Upper St. John River Habitat Conservation Strategy
New Brunswick Eastern Habitat Joint Venture
Steering Committee

EXECUTIVE SUMMARY

This Habitat Conservation Strategy (HCS) was developed through collaboration among member organizations of the Eastern Habitat Joint Venture (EHJV) New Brunswick Steering Committee and partner conservation groups. This HCS is part of a series planned to encompass the entire geographic area of New Brunswick.

HCSs are intended to respond to the need to better communicate, coordinate, and inform conservation actions taken by regional and local conservation organizations. In addition to providing decision support for these groups, it is hoped that HCS development will create opportunities to enhance partnerships, recognizing that each organization is guided by its own particular mission, vision, and/or guiding principles.

Goals

The conservation goals that have been identified to guide the development of this HCS are:

1) Identify areas that are important for conservation priority habitats and species.
2) Establish, support, and enhance conservation partnerships to facilitate decision-making and focus collective conservation efforts.
3) Maintain healthy, intact, and fully functioning ecosystems by building on existing conservation work by the partnership and informing efforts to acquire land for conservation.
4) Support the management and protection of corridors between existing protected areas and other conservation lands through land securement, partnerships, and community outreach (i.e., stewardship).
5) Support the recovery of populations of species at risk through collective conservation actions by the partnership, further informed by federal and provincial resources on species at risk.
6) Support the advancement of collaborative ecosystem and species research to inform decision-making and planning.
7) Support the advancement of community support and understanding of biodiversity values, and inform local stewardship initiatives.

Vision context

The Upper St. John River (USJR) bioregion (Map 1) is a unique region for biodiversity in New Brunswick. Despite considerable anthropogenic change that has occurred in the region, it has largely retained a rich complement of species including numerous rare species. This is due to its unique climate, topography, and geological history. With its headwater tributaries originating in the State of Maine and the Province of Quebec, this section of the river and surrounding area is distinctly different from the floodplains and wetland-dominated lower reach. Spring freshet can be intense here, leading to events of moderate to strong ice scour, which create unique conditions that allow unique flora and fauna to persist or thrive here. Furbish's Lousewort (*Pedicularis furbishae*) and the Cobblestone Tiger Beetle (*Cicindela marginipennis*) are two examples of globally rare species that benefit at least in part from this hydrological regime. The region also contains a distinct group of habitats. The northern hills of the Appalachian range in the bioregion are one example: this is where Mount Carleton occurs. At 820 metres in height, it is the highest peak in the Maritimes, these high elevations are also the areas in New Brunswick where Bicknell's Thrush (*Catharus bicknelli*) can be found. The USJR bioregion also has rich productive upland soils, and remnant stands of the Appalachian Hardwood Forest. Very limited literature is available on this forest type, though it is a highly threatened habitat in the bioregion and the Maritime provinces. Some of the most noteworthy species of significance here include the rich array of rare plants associated with it, such as Maidenhair Fern (*Adiantum pedatum*), Blue Cohosh (*Caulophyllum thalictroides*), and Showy Orchis (*Galearis spectabilis*), as well as many more, which are discussed in this strategy.

Key decisions with biodiversity implications in the bioregion are well-informed by research, and coordinated private and public conservation actions have benefited some native species and systems.

Conservation Priority Habitats
Based on habitat affinities of rare species, species at risk, and bird species identified as conservation priorities, but independently of spatial patterns of species occurrence, the following seven habitat types were determined to be conservation priorities for the USJR bioregion:

1) Beaches
2) Grassland/Agricultural Ecosystems
3) Rock Outcrops
4) Cliffs
5) Acadian Forest Mosaic
6) Appalachian Hardwood Forest
7) Freshwater Wetland
8) Riparian and Aquatic Systems

Exemplifying how no single map can be expected to provide one 'best' answer, two map versions were generated depicting the spatial location of overall conservation priority habitats: one with and the other without integration of grasslands/agro-ecosystems (Map 2 and 3). The need to produce two versions stemmed from the knowledge that the grasslands/agro-ecosystems habitat type, while important, is largely anthropogenic within this bioregion and inherently has a high degree of connectivity. Integration of grasslands/agro-ecosystems in the composite reduces the recognized high relative value of natural habitat types, and is reflected in Map 2. These priority habitat composite maps do not incorporate information on occurrence records of rare and endangered species, or of conservation priority birds.

The subsequent integration of habitat and species information results in Conservation Value Index (CVI) maps for the bioregion; one with and the other without grasslands/agro-ecosystems (Map 4 and 5). The latter CVI map was generated without grasslands/agro-ecosystems habitats because the high CVI scores of the initial output were driven by the inherently larger, well-connected agricultural patches in the LSJR bioregion. As such, the CVI map which included grasslands/agro-ecosystems could not adequately illustrate the high relative importance of the other natural habitat patches in the bioregion. The CVI (*grasslands/agro-ecosystems excluded*) (Map 5) thus provides a necessary complement to the initial CVI for occasions when heavily managed habitats are not considered a conservation priority.

The reader is advised to compare and contrast the priority habitat composite maps (Map 2 and 3) with the Conservation Value Index (CVI) maps (Map 4 and 5) when using this document for decision support. Also of value to the planning process are the species composite maps found in Fig. 29 – 38 (p. 109-118) which illustrate the distribution of 10 distinct flora and fauna classes and assemblages that comprise the whole of the species information in this analysis. To supplement these figures, Appendix C and D present summaries of the species presented in each map, and the dataset used to represent these species.

A map depicting the spatial location of overall conservation priority was developed based on the location of rare and endangered species, distribution of conservation priority birds, as well as the location of priority habitats (Map 4-5 – Conservation Value Index).

Threats

Current

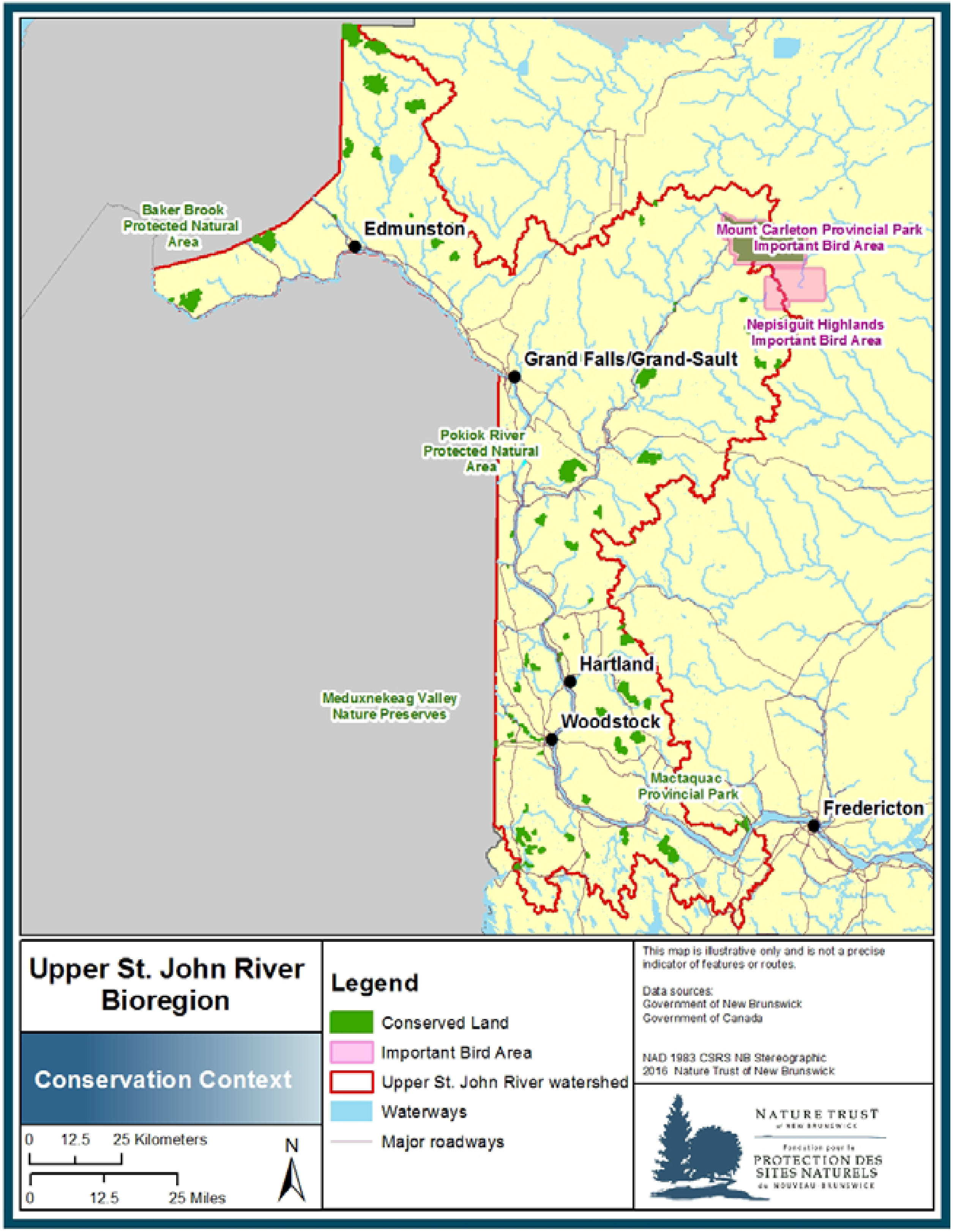
1.1.1 Housing and urban areas
2.1.1 Annual and Perennial Non-timber Crops
2.1.2 Incompatible Agricultural practices
2.2.1 Wood and Pulp Plantations
3.2.1 Mining and Quarrying
4.1.1 Road fragmentation – Roads and Railroads
5.3.1 Incompatible Forestry Practices – Logging and Wood Harvesting
6.1.1 Recreational activities
7.2.1 Dams and other Aquatic Barriers – Water Management/use
8.1.1 Invasive Species –Fish Species
8.1.2 a Invasive Species – Insects and Diseases
8.1.2 b Invasive Non-native/Alien Species – Plants
9.3.1 Agricultural Effluent
9.3.2 Forestry Effluent

Emerging

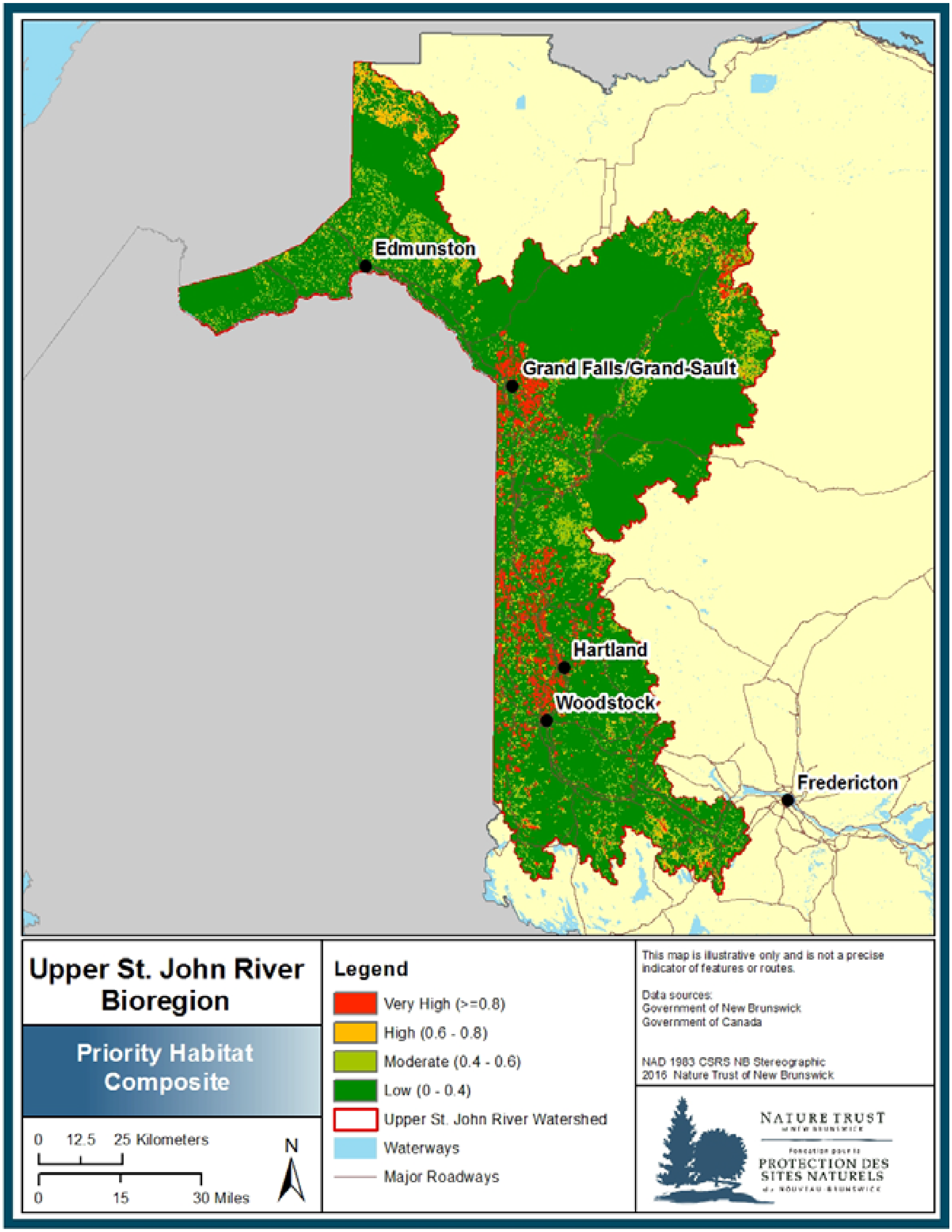
3.1 Oil & Gas Drilling - Energy East Pipeline
11. Climate change & severe weather

Conservation Action

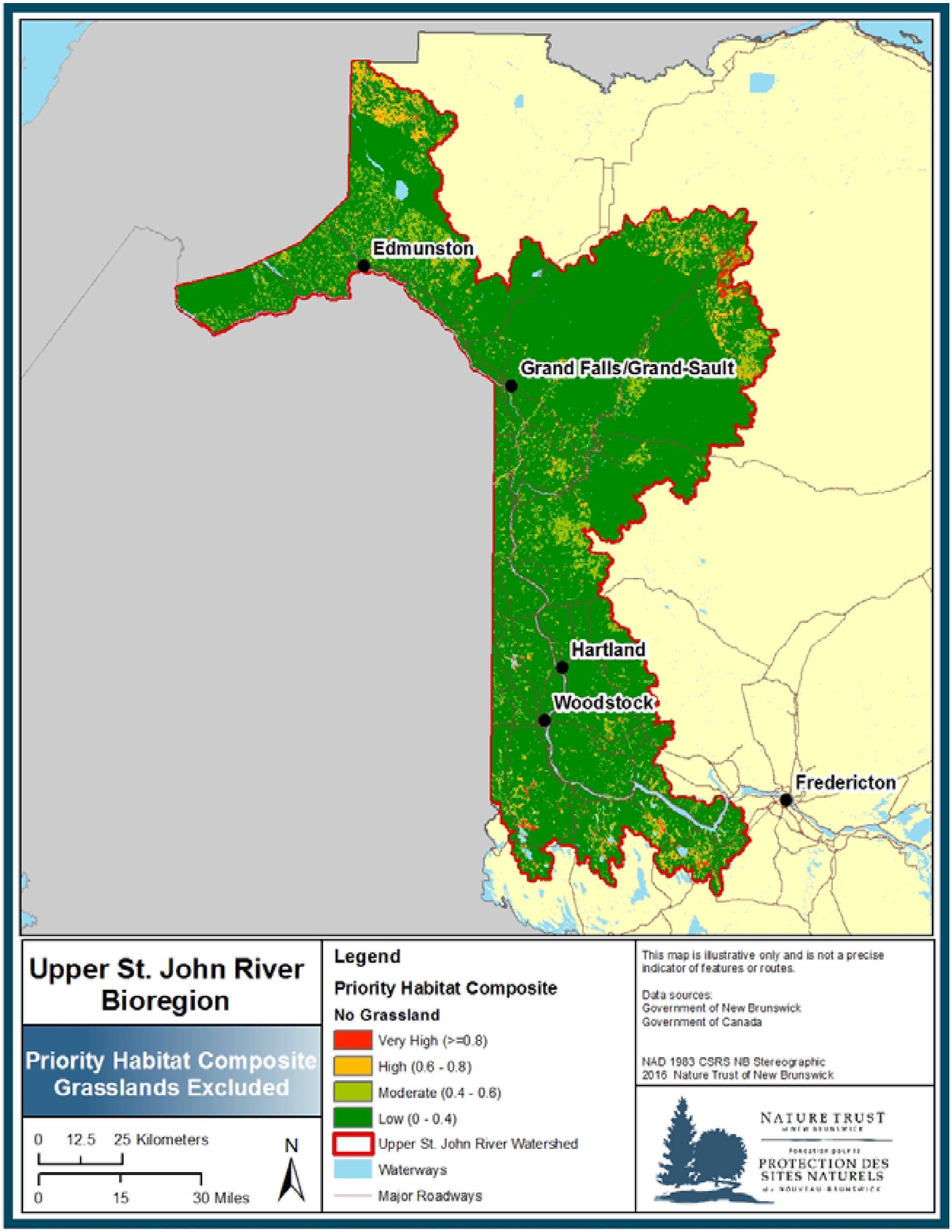
The following summary links the conservation actions undertaken by organizations working in the USJR bioregion to the threats associated with each of the different conservation priority habitats. A more detailed list of conservation actions is presented in Table 12.



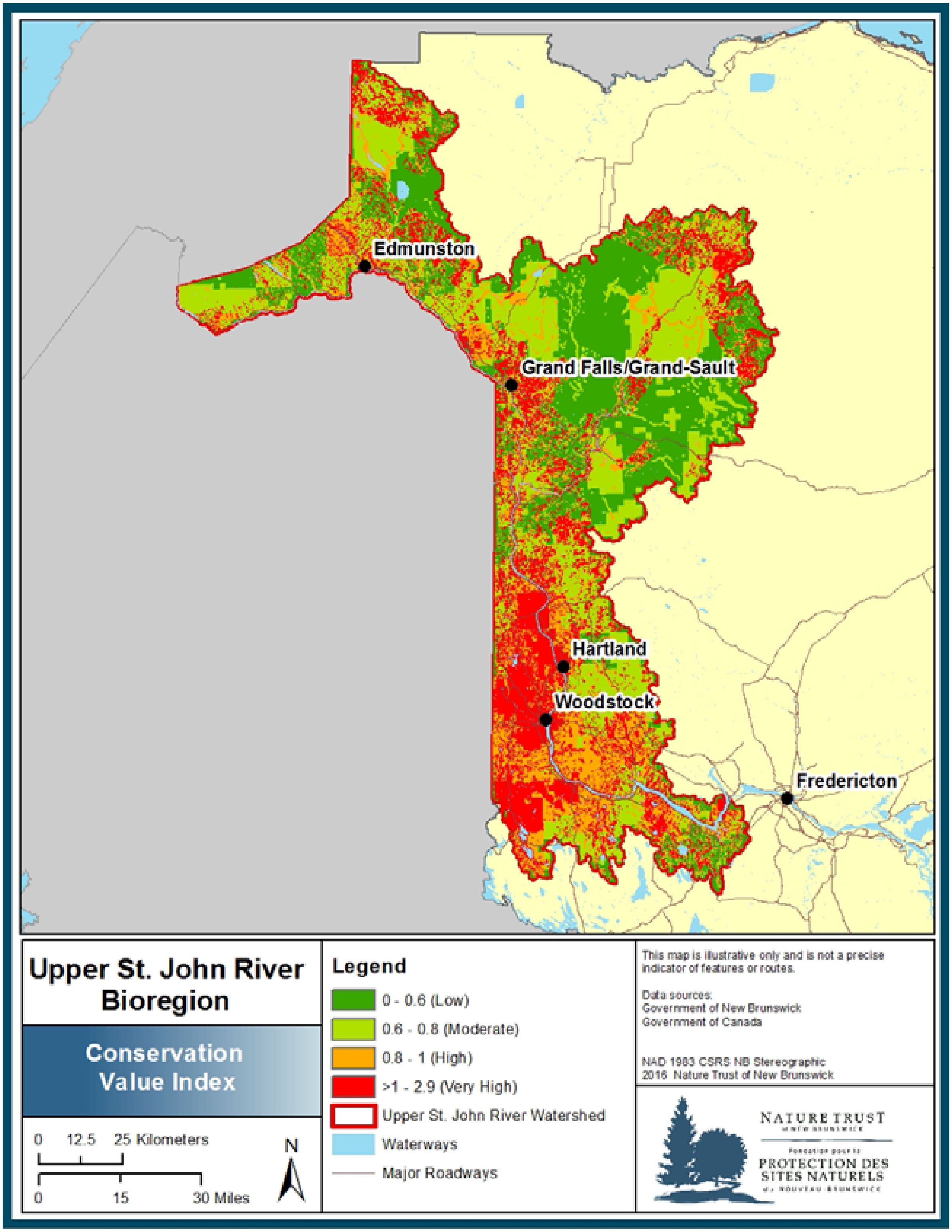
Map 1: Conservation Context for Upper St. John River Bioregion



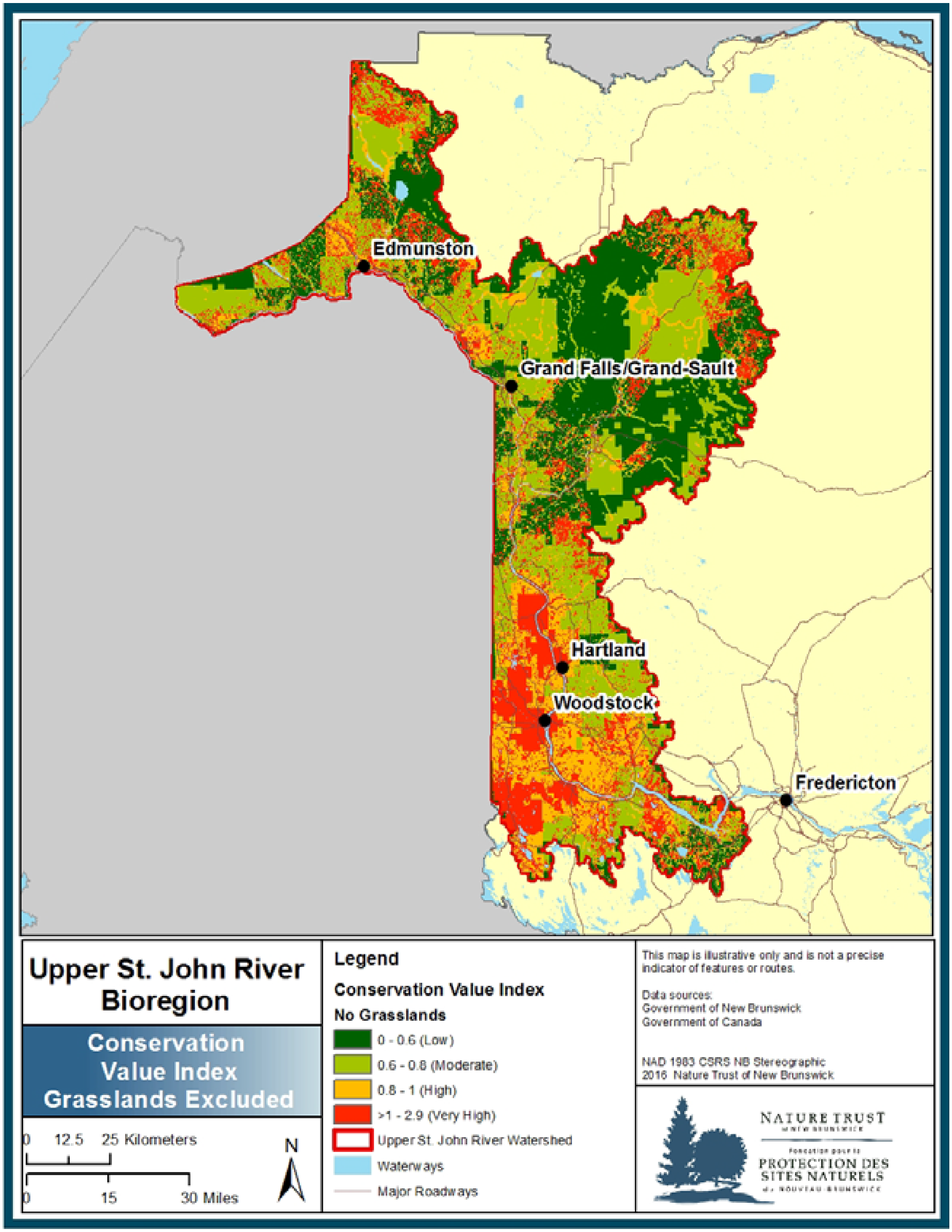
Map 2: Conservation Priority Habitats for the Upper St. John River Bioregion (Including Grasslands / Agro-Ecosystems



Map 3: Conservation Priority Habitats for the Upper St. John River Bioregion (excluding Grassland /Agro-ecosystems)



Map 4: Conservation Value Index for the Upper St. John River Bioregion (Including Grassland / Agro-ecosystems)



Map 5: Conservation Value Index for the Upper St. John River Bioregion (excluding Grassland / Agro-ecosystems)

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Acknowledgements

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1. CONSERVATION CONTEXT

Shared Approach

Each HCS presents descriptions, in general terms, of the spatial extent and ecological significance of the bioregion, the dominant ecological systems found within the bioregion, and the processes that shape them. Each HCS also presents the significance of important habitats for identified species of conservation concern, with a focus on species at risk and other rare taxa, including Bird Conservation Region 14 priority birds. The approach taken in the development of the narrative is meant to be thorough but not exhaustive, emphasizing references to more detailed work and in-depth studies.

Habitat prioritization is based on uniqueness, representivity, and patch size. Species prioritization relies on relative abundance maps derived from available occurrence data for each species. Relative abundance maps are combined to produce various, multi-species composites based on different suites of species with shared ecological characteristics or conservation status. Species receive equal weighting in all composites.

Threats to conservation priority habitats and species are identified, assessed, and wherever possible, mapped at the bioregional scale. Each HCS also presents the conservation and stewardship actions that organizations plan to undertake to mitigate threats and contribute to the conservation of habitats and the species they host over the course of a 5-year planning period. Though it cannot be considered comprehensive, the “Actions” section includes a list by organization and matrix by habitat of conservation actions being undertaken. Remaining gaps in the “Actions” section can be interpreted as opportunities for development of new complementary conservation actions to be undertaken by existing and new groups. It should be noted that conservation groups seeking government funding to undertake conservation actions within the bioregion would do well to use this HCS as a guiding document. This could include applicants to the Aboriginal Fund for Species at Risk, Habitat Stewardship Fund for Species at Risk, National Conservation Plan – National Wetland Conservation Fund, New Brunswick Environmental Trust Fund and the New Brunswick Wildlife Trust Fund, among others. Indeed, applicants to any of these funding sources are strongly encouraged to make specific reference to relevant information contained within the appropriate HCS.

HCSs and their bioregional boundaries are based on meaningful ecological units and important watershed boundaries. Additionally, HCS bioregions are scaled in such a way that they capture regional conservation context, threats and conservation actions (**Fig. 1**). They also are scaled to facilitate the implementation of conservation actions, ranging from land securement to stewardship.

Ultimately, the habitat prioritization map (composite of all habitats) and species prioritization map (composite of all species) are combined to yield a Conservation Value Index (CVI) map of the bioregion. However, the reader is cautioned that the CVI map and various species composite maps can present contrasting perspectives on spatial priorities. This is expected and as such, contrasting approaches to conservation (i.e. land acquisition versus stewardship) may be required for different species. Clearly no single map, including the CVI map or any of the species composite maps, can provide decision support that aligns well with all priorities of all conservation partners. Users of this HCS are thus encouraged to carefully consider the full suite of maps and information presented to obtain the decision support that is most appropriate to their needs.

A. Bioregion scope

Location and size

The Upper St. John River (USJR) bioregion stretches from the western part of the New Brunswick border with Quebec downstream to the Mactaquac Dam, and bordering on the west with the State of Maine. The entire St. John River watershed covers approximately 55,000 km², with large portions of its upper reaches situated in the province of Quebec, and the northern part of the State of Maine. Approximately 28,685 km² of this total area lies within the province of New Brunswick. The Mactaquac Dam creates an artificial, but significant limit to what is generally considered the boundary between the upper and lower St. John River. Within these limits, the USJR bioregion covers approximately 13,298 km2 (13,298 000ha) of land which is approximately 24% % of the St. John River drainage basin and about 18.2% of the total surface of New Brunswick. Notable landscape features in the region include Grand Falls Gorge, Mount Carleton and Bald Peak, as well as intact diminishing Appalachian hardwood forest blocks, shifting alluvial islands, and rich riparian floodplains.

Table 1: Ecological Land Classification in the Upper St. John River Bioregion

NAAP Subregion[1]	Environment Canada Ecoregion	NB DNR Ecoregion[2]	Ecodistrict[2]
Acadian Uplands	Northern New Brunswick Uplands, Saint John River Valley, New Brunswick Highlands	Highlands	Kejwik, Ganong
		Central Uplands	Madawaska, Sisson, Serpentine, Brighton, Beadle
		Valley Lowlands	Wapske, Bluebell, Meductic, Nackavic, Magaguadavic, Yoho, Cranberry
		Northern Uplands	Upsalquitch
		Grand Lake Lowlands	Aukpaque

[1] Anderson et al. 2006
[2] Zelazny, 2007

Fig. 1: Boundaries of the Upper St. John River Bioregion

Boundary justification

Delineation of the boundary for the USJR Integrated Habitat Conservation Strategy is the result of a collaborative decision by HCS project coordinators, including member organizations of the Eastern Habitat Joint Venture (EHJV). This boundary is contiguous with other bioregions in New Brunswick, including the Lower St. John River, Miramichi and Restigouche / Highlands bioregions. The USJR bioregion is of particular conservation concern because of the high ecological value of its remnant hardwood stands, rare floodplain plants, and unique habitats; in many areas, these habitats are threatened by development and forest harvesting (MacDougall and Loo 1998).

The St. John River watershed is the largest in the Maritimes and the entire Gulf of Maine. The region is recognized for its importance to wildlife and flora. It is composed of an impressive variety of habitats, including riparian floodplains, alluvial islands, hardwood uplands, lakes, streams, bogs and fens. This area encompasses habitat for more than 260 resident, breeding, migrating and wintering bird species; 40 of these are wetland obligate species. The Upper St. John River itself provides an expansive corridor providing habitat for a variety of riparian plants and upland hardwood forest stands. Several federally at-risk and provincially significant plants, including the globally rare Furbish's Lousewort (*Pedicularis furbishae*) and numerous other S1-ranked plants, are found in the area. A rare plant survey conducted by the Atlantic Canada Conservation Data Centre and the Nature Trust of New Brunswick in 2002 identified 18 areas of conservation significance for preserving rare plant species and their habitat (Simpson and Blaney 2003). Unfortunately, many sites providing habitat for Species at Risk are threatened by development and urbanization throughout the USJR bioregion, along the river corridor and in its upland forest regions.

This Habitat Conservation Strategy targets both terrestrial and aquatic species. Anadromous fish species like Atlantic salmon (*Salmo salar*) are also included. Wood Turtle (*Glyptemys insculpta*) was identified as another important target in the Atlantic Canada Regional Priority Statement. Further projects related to this and other species will inform stewardship activities required to address threats to this and many other significant species found in the Upper St. John River Bioregion (Environment Canada 2014). The first location in Canada for the Pygmy Snaketail (*Ophiogomphus howei*), a federal species of special concern (COSEWIC 2008a), was found at Baker Brook on the Saint John River in 2002. In addition, a number of confirmed locations for the endangered Cobblestone Tiger Beetle (*Cicindela marginipennis*) have been identified as being of conservation concern (COSEWIC 2008b, Environment Canada 2013b).

Ecological Significance

The USJR bioregion is an area of New Brunswick with an undulating landscape and continental climate experiencing significant annual temperature variations that aren't affected by major water bodies (Zelazny 2007). The climate is somewhat cooler and has more variable precipitation than the lower reach of the river below Mactaquac Dam. The landscape hosts a wide range of habitat types, topographic differences, climatic changes and rare species, all related to their situation within the five Ecoregions that fall within the USJR boundary (**Table 1**). One Ecoregion in particular, the Valley Lowlands, contains all or part of the largest variety of Ecodistricts in the USJR bioregion: Blue Bell, Wapske, Meductic, Nackawic, Yoho, Magaguadavic, and Cranberry Ecodistricts. The Central Uplands Ecoregion also covers a large area. It contains the Madawaska, Sisson, Serpentine, Brighton, and Beadle Ecodistricts, all partially or fully situated within the USJR boundary. The Highlands Ecoregion has part of some northern Ecodistricts, i.e. Kejwik and Ganong, within its boundaries. Finally, although only covering a small area of the bioregion, the last two Ecodistricts are the Northern Uplands' Upsalquitch Ecodistrict and the Grand Lake Lowlands' Aukpaque Ecodistrict (Zelazny 2007).

The landscape of the USJR bioregion gradually diminishes in elevation from north to south. The northern portion of the region is moderately fertile and consists of high-lying, rough topography, averaging 450m above sea level. It harbours turbulent rivers and steep-sided valleys that receive rather abundant precipitation (Zelazny 2007). At 820 metres, Mount Carleton in the Highlands Ecoregion is the tallest summit in the Maritimes. This region also features the headwaters of several major rivers of the province and the divide (i.e. watershed boundary) for the St. John and Nepisiguit river systems (Zelazny 2007). The Madawaska Uplands are situated in the northern part of the Central Uplands. At an average of 350 m of elevation, they are at a considerably higher elevation than the adjacent Valley Lowlands. These northern Ecoregions generate large amounts of precipitation due to orographic lift, a phenomenon that requires steep elevation for cool prevailing winds to climb and thereafter release moisture on the downfall. All the rivers and streams entering the Serpentine Ecodistrict flow towards a common endpoint at the Little Tobique River which is at the juncture of Central Uplands, Northern Uplands and the Highlands Ecoregions. A prominent feature of the Serpentine district is Bald Peak (632 m). With unstable slopes and angular volcanic boulders, the mountain has been described as "the most striking, and mountain-like mountain in New Brunswick" (Zelazny 2007). The Valley Lowlands Ecoregion is dominated by the St. John River as it flows along the Maine border towards the Bay of Fundy. In that stretch, the elevation drops down to 100 metres at its southern border.

Owing to the variety of climates and its undulating terrain, the USJR bioregion supports a wide variety of tree species, particularly in in those stands characterised as the Appalachian Hardwood Forest (AHF). Situated in the central St. John River valley in Carleton and Victoria County, this portion of the Appalachian Hardwood Forest is a forest unlike anywhere else in Atlantic Canada. In turn, it hosts many uncommon plant species for New Brunswick and the Maritimes. The cool wet climate of the Northern Ecoregions supports a forest dominated by Balsam fir (*Abies balsamea*), White birch (*Betula papyrifera*), Black spruce (*Picea mariana*) and White spruce (*Picea glauca*), mainly because these species can withstand the harsh winters. The elevation grades in this area create lower, more sheltered, well-drained areas that can also support Yellow birch (*Betula alleghaniensis*), White pine (*Pinus strobus*), Jack pine (*Pinus banksiana*) and American mountain ash (*Sorbus americana*) (Zelazny 2007). Indeed, American mountain ash is uniquely abundant in the area, occupying the forest canopy as opposed to its normal shrub state. South of the Highlands in the Madawaska Uplands, the climate is slightly warmer and wetter, due to its southward and westward facing slopes. This section of the bioregion supports the highest concentration of southern affiliated tolerant hardwoods, including Yellow birch, Sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*) (Zelazny 2007). Its mixed forest stands also have a well-developed understory of Mountain maple (*Acer spicatum*), Striped maple (*Acer pensylvanicum*) and Hobblebush (*Viburnum lantanoides*), which is unique to this area. With a prominent continental climate, the southern Valley Lowlands experience less precipitation with warmer summers and colder winters (Zelazny 2007). It features a large diversity of southern affinity, mixed wood tree species such as American basswood (*Tilia americana*), Butternut (*Juglans cinerea,* S3), Ironwood (*Ostrya virginiana*), Silver maple (*Acer saccharinum*), Green ash (*Fraxinus pennsylvanica*) and White ash (*Fraxinus americana*).

The rugged terrain of the northern reaches of the USJR bioregion provide conditions less conducive to supporting wetland habitats as compared to the lower reach of the river; nevertheless, comparable characteristics can be found throughout the low-lying areas of the bioregion (Zelazny 2007). Though the northern part of the USJR bioregion has limited wetland formation, it does contain some streamside alder swamps and peatlands created by glacial drainage channels, which are a prime habitat for beaver activity. In contrast, the wetlands that occur throughout the Valley Lowlands ecoregion and the majority of the USJR bioregion are highly diverse. The area ranges from shallow lakes to large peatland complexes that transition into marshes, shrub swamps, or wet forests (Zelazny 2007). The Shea Lake Nature preserve in the Wapske Ecodistrict is a protected, alkaline fen that consists of extensive stands of old growth tree species and rare plants, orchid species in particular. The district also contains important unique riparian systems that encompass the gradient between riversides and their floodplains (Gregory et al. 1991). These systems are created by the large spring freshet (annual spring flooding) and ice break up in the St. John River and are the amongst the most biodiverse, non-marine zones on the planet (Zelazny 2007).

B. Ecological Context

I. Dominant Ecological Processes

The geology of the USJR bioregion varies greatly throughout the region. This contributes significantly to the diversity of species and habitats. The bedrock lithology creates a mosaic of highly calcareous sedimentary and calcareous sedimentary rocks (carbonate and clastic) in the middle reaches of the St. John River, transitioning to non-calcareous sedimentary rocks in the northern and eastern boundaries of the bioregion, with an input of early carboniferous sedimentary rocks, mainly in the Wapske Ecodistrict (Zelazny 2007). Moving south, the lithology becomes increasingly comprised of granites and granodiorites, featuring as deep and shallow water clastic units, with inputs on mafic and felsic volcanic rocks (**Fig. 2**). Naturally, the underlying bedrock geology essentially dictates the nature of the soil in the region. The soils are often acidic in areas underlain with granite and more fertile in the sedimentary and metasedimentary areas, especially where the soils are more calcareous and originate from a limestone parent material (Zelazny 2007). The areas featuring limestone are often highly erodible and forms strong relief where they are incised by rivers (Zelazny 2007). The St. John River valley is a highly productive and fertile area with alluvial deposits from the river contributing substantially to the soil fertility. Once again, soils with a calcareous input are associated with areas of importance for rare and uncommon flora.

