Living Laboratory Project Phase Three

Where to From Here? The Future of Species at Risk in the Context of Climate Change at Deadmans Head, New Brunswick

Monarch feeding at Deadmans Head NB, September 12, 2024

Photo: Laura Lavigne

Kathryn Downton 3094577

Madison Crichton 3763644

Laura Lavigne 3591752

Amandeep Singh 3763310

Faculty of Forestry and Environmental Management

Master of Environmental Management, University of New Brunswick

ENMV 6007 – Practicum in Water, Wildlife, and Environmental Management

Instructor: Dr. Charles Bourque

Project Advisors: Ernie and Judy Edwards

December 9, 2024

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Executive Summary

This report presents the findings and recommendations from Phase 3 of the Living Laboratory project at Deadmans Head, New Brunswick. The project's purpose was to assess the impacts of climate change on species at risk and develop strategies for long-term land management and conservation. The project builds upon two previous phases that established baseline data on forest health and coastal community structures.

The property is a 43-hectare peninsula surrounded by the Bay of Fundy on three sides. The peninsula boasts diverse habitats, including steep rocky cliffs, beaches, meadows, and forested areas. One-third of the property is inhabited and actively used by the property owners Ernie and Judy Edwards, while the remaining two-thirds remain relatively untouched forest.

To accomplish the project goals, the project team conducted research to identify species at risk and establish a baseline for future monitoring. Field surveys were carried out using walk-through and plot survey approaches to identify and document the species present on the property. Profiles were created for each species at risk that could inhabit the property, providing detailed information on their status, habitat requirements, and potential climate change impacts.

Research on the possible impacts of climate change and conservation conflicts and options, took into consideration both local and regional climate projections in discussing possible conservation plans.

Based on the findings and in consultation with the property owners, the project team developed three key recommendations for the future management and conservation of Deadmans Head: 1) a "mixed management" zonal approach with selective habitat restoration in Zone 1 and the Zone 2 left largely to nature and future research, 2) partnering with cross-border land trusts for long-term land protection and preservation, and 3) ensuring the inclusion of Indigenous

knowledge in future research and assessment. These recommendations account for the preferences of the property owners, the review of species at risk and conservation literature, field and climate change data collected during the project, and the expertise of various land conservation organizations. The proposed approaches aim to balance the goals of scientific research, habitat conservation, and long-term land stewardship.

In conclusion, Phase 3 of the Living Laboratory at Deadmans Head established a baseline for species at risk on the property and developed strategies for SAR conservation and future research in the face of climate change including a recommendation to explore a framework for the long-term preservation of this ecologically significant area. The team hopes that the work conducted will be instrumental in achieving Edwards' goal of maintaining the property "in perpetuity" while adapting to changing environmental conditions.

1.0 Acknowledgements

1.1 Land acknowledgement

Deadmans Head and the University of New Brunswick are on the traditional, unceded territory of the Wolastoqiyik, Mi'kmaq, and Passamaquoddy peoples. This territory is covered by the "Treaties of Peace and Friendship", signed by First Nations ancestors and the British Crown in the 1700s.

1.2 Project acknowledgements

Sincere thanks to Ernie and Judy Edwards for providing the opportunity to work on this project. Their experience and guidance were both informative and deeply appreciated. We hope that the work we have done will be helpful in their goal of continuing to grow and evolve the Living Laboratory.

A special thanks goes to Professor Jae Ogilvie for his help on the mapping components, and to course director Charles Bourque for his guidance and expertise. As well thanks goes to Matt Abbot, Marine Conservation Director from the Conservation Council of New Brunswick for his help and advice on regional climate change models; to Dr Janice Harvey for explaining the genesis of climate change and species vulnerability work in the region; to Aiden Pluta of the Nature Trust of New Brunswick for information about the Conservation Partners Program; and Aaron Dowding, Jennifer White and Denise Roy of the Nature Conservancy of Canada for taking the time to explain how they work with landowners, and the long-term conservation options for the people who care deeply about the beautiful and ecologically important Canadian land they have been entrusted with.

2.0 Introduction

2.1 Study area

Deadmans Head is located between the communities of Blacks Harbour and Beaver Harbour, along the Bay of Fundy coastal Route 778 in southwestern New Brunswick. It is a 43-hectare, 3 km long peninsula owned by Ernie and Judy Edwards from Maine, U.S.A. who have been caring for this unique coastal ecosystem for over 20 years (Figure 1). The eastern side faces Deadmans Harbour and features two rocky beaches. The western side has a few small coves and spectacular lookouts, while the southern tip leads out to open ocean.

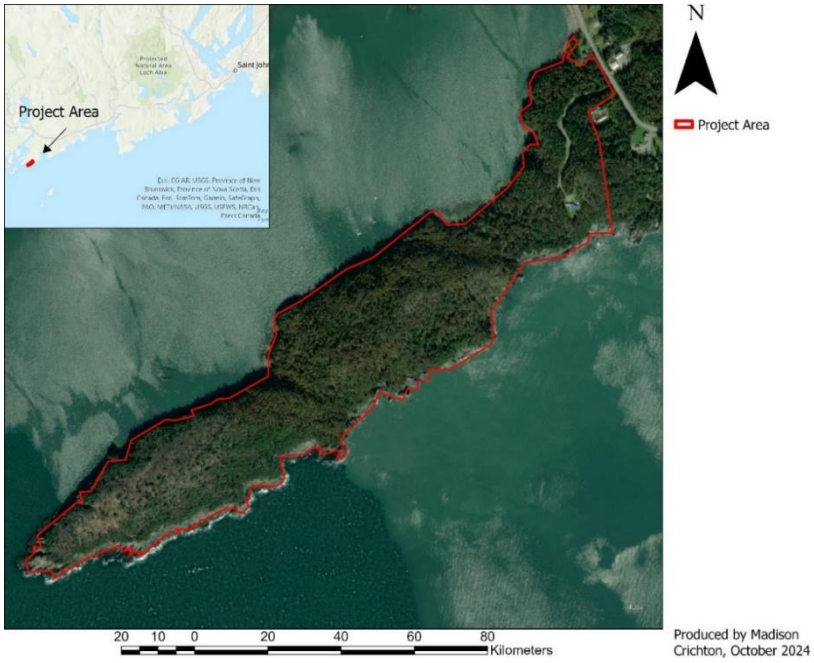

Figure 1. *The project area is at Deadmans Head, New Brunswick, Canada.*

The land is used in two main ways on the property with one-third reserved for human use and the other two-thirds left for nature. The one-third located nearest the access road is inhabited and frequently used by the Edwards. There is a long gravel driveway that leads to a small house

powered by solar panels, and a shed, with some lilacs and Rugosa Rose planted around the buildings. The house looks out onto a wildflower meadow, which leads to an area of regenerating forest. This section of the property has well-maintained trails, beach access to the east and some beautiful ocean lookouts. A vehicle control gate with a video camera is at the entry of the property to prevent uninvited access.

The other two-thirds of the property is forest that has been left relatively undisturbed since the 60's and has more recently been set aside for The Living Lab research project the Edwards have initiated. This section is mainly a mixed Balsam Fir, Spruce and Birch Forest, with one area that leads to a meadow and access to a shale beach on the Deadmans Harbour side. The rest is rough terrain bounded by steep cliffs leading down to the ocean. The cliffs provide the peninsula with some protection from storm events, however there is significant deadfall in the forested areas at the southern tip and at the highest elevations (Figure 2).

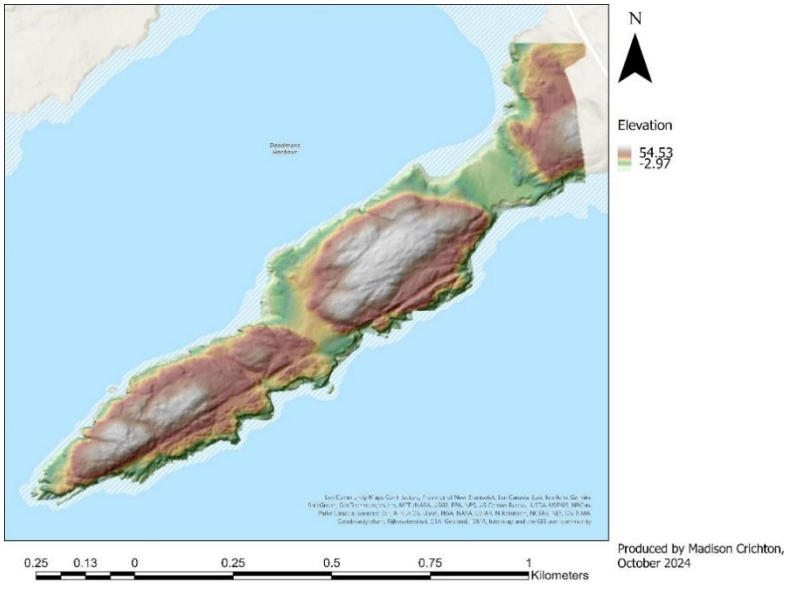

Figure 2. Digital elevation map of Deadmans Head.

In terms of history of the property, there are various traditional stories about how Deadmans Head received its name. One version is that bodies were discovered floating in the harbour in the early 1700s and that this had some connection with pirate treasure (Black's Harbour: Looking back at our beginnings, 2001).

Research suggests that that Passamaquoddy and Maliseet peoples inhabited this region before colonization, however further study is needed (Lotze & Milewski, 2002). The region's cadastral map (a cumulative record of land grants and ownership details) records an 1865 record of the first colonial settler as Thomas Berry (Appendix A). By this time, Deadmans Harbour was a fishing community with 4 settler families. But by 1871, it had a population of 60, and by 1904 had increased to one store and a thriving population of 50 (Provincial Archives, 2024). As was typical of the area, the settler families homesteaded on the property making a living fishing, farming & harvesting lumber. The east side of the property contains vestiges of this history with traces of an old carriage route leading to the remains of the farmhouse foundations.

The forest has been harvested at least several times over the years. The first time was likely during the 1700s when all the coastal forests around the region were reserved for the use of the British King's Navy who valued the tall straight old growth White Pines for frigate and battleship masts (Black's Harbour: Looking back at our beginnings, 2001). Neighbors told the Edwards the last time the forest was cut was in the 60's, and it has been left largely untouched since. (E. Edwards, personal communication, Dec 5, 2024).

When Ernie and Judy acquired the property, they tried to discover key historical information and have continuously sought out those who know more. It is of ongoing interest to the Edwards to have experts such as archeologists, geologists, biologists, ornithologists, divers,

etc., visit the site to explore the unknowns of the property and search for shipwrecks off the point.

2.2 Project background

This report marks the third phase in creating a "Living Laboratory" at Deadmans Head.

Phase 1 of the project gathered baseline data assessing the health and key characteristics of the forest and developed modelling to predict future species presence and potential threats (Evans et al., 2022). Their findings indicated that while the forest is considered "moderately healthy", significant climate-change-related impacts can be anticipated, including a shift northward in current tree species (p. 57). Recommendations included continued monitoring for forest composition and health, pests, and other climate-change-related issues over time.

Phase 2 of the project assessed the coastal community structures within the intertidal zones on the property which resulted in the creation of baseline data for species abundance in the study area (Murphy et al., 2023). Recommendations included: further field research to better understand intertidal species abundance trends; and collaboration with local non-government organizations and scientific organizations to create predictive models of the coastal impacts of climate change and implement best practice habitat restoration and conservation measures on the property (p. 67-68).

2.3 Project description

The purpose of Phase 3 of the Living Laboratory project was to explore how climate change may potentially impact the presence and/or displacement of animal and plant species at risk currently on the property, and to consider ideas and options for future land management and ecosystem conservation given these findings.

The project goals were as follows:

- Conduct a property inventory to aid in species at risk identification, and a baseline for future monitoring and assessment.
- Create spatial analytical maps to define the property boundary and aid in understanding forest type, elevation, and other physical attributes.
- To conduct a literature review of species at risk likely to be found on the property, including a description of life cycles, habitat requirements, and species ecology and dynamics.
- Research and analyze climate-change-related trends predicted for the property, including anticipated impacts on species at risk.
- Learn about species at risk recovery, ecosystem restoration, and long-term conservation as applicable to the property.
- Based on key findings and results, and in collaboration with the landowners, develop recommendations for future land management and conservation.

2.4 Project limitations

The availability of time, resources, and expertise limited what could be achieved during the project. In particular, what could be achieved by the field research was limited by the one-month window available in the fall to conduct a baseline inventory of 43 ha. As daily temperatures fall, insects become less active and species begin hibernating, dying off or migrating. Structured field identification and trapping are better done in the spring and summer. Similarly, avian species were not inventoried as they are most present during their breeding season from April to July and would have already begun their migration period. Vegetation surveys were conducted with some limitations as most species' more easily identifiable

characteristics are not present in the fall. The impact of these limitations on the report findings along with suggestions for future fieldwork design, are found in the recommendations section.

2.5 Team members and roles:

Four Master of Environmental Management students from the University of New Brunswick collaborated on this project. Their diverse backgrounds provided varied perspectives in developing a strong research design and recommendations. The team remained accountable through weekly meetings, upholding high academic and professional standards, and approaching one another with respect. As a result, tasks were generally completed on time and with a high level of excellence.

Kathryn Downton was the project manager and led the climate change and conservation sections of the report. She also developed the PowerPoint presentation following Aman's lead. Kathryn has taken her skills and experiences from a healthcare career and as a long-time environmental advocate into a commitment to professional conservation and stewardship work in New Brunswick.

Laura Lavigne led all aspects of field research and associated data, and co-edited and formatted the final report alongside Madison. Laura has a background in environment and natural resources and has worked with various not-for-profit environmental organizations and charities. She was also responsible for conducting research on insects at risk within New Brunswick.

Amandeep Singh was the presentation lead, developed the mammal and vegetation species at risk sections, and assisted with the field research, photographing and identifying some of the species present in the area. He has a background in biotechnology and environmental management and has previously worked as an environmental technician.

Madison Crichton was the spatial analyst, species at risk lead and responsible for the bird species at risk section. She also co-edited and formatted the final report alongside Laura. Madison has a background in environmental science and has worked as an ecologist.

3.0 Methodology

This project utilized a mixed method approach, that is combining qualitative and quantitative research and analysis to maximize the strengths of each. The recommendations were informed by research conducted in the following areas: history, field research, spatial maps, species at risk, climate change impacts, and conservation conflicts and options.

3.1 History

Historical information was gathered and analyzed using several different sources. The New Brunswick Archives and local accounts were accessed to find maps and area history. Further property and historical information was obtained through interviews with the landowners over the course of the fall of 2024. Some area-related Indigenous history was discovered in 2002 research conducted by H. Lotze and I. Milewski, “Two Hundred Years of Ecosystem and Food Web Changes in the Quoddy Region, Outer Bay of Fundy,”. The need for further research in this area is addressed in the recommendations section.

3.2 Field surveys

Walk-throughs and plot survey analysis were used to determine the species at risk present on Deadmans Head, and to create a baseline species composition for future comparison: Walk-throughs were conducted on Sept 12th and Sept 20th to identify species and species at risk along trails, roads, and infrastructure. An unbiased plot survey system was designed in order to create a

comprehensive species list and determine the possible presence of species at risk across the property.

All species recorded while on site were documented in an Excel spreadsheet with their species at risk status if applicable, coordinate, identifier, survey method, and whether the species was uploaded to iNaturalist. If a species was abundant across the property, no coordinates or photos were taken. Although grasses, sedges, lichen, and mushrooms were identified to the species level where possible, or in some cases to the family or genus level, these species are difficult to identify due to the time of the year or variability, and an expert is often needed to provide certainty.

Property Walk Throughs

The team completed property walk-throughs on Sept 12th and Sept 18th. On Sept 12th, Laura hiked to the peninsula point after a tour provided by Ernie Edwards. The second walk was with Laura, Kathryn, and Amandeep who took photos as they also made their way to the point. During each walk, a species list was created as species were identified. Photos were taken to help with identification later. Merlin was also used to identify bird species while walking throughout the property. The areas visited did not follow a set method. However, all observations were noted in order to help with identifying species at risk and their potential habitats across the property.

Plot Survey

The plot survey mapped 10 evenly spaced coordinates across the peninsula, which were then visited to identify vegetation species (Figure 3). ArcGIS Pro was used to create an unbiased sampling approach to developing the survey grid. The Create Fish Net Data Management tool was used to create a 200 m x 200 m grid system. The centre of each grid space was then identified, and a plot mapped. Since the property is approximately 43 ha in size this resulted in

approximately one plot per four hectares. On site, two plots were moved to reduce bias or to ensure team safety. Plot 9 was moved 3 meters to the West, due to its proximity to Ernie and Judy's home. Plot 8 was moved 30 m North-West, to avoid being on the upper portion of a cliff's edge.

In the field, a two-meter by two-meter quadrat was set up using cardinal directions. All species within each plot were identified and recorded, with photos of unknown species taken for later identification using iNaturalist. The survey aimed solely to determine species presence; it did not assess species absence.

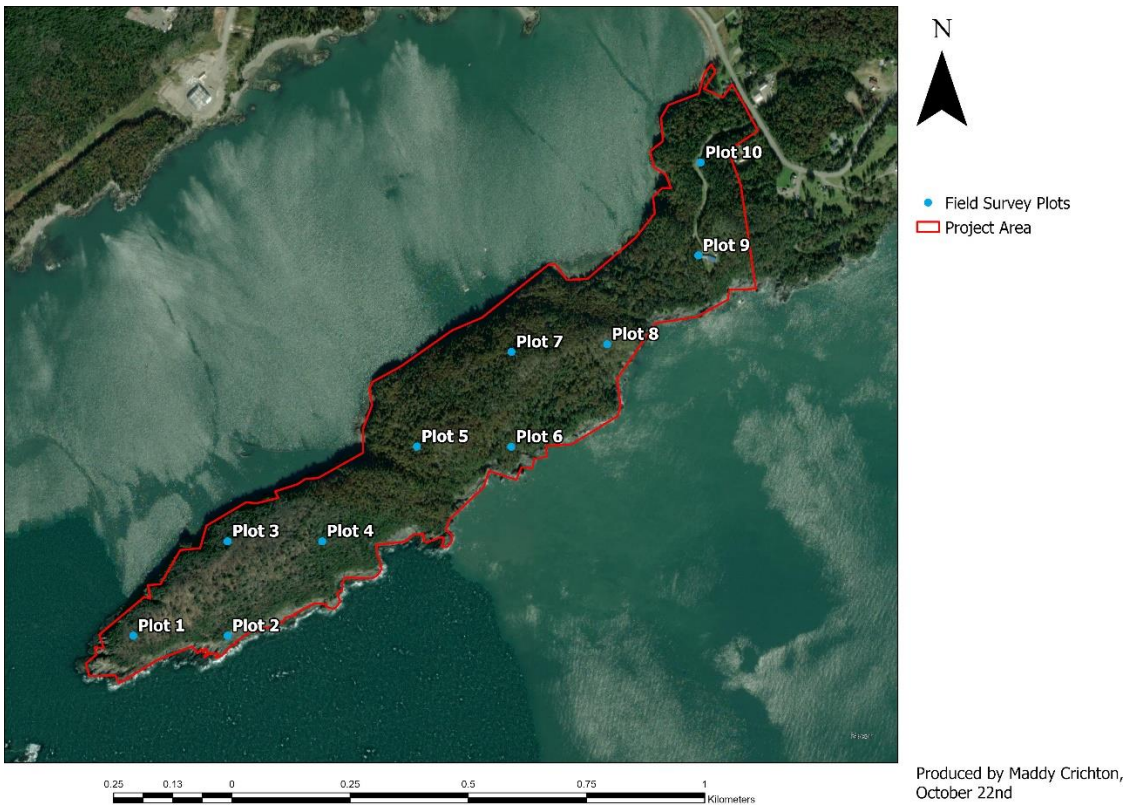

Figure 3. *Vegetation survey plots on Deadmans Head using a fish netting pattern for 1 plot per hectare.*

iNaturalist

The Edwards encourage the use of the iNaturalist website and mobile device application to identify the presence of species for the Living Lab project. This application has been used by

other environmental professionals or citizen scientists to identify other species at risk within the project area. For this project, all uploaded species were accompanied by their approximate GPS coordinates and photos that captured multiple features. Every upload within the project area is automatically added to the Deadmans Head Forest project on iNaturalist. The landowners' goal is to reach Research Grade level, the highest identification standard on the application, so this data can be used in future research to compare the presence of species.

