrictions and requirements. As such, we will review each separately to keep this analysis unambiguous regarding legal instruments governing each topic. Suffice it to say that, taken together, one must union both sets of legal requirements to answer questions like “can we do this, can we do that?”.

6.2 Legal instruments controlling Species-At-Risk (SAR)

The Government of Canada (GOC) SAR Act (GOC SARA, 2024) and the Government of New Brunswick (GNB) SAR Act (GNB SARA, 2012) are the umbrella legal instruments for protection and conservation of SAR in the Province. Each has mechanisms created to manage SAR with the GNB Act being a child of the GOC Act from an enforcement (i.e. court system) perspective. It should be noted that the GOC Act obligates / mandates each Province and Territory to create and maintain its own SAR Act in an effort to provide for the legal co-ordination of protection and conservation controls (Lindgren, 2001). Offences unresolvable under the GNB court system are escalated to the GOC court system where the Supreme Court of Canada has the final determination in any SAR offence / legal challenge. However, practically speaking, all legal issues will begin at the lowest level of the Provincial court system. The SAR Acts are also linked to other federal and provincial laws such as:

- Department of the Environment Act	(federal and provincial)
- Department of Fisheries and Oceans Act	(federal)
-Fish and Wildlife Act	(provincial)
-Canada National Parks Act	(federal)
-Crown Lands and Forests Act	(provincial)

This list is not exhaustive but is meant to expose the complexity of the legal system relative to SAR protection, conservation and funding. Funding is targeted at activities that either restore, conserve or educate relative to SAR. Any SAR utilizing the saltmarsh

are under this jurisdictional umbrella. Figure 20 details these relationships and connections.

6.3 Legal instruments controlling Saltmarshes.

Understanding who owns saltmarshes in Canada / New Brunswick is the starting point to understanding how saltmarshes can be used / altered / protected. Firstly, the Government of New Brunswick establishes laws regarding coastal wetland (saltmarsh) usage. Ownership is divided into crown (public) and non-crown lands (private). Property tax is an annual levy property owners (private) in New Brunswick must pay to retain

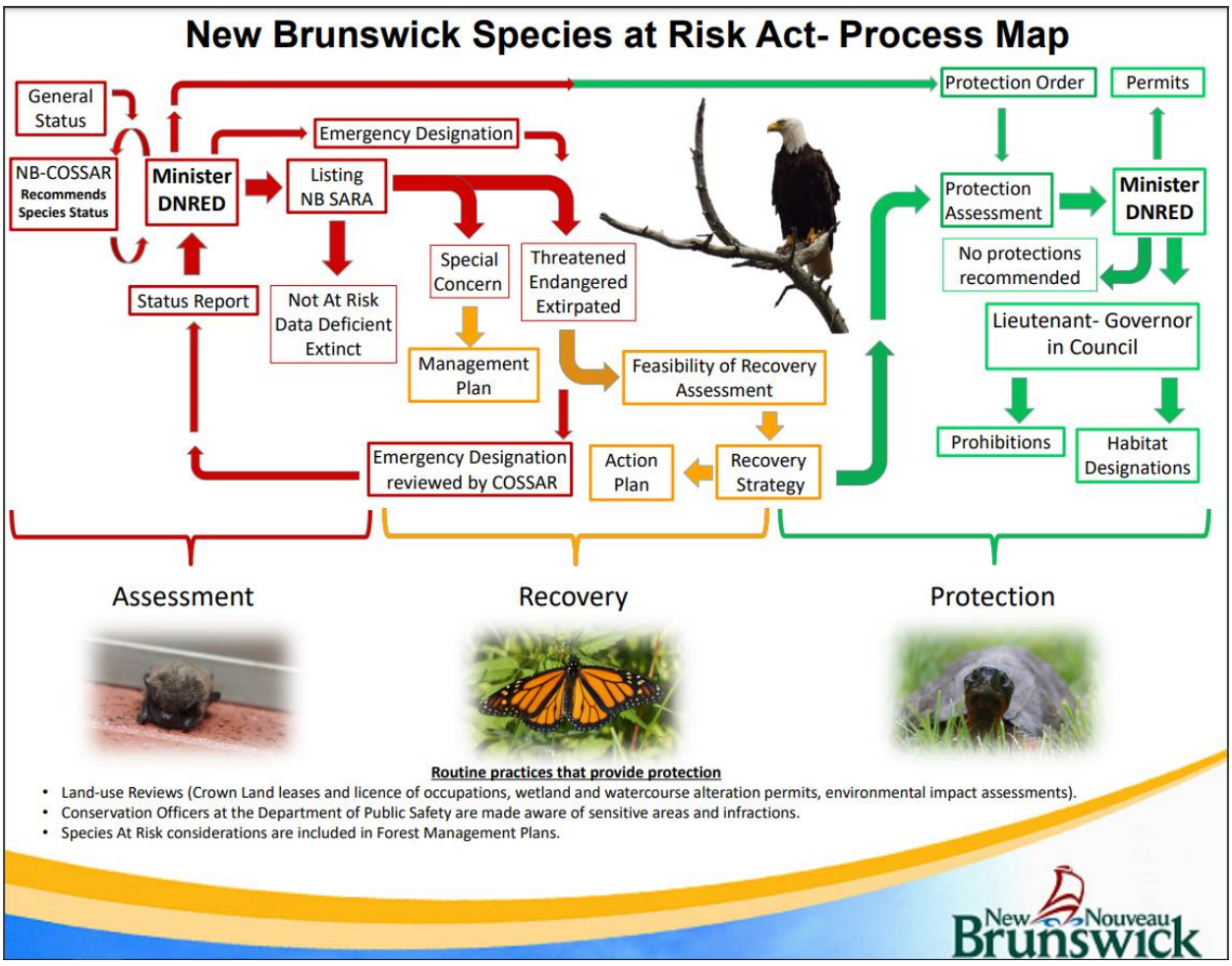


Figure 20: GNB SAR conservation / protection process map (GNB Process Map, 2024).