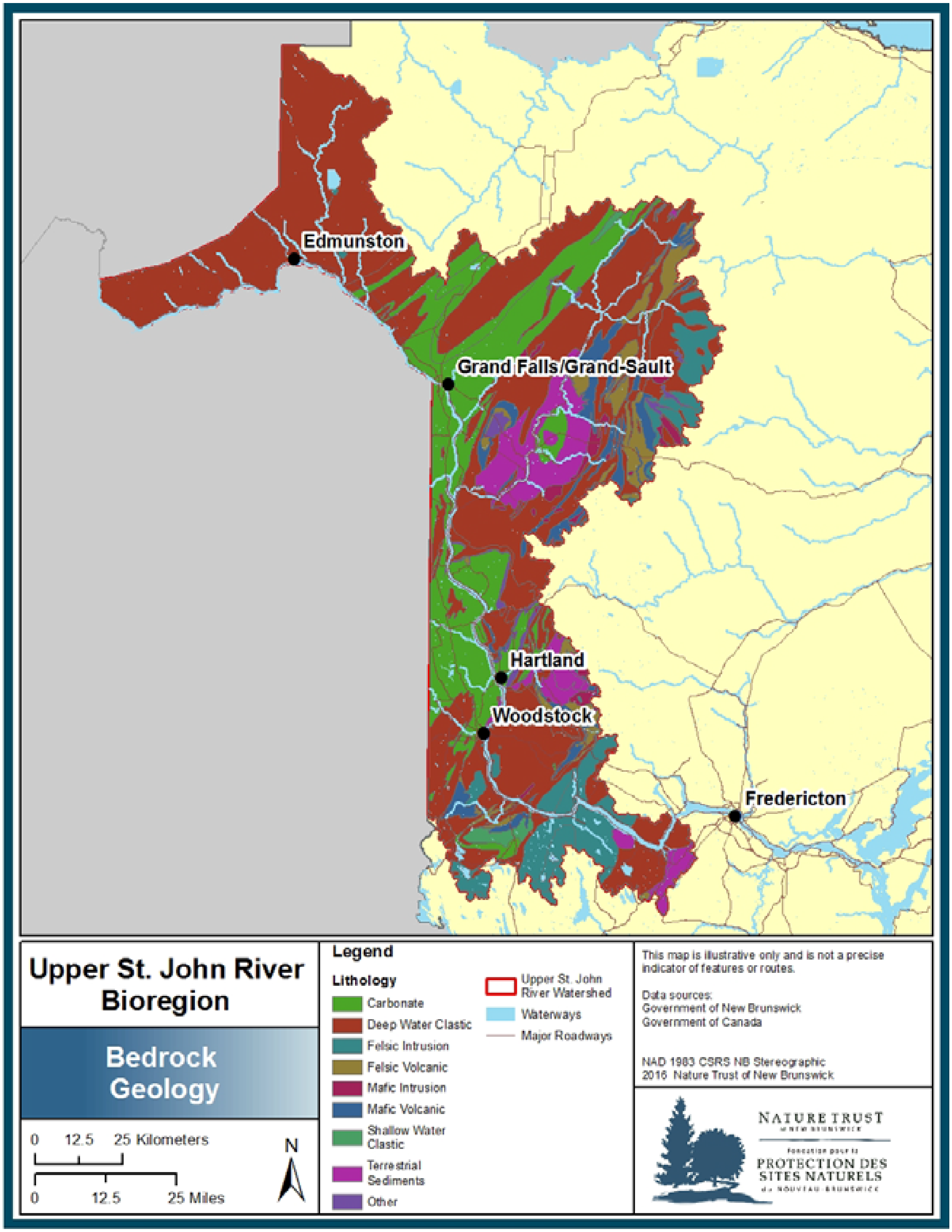

Fig. 2: Dominant Bedrock Geology in the Upper St. John River Bioregion

The USJR bioregion is formed from mainly from four geomorphological regions (**Fig. 3**). As it enters New Brunswick, the northern reach of the river makes a quick run through the Edmundston Highlands, which is characterized by a rugged topography of hills with a strong relief, steep sided ridges and 'V' shaped valleys, with the steepest slopes found along the incised valleys. Thereafter, it traverses of the Chaleur Highlands for a large section of the bioregion (Kidd et al. 2011). This area features an eroded peneplain of valleys and rolling hills whose elevation vary between 200 metres and 500 metres above sea level for the most part, with the exception of the Tobique River watershed, which has an even steeper topography (Kidd et al. 2011). As the watershed extends downstream, the topography is characterized by steep slopes featuring fast flowing streams where they enter the Miramichi Highlands. The topography in this region is rugged and elevations are higher than most bordering land forms (Colpitts et al. 1995). The highest point in the bioregion is Mount Carleton, which rises 820 metres above sea level. It is situated on the boundaries of the Miramichi Highlands and the Chaleur Uplands near Nictau Lake, which is the source of the Tobique River (Zelazny 2007). The last geomorphological region is the St. Croix Highlands, which forms but a small part of the bioregion. This area features a varied topography of steep-walled ridges, rugged hills and undulating plains (Colpitts et al. 1995). There is a very small section that falls into the gently sloping New Brunswick lowlands region. The general relief here is low (Kidd et al. 2011).

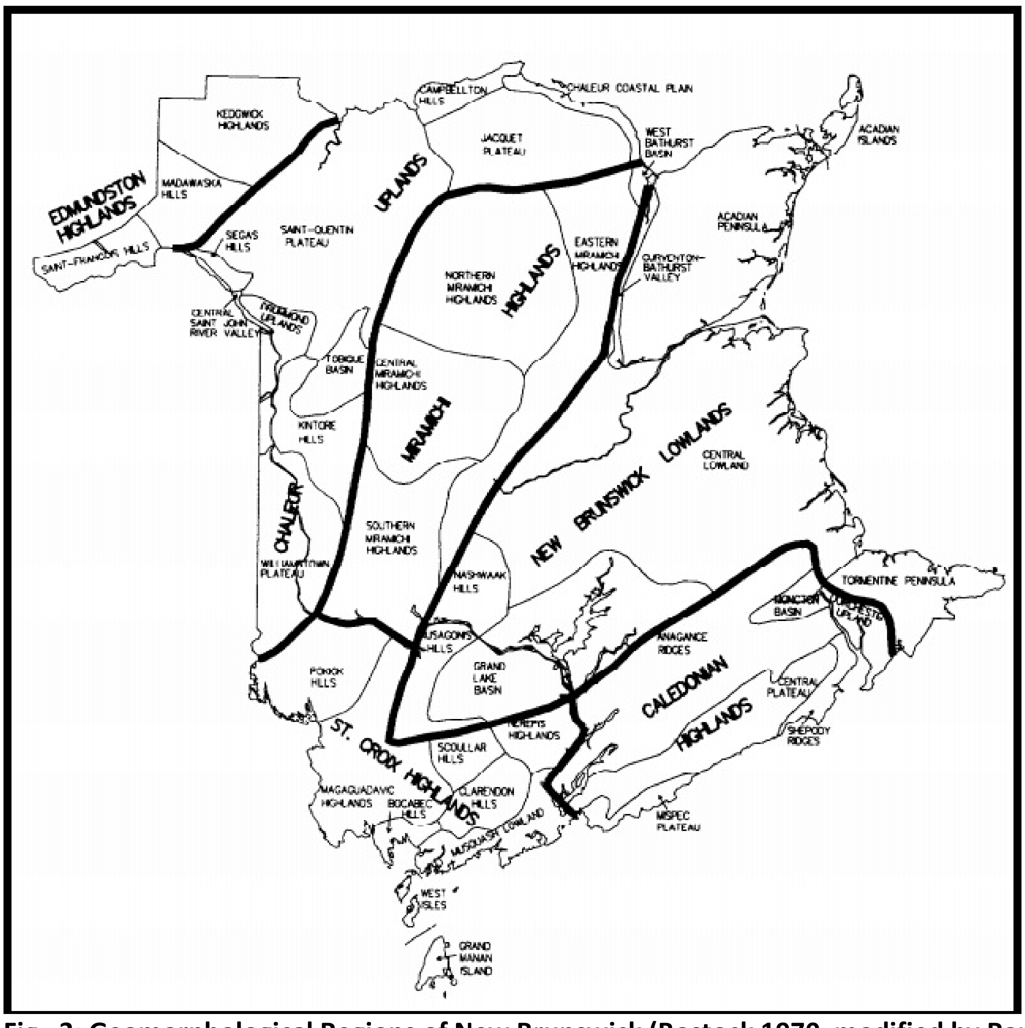

Fig. 3: Geomorphological Regions of New Brunswick (Bostock 1970, modified by Rampton et al. 1984)

The climate of the St. John River Basin is considered "cold", with the watershed experiencing a more humid continental climate (Peel et al. 2007). The annual mean temperature and precipitation are 3.2°C and 109cm respectively at Edmundston (Kidd et al. 2011). The more northerly areas of the river basin in the Madawaska uplands experience a warmer temperature due to its south and west facing slopes, particularly as compared to areas of the same latitude elsewhere in New Brunswick (Kidd et al. 2011). The northeastern areas of the Ganong Ecodistrict boast the lowest annual temperatures in the province, especially around Mount Carleton and Nictau Lake (Kidd et al. 2007). The middle reaches of the river have a more continental climate, with warm summers and cold winters. Many species having southern affinities are found in this area (Kidd et al. 2011). It should be noted that many plants reach their northern limits in the USJR bioregion due to the moderating influence of the river and other lakes and wetlands. Orthographic lift between the lower and higher elevations also leads to increased precipitation in areas like the Central Uplands (Kidd et al. 2011).

The hydrology of the St. John River is influenced by the topography and climate of the basin in the ice-free seasons, where regular flowing water is encountered without ice playing a role (Kidd et al. 2011). Water flow speed and turbulence is influenced by the relief of the landscape, the bedrock over which it flows and the roughness it encounters (Kidd et al. 2011). Ice also plays a major part in the hydrology of the St. John River, as it creates different dynamics compared to flowing water (Beltaos et al. 2003). Ice starts forming in the upper reaches in November, with ice cover being complete by late January. The ice then thickens for a period of time (Beltaos et al. 2003). The formation of river ice causes flooding when it starts to form and also increases flooding when it melts during the spring freshet, in addition to causing lower flows as the water in the basin starts to freeze rather than flowing freely (Prowze et al. 2002). Ice also influences the hydraulic pathways of the river, scouring and reforming the channels and banks during formation and melting (Prowze et al. 2003; Morse et al. 2005).

The St. John River's annual flood cycle is characterised by the spring freshet, much as it is for most of Atlantic Canada's rivers. Since the St. John River is the largest of our rivers, it follows that the extent of these effects involves a greater area. The spring freshet consists of the melting of the snow accumulated over winter and the release of the melted ice on the water surface, often coinciding with rain events (Beltaos et al. 2003). This event can create large floods for a limited time in spring. It also influences many aspects of the river dynamics. During the freshet, velocity of the current increases, there is an increase in sediment uptake, transportation and downput, water temperature changes, and ice jamming events occur.

The spring freshet releases ice and creates flooding and, on occasion, ice jams and more severe flooding in downstream areas (Beltaos et al. 2003). The release of water also brings more sediment and organic material down the river course to settle on the floodplains, forming mostly fertile topsoil via alluvial sedimentation (Morse et al. 2005; Jacobson et al. 2000). A more recent feature to this area is the mid-winter ice break up and jams in the river, something that was unheard of before the 1980's (Beltaos 1999). This seems to be due to an increase in mid-winter milder days and the increase of rainfall during winter, which can be associated with climate change (Tang and Beltaos 2008; Beltaos et al. 2003).

Ice jamming, often also a feature of the freshet, occurs when ice jams in a certain area blocking the passage of free-flowing water, thus creating flooding behind it. Ice scouring on the banks and occasionally on the river bed also occurs during the freshet. During the freshet, organic matter and nutrients that were formerly trapped under the ice now come closer to the surface (**Fig. 4**). Some species are specifically adapted to grow in areas where ice scour has disturbed the habitat. This is particularly relevant in the case of the globally rare and Endangered Furbish's Lousewort (*Pedicularis furbishae*).

The massive amount of water passing through the river system during the freshet eventually slackens as spring transitions into summer. As the water warms in response to the aerial temperature, the organic matter and nutrients now become suspended closer to the surface.

In fall, the air and water temperature start to cool again, with frazzle and anchor ice often forming during nights when temperatures drop below freezing. This starts to alter the behaviour of some species, causing them to seek refuge in areas not prone to frazzle and anchor ice. As the season progresses, the temperature drops further and then doesn't warm up again. The surface water starts to freeze and the organic material and nutrients again go to the warmest part of the flowing water, which is now the bottom of the stream.

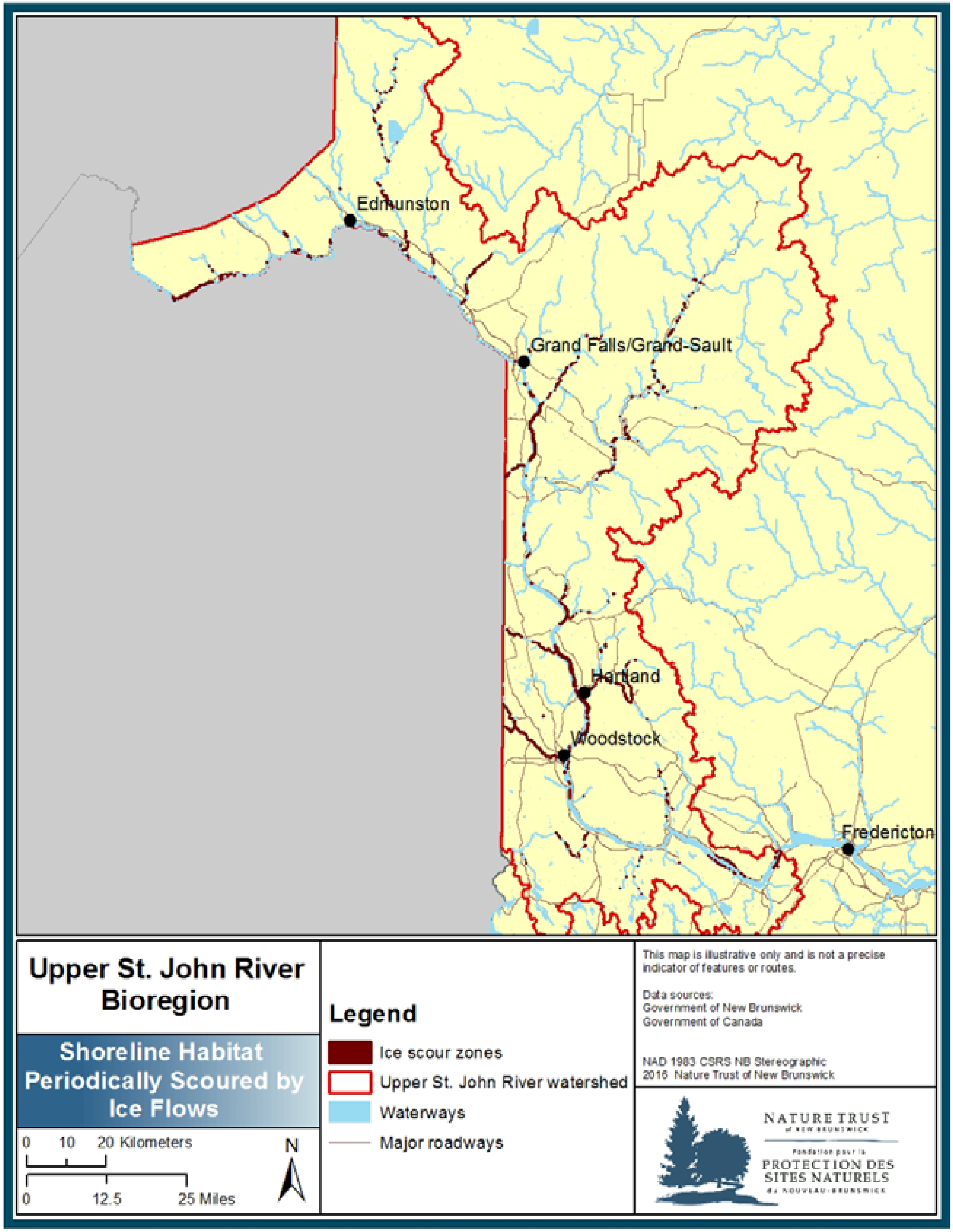

Fig. 4: Areas potentially influenced by Ice Scour

In winter, thick ice cover forms on the rivers. The biota has either taken refuge for the winter or are dwelling in the bottom of the river where the water is still flowing, though the flow is slower and the water volume still in liquid form is lower.

Historical hydrology, the force that sculpted the current landscape of the USJR bioregion, has now also been disrupted by the erection of multiple massive dams within the rivers system in both Maine and New Brunswick, causing significant changes in the hydrology of the system (Kidd et al. 2011). Modern records indicate that flooding is now occurring more frequently in the upper reaches of the river, and this began to occur after the construction of the Grand Falls, Beechwood and Mactaquac dams; moreover, hydroelectric production currently governs the flow of the river in most places, as opposed to the natural flow of water (Kidd et al. 2011).

II. Unique Communities and features

Appalachian Hardwood Forest

The Appalachian Hardwood Forest (AHF) is a unique forest type that is found almost exclusively around the central St. John River Valley of western New Brunswick and Aroostook County of Maine (USA). It is a unique component of the transitional Acadian forest. In character, it is perhaps best described as being a transition between the southern hardwood forest of the central Appalachian range and the northern hardwood forests of northern New England, the Maritimes and Quebec (MacDougal and Loo 1998). Appalachian Hardwood Forest is found predominately on well-drained, calcareous upland and alluvial bottomland soils in an area having relatively moderate climate, and a warm growing season (MacDougal and Loo 1998), and an assemblage of shade-tolerant hardwood trees (Loucks 1962). This forest type is also referred to as the Sugar Maple-Ash zone within in the St. John River Ecozone (Loucks 1962) or the St. John River Valley Hardwood Forest (MacDougal and Loo 1998). This rich upland forest consists of Sugar maple, Yellow birch, American beech, White ash and Ironwood all of which can be associated with hemlock and, in western New Brunswick, also with Butternut and Basswood. The highly diverse understory often includes plants like Northern maidenhair Fern (*Adiantum pedatum*), Plantain-leaved sedge (*Carex plantaginea*), Dutchman's Breeches (*Dicentra cucullaria*), Bloodroot (*Sanguinaria canadensis*), Yellow Violet (*Viola pubescens*) and Trout Lily (*Erythronium americanum*) (MacDougal and Loo 1998; DeWolfe et al. 2005). Other species associated with this unique community are discussed in further detail in the species discussion.

The AHF has been mostly eradicated by anthropogenic activities since European settlement in the eighteenth century with most of the land in this region was either cleared for agriculture or during logging activities (Betts 2000). It is estimated that less than 1% of the original AHF remains; of these, the remaining patches are only 10 hectares in size on average (MacDougal and Loo 1998; Betts 2000). The remainder of this forest type is found predominantly between Perth-Andover and Woodstock in the upper river valley (The St. John River Society 2008). Many of the remaining patches are privately owned woodlots (Clayden and New Brunswick Museum 1994).

The highly diverse assemblages of this forest type are typically associated with more mature forest characteristics (MacDougal and Loo 1998). Sugar maple and American beech are the predominant trees here. They are characteristically associated with Butternut, White ash, Ironwood and Basswood where local conditions permit (Loucks 1962). Unlike most of the natural Acadian Forest mosaic, Red spruce is sparse and almost absent from the AHF (Loucks 1962). The flora in the AHF is truly unique; notably it displays more taxa than any of the other forest types in New Brunswick, many of which are uncommon, rare, or very rare in the Maritime Provinces (MacDougal and Loo 1998; Betts 2000). It supports 71 vascular plant species and 116 moss and liverwort species (MacDougal and Loo 1998). Notable uncommon species found here include Canada wild ginger (*Asarum canadense*), Blue cohosh (*Caulophyllum thalictroides*), Wild Leek (*Allium tricoccum*) and Northern maidenhair fern (*Adiantum pedatum*). Others, such as Lopseed (*Phryma leptostachya*), Showy Orchis (*Galearis spectabilis*) and Cut-leafed Toothwort (*Cardamine concatenata*) are species that occur exclusively in the AHF and nowhere else in Atlantic Canada (Betts 2000; Clayden and New Brunswick Museum 1994). Bryophytes commonly found include *Plagiomnium ciliare* and *Brachythecium reflexum* (MacDougal and Loo 1998). This forest is particularly important to certain fauna, including bird species such as the rare Scarlet tanager (S3S4B, SGs 4-secure), which needs at least 10 hectares of habitat per breeding pair, but also the Red-shouldered hawk S4B, SGs 2-May be at risk) and the Wood thrush (S1S2B, SGs 2- May be at risk), two other regionally rare species also dependent on mature hardwoods. (Betts 2000).

Remnant patches of Appalachian Hardwood Forest (AHF) are found in some protected areas like Beardsley Hill Nature Preserve, Williams Lake Protected Natural Area, and Hovey Hill Protected Natural Area. Beardsley Hill Nature Preserve hosts at least 10 occurrences of AHF species either critically imperiled, vulnerable, or of conservation concern (Mazerolle et al. 2015) and Williamstown Lake Protected Natural Areas hosts at least 25 occurrences of critically imperiled, imperiled and vulnerable species (Mazerolle et al. 2015). These and other rare species are listed in tables 2-4 and discussed in further detail in the next section.

Calcareous Sites

Calcareous soils are characteristic of the above mentioned AHF, creating some of the unique vegetation and floristic community features associated with it (MacDougal & Loo 1998). Over 387 370 ha of calcareous ecosites (**Fig. 5**) occur within the bioregion, representing some 28% of the total terrestrial area. The bedrock geology of these deposits is comprised of Silurian calcareous sandstones with interspersed slates and siltstones. Owing to the easily eroded and rich calcareous sandstones, Eastern White Cedar (*Thuja occidentalis*) is a dominant species in these areas. There are extensive wetlands that occur within this calcareous zone and various uncommon plant species occur here depending on the surface expression of the calcium rich deposits (Zelazny 2007). The area surrounding Williamstown Lake has a high distribution of Cedar Wetlands (on poorly drained soils), in addition to the Cedar Uplands, (on more well drained soils) that feature prominently in the region surrounding the town of Woodstock (Betts 1999). The Meductic Ecodistrict has a rich assortment of unusual and rare plants associated with calcareous soils including the Canada Violet (*Viola candadensis*), Showy Orchis (*Galearis spectabilis*), and the Yellow Lady's Slipper (*Cypripedium parviflorum*) and Goldie's Fern (*Dryopteris goldiana*) occurring in the AHF understory (Zelazny 2007).

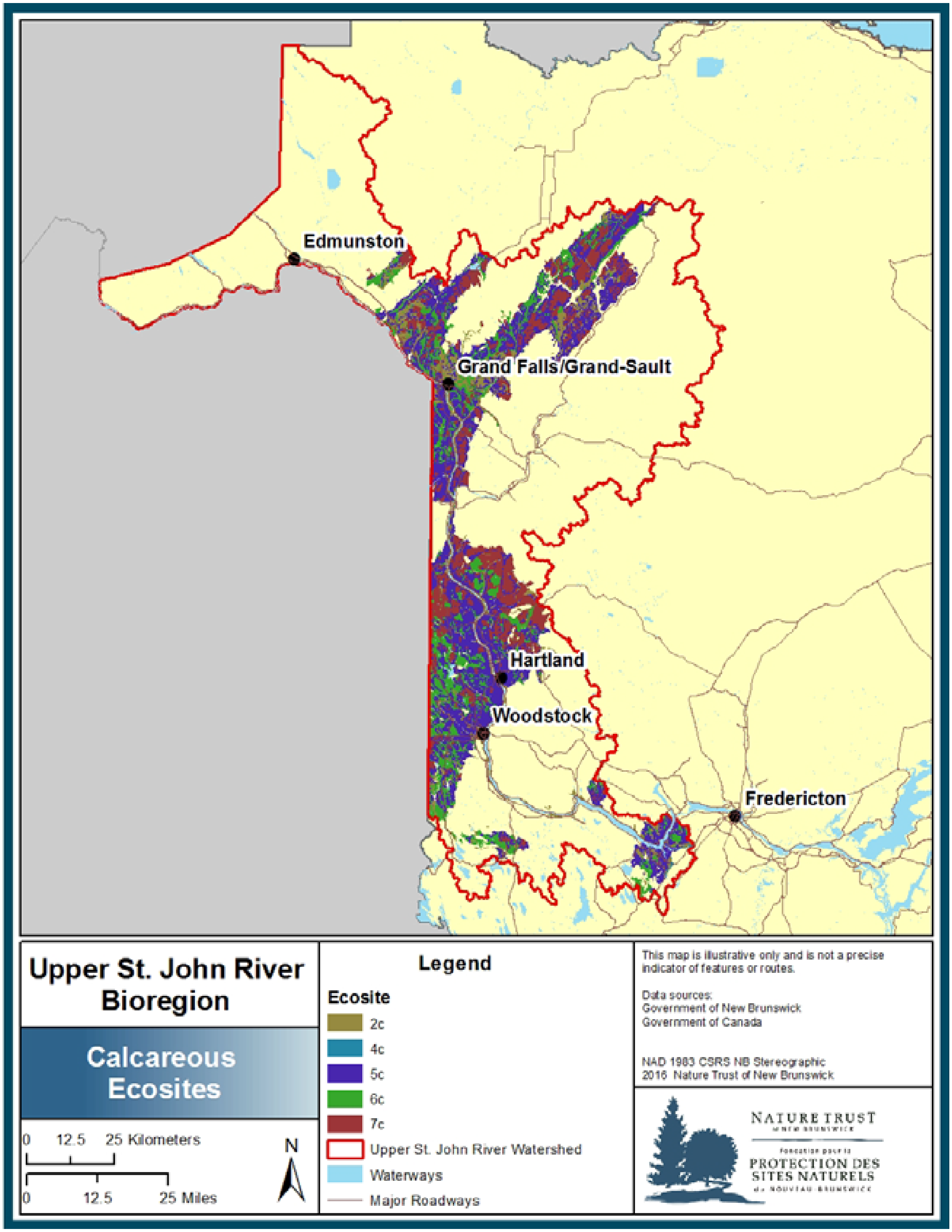

Fig. 5: Calcareous Ecosites within the Upper St. John River Bioregion

III. Priority species

While a number of species references have been made previously within this document, the following is a discussion of particular species deemed of priority within the USJR Bioregion. Species are considered "priority species" if the habitats within the Bioregion are particularly relevant to them, or if the species are considered of conservation concern. Appendix C and D each provide a list of all 248-priority species within the Upper St. John River Bioregion with their associated coarse and fine filter habitats, respectively. These lists include all federally and provincially listed species at risk, provincially (S1 or S2) or globally (G1-G3G4) rare or uncommon element occurrence records from the Atlantic Canada Conservation Data Centre (ACCDC), as well as all BCR 14 priority bird species that occur within the Bioregion. For a glossary of definitions for Biodiversity and Conservation Ranks see Appendix B.

Table 2. Globally significant species (G1-G3G4) and Federally-designated Species at Risk in the Upper St. John River Bioregion

Common name	Scientific name	Global Rank
Furbish's Lousewort	*Pedicularis furbishiae*	G1G2
Narrow-leaved Moonwort	*Botrychium lineare*	G2?
Prototype Quillwort	*Isoetes prototypus*	G2G3
Pygmy Snaketail	*Ophiogomphus howei*	G3
Anticosti Aster	*Symphyotrichum anticostense*	G3
Rugulose Moonwort	*Botrychium rugulosum*	G3
a Moss	*Arctoa fulvella*	G3G5
a Moss	*Hygrohypnum montanum*	G3G5
a Moss	*Seligeria campylopoda*	G3G5
Round-fruited Dung Moss	*Splachnum sphaericum*	G3G5

In addition to species at risk and globally significant species, a diverse assemblage of flora and fauna depend on the diverse suite of ecological systems that occur within the Bioregion.

Table 3: COSEWIC and Provincially species listed as Endangered, Threatened or of Special Concern

Common Name	Scientific Name	COSEWIC Status	Provincial Status
Butternut	*Juglans cinerea*	Endangered	Endangered
Furbish Lousewort	*Pedicularis furbishiae*	Endangered	Endangered
Barrow's Goldeneye (Eastern population)	*Bucephala islandica*	Special Concern	Special Concern
Eastern Wood-Pewee	*Contopus virens*	Special Concern	Special Concern
Harlequin Duck (East pop.)	*Histrionicus histrionicus*	Special Concern	
Peregrine Falcon (*anatum/tundrius*)	*Falco peregrinus*	Special Concern	
Rusty Blackbird	*Euphagus carolinus*	Special Concern	Special Concern
Short-eared Owl	*Asio flammeus*	Special Concern	Special Concern
Yellow Rail	*Coturnicops noveboracensis*	Special Concern	
Monarch	*Danaus plexippus*	Special Concern	Special Concern
Pygmy Snaketail	*Ophiogomphus howei*	Special Concern	Special Concern
Prototype Quillwort	*Isoetes prototypus*	Special Concern	Endangered
Bank Swallow	*Riparia riparia*	Threatened	
Barn Swallow	*Hirundo rustica*	Threatened	Threatened
Bicknell's Thrush	*Catharus bicknelli*	Threatened	Threatened
Bobolink	*Dolichonyx oryzivorus*	Threatened	Threatened
Canada Warbler	*Wilsonia canadensis*	Threatened	Threatened
Chimney Swift	*Chaetura pelagica*	Threatened	Threatened
Common Nighthawk	*Chordeiles minor*	Threatened	Threatened
Eastern Meadowlark	*Sturnella magna*	Threatened	Threatened
Eastern Whip-poor-will	*Antrostomus vociferus*	Threatened	
Least Bittern	*Ixobrychus exilis*	Threatened	Threatened
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Threatened
Whip-Poor-Will	*Caprimulgus vociferus*	Threatened	Threatened
Wood Thrush	*Hylocichla mustelina*	Threatened	Threatened
Anticosti Aster	*Symphyotrichum anticostense*	Threatened	Endangered
Wood Turtle	*Glyptemys insculpta*	Threatened	Threatened
Cobblestone Tiger Beetle	*Cicindela marginipennis*	Endangered	Endangered

Environment Canada Priority Bird Species

In 2013, Environment Canada completed a strategy for BCR 14, encompassing the whole of New Brunswick, including the USJR bioregion. This strategy, one of a suite for each bird conservation region across Canada, is designed to serve as a framework for implementing bird conservation for the region's priority bird species (Environment Canada 2013a). The strategy identifies several 'priority species'. These include those species that regularly occur in the region that are vulnerable due to population size, distribution, population trend, abundance, and other various threats. Some widely distributed and abundant 'stewardship' species are also included because they typify the national or regional avifauna or because they have a large proportion of their range or continental population in the region. Species of management concern are included as priority species when they are at, or exceed, their desired population objectives but nevertheless require ongoing management due to their socio-economic importance as game species or because of their impacts on other species or habitats. Seventy-nine priority bird species listed in BCR 14 are relevant to this HCS (Table 4).

Table 4: New Brunswick Bird Conservation Region 14 (BCR14) Priority Bird Species and those relevant to habitat conservation planning in Upper St. John River Bioregion[1]

Common Name	Bird group	COSEWIC Status	SARA Status	Provincial Status	National / Continental Concern	National / Continental Stewardship
American Bittern	Waterbird					
American Black Duck	Waterfowl					
American Redstart	Landbird					
American Scoter	Waterfowl					
American Three-toed Woodpecker	Landbird					
Bald Eagle	Landbird			V		Yes
Bank Swallow	Landbird					
Barn Swallow	Landbird	T				
Bay-breasted Warbler	Landbird				Yes	
Belted Kingfisher	Landbird					
Bicknell's Thrush	Landbird	T	T	V	Yes	
Black-and-white Warbler	Landbird					
Black-backed Woodpecker	Landbird					Yes
Black-billed Cuckoo	Landbird					
Blackburnian Warbler	Landbird				Yes	Yes
Blackpoll Warbler	Landbird					
Black-throated Blue Warbler	Landbird					
Black-throated Green Warbler	Landbird				Yes	Yes
Blue-headed Vireo	Landbird					Yes
Bobolink	Landbird	T			Yes	
Boreal Chickadee	Landbird					Yes
Boreal Owl	Landbird					
Brown Creeper	Landbird					
Brown Thrasher	Landbird					Yes
Canada Goose (Atl. Pop)	Waterfowl					
Canada Goose (North Atl. Pop)	Waterfowl					
Canada Warbler	Landbird	T	T	L	Yes	
Chimney Swift	Landbird	T	T	L	Yes	
Common Loon	Waterbird					
Common Nighthawk	Landbird	T	T	L	Yes	

[1] Adapted from Environment Canada 2013

Common Name	Bird group	COSEWIC Status	SARA Status	Provincial Status	National / Continental Concern	National / Continental Stewardship
Double-crested Cormorant	Waterbird					
Eastern Meadowlark	Landbird	T				
Eastern Whip-poor-will	Landbird	T	T	L	Yes	
Eastern Wood-Pewee	Landbird	SC				
Evening Grosbeak	Landbird					
Herring Gull	Waterbird					
Killdeer	Shorebird					
Least Bittern	Waterbird	T	T	V		
Magnolia Warbler	Landbird				Yes	Yes
Northern Flicker	Landbird					
Northern Gannet	Waterbird					
Northern Parula	Landbird					
Northern Saw-whet Owl (*acadicus*)	Landbird					
Olive-sided Flycatcher	Landbird	T	T	L	Yes	
Ovenbird	Landbird					
Palm Warbler	Landbird				Yes	Yes
Peregrine Falcon (*anatum/tundrius*)	Landbird	SC	SC	V	Yes	
Pine Grosbeak	Landbird				Yes	Yes
Purple Finch	Landbird					
Red-breasted Merganser	Waterfowl					
Rusty Blackbird	Landbird	SC	SC	L	Yes	
Short-eared Owl	Landbird	SC	SC	L	Yes	
Sora	Waterbird					
Tree Swallow	Landbird					
Veery	Landbird					
Virginia Rail	Waterbird					
White-throated Sparrow	Landbird				Yes	Yes
Wood Thrush	Landbird	T			Yes	
Yellow-bellied Sapsucker	Landbird					Yes

Birds

The USJR Bioregion consists of a wide array of habitat types and ecological communities, of which each in turn harbour a variety of species. Birds are perhaps the group of vertebrates that can move most readily between these habitats and therefore depend on a wider array of habitats than most other organisms. The ACCDC has listed 85 priority bird species in the bioregion, of which 61 are landbirds, 11 are waterbirds, four are shorebirds and nine are waterfowl. For a detailed list of these species as well as their habitat associations, see appendices C and D. Three species occurring in the bioregion, namely the Harlequin Duck, Bald Eagle and Peregrine Falcon, are considered Endangered in New Brunswick. It is important to point out that to date, the Peregrine Falcon has only been recorded in the bioregion as a transient in migration, notwithstanding the fact that potential nesting habitat is present. Moreover, although Harlequin Ducks have not yet been recorded nesting in the bioregion, they were recorded as probable nesters along the turbulent waters of rivers in the Appalachian range just east of the Bioregion during the most recent Maritimes Breeding Bird Atlas. With regards to Bald Eagles, although they have been removed from federal listing and numbers have largely recovered in the bioregion and the Maritimes, they remain listed provincially. Eleven more avian species are listed as federally threatened, including the rare Bicknell's thrush (S2S3B), as well as the Wood thrush (S1S2B), a species of mature hardwood such as those found in the Appalachian Hardwood Forest. Other threatened species that depend on forests include the Olive-sided flycatcher (S3S4B) and the Canada warbler (S3S4B), whereas the Bobolink (S3S4B) and Upland sandpiper (S1B) use grasslands, including some agro-ecosystems. Four others are listed as species of special concern (NBDNR 2015, Environment Canada 2013a).

The 2013 BCR14 Conservation Strategy for bird species of New Brunswick and surrounding marine areas provides a clear and authoritative report on bird fauna and strategies for their conservation in the region. The two habitat types having the highest percentage of priority species are wetlands and mixed wood forest. Cultivated or managed lands, coniferous forest, deciduous forest and inland water bodies are less heavily used, all being used approximately to the same extent by priority species (Environment Canada 2013a). Very few species are exclusive to only one habitat type; however, most species are associated either with forests (44% of priority species), some type of wetland, or a short vegetation type (Environment Canada 2013a). Since the greatest number of species are associated with the three forest types and wetlands, the majority of conservation opportunities and objectives are to be achieved by including those habitats. In addition, some priority species are narrow in their habitat requirements or are particularly specialised in their needs. For example, Bicknell's thrush only occurs in dense, coniferous forest in the region (Environment Canada 2013a) with a high canopy cover (Tuomi 2013), which in this region occur almost exclusively at higher elevations. Naturally, these kinds of factors need to be taken into account for all species, but perhaps in a more comprehensive way for species that have very selective and narrow habitat requirements. At times, only one element of the overall habitat requirements of a species gets taken into account. For instance, nesting habitat may be considered, but feeding habitat and territory size might not. To create an effective strategy, all of these features need to be integrated.

Mammals

Fifty-eight mammal species known to be found in the entire St. John River watershed are potentially native to the Bioregion; to date, 38 species have been recorded here, with six more possibly occurring in the area (Kidd et al. 2011).

The Maritime Shrew (*Sorex maritimus*) is the Maritimes' only endemic species of mammal. It does occur in the Upper St. John River bioregion (Perry et al. 2004). This shrew is typically associated with wetlands having a high graminoid (grass) coverage, with low tree and canopy cover (Herman 2005, Henderson and Forbes 2012). It is also most likely to be found in the presence of Bluejoint Grass (*Calamagrostis canadensis*) (Herman 2005; Henderson and Forbes 2012). These types of habitats are quite fragmented throughout the Maritimes, causing restricted gene flow and connectivity within the meta-population of this species (Herman 2005). Henderson and Forbes also found that the Maritime Shrew is found predominantly in young coniferous forests, especially in moist Black spruce stands. This species presents another example of special requirements for conservation planning.

The Canada Lynx is listed as an Endangered species in New Brunswick and occurs in the northern areas of the Bioregion (NBDNR 2015). The Canada Lynx's home range normally varies between 10 and 250 square kilometres, but can be larger. In some cases, home ranges as large as 783 square kilometres have been recorded (NatureNB 2013; Ruggiero et al. 1999). Lynx are associated with most forested areas of northern Canada, but it is now rare in the southern end of its range, including in New Brunswick (Ruggiero et al. 1999). It is most frequently found in large tracts of dense coniferous forest interspersed with bogs, thickets and rocky outcrops (Ruggiero et al. 1999). Larger, intact tracts such as those required by the Canada lynx are becoming increasingly rare in the bioregion and may already be having a limiting effect on their population here. The size of home ranges is usually determined by prey availability, especially Snowshoe hare (Parker et al. 1982); however, human interference - such as hunting, trapping and habitat alteration - have also had a great influence on Lynx population and distribution (NatureNB 2013; Ruggiero et al. 1999).