3.3 Spatial analysis

The spatial analysis involved creating maps in ArcGIS to visualize and interpret various aspects of the project area, including a project area map, digital elevation model (DEM), forest habitat type map, soil drainage map, and field survey point map. Spatial data, such as vegetation, land use, and LiDAR data, were sourced from the Government of New Brunswick's GeoNB open data catalogue (2024).

LiDAR data was processed in ArcGIS to create a DEM by converting point cloud data into a raster surface representing terrain elevation. Existing vegetation maps were analyzed to classify forest types in Deadmans Head, with each type color-coded for differentiation and verified through field visits. Field survey points were generated using the fishnet tool, exported as a shapefile, and uploaded to Gaia GPS for field use.

3.4 Species at risk literature review

To identify species at risk in the study area not observed during site visits, a multi-step approach was used. The Species at Risk Public Registry (Government of Canada, 2024) served as the initial source, listing Schedule 1 species under the Species at Risk Act (SARA). This

registry was used because it is a reliable source, providing updated information on species at risk across Canada, including those potentially found in New Brunswick.

A preliminary list was compiled of 35 avian (birds and bats), 7 mammals, 20 vegetative, and 10 insects Schedule 1 species potentially found in New Brunswick (Appendix B). To refine this list and make it relevant to the study area, the data was then cross-referenced with various sources. The avian species list was cross-referenced with the Maritime Breeding Bird Atlas, specifically focusing on Charlotte County, which encompasses the project area (Maritime Breeding Bird Atlas, 2024). The Maritime Breeding Bird Atlas is an extensive resource that documents the breeding distribution and abundance of bird species across the Maritime provinces. This cross-referencing process ensured that only those species present on both the federal species at risk list and within the county were considered and resulted in a narrowed list of 17 species.

To further refine the list to species likely present in the project area, a habitat suitability assessment was conducted. GIS mapping and field surveys using LiDAR data from GeoNB (GeoNB, 2024) were used to create a map of dominant forest habitat types, visually representing key habitats (Figure 4). Species-specific habitat requirements and behaviors, including preferred habitat types, breeding, foraging, and migratory patterns, were reviewed through scientific literature and species recovery plans. Each species was then evaluated against the habitat characteristics identified within the project area (Figure 4).

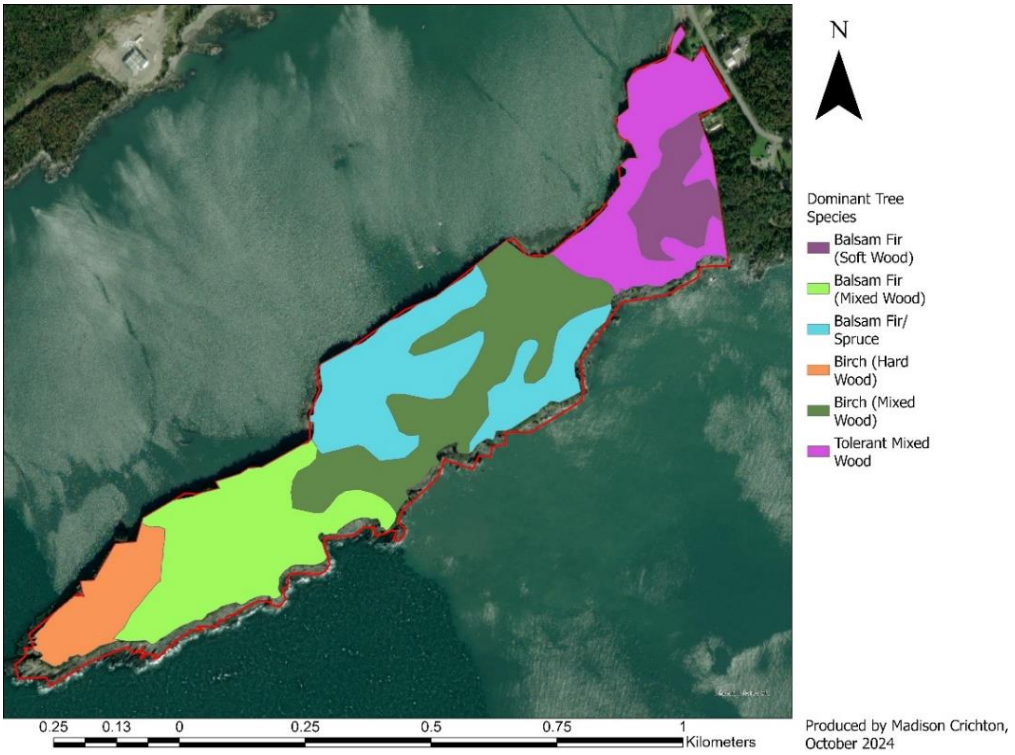

Figure 4. *Dominant forest types within the project area.*

A soil drainage map (Figure 5) was then created to identify potential vegetative and insect species in the area. The soil on the property is classified as imperfectly drained, meaning water is removed slowly enough that the soil remains wet for much of the growing season (Government of Canada, 2013). This condition supports species adapted to both moist and dry soils.

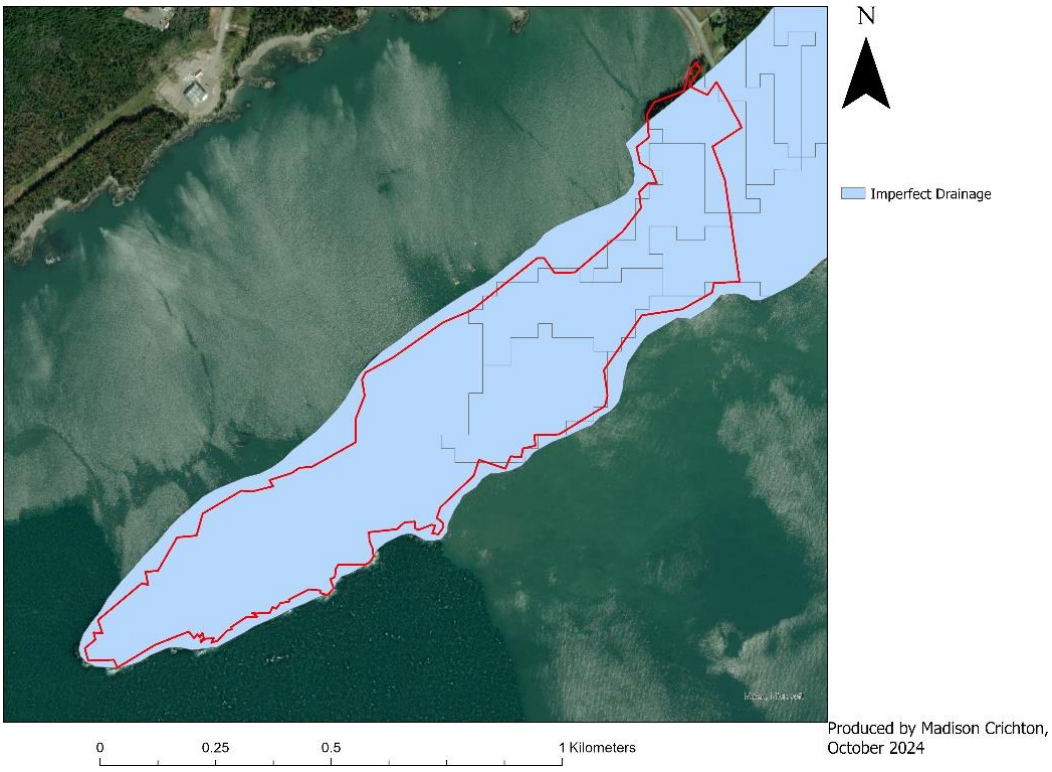

Figure 5. *Soil drainage in the project area.*

Species with habitat requirements matching the project area were included in the final list for detailed research, identifying five birds, six bats, five insects, one mammal, and five plants from the federal species at risk list as potentially present.

Of special note: It is important to note that although The Bald Eagle (*Haliaeetus leucocephalus*) is listed as at-risk on the Government of New Brunswick website (Government of New Brunswick, n.d.), this information is outdated, as Bald Eagle populations have recovered across Canada in the past decade. Also 5 bat species are listed on the federal species at risk list. Although classified as mammals, bats are included in the avian section of this research due to ecological and methodological similarities to birds, including their reliance on flight for foraging and migration, tree roosting, and shared habitats.

3.5 Climate change and conservation research

Research on climate change trends in southwestern New Brunswick and their potential impacts on species at risk (SAR) drew from multiple sources, including the Phase 1 Report (Evans et al., 2022), national data from ClimateAtlas.ca (2024) and the *State of Canada's Forests* report (Natural Resources Canada, 2024), as well as regional resources like ClimAtlantic's forecasts for Atlantic coastal forests (2024) and New Brunswick's climate change action plan (Province of New Brunswick, 2022).

Local insights were gathered through discussions with Matt Abbott, Marine Program Director at the Conservation Council of New Brunswick, regarding conservation efforts in the St. Andrews area (personal communication, Oct. 31, 2024), and Dr. Janice Harvey of St. Thomas University on incorporating historical timelines into baseline climate and species vulnerability research (personal communication, Nov. 23, 2024).

Additional interviews conducted in the fall provided information on stewardship programs for New Brunswick landowners, agreements for securing ecologically significant private lands, and the role of American trusts in facilitating cross-border donations for land preservation. Staff consulted included Aiden Pluta (Nature Trust of New Brunswick), and Jennifer White, Aaron Dowding, and Denise Roy (Nature Conservancy of Canada).

4.0 Field Results

During the initial site visit on September 12, 2024, a Monarch butterfly was identified near Ernie and Judy's house on a milkweed plant. This was the only species at risk found during the field

research. Bald Eagles were observed on multiple visits to Deadmans Head, but as they are no longer listed under COSEWIC, they were not classified as species at risk.

Site walk-through surveys were conducted on September 12 and 20, 2024, which resulted in the identification of 90 species (Appendix C), including 10 birds, 7 arthropods, 51 vascular plants, 17 fungi/lichen, 1 mammal, and 4 mosses.

The ten unbiased survey plots were assessed on Sept 24th, resulted in the identification of 12 species on average per plot. Plot 10 had the highest species richness with 22 species, while plots 1, 5, and 6 had the lowest, each with 9 species (Appendix D).

Combining all data from Deadmans Head, 106 species were identified, excluding unidentifiable plants, sedges, and grasses (Appendix E). Other observations made by the team included vascular plants, fungi/lichen, mammals, mosses, arthropods, and birds (Figure 6).

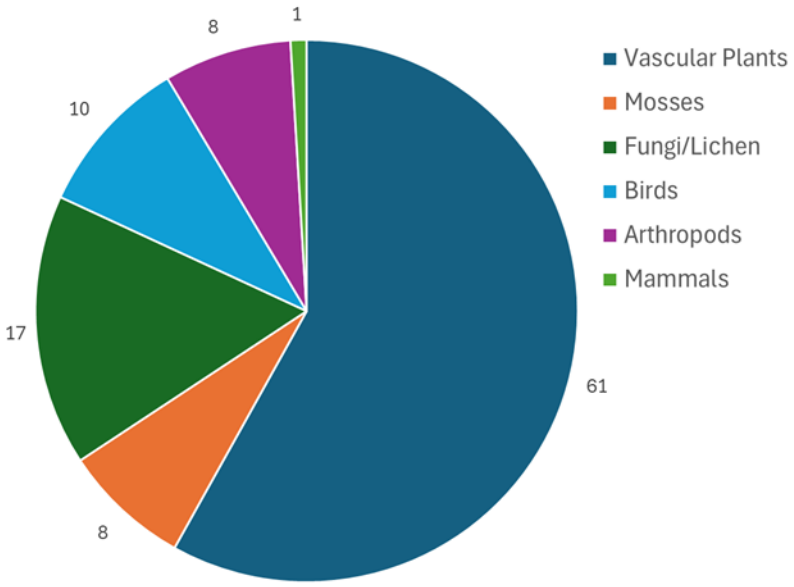

Figure 6. Distribution of species identified through field research by species group.

5.0 Species at risk profiles

Each species profile follows the same template outlining the conservation status, physical attributes, range and habitat, life cycle, and major threats and disturbances of each species at risk. These profiles were then used to determine what conservation and research approaches could be developed. There were 22 profiles created (Table 1).

Table 1. Number of species profiles created per class.

Class	Count
Birds	5
Bats	6
Mammals	1
Vegetation	5
Insect	5
Total	22

5.1 Avian species

Bicknell's Thrush (BITH) *Catharus bicknelli*

Conservation status

The Bicknell's Thrush is listed as threatened under the Species at Risk Act as of 2012.

Physical attributes

Adult BITH are approximately 16-17 cm in length weighing approximately 26-30 g. Distinguishing characteristics include olive-brown heads, backs and tops of wings, white chests, spotted breasts, and chestnut colouration on the tail and wings (Ouellet, 1993).

Current range and habitat

This species is found throughout North America; however, it breeds exclusively in northeastern USA and southeastern Canada (Lambert et al., 2005). BITH is primarily found throughout heavily forested areas dominated by fir, spruce, and birch trees with plenty of dead

trees and snags (Rodenhouse et al., 2008). Their preferred habitat is Balsam Fir forests (Rodenhouse et al., 2008). BITH are also often found in coastal areas (Rodenhouse et al., 2008). They are particularly restricted by their temperature requirements, generally preferring cooler climates (Rodenhouse et al., 2008). Given the general climate and dominant tree species on the property, there is a significant probability that BITH may be present.

Life cycle and behaviour

BITH return to breeding grounds in late May to early June (Chisholm and Leonard, 2008). They are a social species, with males' nests often overlapping extensively with those of other males. Both males and females of the species mate with multiple partners every breeding season, with various males usually providing for the same nest (Goetz et al., 2003). Nests are in dense stands of forests, midway up trees or in the cavities of snags (Rimmer et al., 2001). They primarily feed on invertebrates such as ants, beetles, and lepidopteran larvae (Rimmer et al., 2001).

Threats and disturbances

Due to their limited range, BITH are particularly at a high risk due to changes caused by climate change. As previously mentioned, BITHs prefer cooler climates and warming temperatures in their breeding areas could push them further North. The most significant climate change-related threat is the expected disappearance of the Balsam Fir forests BITH rely on to raise their offspring (Lloyd and McFarland, 2017). Balsam Fir is extremely sensitive to increased temperature and a regional warming of even one degree could reduce BITH habitat by over 50%, warming of two degrees could mean the elimination of all BITH breeding sites (Rodenhouse et al., 2008).

Other threats include land use changes. Much of BITH's habitat in northern USA is within state parks and therefore protected from human interference (Poppick, 2017). However, much of their habitat in eastern Canada is subject to logging or is being replaced by wind farms and agricultural sites (Llloyd and McFarland, 2017). BITH populations are likely to be pushed increasingly farther North due to climate change causing loss of suitable habitat (Poppick, 2017). This makes protecting their existing habitat vital to their survival.

Canada Warbler (CAWA) *Cardellina canadensis*

Conservation status

The Canada Warbler is listed as a species of special concern under the Species at Risk Act of 2012.

Physical attributes

CAWA have blue-grey tails and backs, bright yellow throats and breasts (Phinney, 2015). Their identifying marks include a black stripe on the top of their breasts, yellow spectacle-like rings around their eyes, and the year-round maintenance of their plumage (Phinney, 2015). They are approximately 12-14 cm long and weigh approximately 10-12 g (Environment Canada, 2015b).

Current range and habitat

CAWA are most often found in areas with primarily deciduous canopy cover however, they are also found in coniferous forests with a well-developed, dense shrub layer (Krikun et al., 2018). The CAWA breeds across the southern boreal forest and mixed wood regions across southern Canada and can be found during breeding season as far south as Iowa (Environment Canada, 2015b). CAWA migrate South in early fall, wintering in the northernmost parts of

Brazil, Venezuela, Panama, and Colombia (Environment Canada, 2015b). Due to the dominant tree species, there is a possibility CAWA could be found on the property during breeding season.

Life cycle and behaviour

CAWA have a short breeding season, arriving from May to as late as early August, and leaving in early Fall (NTNB, 2023). They tend to return to the same nest annually, which are found on the ground, hidden by dense shrub layers, covered by mounds of moss, upturned roots, and groups of saplings (NTNB, 2023). CAWA's mate once per season and females lay four to five eggs on average in late June or July (MTRI, 2023). Young are cared for by both parents before becoming self-sustaining at two to three weeks old (MTRI, 2023).

Threats and disturbances

One of the main threats to the CAWA is the degradation of breeding habitat quality (Hunt et al., 2017). The CAWA's range is expected to retract dramatically due to climate change as the current habitat they rely on for breeding season since it can't sustain itself due to warming conditions, forcing CAWA communities further apart and making successful breeding seasons increasingly unlikely (Stralberg et al., 2015). It is particularly likely that CAWA populations will be pushed out of Atlantic Canada due to habitat loss (Westwood et al., 2020). As climate change persists, CAWA habitat during breeding season will move further and further northwest (Westwood et al., 2020).

Evening Grosbeak (EVGR) *Coccothraustes vespertinus*

Conservation status

The Evening Grosbeak is listed as a vulnerable species under the Species at Risk Act.

Physical attributes

EVGR have dark brown or black heads with dull yellow stripes across their foreheads. They have yellow shoulders, black tails and wings, and white patches on their chest and stomach (Domm, 2012). Females have similar, but much duller, colouring with silver often replacing black (Domm, 2012). They weigh approximately 54 g on average and are between 16-18 cm in length (Bekoff and Scott, 1989).

Current range and habitat

EVGR are found across Canada, the United States, and Mexico (COSEWIC, 2016a). Their preferred breeding habitat includes mixed wood forests with dominant White Spruce and fir species (COSEWIC, 2016a). EVGR depend largely on areas with abundant Spruce Budworm populations, whose habitat is Balsam Fir dominant, being their primary food source (COSEWIC, 2016a). Their dependence on Spruce Budworm may restrict EVGR from moving further upwards as cold temperatures can stop the budworms from reproducing (NRC, 2012). Due to the dominant habitat, there is a possibility that EVGRs are found on the property.

Life cycle and behaviour

EVGR arrive at their breeding areas in mid to late May as a breeding pair (Scott and Bekoff, 1991). EVGR are a social species, not displaying particularly territorial behaviour when nesting; however, they become increasingly secretive when laying eggs, with males staying within sight of the nest while foraging during incubation (Scott and Bekoff, 1991). Their nests are made of loosely woven twigs and moss and are found in conifer trees or shrubs (Domm, 2012). They eat seeds, insects, fruits, and flower buds (Domm, 2012).