ownership of their land. It is municipality based and has its own legal instruments that are managed by Provincial / Territorial courts. In New Brunswick, the Government of New Brunswick (GNB) property tax assessments are collected annually (GNB Property

Tax Act, 2024). Failure to pay property tax allows the Crown to seize and liquidate such properties at Public Auction[1]. Among other things, the concept of land ownership can be determined by whether or not property taxes are collected for a certain area (GNB Property Tax Act, 2024). In New Brunswick, property tax data is classified as public information. All property tax assessments can be accessed from the Province of New

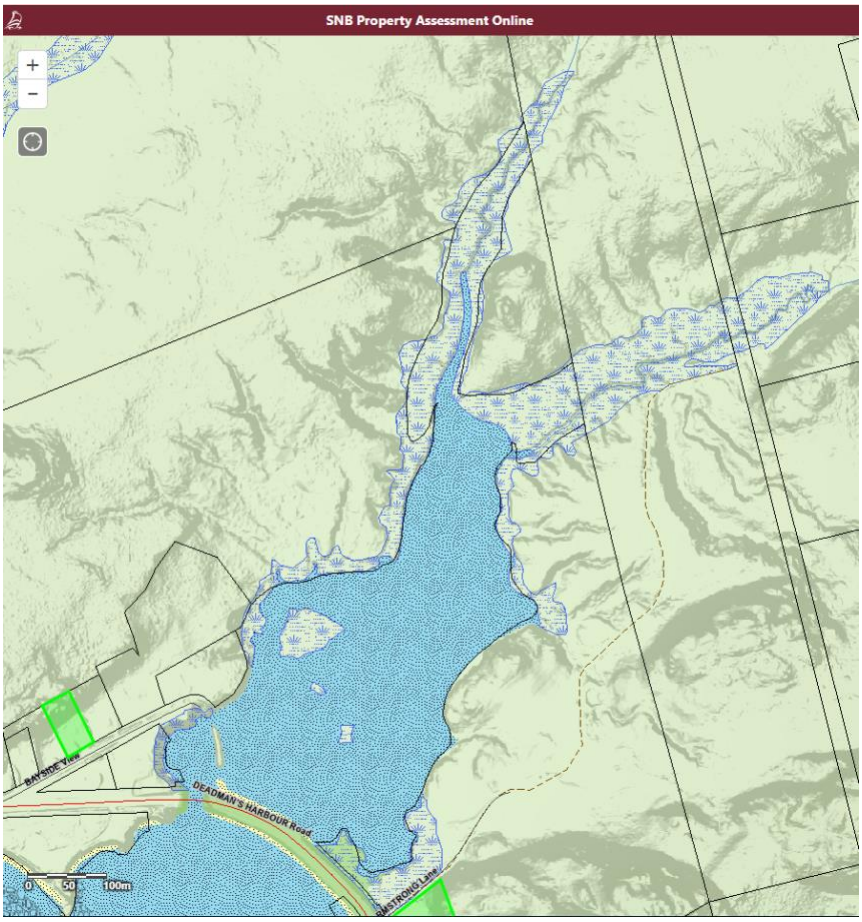


Figure 21: GNB Property Tax Borders Surrounding the Saltmarsh (SNB, 2024).

Brunswick's Property Tax website. For the saltmarsh (Figure 21) outlined in BLUE, the majority of it is designated Crown (public) land which means it cannot be bought / sold. However, property ownership borders (RED) can be seen covering the extreme limits of the two inland branches (Figure 22). Does this mean the landowner is free to do whatever they want with the portion of the saltmarsh that occurs on their property? The simple answer to that question is no. However, what might be legal with the approved permits (for example, filling in the saltmarsh area for forestry or agriculture or building

purposes) differs from what can be done to the public component of the saltmarsh. Private landowners can apply for a Watercourse and Wetland Alteration Permit (WAWA) (Figure 23, 24) to make alterations to wetlands residing on their private property. But this same regulation does not extend to public lands (DNRE 2024, WAWA, 2024). The Coastal Areas Protection Policy (CAPP) (GNB Coastal, 2019) also plays a significant