The Long-tailed shrew (*Sorex dispar*) is found along the central eastern border of the bioregion, particularly in areas of higher elevation. This shrew is closely related to the Gaspé shrew (*Sorex gaspensis*). These may in fact simply be different forms of the same species, so their true status here is somewhat nebulous (Nature Serve 2008). Nevertheless, both the Long-tailed and Gaspé shrews are said to be dependent on mountainous, forested habitat, whether it be coniferous, deciduous or mixed wood forest, with variable amounts of taluses and slopes. They have also been recorded in rocky areas around streams. Moreover, they also seem to favour the man-made habitats of cliffs and embankments created by railroads and highways (COSEWIC 2006).

The Rock vole (*Microtus chrotorrhinus)* is found in the same general area of the bioregion as the afore-mentioned shrews. However, this species prefers mossy habitats near streams in the high elevations of the Appalachian Mountains, as opposed to slopes and taluses (Linzey 2008). Rock voles form isolated colonies, living in shallow burrows and runways, having smaller home ranges of about one acre (0.4 ha) (IUCN 2014). The Rock vole and the shrews' habitat are presumably less vulnerable, as forestry activities are mostly limited to more accessible areas.

The Northern flying squirrel (*Glaucomys sabrinus*) is considered to be a "keystone species", that is to say a species which has a disproportionately large effect on the environment relative to its abundance. It is also seen as an indicator species for old growth forest (Ritchie et al. 2009). Indeed, it has been shown that mycorrhizal fungi get moved around by the squirrels through their feeding behaviour, potentially spreading this important feature of tree nutrient uptake throughout the area where they live (Vernes et al. 2004). They closely rely on connected habitat within a landscape to be able to disperse effectively, as they prefer not crossing open matrix while moving around (Ritchie et al. 2009). Thus, their presence in an area suggests well-connected forest with old growth characteristics, making them an effective indicator of forest health (Ritchie et al. 2009).

Bats

Although there are currently no known natural hibernacula (e.g. caves) for any bats in the area, three bat species of conservation concern potentially occur in the USJR area and are discussed briefly here.

These are the Tri-colored bat (*Perimyotis subflavus*), Little brown myotis (*Myotis lucifugus*), and Northern myotis (*Myotis septentrionalis*). All three species have recently been assessed by COSEWIC as being endangered in Canada (COSEWIC, 2013). Many bat species in North America are affected by the White-nose syndrome, a fungal disease found on the muzzles, ears and wing membranes, which affects them most readily during hibernation (Blehert et al. 2009). This disease has caused regional population collapses across eastern North America and has had a particularly large impact on the Little brown myotis populations (Frick et al. 2010). Other disturbances to bat populations include habitat destruction and fragmentation, (Henderson 2007), and urban encroachment (Kerth and Melber 2009; Grindal 1996; Patriquin and Barclay 2003).

Important areas to target for bat conservation are roosting sites, since bats often return to the same areas for roosting in summer (COSEWIC 2013, Henderson 2007), and also foraging areas and hibernation sites (Henderson 2007). The Little brown myotis and Northern myotis tend to roost in trees with large diameters, which are especially important for maternity roosts, and these very likely have occurred and possibly still occur in the bioregion (COSEWIC 2013).

The Tri-colored Bat is particularly associated with open waterways and their adjacent vegetation for foraging. They are not as particular about the area of forest they use; however, they feed over water and tend to roost nearby (Davis and Mumford 1962; Perry et al. 2007; Poissant and Broders 2010). In more disturbed landscapes, they may roost in man-made structures (COSEWIC 2013). The Little Brown Myotis and Northern Myotis roost in coniferous and deciduous stands, albeit at lower densities in Jack pine stands (Kalcounis et al. 1999), possibly due to lower prey abundance because of a less diverse ecosystem. According to the COSEWIC assessment and status, old growth forests appear to be particularly important for roost sites, possibly because of increased snag density for roosting. Therefore, the reduction in the prevalence of old-growth forest will pose an additional threat to their survival in the region. The Northern Myotis are very forest-dependent for roosting, foraging, and hibernation (Henderson 2007); water sources are also a highly important habitat component, as insectivorous bats obtain significant amounts of their food in the form of aquatic insects with winged forms that emerge from water onto land and into the air as adults, such as mayflies and caddisflies (Vaughn et al. 1996). All three species use waterways and forest pathways to different extents for foraging (COSEWIC 2013).

Fishes

Forty-three fish species occur in the USJR bioregion according to the State of the Environment Report: St. John River (Kidd et al. 2011). Of these species, six are introduced species (non-native) and 37 are native to the river.

The most notable anthropogenic effects to fish habitat in the bioregion are directly attributable to the hydroelectric dams that occur along the St. John River. In particular, the completion of the largest of the three, the Mactaquac Dam, has had a substantial and well-documented effect on the distribution of eight diadromous fish species, i.e. species that are dependent on the river and the ocean for different life stages (Kidd et al. 2011). Striped bass (*Morone saxatalis*, an anadromous species) is known to have spawned upstream of the dam in the past, but no longer spawn in that part of the river, according to the Department of Fisheries and Oceans (2007). The construction of the dam has also influenced the movement of Alewife (*Alosa pseudoharengus*), Blueback herring (*Alosa aestivalis*) and Atlantic salmon (*Salmo salar*). Salmon still spawn in the river; however, they only do so downstream of the dam and minimally upstream of where they are released after being transported past Mactaquac Dam (Kidd et al. 2011). The Atlantic salmon population has declined severely since the construction of the Mactaquac Dam in 1969, and remains in a dire state (Kidd et al. 2011). Tributaries previously known to be prime salmon spawning grounds, such as the Tobique River, have also seen a precipitous decline in numbers (Gibson et al. 2009).

Other notable and affected diadromous species of the bioregion include the American eel (*Anguilla rostrate*), a federally threatened species which spawns in the ocean and matures in freshwater, making it a catadromous species. These have also been impacted by impeded river flow. Rainbow smelt (*Osmerus mordax*) occur throughout the USJR. It is yet another species affected by impeded river flow (Kidd et al. 2011). Round whitefish (*Prosopium cylindraceum*) is a freshwater species that occur throughout the St. John River, thus the impact of impoundments may be less detrimental to their survival (Kidd et al. 2011). Finally, Redbreast sunfish (*Lepomis auritus*), Alewife (*Alosa pseudoharengus*) and Sea lamprey (*Petromyzon marinus*) now only occur below the Mactaquac Dam, though historic records suggest they occurred upstream of there as well, before the dam was constructed (Kidd et al. 2011).

The outcome of the decisions regarding the Mactaquac Dam could substantially influence extant fish populations throughout the St. John River system. The spread of invasive fish species in the river could also increase.

Herptofauna

Eighteen species of reptiles and amphibians occur in the St. John River, according to Kidd et al. (2011). Of these, two species are considered at risk. Indeed, the Wood turtle (*Glyptemys insculpta*) and Snapping turtle (*Chelydra serpentina*) have been classified as Threatened and of Special Concern respectively, both federally and provincially (Kidd et al. 2011).

The Wood turtle has been receiving increased attention due to its declining population throughout its range (Kidd et al. 2011). It was listed under the Canadian Species at Risk Act, schedule 1, as “threatened” in 2010 (Environment Canada, 2016). This species prefers rivers with sandy and gravelly bottoms, usually with clear, winding courses and moderate currents (COSEWIC 2007). Most commonly found along clear freshwater streams and their banks, Wood turtles are also associated with forested and grassy areas in late summer, and may move up to 300m from shore (Seburn and Seburn 2000; COSEWIC 2007). Ideally, these turtles nest in sandy or gravelly beaches with a patchwork of vegetation cover or in areas close to man-made structures with soil that is loose and unconsolidated. Road networks and agricultural practices are the most serious threats to Wood turtles. Other important threats include illegal collection for pets and for consumption, forestry operations, off-road vehicles, water management practices, gravel and sand pit operations, pollution and excessive sediment input in water courses (COSEWIC 2007, Environment Canada, 2016). Wood turtle are indded present in the bioregion, as monitoring by the *La société d’aménagemnt de la rivière Madawaska et du du lac Témiscouata* (SARMLT) have shown. Their work is on-going in conjunction with NB DNR (Don McAlpine, pers. comm. 2016).

The Snapping turtle is found throughout NB in almost all freshwater habitats. Its preferred habitat features include slow-moving water, with a soft, muddy bottom, dense aquatic vegetation and lake peripheries. It tends to stay closer to water than the Wood turtle and is not nearly as often collected for the pet trade of consumption as that species, so threats associated with that are somewhat less, which is reflected in its conservation status (COSEWIC 2008c).

Invertebrates and benthic assemblages

Invertebrates, especially benthic macroinvertebrates, play a vital role in habitat and environmental health, particularly in freshwater (Kidd et al. 2011). The benthic invertebrate community in the St. John River is not well studied; thus, there is some difficulty reporting on important taxa in a meaningful way (Kidd et al. 2011). The most common benthic insects to be found in the USJR area are likely heptageniid and baetid mayflies, chloroperlid stoneflies, and philopotamid and hydropsychid caddisflies (Kidd et al. 2011). Additionally, there have been 98 species of Odonata (dragonflies and damselflies) recorded in the USJR area that occur in both standing and flowing waters, including some species of conservation concern (Kidd et al. 2011). For example, the Pygmy snaketail dragonfly (*Ophiogomphus howei*), occurs in the bioregion. It has been listed as a species of special concern both federally and provincially. They are only found on larger, unpolluted, fast-flowing rivers and are absent for considerable distances above and below areas that are affected by hydroelectric dams. So far in Canada, they are only known from one site in Ontario and eleven sites in New Brunswick. They were first found in Canada at Baker Brook along the St. John River in this bioregion, in 2002 (Brunelle, 2010; Catling, Cannings and Brunelle, 2005). This species' eggs are laid in smooth flowing reaches of turbulent watercourses. Adults are thought to spend much of their time in the tree canopy like other snaketails and are rarely observed at water. The adult stage only lasts for between six to eight weeks (COSEWIC 2008a). Additionally, there are reportedly 75 species of water mites in the St. John River (Smith 2010), and approximately 10 species of freshwater mussels (Kidd et al. 2011).

Another important factor in the conservation of invertebrates and benthic assemblages is pollution, as many invertebrates rely on water for some part of their life cycle (Mingo et al. 1979, Kidd et al. 2011). Pulp mills are a large contributing factor to pollution in the USJR Bioregion which can have a deleterious effect on the community structure of benthic assemblages (Culp et al. 2003).

With regards to terrestrial invertebrates, some Lepidoptera (moths and butterflies), Hymenoptera (bees, ants and allies) and Coleoptera (beetles) are also important to highlight in the bioregion. Priority terrestrial invertebrate species in the USJR bioregion include the threatened Monarch Butterfly (*Danaus plexippus*), which is mostly commonly associated with Milkweed, but also feeds on invasive species like Purple loosestrife (COSEWIC 2010a). Habitat loss and predation has had an adverse effect on their global population, though this is mainly in their wintering habitat in Mexico, making local conservation efforts problematic (COSEWIC 2010a). Clayton's Copper (*Lycaena dorcas claytoni*, S1) (Fig. 6) is a globally rare subspecies of the Dorcas Copper that has a very restricted range. Indeed, it is only known from two small areas in Canada (one in NB, one in NS) and a few in Maine. Its preferred habitat is rich, calcareous fens (a rare habitat) with Shrubby Cinquefoil (*Potentilla fruticosa*), its host plant.

Fig. 6: A Clayton's Copper butterfly at Ketch Lake, Carleton County (Doucet 2007)

Bumble bees are a particularly important component in the bioregion, due to their pollinator role in nature and in agriculture. Several bumble bee species which occur in New Brunswick, notably the Rusty-patched bumble bee (*Bombus affinis,* endangered 2010), the Gypsy cuckoo bumble bee (*Bombus bohemicus,* Endangered 2014) and the Yellow-banded bumble bee (*Bombus terricola,* COSEWIC species of special concern, 2015) have been assessed as being at risk in Canada by COSEWIC (COSEWIC 2010b, 2014 and 2015b). There are several factors cited as causes for declines. These include the effects of pesticides, climate change and the increase in diseased, non-native species. It should also be noted that the Gypsy cuckoo bumble bee's decline, which is a social parasite of other Bumble Bees, has been principally attributed to the decline of its host species due to the lack of nests to parasitize. In eastern North America, the Gypsy cuckoo bumble bee's principal hosts are the Rusty-patched bumble bee and the Yellow-banded bumble bee (COSEWIC 2010b, 2014 and 2015b).

The Cobblestone tiger beetle (*Cicindela marginipennis*) is an invertebrate with two very small disjunct populations in Canada. To date, it is only known from New Brunswick, where it occurs on cobble and gravel beaches where larval stages live in tunnels dug in the substrate. It is also possible ice scour on the St. John River plays a role in habitat maintenance. Although detailed population analyses were done between 2004 and 2007 leading up to the COSEWIC assessment, still comparatively little is known about this species' population trends, historical and otherwise, as it is a relatively recent discovery in New Brunswick in 2003 (COSEWIC 2008b).

The Triangle floater (*Alasmidonta undulata*) is a mollusc that occurs throughout the reaches of the St. John River and its tributaries. It is considered a sensitive species, and is most often found in cleaner streams and rivers. They do not seem to prefer a specific substrate but are often found on sand and gravel. Pollution has been shown to have a significant, deleterious effect on the population of this species (Swartz and Nadeau 2007).

Flora and Vegetation Communities (Vascular plants)

Vegetation may possibly be the first frontier for conservation. Physical geography, hydrology, and climate are only affected over greater time periods and mostly indirectly. However, vegetation is always directly affected by habitat alteration, forestry and development (Cueto and de Casenave 1999; Etheridge et al. 2005). The health and viability of vegetation also has an impact on every other aspect of an ecosystem (Hooper and Vitousek 1997). Vascular plant communities in the USJR bioregion are of particular interest, given that there are many sites of unique, rare species richness and areas of rare vegetation communities. Though the dominant broad habitat in the bioregion is forest, there are many areas with unique communities; this is especially the case with the Appalachian Hardwood Forest (AHF) and river shoreline areas.

Tree species associated with the AHF are found in differing distributions, including the widely distributed American Beech (*Fagus grandifolia*, threatened by Beech bark disease), which is scattered throughout New Brunswick, as well as the more local White elm (*Ulmus americana*, threatened by Dutch elm disease). In addition, Butternut (*Juglans cinerea*, endangered, S1), Black willow (*Salix nigra*), Silver maple (*Acer saccharinum*), and Basswood (*Tilia americana*) are trees reach their northeastern limit in New Brunswick (Clayden and New Brunswick Museum 1994). There are also 15 understory plants reaching their northeastern distribution limits in this province, all of which occur in the rich upland hardwoods of this region (Clayden and New Brunswick Museum 1994). Some of these species are Canada wild ginger (*Asarum canadense*), Reed cinna (*Cinna arundinacea*), Large toothwort (*Dentaria maxima*), Lopseed (*Phryma leptostachya*), Large-fruited sanicle (*Sanicula trifoliata*) and Honewort (*Cryptotaenia canadensis).* It is important to point out that Honewort may now be locally extinct; as it has not been observed in New Brunswick since 1914. It is thought to be a victim of forest clearing and of the flooding behind hydroelectric dams (Clayden and New Brunswick Museum 1994). The plant community diversity and richness is an important feature in the AHF, giving it the overall species richness for which it is renowned. These rich plant assemblages are commonly found in the Meduxnekeag River watershed, a tributary of the St. John River). This particular area also hosts the highest abundance of rare, AHF-associated understory species. Nevertheless, species-rich areas also occur elsewhere, predominantly between Beechwood and Woodstock; however, these do not occur as commonly or at levels comparable to those observed in the Meduxnekeag River watershed.

There are fifty-three vascular plant species generally associated with AHF, some more common than others. Typical species include Red trillium (*Trillium erectum*), Dutchman's breeches (*Dicentra cucullata*), Trout Lily (*Erythronum americanum*), Hooked buttercup (*Ranunculus recurvatus*), Spring beauty (*Claytonia virginica*) and Zig-zag goldenrod (*Solidago flexicaulis*). Rich AHF communities include additional species like Yellow lady's slipper (*Cypripedium parviflorum*), Plantain-leaved sedge (*Carex plantaginea)*, Northern maidenhair fern (*Adiantum pedatum*), Blue cohosh (*Caulophyllum thalictroides*), and Goldie's wood fern (*Dryopteris goldiana*). Nevertheless, it is important to note that some of these species also do occur elsewhere, but are considerably rarer in those instances; in any case, this gives idea few indicators of what to look for when searching for these communities. However, it is also important to note that there are species unique to the AHF. These include Cutleaf toothwort (*Dentaria laciniata*, S2), Showy orchid (*Galearis spectabilis*, S2) and Lopseed, and Sharp-lobed hepatica (*Anemone acutiloba*). Rich AHF areas are often associated with rich calcareous soils and forest understory seepage areas, or on alluvial bottomland, with the most species rich assemblages being most common in older forested areas (MacDougall 1997). This would include Circumneutral Hardwood Floodplain Forest as described by Simpson and Blaney (2003, see below). Other rare plant communities are found along the river shores with seepage areas, and in some cases calcareous soils and outcrops. These communities are often facilitated by ice scour and spring freshet flooding, which helps maintain low tree cover. The following is a discussion of some of the more prevalent ones, as described by Simpson and Blaney (2003).

Circumneutral riverside seeps are described as occurring on saturated, coarse textured soil to low flat areas with stabilized cobble, with a high substrate pH. This habitat includes graminoid dominant, graminoid-forb or shrubby vegetation and occurs below the adjacent forest. The shrubs in this community consist of alders (*Alnus spp*.), Sweet gale (*Myrica gale*) and willows (Salix spp.), with common shrubs like Sticky false asphodel (*Triantha glutinosa*) and Grass-of-Parnassus (*Parnassia glauca*).

Areas of coarse deposits with evidence of flooding and ice-scour are classified as the Sand cherry – Tufted hairgrass river beach community. The substrate is commonly cobble and dry at the surface. Low forbs and shrubs are typical here with dominant plants including roses, Tufted hairgrass (*Deschampsia caespitosa*) and mats of Sand cherry (*Prunus pumila*). Some of the rare plants in this community include Huron tansy (*Tanacetum huronense*), Brunet's Milk-vetch (*Astragalus alpinus var. brunetianus*) and Alpine hedysarum (*Hedysarum alpinum*), which can be locally abundant. The cover of Sweet gale and sedges are overshadowed by grasses and forbs.

The Bluebell – Balsam ragwort shoreline outcrop community can be described as commonly occurring on rivershore ledges and cobble beaches, on circumneutral or calcareous slate. This community is also subject to flooding and ice-scour. Vegetation rarely covers more than 25% of the habitat with a variety of common herbs present. In addition to Bluebell (*Campanula rotundifolia*) and Balsam ragwort (*Packera paupercula*), plants here include Narrow false oats (*Trisetum spicatum*), Hairy goldenrod (*Solidago hispida*), Silverrod (*Solidago bicolor*), and Tufted hairgrass (*Deschampia caespitosa*). In the shrub layer, Poison ivy (*Toxicodendron radicans*) can be locally common in this community. Other common shrubs include Dwarf bilberry (*Vaccinium cespitosum*), Shadbush (*Amelanchier sp.*), and Shrubby cinquefoil (*Potentilla fruticosa*). Where soil allows growth of larger shrubs, Red Osier (*Cornus stolonifera*), Round-leaved Dogwood (*Cornus rugosa*) and willows (*Salix spp.*) are also present.

The Tall meadow grasses community is very common in the most northwesterly section of NB along the Upper Saint John, and often continues uninterrupted over several kilometres in certain section. Mineral soils with flat to slightly sloping terrain supports Bluejoint grass, Freshwater cordgrass (*Spartina* *pectinata*), Flat-topped white aster (*Aster umbellatus*) and Goldenrods (*Solidago spp*). This community is noted to have a moist but not hydric substrate during the growing season, and is so distinguished from other graminoid wetlands.

Aside from the particular vegetation communities, there are a couple of vascular plant species that require particular attention because of their conservation status. Furbish's lousewort (*Pedicularis furbishae*, S1), an Endangered species in Canada, occur in only five sites in New Brunswick, of which all are associated with the St. John River (COSEWIC 2011a), though several other populations occur in Maine (USA). This species is dependent on naturally disturbed, ice-scoured substrate. One of the three populations in New Brunswick is formally protected by the Nature Trust of New Brunswick and two other sites are owned by NB Power (COSEWIC 2000).

Bryophytes and Lichens (Non-vascular plants)

Bryophytes (mosses, liverworts and hornworts) and lichens are non-vascular plants that are directly dependent on water and nutrient availability for their survival. These groups are often used as pollution indicators as species are sensitive to varying degrees to air pollution. Mosses in particular, none of which are considered endangered in New Brunswick to date, are at times used to measure air pollution on occasion, because the pollution elements show up directly in the plant.

Thirty-four species of bryophytes are included in the priority species for the bioregion. Many of these species are particularly associated with AHF. Species of the genus *Fissidens*, of which *F. bushii* (S2) and *F. taxifolius* (S1) are priority species, are restricted to the AHF and would be a good indicator of this forest type, where they tend to attach to the trunk of mature hardwood trees. Other mosses are also commonly associated with calcareous sites, like Serrated trumpet moss (*Tayloria serrata*, S2), *Seligeria campylopoda* (S1S2), *Aphanorrhegma serratum* (S1) and Meadow plait moss (*Hypnum pretense*, S2). These two habitats AHF and calcareous sites are an important feature in the USJR bioregion and have many vascular and non-vascular plants associated with it.

The only priority lichen species that is known in the bioregion is the Black-foam lichen (*Anzia colpodes*). There is a historical record for it along the Aroostook River, though no evidence of it has been recorded more recently (COSEWIC 2015a). While many other lichen species are found in the bioregion, generally not enough is known about these mutualistic organisms, which represents a significant knowledge gap and research opportunity.

Other less studied groups

There is reason to look into the condition of the phyto- and zooplankton and aquatic fungi assemblages in the USJR area, as these groups are an important part of the ecosystem health in all systems, as the primary producers of energy.

The phytoplankton found commonly in the USJR area are the diatom *Melosira* in the middle reaches of the river and the chrysophyte *Dinobryon serulariain* in the unpolluted waters upstream, (Kidd et al. 2011). There are reportedly 44 species of zooplankton in the area, excluding rotifer species (Locke and Klassen 2010).

Aquatic fungi are also a lesser studied group of 30 species or more present in the bioregion. To date, these have only been studied at a single sample site on the St. John River near Waterford (Bärlocher and Marvanová 2010). This group is an important element of ecosystem health and should be looked at more thoroughly, as they play a vital role in the ecosystem (Bärlocher and Marvanová 2010). Aquatic fungi play a vital role in making nutrients more readily available to invertebrates in stream environments (Bärlocher 1985). The potential exists to study the function of this group as a corner stone of the freshwater food web in the USJR bioregion.

IV. Protected Areas and Conservation Lands

In New Brunswick 273460.24 hectares has been secured in Protected Naturals Areas (PNAs), of which 30274.11 hectares of the total are in the USJR Bioregion (Fig. 7). These areas are legally protected under the Protected Natural Areas Act (2003) and managed by the Government of New Brunswick's Department of Natural Resources and private owners. Their purpose is to provide protection for representative examples of New Brunswick's natural landscapes and native biodiversity. Additional Crown Land and private land have been designated by the Province as Protected Naturel Areas (Government of New Brunswick 2014). Some of the addition are extensions to existing PNAs, while others are new sites. Some private conservation lands have also been included as new PNA's in the USJR bioregion based on their ecological value, distribution, composition and configuration (Government of New Brunswick 2014). The Government of New Brunswick also manages two provincial parks that fall partially within the USJR, i.e. Mactaquac Provincial Park and Mount Carleton Provincial Park. Mount Carleton Provincial Park is also an Important Bird Area (IBA). Its three peaks support breeding populations of the rare, vulnerable Bicknell's thrush (*Catharus bicknelli*), which thrive in its dense, high elevation forests.

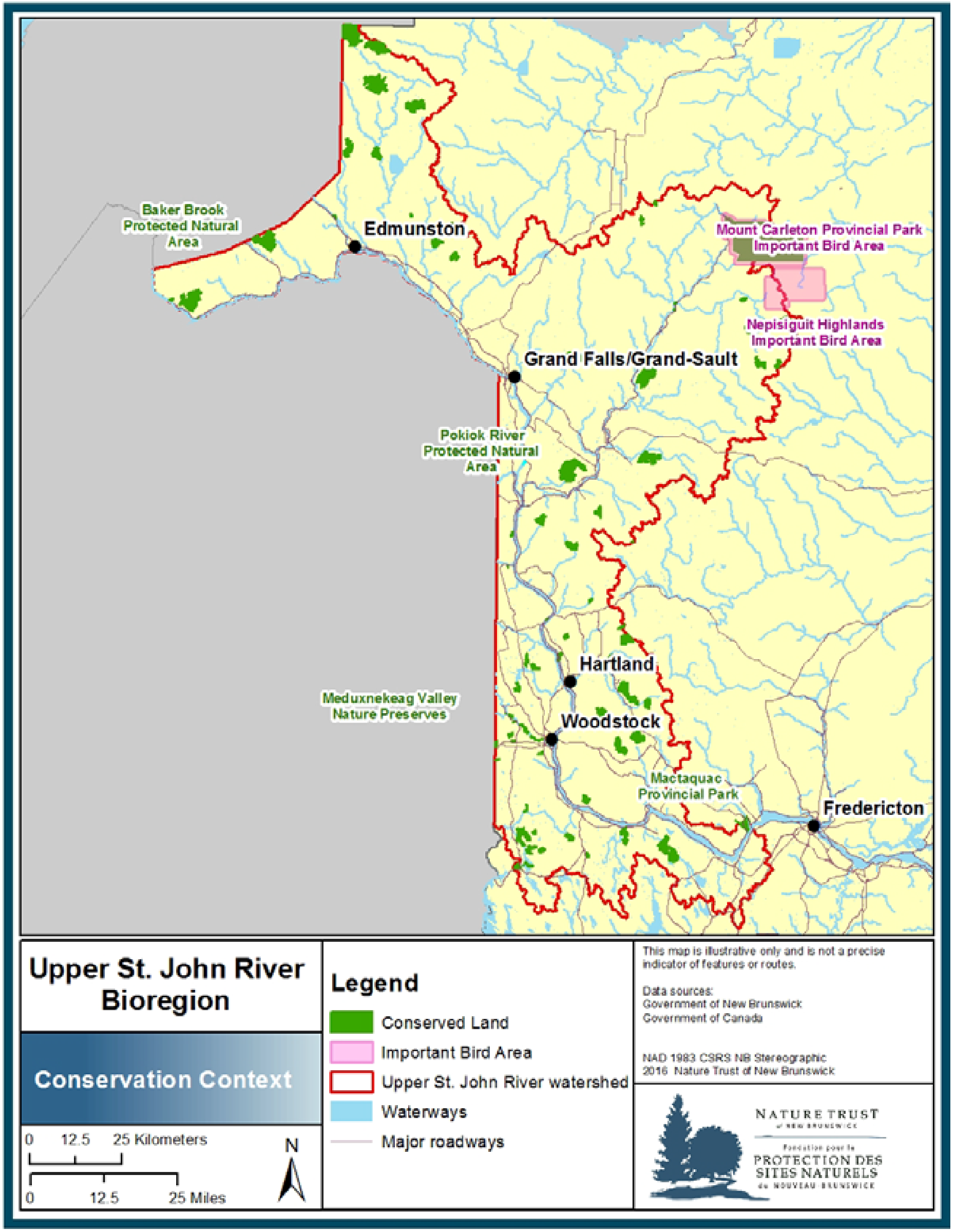

Fig. 7: Designated and Conserved Lands in the Upper St. John River Bioregion

The Nature Conservancy of Canada (NCC) is a non-profit charitable organization that works to directly conserve Canada's most important areas of natural diversity through property securement and long-term management and restoration. NCC has secured approximately 5.10 hectares of wilderness in the Meduxnekeag Valley Nature Preserve (305 ha) and shares management of the area with the Meduxnekeag River Association. This preserve was included as a new PNA in 2012 based on the ecological aspects of the river front and significant rare Appalachian Hardwood Forest.

Table 5: Permanently Conserved areas in the Upper St. John Bioregion[1]

Agency	Total Area Protected (ha)	IUCN Category	Percentage of Bioregion
Government of New Brunswick	38857.06799	Strict Nature Reserve, Wilderness Area	2.846302
Meduxnekeag Valley Nature Preserve & Nature Conservancy of Canada	327.8131	Wilderness Area	0.024012
Nature Trust of New Brunswick	166.64876	Wilderness Area	0.012207
Private	1.146751	Protected Landscape	0.000084
Total	**39352.67661**		**2.882606**

The Nature Trust of New Brunswick (NTNB) is a charitable land trust that works with private landowners to conserve ecologically significant habitat within New Brunswick through securement and conservation easements. NTNB currently protects approximately 116.6 hectares in the USJR bioregion (Table 5). The Shea Lake Preserve at Plaster Rock encompasses 151 hectares and was the first area to be protected by NTNB. It is the site of the rare Lapland buttercup (*Ranunculus lapponicus*). Acquired recently by NTNB, the Green Island Nature Preserve (8 ha), the Arthur Kyle Nature Preserve (2.83 ha) and the Eagle Eye Nature Preserve (12.7 ha) are located in the Upper St. John River. These islands offer the first formal protection of the Anticosti aster (*Symphyotrichum anticostense*) in New Brunswick. Their location and the high cobblestone content also serves as a suitable habitat for the endangered Cobblestone Tiger Beetle (*Cicindela marginipennis*) (Environment Canada 2013b).

While Important Bird Areas (IBAs) (Table 6) are not currently recognized or regulated as protected areas in Canada, some degree of protection is in place in areas where they overlap with officially designated protected areas. Segments of two IBAs can be found in the USJR bioregion, which both support populations of breeding Bicknell’s thrush. This species was recently declared nationally vulnerable by the Committee on the Status of Endangered Wildlife in Canada (BSC 2015). The first IBA overlaps precisely with the Mount Carleton Provincial Park itself. Three peaks in Mount Carleton Provincial Park support between 25 and 50 pairs of breeding Bicknell’s thrush (BSC 2015). Park staff are currently providing good protection, although the protected status of the park might not be entirely secure (BSC 2015). The second IBA in the USJR bioregion is the Nepisiguit Highlands IBA, which is located along the south border of Mount Carleton Provincial Park. With 75 pairs recorded in the area, this is likely the most significant site in New Brunswick for breeding Bicknell’s Thrush. Unfortunately, as it does not overlap with a legally protected site, the Nepisiguit Highlands IBA's protection status is currently low.

[1] See Appendix XX for all Protected areas by agency

Table 6: Important Bird Areas (IBA) in the Upper St. John Bioregion

IBA Code	IBA Name	IBA Criteria	Lat / Long	Elevation (m)	Size (km^2)
NB034	Mount Carleton Provincial Park	Globally Significant: Threatened Species (Bicknell's Thrush)	47.393° N 66.836° W	274-820	240.96
NB024	Nepisiguit Highland	Globally Significant: Threatened Species (Bicknell's Thrush)	47.285° N 66.725° W	305-793	155.42

C. Socio-Economic Context

The social, economic and historical settlement patterns of the USJR bioregion are distinct as compared to the lower reach of the Saint John River. Its vast system of rivers, streams, ponds, and lakes were very important in the settling and development of the Upper St. John River Valley. The large majority of the Upper St. John River Valley has been part of the ancestral homeland for people of the Wolastoqiyik (Maliseet) nation for over 10 000 years.

Wolastoqiyik culture is deeply imbedded in the river and its surrounding lands. Indeed, these people were the first stewards of the St. John River, calling it 'Wolastoq' or 'the good and bountiful river' (Anderson 2006). Here they built their lives and livelihoods. Their connection to the land, its resources and its beauty is apparent in any literature about these people, where they settled in a few areas along the river. Their most important settlement was in the Madawaska Ecodistrict at the confluence of the Madawaska and St. John rivers (Zelazny 2007), even though the settlement with the highest population today is at Negotkuk/Tobique First Nations (Baumflek et al. 2010). The St. John River and its tributaries were the main travel route for the Wolastoqiyik between northern and southern New Brunswick. They could reach the eastern coast via the Tobique tributary of the St. John River, and the southwestern areas via the St. Croix. These naturally included short overland passages (Baumflek et al. 2010). The river has long been their main source of livelihood, including fishing in the river itself, hunting and trapping in the river basin and collecting other food, like fiddleheads and butternuts, in the area. In addition, they also relied on the land for medicinal purposes, collecting medicinal plants and animals for traditional cures and remedies (Gesner 1846).

With the arrival of Acadians first, followed by the British and Americans thereafter, the Wolastoqiyik dealt in beaver pelts and furs and other merchandise to enhance their livelihood (Gesner 1846). This gave them access to European rifles and ammunition, clothes and a different culture. Though the Wolastoqiyik culture is documented predominantly from an outsider's perspective, it remains clear that they have had an integral connection to the St. John River and the region nearby for millennia. Nevertheless, the arrival of Europeans and all the challenges that came with that (disease, etc.) took its toll on the survival of First Nations here as dramatically as it did in other parts of the New World. More than 10 000 Wolastoqiyik are believed to have been living across the province at their "peak". Nowadays, just over 4 500 remain, of which just under 3 300 live in the USJR bioregion (Perley and Blair 2003).

Although visited by explorers as early as 1638, only in the late 1700's did the USJR get its first non-aboriginal settlers, who were Acadians and French Canadians that made their way from the lower St. John River Valley. The floodplains were settled first; these were developed mainly for farming and industry. Settlement then spread up the tributaries to the surrounding lakes. However, in some of the USJR Ecodistricts (e.g. Brighton, Wapske), early European presence in the region centred instead on logging, which supported grist and saw mill activity (Zelazny 2007). In the late 19th century, the St. John River valley was the only winter route between Halifax and Quebec City, which was another reason for migrating north up the river (Craig 1997). Territorial claims were grounds for a large dispute between the United States, Britain, and Quebec for over 70 years. This dispute resulted in the Aroostook War, a bloodless war which ended in a compromise, allowing Canada to retain the St. John River, as well the main contemporary route from Atlantic Canada to Quebec (Zelazny 2007).

While 70% of the population currently living within the entire St. John River basin in New Brunswick is concentrated below the Mactaquac Dam, there is one major population centred in the USJR Bioregion; the city of Edmundston and surrounding communities. This city has a population of approximately 16,000 and supports a significant, regional, forestry-based economy. The proximity of Maine and Québec creates complex patterns of cultural convergence and differentiation. Most of the USJR bioregion was populated later than was the lower St. John River. Farming, mainly potato production, power generation, and saw/paper mills, constitute vital industries for the local and regional economy. Farming is concentrated in the upper St. John River valley, with the most valuable crop being potatoes. Potato farms in the USJR are a major supplier to McCain's, which operates the world's largest french-fry production facility, which is located in Florenceville. The USJR Bioregion is also host to one of the province's power generation corner posts, with its four hydroelectric stations: Grand Falls, Tobique Narrows, Beechwood, and Mactaquac. Most tributaries of the St. John River supported grist and saw mills in the 18th and 19th centuries. Today, the Twin Rivers and Edmundston pulp mills are located in Edmundston and still support a significant cross-border pulp industry.

2. HABITAT, THREAT, AND SPECIES SPATIAL PRIORITIZATION

A. Priority habitat types

Priority habitats are the native biological entities (i.e., ecological systems, communities and/or species[1]) that the Habitat Conservation Strategy is aiming to conserve. The planning team selected priority habitats at a coarse enough scale to encompass the most significant elements of conservation concern that could be addressed at the Bioregion scale. HCS habitats encompass all species of conservation significance occurring in the Bioregion (including CB/ ERA primary habitats, BCR 14 priority bird species, species at risk, S1-S2 and G1-G3G4 ranked species) and are representative of the biodiversity of the Bioregion. The process used to identify priority habitats in this Bioregion was through research of literature, speaking with experts and iterative review with partners. As a result, priority habitats include seven ecological systems:

1) Beaches
2) Grasslands / Agricultural Ecosystems
3) Rock Outcrops
4) Cliffs
5) Acadian forest mosaic
6) Appalachian Hardwood Forest
7) Freshwater wetlands
8) Riparian, shorelines and Aquatic Systems

Priority habitats are mapped in **Fig. 8** – **12, 14, 15**. For each priority habitat type, a detailed viability assessment was made for its size, condition and landscape context (Low, 2003) using background habitat information collected from the Bioregion, a review of literature and expert opinion. The viability of the priority habitats can be ranked as 'poor', 'fair', 'good' or 'very good' (adapted from The Nature Conservancy). The current overall biodiversity habitat viability for the Upper St. John River Bioregion is considered fair.

1) Priority Habitat: Beaches

Habitat Description:
Beaches, according to Anderson et al. (2006), are "thick accumulations of unconsolidated, water-borne, well-sorted sand and pebbles deposited on a shore, or in active transit along it." These areas can be found along coastlines, but also rivers, lakes and islands within rivers. In this bioregion beaches are

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[1] ***Ecological systems***: Assemblages of ecological communities that occur together on the landscape and share common ecological processes (e.g., flooding), environmental features (e.g., soils and geology) or environmental gradients (e.g., temperature).
Communities: Groupings of co-occurring species, including natural vegetation associations and alliances.

- <u>Major groupings of targeted species</u> that share common natural processes or have similar conservation requirements (e.g., forest-interior birds, freshwater mussels)
- <u>Globally significant examples of species aggregations</u> (e.g., migratory shorebird stopover area)

Species: Types of species targets may include:

- <u>Globally imperilled and endangered native species (e.g. G1 to G3G4)</u>
- <u>Species of concern due to vulnerability, declining trends, disjunct distributions or endemism</u>
- <u>Focal species</u>, including keystone species, wide-ranging regional species and umbrella species

found predominantly on alluvial islands within the St. John River, and on the shores of this river and its major tributaries.

Ecological Justification Beaches:
Beaches, especially those found along the St. John River, are ecologically significant ecosystems, as they support several rare and at-risk species. For instance, the Cobblestone tiger beetle is found exclusively on island beaches in the USJR and is one of only two such known populations in Canada, the other of which is on the shores of Grand Lake, also in New Brunswick (COSEWIC 2008b). In addition, Wood turtles use habitat such as beaches and shorelines along rivers or sreams with gravel and/or sand as nesting habitat (Seburn and Seburn 2000). Conservation of these habitats will contribute to the health and conservation of over 125 significant species (48.5 %; Appendix C).