Threats and disturbances

Climate change poses a significant threat to EVGR populations. Spruce Budworm, EVGRs' primary food source, is expected to be extinguished from eastern Canada over the next

several decades due to increased humidity (Morin et al., 2008). Furthermore, there is expected to be a 45% decrease in climactically suitable habitat for EVGR in the next 50 to 70 years in eastern Canada (Stralberg et al., 2015). This means that populations will likely be pushed toward the northwest to find suitable habitat and food sources.

Olive-sided Flycatcher (OSFL) *Contopus cooperi*

Conservation status

The Olive-sided Flycatcher is listed as threatened under the Species at Risk Act.

Physical attributes

The OSFL weighs approximately 31-34 g and reaches 18-20 cm when fully grown (Environment Canada, 2016). OSFL have olive-grey plumage on their heads, backs, and tails, with white throats and breasts (Environment Canada, 2016).

Current range and habitat

Over 50% of the breeding OSFL population inhabits southern Canada (Environment Canada, 2016). They breed across southern Canada and Northwestern USA, and winter in northern South Africa (Environment Canada, 2016). OSFL nest exclusively in living trees, requiring forests with minimal dead species (Wright, 1997). They generally nest in spruce trees 6-7 m from the ground (Wright, 1997). They often prefer habitats containing mature conifer species, with access to wetland areas or water bodies nearby (Hache et al., 2014). Due to the dominant habitat and presence of a nearby water body, there is a possibility that OSFLs are found on the property.

Life cycle and behaviour

OSFLs are territorial birds and males will often call and display themselves aggressively within a 100-metre radius of their nests to deter other males or threats from approaching (Short, 2017). The OSFL lays relatively small clutches, so parents often forage near the nest to lessen the risk of nestling mortality (Short, 2017). They feed primarily on flying insects which they capture in flight, such as ants, wasps, bees, dragonflies, beetles, and moths (NAS, 2024a). Their breeding season is relatively short, with migration occurring in late spring and early fall (NAS, 2024a).

Threats and disturbances

One of the largest predicted threats to the future of the OSFL is the effects of climate change. While OSFL habitat is relatively broad, they reside mainly in mature forests, particularly during breeding season (Norris et al., 2021). Climate change is expected to increase the number of forest fires that occur yearly, indicating a decrease in the optimally aged forest habitats the OSFL require, which will be replaced by early succession forests that cannot support the species' needs (Norris et al., 2021).

Wood Thrush (WOTH) *Hylocichla mustelina*

Conservation status

The Wood Thrush is listed as a threatened species by the Canadian Species at Risk Act.

Physical attributes

An adult WOTH is between 19-21 cm in length and weighs 40-50 g (COSEWIC, 2012). Adults have rusty-brown crowns, which fade to an olive brown on their back, wings, and tail, with white chests (COSEWIC, 2012). They have distinctive black spots on their breasts, wings, and tails (COSEWIC, 2012).

Current range and habitat

WOTHs breed in southeast Canada, from Southern Ontario to Nova Scotia, and nests across the USA (ENR, 2024c). WOTH winter in the lowlands and tropical forests along the Atlantic of Central America (ENR, 2024c). WOTH nest mainly in mature deciduous and mixed forests with well-developed understories (ENR, 2024c). Due to the dominant tree species and understory layer, there may be WOTH on the property during breeding season.

Life cycle and behaviour

WOTH mainly eat berries, snails, isopods, and spiders, but are often outcompeted for food by other avian species (Ladin, 2015). Male WOTHs arrive at breeding grounds first and immediately establish their territory, singing loudly to defend it, before females arrive in the following days (NAS, 2024b). They build their nests, of grass, leaves, moss, bark, and weeds, 3-4.5 m up their trees (NAS, 2024b). They forage mainly on the ground, using their strong bills to flip leaf litter and stones looking for prey (NAS, 2024b).

Threats and disturbances

Climate change is causing mass habitat loss in the WOTH's wintering habitat in Central and South America (ENR, 2024c). This means the species will likely be pushed further South during the winter, making it increasingly difficult for them to return to their breeding and nesting habitat in North America. Furthermore, as climate change reduces their breeding habitat, Cowbirds become increasingly likely to outcompete WOTHs. Cowbirds are Wood Thrush's largest competitors for food and will often penetrate WOTH's nests to lay their own eggs (NAS, 2024b). As suitable breeding habitat continues to decrease, the more likely Cowbirds are to outcompete and overtake the wood thrush populations (NAS, 2024b).

Avian profile summary

Table 2. Bird profile summary

Species	**Status**	**Major threat**
Bicknell's thrush	Threatened	Very vulnerable to temperature change. Preferred habitat being pushed further North.
Canada warbler	Special Concern	Degradation of dense deciduous canopy/shrub layer breeding habitat pushing breeding communities further apart.
Evening grosbeak	Vulnerable	Primary food source (spruce budworm) being extinguished in Eastern Canada due to increasing humidity levels.
Olive-sided flycatcher	Threatened	Decrease in mature forests due to forestry & increase in forest fires. Not suited to resulting successional forests.
Wood thrush	Threatened	Mass wintering habitat loss pushing them further South during migration, making it increasingly difficult for returns to Northern breeding habitat.

Bats

Six bat species are considered at risk in New Brunswick, the Hoary Bat (*Lasiurus cinereus*), the Eastern Red Bat (*Lasiurus borealis*), Little Brown Myotis (*Myotis lucifugus*), the Northern Myotis (*Myotis septentrionalis*), the Silver-haired Bat (*Lasionycteris noctivagans*), and the Tri-coloured Bat (*Perimyotis subflavus*). Due to similarities in range and habitat, life cycle and behaviour, and threats, they are being considered together.

Conservation Status

These bats are listed as endangered species by the Canadian Species at Risk Act.

Physical attributes

The Hoary Bat has a yellowish-brown collar, with yellow ears edged with black (TPWD, n.d.). Adults weigh between 20-38 g (TPWD, n.d.).

The Eastern Red Bat adult males have a reddish-orange coat, while females and juveniles are grey (TPWD, n.d.). Both sexes have white patches of fur on their shoulders and wrists and weigh between 7-16 g (TPWD, n.d.).

The Little Brown Myotis is 8-10 cm in length, weighs between 7-9 g and has glossy brown fur (NCC, 2024a).

The Northern Myotis weighs between 6-9 g, has dark brown fur on its back with pale undersides, and is distinguishable from the Little Brown Myotis by its longer ears that extend beyond its nose when pressed forward (NWT, 2023).

Silver-haired Bats have dark brown to black fur, they are named after their silvery-white tips (ADFG, n.d.). They weigh approximately 8-12 g and range from 9-12 cm (ADFG, n.d.).

The Tri-coloured Bat has pale-brown fur, orange-red ears and forearms, and dark brown wings (NCC, 2024c). Its name originates from the black, yellow, and brown hair found across its back (NCC, 2024c). Additionally, it weighs approximately 7 g and has a wingspan of 23 cm (NCC, 2024c).

Current range and habitat

The Hoary Bat has the widest range of any North American bat, extending from Argentina to Southern Canada (TPWD, n.d.). In Canada, it is most often found in coniferous forests consisting of hardwoods (TPWD, n.d.).

Eastern Red Bats are found across Southern Canada and extend as far south as Central Florida and Northern Mexico (TPWD, n.d.). Eastern Red Bats prefer forested environments, hibernating in tree hollows and leaf litter (TPWD, n.d.). During the summer they roost in foliage, hanging upside by one foot to resemble dead foliage (TPWD, n.d.).

The Little Brown Myotis and Northern Myotis are found across Canada, from British Colombia to Labrador, as well as across the Territories (COSEWIC, 2013). In the winter, they are found in cold, humid hibernacula, such as caves and mines (COSEWIC, 2013). In the summer, females establish colonies in large-diameter trees (COSEWIC, 2013). Both species forage over water and along forest edges (COSEWIC, 2013).

Silver-haired Bats are found across forests in North Ameri.ca, particularly in old-growth coniferous and mixed wood stands, during both the winter and summer months (BCI, 2024). They rely on the density of dead and dying trees and feed on insects in small clearings and over water courses (BCI, 2024).

The Tri-coloured Bat is found in eastern North America, from Ontario to Nova Scotia, in forested habitats, roosting in trees and human-made structures (NCC, 2024b). It hibernates in warm and wet areas such as caves (NCC, 2024b).

Life cycle and behaviour

The Hoary and Eastern Red Bats typically live alone, or in family groups consisting exclusively of mothers and their young, typically between one to five pups (TPWD, n.d.). They are only found in groups to mate and migrate (TPWD, n.d.).

The Little Brown Myotis and Northern Myotis females have one pup (Utrup & Jordan, 2017). Females undergo delayed fertilization while hibernating in the winter, a process during which they store sperm allowing them to give birth in May or June (Utrup & Jordan, 2017). The Tri-coloured Bat roosts alongside the Little Brown Myotis and Northern Myotis, however, in much smaller numbers (Forbes, 2012).

Silver-haired Bats are solitary, often roosting alone or in small colonies throughout the year (Saunders, 1988). They feed on insects and compete with larger bat species for food sources (Saunders, 1988).

Threats and disturbances

The largest threats to bat species across Canada include starvation due to the decline in insect populations, predation by cats, loss of habitat, and inflammation and infections (Segers et al., 2022). White-nose syndrome, an easily contractible disease among bat species, is largely responsible for threats to bats in Atlantic Canada (Segers et al., 2022). The Little Brown Myotis, Northern Myotis, and Tri-coloured Bat are at particular risk of White-nose syndrome and other diseases as they roost in the same hibernacula (Forbes, 2012). Approximately 52% of bat species in North America are likely to go extinct over the next several decades, with climate change being the third largest risk to bat species in Canada, and the biggest threat in the United States and Mexico (Adams et al., 2024). In Canada, droughts are expected to be the largest climate change-related threat to bat species (Adams et al., 2024).

Bat profile summary

Table 3. Bat profile summary

Species	**Status**	**Major threat**
Eastern red bat	Endangered	• Starvation due to declines in insect populations • Loss of habitat • Predation • Spread of white nose syndrome & other contractable diseases • Droughts
Hoary bat	Endangered	
Little brown myotis	Endangered	
Northern myotis	Endangered	
Silver-haired bat	Endangered	
Tri-coloured bat	Endangered	

5.2 Vegetation

Black Ash *Fraxinus nigra*

Conservation status

As of 2018, Black Ash is classified as threatened under the federal assessment by COSEWIC (COSEWIC, 2018a).

Physical attributes

Black Ash is a medium-sized deciduous tree, which grows to 15-20 m high with a trunk diameter as wide as 60 cm (COSEWIC, 2018a). The most distinctive feature is the thick, grey bark, which will develop a scaly texture as the tree ages. The leaves are opposite and pinnately compound, usually 7-13 leaflets, which are 20-45 cm long (COSEWIC, 2018a). In autumn, Black Ash turns bright yellow before falling early in the season. This is one of the distinguishing features of the species; no other trees in its natural habitat lose their leaves that early (COSEWIC, 2018a).

Current range and habitat

In New Brunswick, Black Ash is predominantly found in northern and western regions, as well as in parts of the Bas Saint-Laurent area of Quebec (COSEWIC, 2018a). It thrives in wetland habitats and is often associated with swamps and riparian zones where soil moisture levels are consistently high. It can also occur in moist upland areas albeit in lower density. The species prefers moderate light levels and tends to occur more densely in alkaline sites (COSEWIC, 2018a). Due to the imperfectly drained soil types within the project area, there is a possibility of the species being found on the property.

Life cycle

The life cycle of Black Ash is characterized by its unique phenological traits. This species typically begins leafing out early in the spring but is also one of the first trees to lose its leaves in

autumn. The leaves turn bright yellow before falling off, which can be attributed to its adaptation to wetland conditions where nutrient availability may fluctuate (COSEWIC, 2018a).

Black Ash produces small flowers that emerge before the leaves in early spring; these flowers are wind-pollinated and develop into samaras—winged seeds that disperse through wind currents once matured. Although specific details about its reproductive success in New Brunswick are limited, the tree's ability to regenerate through seed dispersal plays an essential role in maintaining its population (COSEWIC, 2018a).

Threats and disturbances

The most significant threat to Black Ash populations is the invasive Emerald Ash Borer (EAB), whose larvae feed on the inner bark of ash trees, disrupting nutrient flow and eventually rendering the tree dead. Over the last two centuries, Black Ash populations in the mixed wood swamps of Atlantic Canada have faced a sharp decline, which was roughly 6.5% in the early 1800s to fewer than 1% by 1993 (Loo & Ives, 2003). Expected increases in minimum temperatures are expected to result in better EAB survival and reproduction. Therefore, climate change presents an indirect threat as it may worsen pest outbreaks by altering habitat conditions. Habitat loss from urbanization and agricultural practices is another significant factor contributing to the decline of black ash populations (COSEWIC, 2018a).

Boreal Felt Lichen *Erioderma pedicellatum*

Conservation status

Two designated populations exist for the Boreal Felt Lichen: The Boreal population in Newfoundland and the Atlantic population in New Brunswick and Nova Scotia. While the Boreal population has been assigned special concern status, the Atlantic population has been assigned as

endangered in the 2014 COSEWIC assessment report but is believed to have been extirpated from New Brunswick (COSEWIC, 2014a). Since species considered extirpated are in rare cases "re-discovered", it is being included here.

Physical attributes

Boreal Felt Lichen is a distinctive foliose lichen that has cyanobacteria as its photosynthetic partner. While it appears greenish when moist, its dry specimens become grey. Its common name comes from its surface which has a felt-like texture. One of its unique attributes is its upturned edges which bare the fringy white undersides, displaying a noticeable contrast between the two surfaces. The presence of small reddish-brown apothecia in this species helps to differentiate it from other North American *Erioderma* species (COSEWIC, 2014a).

Current range and habitat

The species was historically first seen and identified on Campobello Island in 1902 and has not been found since in the New Brunswick. The lichen usually grows on mature Balsam Fir trees, especially in Nova Scotia; outside of Nova Scotia, it is also seen growing on Black Spruce in old forests (NB DNRED, 2024). The species generally prefers cool, humid coastal forests, which corroborates the finding that all known occurrences of this lichen are within 25 km of the Atlantic coast (COSEWIC, 2014a).

Life cycle

It is a cyanolichen, consisting of a fungal partner and a cyanobacterium (*Scytonema*) that photosynthesizes and fixes atmospheric nitrogen. An Intermediate Liverwort 'nursemaid', *Frullania tamarisci* facilitates the lichenization and establishment of the lichen on its host tree. The lichen reproduces through wind dispersal of spores (sexual reproduction) or possibly arthropod vectors. It does not produce specialized means of vegetative reproduction, making it

dependent on the chance encounter between fungal spores and suitable cyanobacteria to initiate a new life cycle (COSEWIC, 2014a).

Threats and disturbances

Boreal Felt Lichen faces several natural and anthropogenic threats, with habitat loss and forest degradation being the primary culprits. The species is also particularly sensitive to air pollutants like sulphur dioxide and the resultant acid rains. Predation by slugs introduced for herbivory also contributes to the deterioration of this species. In addition, climate change and severe weather events, can alter the lichen's preferred microclimate and increase the frequency of windfall events that damage host trees, jeopardizing the species habitat (COSEWIC, 2014a).

Butternut *Juglans cinerea*

Conservation status

As of 2017, Butternut is listed as endangered by COSEWIC. In New Brunswick specifically, it is listed under the provincial Species at Risk Act, but with no prohibitions in place. The species is considered critically imperilled in New Brunswick (COSEWIC, 2017).

Physical attributes

Butternut is a medium to large-sized deciduous tree of the walnut family, typically reaching heights of up to 30 m and diameters up to 91 cm. It has an open crown with yellowish leaves, composed of several pinnately arranged, and has 11-17 stalkless leaflets. Its double-chambered stout and hairy twigs bear a central pith. Young bark is usually light grey or greyish brown and eventually becomes shallow or fissured. Butternut can be distinguished from similar walnut trees by its large terminal leaflets, hairy yellowish-orange twigs, and the nut is light green, sticky, and fuzzy (COSEWIC, 2017).

Current range and habitat

In New Brunswick, Butternut is usually found in the Western and Southern regions, along a 300 km section of the Saint John River watershed from Grand Falls in Victoria County to Browns Flats in Kings County. It prefers loamy, moist, rich, and well-drained soils, and is intolerant of shade, requiring sunny conditions for survival. Butternut can be found in deciduous and mixed forests, often as single trees or small groups (COSEWIC, 2017).

Life cycle

Butternut is a shade-intolerant deciduous tree with a lifespan of under 100 years. Being a monoecious deciduous tree, it bears separate male and female flowers that have different maturation times allowing for wind-pollinated out-crossing. Flowering occurs between April and June (COSEWIC, 2017).

Butternut can hybridize with several other walnut species, and its fruit matures in September or October in the year of pollination. Once the tree is 20 years old, seed production commences and peaks when the tree grows to 30-60 years. The species has a generation time of 45 years, and its seeds remain viable for up to two years in soil. Seed dispersal is animal-mediated on land, with long-distance dispersal being mediated via water and pollens (COSEWIC, 2017).

Threats and disturbances

Butternut Canker, a fungal tree disease, is the most limiting factor in the survival of Butternut trees, causing rapid mortality in almost 100% of infected trees. The disease is caused by the fungus *Ophiognomonia clavigignenti-juglandacearum*, which kills the saplings early on and compromises mature trees by excess crown loss and gradual girdling by stem cankers. The fungus, likely introduced from Asia, now spans over the entire provincial Butternut range having

infested over 70 percent of the total New Brunswick population and almost all trees in Ontario and Quebec (COSEWIC, 2017). Additionally, habitat destruction due to urbanization and harvesting activities also poses a serious threat to the Butternut population.

The situation is worsened by the introduction of a foreign butternut species, the Japanese Butternut, whose crossover with the native counterpart was initially attempted and intended to confer better fungal resistance. However, due to excessive natural hybridization and extensive backcrossing between the two species, the genetic identity of the native Butternut species is now jeopardized.

Climate change related changes may introduce mixed outcomes for the Butternut. Excessive browsing of young Butternut by White-tailed Deer is another threat who prefer the saplings. Altered weather patterns due to climate change can make the winters less severe which are likely to boost deer populations thereby intensifying browsing pressure. On the other hand, lower winter temperatures may improve the growth and reproduction of the Butternut unless these conditions better support canker development (COSEWIC, 2017).

Scaly Fringe Lichen *Heterodermia squamulosa*

Conservation status

As of 2022, the Scaly Fringe Lichen has been listed as threatened by COSEWIC. In New Brunswick, it has been ranked S1, meaning it is critically imperilled in the province (COSEWIC, 2022).

Physical attributes

Scaly Fringe Lichen is a foliose lichen that is pale grey to blueish-grey colouration and forms rosettes up to 5 cm in diameter. Its lobes are narrow and elongated, measuring about 0.5-

1.5 mm wide. Its lobes are laden with small, scaly, fine, upright structures called squamules, which not only help in its distinctive identification but also give it its common name. Small hairlike structures called cilia populate the lobe margins, conferring a 'fringed' appearance. While the lichen's medulla is white, its underside features a centrally purple-pigmented zone devoid of cortex (COSEWIC, 2022).