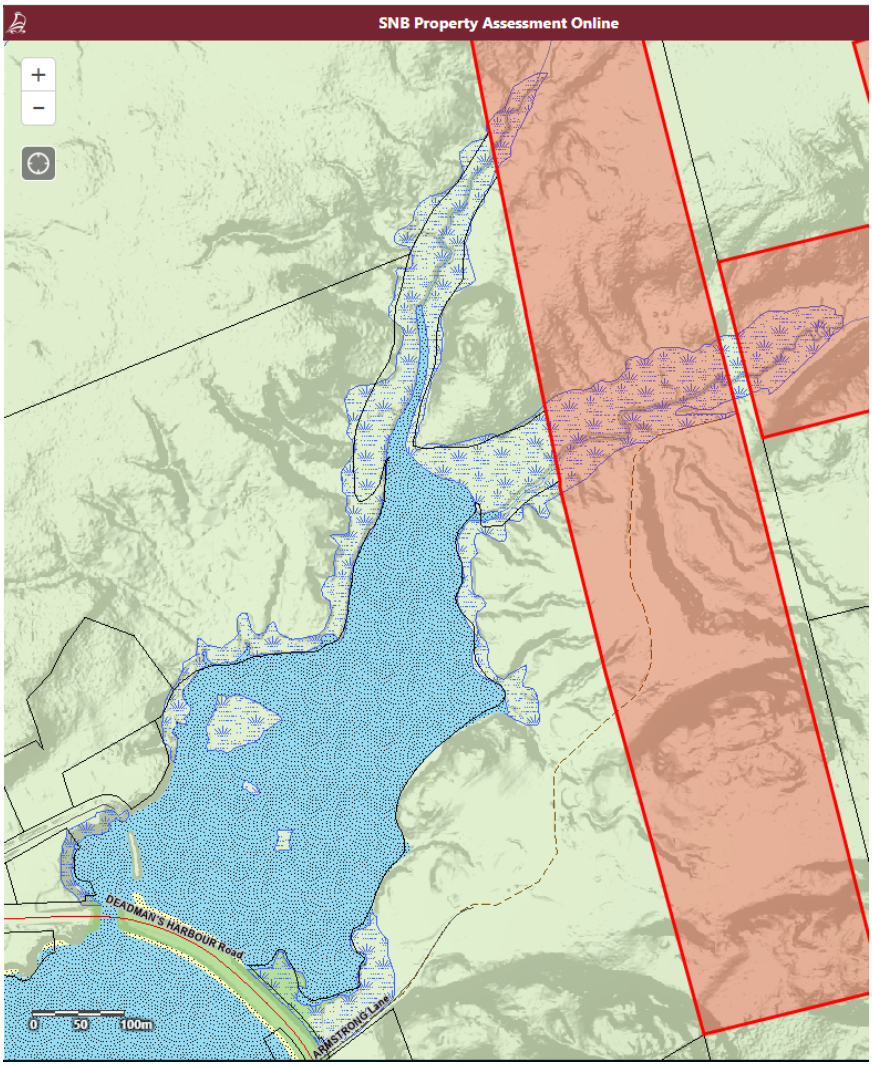


Figure 22: Saltmarsh areas residing within the border of private lands (SNB, 2024).

role in determining activities that can be undertaken on the saltmarsh and by who. It defines three classifications (zones) for all provincial coastal wetlands and includes what activities are / are not permissible. Zone A wetlands are considered the most ecologically sensitive and prohibit infilling / excavation of any kind. It also prohibits dredging & quarrying and the construction of any permeant structure. It also prohibits

the construction of causeways and instead requires bridges to be built. Lastly, it prohibits the construction of any erosion control structures. The saltmarsh is a ***Zone A provincially significant wetland*** in this regard. Therefore, even for those portions of the saltmarsh residing on private lands, these designations prohibit any type of alternation. Conservation activities are allowed but under strict circumstances.

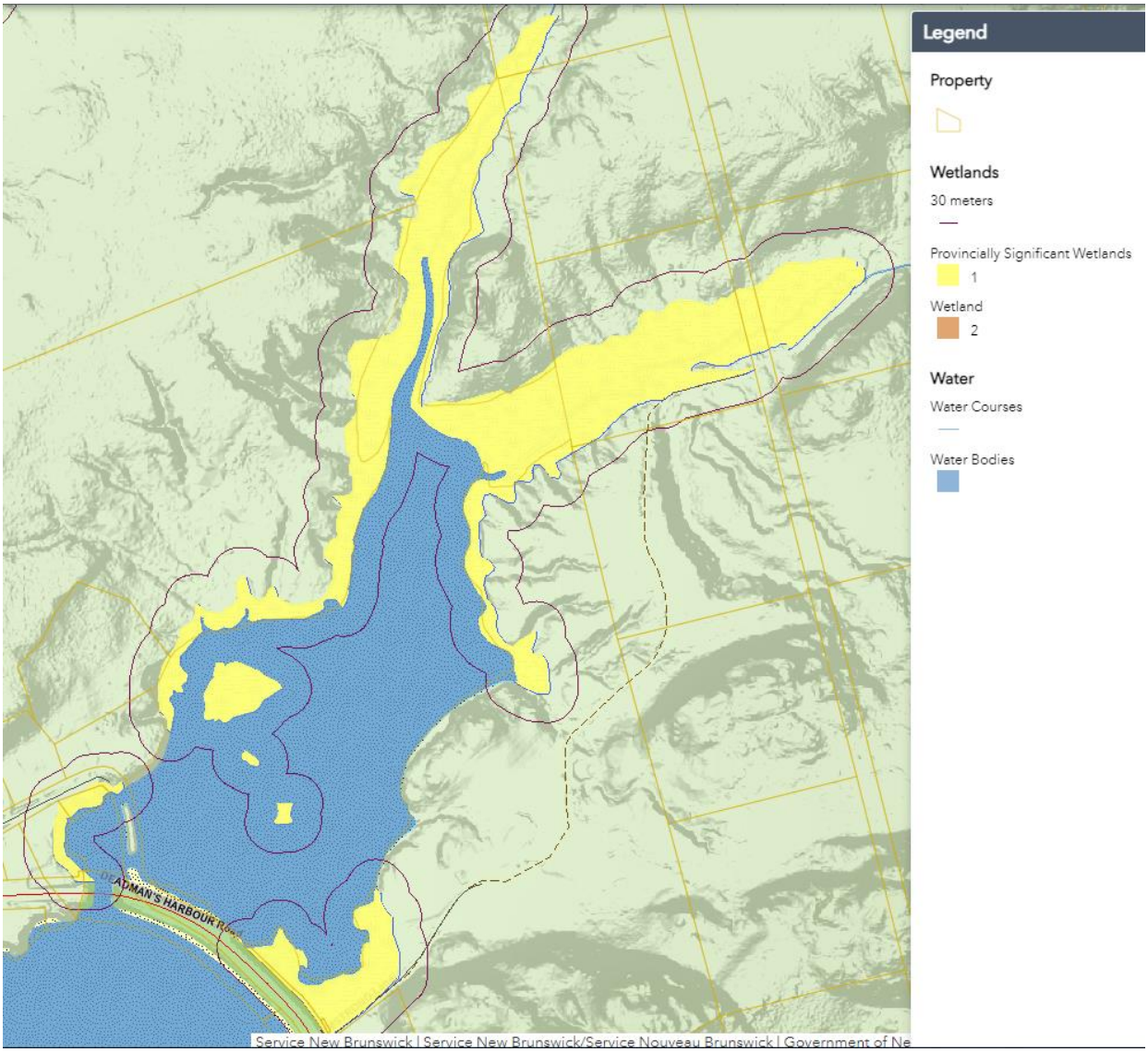
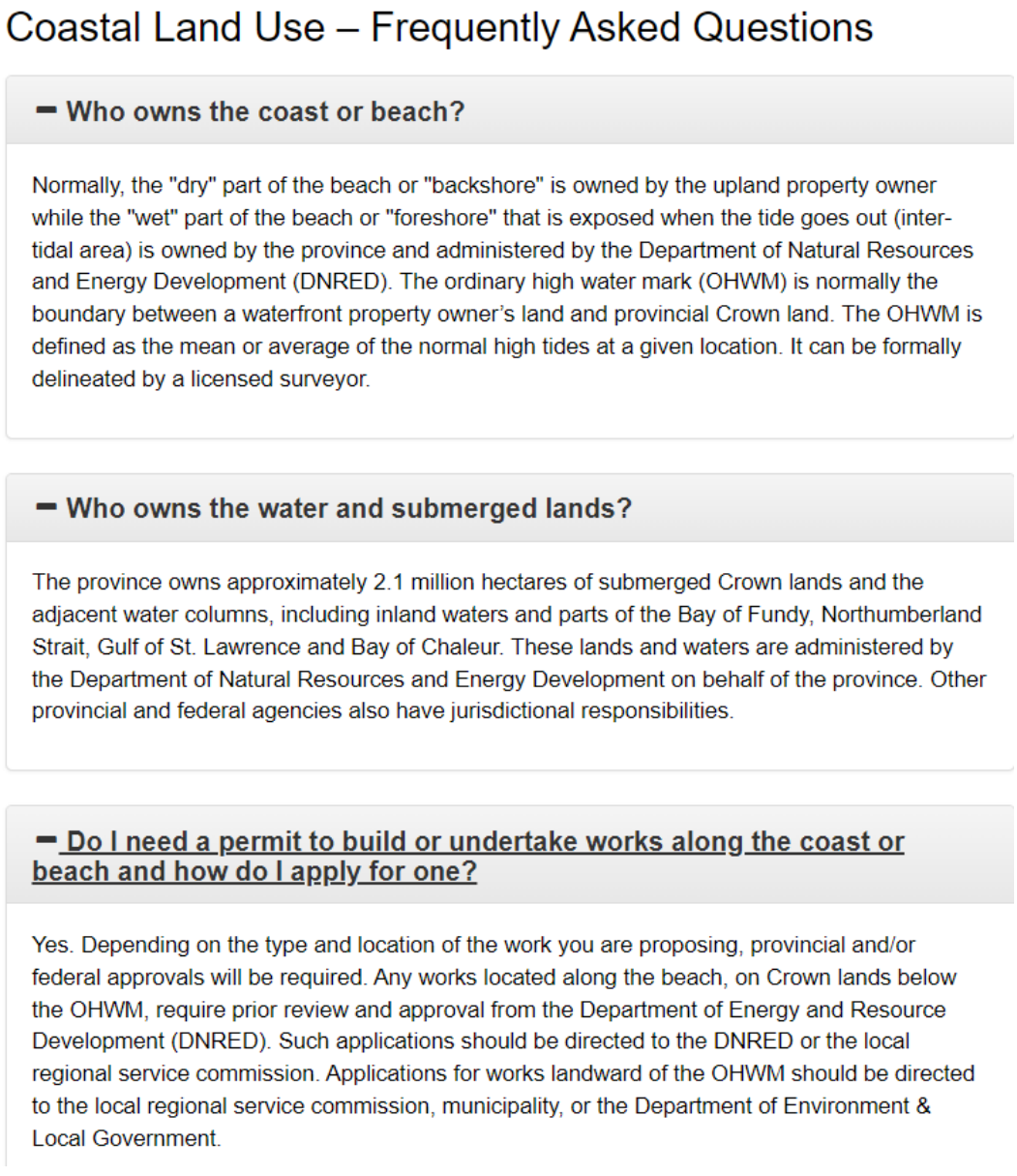