Landscape Context Assessment Beaches: Good
The landscape context for beaches (**Fig. 8**) was assessed by estimating the proportion of beech habitat tat is embedded in natural habitat. It was calculated that 61.3 % of beaches are surrounded by natural habitat within a 275-meter buffer, which is considered to be a good rating. This assessment also indicates that an examination of the threats to beach habitat is warranted in this bioregion, and that an increase in disturbance along riverine and riparian ecosystems could cause a significant impact on beach habitat along the St. John River. The most prominent sources of direct disturbance to this habitat are related to ease of access and recreation in the beach habitat, including road development and shoreline clearing related to housing and agriculture, and off-highway vehicle (OHV) use (Arnold 2005).

Conditional Assessment Beaches: Poor
Along the Upper St. John River, beach habitat structure is regularly maintained by ice scour in late winter to spring and the subsequent flooding caused by the spring freshet. This results in the area being naturally disturbed frequently, which may help curb the potential threat of invasive plant species populating the area. These predictable disturbances also create the habitat conditions that support the many rare plant communities found along the shores and islands of the river. Conversely, these rare plant communities and other sensitive species such as the Cobblestone tiger beetle are highly sensitive to anthropogenic disturbance associated with the human-related activities that may take place along the shoreline beaches in the Upper St. John River (COSEWIC 2008b). Therefore, the condition assessment measure of accessibility is applicable to these species. Condition of shoreline and island beaches were assessed by considering their embeddedness within natural habitats, the presence of Cobblestone tiger beetle, in addition to the beach’s accessibility to recreation activities. Islands beaches are generally less disturbed due to limited access via by boat, though some island beaches are frequently used by the public. Roads within 100 meters of beaches give ease of access to 42.4 % of these habits in the bioregion. Of these habitats 14.4 hectares are located on permanently conserved land in bioregion, forming only 6.8% of the bioregion’s beach habitats.

Size Assessment Beaches: Very Good
The beach habitat sizes range from less than one hectare to 19 hectares, with the average being 2.3 hectares. Clearly these are not large areas of habitat and they are restricted to a river area comprising only 214 hectares of the bioregion. According to Anderson et al. 2006, habitats larger than 8 hectares comply with the critical threshold criteria. Only four of the 96 beach habitats meet this size threshold; however, this metric may not accurately reflect the unique beach habitats in the USJR. For example, these beaches are essentially the only habitat that the Cobblestone tiger beetle use in for this region. Tiger beetles are often used as environmental indicators (COSEWIC 2008b), and the minimum habitat

size required is estimated at 0.08 hectares (Nothnagle 1995). All of these cobblestone beach habitats are thought to be of viable size for the Cobblestone tiger beetle and many rare plant communities.

Overall Assessment Beaches: Fair

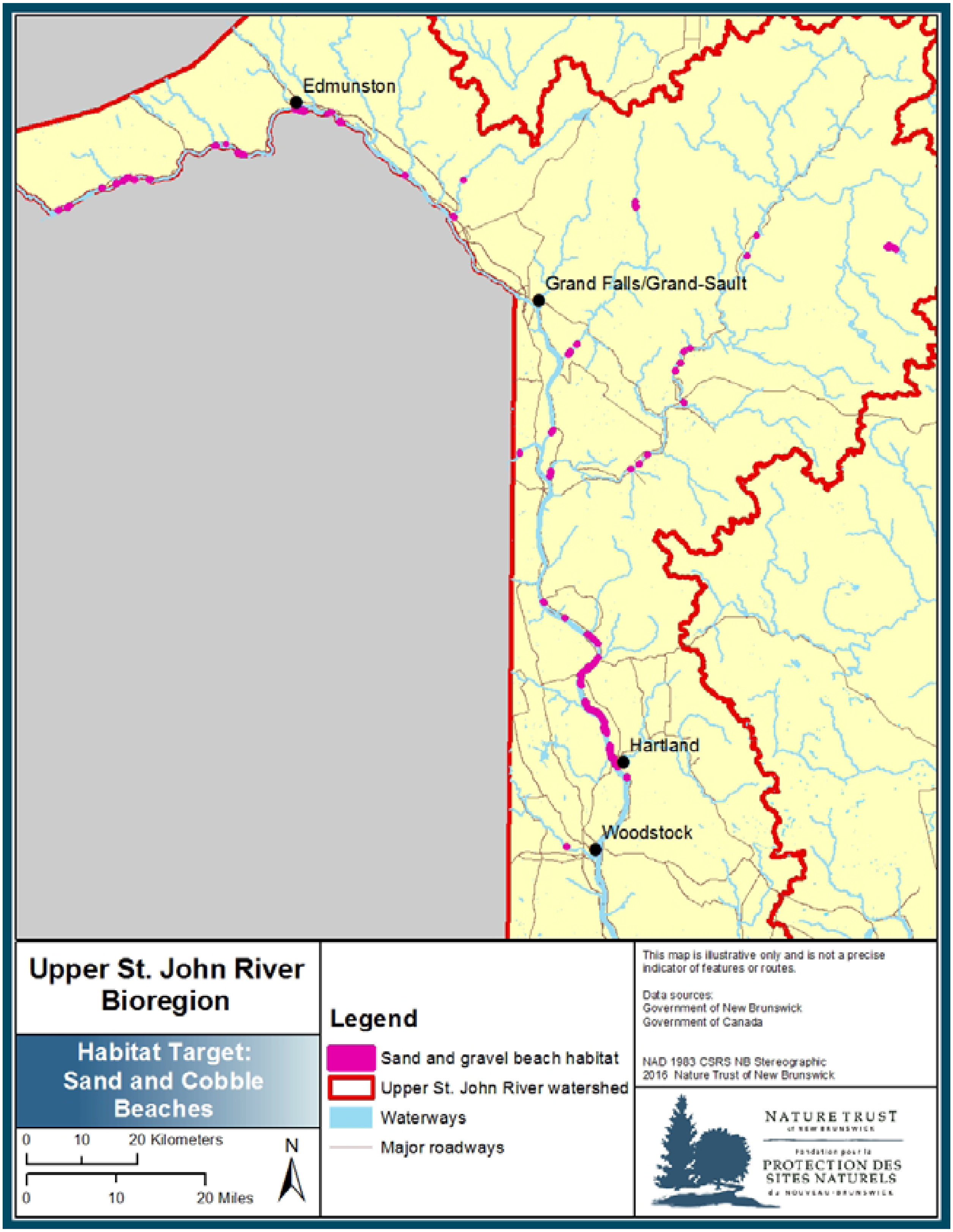

Fig. 8: Beach habitats identified in the Upper St. John River Bioregion

2) Priority Habitat: Grasslands / Agricultural Ecosystems

Habitat Definition Grasslands /Agricultural Ecosystems:
Grassland ecosystems in the USJR bioregion consist almost exclusively of agro-ecosystems, since records show that prior to European settlement, natural grasslands in the area were very limited. Today, the valley lowlands ecoregion is particularly influenced by agriculture and highly modified landscapes are common in the areas that were first settled for agriculture in the 19th Century (Zelazny 2007). Even though they were not originally common in the area, grasslands now represent an important habitat for some species of conservation concern such as Bobolink, Eastern meadowlark, Barn swallow, and Monarch butterfly. Not all land converted to farmland is continuously in intensive rotation, and can provide relatively safe areas for breeding, foraging, and dispersal of certain species, even in the early successional stages of reforestation. Abandoned farmlands are commonly dominated by early successional White spruce and Tamarack trees and, in some instances, White cedar (Zelazny 2007).

Ecological Justification Grasslands / Agricultural Ecosystems:
The grasslands (**Fig. 9**) in the USJR bioregion are mostly agricultural in nature and in use for predominantly potato, various grains, beef or dairy farming and their associated practices, such as hay cultivation (Environment Canada 2013a; Zelazny 2007). The St. John River valley is a particularly rich agricultural area because of warm climate and rich, limestone-based soils (Zelazny 2007). Priority species dependent on grasslands in this region are predominantly birds and insects. Priority species from BCR 14 that depend on grasslands include the Eastern meadowlark, Bobolink, Barn swallow, Common nighthawk, Short-eared owl, and the Yellow rail, the latter of which may be in the bioregion, but has not yet been recorded here (Environment Canada 2013a). The Wood turtle (a Threatened species under SARA) may also be found in these areas. Wood turtle habitat can be found within 300 meters of a river or stream, using the surrounding area or "riparian buffer" for foraging (Seburn and Seburn 2000), these areas are often agricultural lands. Other species using grasslands either for forage or nesting or both include the Little brown myotis, and several migratory waterfowl species (Environment Canada 2013a). Bumble bees also occur predominantly in these types of habitats, including meadows, old fields, and mixed farmland. In New Brunswick, these include Species at Risk, such as the Endangered Rusty-patched bumble bee (*Bombus affinis*) and the Endangered Gypsy cuckoo bumble bee (*Bombus bohemicus*), as well as the still relatively common Yellow-banded bumble bee (*Bombus terricola*), which was designated as a species of Special Concern in May of 2015 (COSEWIC 2010b, 2014 and 2015b). A common threat to grasslands species consists of early hay harvesting, which causes the destruction of nests during breeding and brooding seasons, and mortality of Wood turtles foraging in fields at the time of harvest. Another is the direct or indirect poisoning of individuals or populations due to agricultural chemicals such as herbicides and insecticides (Environment Canada 2013a).

Landscape Context Assessment Grasslands / Agricultural Ecosystems: Unknown
The LCI for the Grassland / Agricultural ecosystem could not be calculated from NAAP data and methodology, nor did the connectedness give an accurate representation of this largely anthropogenic ecosystem. The connectedness examines those features and processes which create resistance to species movement by increasing risk of harm; as such the connectedness considers this type of habitat to be a threat to landscape connectivity itself. Agricultural land use is weighted as a type of development calculation of the connectedness, which would contribute significantly to the poor connectedness ranking. For those species which depend on agricultural systems to provide habitat including grassland birds, the connectedness is not an accurate indicator of habitat suitability; owing to

the man-made nature of these habitats, condition and size assessments are much more useful indices. The poor connectedness score for the Upper St. John River Bioregion does, however, reveal that existing agricultural patches create large impediments to connectivity between intact, natural habitat patches such as forests, wetlands, and riparian areas. Extensive road networks connecting agricultural patches also increase the impact of these connectivity impediments, and lead to poor connectedness.

Instead, the landscape context was assessed by comparing the unviable agricultural land to the viable, by querying out attributes connected to grassland specific features. For the viable systems Fallow pasture and inactive croplands where isolated, in comparison to active croplands which would include row crops and actively managed lands. The ratio of unviable to viable was calculated as 5:1, suggesting that within the agro-ecosystem features that could sustain grassland biodiversity form only 16.6 % of the system. This does not suggest that biodiversity cannot exist in the 'unviable' areas of this landscape, but is merely an indication of grassland biodiversity potential.

Conditional Assessment Grasslands / Agricultural Ecosystems: Unknown
An accurate condition assessment of agricultural systems using existing spatial data was unfeasible owing to the shifting nature of agricultural land use (ie. crop rotation), and the lack of information available regarding current agricultural land cover on individual habitat patches. Even in viable breeding habitats, harvesting practices in the agricultural system can have a significant impact on to breeding bird populations and potentially to Wood turtle, as well, who require foraging habitat up to 300 meters from a water course (Seburn and Seburn 2000). Mortality to these species caused by haying is a significant threat to those species using active hayfields as breeding and foraging habitat. Fifty-six of the priority species are associated with the Grassland / Agro-ecosystem habitat[1] of which 22 are bird species.

In the USJR bioregion, there are an estimated 50 000 hectares of potatoes in rotation, with approximately 550,000 acres being harvesting every year (Kinnie 2016 pers. Comm.). Potatoes are the agricultural mainstay of the bioregion (Kinnie 2016 pers. Comm.), forming most of the potential habitat for grassland species. However, as potatoes are considered a row crop, fields of potatoes do not form viable grassland habitat. When potatoes are in rotation with barley, winter wheat and fallow land, it is considered a more suitable habitat, as the rotation crop forms a more grass-like substrate. Barley is often preferred in rotation as it reduced the diseases in the soil (Griffin and Larkin 2007). In this agricultural region, the ideal is to have a rotation of potatoes two and half years following a rotation of grass, however barley is often under seeded here with grass, thus get the benefits of both substrates (Kinnie 2016 pers. Comm.). Doing so forms viable grassland habitat which offers more vertical structure that can be used by species of concern, like Bobolink. Other agriculture types in the area with the potential to host grasslands species are livestock (beef), dairy, and grain (Kinnie 2016 pers. Comm.).

Size Assessment Grasslands / Agricultural Ecosystems: Poor
A habitat size assessment was carried out to identify the potential for the bioregion to provide grassland bird breeding habitat of viable area. Unfortunately, currently available spatial data does not allow for an accurate identification of the most suitable (hay and fallow field) vs unsuitable habitat (grain/potato crop) for breeding grassland birds presently found on the landscape. The total area of grassland/agricultural ecosystems in the bioregion is 100,028 hectares, which accounts for 3.5% of the bioregion.

According to Anderson et al. 2006 the critical threshold in size for grassland habitats is 40 hectares (see Appendix H for clarification on critical thresholds). When comparing the viable habitat in the agricultural system in the bioregion to this size, 6.5 % was found to fall within this threshold. However,

[1] Note that species may be associated with multiple habitats, thus the accumulated percentage maybe above 100%.

when considering grassland birds, 9.3 % of the habitat patches are of large enough size to host Bobolink breeding territories (i.e. minimum of 30 hectares). Bobolink requires one of the larger territories for breeding of all eastern grassland birds; in contrast, Eastern meadowlark requires only five hectares for breeding habitat. In this case, 60.1% of the viable habitat patches would be large enough. Using Bobolink breeding habitat size as the threshold enhances the capability of these habitats to sustain a larger array of species, giving the habitat more conservation potential (Ribic et al. 2009).

Though size is a useful measurement for estimating breeding habitat potential for these bird groups, other habitat characteristics can also play a role. Bobolink and Eastern meadowlark both prefer habitats larger than the minimum required size, with Bobolink reproductive success increasing with an increase in patch size (COSEWIC 2010c; COSEWIC 2011a). In an agricultural setting, forage crops, including hay fields and pasture, are distinctly preferred by both species, with neither species preferring row crops (COSEWIC 2010c; COSEWIC 2011a). However, Eastern meadowlark will breed in areas with a grass-like understory, e.g. orchards. In addition, older forage crop fields (i.e. not seeded within the last year) are also preferred by both species, where low to medium herbs and forbs of this more diverse system provide perching sites and cover (COSEWIC 2010c; COSEWIC 2011a). The Eastern meadowlark distinguishes less between grass heights, whereas Bobolink are rarely found in areas with more short grass (COSEWIC 2010c, 2011a). In addition, Bobolink are rarer in areas close to forest edges and reproductive success is negatively correlated with small highly fragmented habitats (COSEWIC 2010c).

The population size of two Species at Risk, Bobolink and Barn swallow (COSEWIC 2011b), was used as an indicator of viable grassland size. These species populations sizes are link to the available nesting habitat size and feeding habitat availability within the grassland system. Bobolink and Barn swallow were both assessed to have poor population sizes. This, in combination with the viable patch sizes for Bobolink and Eastern meadowlark, has given this habitat type a conditional assessment of poor.

Overall Assessment Grasslands / Agricultural Ecosystems: Unknown, condition poor

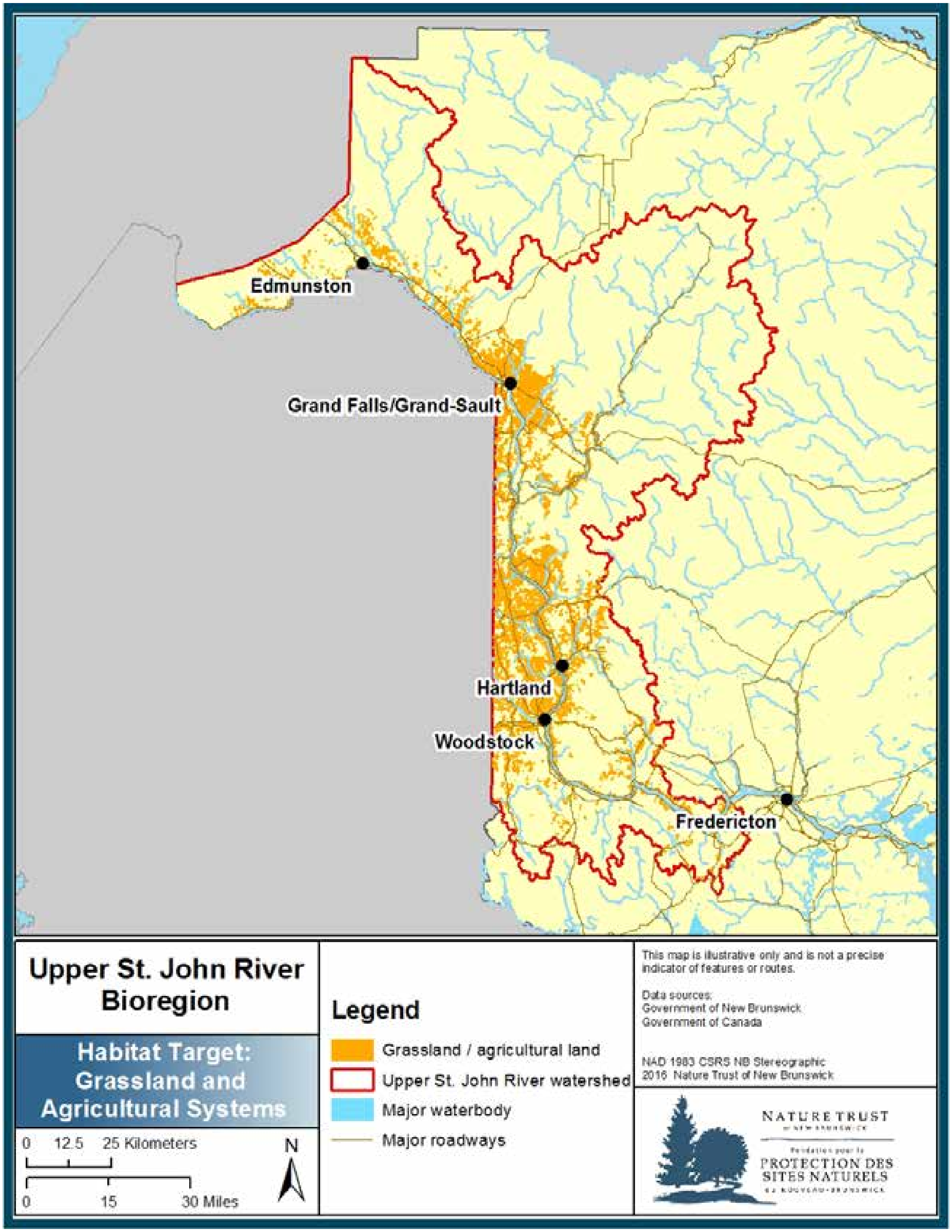

Fig. 9: Grassland / Agricultural Ecosystems in the Upper St. John River Bioregion.

3) Priority Habitat: Rock Outcrops

Habitat Definition Rock Outcrops:
Rock outcrop ecosystems are characterised by exposed, natural rock, however, they take on a variety of forms and generally support diverse floral and faunal communities. The various ecosystem sub-types include bare rock surfaces, rocky ridges, soil islands, talus slopes, as well as low and mid elevation summits (**Fig. 10**) (Anderson et al. 2006). Habitat conditions in the various areas are driven by soil nutrients, water availability, soil depth, and the nature of the soil substrate, all of which act together to create distinct floral communities (Anderson et al. 2006).

Ecological Justification Rock Outcrops:
The acidic upper slopes and ridge-tops of the Kedgwick Ecodistrict support a mixed-wood forest of balsam fir, red maple, white birch and yellow birch as the dominant hardwoods. American mountain-ash is more common here than elsewhere and can reach treelike dimensions, potentially due to the limited population of white-tailed deer (Zelazny 2007). Rockier ridges in the Valley Lowlands Ecoregion may support communities including red oak and ironwood, with very rocky sites dominated by red spruce, white pine or white spruce. The same Ecoregion hosts a tolerant hardwood stand at Dorn Ridge supporting sugar maple, American beech, yellow birch and white ash (Zelazny 2007). An interesting and uncommon feature in Mount Carleton Provincial Park is its angular bedrock projections called "tors", which are rocks shattered by ice melt following glaciation (Zelazny 2007).

One of the rarer species found in the USJR bioregion's rocky outcrops is the rock vole (aka yellow-nosed Vole, *Microtus chrotorrhinus*), which can be found in isolated colonies on the slopes and rocky outcrops of the Tobique River valley (Zelazny 2007).

It should be considered that plant communities in these habitats and ecological communities are often too small to be identified and displayed spatially at a larger scale. These communities also operate at a smaller scale, often along the major rivers like the St. John River and the Aroostook River, associated with the disturbance events along the rivers which prevents succession and shading (Blaney 2016 pers. Comm.). The pH at these sites also plays a notable role in the occurrence of these communities, with calcareous rocks supporting rarer flora, especially in the case of limestone substrate (Blaney 2016 pers. comm.).

Landscape Context Assessment Rock Outcrops: Very Good
The Landscape Context Index (LCI) for Rock Outcrops indicates that 86.7 % of these habitats score below 20 (NAAP methodology and data), which is considered very good. These habitats were assessed and mapped by using NBDNR Bedrock Geology maps, the Critical Occurrences map (Anderson et al. 2006 NAAP) and the Modeled Outcrop and Summit Habitats map (TNC 2005). These outcrops are frequently the result of volcanic mafic and felsic bedrock intrustions, which are more resistant than the surrounding, predominantly sedimentary bedrock (Zelazny 2007). Other outcrops of clastic lithology are also present within the area (Zelazny 2007).

Conditional Assessment Rock Outcrops: Unknown
Rock outcrops often form unique communities of rare vascular and non-vascular plants. Thirty-six of the priority species in the bioregion are found in this habitat type, all of which are vascular and non-vascular plants. While not well represented in the currently conserved landbase (only 4 % of them are found within permanently protected areas), these habitats are surrounded primarily by natural habitat (65.5 %), providing a buffer against disturbance. In addition, 45.6 % of Rock Outcrop habitat is very well connected to the natural landscape, making the dispersal and persistence of rare species more secure. Assessing rock outcrops is very difficult, as few of these habitats has been targeted in previous formal

research, therefore, these assessments are carried out mainly by spatial analyses. The unknown condition of these habitats show that a data gap is present, and more research in this area is needed.

Size Assessment Rock Outcrops: Very Good

The average patch size for Rock Outcrops is 12.9 hectares, with the smallest patch being less than one hectare and the largest 112.5 hectares. The critical threshold for this habitat is suggested at 12 hectares (Anderson et al. 2006), with 89.7% of the habitats meeting or exceeding this threshold. This suggests that this habitat is very good with respect to habitat patch size. However, it needs to be noted that many of the rare plant communities found in rock outcrops are too small for available spatial data to detect (Blaney 2016 Pers. Comm.). More accurate spatial data is needed for these habitats to give a more accurate representation of their condition, in addition to more accurate threshold indices, related to this specific region.

Overall Assessment Rock Outcrops: Unknown, landscape context Very good, Size Very good

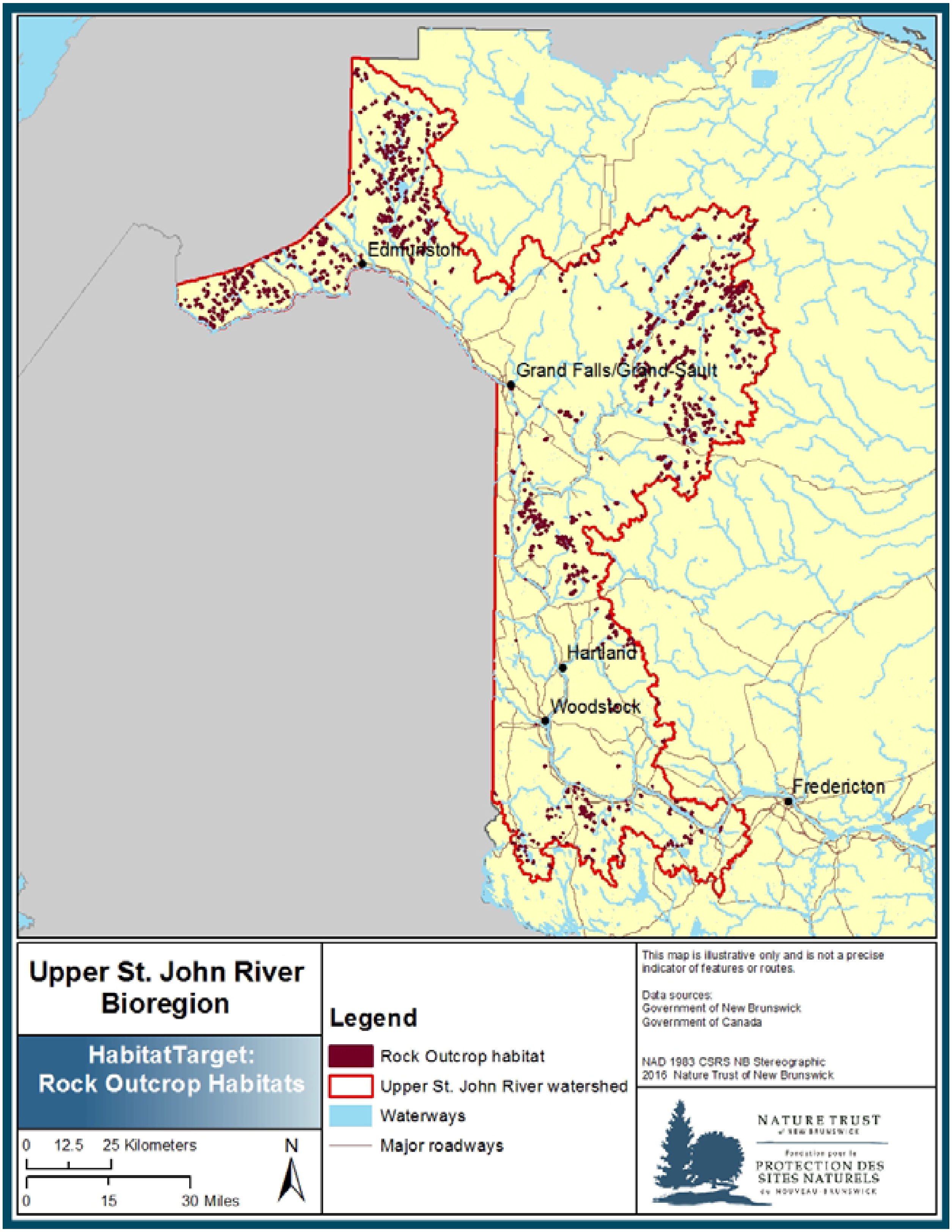

Fig. 10: Rock Outcrops in the Uppers St. John River Bioregion

4) Priority Habitat: Cliffs

Habitat Definition Cliffs

Cliffs are characterised as "precipitous faces that slough-off rock pieces and shed water, while collecting soil and nutrients at their bases", as per Anderson et al. (2006). These conditions create contrasting environments of dry, nutrient poor vertical surfaces of bedrock with nutrient rich, moist taluses on the slopes, which can lead to very interesting communities in both locations. Differences in underlying lithology may also create a greater diversity within these communities (Anderson et al. 2006).

Ecological Justification Cliffs:

Rivers carve out the landscape and help form some of these cliffs (**Fig. 11**), such is the case with the middle reaches of the Green River, the Madawaska River, and the St. François River. Here one can find deep incisions in the landscape sometimes reaching up to 200 metres in height. Though areas with cliffs are generally limited in New Brunswick, some cliff communities host rare plant species and provide suitable habitat for specialized fauna. Peregrine falcons use such cliffs as nesting habitat; although they are not currently known to nest in the bioregion, conserving potential habitat may allow them to do so in the future, as long as there is a sufficient and dependable food source available. Barn and cliff swallows will also nest in rocky cliff areas of the Bioregion, and bank swallows will nest in river banks and the sedimentary or unconsolidated layer on the top of a cliff, if it is thick enough. (Zelazny 2007). The calcareous cliffs at Sisson Gorge support communities of rare plants associated with more northern areas: elegant sedge (*Carex concinna*); glaucous meadow grass (*Poa glauca*); and seep leopardbane (*Arnica lonchophylla*), (Zelazny 2007). The calcareous cliffs between Wapske and Plaster Rock also support an assortment of other rare plant species (Zelazny 2007).

Landscape Context Assessment Cliffs: Very Good

The LCI for cliff habitat indicates that 75.5 % of the habitat is below 20 (NAAP data and methodology). Cliffs only comprise of 0.005 % of the total land base and support only 11 % of priority species. In addition, 75.5 % of these habitats are very well-connected to the natural landscape, potentially due to these habitats often being hard to access and away from developed areas, thus the context is more natural than the other habitats. The conserved cliff habitats are found primarily in the Mount Carleton Provincial Park in Restigouche County, and Blind Gully Brook PNA in Victoria County (Zelazny, 2007). Many of the cliff habitats in the Bioregion are located in areas where flowing water has eroded the landscape over many years, and along the boundaries where different bedrock lithologies converge and less erodible bedrock remains, creating cliff features.

Conditional Assessment Cliffs: Very Good

Twenty-nine of the bioregion's priority species[1] occur in this habitat, including the peregrine falcon which uses cliff habitat exclusively for nesting. In addition, 38.7 % of cliff habitats are found in permanently protected areas. The isolation of these habitats can also be seen in the 74.1 % of them being surrounded by natural habitat.

The above-mentioned measures only give a glimpse into a potential assessment of the condition of these habitats, as formal published research on cliff habitats in the Bioregion is scarce and hard to come by. This shows that like with Rock outcrops, the smaller localized habitats supporting unique communities are often underrepresented in the literature, presenting a large data gap. These smaller communities are frequently comprised of rare and uncommon species which are naturally disturbed regularly, thus creating habitats where succession of more competitive species is not possible, and as such maintain the unique communities (Blaney 2016 pers. Comm., Zelazny 2007).

[1] Note that species may be associated with multiple habitats.

Size Assessment Cliffs: Unknown
The size assessment on cliff habitats is relatively incomplete, as unique floral communities operate at a smaller scale than can be identified with spatial data at the bioregion scale, thus, size may not be the most appropriate assessment measure, since some more unique and rare communities' sizes fall below the Critical Threshold identified by Anderson et al. 2006. The critical threshold for this habitat is 10 hectares making only 56.1 % of the 146 patches recorded viable according to Anderson et al. 2006. The smallest patch is less than 1 hectare, and the largest 115 hectares, with the average patch size being 4.35 hectares. The critical threshold for this habitat is 10 hectares making only 56.1 % of the 146 patches recorded viable according to Anderson et al. 2006. However, as with Rock outcrops, insufficient spatial data and data on communities in this habitat is proving a significant data gap.

Overall Assessment Cliffs: Very Good (Size unknown)

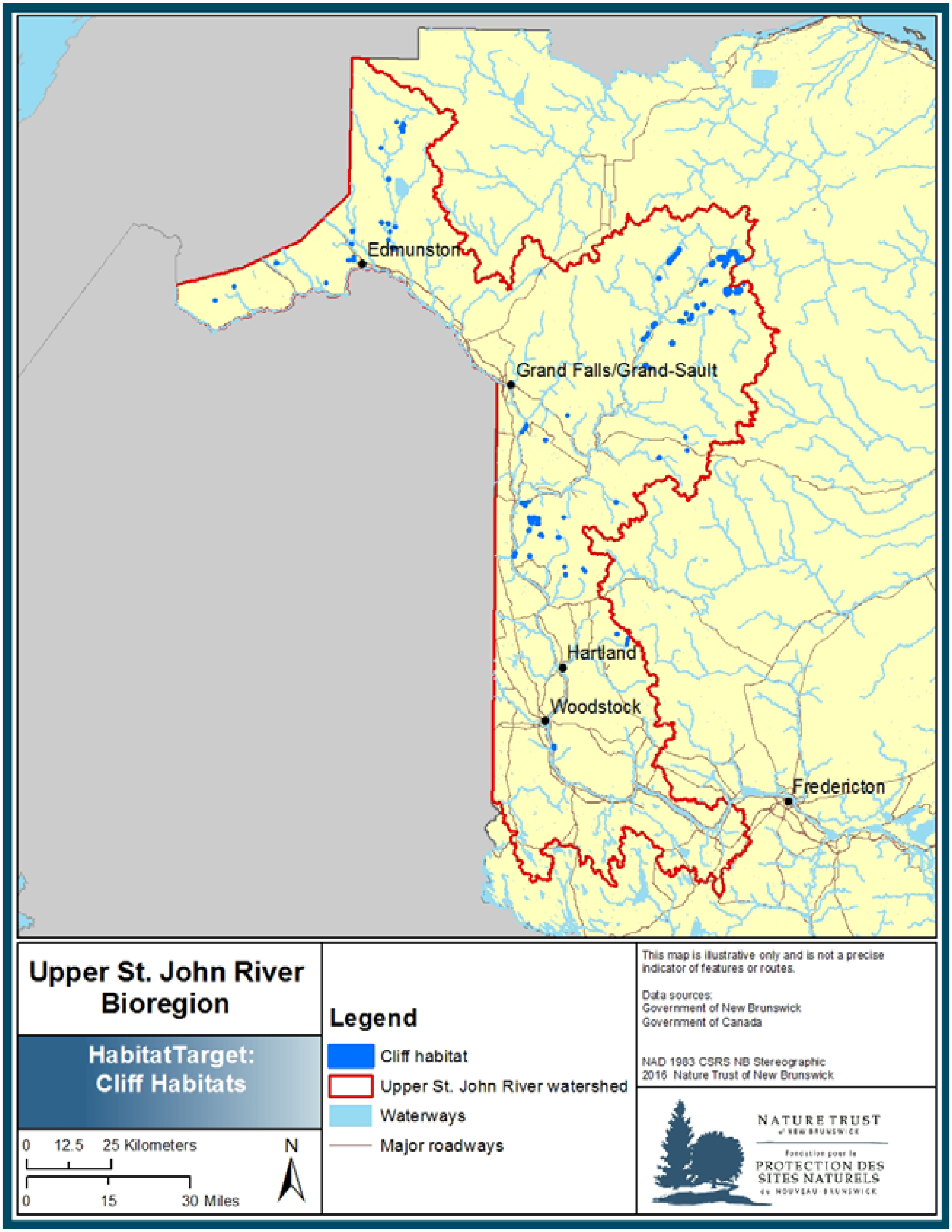

Fig. 11: Known cliff habitat in the Upper St. John River Bioregion

5) Priority Habitat: Acadian Forest Mosaic

Habitat Definition Acadian Forest Mosaic:
The Acadian Forest Mosaic refers to the diversity of forest types which occur within this bioregion. This includes old forest communities as defined by the New Brunswick Department of Natural Resources (NBDNR 2011), rare and unique forest communities identified by the ACCDC and other partners, forest of high conservation value as identified by NBDNR (presence of rare species, forest of exceptional quality) and NAAP delineated forest habitats and nested habitats within forests (e.g. sheltered forest coves and summits; **Fig. 12**). Note: NBDNR is now known as the New Brunswick Department of Energy and Resource Development (NB DERD).

Ecological Justification Acadian Forest Mosaic:
The Acadian forest type is considered by the World Wildlife Fund to be one of the most endangered forest types in North America (Davis et al. 1999). This forest type is seen as the intermediate between boreal forest in the North and temperate forests in the South and incorporating a suite of species from both, thus creating a very biodiverse system (Trombulak et al. 2008; Davis et al. 1999). Historically, New Brunswick, including the USJR Bioregion, is thought to have been dominated by up to 85 % Acadian forest prior to European settlement, as indicated by pollen data analyses from various areas (Mosseler et al. 2003). Presently, less than 5 % of its original land base remains that has not been anthropogenically altered (Davis et al. 1999). It is believed that before the eighteenth century, much of the original occurrence of Acadian forest was old growth forest, all of which had begun to develop since the retreat of the ice from the last glaciation 10 000 years ago (Mosseler et al. 2003; Anderson 2006; DeWolfe et al. 2005).

Approximately thirty tree species are native to the Acadian forests (Davis et al. 2005); a distinguishing feature of the Acadian forest is the prominent occurrence of red spruce, a long-lived, shade tolerant species that is adapted to high atmospheric moisture (Mosseler et al. 2003). Another important feature of the Acadian forest's late successional forest types is the association of the same red spruce with Eastern hemlock, Eastern white pine, balsam fir, and yellow birch (Mosseler et al. 2003; DeWolfe et al. 2005). Old growth Acadian forest is dominated by long-lived, shade tolerant trees that regenerate naturally in the absence of large-scale catastrophic disturbances like glaciation (Mosseler et al. 2003). Prior to European settlement, 50 % of this forest would have been considered old growth forest (average dominant tree age of 150 years) and more than 80 % would have been considered mature forest (average tree age of 80 years or more), (Mosseler et al. 2003; DeWolfe et al. 2005). By 2004 mature forest on Crown lands had declined to 45% of the forested area (DeWolfe et al. 2005).

Old growth forest ecosystems are comprised of multi-successional and multi-aged trees, standing dead (snags), as well as fall trees and associated understory species that grow under the conditions that have developed over time. These forests have a multi-layered canopy, and typically contain shade tolerant, late successional species (Mosseler et al. 2003). Old growth forests are important for supporting species uniquely dependent on these habitats. Bird species dependent on old growth forest include American three-toed woodpecker, blackburnian warbler, Canada warbler, chimney swift, white-breasted nuthatch, and Northern goshawk (Environment Canada 2013a). Other terrestrial species with affinities for old growth or mature forests are the Canada lynx, American marten, and Northern flying squirrel (Anderson 2006; Hargis et al. 1999; Mosseler et al. 2003). The pileated woodpecker has often been used as an indicator species for old growth forest areas, since they use snags, dead standing trees and logs for nesting, roosting and foraging (Lemaitre and Villard 2005). As such an indicator, this species can be a very useful conservation tool.

Landscape Context Assessment Acadian Forest Mosaic: **Fair**

The connectedness for the Acadian Forest Mosaic was calculated at 33.8 %. That is considered well-connected to the natural landscape, with 60.3 % mature/old forest being imbedded in natural habitat (note that plantations and ruderal forest were not considered natural), which is considered good. High road density and land clearing (forest harvesting) in the bioregion have created a more fragmented forest. These roads, in addition to the activities of agriculture and forestry, have the greatest impact on the landscape, however, it needs to be noted that the connectedness spatial model considers plantations as natural habitat, thus making it appear that a much larger proportion is naturally connected than is the case in reality. Spatial data indicates that the forested area in the USJR Bioregion is significantly fragmented with the highest percentage of anthropogenic development occurring closest to the river margins where potato farming and urban development dominate. Forestry practices which rely on clear cutting and other intensive silvicultural practices have also reduced the forest to a network of small, fragmented patches. Of note is the incomplete nature of the land cover spatial dataset, with large patches of industry freehold data unavailable for this assessment. Therefore, the landscape assessments are not a 100 % accurate representation of true habitat connectivity.