Current range and habitat

In Canada, The Atlantic population is distinct from its core North American Appalachian population. In Nova Scotia and New Brunswick, it has always been found within 50 km of the coastline, most often along and around the Bay of Fundy. It prefers areas with high humidity and moderate light conditions, often occurring in mature old growth hardwood and mixed-wood forests with long ecological continuity. The lichen's usual host trees include Yellow Birch, Sugar Maple, Red Maple, and White Ash trees growing in nutrient-rich moist soils (COSEWIC, 2022).

Life cycle

This lichen reproduces, principally, with its vegetative lobules. Like all lichens, this species also bears a photosynthetic symbiont, *Trebouxia* – a green alga which is lodged inside the lichen's lobules. Following the lobule dispersal to a suitable habitat, lobules get anchored to the substrate and thallus begins to expand. Subsequently, growth zones differentiate, and lobules take form giving rise to a complete lichen body capable of further propagation. An individual Scaly Fringe Lichen is thought to have a 19-year generation time (COSEWIC, 2022).

Threats and disturbances

Scaly Fringe Lichen is sensitive to open sunlit conditions. Road building is considered a primary threat to the Scaly Fringe Lichen as it encompasses forest clearing and canopy thinning. Activities that alter local hydrology and disrupt favourable environmental conditions ultimately

threaten the survival of this species. This is also exacerbated by logging and wood harvesting, which often opens the canopy but also destroys the thalli-bearing host trees. Further, air pollution, particularly acid rain and atmospheric pollutants can be harmful to sensitive lichen species in addition to climate change-induced ecological challenges. Emerald Ash Borer, an invasive insect species, decimates the ash trees that are one of the species that harbour the lichen, contributing to its disappearance (COSEWIC, 2022).

Vole Ears Lichen *Erioderma mollissimum*

Conservation status

Vole Ears Lichen was first designated as endangered by COSEWIC in 2009, which was reconfirmed in 2021 with the same status (COSEWIC, 2009). While it has not yet been assessed independently by the New Brunswick Committee on the Status of Species at Risk (NBCOSSAR), it is considered to be possibly extirpated, as it has not been recorded in the province since the 1980s (COSEWIC, 2021). Since species considered extirpated are in rare cases “re-discovered”, it is being included here.

Physical attributes

Akin to the Boreal Felt Lichen, Vole Ears Lichen is a green leafy cyanolichen that grows up to 12 cm across and has a felt-like upper surface that appears grey-brown when dry and grey-green when wet. Its common name comes from the soft, fuzzy texture of its thallus (body) resembling vole ears. Its brownish grey and greenish upper surface well contrast its white underside. The absence of apothecia helps to distinguish it from the Boreal Felt Lichen (COSEWIC, 2021).

Current range and habitat

This lichen prefers Balsam Fir and Red Maple as its host trees, with the latter being the usual host in Nova Scotia, where the lichen is most abundant. In New Brunswick, this species has only been reported twice; once in 1902 on Campobello Island and in the 1980s in Fundy National Park. Limited occurrences and the lack of research on this species make it challenging to determine its habitat requirements in New Brunswick. However, generally, cool climates, mild winters, frequent fog, and high annual precipitation (more than 1400 mm) are favourable for the growth of this species (COSEWIC, 2021).

Life cycle

As a cyanolichen, Vole Ears Lichen bears a *Rhizonema* genus cyanobacterium as its photosynthesizing mechanism. It seldom reproduces sexually via apothecia, however, structures specialized for asexual reproduction, soredia, are commonly found and used besides fragmentation. Soredia dispersal is limited to a short distance, usually spreading and growing on the same tree. Although rarely seen, long-distance dispersal of soredia is facilitated by bird feathers (COSEWIC, 2021).

Threats and disturbances

Transboundary air pollution combined with climate change is predicted to threaten this species over the next three generations, given its sensitivity to acid rain. Moreover, the projected droughts and forest fires can potentially decimate the existence of this species as it utilizes water for photosynthesis and moisture for its survival. Forestry also poses a direct risk by removing host trees. While protected zones exist on Crown Land, private land remains unprotected. Additional threats include mining, development, and excess browsing by moose and deer - all of which reduce suitable habitats for the lichen (COSEWIC, 2021).

Vegetation profile summary

Table 4. Vegetation profile summary

Species	**Status**	**Major threat**
Black Ash	Threatened	Infestation by Emerald Ash Borer and habitat loss due to deforestation & urbanisation
Boreal Felt Lichen	Endangered/ Possibly extirpated	Habitat degradation and deforestation, air pollution, increase in windfall.
Butternut	Endangered	Butternut Canker is a fungal disease with almost 100% mortality & 70% spread in NB.
Scaly Fringe Lichen	Critically imperilled	Activities that open up forest canopies such as roadbuilding.
Vole Ears Lichen	Endangered/ Possibly extirpated in NB	Loss of mature hardwood forests, especially maple. Warming climate, air pollution.

5.3 Land mammals

Canada Lynx *Lynx canadensis*

Conservation status

Federally, Canada Lynx has been assigned the status of being Not at Risk by COSEWIC in 1989 and 2001. However, the New Brunswick Endangered Species Act designated this species as endangered in 1976, which has been maintained even after the inception of the Species at Risk Act in 2012 (NB DNRED, 2022a).

Physical attributes

Slightly larger than bobcats, the Canada Lynx is a medium-sized cat (0.8 – 0.85 m in length) with a grizzled appearance attributable to grey and black guard hair constituting their coat. They have distinctive long tufts of fur on their ears and large paws covered in thick, coarse hair. Its relatively larger hind legs, thick fur, and spreading toes not only ease its movement in snow but also allow it to hunt snowshoe hares effectively (NB DNRED, 2022a).

Current range and habitat

Canada Lynx have been found in all provinces of Canada except Prince Edward Island. 90% of its global range is within Canada at 5.5 million km^2 (Poole, 2003). Eastern Canada comprises only a small portion of the species' Canadian range. Despite their high dispersal rates, lynxes are known to be restricted in their original habitats. In New Brunswick, they are primarily found in the extreme northwest, with only occasional sightings and trapping recoveries in the southeast. They are known to often migrate to Quebec and Maine and vice versa. They prefer intact forests and are typically found in areas with dense coniferous or mixed forests that provide cover and support populations of their primary prey, the Snowshoe Hare (NB DNRED, 2022a).

Life cycle

This species' life cycle is determined by the availability of its major prey, the Snowshoe Hare. Currently, there are no studies within New Brunswick that indicate the life span or generation time of Canada Lynx within the province. However, when Snowshoe Hares are abundant, lynxes are known to live up to 4 years on average. Snowshoe Hare prefer regenerating clear-cut areas over partially cut areas due to the high stem density the clear cut provides. Due to the lack of studies and reliable data, the Lynx population numbers might not be exact or even accurate (NB DNRED, 2022a).

The life cycle begins with mating in late winter, typically between March and April. After a gestation period of about 63 days, females give birth to litters of 1 to 4 kittens, usually in May or June. The abundance of Snowshoe Hare has been implied to affect the litter size. Male lynxes are polygamous and do not assist females in nursing the kittens. Females reach sexual maturity at 22 months (NB DNRED, 2022a).

Threats and disturbances

One of the primary threats is habitat loss and fragmentation due to logging, road construction, and urban development, which reduce the availability of dense forest areas that lynx rely on for hunting and shelter. Lynxes are adapted to snow conditions, meaning they have a competitive advantage for hunting in snow, however, climate change and warmer winters affect this biological advantage. In this aspect too, habitat loss and fragmentation due to urbanization, and deforestation confound the problem. Finally, trapping and hunting, though regulated, still pose risks, as lynx can become accidental bycatch in traps set for other species. (NB DNRED, 2022a).

Mammal profile summary

Table 5. Mammals profile summary

Species	**Status**	**Major threat**
Canada lynx	Endangered	Habitat loss and fragmentation

5.4 Insects

Bohemian Cuckoo Bumble Bee *Bombus bohemicus*

Conservation status

As of 2014, the Bohemian Cuckoo Bumble Bee is listed as Endangered by COSEWIC, has a Schedule 1 Status as of 2018 and is listed as Endangered by NBCOSSAR (NB DNRED, 2021a).

Physical attributes

Bohemian Cuckoo Bumble Bees are medium-bodied bees whose females are generally larger than males. Both sexes range from 12 – 18 mm in body length and 5 – 8.5 mm in width (COSEWIC, 2014b). Females' abdominal hair pattern is as follows; segments one and two are black, and segments three to five vary in colouration to yellowish white (COSEWIC, 2014b).

Their head and face are generally black with some yellow hair on top of their head (COSEWIC, 2014b). Males' abdominal hair pattern is as follows; segment one is yellow sometimes with black amongst them, segments two and seven are black, segments three, five and six are yellow with some black hairs towards the centre, and segment four is yellow (COSEWIC, 2014b).

Current range and habitat

Globally this species is found in North America, Europe, and Asia. Within North America, the Bohemian Cuckoo Bumble Bee is found in the North and Northeast United States and throughout Canada, besides Nunavut. The last specimen collected in New Brunswick was in 1979 (NB DNRED, 2021a). Although there have been no recent sightings of the species, they could persist within New Brunswick due to the presence of host species and being in neighbouring provinces. In general, Bohemian Cuckoo Bumble Bees prefer a variety of different habitats such as meadows, old fields, boreal forests, edges of wetlands, farmlands, urban areas, and open woodlots (NB DNRED, 2021a & COSEWIC, 2014b).

Life cycle and behaviour

The Bohemian Cuckoo Bumble Bee's life cycle is one year (COSEWIC, 2014b). Since it is a socially parasitic bee it syncs to the life cycle pattern of its host species (COSEWIC, 2014b). In New Brunswick, their host species consist of the Yellow-banded Bumble Bee and less commonly the Rusty-patched Bumble Bee (NB DNRED, 2021a & NB DNRED, 2023b).

In the spring the adult females invade their host species' nests and either kill the queen or injure her resulting in a free nest (COSEWIC, 2014b). She then lays her eggs in this nest and uses the workers of the queen to take care of them for her (COSEWIC, 2014b). It takes approximately 32 days for the eggs to go through all stages of metamorphosis and emerge as adults (COSEWIC, 2014b). Once emerged the adult males and females mate. The males die

shortly after mating while the females overwinter and lay eggs the next spring, starting the cycle again.

Threats and disturbances

The most significant threat to the Bohemian Cuckoo Bumble Bee is the decline in host species. They depend on the Yellow-banded Bumble Bee and the Rusty-patched Bumble bee, which are both endangered in New Brunswick (NB DNRED, 2021a). The use of pesticides has also caused a significant decline in bumble bee species, especially those containing neonicotinoids (COSEWIC, 2014b). Pathogens introduced by non-native bees from commercial settings have caused a decline in all native bees (NB DNRED, 2021a). Habitat loss and fragmentation are also probable causes of species decline (NB DNRED, 2021a). Bumble bees generally have narrow climate tolerances so as climate change progresses this species may be affected by climate change (COSEWIC, 2014b).

Monarch *Danaus Plexippus*

Conservation status

As of 2016, the Monarch is listed as Endangered by COSEWIC, has Schedule 1 Status as of 2023, and is listed as Endangered by NBCOSSAR (COSEWIC, 2016b, NB DNRED, 2022b).

Physical attributes

The most notable stage of the Monarch is its butterfly stage when I can be identified by its bright orange, white and black wings with a black abdomen and a thorax that is black with white spots. The Monarch is a large butterfly with a wingspan of approximately 93-105 mm (COSEWIC, 2016b). Monarch eggs are tiny (1 mm in length), white, and oval with a flat base that comes to a blunt point at its apex (COSEWIC, 2016b). The caterpillar grows to about 50

mm and has a striped pattern of white, yellow and black (COSEWIC, 2016b). The chrysalis changes colouration as time progresses, at the beginning the chrysalis is light green with a black and gold band and turns transparent before entering the adult phase (COSEWIC, 2016b).

Current range and habitat

The native range of Monarchs is from Central America from the continental United States to southern Canada (COSEWIC, 2016b). Monarchs are distributed throughout New Brunswick.

Habitat requirements of Monarchs change with their life stage. The breeding habitat of Monarchs is exclusively where Milkweed grows since Monarch pupae feed solely on Milkweed species (NB DNRED, 2022b). The native range of Common Milkweed is in old fields, roads, railbeds and shorelines (NB DNRED, 2022b). The native range of Swamp Milkweed is along shorelines, wetlands, marshes, wet meadows and floodplains (NB DNRED, 2022b).

Adult Monarchs have a much wider range of species that they feed on. They nectar on a wide variety of native flower species (NB DNRED, 2022b). Key habitat includes fields, meadows, pollinator gardens and other disturbed areas. Flower species within New Brunswick that adults are often feeding from include milkweeds, goldenrods, asters, clovers and thistles (NB DNRED, 2022b). Overwintering habitat will not be discussed since they over winter in Mexico.

Life cycle and behaviour

Like all butterflies, Monarchs go through four stages of metamorphosis. Their four stages are as follows, egg, larva (caterpillar), pupa (chrysalis), and adult (butterfly). Non-overwintering butterflies known as summer Monarchs mate shortly after becoming adults allowing for multiple generations of butterflies in one season. They can lay eggs from June to October in some regions (COSEWIC, 2016b). Females lay eggs immediately after mating and can mate up to 10 times in a season allowing them to lay between 300 to 400 eggs in one summer (COSEWIC, 2016b).

Eggs are laid on the underside of milkweed leaves and laid singularly. They then hatch to become caterpillars which then transform into their chrysalis form before emerging as adults. (COSEWIC, 2016b) It takes Monarchs 28 -32 days to reach adulthood from the time their egg is laid (COSEWIC, 2016b). Summer adults live around two to five weeks while overwintering adults can live up to nine months (COSEWIC, 2016b). The last generation of Monarch adults in the summer migrate to their overwintering grounds.

Threats and disturbances

Although Monarch's presence in New Brunswick has increased in the past few decades, declines in populations across Canada have been witnessed due to several factors (NB DNRED, 2022b). Within Canada, the primary threat to Monarchs is the quantity of milkweed (COSEWIC, 2016b). Since the use of herbicides, extreme weather, and habitat loss there has been a decline in milkweed population and distribution which Monarchs depend on as a part of their life cycle (NB DNRED, 2022b). Other threats include pesticides that use neonicotinoids, disease and declining nectar sources due to urbanization, deforestation, etc. (NB DNRED, 2022b). Overwintering individuals are threatened by weather extremes since their metabolism slows and habitat loss since they inhabit specific habitats (COSEWIC, 2016b).

Pygmy Snaketail *Ophiogomphus howei*

Conservation status

As of 2018, the Pygmy Snaketail is listed as Special Concern by COSEWIC, has a Schedule 1 Status as of 2011 and is being reassessed by NBCOSSAR (COSEWIC, 2018b).

Physical attributes

The Pygmy Snaketail is the one of smallest dragonflies in Canada. An adult is typically 31 - 34 mm long with a hindwing length of 19 - 21 mm (COSEWIC, 2018b). Their wings have a yellow ting near the thorax and become opaque when continuing outwards. The body of the dragonfly is dark brown and black (COSEWIC, 2018b). The abdomen has bright yellow markings while the thorax is bright green (COSEWIC, 2018b). Before morphing into adult dragonflies, the larvae are 19 - 22.5 mm in length (COSEWIC, 2018b). At this stage, the larvae have wing cases ending at segment four of the abdomen (COSEWIC, 2018b).

Current range and habitat

The Pygmy Snaketail has two ranges within Canada, New Brunswick and Northwestern Ontario (COSEWIC, 2018b). This species stretches to regions of Georgia, Michigan, Wisconsin, and Minnesota. Within New Brunswick, this species is found in proximity to large river systems including the Wolastoq (Saint John River), St. Croix, Magaguadavic which is within 10km of the study site, Southwest Miramichi, Cains, and Salmon River (COSEWIC, 2018b).

Larvae inhabit large rivers with widths greater than 40 m that have a moderate gradient with swiftly flowing waters (COSEWIC, 2018b). They require rivers that are relatively pristine with unpolluted waters with areas with fine sand or gravel substrate (COSEWIC, 2018b). When emerging they select riparian zones that border meadows, forests or thickets (COSEWIC, 2018b). As adults, they remain near their natal river in forest canopies (COSEWIC, 2018b).

Life cycle and behaviour

The Pygmy Snaketail spends its egg, and larval stages within aquatic environments. Adult females lay eggs in flowing water that then land amongst the substrates. The eggs then develop into larvae, and after approximately two years they travel approximately 1 m from the stream (COSEWIC, 2018b). They emerge as adults and leave their exvuvia on the bank. The immature

adult goes into the surrounding forest to mature into a breeding adult. Adults are typically at flight between May and July (COSEWIC, 2018b).

Threats and disturbances

There are several potential threats that could impact the Pygmy Snaketail. Dams are presumed to be the greatest threat since they impound running waters and can destroy breeding habitats (COSEWIC, 2018b). Dams can create lentic habitats which would negatively impact larvae and eggs as they require lotic habitats (COSEWIC, 2018b). Urban and industrial activities may impact this species due to effluents entering the waterway. This species requires near pristine waters and cannot cope with pollutants (COSEWIC, 2018b). Streambank and shoreline development or clearing can cause habitat loss since adults enter adjacent forests. Climate change is also anticipated to pose a risk to dragonflies. Climate change may shift or expand their range, restrict cold-adapted species, threaten vital habitats and impact their life cycle (Ducks Unlimited Canada, 2022).

Transverse Lady Beetle *Coccinella transversoguttata*

Conservation status

As of 2018, the Transverse Lady Beetle is listed as Special Concern by COSEWIC, has a Schedule 1 Status as of 2021 and is listed as Endangered by NBCOSSAR (COSEWIC, 2016c, NB DNRED, 2021b).

Physical attributes

The Transverse Lady Bettle undergoes four life stages egg larva, pupa and adult, they appear physically different in each stage. Adults are relatively large measuring from 5 to 7.8 mm in length and are slightly oval with red, orange, or red-orange, wing covers that have black

markings. Although there is no formal description of the eggs and larvae of Transverse Lady Beetles, it is theorized that they are similar to those in its genus.

Current range and habitat

The Transverse Lady Beetle can be found across Canada and the United States. Although there have been no sightings of this lady beetle since 1991 in New Brunswick, it is still thought to persist in very small numbers as there is still suitable habitat (NB DNRED, 2021b).

The Transverse Lady Beetle utilizes a variety of habitats as it is considered a habitat generalist. These lady beetles can inhabit agricultural land, edge of dunes, suburban areas, coniferous forests, deciduous forests, grasslands, meadows, mixed woods forests and riparian zones (NB DNRED, 2021b). Adults overwinter in microhabitats such as beneath stones, within rocks, leaf litter, garden trimmings, and beneath exposed tree bark (COSEWIC, 2016c).

Life cycle and behaviour

When determining the life cycle of the Transverse Lady Beetle general lady beetle biology was used as there is little known about this beetle's life cycle. Lady beetles complete four stages in metamorphosis: egg, larva, pupa, and adult. The estimated lifespan of Transverse Lady Beetles is 20 to 60 days, based on closely related species (COSEWIC, 2016c).

Lady beetles lay tightly packed eggs with the point of the oval-shaped egg pointing upwards. Approximately 3 days after eggs are laid the larvae emerge and undergo four stages in 13 days before pupating (COSEWIC, 2016c). The pupa then takes approximately 5 days to emerge as adults (COSEWIC, 2016c). These beetles mate multiple times with multiple partners. Food and climate are factors in lady beetle size and weight which directly influence their survival rates when overwintering (COSEWIC, 2016c).