Figure 23: Provincially significant wetlands (WAWA, 2024).

Chapter 7: Recommendations

7.1 Non-Governmental Organization (NGO)

Every location on the Earth can be viewed as a combination of a geospatial area and the species that inhabit that area. Protecting both SAR and non-SAR is linked to protecting the associated environment used by these species. Protection comes in two flavors: active and passive. Passive protection occurs as a consequence of the legal system that has jurisdiction over a particular location. The legal system in effect on the day a particular action is taken governs whether or not the action is legal or illegal. For



Coastal Land Use – Frequently Asked Questions

– Who owns the coast or beach?

Normally, the "dry" part of the beach or "backshore" is owned by the upland property owner while the "wet" part of the beach or "foreshore" that is exposed when the tide goes out (inter-tidal area) is owned by the province and administered by the Department of Natural Resources and Energy Development (DNRED). The ordinary high water mark (OHWM) is normally the boundary between a waterfront property owner's land and provincial Crown land. The OHWM is defined as the mean or average of the normal high tides at a given location. It can be formally delineated by a licensed surveyor.

– Who owns the water and submerged lands?

The province owns approximately 2.1 million hectares of submerged Crown lands and the adjacent water columns, including inland waters and parts of the Bay of Fundy, Northumberland Strait, Gulf of St. Lawrence and Bay of Chaleur. These lands and waters are administered by the Department of Natural Resources and Energy Development on behalf of the province. Other provincial and federal agencies also have jurisdictional responsibilities.

– Do I need a permit to build or undertake works along the coast or beach and how do I apply for one?

Yes. Depending on the type and location of the work you are proposing, provincial and/or federal approvals will be required. Any works located along the beach, on Crown lands below the OHWM, require prior review and approval from the Department of Energy and Resource Development (DNRED). Such applications should be directed to the DNRED or the local regional service commission. Applications for works landward of the OHWM should be directed to the local regional service commission, municipality, or the Department of Environment & Local Government.

Figure 24: Defining saltmarsh ownership, usage and control by GNB (DNRE, 2024).

example, the Living Laboratory wishes to cut down all the trees on its peninsula at Deadman's Head. The existing laws governing this area require terrestrial buffers be maintained between water and land. So, this area cannot be harvested. What is left can be harvested for better or for worse. Active protection comes from citizens / groups whose beliefs are orientated to maintaining some ecological state for a location. With active protection, the fate of a location has a higher probability of being protected in its natural state as there are people actively engaged in activities to ensure this outcome. Beyond this, it takes a critical mass of individuals and money for environmental protection to occur. As the adage goes "freedom is not free" so equally it applies to "preserving nature is not free". It takes a well-organized and well-funded effort to conduct modern conservation / protection / restoration. NGOs are non-profit organizations in Canada that are well positioned for active protection of locations and species.