Conditional Assessment Acadian Forest Mosaic: Poor

The Acadian Forest Mosaic is highly altered, with anthropogenic influences having made a significant impact on the overall condition of the forest, and its viability for supporting biodiversity. Of the 1,05 2,927.5 hectares of forest for which data is available, 220,094 hectares (20.9 %) is considered mature and over-mature forest, which is an essential aspect for the continued sustainability of the forest. However, only 3.5 % of the forest habitat is included in permanently protected areas, making this a highly under-represented habitat in the bioregion.

Within the USJR Bioregion, 130 (49.6%) significant species use the various forest habitats (look at species-habitat matrix). Old forest communities provide habitat for a variety of federally listed species such as the Canada Warbler, Bicknell's thrush, and olive-sided flycatcher. Rare forest communities such as the Appalachian Hardwood Forest are home to a diversity of provincially-rare and uncommon plant, lichen, and bryophyte species, and forests located within calcareous areas support a variety of rare flora. It is critical that both unique and representative forest communities be protected to ensure the continued viability of the various species that depend on them. This also includes connectivity between forest patches, which is required for the long-term viability of biodiversity and ecosystem processes. Connectivity is therefore a crucial factor to consider when looking to conserve additional tracts of land.

Size Assessment Acadian Forest Mosaic: **Good**

From the available data, the largest patch of intact forest is 2,893 hectares and the smallest is less than one hectare in size, with the average patch size being 11 hectares. This average patch size is well under the minimum patch size of 375 hectares as outlined by NB DERD to capture viable populations of old growth species (NBDNR 2012). However, only 16.9 % of the Mature/Old forest meet the criteria set by NB DERD.

Overall Assessment Acadian Forest Mosaic: Fair

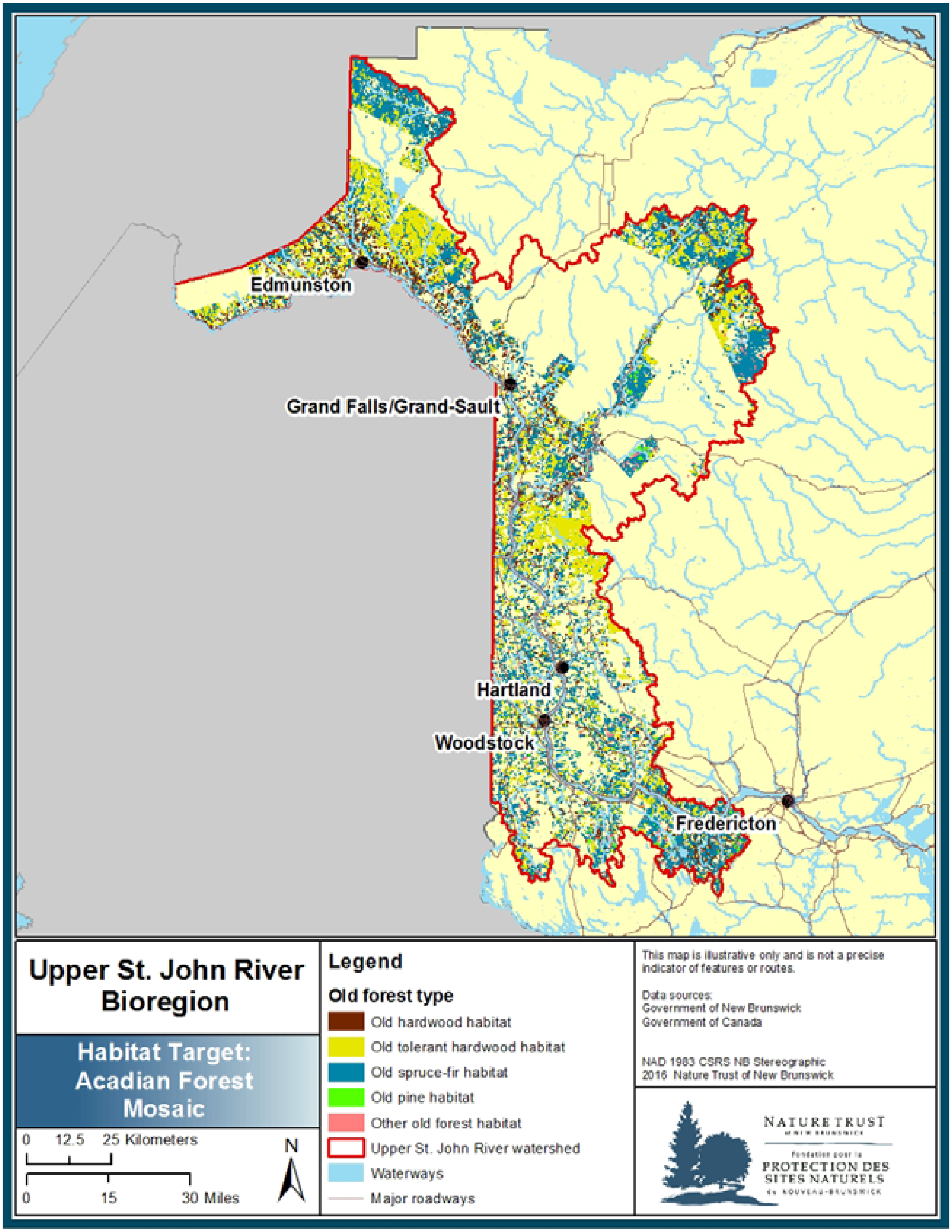

Fig. 12: Acadian Forest Mosaic in the Upper St. John River Bioregion

6) Appalachian Hardwood Forest

Habitat Definition Appalachian Hardwood Forest
Within the Acadian forest exists the Appalachian Hardwood Forest (AHF). This forest type is found predominately on well-drained, calcareous upland and alluvial bottomland soils in an area of Carleton and Victoria Counties having relatively moderate climate and a long growing season (MacDougal and Loo 1998). AHF supports a distinctly rich understory community associated with Butternut and American basswood, with a sugar maple, white ash, yellow birch, and American beech canopy.

Ecological Justification Appalachian Hardwood Forest:
The AHF is unique to the St. John River valley between Woodstock and Perth-Andover, with approximately 0.8 % of its pre-European coverage remaining (Betts 2000). The USJR is considered one of the major agricultural areas within New Brunswick, with the so-called potato belt overlapping with the exact range of the pre-settlement AHF. This is due to the warm climate, nutrient rich soils found on natural calcareous inputs, and easily workable alluvial bottomlands (MacDougal and Loo 1998). What remains of the AHF is threatened by modern agriculture and intensive forestry practices, however, very little is known about the current extent of this forest type and its persistence. This is a significant data gap that needs to be addressed.

Landscape Context Assessment Appalachian Hardwood Forest: Unknown

Size Assessment Appalachian Hardwood Forest: Unknown

Overall Assessment Appalachian Hardwood Forest: Unknown

7) Priority Habitat: Freshwater Wetlands

Habitat Definition Freshwater Wetlands:
Freshwater wetlands within the Bioregion include bogs, fens, marshes, swamps, shrub- and forest-dominated wetlands. Forested wetlands are the most common wetland type within the Bioregion and are mostly comprised of Black Spruce and/or Northern White Cedar (GIS determined). All freshwater wetlands, including critical occurrences from the NAAP (size >=20 ha; Anderson et al. 2006) are mapped in **Fig. 14**.

Ecological Justification Freshwater Wetlands:
Wetlands are seen as a transitional area between aquatic and terrestrial systems. In these areas, the water table is near or at the surface. In some cases, this may be associated with a shallow water covering (flooding) at a certain point during the growing season. These areas commonly have poorly drained soils and host water-tolerant vegetation (Department of Natural Resources, NB 2006), and are some of the most productive habitats in the world. Examples of their function include water filtering, the purification of pollutants and the stabilization of river shorelines. They are also critical to the survival of wildlife, including mammals, waterfowl, other birds, fish, plants and invertebrates (GNB). Many species including a large diversity of insects and myriad birds, such as rail species (sora, Virginia rail and yellow rail), black-crowned night herons and marsh wrens, to name a few. Amphibians, i.e. salamanders and frogs, are highly dependent on these systems, be it for breeding or otherwise (Anderson et al. 2006).

Wetlands in the USJR Bioregion are classified as freshwater wetlands, since they receive no influence from saltwater from the ocean; the region is characterised by an abundance of shrub wetlands and forested wetlands, both of which are commonly found along stream banks (Zelazny 2007). These two wetland habitats are the dominant wetland types throughout the bioregion, with freshwater marshes, fens and bogs becoming more abundant in the middle to lower reaches of the area (**Fig. 14**). Wet meadows also occur sporadically, often the result of beavers damming up watercourses with plant matter filling them in over time. A number of wetland areas are known to be used specifically by migratory birds, but they are also important breeding areas; indeed, such is the case for Williamstown Lake (Zelazny 2007). It is important to note that sites are used by waterfowl and other birds like chimney swift, swallow species and shorebirds in migration or as feeding areas (Environment Canada 2013a). Other priority bird species that use wetlands as habitat include American bittern, Canada warbler, and Canada goose (Environment Canada 2013a). The USJR bioregion's wetlands are also host to several other priority faunal species such as wood turtle, snapping turtle, and alewife floater (*Anodonta implicata*).

With regards to flora, rare plant species are often found within wetlands or along wetland edges or wetland-associated transitional areas. For example, the Northern bog aster (*Symphyotrichum boreale*) occurs at the Lynch Brook cedar swamp (Zelazny 2007). Another cedar swamp at Burnt Hill Mountain hosts the very rare pale touch-me-not (*Impatiens pallida*) amongst other plants in its delicate understory (Zelazny 2007). The Shea Lake Nature Preserve protects an alkaline fen with various rare species, including the small round-leaved orchid (*Galearis rotundifolia*), lapland buttercup (*Ranunculus lapponicus*, S1) and the swamp fly honeysuckle (*Lonicera oblongifolia*, S2). This preserve is also hosts extensive stands of old growth white cedar, hemlock, and balsam fir (Zelazny 2007). Butternut and ironwood are found on poorly drained alluvial bottomlands in the Meductic Ecodistrict, where white cedar occurs on poorly drained calcareous flatlands. Such an area in the region is Payson Lake. Williamstown Lake hosts red maple, white elm, and black ash (Zelazny 2007). This Ecodistrict is also known for the diversity of plants in its wetlands, including several significant orchid species, such as rose pogonia (*Pogonia ophioglossoides*) (Zelazny 2007).

Landscape Context Assessment Freshwater Wetlands: Poor
The degree of ecological connectedness across the landscape is used as a metric to assess the context of freshwater wetlands, the analysis indicates that 24.9 % of these habitats are considered well-connected. This habitat is impacted by forestry practices, industrial operations and agriculture, given that 16.5 % of wetlands fall within 100 meters of the agriculture systems. Of the wetlands in the bioregion, 11.2 % are within 30 meters of the road network, and 63.6 % within one kilometer of a road, this negatively influences the connectedness between wetland systems. The array of wetland types in the bioregion include Forested wetland, Shrub wetland, Freshwater marsh, Fen, Bog and aquatic bed, while the forested wetland type clearly dominates the wetland landscape in the bioregion.

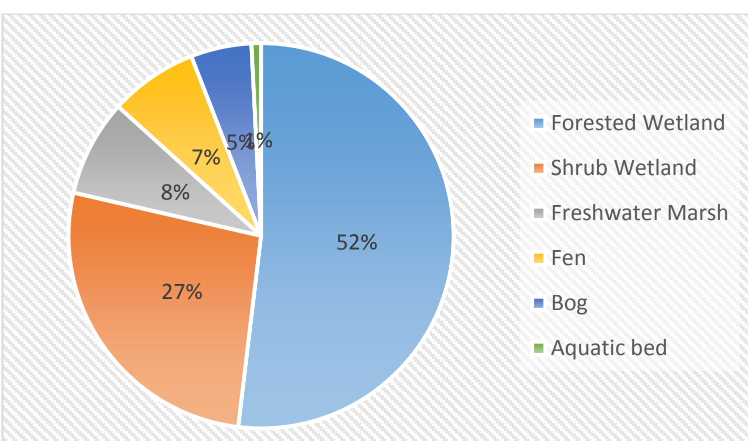

Fig. 13: Freshwater Wetland habitat distribution in the Upper St. John River Bioregion

Conditional Assessment Freshwater Wetlands: Fair

Permanently conserved lands protect 8 % of wetlands in the Bioregion. Also, note that 83 % of priority species in the Bioregion can occur in wetlands, of which most (62 %) occur in forested wetlands. Invasive species are a significant concern in wetland areas as these areas are particularly sensitive to invasion from species including purple loosestrife, glossy buckthorn, and reed canary grass. Currently a Watercourse and Wetland Alteration permit from the New Brunswick Department of Environment and Local Government is required to do any work within 30 meters of a designated wetland, which is a regulation introduced to curb the impact on these systems. Any work within 30 meters of a wetland larger than one hectare in size needs to be accompanied by an assessment by a professional involving the function and potential negative impacts associated with the works, which needs to be submitted with the permit application. In addition to this, a Wetland Compensation Plan is required for any loss of wetland habitat with the clause of a compensation of 2:1 for every hectare of wetland lost (NB DELG 2012). Moreover, any work within 30 meters of a provincially significant wetland (PSW) is prohibited (NB DELG 2012). Provincially Significant Wetlands make up only 0.0025 % of this habitat in the bioregion, therefor these permits are of particular importance. Wetlands are largely embedded in natural habitat with 71.5 % occurring within a 200-meter buffer, which contributes to intact functioning and connectivity for this habitat (Jones et al. 1988).

Size Assessment Freshwater Wetlands: Good

The critical threshold for wetland size is >= 20ha (Anderson et al. 2006). In the USJR bioregion, only 13.7 % of the wetlands fall within this category. The range of sizes varying between less than 1 hectares to 236 hectares, with an average patch size of 3.7 hectares. The total wetland area is 66,764 hectares, comprising 0.5 % of the bioregion's habitat. Wetland complexes are concentrated in the far southern areas of the bioregion, often occurring on igneous bedrock substrate. Complexes are of great importance as this creates continuity within the wetland landscape, creating dispersal corridors for wetland-obligate species and migratory species (Environment Canada 2013). This bioregion has a noticeably small number of large wetland complexes compared to the lower reaches of the St. John River, due to regional topography, lithology, and other natural factors.

Overall Assessment Freshwater Wetlands: Fair

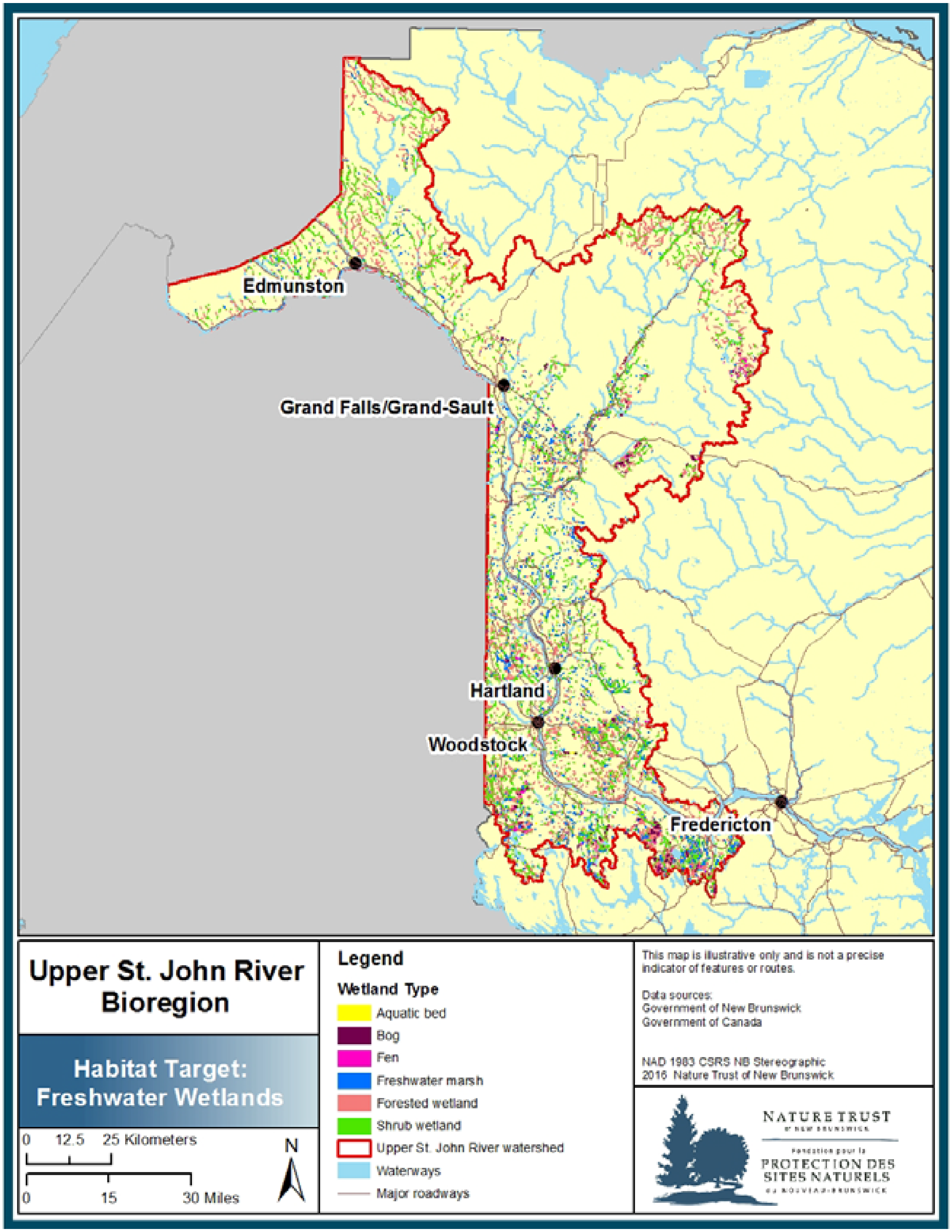

Fig. 14: Freshwater Wetlands in the Upper St. John River Bioregion

8) Priority Habitat: Riparian and Aquatic Systems

Habitat Definition Riparian and Aquatic Systems:

Riparian systems are characterized as aquatic ecosystems with their adjacent uplands (riversides and floodplains) and the gradient between the two (Gregory et al., 1991). A variety of habitats occur within riparian systems, where upland and floodplain forests, herbaceous and woody wetlands, sandbars and oligotrophic-eutrophic freshwater systems interact to form a complex ecosystem rich in biodiversity. The habitat definition for riparian systems within the Bioregion includes all NAAP critical floodplain occurrences (size >= 40 ha; Anderson et al., 2006) as well as all rivers and streams up to 275 metres, and 200 metres of riparian habitat surrounding lakes (Jones et al. 1988). All riparian systems are mapped in **Fig. 15**. Lakes and flowing water aquatic systems (i.e. rivers and streams) are included in this description.

Riparian systems

Apart from marine ecosystems, riparian systems are seen as the most diverse systems on earth and one the most dynamic areas in any landscape (Naiman et al. 1993). In the USJR Bioregion, riparian systems are hydrologically and physically influenced by annual ice scour and spring melt events. These particular conditions provide important habitat for rare fauna and flora, riparian systems for example, include floodplains which provide rich food sources for fish and other aquatic species (Anderson et al. 2006). It is also crucial to note that the largest impact of hydroelectric dams in the USJR Bioregion is likely on riparian systems.

Aquatic systems

Rivers and streams are the lotic or flowing water courses that support fivers riparian vegetation and faunal communities in most ecosystems. First order streams are the point of origin of all river systems, and the riparian vegetation surrounding these streams provides the initial organic input to these systems. Lakes are the inland water bodies surrounded by land, with a freshwater input from the surrounding area. They are formed on substrate having poor drainage, sometimes even on bare bedrock (Longman 2003). In the case of larger lakes and waterbodies, these can even occasionally affect the climate of the surrounding area by releasing stored heat during the winter, locally increasing the amount of 'frost free days' in winter (Bates et al. 1993). Lakes can also support a great variety of species in different ways. Fish and waterfowl species are some of the first to come to mind when one thinks of lakes; however, zooplankton, water dependent insects, herptofauna (reptiles and amphibians) and plants are all supported by these waterbodies as well (Kidd et al. 2011; LAMP 2013). Notable lake systems in the Bioregion include Williamstown Lake and those in the Trousers Lake-Long Lake region of the Tobique River watershed.

Ecological Justification Riparian and Aquatic Systems:

Riparian

Within these broad areas, a large variety of habitats are found, including floodplain and upland forests, grasslands, herbaceous wetlands, and oligotrophic-eutrophic freshwater systems. All of these habitats interact to form a rich ecosystem with complex layers of interdependence (Anderson et al. 2006). Riparian zones are particularly sensitive to environmental change and hydrological cycle variations. Each of the habitats in the riparian zone support a multitude of species; together they also function as a filter between terrestrial and aquatic systems, and serve as a migration and dispersal route for a variety of organisms (Naiman and Decamps 1997). For this project, riparian systems in New Brunswick include all rivers as delineated by a 275-metre buffer (Wood turtle habitat requirement, source: NBDNR), including their respective headwaters.

Riparian zone habitats are vital feeding areas for many species, as they provide important breeding grounds for many species, such as the Wood turtle, the Wood frog and other herptofauna. Riparian zones also create a rich habitat for flood-tolerant tree species such as silver maple, American elm, black ash, and various other undergrowth species like ostrich fern and wood nettle (Anderson *et al.* 2006). One of the larger, undisturbed floodplains can be found at the southern tip of Platin de St-Basile; this site, as well as Iroquois, especially near the water treatment plant at the latter site, are well-known migratory bird locations (Zelazny 2007). In the Aukpaque Ecodistrict, Quisibis Island and the mouth of the Green River are also sites where migratory waterfowl congregate in the spring and fall season (Zelazny 2007). White ash and Red oak trees can be found on the shores of the St. John River (Zelazny 2007). Quisibis Island also supports a population of bluestem (*Schizachyrium scoparium*) and Richardson's muhlenbergia (*Muhlenbergia richardsonis*) (Zelazny 2007).

In the Meductic Ecodistrict, showy orchis (*Galearis spectabilis*) can be found along on the banks of the Meduxnekeag River sometimes accompanied by yellow lady's-slipper (*Cypripedium calceolus var. makasin*, Northern maidenhair fern (*Adiantum pedatum*) and Goldie's woodfern (*Dryopteris goldiana*). Ten-rayed sunflower (*Helianthus decapetalus*) and sweet viburnum (*Viburnum lentago*) can be found on the shores and bottomlands in the same ecodistrict (Zelazny 2007). Near Dow Settlement in the Cranberry Ecodistrict, the Shogomok Stream hosts the rare riverweed (*Podostemum ceratophyllum)* which occurs just below the waterline (Zelazny 2007).

The rich riparian systems provide habitat for a variety of federally-listed species, including mussels, turtles, riparian specific flora, and anadromous and catadromous fish. Riparian habitat in the bioregion covers 747,962.6 hectares, 38.1 % of which has been anthropogenically altered and fragmented by development, agriculture, and forestry associated practices. This habitat also helps support 144 (55 %) of the priority species known from the bioregion.

Aquatic systems
The USJR bioregion has a variety of lakes all along the main river reach and its tributaries. For example, it hosts States Lake in the Kejwik Ecodistrict, which at 50 metres in depth is the deepest lake in the province, and Ayers Lake in the Nackawic Ecodistrict; both of these lakes support a self-sustaining population of Lake trout, two of only a dozen spots in New Brunswick to do so (Zelazny 2007). Prominent lakes in the Central Uplands Ecoregion include Glasier and Baker lakes on the panhandle and First, Second and Third Lakes on the Green River. Glasier Lake Ecological Reserve also hosts an old growth community of Balsam fir, American elm and Trembling aspen.

Loon Lake is a diverse, rich, boggy site that features rare plants like Mountain valerian, livid sedge and a small population of round-leaved orchids at a mossy site close to the lake (Zelazny 2007). In the same ecoregion, the artificial Sisson Branch reservoir has also become a refuge for Great blue heron and Osprey. At Siegas Lake, the American black duck, Blue-winged teal and Common merganser have been known to visit the area (Zelazny 2007).

The Valley Lowlands Ecoregion has numerous lakes including First Eel Lake, which supports breeding populations of Common loons, Bald eagle, Osprey, Wood duck, Pied-billed grebe. The surrounding woods also harbour the very rare Scarlet tanager (Zelazny 2007). The watery, calcareous soil of Williamstown Lake hosts cedar stands, but also provides habitat for various waterfowl species. Ketch Lake's surrounding fen supports a very rare albino version of the Small purple-fringed orchid (*Platanthera psychodes*), in addition to the rare Clayton's copper butterfly (*Lycaena dorcas claytoni*, S1) that can be seen in the area (Zelazny 2007). The Robbin's spikerush (*Eleocharis robbinsii*) is known from Scotch Lake, one of just a handful of sites in the province for this rare plant.

The rivers, streams and lakes in the USJR bioregion of great significance from an ecological perspective and contribute to the diversity and uniqueness of the bioregion. The first major ecological report of this watershed since 1975 was completed in 2011, entitled "The Saint John River: A State of the Environment Report", and was completed by the Canadian Rivers Institute. In addition, the Atlantic Salmon Federation has compiled multiple reports on the aquatic systems in New Brunswick, including this bioregion.

Landscape Context Assessment Riparian and Aquatic Systems: Fair

Analyses of riparian habitats in the bioregion show that 55.1 % of it is well-connected to the surrounding landscape, with 57.9 % of the habitat being surrounded by natural habitat. However, the WWF has assessed the St. John River as having a Poor environmental flow due to the number of dams and barriers in the river system.

Historically, riparian areas of the St. John River system have been subjected to a multitude of disturbances, from intensive forestry, agriculture, and resource extraction, to housing development and recreational activities (Gesner 1846). Even though the regulated buffer area (30 meters) is enforced on private and public land, past land conversion activities have left a lasting impact in certain areas. For example, land conversion to agricultural use has caused erosion and sedimentation all along the length of St. John River, however, the extent of these impacts is not well known. In addition, the multitude of the barriers created by road crossings and other aquatic barriers can be seen in **Fig. 25**. The condition of these structures is presently unknown, and this presents a significant data gap that should be addressed to accurately describe aquatic habitat viability. Roads have also been constructed in close proximity to the St. John River and its tributaries, often within the active riparian zone, leading to habitat fragmentation in addition to habitat disturbance. Road building also increases the risk of invasive species colonization and recreation disturbance.

Conditional Assessment Riparian and Aquatic Systems: Poor

The condition of the Bioregion's riparian habitat is assessed by examining the percentage of the 275-meter riparian buffer area in natural cover. A total of 61.9 % of the riparian area has natural cover, of which 80 % is intact forest and wetland. Within this area of natural cover, 29 % is plantation and ruderal forest, which are often subject to intensive silvicultural practices including large-scale clear cuts and strip cuts. Agriculture is also very prevalent in the bioregion, and while these lands make up only 4.6 % of the riparian area, these heavily disturbed lands are often found on the rich alluvial soils close to the shorelines of major rivers and tributaries. A 2005 assessment of the threats to riparian flora along the main stem of the St. John River estimated that 42 % of the river's shoreline habitat is threatened by a diversity of land use activities including roads, gravel and soil extraction, garbage dumping, and housing development (Arnold 2005). The importance of this habitat is emphasized by the fact that 55 % of priority species occur here, although only 3.3 % of the habitat is permanently protected.

Size Assessment Riparian and Aquatic Systems: Unknown

The critical occurrence threshold for riparian habitats is 40 hectares (Anderson et al. 2006). Thirty seven percent of the riparian habitats meet this critical threshold. Riparian habitat makes up 747,962.6 hectares (25.9%) of the land cover in the bioregion, of which 59.2% is naturally vegetated. It needs to be noted that the riparian area includes other habitats, and is not excluded from the other habitat types mentioned. Considering that riparian habitat encompasses all habitats within 275 metres of a stream or river and 200 metres (Jones et al. 1988) of a lake or water body, it can therefore be said that it forms the largest of the habitats within the bioregion.

Overall Assessment Riparian and Aquatic Systems: Fair

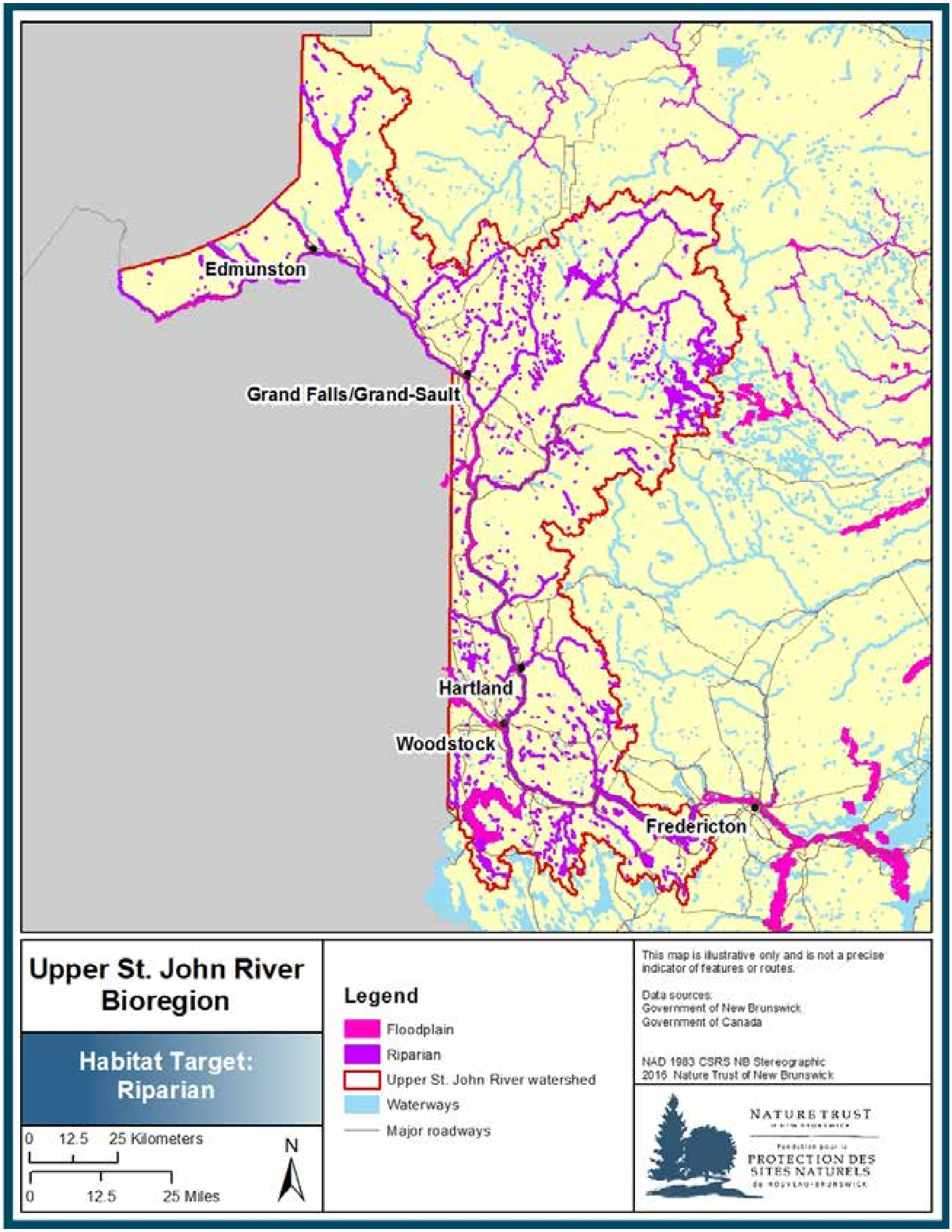

Fig. 15: Riparian Habitat of the St. John River's major tributaries in the Upper St. John River Bioregion

B. Threats

I. Current threats

Threats are the proximate activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of one or more of the identified priority habitats by impacting a habitat's viability and/or key ecological attributes (Anderson et al. 2006). Threats to the priority habitats were identified by the Upper St. John River Bioregion project team using past studies, local expert knowledge, and a review of published and grey literature. The list in this document should be interpreted as a comprehensive summary of known threats to the Bioregion's priority habitats. These threats were ranked based on their scope, severity, and irreversibility of damage to habitats over a 10-year period using the Conservation Action Planning Workbook (Low 2003), and were categorized using established international taxonomy (IUCN-CMP 2006), with local descriptions. **Table 7** provides a summary of the threats identified from the Upper St. John River Bioregion. The overall threat status for the Upper St. John River Bioregion has been determined to be *high*. The geographic extent of each identified threat is indicated, where known, in **Fig. 16-25**.

Table 7: Summary of threats to biodiversity in the Upper St. John River bioregion

Theats/ Targets	Freshwater Wetlands	Riparian & Aquatic systems	Acadian Forest	Appalachian Hardwood Forest	Grasslands / Agro-ecosystems	Beaches	Cliffs	Rock Outrcops	Overall threat Rank
1.1.1 Housing cottage development	MEDIUM	MEDIUM	MEDIUM	UNKNOWN		MEDIUM	UNKNOWN	UNKNOWN	MEDIUM
2.1.1 Annual and perennial non-timber crops	LOW	LOW	MEDIUM	UNKNOWN					LOW
2.1.2 Incompatible agricultural					HIGH				MEDIUM
2.2.1 Wood and Pulp plantations	LOW	LOW	LOW	UNKNOWN			UNKNOWN	UNKNOWN	LOW
3.2.1 Mining and quarrying	MEDIUM	MEDIUM	MEDIUM	UNKNOWN		MEDIUM	MEDIUM	MEDIUM	MEDIUM
4.1.1 Road fragmentation	MEDIUM	MEDIUM	MEDIUM	UNKNOWN	VERY HIGH				MEDIUM
5.3.1 Incompatible forestry	HIGH	MEDIUM	MEDIUM	UNKNOWN			LOW	LOW	MEDIUM
6.1.1 Recreational Activities	LOW	LOW	LOW	UNKNOWN		LOW			LOW
7.2.1 Dams and other Aqautic barriers	LOW	HIGH				LOW			MEDIUM
8.1.1 Invasive aquatic species: Fish		MEDIUM							LOW
8.1.2 Invasive terrestrial species: Plants	LOW	LOW	LOW	UNKNOWN		LOW	LOW	LOW	MEDIUM
9.3.1 Agricultural effluents	LOW	LOW			HIGH				MEDIUM
9.3.2 Forestry effluents	LOW	LOW	LOW	UNKNOWN					LOW
Threat status for Target and Project	MEDIUM	HIGH	MEDIUM	UNKNOWN	HIGH	MEDIUM	LOW	LOW	HIGH

1.1.1 Housing and urban areas (Threat status: Medium)

The population of New Brunswick has grown relatively slowly over the last 30 years (696,403 in 1981 vs 751,171 in 2011 (Statistics Canada 2011 Census of Population). Nevertheless, there has been an important shift in population patterns during this period. As is the case in much of the world, the population in this province is becoming increasingly urban-centred. Although this phenomenon involves population migration to the three largest urban centres in the province, none of them are in the USJR bioregion and it could be argued that the pattern in this bioregion is rather one of population decline. The main urban centre of the bioregion is Edmundston, with 21,903 people in the agglomeration, as per the Statistics Canada 2011 Census of Population (Statistics Canada 2012). It includes the municipalities of Edmundston, Saint-Joseph, Saint-Jacques, Rivière-Verte, Saint-Basile, Saint-Hilaire, St. Basile and St. Hilaire. Indeed, the population of Edmundston agglomeration has actually decreased by 2.5 % since 2006. Consequently, it may seem like increasing residential and cottage development associated with changing population patterns likely constitute a medium threat to habitat conservation priorities in the Upper St. John River bioregion at this time.

In spite of this negative population trend, the majority of the population in New Brunswick and the Upper St. John River Bioregion is concentrated along major river systems, largely due to historical settlement patterns (**Fig. 16**). As the largest river in the province and the second largest in Eastern Canada, the St. John River itself has a long history of human presence on its shores (Kidd et al. 2011). As a consequence, the riparian systems are threatened by development along inland water bodies; these tend to be linear, extending along the shoreline and interrupting the natural connections between aquatic environments and their adjacent terrestrial uplands. Specific activities associated with housing, cottage, and rural developments in the USJR bioregion have the potential to negatively impact the riparian/aquatic species at risk in a number of ways, the most obvious of which is the direct loss and degradation of critical habitat.

Clearing land for housing, bringing with it impervious surfaces, can lead to permanent changes in the natural environment, for example when forest or wetland habitats are altered or left fragmented for extended periods of time (Wang et al. 2011). Such an extreme change of natural conditions eliminates natural species and vegetation, an impact which is practically irreversible (Wang et al. 2011). Urban development can also lead to an increase of invasive and non-native species, decrease of forest cover, and a loss of native vegetation. Additionally, it also influences water run-off, and nutrient and sediment movement in the water (Alberti et al. 2003). When ecosystem functioning is altered, the need to substitute these functions is also created, to find costly engineered solutions to flood control, water filtration, and air filtration, to prevent the further degradation of the natural and built environment.

The Human Footprint index, developed by the Wildlife Conservation Society (Woolmer 2008), is a measure of the extent and relative intensity of human influence on terrestrial ecosystems at a resolution of 90 metres using best available datasets on human settlement (i.e., population density, dwelling density, urban areas), access (e.g., roads, rail lines), landscape transformation (e.g., landuse / landcover, dams, mines, watersheds), and electrical power infrastructure (i.e., utility corridors). Each 90-metre grid cell is attributed with a Human Footprint score between 0 and 100, where 0 represents no human influence and 100 represents maximum human influence at that location (**Fig. 17**). The reader will observe in **Fig. 17** that development is focused around the St. John River, especially around the towns of Woodstock, Grand Falls, and Edmundston.