Threats and disturbances

The greatest threat to Transverse Lady Beetles is the introduction of non-native lady beetles. The introduction of non-native species increases competition, increases predation, and can increase the transmission or introduction of pathogens (COSEWIC, 2016c).

Other threats to lady beetles include pesticides and ecosystem modifications. Although lady beetles are more resilient to pesticides used in agriculture settings, direct contact, residual exposure and inhalation can result in their death (COSEWIC, 2016c).

The impacts of climate change may interact with lady beetles negatively. Since the Transverse Lady Beetle is adapted to cold weather, they could potentially go extinct or extirpated as temperatures continue to rise (Sloggett, 2021). They have the potential to change their range and migrate towards the north. Climate change may also change their interactions with prey species such as aphids (Sloggett, 2021).

Yellow-banded Bumble Bee *Bombus terricola*

Conservation status

As of 2015, the Yellow-banded Bumble Bee is listed as Special Concern by COSEWIC, has a Schedule 1 Status as of 2018 and is listed as Special Concern by NBCOSSAR (COSEWIC, 2015, NB DNRED, 2023c).

Physical attributes

Yellow-banded bumble bees are considered medium-sized bees, ranging from 13 – 21 mm in size based on their role within the hive (COSEWIC, 2015). Males have short heads compared to females while both have short and even body hair (COSEWIC, 2015).

Females and queens share the same colour pattern. Their heads are covered with black hair with some short paler hairs intermixed and they have yellow patches on their body

(COSEWIC, 2015). When differentiating males from females, females have pollen sacks on their hind legs. Males are similar in colouration to the females and queens however, their faces usually contain more yellow hairs (COSEWIC, 2015).

Current range and habitat

The Yellow-banded Bumble Bee is found across North America, spanning across Canada and in 25 states. Within New Brunswick, the Yellow-banded Bumble Bee has been found within all ecoregions (NB DNRED, 2023c). It is estimated that New Brunswick has a population that exceeds 10,000 individuals (NB DNRED, 2023c).

This species of bumble bee is considered a habitat generalist as it can inhabit various habitats such as a variety of forest types, clear-cuts, riparian areas, meadows, grasslands, roadsides, subalpine habitats, fields, urban areas, wetlands, and dunes (NB DNRED, 2023c). Overwintering habitat includes loose soil or rotting wood that allows for easy burrowing (COSEWIC, 2015).

Life cycle and behaviour

Bumble bees complete a metamorphic cycle, they start as an egg, develop into a larva, then a pupa and end as an adult. Males are only mates for the queen, so they die shortly after (COSEWIC, 2015). In the spring when the queens emerge in April or May they forage and look for nesting sites. Once eggs are laid it takes approximately 32 for them to develop into adults.

The first eggs to hatch are all females that tend to the colony by foraging for them, tending to the nest, feeding brood and protecting them. The queen continues to lay eggs, laying approximately 90 to 105 worker eggs per season (COSEWIC, 2015).

As the summer progresses and as the colony cycle approaches the end males are produced along with potential queens. All mating individuals leave the nest to mate, one male per each young queen (COSEWIC, 2015)

Threats and disturbances

The Yellow-banded Bumble Bee has several potential threats including the introduction of non-native bee species, pathogens or diseases, toxic effluents, habitat loss, and climate change (COSEWIC, 2015).

Non-native bee species compete with native bee species and often introduce pathogens that are spread to native species. This is potentially the largest threat to the native North American bumble bees (COSEWIC, 2015).

Bumble bees are exposed to pesticides directly while foraging or nesting and indirectly while feeding on pollen and nectar which can be lethal depending on the chemical and/or exposure (COSEWIC, 2015). Pesticides can accumulate through the long-life cycle of the colony which can make the species vulnerable (COSEWIC, 2015).

Habitat loss through logging, urbanization, and agricultural leads are other factors in the decline of this species (NB DNRED, 2023c). The removal of flowering communities and nesting sites results in bumble bees having to move to new locations causing a local decline in this species (NB DNRED, 2023c). Agricultural land also reduces the quality of foraging species, especially when monocultures are planted.

As climate change progresses severe weather events can threaten the existence and recovery strategies of the Yellow-banded Bumble Bee. Climate change is predicted to create more variable weather patterns which can impact the bumble bee's life cycle (COSEWIC, 2015). Variations in temperatures can cause life stages to take longer or cause them to stay in one stage

for longer than before (COSEWIC, 2015). An increase in droughts can affect foraging patterns and available plants to forage from. Bumble bees also have narrow climate tolerances which makes them vulnerable to climate change and rapid temperature increases (COSEWIC, 2015).

Insect profile summary

Table 6. Insect profile summary

Species	Status	Major threats
Bohemian Cuckoo Bumble Bee	Endangered	Use of pesticides, pathogens from commercial bees, habitat loss & fragmentation, and narrow temperature tolerance. Host species are also endangered.
Monarch	Endangered	Threats to Southern overwintering habitat & food source. Loss of food & habitat in NB, pesticides, extreme weather (heat, drought).
Pygmy Snaketail	Special Concern	Polluted or dammed rivers. Development eliminates shore habitat. Extremes of climate change (flooding, drought, heat).
Transverse Lady Beetle	Special Concern / Endangered	Introduction of non-native species. Pesticides. Habitat disturbance. Early spring warming. Low tolerance to cc temperature increases.
Yellow-banded Bumble Bee	Special Concern	Introduction of non-native species & pathogens, cumulative pesticide exposure, toxic effluents, habitat loss due to development & mono agriculture, climate change-related variable weather patterns & heat intolerance.

6.0 Climate change impacts

Climate change is expected to continue driving significant environmental changes in New Brunswick generally, and Charlotte County more specifically in the coming decades. Key predictions include rising temperatures, reduced snowfall, and more intense rainfall. These shifts will bring more frequent and intense storms, rising sea levels, and changes in ocean temperatures, oxygen, and acidity levels, all of which will affect ecosystems on both land and in the ocean (ClimAtlantic 2024; New Brunswick Department of Environment and Local Government, 2023a).

6.1 General climate change-related changes expected for Atlantic coastal forests

Atlantic coastal forests like those at Deadmans Head face increased vulnerability from climate change. Severe weather events, such as storms and wildfires, are expected to become more frequent and intense, weakening forest resilience and negatively impacting biodiversity. Additionally, the spread of invasive species will likely accelerate, further stressing forest ecosystems. As species react differently to climate changes, forest composition is expected to shift, with new pests and invasive species colonizing areas in New Brunswick (ClimAtlantic, 2024; Natural Resources Canada, 2024; New Brunswick Department of Environment and Local Government, 2023a).

6.2 Climate change predictions for Deadmans Head Forest

Deadmans Head Forest will be significantly impacted by the predicted climate changes. The primary factors identified in the Phase 1 report are increasing daily and annual temperatures and changing precipitation patterns (Climate Atlas 2022 as cited in Evans et al., 2022). These two drivers will dramatically alter the forest's ecosystem dynamics.

Temperature

Global temperatures are projected to continue rising unless greenhouse gas emissions are curbed (IPCC, 2022). As a result, the forest will experience increased mean annual temperatures and more frequent heatwaves (Climate Atlas, 2024; ClimAtlantic 2024). Higher temperatures could lead to faster evaporation, drying out soils and increase the risk of droughts (Natural Resources Canada, 2022).

Precipitation

While annual precipitation is expected to increase, a “snow drought” may emerge due to the reduced snowpack in winter, which traditionally replenishes soil moisture (Harpold et al.,

2017). Increased rainfall intensity will lead to greater runoff and less water absorbed into the soil, affecting forest health. Flooding concerns, particularly in coastal areas like Charlotte County, are rising due to sea-level rise (Daigle, 2020). However, Deadmans Head Forest is not expected to be vulnerable to flooding due to its higher elevation and the natural protection provided by rocky cliffs (E. Edwards, private communication, Sept 18, 2024).

Flooding

Although Deadmans Head is less likely to experience flooding directly (E Edwards, personal communication, Sept 18, 2024), the region's shifting storm tracks and more frequent hurricanes will bring stronger winds and heavier rain. This could lead to increased blowdown and further stress on the forest's resilience (New Brunswick Department of Environment and Local Government, 2023a; Fisheries and Oceans Canada, 2023).

Erosion

As the Living Lab Phase 2 report concluded, while Deadmans Head Forest is currently protected from significant coastal erosion by the surrounding cliffs, freeze-thaw cycles and storm-related damage to coastal vegetation could exacerbate erosion over time (Murphy et al., 2023). While erosion remains a concern for forest and ecosystem health, it is not an immediate threat due to the forest's natural geography and the limited erosion observed to date (E. Edwards, private communication, Sept 18, 2024). However, unknowns include the cumulative degradation coastal forests will experience due to the interaction of all the conditions discussed (Penney, 2022).

Wildfire

Climate change will exacerbate factors influencing wildfire risk, including dry fuels, frequent lightning, and windy conditions. Although Atlantic Canada could see a 200-300%

increase in "fire weather" by century's end, raising concerns for the region's forests, unless landowners are willing to "fire safe" their properties by removing deadfall, cutting trees back from structures, and limiting human access, there is little they can do to mitigate these risks. (Climate Atlas, n.d.). In 2023, a major wildfire in Charlotte County burned over 540 hectares, underscoring this growing threat to coastal forests and the species that depend on them (CBC News, 2023).

6.3 Climate change-related threats to Species at Risk and their habitat

The impact of climate change on SAR varies depending on the specific habitat needs and vulnerabilities of each species. Although no single conclusion can be drawn for all SAR, habitat availability and specificity emerge as key factors (Environment Canada, 2015a). A 2022 report from Eastern Charlotte Waterways emphasizes that protecting key habitats should be a priority for conserving regional species. For example, species such as lichens and fungi are particularly vulnerable to temperature increases and drought periods, while migratory birds are particularly vulnerable to habitat availability and changes (Penney, 2022).

Even with uncertainties in climate predictions, efforts to protect and enhance habitat quality remain crucial. Understanding these dynamics will allow for more confident assessments of species' needs in the face of changing environmental conditions (Penney, 2022). To see a complete summary of the species at risk – threats and which conservation approaches may be within human control, see Appendix F.

6.4 The future of the Deadmans Head ecosystem in the context of climate change

The research findings, coupled with predictions for climate change impacts—such as rising temperatures, increased precipitation, flooding, erosion, and wildfire—underscore the need for a holistic approach to ecosystem conservation. While the forest at Deadmans Head is

currently considered moderately healthy and relatively resilient to climate change (Evan et al., 2022), it is not immune to shifting climate dynamics. Temperature increases and changing precipitation patterns will likely cause a shift in forest composition, with species adapted to cooler climates, such as Balsam Fir, potentially being replaced by species more tolerant of warmer conditions, such as White Pine and Red Maple (Natural Resources Canada, 2022).

As climate change intensifies, the integrity of the forest's ecosystem and its ability to support species at risk will depend on preserving habitat quality and understanding the interconnections among species and environmental changes. The challenges posed by climate change require integrated species at risk and ecosystem conservation strategies that balance long-term ecological health with the dynamic conditions anticipated in the future.

7.0 Conservation conflicts and conservation options

Many owners of ecologically significant land are witnessing these impacts of climate change firsthand and are uncertain about how much intervention is appropriate or effective. In discussions that took place over the course of the fall, the Edwards expressed a sense of conflict between their desire to actively manage their property to support species at risk and enhance ecosystem resilience, versus their long-term goal of maintaining the property as a "Living Lab" for research on climate change impacts in a largely untouched ecosystem (E. Edwards & J. Edwards, private communications, Sept 18, Oct 31, Nov 1, 2024). This dilemma is common among private landowners today, who must balance proactive management with conservation objectives.

Organizations such as ClimAtlantic advocate for active interventions in land management, recommending approaches like silviculture to mitigate climate impacts and capitalize on new opportunities (Kania et al., 2021). For the Edwards, these measures might

include increasing forest resilience by planting climate-appropriate tree species or removing blowdown to reduce wildfire risk. However, the Edwards expressed concerns about the time, expertise, and resources required for such interventions, as well as the potential conflict with their goal of providing the forest which has largely been untouched since the 60's, as a research environment for the Living Lab.

Smaller-scale interventions were also considered. For instance, the Nature Conservancy of Canada's "Small Acts of Conservation" program encourages landowners to enhance habitats and food sources for specific species (Nature Conservancy of Canada, 2024d). This type of intervention supports the continued functioning of ecosystems and helps mitigate unintended consequences, such as the introduction of invasive species (Leuzinger & Rewald, 2021). The Edwards discussed potential actions, such as planting milkweed, a critical host plant for Monarch caterpillars and a declining species in New Brunswick.

While such interventions may seem straightforward, the ethics of these actions can be complex. As author, Benjamin Vogt notes, "helping" Monarchs requires more than planting milkweed; a complete native plant and other species community is essential for this species' survival, and addressing these ecological interactions in a broader ethical framework is key (Vogt, 2022).

Further complicating the landowner's decision-making process are the unique recovery needs of different SARs. To take an example from the SAR bird profiles, the Bicknell's Thrush requires minimal human intervention, such as leaving snags and blowdown while the Olive-sided flycatcher's recovery strategy might involve removing deadfall and planting for pollinators (Table 6).

Table 6. SAR conservation conflict example

SAR	Requires	Not in the landowner's control	What could help?
Bicknell's Thrush	Dense Balsam Fir & Spruce Forest, & dead trees & snags	Devastated by a small temp increase	Leave snags & blowdown. Protect from human interference
Olive-sided Flycatcher	Mature mixed forest for high-up nests, require minimal deadfall & access to wetland/water	CC will increase # of successional vs mature forests	Leave mature forest intact but remove deadfall. Privilege pollinator-friendly plants for a healthy insect population

These contrasting needs can create recovery-action antagonism, where efforts to benefit one species may harm another (Silver et al., 2023). The SAR profiles developed for this project highlight these complexities, showing that what helps one species may unintentionally hurt another (see Appendix F for similar information on all the SAR profiled).

Silver et al. (2023) also note that SAR recovery planning often lacks a comprehensive understanding of interspecific relations and ecological dynamics. Their research suggests that multispecies and ecosystem-based approaches may offer better solutions, but resources are often limited, and ineffective or redundant actions can undermine conservation efforts.

To address these complexities, organizations like the Nature Trust of New Brunswick (NTNB) are expanding stewardship programs to support landowners in navigating these challenges (Nature Trust of New Brunswick, 2019b). The Edwards have already engaged with NTNB's Conservation Partner Program and are aware of it as a potential future informational resource, as well as a venue that fosters relationships with other landowners facing similar issues, or a source of advice on how to seek funds to support land stewardship projects (A. Pluta, private communication, Oct 23, 2024; Environment and Natural Resources Canada, 2024).

In response to these challenges and options discussed over the course of the fall, the Edwards communicated the decision that they wanted this report to focus recommendations on a "mixed management" approach. This approach would divide the property into two conservation zones: Zone 1, surrounding the house and meadow, would allow for selective habitat restoration; Zone 2, the forested area, would be reserved for ongoing Living Lab research with minimal human interference (Figure 7). This strategy balances their ecological goals with the need to protect the property for future research.

Figure 7. The project area is divided into Zone 1 and Zone 2.

The Edwards' decision to adopt a mixed management approach represents a thoughtful compromise between their ecological and research goals. This flexible, zone-based strategy allows for active habitat restoration where needed while preserving the integrity of the Living Lab. It exemplifies the nuanced decision-making required when balancing ecological conservation with the complexities of species recovery and climate change adaptation. As more landowners face similar challenges, such mixed approaches may offer a valuable model for long-term stewardship and biodiversity conservation.

8.0 Recommendations

Based on the preferences of the property owners as outlined above, the review of the SAR and conservation literature, the field and climate change data collected and the expertise of group members, the following three approaches are recommended for the development of the Living Lab, and the long-term maintenance of the Edward's property "in perpetuity", even under conditions of climate change.

1) A "Mixed Management" approach dividing the property into two conservation zones with
    a) Zone 1 around the house and meadow set aside for some selective habitat restoration measures, and
    b) Zone 2 allows for continued Living Lab-related research but otherwise minimal access to and interference in the forest.
2) Exploring preserving the special qualities of the property "in perpetuity" through a cross-border land trust.
3) Inclusion of Indigenous knowledge in future Living Lab research and assessment.

8.1 Selective habitat restoration – Zone 1

A selective habitat restoration approach would involve specific interventions that alter the natural environment in the area of the property already most impacted by human settlement – around the house, shed, and the nearby meadow and regenerating forest. This approach could help support the habitat preferences and requirements of specific species at risk, while also generally increasing biodiversity and whole ecosystem health.

Examples of selective habitat restoration approaches that could be considered are listed below:

- Install or assist in creating habitat: install nesting boxes for bats and bird species that prefer cavities to nest in. Pile up logs for insect and amphibian homes. Develop burrows or dens for species that need them by cutting off the tops of dead trees to create snags that owls, woodpeckers, etc. will cultivate. Plant non-invasive swamp milkweed in the field around the house for the Monarch Butterfly.
- Plant native vegetation: support and increase the health of the whole ecosystem by planting native species that produce seeds and fruits that meet the nutritional requirements of native species and wildlife. For example, planting native burr oak can not only increase the hardiness of the forest mix generally, but provides seeds & nuts for wildlife.
- Maintain natural features. Preserve the natural habitat within the project area that are critical for SAR and existing species. For example: retain leaf litter and fallen branches as habitat for decomposers and other insects; maintain dead and dying trees that provide natural nesting cavities and perches; when removing blow down, preserve a 10–12-foot snag for nesters.

8.2 Protect and manage – Zone 2

A "protect and manage" approach, would allow for the continued study through the Living Lab of the ecosystem in general, and identified species in particular; and how they are influenced by climate change over time. With this approach, the landowners would continue to protect the forested zone from human influence with gated and monitored "invitation-only" access, and minimal interference in the form of path and blow down clearing only as necessary. It should be noted that although the goal would be to limit further human interference, some research techniques represent more of an "intervention" than others and the rationale

for/tolerance to each intervention would have to be considered. For example, bird banding has an influence on bird behaviour, while remote sensing does not generally interfere with wildlife.

Research opportunities for the forested zone of the property could be as follows:

Avian species

- Annual migratory and breeding bird surveys: conduct surveys to monitor the presence, abundance, and breeding successes of migratory and resident bird species annually. These surveys should include standardized point counts, transect walks, and seasonal observations to capture species composition over time.
- Avian recording units (ARUs): Place recording devices in various habitats across the property area to continuously capture bird and bat sounds. This allows for the detection of nocturnal species and provides data on avian activity patterns and species composition.
- Bird banding: Implement a bird banding station to individually mark birds with uniquely coded bands. This facilitates a long-term study on bird movement and determines if they are returning to the same locations annually (Bonnet-Lebrun et al., 2024).

Vegetation

- Reassessment and create permanent vegetation plots: Return to vegetation plots to record changes in plant species composition and abundance. Detailed vegetation surveys should include measurements such as plant height, coverage, and biomass to assess ecological succession and habitat quality. This should be completed in various seasons to encompass all species' lifecycles.
- Remote sensing: Use of satellite imagery and aerial photography to monitor vegetation and land cover changes over time. Remote sensing data can be analyzed using GIS to detect changes in vegetation health and habitat.