With that said, it is recommended that the Living Laboratory explore joining with an existing conservation-based NGO whose geospatial range overlaps that of the Living Laboratory and whose mission / vision statement aligns with that of the Living Laboratory. If this option is not feasible, then we recommend the creation of a long-term NGO with citizen membership from the local area as well as academia and other NGOs all united for the purpose of long-term (i.e. perpetuity) conservation of the environments on and around the Edwards property. Several well-established NGOs are potential candidates for this purpose including:

-**Eastern Charlotte Waterways Inc**. (ECW) is an NGO promoting sustainability in southwestern New Brunswick (https://www.ecw.ngo/).

-**Nature Trust of New Brunswick** (https://www.naturetrust.nb.ca/en/pagan-point-nature-preserve) is an NGO protecting habitat in New Brunswick in perpetuity. Amongst its assets is the 920-acre Ross Island property on Grand Mana in the Bay of Fundy and the Pagan Point Nature Reserve in St. Andrews. These particular habitats shares many similarities to both the saltmarsh and its surrounding environments.

-**Ducks Unlimited Canada** (https://www.ducks.ca/stories/wetlands/perched-on-the-edge-of-your-sea/) is an NGO focusing on wetlands (freshwater and saltwater) preservation by buying, restoring and protecting these areas in perpetuity.

7.2 Long-term Monitoring

In terms of long-term monitoring of saltmarsh SAR species, the opportunity exists to establish a program that actively tries to measure both presence / absence as well as abundance. However, this is not a small undertaking and requires an organized approach that will persist though time. Such an effort requires both a commitment of time, money and resources. A strategic plan would need to be created that would address several critical issues. These are:

Ownership: what group / organization / interested party will take on the long-term monitoring of the saltmarsh for SAR species? Here, long-term means in perpetuity. Whoever takes on this key role must have the means and continuity-of-purpose to ensure that the monitoring program persists and has the resources it needs to be successful.

Monitoring Surveys: The survey plan itself needs to be designed based on the inputs found throughout this report. Creation of this plan should be done by experts with sufficient knowledge of the SAR species identified in this report to be able to competently define the times of year, the survey techniques and the execution plan of those surveys with sufficient detail to ensure success. A budget plan should also be created defining the equipment needed as well as the labor effort and any other details needed to execute the survey plan. This includes all data collection, analysis and dissemination.

Funding: Financial support will need to be secured from 1...n sources. This can include a combination of both private and public funds. However, the probability of securing funding will hinge upon A) the completeness and quality of the strategic plan for SAR monitoring on the saltmarsh and B) the effort by the ownership to pursue all existing and emerging funding streams in this regard.

It is recommended that such a strategic plan be drafted by volunteers from UNB.

7.3 Pre-causeway study

The boundaries of the saltmarsh may have been / are being negatively affected by the causeway on Route 778 (Figure 25). It is unknown what the natural boundaries of the saltmarsh were pre-European colonization. It is further unknow what the tidal exchanges were in terms of volume and pattern before the causeway. Lastly, it is unknow whether or not this anthropogenetic activity started a chain-reaction of events that are effectively causing the saltmarsh to diminish over time. Therefore, it is recommended that a study be conducted to answer these questions. Depending upon the outcomes, the long-term strategic plan for the conserving the saltmarsh should be adjusted accordingly. Outcomes could range from do nothing as there was / is no significant impact to total removal / replacement of the causeway to restore the saltmarsh to a more natural state.

Figure 25: Causeway blocking 90% of the saltmarsh's access to the Bay of Fundy.

Figure 26 is a map obtained from the New Brunswick Provincial Archives. The map was drawn in 1847 by the Royal Navy. This is the earliest recorded image of what the saltmarsh looked like spatially in its original state. There were no land crossings (roads, bridges, causeways) at this time. Note also the relationship to the Deadman's Head Peninsula. Figure 27 contains this map's geospatial attributes including its scale in

Figure 26: Map drawn in 1847 showing the saltmarsh in its pre-European state.

"CABLES". In the British Navy the length of the cable is now officially set at 608 feet. It also includes depth soundings as well as a geological taxonomy for rocks / minerals and a compass rose indicating direction. Figure 28 is an aerial photograph of the saltmarsh in 1935 and we see what is believed to be the first instance of a causeway crossing the marsh. Lastly, Figure 29 was obtained from Google Earth's satellite imagery and shows a different causeway closer to the mouth of the estuary. It is unknow who built the 1935 causeway or how it was constructed or what became of it.