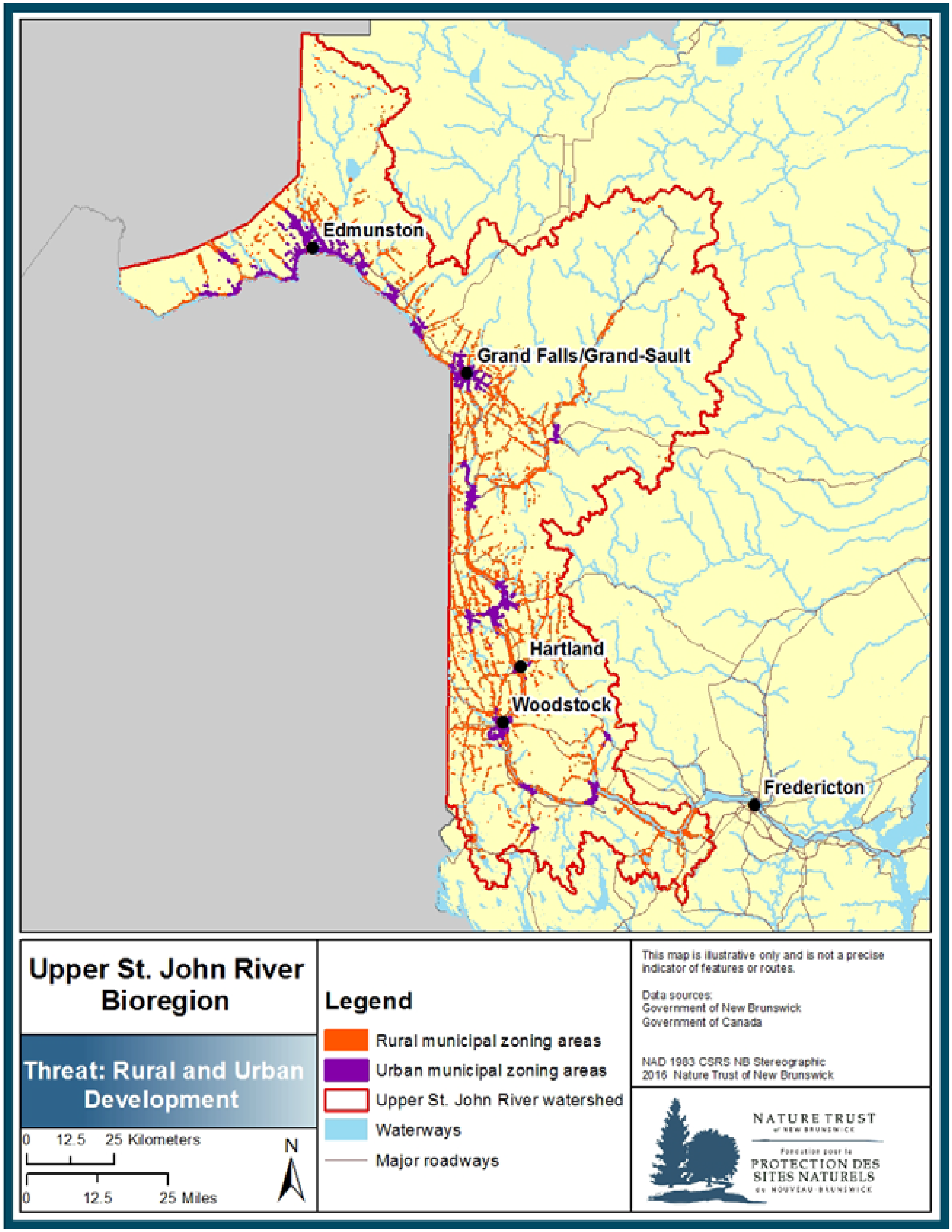

Fig. 16: Rural and Urban Developmental threats in the Upper St. John River Bioregion

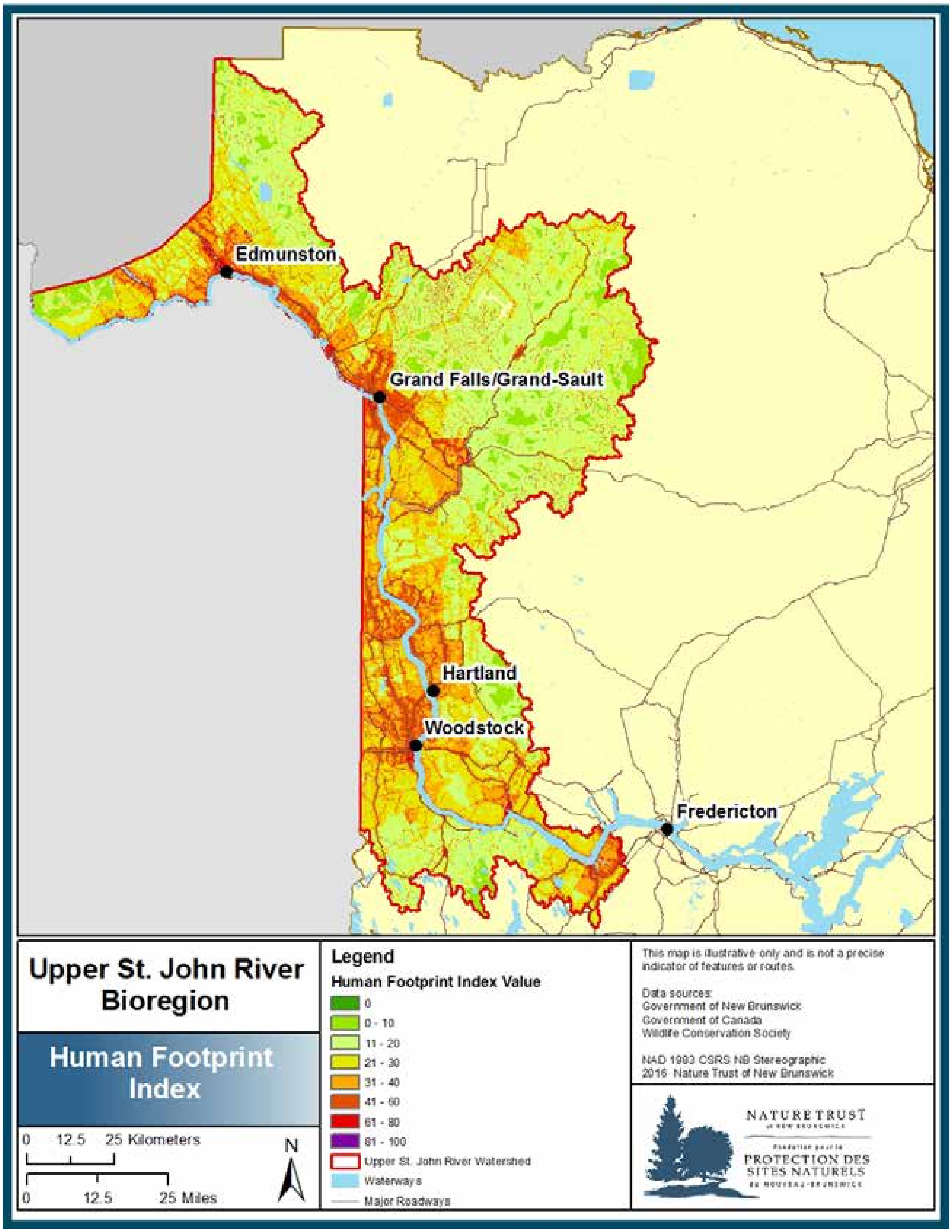

Fig. 17: Human Footprint Index for the Upper St. John River Bioregion

2.1.1 Annual and Perennial Non-timber Crops (Threat status: Low) & 2.1.2 Incompatible agricultural practices (Threat Status: Medium)

One of the most significant economic activities in the upper St. John River region is farming, directly involving roughly 6 % of the Bioregion's lanbase. In particular, around the towns of St. Leonard and Grand Falls and up- and downstream of Florenceville, one quarter of the land base has been converted to agriculture, and much of it is used for intensive potato production (Zelazny 2007). This process of land alteration has been occurring for a considerable time, in fact by 1900, most of the hardwood stands west of the St. John River between the Meduxnekeag and the Aroostook Rivers had already been cleared and replaced with agricultural land (Clayden 1994).

Agriculture has had and continues to have significant impact on the USJR Bioregion, see **Fig. 18**. Much of the bioregion forms part of what is known as the New Brunswick "potato belt", which accounts for almost 14 % of Canada's potato production (Agriculture and Agri-Food Canada 2015). New Brunswick is the second largest exporter of fresh and seed potatoes of the Canadian provinces (Agriculture and Agri-Food Canada 2015).

A major concern is that the potato-growing region is prone to some of the most serious water runoff and runoff-induced soil erosion, especially because row potatoes crops are planted in hilly areas with high levels of precipitation (Agriculture and Agri-Food Canada 2014). Without being protected, soil losses can amount to over 20 tonnes per hectare over a year (Agriculture and Agri-Food Canada 2014). The erosion of agricultural soils also leads to excessive amounts of sediment and nutrients entering surface waters (Xing et al. 2012). This increase in sediment and nutrient pollution leads to the degradation of fish spawning habitat, declines in water quality, oxygen availability and food resources for many species that are part of the aquatic food chain, all of which can cause a decline of fish and other species populations (WWF 2014). Sedimentation in the river also magnifies the impacts of eutrophication by lowering the dissolved oxygen level even further, changing the habitat even more. In addition to run-off, point source pollution is covered in 9.3.1.

Agricultural Best Management Practices (BMPs) have been created for addressing the impacts from excessive run-off and soil erosion, fore example, the creation of grassy waterways and diversion terraces, which slow water run-off and water infiltration (Agriculture and Agri-Food Canada 2014; Xing et al. 2012). Increasing buffer areas around fields can help reduce effects on waterways, especially near riparian areas and wetlands, where increased sedimentation can greatly impact fish and aquatic invertebrate populations (Skagen et al. 2008).

Incompatible agricultural practices associated with grassland-dependent bird species are also an area of concern for conservation in this bioregion. Although the current extent of grassland habitats is limited to mainly agricultural areas in this bioregion, these bird species are still dependent on these anthropogenically-created ecosystems. Two main groups of birds are dependent on these areas, grassland nesting birds and aerial insectivores, and impacts on these bird groups include the mowing or haying of fields during the breeding season of grassland-obligate nest species, like Bobolink. Mowing or haying fields before the middle of July can severely impact the survival of the young of this species and other grassland bird species (COSEWIC 2010c). Additionally, active management of large-scale agriculture can alter local and regional insect communities, reducing food sources for insectivorous bird groups (spraying, lack of habitat diversity etc).

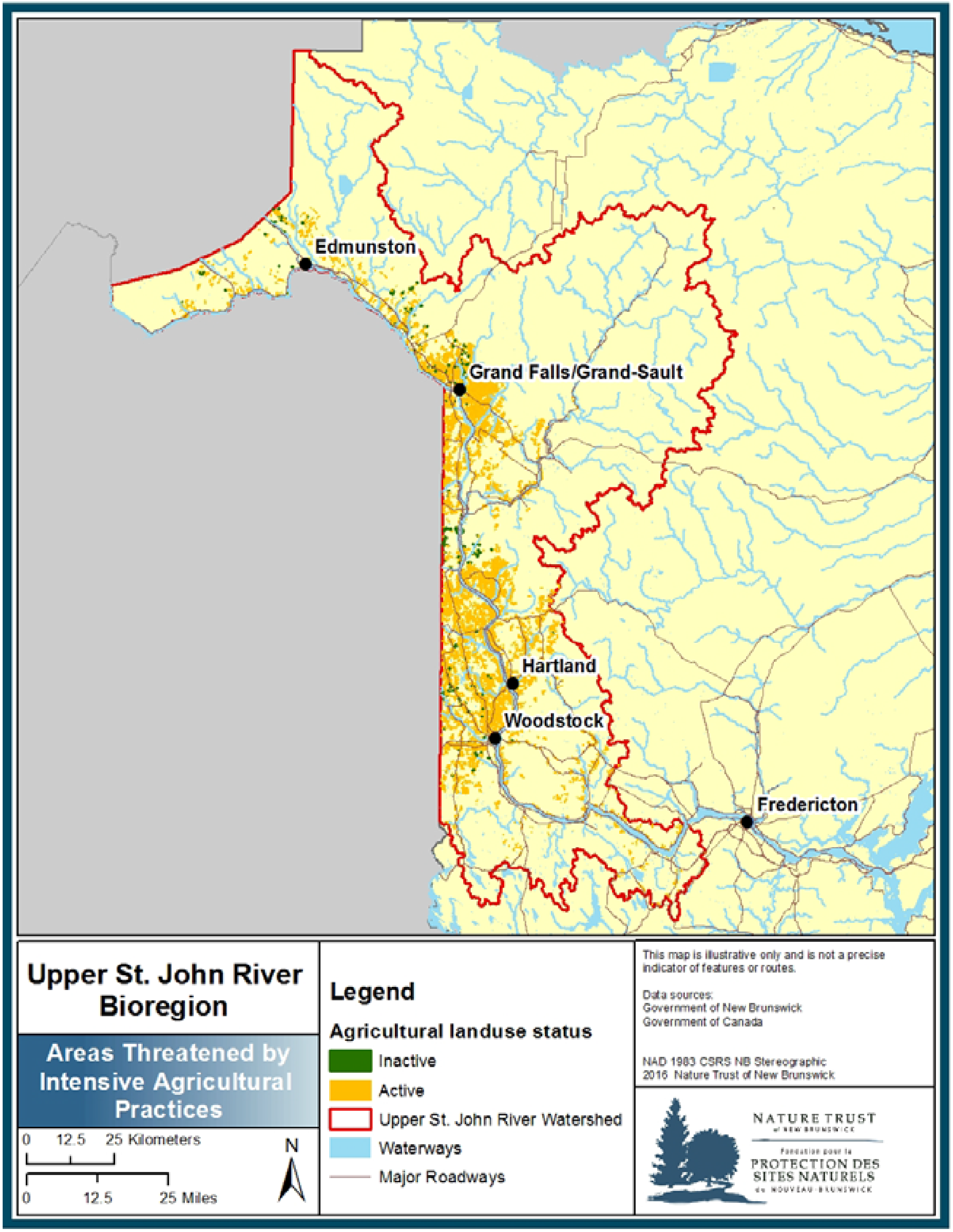

Fig. 18: Agricultural threats in the Upper St. John River Bioregion

2.2.1 Wood and Pulp Plantations (Threat Status: Low)

This threat can be directly associated with the *logging and wood harvesting – incompatible forestry practices* threat (5.3.1.). A large portion of the bioregion's hardwood and mixed forest has been cleared for agricultural purposes (see 2.1.2.), with approximately 68 000ha in plantations (TNC 2005), currently, only 1 to 5 % of the province's forest cover is dominated by trees older than 100 years (Mosseler et al. 2003). New Brunswick is highly dependent on the forestry industry, which includes pulp and paper, timber, and other wood products, for revenue and employment.

In general, forest plantations consist of even-aged areas with a lesser diversity than natural Acadian forest, these are planted or regenerated after clear-cuts, of selected shade-intolerant, fast-growing softwood species that provide abundant softwood fiber for pulp mills. Native tree species used include jack pine, and black spruce, with smaller numbers of white spruce, red spruce, Norway spruce, white pine and red pine, as well as balsam fir for the Christmas tree industry (Wuest and Betts 2010).

Plantations have been shown to have a negative impact on species richness and diversity, when the habitat is made more homogenous with fewer tree species, which in turn has fewer species associated with it overall (Waldick et al. 1999). Fore example, plantations generally support about 10 % hardwood species, most of which are intolerant hardwoods, as opposed to the 20 % naturally present in the Acadian forest, which includes tolerant hardwoods (Betts et al. 2005). There is further evidence that forest species biodiversity is negatively influenced by plantations at stand level in birds (Parker et al. 1994), bryophytes (Ross-Davis and Frego 2002), herbaceous plants (Ramovs and Roberts 2003) and structural attributes (standing dead wood, snags) on which other species depend (Freedman et al. 1994). This reduced diversity may also lead to a broader susceptibility to disease and infestations.

As a by-product of the wood and pulp plantations, effluent from pulp mills entering waterways has been shown to increase in-stream nutrient levels leading to a rise in algae populations, which can in turn cause changes in aquatic species assemblage structure and community composition; this is visible in the significant changes in the taxonomic composition of benthic invertebrates (Culp et al. 2003). The increase of these species can cause a shift in the balance of the natural ecosystem, with cascading impacts through the trophic levels. These species changes can impact fish populations such as, including slimy sculpin, fathead minnow and a few others; species surveys indicate an increase in individual size below-stream of where these effluents are added to the streams (Culp et al. 2003). Although this may not be a direct detriment to the immediate system, any severe change in population and organism size can affect the ecosystem at a greater level, changing the associated species' composition and ecosystem function as a result. Upsetting the community balance of freshwater systems can impact the quality of drinking water, and the survival of species dependent on the system.

3.2.1 Mining and Quarrying (Threat Status: Medium)

Mining in the USJR bioregion is not currently a large industry. Extraction activities (**Fig. 19-20**) in the region center primarily on antimony, base metals, manganese, gypsum, lime, and marl. Very few of these are active at present, although lime, gypsum, and marl extractions are periodically operational, dependent on commercial demand.

The antimony mine in the Lake George area is of conservation concern, since antimony shares several properties with arsenic with regards to toxicity. (Murciego et al. 2007). However, studies have shown that although it can be a major pollutant, it rarely makes its way into ground water and predominantly stays in the surface soil layers (Flynn et al. 2003). The impact of the end-product may not be the main concern with regards to this mining activity, but rather the process of extraction and the smelting by-products in the form of rock dumps, tailings, and slag. There are a few claims for this and other minerals that are still active in this bioregion, although very few if any, are currently being extracted.

Gypsum and lime were historically extracted from the Plaster Rock area, and although the resource is still available on site, albeit somewhat depleted, these activities have largely ceased or severely declined to limited extractions. Lime (Calcium carbonate, $CaCO_3$) from the areas is mostly used in for agricultural purposes, whereas gypsum (Calcium sulphate, $CaSO_4$) is used mainly for manufacturing drywall and other related products. The extraction of marl from lakes at Upper Kent in Carleton County is also sporadic and driven by demand by farmers in the area. Marl is extracted by using a dredge line to remove the substance from the lake. This extraction method destroys the habitat within the lake and potentially species directly associated with the mineral substrate in it; the Maplehurst Marl Pit, also in Carleton County, is known to support a number of rare plant species associated with calcareous sites and Appalachian hardwood forest.

The most common extraction activity in the area is quarrying (**Fig. 20**), predominantly for gypsum and lime quarries, in addition to the extraction of aggregate and gravel for building material. A 2005 study conducted by the Nature Trust of New Brunswick identified and classified quarrying and a variety of other activities disturbing the banks of the St. John River (Arnold 2005). There are 960 known quarries and gravel extractions sites in the bioregion, most of these occur close (within 1000 metres) to major roads (91 %) or to the St. John River system and its major tributaries (99.2 %) or both. This pattern of habitat degradation focused in stream and river floodplains can be of great concern because of the high diversity of insect, bird, and plants using the river and associated habitat (Arnold 2005).

Impacts on natural ecosystems can include removal of topsoil, isolating species populations, direct loss of habitat and species, soil erosion, ground water pollution (Milgram 2008). The direct destruction of habitat and species have an immediate impact on populations, with the indirect effects of erosion, fragmentation and the irreversibility of the impact having more long-term impacts. Land clearing for quarry development and other forms of extraction also creates the possibility of future land use, and development especially if a site is not remediated or rehabilitated. Rehabilitation potential depends on the depth and area of the affected habitat, and the method of extraction (explosive or non-explosive). Natural recovery would be dependent on the remaining soil depth, surrounding seed bank and remaining vegetation (Gunn and Bailey 1993).

Fig. 19 indicates current quarrying activities and lands under mining agreement. The highlighted exploration and mining properties in the USJR bioregion are located around Fredericton and Woodstock and commercialize either Gold/Antimony or Manganese/Iron.

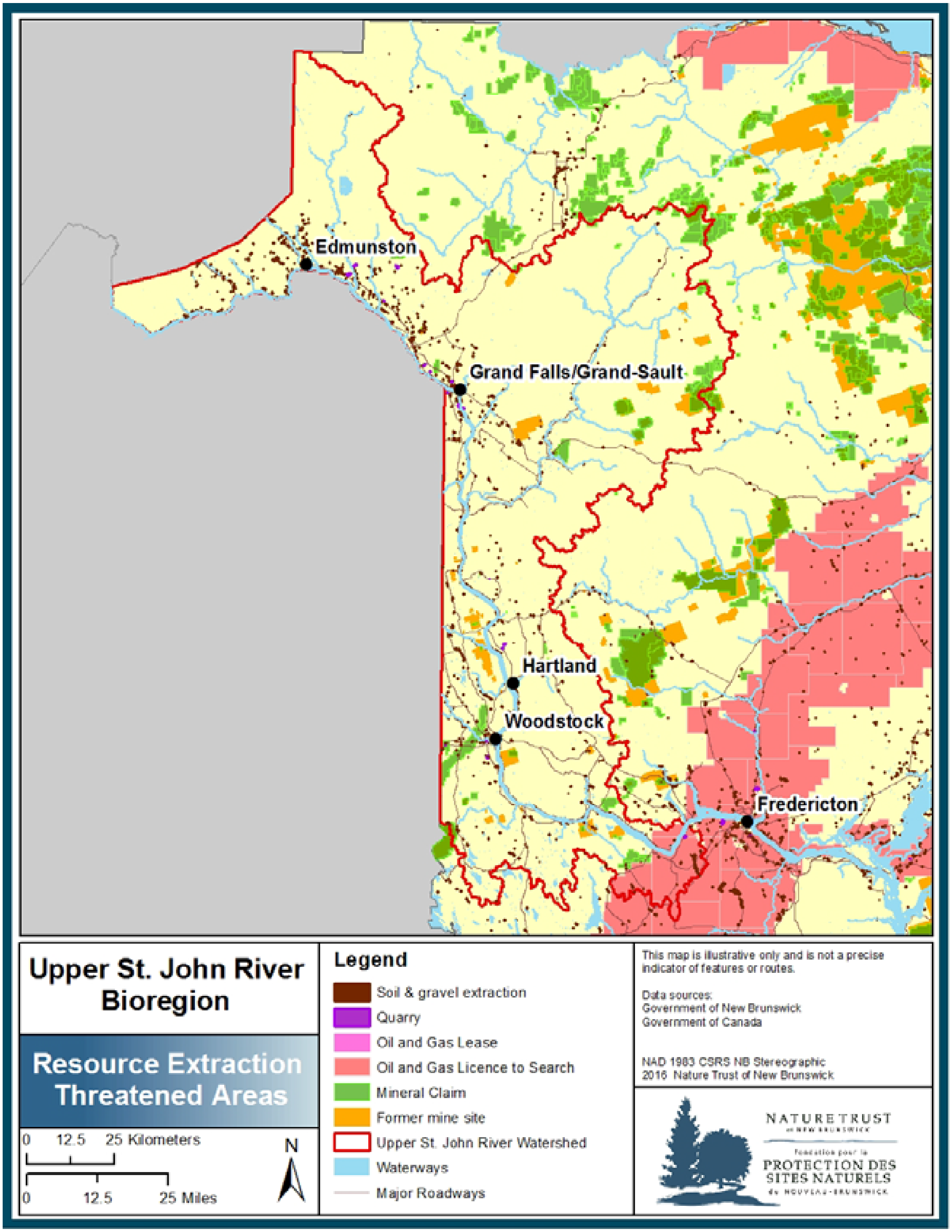

Fig. 19: All extractions as a threat in the Upper St. John River Bioregion

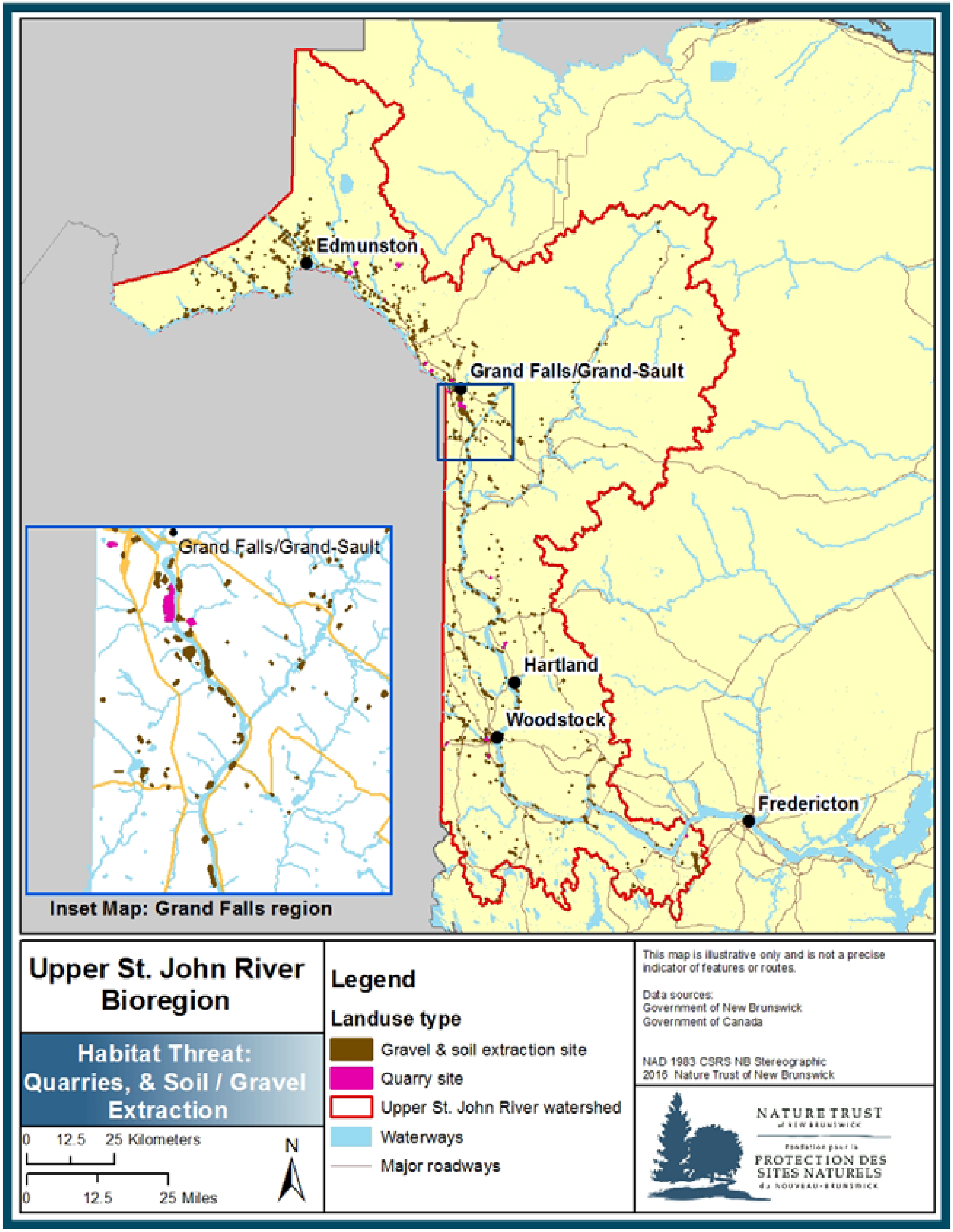

Fig. 20: Aggregate Quarrying as a threat in the Upper St. John River Bioregion

4.1.1 Road fragmentation – Roads and Railroads (Threat Status: Medium)

The presence of roads and railroads (**Fig. 21**) can lead to a variety of impacts on the surrounding environment and native species. Indeed, assessing road fragmentation has become an efficient way of measuring human impact on a landscape in general (Saunders et al. 2002). While railroads have been largely reduced and abandoned across New Brunswick in recent years, some areas in the central and northern parts of the USJR Bioregion still have active lines. The USJR Bioregion also has a relatively high road density, with a particularly large concentration in the potato belt area, while many smaller logging roads have been built in the region's vast forests. These roads and paths can lead to widespread fragmentation-type impacts even if they aren't paved, especially given the sheer number of them in New Brunswick.

Roads are generally associated with a negative impact on native biodiversity and ecological integrity, in addition to deterioration of wildlife habitat, water, and air quality. The impacts of roads begin with their construction, wherein soil compaction / paving, alteration of waterways, and fragmentation of habitat all take place in the construction phase (Trombulak and Frissel 2000). Light penetration into the forest understory is altered by canopy removal, which although limited, changes successional species composition, in combination with other changes in forest microclimate. Changes in water flow, run off, and sedimentation are impacts related to the manner in which roads alter the natural environment (Trombulak and Frissel 2000). The creation of roads also increases pollution to the water, air and soil in the form of heavy metals, petroleum products, increased nutrients, and salts. Road de-icing salt can influence communities living in roadside ponds directly, as some amphibians and insects avoid ponds with high salt content (Collins and Russel 2009).

Mortality on roads via vehicle collisions is a well-known effect, especially in slower moving animals with large ranges and low reproductive rates, as well as animals that are attracted to road conditions and can't escape collision easily (Trombulak and Frissel 2000). Numerous small and large wide-ranging mammals, often use or cross road surfaces and thus are frequently killed by vehicles (Fahrig and Rytwniski 2009), and roads can also act as genetic barriers to species which change their behavior to avoid crossing these man-made barriers, essentially blocking populations off from each other (Trombulak and Frissel 2000). Invasive exotic species have become a major influence on the landscape and these are often dispersed via paved and unpaved roads. Roadsides form an ideal uninhabited area with low competition for these species to establish and thrive: the soil is modified and conditions are ideal for pioneer exotics to establish themselves. In fact, some exotic species are known to prefer growing on roadsides (Trombulak and Frissel 2000). Increased public access via road networks also has the negative impact of increasing the likelihood of streams or rivers being stocked with exotic fish or molluscs to increase recreational use.

The average density of roads in New Brunswick's Acadian forest is 1.84 km/km^2, which is three times the recommended density according to the Fundy Model Forest research (Betts and Forbes 2005). In addition, approximately 10 % of riparain, freshwater wetland, and forested habitat in the USJR is directly impacted by fragmentation by existing road networks in the USJR Bioregion, and 69 % of viable grassland bird nesting habitat patches are smaller than 30 hectares (bobolink breeding patch size). This is partly due to fragmentation caused by roads and partly due to the variation in crop type in adjacent fields.

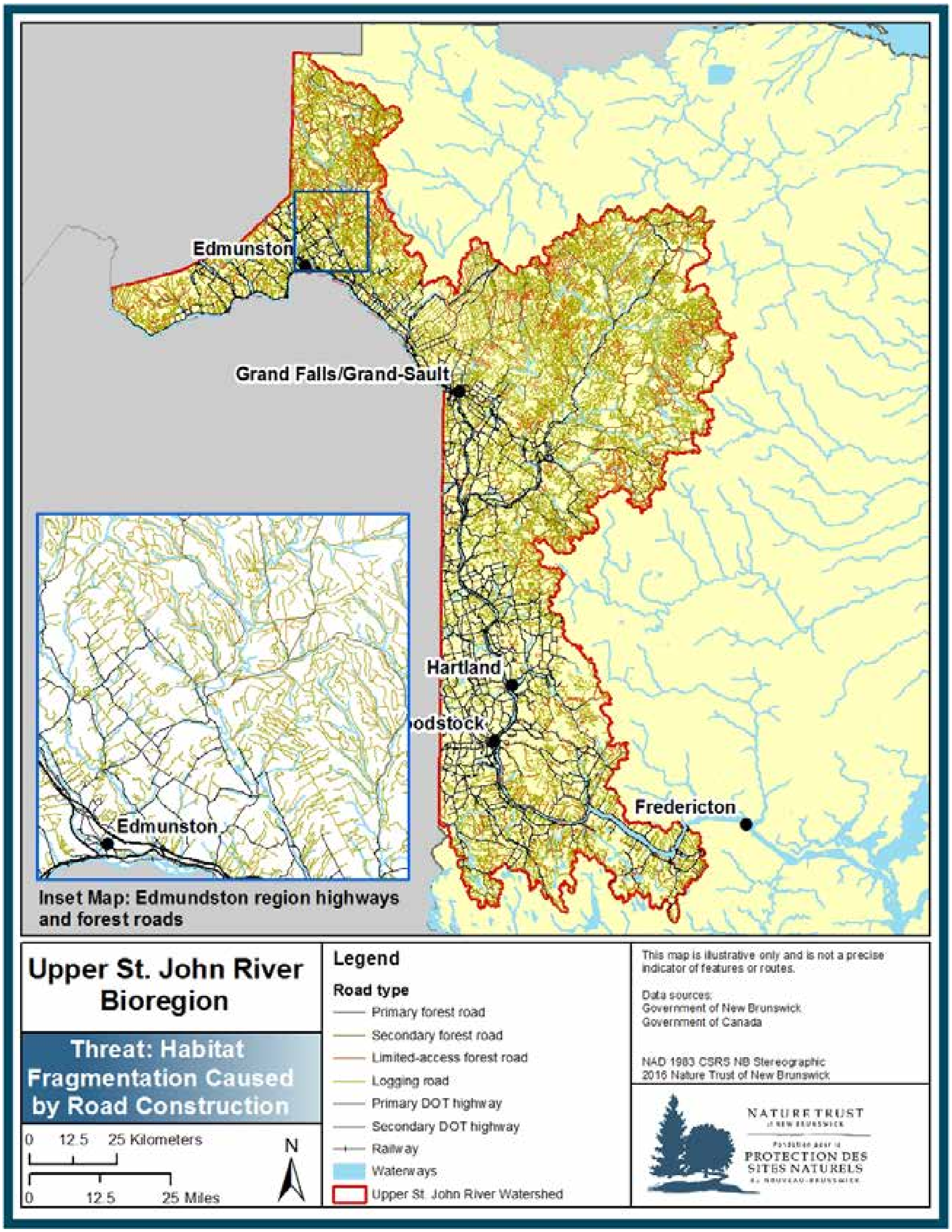

Fig. 21: Roads as a fragmentation threat in the Upper St. John River Bioregion

5.3.1 Incompatible Forestry Practices – Logging and Wood Harvesting (Threat Status: Medium)

Healthy forests generally harbour a large diversity of flora and fauna species, and intensive forest management activities can lead to changes in the composition and structure of forests. In turn, these changes can affect the ecological balance and native biodiversity of forested ecosystems; it is within this context that the threats to the Acadian forest ecosystem in the USJR bioregion are examined.

The characteristics of the pre-settlement Acadian Forest have been drastically altered by forestry activities since the arrival of Europeans to this region (**Fig. 22**). The presence of features such as large diameter trees, large woody debris, and natural canopy openings have been dramatically reduced (NBDNR 2011). In certain areas, the composition of the Crown forest has changed to the point where it now contains only 44% of trees older than 70 years, as opposed to 86 % only 60-years prior (Etheridge et al. 2005). The Crown forest has also become denser, with more stems per hectare, and age classes have become more even due to continuous harvesting, forming more homogenous species composition and age structure (Etheridge et al. 2005). On Crown land, there has been an increase in hardwood dominated forest (Etheridge et al. 2005), however this does not distinguish between tolerant and intolerant hardwoods. Research indicates that following a clear-cut harvest in the Acadian forest, biodiversity on a landscape-scale is impacted negatively (Betts et al. 2003; Betts et al. 2006). Impacts include poor regeneration of tolerant hardwood and mixed wood forests in clear-cut areas, and standing deadwood snags and associated structural components of forest are generally not retained (Betts et al. 2003, Freedman et al. 1994). These components form integral parts of the habitat requirements of certain forest-dependant species such as pileated woodpeckers (Lemaître and Villard, 2005).

Modern forestry practices have led to a shift in the species composition at the landscape level in New Brunswick and the USJR bioregion. For example, planted jack pine numbers in the province have increased to the point where this species is now much more prevalent in areas where red spruce was much more dominant previously (Erdle and Pollard 2002). In the Acadian forest region, habitat loss also outpaces the rate of regeneration of forested areas (Betts et al. 2003), a trend which could lead to resource depletion.

Certain forest types in the USJR Bioregion have been affected more intensely by modern forestry practices than others, including rich tolerant hardwoods, like the Appalachian Harwood Forest, or cedar wetland forests (MacDougal et al. 1998). For instance, of the known remnant patches of Appalachian Hardwood Forest, the majority is found on unprotected private and freehold land which are not subject to harvesting regulations of the Crown Lands and Forests Act. There are knowledge gaps regarding how these forest types are managed, what remains intact, and how to distribute the appropriate management information to landowners. Forestry impacts also vary amongst the various landownership groups; the forests of New Brunswick are owned by the Crown, industrial operators, and private woodlot owners. Harvesting takes place at different scales and intensities among these groups (**Fig. 22, Fig. 23**).

There is a lack of published data on the management of forests on private land and industrial freehold land in New Brunswick. Private land forests are generally either under the advisement of woodlot associations, or landowners use their own judgement and experience as the driver for management. Industrial freehold land is intensively managed for continued long term profitable timber production, with management plans aimed at this purpose (Etheridge et al. 2005). The rate of forest conversion in these areas are unknown, unlike on Crown Land which requires management plans and reporting by license holders. The improved sustainability of harvesting treatments and stand management may be the solution to continued wood supply, and the protection of biological diversity on private and freehold land.

Of the Crown land in the USJR Bioregion designated as Old Forest Community or Old Forest Wildlife Habitat, 88.7% is connected to other Old Forest Communities or Wildlife Habitat, designated watercourse and wetland buffer or conserved lands. Of the priority forest habitat on private land only 6% is connected to other priority forest areas or conserved lands. Connectivity is an important feature in the long-term persistence of biodiversity at a landscape scale, especially with respect to climate change impacts (Krosby et al. 2010). Corridors of safe movement is needed for all species to persist and adapt to changes in this region (Krosby et al. 2010).