- Photographic monitoring: Set up fixed photo points and take repeat photographs at regular intervals, seasonally and annually, to document changes in vegetation and land cover This provides a visual record of habitat alterations over time.

Mammals

- Motion cameras: Install motion-sensing cameras in strategic locations to capture images and videos of mammal species. This is a non-invasive way to monitor mammas and provide data on species presence and behaviour.

Insects

- Pitfall traps: Place pitfall traps in various habitats that will capture ground-dwelling insects. These traps are made of containers buried with soil and will capture beetles, ants, and other terrestrial arthropods, providing data on species diversity and abundance (Coleman et al., 2004).
- Sweep netting: Use fine mesh nets to sweep insects out of vegetation, this will capture large numbers of insects efficiently and with a low risk of mortality (DeWalt et al., 2015).
- Light traps: Set up light traps with ultraviolet bulbs to attract nocturnal insects such as moths. This will monitor insect diversity and activity in different habitat types (Ramamurthy et al., 2010).

8.3 Long-term conservation – a cross-border land trust

Given the unique ecological value of Deadmans Head and the growing real estate demand for coastal properties, it is recommended that the landowners explore the possibility of entering into a cross-border land trust agreement. Land trusts are increasingly recognized as a vital tool for biodiversity conservation on private land, providing provide essential habitat and corridors for species at risk, particularly for smaller properties in more fragmented regions like

Deadmans Head. (Alliance of Canadian Land Trusts, 2024). As the landowners are of retirement age, proactive conservation measures are crucial to ensure that the property is safeguarded according to their wishes, particularly should unforeseen circumstances arise. The property's future, particularly regarding its ecological importance and the risk of development, may be at risk if left unprotected. Additionally, the binational tax and estate considerations further complicate the situation.

One option would be to enter a conservation agreement with a binational land trust, such as the American Friends of Canadian Conservation, which facilitates donations of land and funding from US taxpayers to Canadian conservation organizations (American Friends of Canadian Conservation, 2024). Certain types of land trust agreements, such as life estates or easements, allow landowners to retain the right to live on and continue to manage their property during their lifetimes while ensuring the land will be cared for and protected in the future (Nature Trust of New Brunswick, 2019a; 2019b). While the process of establishing such agreements, especially across borders, can be complex and time-consuming (on average 1-3 years), land trusts work closely with landowners to navigate legal frameworks, tax implications, and funding strategies (Aaron Dowding, private communication, Oct. 28, 2024).

As land trusts' resources are limited and each potential property is carefully prioritized according to a standardized set of criteria concerning its ecological significance, it is especially encouraging that Deadmans Head has already passed an initial screening (Denise Roy, private communication, Nov. 14, 2024).

Considering the growing efforts by land trusts in New Brunswick to meet the ambitious 30/30 goal (30% of land conserved by 2030 as proposed by the High Ambition Coalition for Nature and People in 2020), and the Edwards' commitment to the Living Lab project, this is an

opportune time to consider this recommendation. A cross-border land trust agreement could offer this American couple a reliable and long-term solution for conserving their Canadian property's significant ecological features in perpetuity.

8.4 Inclusion of Indigenous Knowledge

The project area is located on the traditional land of the Wolastoqiyik, Mi'kmaq, and Passamaquoddy peoples. As the original stewards of the land, they are key spiritual, cultural and ecological knowledge holders and vital in addressing climate change and its effects on the natural environment (Government of Canada, 2024). There is strong evidence behind the benefits of the inclusion of Indigenous knowledge systems and practices in terms of conservation research and sustainable land management. The incorporation of Indigenous knowledge has been shown to enhance the understanding of ecological components of land management decisions (Jessen et al., 2021). Best practices for effective engagement include acquiring cross-cultural knowledge and building relationships for meaningful discussion (Innes, 2024). It is recommended that the landowners reach out to local First Nations communities to begin building relationships, and to work together to incorporate Indigenous knowledge and perspective in future Living Lab research and land management decisions.

9.0 Conclusion

This report concludes Phase 3 of the Living Laboratory Project which aimed to assess the presence of species at risk (SAR) at Deadmans Head, New Brunswick, and propose conservation strategies given probable threats posed by climate change. Focusing on the 43-hectare peninsula with diverse habitats, the project included historical, field research, spatial analysis, and SAR literature reviews to establish a baseline inventory of species for future research and monitoring, and to develop long-term conservation recommendations.

Limitations such as seasonal constraints and time for fieldwork affected the comprehensiveness of the data, emphasizing the need for additional research.

Field research identified 106 species using two on-site and data analysis methods. The Monarch was the only SAR directly observed during site visits.

The potential for the presence of additional SAR was identified through habitat analysis and cross-referencing available resources. Various maps including a dominant forest type map, soil drainage map, field survey map, and a DEM map were also used to identify which SAR may be present.

A total of 22 SAR profiles were created, including 5 birds, 6 bats, 5 insects, 1 mammal, and 5 plants/vegetation. Each profile contained information regarding conservation status, physical attributes, current range and habitat, life cycle, and threats and disturbances. Summary tables were created that contained the species, conservation status, major threats including climate change-related issues, and finally what conservation measures, if any, could be implemented.

Climate change impacts were analyzed and projections for Atlantic coastal forests, combined with local insights, were outlined. Increased annual temperature, precipitation, and severe storm events were identified as the factors most likely to negatively influence SAR habitat on the property over time. Threats to the over-all ecosystem posed by these changes include a loss of soil moisture that will affect forest growing conditions, hotter annual temperatures that will mean a decline in current tree species and a smaller survival window for cooler-climate preferring SAR, and increased deadfall and habitat deterioration from storm events.

The project also explored conservation conflicts and opportunities, emphasizing the balance between land use, landowner capacity and desires, and habitat protection. It was

emphasized that the impact of climate change on each SAR varies depending on their specific habitat needs and vulnerabilities, making it difficult to come to uniform adaptive management strategies.

Based on discussions regarding the preferences of the property owners, a review of the SAR and conservation literature, field and climate change data collected during this project and the expertise of group members, three key recommendations were made.

1) The implementation of a mixed-management strategy which would see the property divided into two zones. Zone 1 would allow for selective habitat restoration in the human-influenced areas such as around the house and nearby meadow. Zone 2 would be left as a largely "untouched" forest with ongoing access to Living Lab-related research.
2) Exploring preserving the special qualities of the property "in perpetuity" through a cross-border land trust.
3) The inclusion of Indigenous knowledge in future Living Lab research and assessment.

In summary, this phase of the Living Laboratory Project lays a strong foundation for ongoing research and conservation at Deadmans Head. The findings and recommendations provide a roadmap for preserving this ecologically significant area in the face of climate change, with the Living Lab serving as a model for private land conservation and adaptive land management.

10.0 References

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Appendix A: *Province of NB Cadastral Map No 166, NB Provincial Archives*

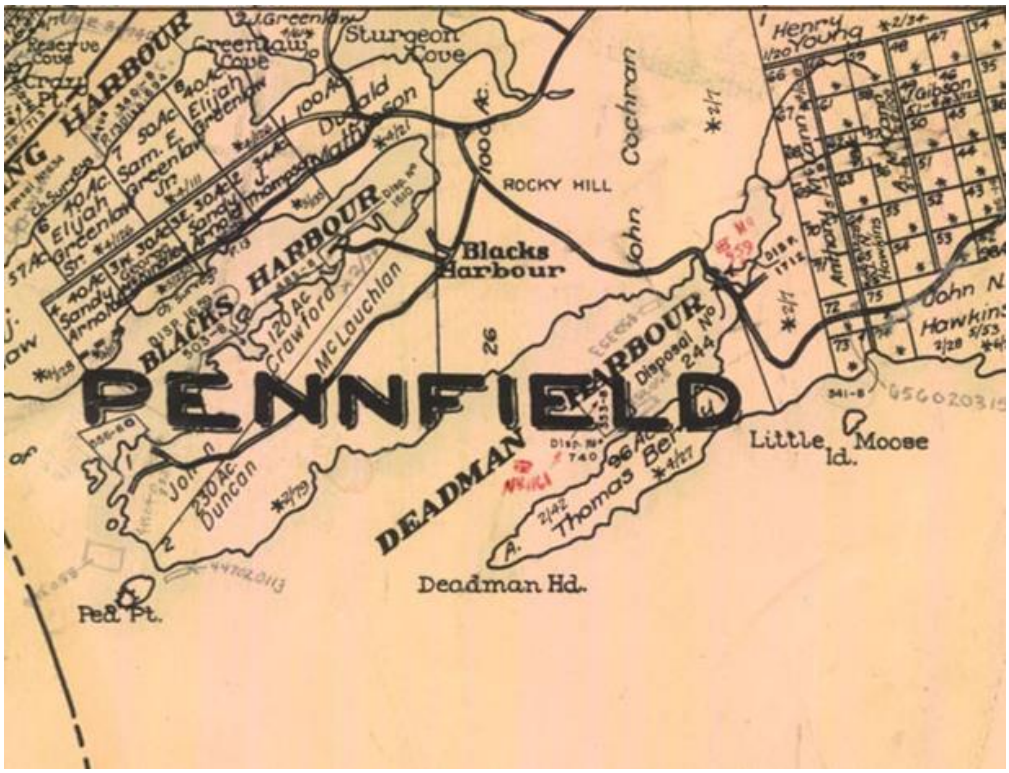

Figure 8. Cadastral Map of Blacks Harbour from 1865 (Government of New Brunswick, 2024).

Appendix B: *Complete species at risk New Brunswick list*

Table 7. All species at Risk in New Brunswick designated by COSEWIC and/or NBSAR as of December 2024.

Avian species			
Bank Swallow	*Riparia riparia*	Threatened or Endangered	COSEWIC and NBSAR
Barn Swallow	*Hirundo rustica*	Special Concern and Threatened	COSEWIC and NBSAR
Barrow's Goldeneye	*Bucephala islandica*	Special Concern	COSEWIC and NBSAR
Bicknell's Thrush	*Catharus bicknelli*	Threatened	COSEWIC and NBSAR
Bobolink	*Dolichonyx*	Special Concern and Threatened	COSEWIC and NBSAR
Canada Warbler	*Cardellina canadensis*	Special Concern and Threatened	COSEWIC and NBSAR
Chimney Swift	*Chaetura pelagica*	Threatened and Pending	COSEWIC and NBSAR
Common Nighthawk	*Chordeiles minor*	Special Concern and pending	COSEWIC and NBSAR
Eastern Meadowlark	*Sturnella magna*	Threatened	COSEWIC and NBSAR
Eastern Whip-poor-will	*Antrostomus vociferus*	Special Concern and Threatened	COSEWIC and NBSAR
Eastern Wood-pewee	*Contopus virens*	Special Concern	COSEWIC and NBSAR
Eskimo Curlew	*Numenius borealis*	Endangered	COSEWIC and NBSAR
Evening Grosbeak	*Coccothraustes vespertinus*	Special Concern	COSEWIC
Harlequin Duck	*Histrionicus histrionicus*	Special Concern and Endangered	COSEWIC and NBSAR
Horned Grebe	*Podiceps auritus*	Special Concern	COSEWIC and NBSAR
Hudsonian Godwit	*Limosa haemastica*	Threatened	COSEWIC
Least Bittern	*Ixobrychus exilis*	Threatened	COSEWIC and NBSAR
Lesser Yellowlegs	*Tringa flavipes*	Threatened	COSEWIC
Olive-sided Flycatcher	*Contopus cooperi*	Special Concern and Endangered	COSEWIC and NBSAR
Piping Plover melodus Subspecies	*Charadrius melodus melodus*	Endangered	COSEWIC and NBSAR
Red Knot rufa subspeies	*Calidris canutus rufa*	Endangered	COSEWIC and NBSAR
Red-necked Phalarope	*Phalaropus lobatus*	Special Concern	COSEWIC
Roseate Tern	*Sterna dougallii*	Endangered	COSEWIC and NBSAR
Rusty Blackbird	*Euphagus carolinus*	Special Concern	COSEWIC and NBSAR

Short-eared Owl	*Asio flammeus*	Threatened and Special Concern	COSEWIC and NBSAR
Wood Thrush	*Hylocichla mustelina*	Threatened	COSEWIC and NBSAR
Yellow Rail	*Coturnicops noveboracensis*	Special Concern	COSEWIC and NBSAR
Bald Eagle	*Haliaeetus leucocephalus*	Endangered	NBSAR
Peregrine Falcon	*Falco peregrinus*	Endangered	NBSAR
Hoary Bat	*Lasiurus cinereus*	Endangered	COSEWIC
Eastern Red Bat	*Lasiurus borealis*	Endangered	COSEWIC
Little Brown Myotis	*Myotis lucifugus*	Endangered	COSEWIC and NBSAR
Northern Myotis	*Myotis septentrionalis*	Endangered	COSEWIC and NBSAR
Silver-haired Bat	*Lasionycteris noctivagans*	Endangered	COSEWIC
Tri-coloured Bat	*Perimyotis subflavus*	Endangered	COSEWIC and NBSAR
Mammals			
Canada Lynx	*Lynx canadensis*	Special Concern	NBSAR
Vegetation			
Anticosti Aster	*Symphyotrichum anticostense*	Special Concern	COSEWIC and NBSAR
Beach Pinweed	*Lechea maritima*	Special Concern or Endangered	COSEWIC and NBSAR
Black Ash	*Fraxinus nigra*	Threatened	COSEWIC
Black-foam Lichen	*Anzia colpodes*	Threatened	COSEWIC
Blue Felt Lichen	*Degelia plumbea*	Special Concern	COSEWIC
Boreal Felt Lichen	*Erioderma pedicellatum*	Endangered	COSEWIC
Butternut	*Juglans cinerea*	Endangered	COSEWIC and NBSAR
Eastern Waterfan	*Peltigera hydrothyria*	Threatened	COSEWIC
Furbish's Lousewort	*Pedicularis furbishiae*	Endangered	COSEWIC and NBSAR
Gulf of St.Lawrence Aster	*Symphyotrichum laurentianum*	Endangered	COSEWIC and NBSAR
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Threatened	COSEWIC
Prototype Quillwort	*Isoetes prototypus*	Special Concern	COSEWIC and NBSAR
Scaly Fringe Lichen	*Heterodermia squamulosa*	Threatened	COSEWIC
Vole Ears Lichen	*Erioderma mollissimum*	Endangered	COSEWIC
White-rimmed Shingle Lichen	*Fuscopannaria leucosticta*	Threatened	COSEWIC
Wrinkled shingle lichen	*Pannaria lurida*	Threatened	COSEWIC
Parker's Pipewort	*Eriocaulon parkeri*	Endangered	NBSAR
Pinedrops	*Pterospera andromedea*	Endangered	NBSAR

Southern Twayblade	*Listera australis*	Endangered	NBSAR
Wan Brunt's Jacob's-ladder	*Polemonium vanbruntiae*	Threatened	NBSAR
Insects			
Cobblestone Tiger Beetle	*Cicindela marginipeenis*	Special Concern	COSEWIC and NBSAR
Gypsy Cuckoo Bumble Bee OR Bohemian Cuckoo Bumble Bee	*Bombus bohemicus*	Endangered	COSEWIC and NBSAR
Maritime Ringlet	*Coenonympha nipisiquit*	Endangered	COSEWIC and NBSAR
Monarch	*Danaus plexippus*	Endangered	COSEWIC and NBSAR
Pygmy snaketail	*Ophiogomphus howei*	Special Concern	COSEWIC and NBSAR
Rusty-patched Bumble Bee	*Bombus affinis*	Endangered	COSEWIC and NBSAR
Skillet Clubtail	*Gomphurus ventricosus*	Special Concern or Data Deficient	COSEWIC and NBSAR
Suckley's Cuckoo Bumble Bee	*Bombus suckleyi*	Threatened or Endangered	COSEWIC and NBSAR
Transverse Lady Beetle	*Coccinella transversoguttata*	Special Concern or Endangered	COSEWIC and NBSAR
Yellow-banded Bumble Bee	*Bombus terricola*	Special Concern	COSEWIC and NBSAR

Appendix C: *Walk-through approach, raw data*

Table 8. All raw data from the walk-though method field research approach.