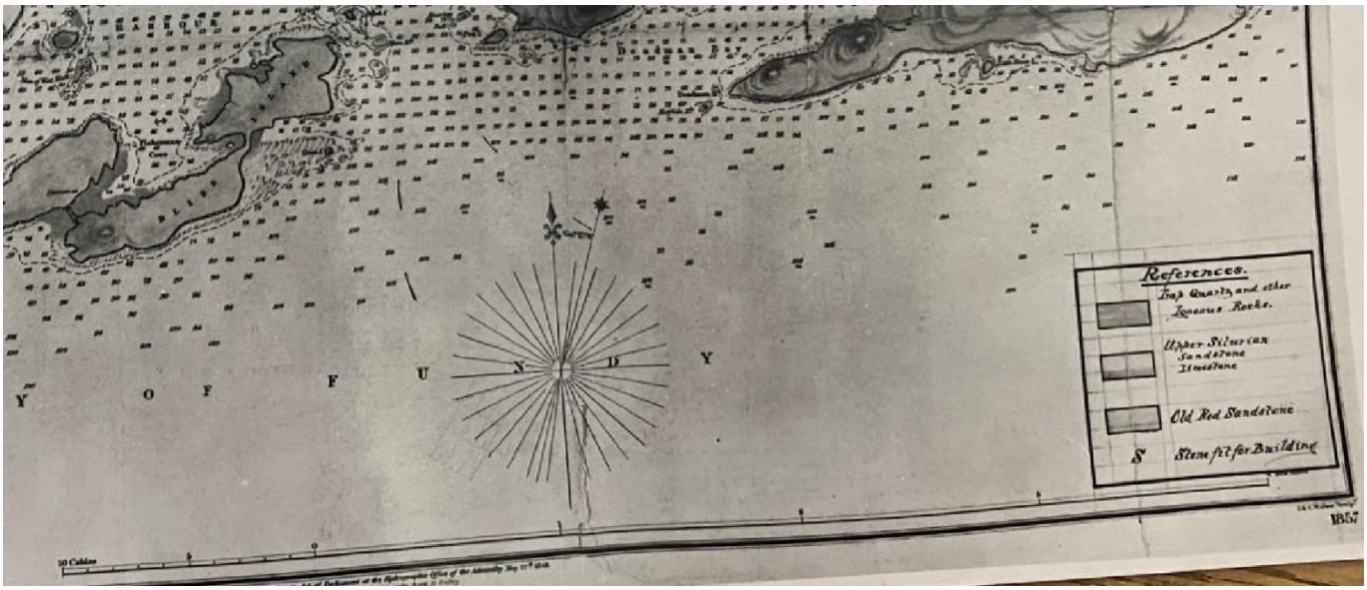


Figure 27: Map drawn in 1847 with scale, legend and compass rose indicated.

7.4 Carbon storage

Saltmarshes are strong agents for carbon sequestration (Council of Canadian Academies, 2022) in Canada. This has two potential opportunities: a means of fighting the effects of climate change and a means of generating revenue for conservation through the sale of carbon credits. To this end, it is recommended that a study be done to measure the potential for carbon storage within the saltmarsh as it exists today as well as if it was returned to its nature state from the actions of 7.2. It is further recommended that the potential for a revenue stream from selling carbon credits within the boundary of the saltmarsh be analyzed to see if there is a significant cost/benefit.

Figure 28: Aerial photograph taken in 1935 of the saltmarsh with causeway.

7.5 Pollution clean-up and control

During the SAR surveys executed in the fall of 2024, a large amount of waste was observed throughout the saltmarsh (Figure 30). It is recommended that an annual clean-up day be organized to remove all waste from the all-saltmarsh zones. This will enhance the quality of the saltmarsh habitat and promote a high-standard of environmental quality.

7.6 Funding for restoration and Funding for purchase of adjacent lands

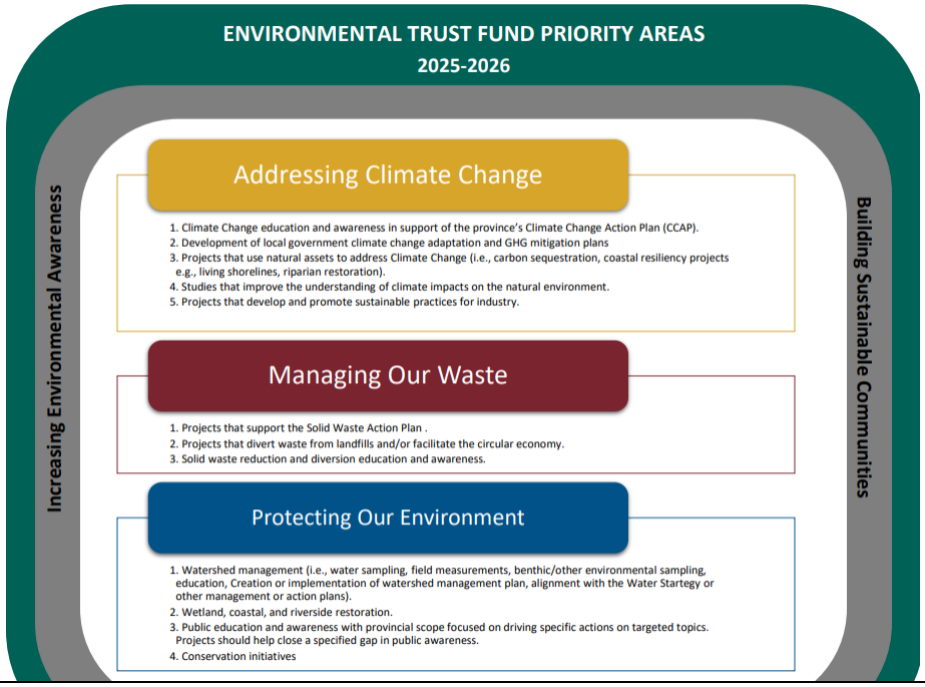
Whatever activities are planned for the saltmarsh's future, they will require money. Today, there exists multiple sources of funding for conservation, restoration and protection activities directly aimed at saltmarshes in New Brunswick. A search was conducted on sources of funding for both SAR and saltmarsh habitat conservation. The

results are very positive in that there are tens of sources available in this regard. Table 4 contains the ten funds we consider of significant value in this regard.

Figure 29: Google Earth satellite image taken in 2024 of the saltmarsh with causeway.

Figure 30: Waste examples observed on the saltmarsh Fall 2024.