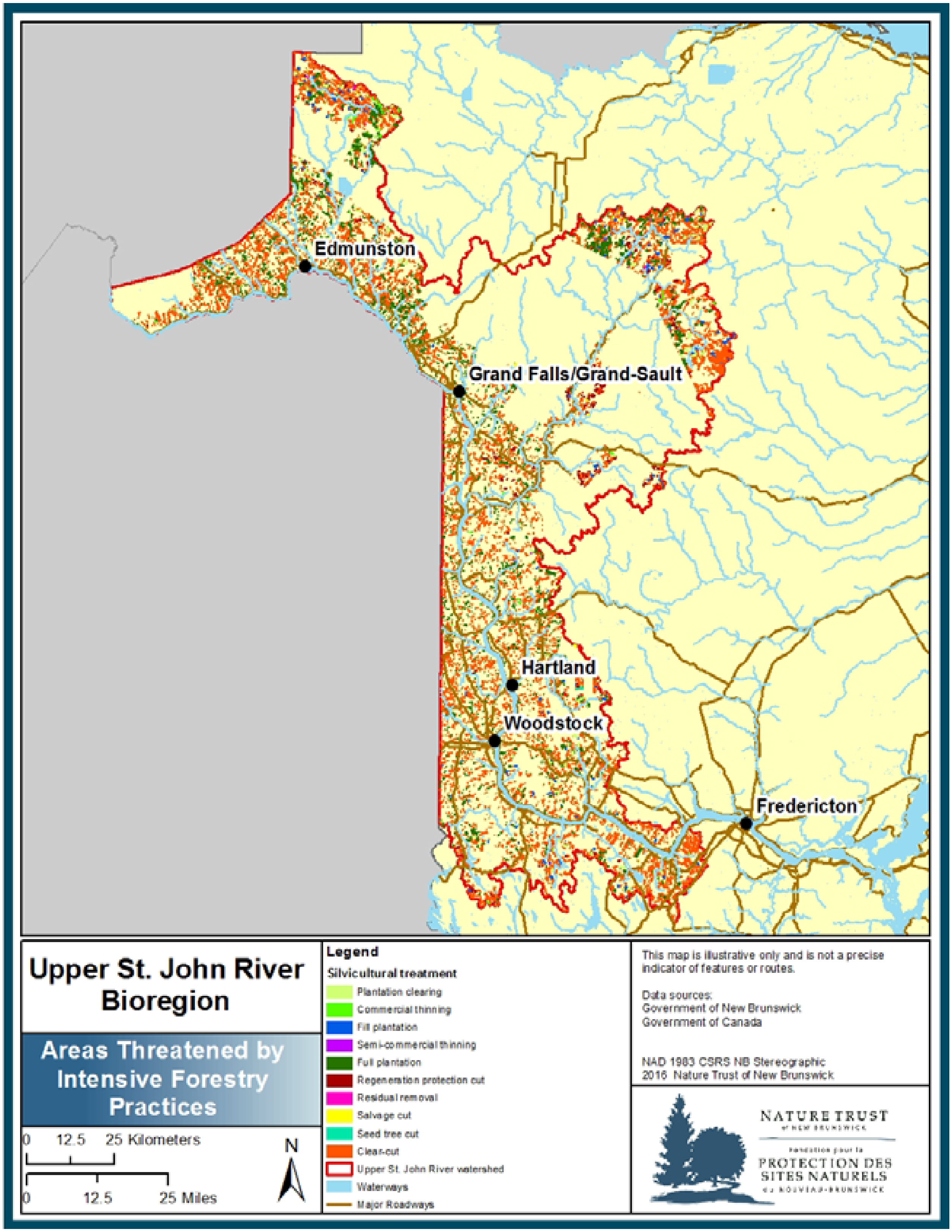

Fig. 22: Forestry threats in the Upper St. John River Bioregion

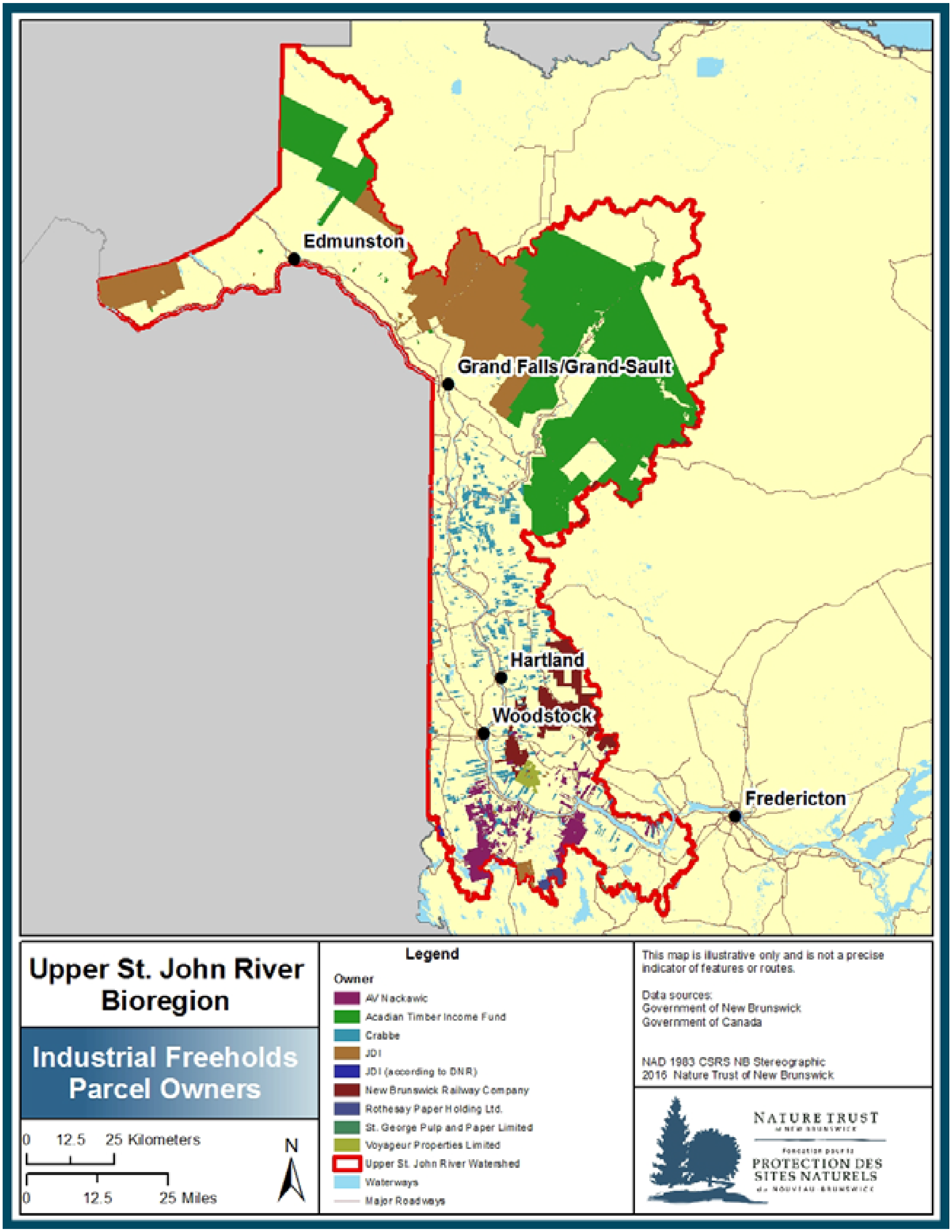

Fig. 23. Industrial Freeholds Parcels in the Upper St. John River Bioregion

6.1.1 Recreational activities (Threat Status: Low)

The impact of recreation stretches to most parts of the ecosystem and doesn't simply end with littering; the severity of the activity often predicts the impact on the ecosystem. Recreational activities include Off Highway Vehicles (OHVs or ATVs), hiking or associated impact activity such as bird watching, pets in natural areas, off road motor-biking, skiing, campsites, caving, rock climbing and others. Impacts from activities can be as minor as a trackway, though others can be more severe and lead to a cascade of effects (Weaver 2001).

The use of OHVs in wetland areas is particularly damaging, where sensitive soils and vegetation can take many years to recover from heavy disturbance. In New Brunswick, this threat is being addressed, at least in part, by the Regulation 90-55 of the 2012 New Brunswick Trespass Act, where no OHVs are allowed in or on wetlands, swamps, marshes, watercourses, sand dunes, and beaches under threat of penalty. The use of OHVs in sensitive areas has been shown to directly threaten the habitat of wood and snapping turtles, as well as that of the pygmy snaketail, and along cobble beach habitats supporting Cobblestone tiger beetle (COSEWIC 2007; 2008a, 2008c).

Plants are directly affected by trampling from all associated activities, and in addition are impacted indirectly by the effects of soil compaction. With an increase in trampling activities there is a decrease in vegetation cover. With plant cover decreased, the first species that tend to disappear are those species sensitive to changes in light and temperature, which are often rare species, for example Furbish's lousewort (Endangered, S1), Showy lady's slipper (S3), or Northern maidenhair fern (S3). Additionally, trampling and collecting by well-intentioned individuals can decrease populations of sought-after rare and at-risk species. These species can also often be found in habitats that are prone to OHV usage. OHV users may not distinguish wet seepage areas, streams, and other ecologically-unique areas as being sensitive habitats and could cross through them especially in areas where no specific stream crossings or bridges are accessible. In the USJR Bioregion, these are areas with a high diversity of plant species, and where the highest number of rare and sensitive species occur due to the rich soils and ideal microclimates, for example in the Appalachian Hardwood Forest.

Other sensitive Species at Risk in this bioregion can be impacted by recreation and the use of OHV. Cobblestone tiger beetle (Endangered S1) is particularly sensitive to disturbance from OHV and other intensive recreation in the beach habitat where it spends its larval and adult live stages (COSEWIC 2008b). Soil compaction and disturbance often occurs when OHV's are used in these habitats. Though these beetles are limited to a few islands in the USJR, the impact of recreational access to the islands especially the cobble beaches, represents a significant impact on their reproduction success and the survival of remaining populations (COSEWIC 2008b).

7.2.1 Dams & other Aquatic barriers – Water Management / Use (Threat Status: Medium)

The Upper Saint John River bioregion has been impacted by alterations to its hydrological flow since the creation of the first major dam at Caribou, Maine in 1890, along the Aroostook river tributary of the St. John River (Warner 1956). Virtually no stretch of the main course of the river below Grand Falls remain unaffected. The study area itself now harbours eight main hydroelectric and other dams, three of which are on the main stem of the river (Mactaquac, Beechwood, Grand Falls) and, two on the Tobique River (Tobique Narrows, Sission Lake). The other three dams are at Edmundston (Madawaska River), Hargrove (Monquart stream) and Second Falls (Green River). It is also important to point out that for the most part, this account does not even consider the dams on the USA side of this watershed. There are also 85 known non-hydroelectric dams (**Fig. 24**) and numerous potential aquatic barriers[1] **(Fig. 25**) located on tributaries and the main stem of the St. John River in the bioregion (Kidd et al*.* 2011). Twenty-three of the dams occur in the Tobique River tributary, which constitutes 27 % of the dams in the USJR bioregion.

Hydroelectricity accounts for up to 31 % of New Brunswick's power generation capacity at any given time (NB Power 2015) and is thus a major part of what keeps the province supplied with electrical power. The process of dam construction, destroys habitat via periodic or permanent flooding, through fragmentation and alteration of the riparian zone, and although new habitats form over time, native species complexity and richness are lost, thus altering the ecological continuity of the area (Nilsson and Berggran 2000; Jansson et al. 2000). The creation of large water bodies associated with dams have the capacity to alter the regional climate and natural river dynamics; the same can be said of large, man-made reservoirs on the St. John River such as that found above the Mactaquac or Tobique Dams. In these artificial lakes, surface water tends to increase in temperature, changing the habitat of native biota (Bunn and Arthington 2002). In addition, river morphology and sediment distribution are disrupted, with accumulation within the reservoir increasing, resulting in its delayed or completely halted release below the reservoir (Baxter 1977; Petts 1980). A number of island habitats were lost in the Bear Island region above Fredericton with the creation of Mactaquac, and higher water levels have flooded out in-stream and riparian habitat as far up-river as Woodstock.

One of the major impacts of dam construction in this bioregion is the loss of river connectivity to diadromous fish species. This is particularly acute in the case of the anadromous Atlantic salmon in the USJR bioregion. Studies have shown a drastic decrease of this species in the river since the establishment of the large dams in the river system (Kidd et al. 2011). While reservoirs with fish passages have had some success, Mactaquac dam has not. Adult spawning salmon are collected below the dam wall and trucked upstream for release. From here they can swim into tributaries to spawn, of which many have also been dammed (Kidd et al. 2011). Reservoirs also form downstream barriers to smolts migrating to the ocean. Unfortunately, frequently dams have no downstream outlet other than hydroelectric turbines. In such cases, fish either succumb to the pressure created there, or die from gas-bubble disease due to an increase in dissolved gasses in the water. This is compounded by the fact that even before the fish reach the turbines, they often get lost in the dam system, as the current that would normally help guide them down to the ocean disappears in the stagnant water of the dams (Baxter 1977; Carr 2001; Nilsson and Berggren 2000; Kidd et al. 2011). Regulated rivers have a lesser impact on survival of Atlantic salmon eggs for incubation, albeit still important. Such systems often have more stream bed scour, a higher variability in winter water discharge, higher intra-gravel temperature during incubation, and an earlier surge of warm water input prior to spring freshet (Flanagan 2003).

Culverts also create stream impediments to flow and natural stream dynamics. A simple culvert with a drop at the end (i.e. a hanging culvert) can prevent upstream movement of migrating fish. There are approximately 11390 known stream crossings in the bioregion, representing approximately one crossing every 1.15 km^2 (see **Fig. 25**). The full extent of this loss in stream connectivity is not currently known. A data gap exists related to assessment of culvert and crossing condition, which needs to be investigated to best address this threat.

[1] Note that potential aquatic barriers are map here as any instance where a road or path crosses a stream. The condition of these potential impairments are unknown.

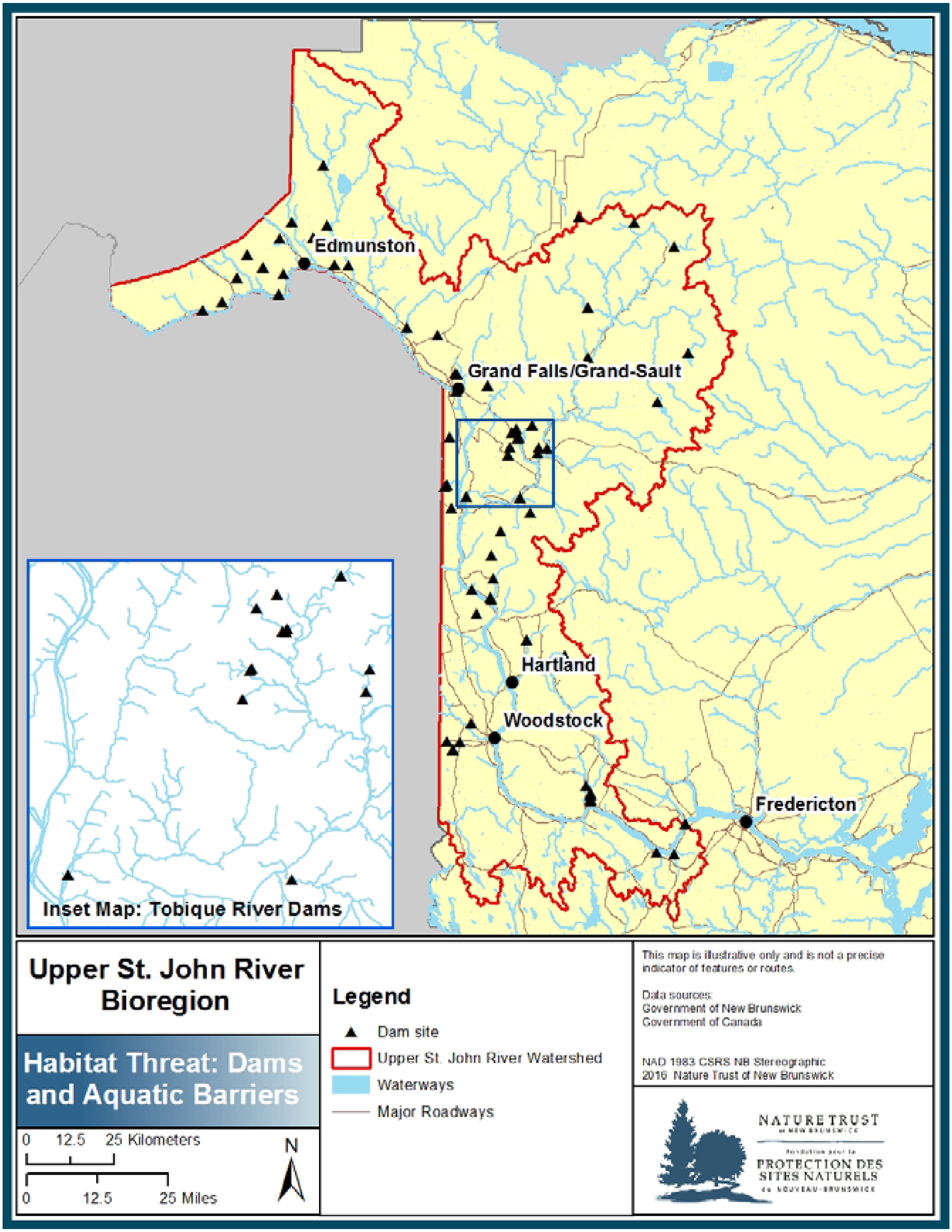

Fig. 24: Major Dams and Aquatic barriers in the Upper St. John River Bioregion

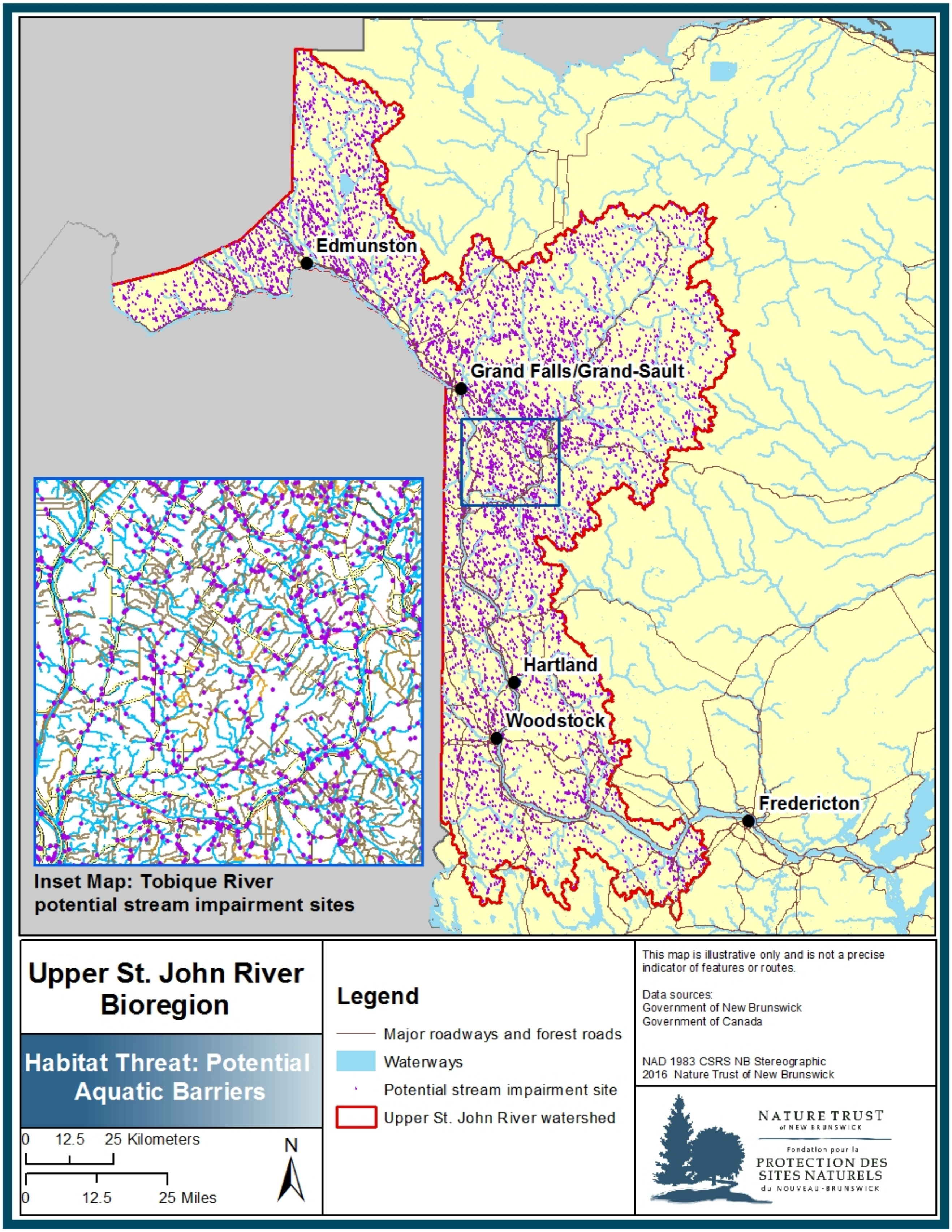

Fig. 25: Road stream intersection locations as potential aquatic barriers in the Upper St. John River Bioregion.

The Mactaquac Dam

The Mactaquac Dam, constructed in 1968, was thought to have reached an early end to its intended lifespan. This was due to problems with the aggregate used in the concrete constructing the dam. Three options were put forward by NB Power to consider during the three-year consultation process regarding the dam's life span: *Option 1, Repowering: Refurbish the Station by constructing a new powerhouse, spillway, and other components, followed by the removal of the existing concrete structures at the Station; Option 2, Retain the Head-pond (No Power Generation): Build a new concrete spillway and maintain the dam as a water control structure without power generation, followed by the removal of existing concrete structure at the Station; Option 3, River Restoration: Remove the Station and enable the river to return to a free-flowing state.*

After three years of public, First Nations, and engineering consultation and expert research, a decision was reached in 2016 (Stantec 2015). This involves the continued existence of the dam as a functioning hydroelectrical generator to the reach its intended lifespan until 2068, with a modified approach to maintenance and adjusting and replacing equipment over time. This decision allows for the environmental and social impacts during operation to continue as status quo, with potential improvement. NB Power has committed to work with the Canadian Rivers Institute and the Department of Fisheries and Oceans to achieve target fish passage goals. The goals are informed by science, stakeholders, First Nations and future regulatory decisions. These goals allow for a multi-species fish passage installation, in addition with existing facilities, with the input of improved technology and current research. Approximately 100 million dollars have been budgeted for this project.

8.1.1. Invasive Species – Fish Species (Threat Status: Low)

There are several non-native fish species that can pose an impact on aquatic ecosystems. Of these species, the Muskellunge (Musky, *Esox masquinongy*) is an apex piscivorous predator that has an impact on young Atlantic salmon parr, among others, in the St. John River system.

Large and smallmouth bass (*Micropterus salmoides* and *Micropterus dolomieu*) have also been introduced into the St. John River and are known to have spread throughout the watershed. Smallmouth bass also has potential to shift the food web dynamics of the ecosystem, since they are a top predator (Brown et al. 2009a), although, the impact of this species may be higher in lake ecosystems than in river ecosystems (DFO 2009). Largemouth bass can outcompete other fish with similar behaviour, mostly due to the fact that this species is often larger and more aggressive; even outcompeting the smallmouth bass. Both small-and largemouth bass have been noted to predate on salmonid species, which could be especially detrimental here, especially considering the state of the Atlantic salmon in this bioregion (Brown et al. 2009a, b).

8.1.2 Invasive Terrestrial Species (Pathogens & Microbes) – Insects and Diseases (Threat Status: Medium)

The impact of invasive insects and diseases are fairly well known. Spanning from direct threats to biodiversity via disease transmission and the ultimate death of species, to gradually outcompeting native species and changing habitat conditions to the detriment of native species, the effects of invasive species are many and wide-ranging (Mooney and Cleland 2001; TNC 1996; Wilcove et al. 1998). Consequently, this is considered one of the major threats to native biodiversity worldwide (UNEP 2002; Hermoso et al. 2011). With the increase in trans-continental travel and trade, the potential of the spread of invasive species has increased substantially, especially in first entry ports such as the Maritimes (Boyd et al. 2013).

Although not established in the northern part of the bioregion, the European gypsy moth (*Lymantria dispar*) is present in the southern regions and constitutes a major defoliator of over 200 hardwood tree species (NBDNR 2014). The Balsam woolly adelgid (*Adelges piceae*) has yet to cause significant damage across the bioregion, but populations are expanding continuously. The only outbreak in New Brunswick associated with tree mortality was documented at Kingsclear in the southern area of the bioregion (NBDNR 2014). The Brown spruce longhorn beetle (*Tetropium fuscum*), which attacks and kills spruce trees, is established in Halifax (Smith and Humble 2000), however, evidence has not yet been found for established populations in New Brunswick or the USJR bioregion. At this point, the Emerald ash borer (*Agrilus planipennis*) is still classed as an emerging threat, as it is not known to have reached New Brunswick, according to the most recent data available (Dobesberger 2002). However, it has reached areas in Quebec and could arrive in USJR bioregion in the near future, so this is certainly a species to of concern. A summary of current and emerging insects and diseases can be seen in **Table 8**, with additional insects and disease mentioned that are not addressed here.

Several non-native diseases are also found within New Brunswick. European larch canker (*Lachnella willkommii*), though confined mostly to the southern areas of NB, is a harmful fungus that infects the native larch or tamarack, i.e. *Larix laricina* (NBDNR 2014). There has been no update on this diseases' presence since 2000, when the last survey was done (NBDNR 2014). Dutch elm (*Ophiostoma* spp) disease has spread through the Maritimes, leaving such destruction in its wake that Elm is now considered a minor component of the forest in the area, where once it was much more common and widespread (Hurley et al. 2003). Beech bark (*Nectria coccinea)* disease, enabled by the insect *Cryptococcus fagisuga* which attacks the Amercican beech tree, is also widely distributed throughout the Maritimes with a particular prevalence in northern New Brunswick (NBDNR 2014) and in the USJR bioregion. This insect-disease complex makes the American Beech (*Fagus grandifolia*) susceptible to a bark fungus. It impacts its reproduction, due to the tree having to use most of its available energy fighting the disease (Hurley et al. 2003). Butternut canker (*Ophiognomonia clavigignenti-juglandacearum*) was first observed in New Brunswick in 1997, though it is widespread in the area, and is likely more common than the noted findings. Butternut has since been listed as Endangered under SARA, such is the devastation of this disease (Hurley et al. 2003). This canker causes the necrosis of cambial tissue, disrupts the flow of nutrients and is eventually fatal to the tree (NBDNR 2014). It should be noted that it is possible that the Butternut in NB is genetically distinct from other populations, which could put this population at even greater risk or provide opportunity for species recovery efforts. The genome of New Brunswick's butternut has not been mapped as yet, but is being investigated by the Canadian Forest Service (Environment Canada 2010).

Finally, the European race (EU) of the Scleroderris canker (*Gremmeniella abietina*) has been detected in northwestern New Brunswick in three areas in close proximity to each other. This strain causes more fatalities than the North American race (NA), which nevertheless also causes some mortality in trees; the species most impacted by the EU race are Red and Scots pine. Therefore, the potential for establishment of EU and its spread outside of its native distribution is high. Meanwhile the NA race impacts Jack and Red pine, causing cankers and the mortality of seedlings (NBDNR 2014). This fungus affects monoculture plantations of the susceptible species much more severely than the natural, highly diversified Acadian Forest.

Table 8: Present and Emerging Insects and/or Disease in the Upper St. John River Bioregion

Common name	Scientific Name	Host	Presence	Industry Impacted
Present Insects and/or disease				

Balsam Fir Tip Blight	*Delphinella balsameae* [Waterman]	Balsam Fir	Scattered Throughout NB, severe in Northern NB	Christmas Tree
Balsam Gall Midge	*Paradiplosis tumifex* Gagné	Balsam Fir	Throughout province, 7 year cycle, on decrease in cycle	Christmas Tree
Balsam Twig Aphid	*Mindarus abietinus* Koch	Balsam Fir	Throughout province, on increase in cycle	Christmas Tree
Balsam Woolly Adelgid	*Adelges piceae* [Ratzebug]	*Abies spp.* (True firs)	Southern NB, severe mortality at Kingsclear	Forestry, Christmas tree
Brown Spruce Longhorn Beetle	*Tetropium fuscum* [Fabricius]	Picea (main host), *Abies, Pinus, Larix*	Nova Scotia, not present in NB	Forestry
European Larch Canker	*Lachnellula willkommii* [Hartig]	*Larix spp.*	Southern NB	Forestry
Hemlock Looper	*Lambdina ficellaria* [Guenée]	Hemlock, Balsam Fir	Common Newfoundland & Labrador, Québec, present NB	Forestry
Jack Pine Budworm	*Choristoneura pinus* Freeman	Jack Pine	Ontario, Manitoba, NB no outbreak since 1983	Forestry
Larch Casebearer	*Coleophora laricella* [Hubner]	*Larix spp.*	Southern NB	Low impact
Scleroderris Canker of Pine	*Gremmeniella abietina*	*Pinus spp.*	Three sites in Northern NB	Forestry
Sirococcus Shoot Blight on Red Pine	*Sirococcus songenus* [Dc.] Cannon & Minter	Red Pine (primarily)	Throughout NB, high in Southwestern NB	Forestry
Spruce Budworm	*Choristoneura fumiferana* [Clemens]	Balsam Fir, *Picea spp.*	Throughout NB, mostly Northern NB	Forestry
Birch Skeletonizer	*Bucculatrix candensisella* Chambers	*Betula spp.*	Southern NB	Low impact
Bruce Spanworm	*Operophtera bruceata* [Hulst]	*Acer spp., Fagus spp., Populus spp.*	Northern NB	
Butternut Canker	*Ophiognomonia clavignenti-juglandacearum* [N.B. Nair, Kostichka & J.E. Kuntze]	Butternut	Throughout NB	Low impact
European Gypsy Moth	*Lymantria dispar* [L.]	*Quercus spp., Populus spp., Betula spp.* All favoured	Southern NB	Forestry
Dutch Elm Disease	Ophiostoma *spp*	Elm	Throughout NB	Forestry, Fire wood
Forest Tent Caterpillar	*Malacosoma disstria* Hubner	*Populus spp.* (mainly), other hardwoods	Throughout NB	Forestry
Satin Moth	*Leucoma salicis*[L.]	*Populus spp., Salix spp.*	Northern NB	Forestry
Beech bark Disease	*Nectria coccinea*	American beech	Throughout NB, common in Northern NB.	Forestry
Large Aspen Tortrix	*Chorisroneura conflictana* [Walker]	Trembling Aspen	Throughout NB, most recent Central Western NB.	Forestry
Emerging Insects and/or Disease				
Asian Longhorned Beetle	*Anoplophora glabripennis* [Motschulsky]	Hardwoods	Northern US, Ontario	Forestry
Beech Leaf-mining Weevil	*Orchestes fagi* [L.]	*Fagus spp.*	Nova Scotia, not present in NB	
Emerald Ash Borer	*Agrilus planipennis* Fairmaire	Fraxinus spp.	Southern Québec, New Hampshire US	Forestry
European Wood Wasp	*Sirex noctilio* Fabricius	Pinus spp.	Southern Ontario, Western Québec, New York State US	Forestry
Hemlock Woolly Adelgid	*Adelges tsugae [Annand]*	Hemlock	Nova Scotia, Southern Ontario, Maine, US	Forestry
Pine Shoot Beetle	*Tomicus piniperda* L	Pinus spp.	Québec, Western Maine US	Forestry

White-nose syndrome (WNS), a fungal disease in bats, was first observed in North America in 2006 (Lorch et al. 2011). Since then, it has caused great declines among most hibernating or non-migratory bat species on the continent. The USJR bioregion is no exception to this. Mortality rates have been so high in eastern Canada that extirpation of several affected species may soon be the result (COSEWIC 2013). It is thought that the only likelihood of survival will occur via individuals who are genetically resistant to WNS which are able to produce resistant offspring. During laboratory and banding trials, such resistance has been observed in a small percentage of individuals (Meteyer et al. 2011; Dobony et al. 2011). This is thought to have occurred in European populations at some point in the past, as species there exhibit low fatality despite WNS being present (Turner et al. 2011).

Invasive species enter systems at such a rate that unless it is a top priority with substantial resources allocated, it is inevitable that research and prevention will behind in its investigations. There is currently a significant gap in knowledge in terms of the number of invasive species, their spread, and the actual impact they are having on natural ecosystems.

8.1.2. Invasive Terrestrial species (Invasive Non-native/Alien Species) – Plants (Threat Status: Medium)

Invasive exotic plant species have become a significant threat globally because they are able to outcompete and can push native populations out of an area. In New Brunswick, some of these species were introduced as early as during the time of First Nations settlement in the region (Hill and Blaney 2009). Invasive plants are known to establish more readily in disturbed areas, making floodplains and shores, roadsides, and arable lands ideal for their quick establishment (Hill and Blaney 2009). These species are often known to reproduce aggressively or use nutrients more efficiently than native species. There are 486 declared invasive plants in Canada, with 321 of these known in New Brunswick (CFIA 2008). According to the Atlantic Canada Conservation Data Centre, 32 % of New Brunswick's total plant diversity is of exotic origin (Hill and Blaney 2009).

Of the invasive plants in New Brunswick, some are particularly prevalent in the USJR bioregion. Woodland angelica (*Angelica sylvestris*), found along the middle reaches of the St. John River, is common in moist woodland habitats, where it has a tendency to overwhelm other plants and produce an abundance of seed (NBISC 2009). The sap of this plant can cause skin rashes and blisters when exposed to sunlight. A similar but more extreme reaction is caused by Giant hogweed (*Heracleum mantegazzianum*), with severe blisters and burns having been reported. This species has spread throughout eastern North America and is present in New Brunswick and in the central St. John River valley within this bioregion.

Japanese knotweed (*Fallopia japonica*) is a plant with a bamboo like stem which can grow up to eight centimetres a day, spreading mainly vegetatively, and has been reported in this bioregion. It is very adaptable, but prefers shaded moist areas away from full sunlight (NBISC 2009, Mazerolle 2017). The quick growing vine species Oriental bittersweet (*Celastrus orbiculatus*) can wrap around trees and cause them to break due to excess weight during storms. This is another fast grower, growing approximately three metres per year. New Brunswick has a similar native species (Climbing bittersweet), though it is thought to be extirpated (NBISC 2009). Garlic mustard (*Alliaria petiolata*) spreads aggressively through disturbed areas, affecting mycorrhizal fungi in the soil and thus impeding tree seedling establishment. This plant prefers moist calcareous soils in floodplain forests, thus impacting the Appalachian Hardwood Forest specifically. It is particularly prevalent in the Keswick Islands areas and the Meduxnekeag River, but is generally associated with the St. John River valley as a whole (NBISC 2009, Mazerolle 2017). Flowering rush (*Butomus umbellatus*) has spread widely throughout North America and can also outcompete and displace native vegetation. It prefers marshes, but it can also grow in water as deep as three metres (NBISC 2009). In a similar fashion, the Common reed (*Phragmites australis*) can grow in moist soil, standing water or even as a floating mat. The plants grow densely and vigorously, taking up an incredible amount of space and decreasing the amount of sunlight that reaches the ground (Engloner 2009). Purple loosestrife (*Lythrum salicaria*) may also occur in the bioregion, though it is wide spread along lower St. John River. This species invades wetlands and can form dense stand swiftly, in doing so outcompeting and displacing native species and their accompanying invertebrates and birds (NBISC 2009). The seeds of this plant disperse by wind, water, wildlife, and people, and had the capability to lie dormant for years before germinating (NBISC 2009).

Smooth bedstraw (*Galium mollugo*) has also become common hayfields in New Brunswick and within the USJR. This species often emerges on road sides, gradually moving its way into hayfields from here. Significant reduction in forage quality is observed with the presence of this species in pastures. Glossy buckthorn (*Frangula alnus*) grows in sunny moist woodlands and wetlands. It rapidly forms dense thickets (NCC 2015, Mazerolle 2017), creating a canopy over the undergrowth, which changes the micro-environment completely (CFIA 2008). This species is easily dispersed by birds, thus moving greater distances, and is said to be one of the top three most dangerous invasive exotics, according to many experts (Blaney 2016)

Reed canary-grass (*Phalaris arundinacea*) is another species known to displace native species, particularly in riparian floodplains and wetlands. It is now known to occupy thousands of hectares in the St. John River floodplain as well as those of its tributaries (Blaney 2016). Reed canary grass is both native and introduced and as such has caused less concern, however the introduced European cultivar can over time outcompete the native varieties. This could cause the elimination of the native cultivars from the province (Apfelbaum and Sams 1987, Environment Canada 1999).

With regard to non-vascular plants, the role of a particular algae should be noted as well. Didymo (*Didymosphenia geminatea*) is a known invasive diatom species with a preference to flowing water, in various areas. It has been noticed in Atlantic Canada in several places including the USJR bioregion at Shikatehawk Stream (GNB 2015 online). Though not prevalent yet in the bioregion, it spreads very fast and can cause massive algal blooms (Kilroy 2004).

9.3.1 Agricultural Effluent (Threat status: Medium)

The agricultural industry in the USJR bioregion is dominated by potatoes, followed by corn, canola, soybeans, clover, ryegrass, oats, with additional pastures / forage making-up a small proportion (Kinney and McCully 2017).

Potato agriculture, being the mainstay of the industry, has complex implications for the natural environment, which includes non-point source pollution. The use of fertilizers, especially nitrogen and phosphorus-based varieties, increase crop yields and qualities significantly; however, evidence shows that this use can lead to substantial non-point source pollution of surface and ground waters (Davenport et al. 2005). Eutrophication is one of the major implications of increased phosphorus and nitrogen in water. Eutrophication is an increase of nutrients in the water, often leading to an increase in algal growth and a subsequent reduction of dissolved oxygen in the water. The trend in potato cultivation is to apply excess phosphorus than can be taken up by plants, which is associated particularly with the reduction in surface water quality (Chow et al. 2011). In contrast, nitrogen is more associated with groundwater pollution, as plants can only take up this nutrient by its roots when it is dissolved in water (Davenport et al. 2005).

Pesticides also play an important role in modern agriculture, since crop yields are often increased substantially with their application; however, pesticides also have detrimental effects on natural systems, particularly on water quality. A study within the bioregion involving the Black Brook and Little River watersheds in 2012, detects nine pesticides in the water runoff of these watersheds that had levels above the guidelines set by the Canadian Council of Ministers of the Environment (Agriculture and Agri-food Canada 2013), and shows an increase in the concentrations of pesticide runoff in the water system correlated with periods of high rainfall. This study also shows an increased amount of pesticides associated with potato crops as compared to grain crops (Xing et al. 2012). Neonicotinoids are a commonly used pesticide in the potato industry used to combat the Colorado potato beetle; this pesticide is water soluble and therefore can infiltrate the groundwater system. There are other herbicides applied to reduce weeds growth, which are usually sprayed only once after planting. Neonicotinoids are toxic to arthropods which they target, but are found to be fatal when consumed by some birds and are likely to impact pollinators, and soil and aquatic invertebrates (Goulson 2013).

Other than water pollution from pesticides, there are also direct effects to flora and invertebrates and indirect effects to animals further up the food chain (de Snoo 1999). These effects include bioaccumulation and biomagnification effects to be considered on the surrounding and affected species, in addition to interdependent effects to species associated with the area (Henny et al. 2003). Drift from the spraying pesticides could also have an impact and should be considered in planning as species not directly associated with the area may be affected by its application (de Snoo 1999).

Best management practices have been developed and evaluated by Agriculture and Agri-food Canada (Stuart et al. 2010) to offset some of the negative ecological impacts associated with potato farming, particularly those associated with non-point source pollution. The inclusion of grassy waterways and diversion terraces have shown to decrease the infiltration of phosphorous in surface water and also leads to a decrease in erosion associated with downhill row-cropping of potatoes. While BMPs can solve many environmental concerns including soil loss, sediment loading and transport of pesticides associated with surface water, they can also induce negative consequences, such as the increase of infiltration of nitrogen and pesticides into groundwater as they increase absorption (Agriculture and Agri-Food Canada 2014; Xing et al. 2012).