	Common Name	Scientific Name	Status	Date	Location	Identifier	Picture	iNaturalist	Notes
1	Lingonberry	*Vaccinium vitis-idaea*		12-09-2024	N/A	Laura Lavigne	No	No	
2	Black crowberry	*Empetrum nigrum*		12-09-2024	45.0476, -66.76783	Laura Lavigne	Yes	Yes	
3	Bunchberry	*Cornus canadensis*		12-09-2024	N/A	Laura Lavigne	No	No	
4	Starflower	*Lysimachia borealis*		12-09-2024	N/A	Laura Lavigne	No	No	
5	Whorled wood aster	*Oclemena acuminata*		12-09-2024	N/A	Laura Lavigne	No	No	
6	Yellow birch	*Betula alleghaniensis*		12-09-2024	N/A	Laura Lavigne	No	No	
7	American mountain ash	*Sorbus americana*		12-09-2024	45.0431, -66.77918	Laura Lavigne	Yes	Yes	
8	Canada mayflower	*Maianthemum canadense*		12-09-2024	N/A	Laura Lavigne	No	No	
9	Red spruce	*Picea rubens*		12-09-2024	N/A	Laura Lavigne	No	No	
10	White spruce	*Picea glauca*		12-09-2024	N/A	Laura Lavigne	No	No	
11	Balsam fir	*Abies balsamea*		12-09-2024	N/A	Laura Lavigne	No	No	
12	Long beech fern	*Phegopteris connectilis*		12-09-2024	N/A	Laura Lavigne	No	No	
13	Hay-sented fern	*Dennstaedtia punctilobula*		12-09-2024	N/A	Laura Lavigne	No	No	
14	Threeleaf goldthread	*Coptis trifolia*		12-09-2024	N/A	Laura Lavigne	No	No	
15	Sphagnum moss	*Sphagnum sp.*		12-09-2024	45.0441, -66.77654	Laura Lavigne	Yes	Yes	
16	Cinnamon fern	*Osmunda cinnamomea*		12-09-2024	N/A	Laura Lavigne	No	No	
17	Intermediate wood fern	*Dryopteris intermedia*		12-09-2024	N/A	Laura Lavigne	No	No	
18	Schreber's moss	*Pleurozium schreberi*		12-09-2024	N/A	Laura Lavigne	No	No	
19	White birch	*Betula papyrifera*		12-09-2024	N/A	Laura Lavigne	No	No	
20	Old man's beard	*Usnea sp.*		12-09-2024	45.0424, -66.78006	Laura Lavigne	Yes	Yes	
21	Sunburst lichen	*Xanthoria sp.*		12-09-2024	45.0406, -66.78403	Laura Lavigne	Yes	Yes	
22	Bald eagle	*Haliaeetus leucocephalus*	**	12-09-2024	N/A	Laura Lavigne	No	No	** Not listed under COSEWIC
23	Double-created cormorant	*Phalacrocorax auritus*		12-09-2024	N/A	Laura Lavigne	No	No	
24	Monarch	*Danaus plexippus*	Endangered	12-09-2024	45.0484, -66.76749	Laura Lavigne	Yes	Yes	
25	Creeping buttercup	*Ranunculua repens*		12-09-2024	45.0479, -66.77054	Laura Lavigne	Yes	Yes	
26	Northern blue flag iris	*Iris versicolor*		12-09-2024	45.0474, -66.76978	Laura Lavigne	Yes	Yes	
27	New York aster	*Symphyotrichum novi-belgii*		12-09-2024	45.0477, -66.76754	Laura Lavigne	Yes	Yes	
28	New England aster	*Symphyotrichum novae-angliae*		12-09-2024	45.0484, -66.76772	Laura Lavigne	Yes	Yes	
29	Three-leaved Rattlesnake root	*Nabalus trifoliolatus*		12-09-2024	45.0407, -66.78397	Laura Lavigne	Yes	Yes	See at two locations on different dates (24-09-2024, 45.0411, -66.78059)
30	Green alder	*Alnus alnobetula*		12-09-2024	45.0476, -66.76784	Laura Lavigne	Yes	Yes	
31	Virginia strawberry	*Fragaria virginiana*		12-09-2024	N/A	Laura Lavigne	No	No	
32	Flat-topped goldenrod	*Euthamia graminifolia*		12-09-2024	45.0479, -66.77054	Laura Lavigne	Yes	Yes	
33	Rough-stemmed goldenrod	*Solidago rugosa*		12-09-2024	45.0479, -66.77052	Laura Lavigne	Yes	Yes	
34	Red raspberry	*Rubus idaeus*		12-09-2024	45.0477, -66.77103	Laura Lavigne	Yes	Yes	
35	Pyrobombus	*Pyrobombus (subgenus)*		12-09-2024	45.0484, -66.76771	Laura Lavigne	Yes	Yes	Subspecies of bombus
36	Violet	*Viola sp.*		12-09-2024	N/A	Laura Lavigne	No	No	
37	Creeping Jenny**	*Lysimachia nummularia*		12-09-2024	45.0469, -66.77249	Laura Lavigne	Yes	Yes	**NEEDS ID
38	Tawny Grisette	*Amanita fulva*		12-09-2024	45.0459, -66.77399	Laura Lavigne	Yes	Yes	
39	Sea plantain	*Plantain maritima*		12-09-2024	45.0406, -66.78406	Laura Lavigne	Yes	Yes	
40	Irregular earth tongue	*Neolecta irregularis*		12-09-2024	45.0468, -66.77281	Laura Lavigne	Yes	Yes	
41	Hypoxylaceae	*Hypoxylaceae sp.*		12-09-2024	45.0425, -66.77970	Laura Lavigne	Yes	Yes	
42	Hickory tussock moth	*Lophocampa caryae*		20-09-2024	45.0446, -66.77520	Laura Lavigne	Yes	Yes	
43	Cabbage white	*Pieris rapae*		20-09-2024	45.0485, -66.76788	Laura Lavigne	Yes	Yes	
44	Marsh skullcap	*Scutellaria galericulata*		20-09-2024	45.0482, -66.77042	Laura Lavigne	Yes	Yes	
45	Wild radish ***	*Raphanus Raphanistrum*		20-09-2024	45.0482, -66.77043	Laura Lavigne	Yes	Yes	*** NEEDS ID
46	Nordmann's orbweaver	*Araneus nordmanni*		20-09-2024	45.0418, -66.78172	Laura Lavigne	Yes	Yes	
47	Whitetops sp.	*Doellingeria sp.*		12-09-2024	45.0408, -66.78339	Laura Lavigne	Yes	Yes	
48	Common yarrow	*Achillea millefolium*		12-09-2024	45.0406, -66.78403	Laura Lavigne	Yes	Yes	
49	Cross orbweaver	*Araneus diadematus*		12-09-2024	45.0413, -66.78244	Laura Lavigne	Yes	Yes	
50	Black knapweed	*Centaurea nigra*		12-09-2024	45.0477, -66.76747	Laura Lavigne	Yes	Yes	
51	Mountain woodsorrel	*Oxalis montana*		12-09-2024	N/A	Laura Lavigne	No	No	
52	Common Eider	*Somateria mollissima*		20-09-2024	45.0404, -66.78408	Laura Lavigne	Yes	Yes	
53	Northern red belt	*Fomitopsis mounceae*		20-09-2024	45.0440, -66.77732	Laura Lavigne	Yes	Yes	
54	Pearly everlasting	*Anaphalis margaritacea*		24-09-2024	N/A	Laura Lavigne	No	No	
55	Colt's-foot	*Tussilago farfara*		24-09-2024	N/A	Laura Lavigne	No	No	
56	Golden-crowned kinglet	*Regulus satrapa*		24-09-2024	N/A	Laura Lavigne	No	No	Identified using Merlin
57	Yellow-rumped warbler	*Setophaga coronata*		24-09-2024	N/A	Laura Lavigne	No	No	Identified using Merlin
58	Ruby-crowned kinglet	*Corthylio calendula*		24-09-2024	N/A	Laura Lavigne	No	No	Identified using Merlin
59	Black-capped chickadee	*Poecile atricapillus*		24-09-2024	N/A	Laura Lavigne	No	No	
60	Winter wren	*Troglodytes hiemalis*		24-09-2024	N/A	Laura Lavigne	No	No	Identified using Merlin
61	Hairy woodpecker	*Dryobates villosus*		24-09-2024	N/A	Laura Lavigne	No	No	
62	White-breasted nuthatch	*Sitta carolinensis*		24-09-2024	N/A	Laura Lavigne	No	No	
63	Atlantic Grey Seal	*Halichoerus grypus atlantica*		12-09-2024	N/A	Laura Lavigne	No	No	Spotted multiple times
64	Orange-latex Milky	*Lactarius deterrimus*		24-09-2024	45.0411, -66.78102	Laura Lavigne	Yes	Yes	
65	Grass sp.	*Poaceae sp.*		24-09-2024	45.0411, -66.78107	Laura Lavigne	Yes	Yes	

66	White meadowsweet	*Spiraea alba*		24-09-2024	45.0410, -66.78092	Laura Lavigne	Yes	Yes	
67	Virginian Rose	*Rosa virginiana*		24-09-2024	45.0410, -66.78096	Laura Lavigne	Yes	Yes	
68	American Cranberry	*Vaccinium macrocarpon*		24-09-2024	45.0410, -66.78103	Laura Lavigne	Yes	Yes	
69	Lowbush blueberry	*Vaccinium angustfolium*		24-09-2024	45.0417, -66.78109	Laura Lavigne	Yes	Yes	
70	Honey Mushrooms	*Armillaria sp.*		24-09-2025	45.0446, -66.77587	Laura Lavigne	Yes	Yes	
71	Skunk currant	*Ribes glandulosum*		24-09-2026	45.0463, -66.77109	Laura Lavigne	Yes	Yes	
72	Creeping snowberry	*Gaultheria hispidula*		24-09-2027	45.0501, -66.76818	Laura Lavigne	Yes	Yes	
73	Common eyebright	*Euphrasia nemorosa*		24-09-2028	45.0500, -66.76809	Laura Lavigne	Yes	Yes	
74	Calico aster	*Symphyotrichum lateriflorum*		24-09-2029	45.0499, -66.76800	Laura Lavigne	Yes	Yes	
75	Flat-top white aster	*Doellingeria umbellata*		24-09-2030	45.0499, -66.76799	Laura Lavigne	Yes	Yes	
76	Pixie cup lichen	*Cladonia sp.*		20-09-2024	45.0450, -66.77520	Amandeep Singh	Yes	Yes	
77	Reindeer lichen	*Cladonia sp.*		20-09-2024	45.0450, -66.77520	Amandeep Singh	Yes	Yes	
78	Haircap moss	*Polytrichum sp.*		12-09-2024	45.0469, -66.77232	Laura Lavigne	Yes	Yes	
79	Twinflower	*Linnara borealis*		12-09-2024	N/A	Laura Lavigne	No	No	
80	Bonnets	*Mycena sp.*		20-09-2024	45.0462, -66.77368	Amandeep Singh	Yes	Yes	
81	Amanita Mushrooms	*Amanita sp.*		20-09-2024	45.0437, -66.77817	Amandeep Singh	Yes	Yes	
82	Oyster Mushroom	*Pleurotus ostreatus*		20-09-2024	45.0426, -66.77985	Amandeep Singh	Yes	Yes	
83	Brittlegills	*Russula sp.*		20-09-2024	45.0437, -66.77816	Amandeep Singh	Yes	Yes	
84	Diastrophus turgidus	*Diastrophus turgidus*		20-09-2024	45.0419, -66.78210	Amandeep Singh	Yes	Yes	
85	Loxospora species	*Loxospora sp.*		20-09-2024	45.0424, -66.78021	Amandeep Singh	Yes	Yes	
86	Callicladium species	*Callicladium sp.*		20-09-2024	45.0484, -66.77034	Amandeep Singh	Yes	Yes	
87	Docks and Sorrels	*Rumex sp.*		20-09-2024	45.0462, -66.77359	Amandeep Singh	Yes	Yes	
88	Chocolate Milky	*Lactarius lignyotus*		20-09-2024	45.0443, -66.77571	Amandeep Singh	Yes	Yes	
89	Shield Lichen	*Parmelia sp.*		20-09-2024	45.0471, -66.77146	Amandeep Singh	Yes	Yes	
90	Rhubarb sp.	*Rheum sp.*		12-09-2024	45.0480, -66.77042	Laura Lavigne	No	No	

Appendix D: *Plot survey approach, raw data*

Table 9. All raw data from the plot survey method field research approach.

	Common Name	Scientific Name	Status	Date	Location	Plot #	Identifier	Picture	iNaturalist	Notes
1	Whorled wood aster	*Oclemena acuminata*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
2	Mountain woodsorrel	*Oxalis montana*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
3	Balsam fir	*Abies balsamea*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
4	Intermediate wood fern	*Dryopteris intermedia*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
5	Schreber's moss	*Pleurozium schreberi*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
6	White birch	*Betula papyrifera*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
7	Old man's beard	*Usnea sp.*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
8	Northern starflower	*Lysimachia borealis*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
9	American mountain ash	*Sorbus americana*		24-09-2024	45.0412, -66.78318	1	Laura	No	No	
1	Whorled wood aster	*Oclemena acuminata*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
2	Lingonberry	*Vaccinium vitis-idaea*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
3	Balsam fir	*Abies balsamea*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
4	Grass sp.	*Poaceae sp.*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
5	American mountain ash	*Sorbus americana*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
6	Bunchberry	*Cornus canadensis*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
7	Canada mayflower	*Maianthemum canadense*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
8	Sedge sp.	*Cyperaceae sp.*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
9	Northern starflower	*Lysimachia borealis*		24-09-2024	45.0412, -66.78064	2	Laura	No	No	
10	Asters and Allies	*Astereae sp.*		24-09-2024	45.0412, -66.78064	2	Laura	Yes	Yes	
1	Schreber's moss	*Pleurozium schreberi*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
2	Balsam fir	*Abies balsamea*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
3	Whorled wood aster	*Oclemena acuminata*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
4	American mountain ash	*Sorbus americana*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
5	Northern starflower	*Lysimachia borealis*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
6	Mountain woodsorrel	*Oxalis montana*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
7	Intermediate wood fern	*Dryopteris intermedia*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
8	Wild sarsasparilla	*Aralia nudicaulis*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
9	Canada mayflower	*Maianthemum canadense*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
10	Red spruce	*Picea rubens*		24-09-2024	45.0430, -66.78065	3	Laura	No	No	
11	Bazzania	*Bazzania sp.*		24-09-2024	45.0430, -66.78065	3	Laura	Yes	Yes	
1	Bunchberry	*Cornus canadensis*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
2	Balsam fir	*Abies balsamea*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
3	Mountain woodsorrel	*Oxalis montana*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
4	Schreber's moss	*Pleurozium schreberi*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
5	Intermediate wood fern	*Dryopteris intermedia*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
6	Twinflower	*Linnaea borealis*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
7	Whorled wood aster	*Oclemena acuminata*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
8	Grass sp.	*Poaceae sp.*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
9	White birch	*Betula papyrifera*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
10	Northern starflower	*Lysimachia borealis*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
11	Sphagnum moss sp.	*Sphagnum sp.*		24-09-2024	45.0430, -66.77812	4	Laura	No	No	
12	Lowbush blueberry	*Vaccinium angustifolium*		24-09-2024	45.0430, -66.77812	4	Laura	Yes	Yes	
13	Species Unknown	*Plantae*		24-09-2024	45.0430, -66.77812	4	Laura	Yes	Yes	
1	Long beech fern	*Phegopteris connectilis*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
2	Mountain woodsorrel	*Oxalis montana*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
3	Whorled wood aster	*Oclemena acuminata*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
4	Northern starflower	*Lysimachia borealis*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
5	Intermediate wood fern	*Dryopteris intermedia*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
6	Balsam fir	*Abies balsamea*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
7	White birch	*Betula papyrifera*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
8	Schreber's moss	*Pleurozium schreberi*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
9	Grass sp.	*Poaceae sp.*		24-09-2024	45.0448, -66.77559	5	Laura	No	No	
1	Whorled wood aster	*Oclemena acuminata*		24-09-2024	45.0448, -66.77305	6	Laura	No	No	
2	Mountain woodsorrel	*Oxalis montana*		24-09-2024	45.0448, -66.77305	6	Laura	No	No	

3	Intermediate wood fern	*Dryopteris intermedia*		24-09-2024	45.0448, -66.77305	6	Laura	No	No	
4	Balsam fir	*Abies balsamea*		24-09-2024	45.0448, -66.77305	6	Laura	No	No	
5	Northern starflower	*Lysimachia borealis*		24-09-2024	45.0448, -66.77305	6	Laura	No	No	
6	American mountain ash	*Sorbus americana*		24-09-2024	45.0448, -66.77305	6	Laura	No	No	
7	White birch	*Betula papyrifera*		24-09-2024	45.0448, -66.77305	6	Laura	No	No	
8	Bunchberry	*Cornus canadensis*		24-09-2024	45.0448, -66.77305	6	Laura	No	No	
9	Bazzania	*Bazzania sp.*		24-09-2024	45.0448, -66.77305	6	Laura	Yes	Yes	
1	Balsam fir	*Abies balsamea*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
2	Red spruce	*Picea rubens*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
3	Intermediate wood fern	*Dryopteris intermedia*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
4	Northern starflower	*Lysimachia borealis*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
5	American mountain ash	*Sorbus americana*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
6	White birch	*Betula papyrifera*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
7	Mountain woodsorrel	*Oxalis montana*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
8	Broom moss	*Dicranum sp.*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
9	Old man's beard	*Usnea sp.*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
10	Canada mayflower	*Maianthemum canadense*		24-09-2024	45.0466, -66.77306	7	Laura	No	No	
1	Intermediate wood fern	*Dryopteris intermedia*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
2	Red raspberry	*Rubus idaeus*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
3	Mountain woodsorrel	*Oxalis montana*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
4	Grass sp.	*Poaceae sp.*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
5	Red spruce	*Picea rubens*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
6	Balsam fir	*Abies balsamea*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
7	White birch	*Betula papyrifera*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
8	Whorled wood aster	*Oclemena acuminata*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
9	Bunchberry	*Maianthemum canadense*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
10	Spotted tussock moth	*Lophocampa maculata*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
11	Schreber's moss	*Pleurozium schreberi*		24-09-2024	45.0468, -66.77049	8	Laura	No	No	
1	Balsam fir	*Abies balsamea*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
2	Red raspberry	*Rubus idaeus*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
3	Red spruce	*Picea rubens*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
4	Grass sp.	*Poaceae sp.*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
5	White birch	*Betula papyrifera*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
6	Green alder	*Alnus alnobetula*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
7	Long beech fern	*Phegopteris connectilis*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
8	Intermediate wood fern	*Dryopteris intermedia*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
9	Creeping buttercup	*Ranunculus repens*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
10	Whorled wood aster	*Oclemena acuminata*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
11	Horsetail sp.	*Equisetum sp.*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
12	Northern starflower	*Lysimachia borealis*		24-09-2024	45.0485, -66.76805	9	Laura	No	No	
13	Rough Goose Neck Moss	*Hylocomiadelphus triquetrus*		24-09-2024	45.0485, -66.76805	9	Laura	Yes	Yes	
14	Canada goldenrod	*Solidago canadensis*		24-09-2024	45.0485, -66.76805	9	Laura	Yes	Yes	
15	Groundsels	*Senecio sp.*		24-09-2024	45.0485, -66.76805	9	Laura	Yes	Yes	
16	Common Dandelion	*Taraxacum officinale*		24-09-2025	45.0485, -66.76806	9	Laura	Yes	Yes	
1	Creeping buttercup	*Ranunculus repens*		24-09-2025	45.0502, -66.76800	10	Laura	No	No	
2	Mountain woodsorrel	*Oxalis montana*		24-09-2026	45.0502, -66.76800	10	Laura	No	No	
3	Balsam fir	*Abies balsamea*		24-09-2027	45.0502, -66.76800	10	Laura	No	No	
4	Whorled wood aster	*Oclemena acuminata*		24-09-2028	45.0502, -66.76800	10	Laura	No	No	
5	Bedstraw sp.	*Galium sp.*		24-09-2029	45.0502, -66.76800	10	Laura	Yes	Yes	
6	Dwarf raspberry	*Rubus pubescens*		24-09-2030	45.0502, -66.76800	10	Laura	No	No	
7	Long beech fern	*Phegopteris connectilis*		24-09-2031	45.0502, -66.76800	10	Laura	No	No	
8	Rough-stemmed goldenrod	*Solidago rugosa*		24-09-2032	45.0502, -66.76800	10	Laura	Yes	Yes	
9	Violet sp.	*Viola sp.*		24-09-2033	45.0502, -66.76800	10	Laura	Yes	Yes	
10	Schreber's moss	*Pleurozium schreberi*		24-09-2034	45.0502, -66.76800	10	Laura	No	No	
11	Intermediate wood fern	*Dryopteris intermedia*		24-09-2035	45.0502, -66.76800	10	Laura	No	No	
12	Spotted jewelweed	*Impatiens capensis*		24-09-2036	45.0502, -66.76800	10	Laura	No	No	
13	White Birch	*Betula papyrifera*		24-09-2038	45.0502, -66.76800	10	Laura	Yes	Yes	
14	Pellia sp.	*Pellia sp.*		24-09-2039	45.0502, -66.76800	10	Laura	Yes	Yes	
15	Red spruce	*Picea rubens*		24-09-2040	45.0502, -66.76800	10	Laura	No	No	
16	Sphagnum moss sp.	*Sphagnum sp.*		24-09-2041	45.0502, -66.76800	10	Laura	No	No	
17	Grass sp.	*Poaceae sp.*		24-09-2042	45.0502, -66.76800	10	Laura	No	No	
18	Flat-topped goldenrod	*Euthamia graminifolia*		24-09-2044	45.0502, -66.76800	10	Laura	Yes	Yes	
19	Pennsylvania bittercress	*Cardamine pensylvanica*		24-09-2044	45.0502, -66.76800	10	Laura	Yes	Yes	
20	Unknown species	*Plantae*		24-09-2044	45.0502, -66.76800	10	Laura	Yes	Yes	
21	Unknown species	*Plantae*		24-09-2044	45.0502, -66.76800	10	Laura	Yes	Yes	

Appendix E: *Deadmans Head, New Brunswick species list 2024*

Table 10. All raw data from 2024 research methods.