Table 4: Sources of Funding

Organization	Value	Notes
1) Environmental Trust Fund (GNB)	100%	https://www2.gnb.ca/content/gnb/en/corporate/promo/environmental-trust-fund.html https://www2.gnb.ca/content/gnb/en/news/news_release.2010.10.1657.html 
2) Aquatic Ecosystems Restoration Fund (DFO)	100%	The AERF will support efforts that protect and restore coastal as well as marine areas by: -contributing to strategic planning and responding to restoration priorities -supporting restoration and rehabilitation of aquatic habitats and their long-term sustainability -educating the public on the impacts of human behavior on aquatic habitats -supporting co-benefits of aquatic restoration activities (e.g., nature-based solutions to climate change) -encouraging and building local community capacity St. Mary's University in Halifax will receive **$5 million over five years to restore approximately 30 hectares of saltmarsh habitat and natural hydrology through managed dyke realignment, and natural coastal processes to sequester carbon and reduce greenhouse gas emissions**. The project will also include a Mi'kmaw Indigenous knowledge assessment to help to build

		local scientific and technical capacity in the application of coastal restoration techniques. https://www.dfo-mpo.gc.ca/oceans/aerf-frea/index-eng.html
3) Wildlife Trust Fund		
4) Ecosystems and Oceans Science Contribution Framework (DFO)	100%	Fisheries and Oceans Canada (DFO) provides funding for ocean and freshwater science and technology in areas that support the mission of the Department to increase our understanding of ocean and freshwater environments. The Department provides funding to projects that deliver scientific research and related scientific activities that support evidence-based decision making and increase public understanding of marine and freshwater ecosystems. Related scientific activities complement and extend scientific research by contributing to the generation, dissemination and application of scientific and technological knowledge. Examples of this include: -data collection and integration -ocean and freshwater monitoring -data analyses -modelling and hypothesis testing -scientific capacity building (Indigenous recipients only) -communication of science in support of ocean literacy https://www.dfo-mpo.gc.ca/science/partnerships-partenariats/funding-financement/overview-apercu/index-eng.html
5) Coastal Restoration Fund (DFO)	100%	Northumberland Strait Saltwater Marsh Restoration Recipient: Clean Foundation Project achievements: Together with partners, the project team: -completed widespread assessments of saltmarsh health and function across the Northumberland Strait (Nova Scotia) -identified restoration sites with substantial input from regional communities Restoration at Marshall's Crossing converted failing culverts into a bridge and restored the natural hydrology of the area. At the Sitmu'k site of Pictou Landing First Nation they: -deployed a short segment of intertidal reef balls in front of the saltmarsh -planted the area with Spartina alterniflora (the saltmarsh bioengineering species) -sped stabilization and saltmarsh growth of the region Contributions made to existing guidance documents and shareable, open-access data resources has expanded capacity for other groups wanting to complete similar restoration work.

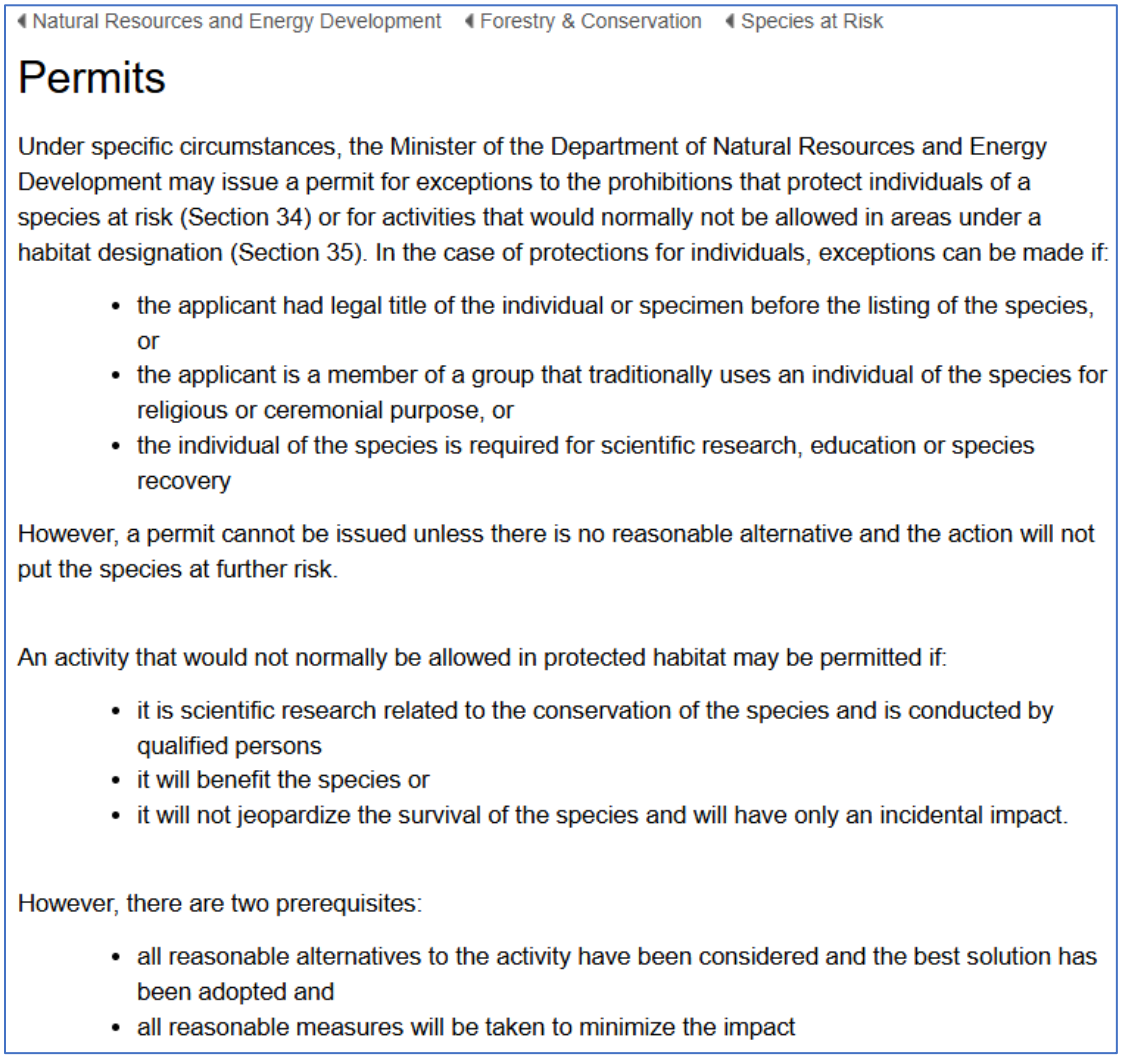
		Fund allocation: $2,414,173 over 5 years https://www.dfo-mpo.gc.ca/oceans/crf-frc/ns-ne-eng.html
6) Environmental Damages Fund (ECCC)	100%	The Environmental Damages Fund (EDF) is a Government of Canada program administered by Environment and Climate Change Canada. The Fund receives money from fines, penalties, court orders, and voluntary payments for environmental violations. This money is used to support projects that will benefit Canada's natural environment, usually in the area where the violation occurred. The Fund invests in projects falling within 4 funding categories: -Restoration -Environmental quality improvement -Research and development, and -Education and awareness Since 1995, more than $195 million has been invested in over 500 projects benefitting ecosystems and communities across Canada. https://www.canada.ca/en/environment-climate-change/services/environmental-funding/programs/environmental-damages-fund.html
7) MapleCross (https://maplecross.ca/)	Various	We make donations to organizations that have a Canada Revenue Agency (CRA) registered charitable number. Our funds are primarily for land securement with the objective of land conservancy and the preservation of Canada's nature. MapleCross does not accept donations from individuals or corporations. **Our pre-requisites for partnering with a land trust/conservancy:** • Board of governors (and advisory boards) • Organizational structure (leadership, management, volunteers) • Financial reports • Proven ability to raise funds from private and public sectors • Community support **Our pre-requisites for funding a project:** • Quality of the property: ecological importance, biodiversity, contiguity • Timing of acquisition • Breakdown of total project costs: property purchase price, affiliated costs (appraisal, legal, HST, etc.), stewardship costs • Leverage potential: private donors, government grants, community involvement, matching fund campaigns
8) Nature Conservancy Canada	Various	https://www.natureconservancy.ca/en/ https://www.natureconservancy.ca/en/where-we-work/new-brunswick/featured-projects/bay-of-fundy/musquash-estuary/

9) Habitat Stewardship Program for Species at Risk (ECCC)	$25K to $100K / year 1:1 dollar match	**Overview** The Habitat Stewardship Program for Species at Risk (HSP) was established in 2000. It provides funding for projects submitted by Canadians that contribute directly to the recovery objectives and population goals of species at risk listed on schedule 1 of the Species at Risk Act and that prevent other species from becoming a conservation concern. Environment and Climate Change Canada (ECCC) administers HSP funds that support terrestrial stewardship projects while Fisheries and Oceans Canada is responsible for administering the HSP for Aquatic Species at Risk. **Objectives** The objectives of this program are to: -support habitat projects that benefit species at risk, -enable Canadians to become actively involved in stewardship projects for species at risk, which will result in tangible and measurable conservation benefits, and -improve the scientific, sociological and economic understanding of the role of stewardship as a conservation tool. **Eligible activities** The Habitat Stewardship Program funds the following activities. More details can be found in the applicant guide. Habitat protection and securement Habitat improvement Species and habitat threat abatement Conservation planning Surveys, inventories and monitoring Outreach and education Project evaluation https://www.canada.ca/en/environment-climate-change/services/environmental-funding/programs/habitat-stewardship-species-at-risk.html
10) Canada Nature Fund for Aquatic Species at Risk (CNFASAR)	$50K to $1M	Objective of the program **The objective of the CNFASAR is to slow the decline of aquatic species at risk and enable their recovery through funding multi-species recovery and protection activities through place-based and threat-based approaches. DFO has identified 2 priority marine threats and 9 priority places as the focus for projects funded by CNFASAR. The fund is intended for medium to large projects that range from $50,000 to $1 million over 3 years. The fund will prioritize Indigenous led projects, as well as projects that clearly**

		demonstrate the inclusion of Indigenous partners (i.e., as part of the development, design and implementation processes). Preference will also be given to projects that engage many partners and address program priorities. **Funding is available for projects that can be completed by March 31, 2026. To apply for this funding, an expression of interest must be completed and emailed to a regional coordinator by July 14, 2023 at 23:59 (closing at 11:59pm for your region) to be considered.**

7.6 Saltmarsh Permitting in New Brunswick

There is a hierarchy of government permits (Figure 31) required to conduct activities on the saltmarsh. Three of the most significant are:



Natural Resources and Energy Development ◂ Forestry & Conservation ◂ Species at Risk

Permits

Under specific circumstances, the Minister of the Department of Natural Resources and Energy Development may issue a permit for exceptions to the prohibitions that protect individuals of a species at risk (Section 34) or for activities that would normally not be allowed in areas under a habitat designation (Section 35). In the case of protections for individuals, exceptions can be made if:

- the applicant had legal title of the individual or specimen before the listing of the species, or
- the applicant is a member of a group that traditionally uses an individual of the species for religious or ceremonial purpose, or
- the individual of the species is required for scientific research, education or species recovery

However, a permit cannot be issued unless there is no reasonable alternative and the action will not put the species at further risk.

An activity that would not normally be allowed in protected habitat may be permitted if:

- it is scientific research related to the conservation of the species and is conducted by qualified persons
- it will benefit the species or
- it will not jeopardize the survival of the species and will have only an incidental impact.

However, there are two prerequisites:

- all reasonable alternatives to the activity have been considered and the best solution has been adopted and
- all reasonable measures will be taken to minimize the impact

Figure 31: Permit exception process to override SAR protection regulation in New Brunswick (GNB Natural Resources and Energy Development, 2024)

7.6.1 Watercourse and Wetland Alteration Permit (WAWA)

-These are issued by the New Brunswick Department of Environment and Local Government.

-The purpose of the Watercourse and Wetland Alteration Regulation (90-80) - Clean Water Act is to protect provincial streams, rivers, lakes, and wetlands from work or ground disturbance in their vicinity (GNB Environment and Local Government, 2024).

7.6.2 Natural Resources and Energy Development – Government of New Brunswick

-There is a process for obtaining exceptions to the prohibitions that protect SAR individuals. This is a critical legal loophole to be aware of when creating long-term strategic plans for the conservation of SAR on the saltmarsh (Figure x).

7.6.2 DFO Scientific Research Permit

7.6.3 Dept. of Transportation for roadway permits

(https://www2.gnb.ca/content/dam/gnb/Departments/trans/pdf/en/RoadsHighways/EnvironmentalManagementManual.pdf)

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