	Common Name	Scientific Name	Status	Date	Location	Identifier	Picture	iNaturalist	Field Method	Notes
1	Amanita Mushrooms	*Amanita sp.*		20-09-2024	45.0437, -66.77817	Amandeep Singh	Yes	Yes	Walkthrough	
2	American Cranberry	*Vaccinium macrocarpon*		24-09-2024	45.0410, -66.78103	Laura Lavigne	Yes	Yes	Walkthrough	
3	American Mountain Ash	*Sorbus americana*		12-09-2024	45.0431, -66.77918	Laura Lavigne	Yes	Yes	Plot(s) & Walkthrough	
4	Asters and Allies	*Astereae sp.*		24-09-2024	45.0412, -66.78064	Laura Lavigne	Yes	Yes	Plot(s)	
5	Atlantic Grey Seal	*Halichoerus grypus atlantica*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
6	Baldeagle	*Haliaeetus leucocephalus*	*	12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	* Not endangered under COSEWIC but endangered under NB SAR
7	Balsamfir	*Abies balsamea*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
8	Bazzania	*Bazzania sp.*		24-09-2024	45.0430, -66.78065	Laura Lavigne	Yes	Yes	Plot(s)	
9	Bedstraw sp.	*Galium sp.*		24-09-2029	45.0502, -66.76800	Laura Lavigne	Yes	Yes	Plot(s)	
10	Black crowberry	*Empetrum nigrum*		12-09-2024	45.0476, -66.76783	Laura Lavigne	Yes	Yes	Walkthrough	
11	Black knapweed	*Centaurea nigra*		12-09-2024	45.0477, -66.76747	Laura Lavigne	Yes	Yes	Walkthrough	
12	Black-capped chickadee	*Poecile atricapillus*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
13	Bonnets	*Mycena sp.*		20-09-2024	45.0462, -66.77368	Amandeep Singh	Yes	Yes	Walkthrough	
14	Brittlegills	*Russula sp.*		20-09-2024	45.0437, -66.77816	Amandeep Singh	Yes	Yes	Walkthrough	
15	Broom moss	*Dicranum sp.*		24-09-2024	45.0466, -66.77306	Laura Lavigne	Yes	Yes	Plot(s)	
16	Bunchberry	*Cornus canadensis*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
17	Cabbage white	*Pieris rapae*		20-09-2024	45.0485, -66.76788	Laura Lavigne	Yes	Yes	Walkthrough	
18	Calico aster	*Symphyotrichum lateriflorum*		24-09-2029	45.0499, -66.76800	Laura Lavigne	Yes	Yes	Walkthrough	
19	Callicladium species	*Callicladium sp.*		20-09-2024	45.0484, -66.77034	Amandeep Singh	Yes	Yes	Walkthrough	
20	Canada goldenrod	*Solidago canadensis*		24-09-2024	45.0485, -66.76805	Laura Lavigne	Yes	Yes	Plot(s)	
21	Canada mayflower	*Maianthemum canadense*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
22	Chocolate Milky	*Lactarius lignyotus*		20-09-2024	45.0443, -66.77571	Amandeep Singh	Yes	Yes	Walkthrough	
23	Cinnamon fern	*Osmunda cinnamomea*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
24	Colt's-foot	*Tussilago farfara*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
25	Common dandelion	*Taraxacum officinale*		24-09-2024	45.0485, -66.76806	Laura Lavigne	Yes	Yes	Plot(s)	
26	Common eider	*Somateria mollissima*		20-09-2024	45.0404, -66.78408	Laura Lavigne	Yes	Yes	Walkthrough	
27	Common eyebright	*Euphrasia nemorosa*		24-09-2028	45.0500, -66.76809	Laura Lavigne	Yes	Yes	Walkthrough	
28	Common yarrow	*Achillea millefolium*		12-09-2024	45.0406, -66.78403	Laura Lavigne	Yes	Yes	Walkthrough	
29	Creeping buttercup	*Ranunculus repens*		12-09-2024	45.0479, -66.77054	Laura Lavigne	Yes	Yes	Plot(s) & Walkthrough	
30	Creeping Jenny	*Lysimachia nummularia*		12-09-2024	45.0469, -66.77249	Laura Lavigne	Yes	Yes	Walkthrough	
31	Creeping snowberry	*Gaultheria hispidula*		24-09-2027	45.0501, -66.76818	Laura Lavigne	Yes	Yes	Walkthrough	
32	Cross orbweaver	*Araneus diadematus*		12-09-2024	45.0413, -66.78244	Laura Lavigne	Yes	Yes	Walkthrough	
33	Diastrophus turgidus	*Diastrophus turgidus*		20-09-2024	45.0419, -66.78210	Amandeep Singh	Yes	Yes	Walkthrough	
34	Docks and Sorrels	*Rumex sp.*		20-09-2024	45.0462, -66.77359	Amandeep Singh	Yes	Yes	Walkthrough	
35	Double-created cormorant	*Phalacrocorax auritus*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
36	Dwarf raspberry	*Rubus pubescens*		24-09-2024	N/A	Laura Lavigne	No	No	Plot(s)	
37	Flat-top white aster	*Doellingeria umbellata*		24-09-2024	45.0499, -66.76799	Laura Lavigne	Yes	Yes	Walkthrough	
38	Flat-topped goldenrod	*Euthamia graminifolia*		12-09-2024	45.0479, -66.77054	Laura Lavigne	Yes	Yes	Plot(s)	
39	Forkmosses	*Dicranum sp.*		24-09-2024	45.0502, -66.76800	Laura Lavigne	Yes	Yes	Plot(s)	
40	Golden-crowned kinglet	*Regulus satrapa*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
41	Green alder	*Alnus alnobetula*		12-09-2024	45.0476, -66.76784	Laura Lavigne	Yes	Yes	Plot(s) & Walkthrough	
42	Groundsels	*Senecio sp.*		24-09-2024	45.0485, -66.76805	Laura Lavigne	Yes	Yes	Plot(s)	
43	Haircap moss	*Polytrichum sp.*		12-09-2024	*Polytrichum sp.*	Laura Lavigne	Yes	Yes	Walkthrough	
44	Hairy woodpecker	*Dryobates villosus*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
45	Hay-sented fern	*Dennstaedtia punctilobula*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
46	Hickory tussock moth	*Lophocampa caryae*		20-09-2024	45.0446, -66.77520	Laura Lavigne	Yes	Yes	Walkthrough	
47	Honey Mushrooms	*Armillaria sp.*		24-09-2025	45.0446, -66.77587	Laura Lavigne	Yes	Yes	Walkthrough	
48	Horsetail sp.	*Equisetum sp.*		24-09-2024	N/A	Laura Lavigne	No	No	Plot(s)	
49	Hypoxylaceae	*Hypoxylaceae sp.*		12-09-2024	45.0425, -66.77970	Laura Lavigne	Yes	Yes	Walkthrough	
50	Intermediate woodfern	*Dryopteris intermedia*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
51	Irregular earth tongue	*Neolecta irregularis*		12-09-2024	45.0468, -66.77281	Laura Lavigne	Yes	Yes	Walkthrough	
52	Lingonberry	*Vaccinium vitis-idaea*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
53	Long beech fern	*Phegopteris connectilis*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
54	Lowbush blueberry	*Vaccinium angustifolium*		24-09-2024	45.0417, -66.78109	Laura Lavigne	Yes	Yes	Plot(s) & Walkthrough	
55	Loxospora species	*Loxospora sp.*		20-09-2024	45.0424, -66.78021	Amandeep Singh	Yes	Yes	Walkthrough	
56	Marsh skullcap	*Scutellaria galericulata*		20-09-2024	45.0482, -66.77042	Laura Lavigne	Yes	Yes	Walkthrough	
57	Monarch	*Danaus plexippus*	Endangered	12-09-2024	45.0484, -66.76749	Laura Lavigne	Yes	Yes	Walkthrough	
58	Mountain woodsorrel	*Oxalis montana*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
59	New England aster	*Symphyotrichum novae-angliae*		12-09-2024	45.0484, -66.76772	Laura Lavigne	Yes	Yes	Walkthrough	
60	New York aster	*Symphyotrichum novi-belgii*		12-09-2024	45.0477, -66.76754	Laura Lavigne	Yes	Yes	Walkthrough	
61	Nordmann's orbweaver	*Araneus nordmanni*		20-09-2024	45.0418, -66.78172	Laura Lavigne	Yes	Yes	Walkthrough	
62	Northern blue flag iris	*Iris versicolor*		12-09-2024	45.0474, -66.76978	Laura Lavigne	Yes	Yes	Walkthrough	
63	Northern red belt	*Fomitopsis mounceae*		20-09-2024	45.0440, -66.77732	Laura Lavigne	Yes	Yes	Walkthrough	
64	Northern Starflower	*Lysimachia borealis*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
65	Old man's beard	*Usnea sp.*		12-09-2024	45.0424, -66.78006	Laura Lavigne	Yes	Yes	Plot(s) & Walkthrough	
66	Orange-latex Milky	*Lactarius deterrimus*		24-09-2024	45.0411, -66.78102	Laura Lavigne	Yes	Yes	Walkthrough	
67	Oyster Mushroom	*Pleurotus ostreatus*		20-09-2024	45.0426, -66.77985	Amandeep Singh	Yes	Yes	Walkthrough	
68	Pearly everlasting	*Anaphalis margaritacea*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
69	Pellia sp.	*Pellia sp.*		24-09-2024	45.0502, -66.76800	Laura Lavigne	Yes	Yes	Plot(s)	
70	Pennsylvania bittercress	*Cardamine pensylvanica*		24-09-2024	45.0502, -66.76800	Laura Lavigne	Yes	Yes	Plot(s)	
71	Pixie cup lichen	*Cladonia sp.*		20-09-2024	45.0450, -66.77520	Amandeep Singh	Yes	Yes	Walkthrough	
72	Pyrobombus	*Pyrobombus (subgenus)*		12-09-2024	45.0484, -66.76771	Laura Lavigne	Yes	Yes	Walkthrough	
73	Red raspberry	*Rubus idaeus*		12-09-2024	45.0477, -66.77103	Laura Lavigne	Yes	Yes	Plot(s) & Walkthrough	
74	Red spruce	*Picea rubens*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
75	Reindeer lichen	*Cladonia sp.*		20-09-2024	45.0450, -66.77520	Amandeep Singh	Yes	Yes	Walkthrough	
76	Rhubarb sp.	*Rheum sp.*		12-09-2024	45.0480, -66.77042	Laura Lavigne	No	No	Walkthrough	
77	Rough Goose Neck Moss	*Hylocomiadelphus triquetrus*		24-09-2024	45.0485, -66.76805	Laura Lavigne	Yes	Yes	Plot(s)	

78	Rough-stemmed goldenrod	*Solidago rugosa*		12-09-2024	45.0479, -66.77052	Laura Lavigne	Yes	Yes	Plot(s) & Walkthrough	
79	Ruby-crowned kinglet	*Corthylio calendula*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
80	Schreber's moss	*Pleurozium schreberi*		24-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
81	Sea plantain	*Plantain maritima*		12-09-2024	45.0406, -66.78406	Laura Lavigne	Yes	Yes	Walkthrough	
82	Shield Lichen	*Parmelia sp.*		20-09-2024	45.0471, -66.77146	Amandeep Singh	Yes	Yes	Walkthrough	
83	Skunk currant	*Ribes glandulosum*		24-09-2026	45.0463, -66.77109	Laura Lavigne	Yes	Yes	Walkthrough	
84	Sphagnum moss sp.	*Sphagnum sp.*		12-09-2024	45.0441, -66.77654	Laura Lavigne	Yes	Yes	Plot(s) & Walkthrough	
85	Spotted jewelweed	*Impatiens capensis*		24-09-2024	N/A	Laura Lavigne	No	No	Plot(s)	
86	Spotted tussock moth	*Lophocampa maculata*		24-09-2024	45.0468, -66.77049	Laura Lavigne	Yes	Yes	Plot(s)	
87	Sunburst lichen	*Xanthoria sp.*		12-09-2024	45.0406, -66.78403	Laura Lavigne	Yes	Yes	Walkthrough	
88	Tawny Grisette	*Amanita fulva*		12-09-2024	45.0459, -66.77399	Laura Lavigne	Yes	Yes	Walkthrough	
89	Threeleaf goldthread	*Coptis trifolia*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
90	Three-leaved Rattlesnake root	*Nabalus trifoliolatus*		12-09-2024	45.0407, -66.78397	Laura Lavigne	Yes	Yes	Walkthrough	More than one sighting, find other on iNaturalist
91	Twinflower	*Linnaea borealis*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
92	Violet sp.	*Viola sp.*		24-09-2024	45.0502, -66.76800	Laura Lavigne	Yes	Yes	Plot(s)	
93	Violet sp.	*Viola sp.*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
94	Virginia strawberry	*Fragaria virginiana*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
95	Virginian Rose	*Rosa virginiana*		24-09-2024	45.0410, -66.78096	Laura Lavigne	Yes	Yes	Walkthrough	
96	White birch	*Betula papyrifera*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
97	White meadowsweet	*Spiraea alba*		24-09-2024	45.0410, -66.78092	Laura Lavigne	Yes	Yes	Walkthrough	
98	White spruce	*Picea glauca*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
99	White-breasted nuthatch	*Sitta carolinensis*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
100	Whitetops sp.	*Doellingeria sp.*		12-09-2024	45.0408, -66.78339	Laura Lavigne	Yes	Yes	Walkthrough	
101	Whorled wood aster	*Oclemena acuminata*		12-09-2024	N/A	Laura Lavigne	No	No	Plot(s) & Walkthrough	
102	Wild radish ***	*Raphanus Raphanistrum*		20-09-2024	45.0482, -66.77043	Laura Lavigne	Yes	Yes	Walkthrough	
103	Wild sarsasparilla	*Aralia nudicaulis*		24-09-2024	N/A	Laura Lavigne	No	No	Plot(s)	
104	Winter wren	*Troglodytes hiemalis*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
105	Yellow birch	*Betula alleghaniensis*		12-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	
106	Yellow-rumped warbler	*Setophaga coronata*		24-09-2024	N/A	Laura Lavigne	No	No	Walkthrough	

Note: This list does not include unknown plants, Grass sp., or Sedge sp. that were recorded at the site. If sightings occurred on multiple dates the first date was recorded here.

Appendix F: *Species at risk conflicts and conservation approaches*

Table 11. Species at risk conflicts and conservation approaches that could inhabit Deadmans Head project area.

SAR	**Depends on:**	**Presence on land?**	**What could help?**	**Out of the landowner's control**
Birds/Bats				
Bicknell's Thrush	Depends on heavily forested areas (primarily Balsam Fir, spruce, birch) & dead trees & snags. They prefer a cooler climate	Highly likely	Dense Balsam Fir mixed forest, snags, healthy insect population. Protection from human interference	Devastated by a small temperature increase
Canada Warbler	Likes deciduous forest but also coniferous forest. Needs dense shrub cover for nests & returns yearly.	Possible	Dense canopy cover with shrub layer. Leave land undisturbed as they return to nests annually	Can't sustain warming, will move north.
Evening Grosbeak	Mixed forest (fir, spruce) & shrubs. Sensitive to disturbance during the breeding season	Possible	Depends on Spruce Budworm. Needs seeds, insects, fruits & flower buds	Will move north with their habitat
Olive-sided Flycatcher	Nest in mature spruce trees 6-7 m, require minimal deadfall; access to wetland/water; flying insects	Possible	Leave mature forest intact. Tied to the health of flying insect population: ants, wasps, bees, dragonflies, beetles, and moths	Climate change will increase the number of succession forests verse mature forests
Wood thrush	Depends on mature mixed forests with mature understory	Possible	Ground foragers. Leave ground undisturbed. Discourage Cowbirds	Mass loss of wintering habitat. Outcompeted by Cowbirds
Bats	Specific habitat i.e., hardwoods (Hoary), tree hollows & leaf litter (Eastern Red), dead & fallen trees (Silver-haired), & structures such as bat boxes (tri-coloured)	Unknown	Introduce hardwoods (Hoary). Leave tree hollows & leaf litter (Eastern Red). Leave dead trees (Silver-haired). Consider bat boxes (tri-coloured). Privilege insect population	Overall decline of insect populations, cat predation, loss of habitat, White-nose Syndrome & other diseases
Vegetation				

Black Ash	High soil moisture levels, moderate light, alkaline conditions	Unlikely	Limit the introduction of firewood & vehicles to the site to limit the spread of EAB	Warmer temperatures will result in better conditions for EAB
Butternut	Loamy, rich, well-drained soil, shade intolerant, thrives in groups	Possible	Plant canker-resistant variety in sunny openings. Protect saplings from deer. Limit the introduction of firewood	Almost 100% mortality rate once Canker is introduced
Boreal Felt Lichen	Mature Balsam Fir & Black Spruce forests, little deadfall, very clean air/water	Extremely unlikely	If it were found, it needs mature Balsam Fir or Black spruce.	Extirpated in NB due to loss of mature forests, air/rain degradation (acid rain), & increase of windfall from severe storms
Vole Ears Lichen	Balsam Fir/mature Red Maple mix. Cool climate, mild winters, frequent fog, high precipitation	Very unlikely	Planting maples and protecting them from moose & deer.	Possibly extirpated. Loss of mature hardwoods, warming climate, & presence of acid rain
Scaly fringe lichen	Mature mixed old-growth coastal forests (Yellow Birch, Sugar Maple, Red Maple, White Ash), high humidity, moderate light. Clean air & rain	Very unlikely	Introduce hardwoods, especially maple & White Ash. Leave the forest (& canopy) undisturbed.	Requires old-growth (uncut) forests, nutrient-rich soil. Needs 19 years to regenerate. Sensitive to acid rain, pollution
Mammals				
Canada Lynx	Need dense intact large tracts of forest which support prey population (snowshoe hares).	Very unlikely	Leave the forest undisturbed	Habitat loss & fragmentation, warmer winters
Insects				
Bohemian Cuckoo Bumble Bee	Require a host species (Yellow-banded BB). Need a variety of different	Very unlikely	Maintain diverse habitats on the property (meadow, forest)	Use of pesticides, pathogens from commercial bees, habitat loss &

	habitats for nesting, foraging, & overwintering - meadows, old fields, boreal forests, edges of wetlands, farmlands, urban areas, and open woodlots			fragmentation, & narrow temperature tolerance. Host species are also endangered
Monarch Butterfly	Require Common Milkweed and/or Swamp Milkweed – the only food source for caterpillars. Native flowers – food for adults	Verified as present	Increase local suitable habitat by planting common & swamp milkweed in old fields & along the shoreline, & plant a pollinator garden with native species	Threats to Southern overwintering habitat & food source. Loss of food & habitat in NB, pesticides, extreme weather (heat, drought)
Pygmy Snaketail	Require nearby pristine rivers, swiftly flowing undammed water, intact streams & shorelines, and forests with sufficient insect population	Very unlikely	Leave forest undisturbed, Use land management practices which privilege insects	Polluted or dammed rivers. Development eliminates shore habitat Extremes of climate change (flooding, drought, heat)
Transverse Lady Beetle	Need undisturbed overwintering habitat. Seasonal timing. Availability of prey species (aphids)	Unlikely	Leave overwintering habitat intact (leaf litter, stones, bark)	Introduction of non-native species. Pesticides. Habitat disturbance. Early spring warming. Low tolerance to cc temperature increases
Yellow-banded Bumble Bee	Can thrive in a variety of habitats. Overwintering requires undisturbed loose soil or rotting wood	Very likely	Plant a pollinator garden & privilege native species throughout the property. Ensure access to clean water sources	Introduction of non-native species & pathogens, cumulative pesticide exposure, toxic effluents, habitat

				loss due to development & mono agriculture, climate change related variable weather patterns & heat intolerance