9.3.2 Forestry Effluent (Threat status: Low)

In New Brunswick, herbicides have been sprayed over plantations for several decades, after it was permitted on clear-cut natural forest to make room for softwood plantations. Herbicides applied to softwood plantations are used to kill broad leaved trees, shrubs, and grasses competing with softwood seedlings. This flora is often the food source and habitat for many forest species (including deer. Spraying occurs one or two years after the plantation has been established, and once or twice over more targeted sites. Several scientific studies now indicate some of the negative impacts that glyphosate and its associated accompanying chemicals have on various species, including humans (Benachour and Séralini 2009, Gasnier et al. 2009, Relyea and Jones 2009, Guyton et al. 2015, Myers et al. 2016). Indeed, the World Health Organisation's International Agency for Research on Cancer (IARC 2015) has classified it as a probable human carcinogen. Other research also suggest that glyphosate has a negative impact on the structure and the function of freshwater ecosystems (Vera et al. 2010).

II. Emerging threats

3.1 Oil & Gas Drilling - Energy East Pipeline

The Energy East Oil pipeline is a proposed pipeline which would stretch from Alberta to the Irving Oil refinery in New Brunswick, literally crossing thousands of water courses over its span. This project has generated a great amount of concern and media coverage, focused on the large number of potential impacts including leakage and spillage, the impact on the terrestrial and aquatic ecosystems during construction and the end product of greenhouse gasses. Though this potential development does not cross the St. John River itself, it does cross multiple tributaries, one of which, the Tobique a major source of water for the bioregion. Other tributaries crossed include Rivière Verte, Grande-Rivière, La Rivière Madawaska and Salmon River. In October 2017, the TransCanada Corporation announced that it had cancelled its plans to construct the Energy East Pipeline and that the project had been terminated.

11 Climate change & Severe Weather

Climate changes is on the forefront of the world's environmental concerns, with most of the anthropogenic impacts relating back to this crisis. New Brunswick is not exempt from the impacts of climate change, nor will the USJR bioregion.

Some of the impacts related to species distribution and survival have been forecast for New Brunswick. If the assumption is made that CO_2 concentration in the atmosphere is to triple from now until 2099, an increase in the annual minimum and maximum temperatures are expected, with a potentially greater increase in air temperatures in the central region of New Brunswick, which forms the bulk of the USJR bioregion. The expected changes in temperature are on the order of 4 to 5°C higher for the minimum air temperatures and 4°C higher for maximum temperatures.

Seasonally the changes would increase the spring maximum temperature by 5 to 6°C and the winter minimum by 4 to 6°C (Swansburg et al. 2004). These increases will cause an increase in water temperature which will impact various species. One of those certain to be impacted is the already endangered Atlantic salmon, which relies on cold stream temperatures. Many other aquatic species will be affected with regards to growth rate, development, behaviour and survival (Swansburg et al. 2004). Temperature increases will also heighten the need for irrigation of crops, as the evapotranspiration rate increases with temperature, increasing pressure on the regional water supply. However, this increase in temperature in combination with a possible extended growing season will increase the agricultural pressure on the USJR. Naturally, the timing and duration of snow cover and melt will be impacted, and this will also affect the moisture availability in different seasons, as well as the flood regime of the region (Swansburg et al. 2004).

It is predicted that mean daily annual precipitation will increase by 25% to 50% in this bioregion, with seasonal precipitation increasing by similar percentages (Swansburg et al. 2004). There is no indication how much of this increase will be in the form of snow. Average annual river discharge is another important factor in the USJR that is predicted to increase by 16 to 45%. Winter and spring discharges are predicted to increase significantly, with summer discharges decreasing and fall discharge not changing significantly (Swansburg et al. 2004). There are still multiple knowledge gaps to be addressed with regards to climate change impacts, including species distribution, range changes, and specific climatic change effects on individual species groups.

Table 9 summarizes the major threats to birds that are identified in the BCR 14 document. The most severe threat to birds in this area is logging & wood harvesting. The threats that are the most widespread, affecting the most species are **agricultural & forestry effluents, utilities & service lines,** and **roads & railroads**.

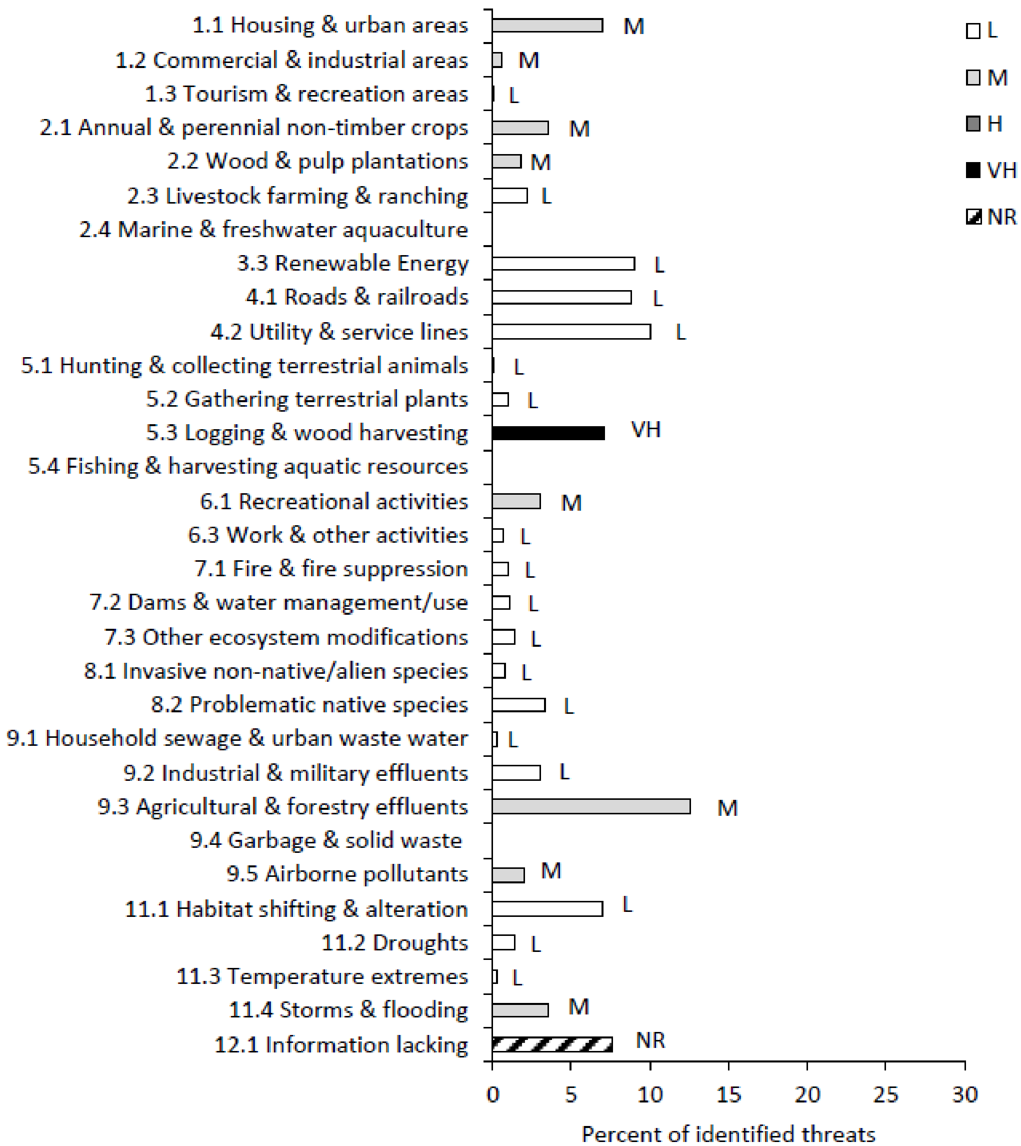

Fig. 26: Percent of identified threats to priority bird species within BCR 14 New Brunswick[1] by threat sub-category (Directly from Environment Canada 2013)[2]

[1] Note these threats apply to the whole of New Brunswick, not only the USJR bioregion.
[2] "Each bar represents the percent of the total number of threats identified in each sub-threat category in BCR 14 NB (for example, if 100 threats were identified in total for all priority species in BCR 14 NB, and 10 of those threats were in the category 1.1 Housing & urban areas, the bar on the graph would represent this as 10%). Progressive shading in the bars represents the rolled up magnitude of all threats in each threat subcategory in the BCR. N/A are unranked threats due to lack of information (12.1)." (Environment Canada 2013).

Table 9: Presence of identified threats to priority bird species within and according to BCR 14 NB by threat sub-category[1]

Threat Category to Birds	Low/Med/High	% of identified risk	Impact on species other than birds
1.1 Housing & urban areas	M	8	Yes
1.2 Commercial & industrial areas	M	1	yes
2.1 Annual/perennial non-timber crops	M	5	yes
2.2 Wood/Pulp plantations	M	3	yes
2.3 Livestock farming & ranching	L	3	yes (possible M in USJR)
2.4 Marine & freshwater aquaculture	-	0	yes (M risk to freshwater wildlife)
4.1 Roads & railroads	L	9	yes (M-H for terrestrial wildlife)
4.2 Utility & service lines	L	11	yes (M-H for terrestrial wildlife)
5.1 Hunting & collecting terrestrial animals	L	1	yes (terrestrial)
5.3 Logging & wood harvesting	VH	8	yes (VH)
6.1 Recreational activities	M	3	yes
9.3 Agricultural/forestry effluents	M	13	yes (M)
9.5 Airborne pollutants	M	3	yes (L)
11.3 Temperature extremes	L	0.5	yes (increasing recently-heavy snowfall/storms)
11.4 Storms & flooding	M	3	yes (M)

Very high	The threat is likely to *destroy or eliminate* the priority habitat type
High	The threat is likely to *seriously degrade* the priority habitat type
Medium	The threat is likely to *moderately degrade* the priority habitat type
Low	The threat is likely to *only slightly impair* the priority habitat type
-	The threat's impact on priority habitat type is *negligible*
Unknown	The threat's impact on priority habitat type is *unknown*

Housing & urban areas, utility & service lines, roads & railroads, and agriculture are interpreted to be the major threats to terrestrial animals in this region, following Logging & wood harvesting as the most significant threat. Freshwater wildlife is considered to be most affected by aquaculture, agriculture/forestry effluents, commercial & industrial areas, & temperature extremes.

Table 9 represents the relative magnitude of identified threats to priority species within the BCR 14 NB by threat category and habitat.

Overall, Coniferous Forests where priority bird species reside are threatened the most in New Brunswick. Biological Resource Use poses a Very High threat across habitats, though highest in forested areas and riparian zones. Residential & Commercial Development (highest in urban areas), Agriculture & Aquaculture, Human intrusions/disturbances, & Pollution (highest in coniferous forests) are all Medium threats across habitats.

[1] L = Low magnitude threats; M = Medium; H = High; VH = Very High. Blank cells indicate that no priority bird species had threats identified in the threat category / habitat combination. Adapted with permission from Environment Canada 2013.

3. CONSERVATION STRATEGY

This Habitat Conservation Strategy has been developed by partners and collaborators of the Eastern Habitat Joint Venture (EHJV) New Brunswick Steering Committee. The purpose of this strategy is to identify the species and ecosystems of conservation priority for the Upper St. John River Bioregion, their spatial location, and the actions that conservation organizations plan to undertake to achieve their conservation and stewardship.

A. Vision

This bioregion's natural environment is most well-known for the Appalachian Hardwood Forest, Rich Calcareous sites, in addition to rare species occurring in select locations. Furbish's lousewort (*Pedicularis furbishiae*) is one of these species endemic to the Upper St. John River. Potato agriculture and forestry are major economic drivers in this bioregion, creating a delicate balance between continued economic stability and further environmental protection. Species at Risk and rare species are numerous in the bioregion, though information on many of these are lacking. This is supported by the lack of knowledge of the smaller more isolated habitat types, like beaches, cliffs and rock outcrops, where many of these species occur.

B. Goals

Table 10. Conservation goals for the Upper St. John River Bioregion.

1) Conserve as much of the remaining forests as possible, especially the AHF and mature to old forest habitats
2) Set aside more conservation lands in other habitats, including riparian and wetland areas and calcareous zones
3) Reducing impacts of industrial agriculture
4) Further mitigating the impacts that the dams have had on the SJR

C. Habitat spatial prioritization

As part of this Habitat Conservation Strategy, methodologies were developed by EHJV partners to define and combine a series of priority habitats with priority species composites to identify areas within the USJR bioregion that have high conservation value. The goal is to achieve the best possible impact of collective conservation actions in those areas that are the most critical for the priority habitats and species. Three sets of maps were produced in the analysis which should be used together as decision-support tools: the Priority Habitat Composite, Conservation Value Index (CVI), and the Species Composite maps. Though the Conservation Value Index map can be considered, other maps provided in this document likely will provide decision-support that is more appropriate to the mandate of a given conservation group or agency. No single map is intended to answer all questions regarding conservation needs and these maps are not designed as stand-alone products; the narrative of this report as well as the habitat and threat occurrence maps are important elements to be examined. For various reasons, including introduced bias, the CVI map, priority habitat maps and various species composite maps can present contrasting perspectives on spatial priorities. This is expected and also reflects the reality that contrasting approaches to conservation may be required for the conservation of different species and the habitats that host them (i.e. land acquisition versus stewardship).

Habitat Classification and Data Pre-processing

Prior to assigning conservation priority scores to habitat patches, spatial data for each priority habitat type was "pre-processed" in order to identify and isolate those habitat patches with the highest potential to have conservation value. For rare habitat types (ex. cliffs or beaches) all habitats found to be present were considered to have potential, thus no occurrences of these habitats were eliminated from the analysis. More widespread and complex habitats (ex. forest or non-forested areas) also include patches of land unsuitable for conservation action such as clear cuts or plantation forest blocks, very young forest, or urban and industrial land. Prior to habitat scoring, these patches of land were eliminated from the analysis by methods developed by EHJV partners. For a detailed description of the datasets used and the habitat classification methods employed in this step please refer to Appendix F. Of important note is that forested wetland, "poorly drained", and "seasonally saturated" forest patches identified by the NB DNR Forest Resource Inventory were classified as wetlands rather than forest habitat in this analysis. The rationale for this decision was to ensure that the dominant ecological characteristic (prolonged presence of water) for these areas was captured in the analysis. These sites tend to be found in the large interconnected wetland complexes, and along the river flood plains of the St. John River and its major tributaries (ex. Tobique River).

Habitat Patch Weighting

The process for assigning priority ranks to habitat within the LSJR bioregion involved weighting (scoring) certain characteristics of the priority habitats higher than others. Wetland and Acadian forest mosaic habitat occurrences were scored using a three-tiered equation that equally divides the scoring by size (e.g. minimum patch size), representivity (by ecodistrict) and uniqueness (rarity within each ecodistrict and within the Bioregion). All other habitat types were weighted according to size or presence / absence as noted above. For a detailed explanation of the habitat weighting process, please refer to Appendix F. The methodology was deliberately designed to emphasize parcels of land that contained larger patches of priority habitats, those that were not adequately represented within an ecodistrict, and containing rare/priority species and habitat occurrences. The more high-quality priority habitats that an area contained, the higher the priority rank it received, and higher scores were given to areas with larger patches of ecosystems selected as biodiversity habitats. Area measurements for the minimum patch size required to supporting biodiversity in each habitat type were used to comparatively rank habitats in order to avoid over-weighting small habitat patches. For each priority habitat type, final scores between 0 and 1 were assigned to each patch represented in the spatial dataset, 1 representing completely suitable habitat for nested habitats and 0 representing unsuitable habitat. Existing protected areas and other conservation lands were not included in the analysis.

Table 11: Composites of all habitats, species and conservation value

Fig.	Composite	p.	Description
27	Priority habitat (Including Grassland / Agro-ecosystems)	108	All priority habitats, showing relative patch values, including Grasslands / Agro-ecosystems
28	Priority habitat (Excluding Grassland / Agro-ecosystems)	109	All priority habitats, showing relative patch values, grasslands/agro-ecosystems habitats excluded
29	Biodiversity composite of all priority species	111	All priority species of concern identified in the LSJR Habitat Conservation Strategy
30	Biodiversity composite of bird species at risk	112	All bird species at risk known occurrences in the LSJR bioregion
31	Biodiversity composite of non-bird species at risk	113	All non-bird species at risk known occurrences in LSJR bioregion
32	Biodiversity composite of the relative abundance of priority bird species	114	Relative abundance of birds across the LSJR bioregion
33	Biodiversity composite of the breeding evidence of priority bird species	115	Documented breeding evidence for birds breeding in the LSJR bioregion for which relative abundance measures could not be derived otherwise from point count data.

34	Biodiversity composite of rare non-bird species	116	Rare non-bird species known occurrences across the LSJR bioregion
35	Biodiversity composite of rare amphibians and reptiles	117	Rare Amphibians and reptiles known occurrences across the LSJR bioregion
36	Biodiversity composite of rare terrestrial invertebrates	118	Known occurrences of rare terrestrial invertebrates across the LSJR bioregion
37	Biodiversity composite of rare mammals	119	Known occurrences of rare mammals across the LSJR bioregion
38	Biodiversity composite of rare plants, lichens, and bryophytes	120	Known occurrences of rare plants, lichens, and bryophytes across the LSJR bioregion
39	Conservation Value Index	122	All priority habitats and all priority species
40	Conservation Value Index (excluding grasslands/agro-ecosystems)	123	All priority habitats, grasslands/agro-ecosystems excluded, and all priority species

Priority Habitat Composite

The first set of maps produced present composites of the seven priority habitat types but exclude the species-based information; these maps were produced by using an additive function that layered each habitat dataset and compiled the scores for each habitat patch. Scores making up the priority habitat composites include consideration of the uniqueness, representivity, and size of individual patches of defined priority habitat types (see Appendix F for a detailed description of the methodology). The habitat composites represent all of the ranked habitats contained in the bioregion with a value (ranging from 0 to 3) that could be classified and used to illustrate the ranges in conservation value for habitat. In order to create a decision support tool free from any bias inherent in the species data, the species data / biodiversity composite layer was excluded from this piece of the analysis. Similarly, in an effort to discern the driving factors behind the high and very high-ranked conservation value habitats, the second of the two Priority Habitat Composite maps excludes grassland layers. The large, interconnected grassland/agro-ecosystems can clearly be seen to have a high ranking in particular areas of the bioregion (ex. Woodstock area), overshadowing the importance of wetlands and forests in these areas. Please refer to **Fig. 27** and **Fig. 28**.

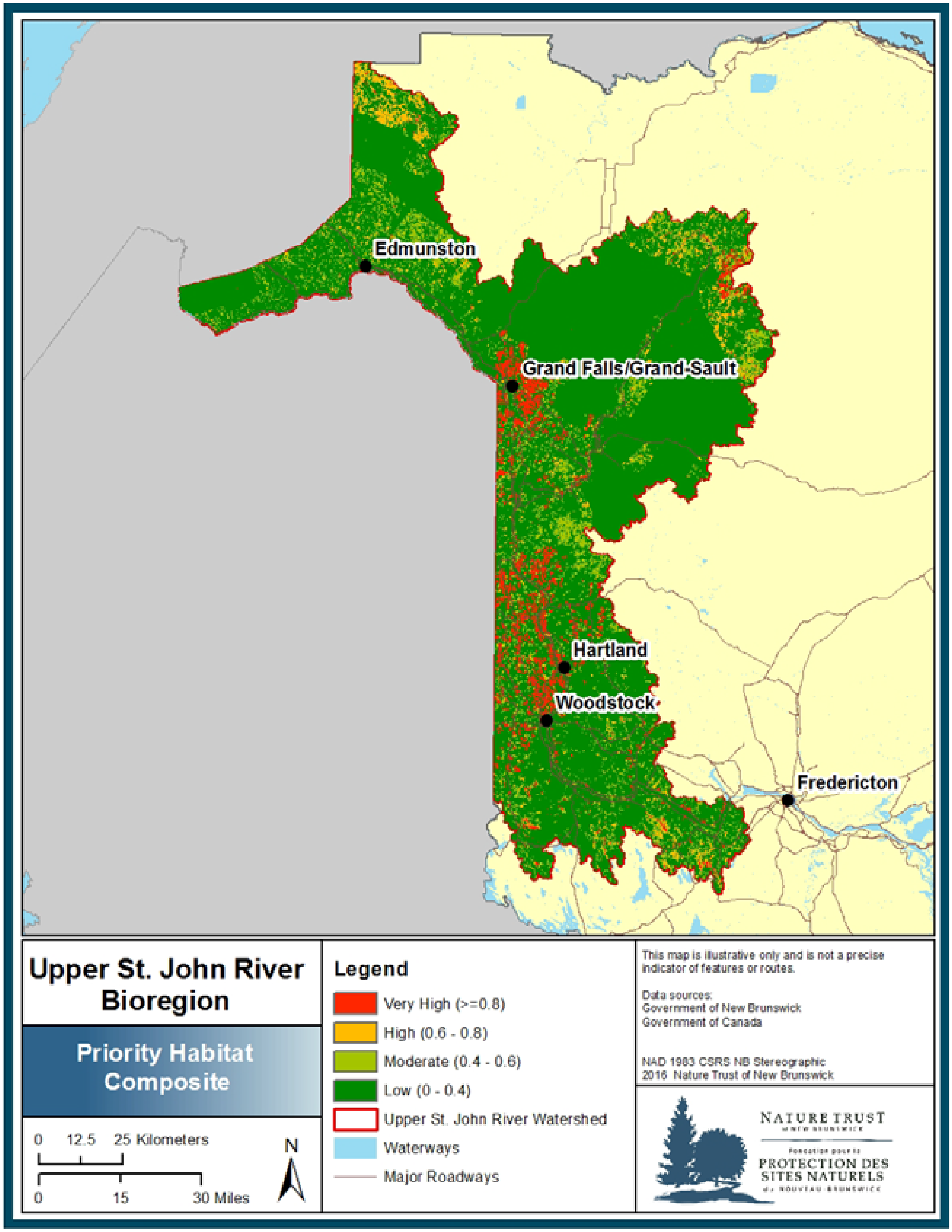

Fig. 27: Priority Habitat Composite including Grasslands / Agro-ecosystems in the Upper St. John River Bioregion

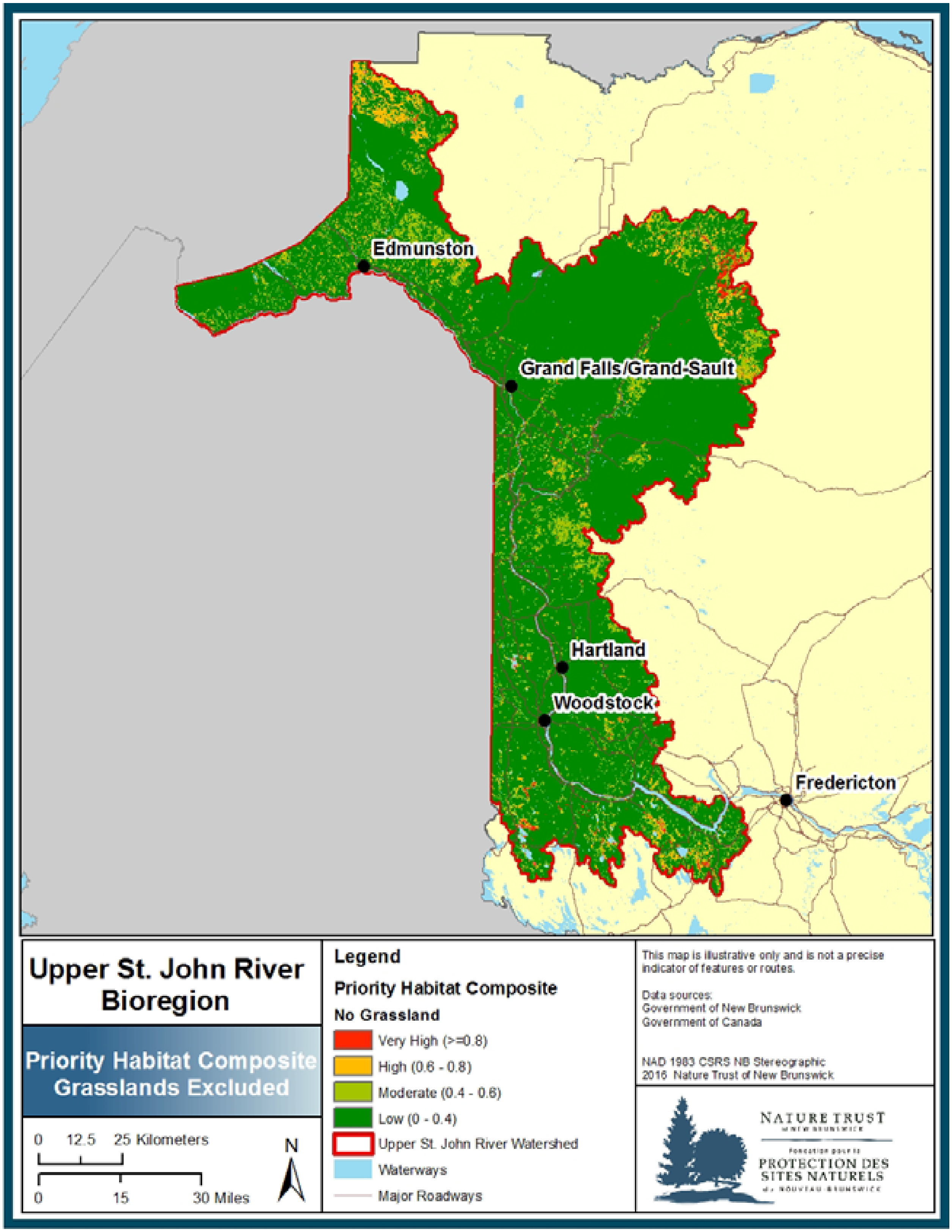

Fig. 28: Priority Habitat Composite excluding Grasslands / Agro-ecosystems in the Upper St. John River Bioregion

D. Species spatial prioritization

Species Composite Maps

Spatial data were gathered for each priority species from various sources. For some species, multiple sources of spatial data exist, so the most complete or appropriate dataset was chosen. A single layer of information was derived for each species based on the most appropriate data available, and used to generate a spatial representation of relative occurrence across the province. A detailed description of the methodology used to create the individual species layers can be found in Appendices B and C. The reader is cautioned that species occurrence data are for the most part temporally and/or spatially incomplete; as such, maps that rely on species occurrence data can be expected to reflect bias due to uneven effort intensity and should be interpreted as presenting relative available evidence of occurrence rather than true relative abundance. Such effort bias expectedly is pronounced in maps of species for which detections are rare (e.g., difficult to detect species, rare species) or that require intensive or survey approach.

Individual species datasets have been compiled in this analysis to produce various multi-species composites based on different suites of species sharing ecological characteristics, conservation status, or survey approach. Individual species maps are generated at the scale of the province, not the bioregion, and all species receive equal weighting in species composite maps. In order to improve future iterations of species maps, we encourage all those with any additional rare and priority species occurrence data (Appendix C) to contribute their records to the Atlantic Canada Conservation Data Centre.

An overall biodiversity composite, including data for the full suite of terrestrial and terrestrial aquatic species was generated at the scale of the whole province; with all species receive equal weighting in (**Fig. 29**). However, given important expected difference among species, conservation status, ecological requirements, and survey bias, different partial composites representing different sub-suites of species were also generated (**Fig. 30-38**). Table 11 describes the various priority species composites that were generated and the type of information they present. A full list of priority species including conservation status and habitat association for each species can be found in Appendix C and D, while a list of the datasets and species included in each species composite map are presented in Appendix E. Sub-sets include taxonomic affiliation (i.e., birds, plants, mammals), COSEWIC status (species at risk), and in the case of birds, survey type (i.e., breeding evidence data, point count data). Consideration of the sub-suite maps will provide the reader with a better sense of the species and data sources driving certain map outputs, and will better enable the reader to consult the underlying data that are most appropriate to the question of interest and hopefully make more accurate conservation decisions. It was felt that this approach and the materials produced would better reflect the ecological complexity of the bioregion and would provide more complete decision support for the broad range of users expected to make use of this Habitat Conservation Strategy.

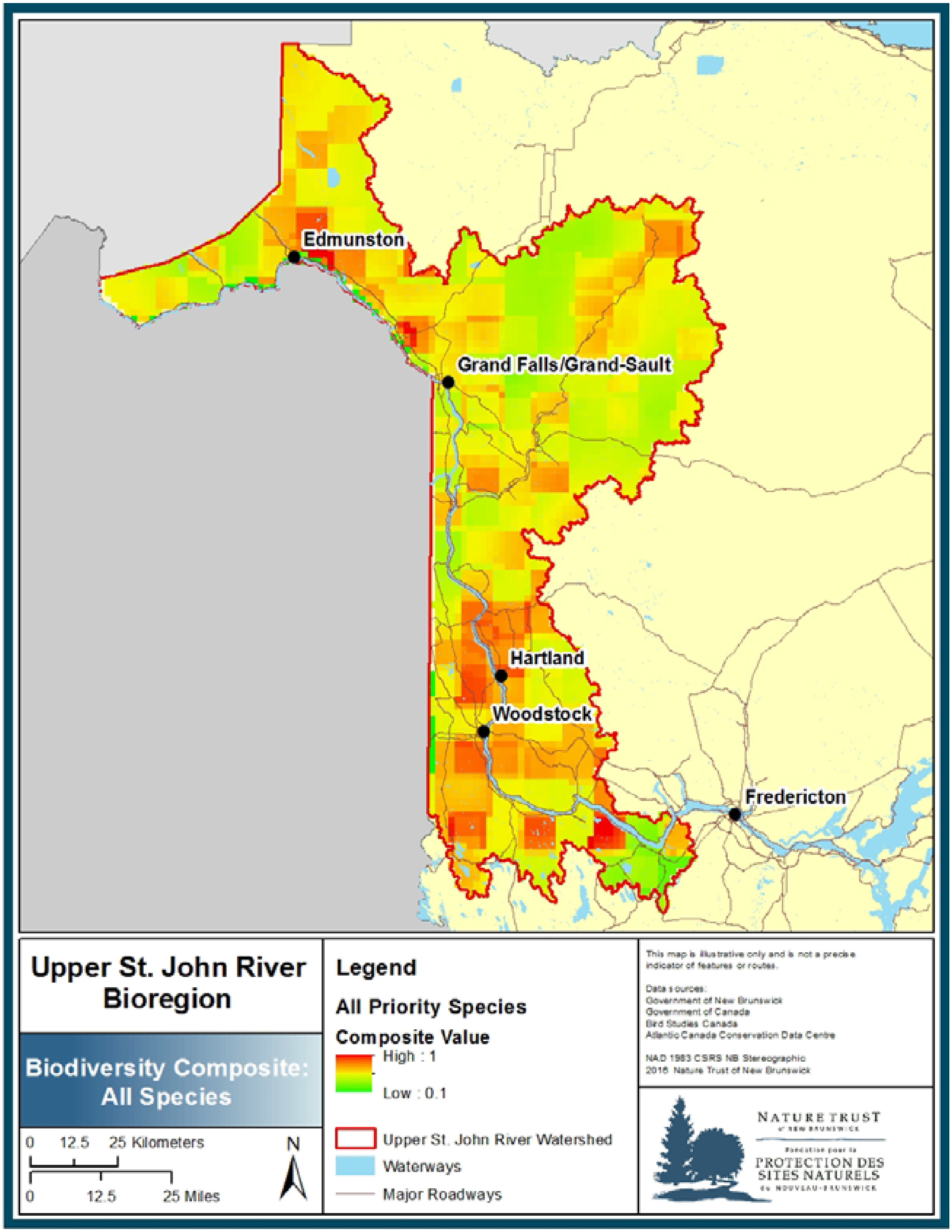

Fig. 29: Biodiversity Composite for all Priority Species in the Upper St. John River Bioregion

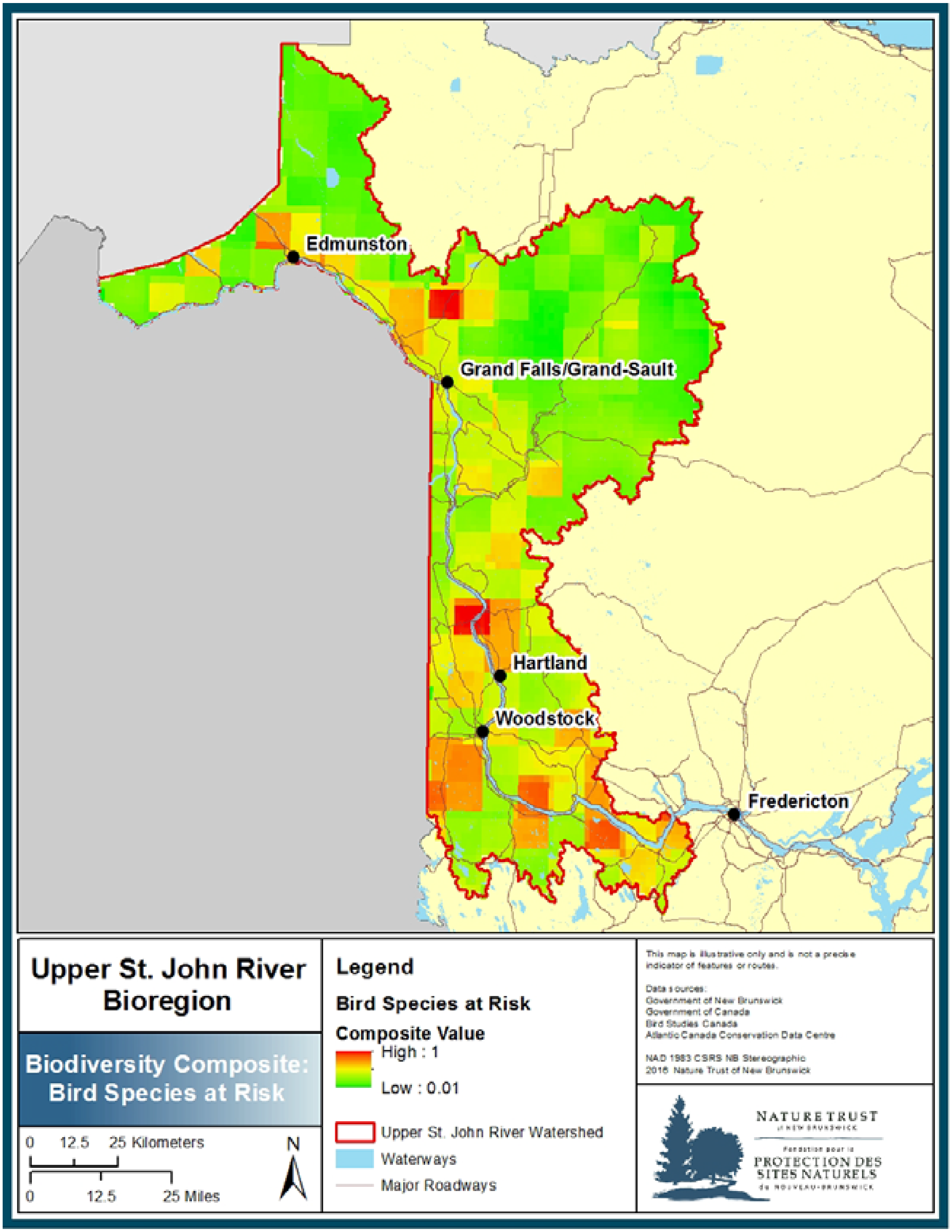

Fig. 30: Biodiversity Composite for Bird Species at Risk in the Upper St. John River Bioregion

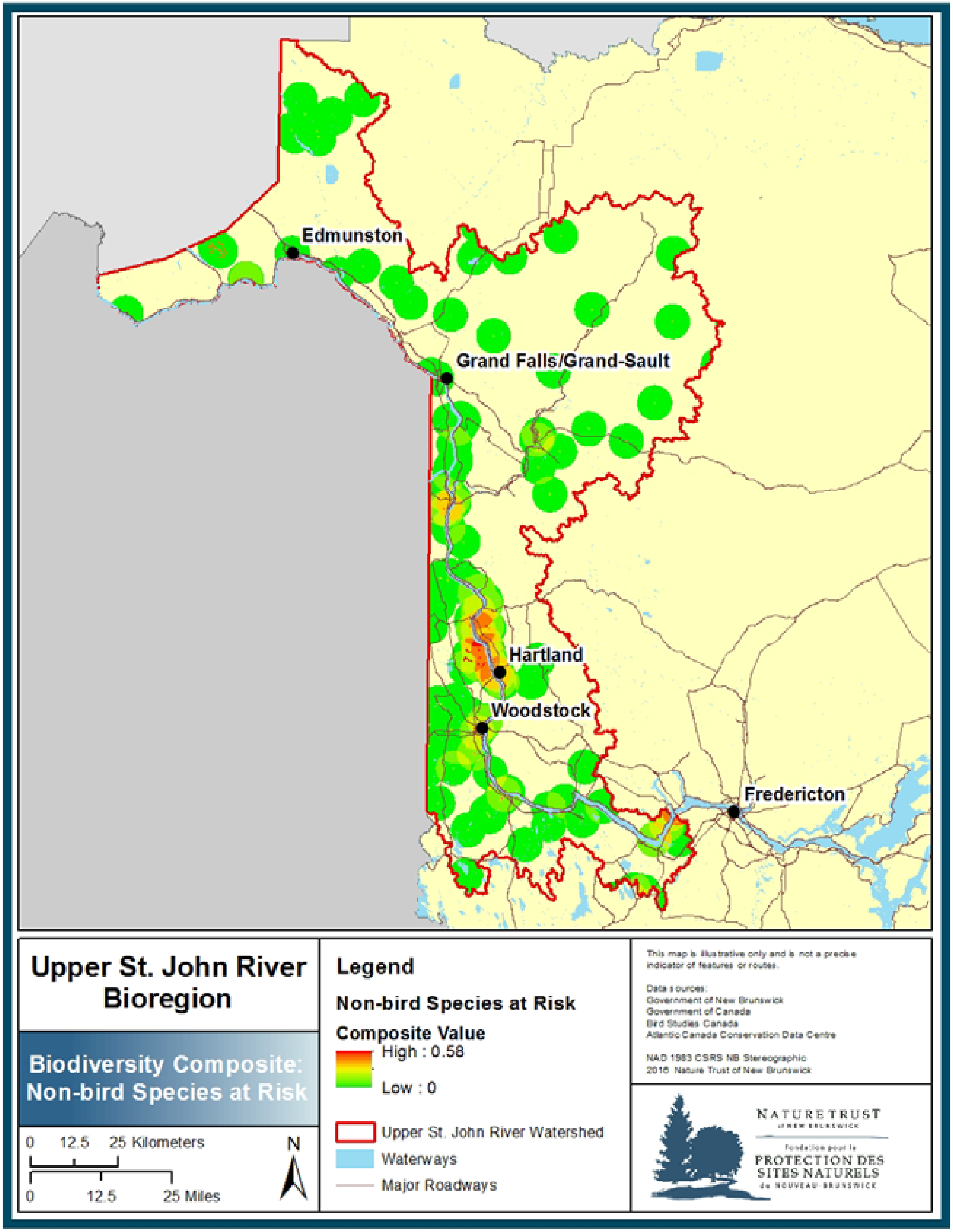

Fig. 31: Biodiversity Composite for Non-bird Species at Risk in the Upper St. John River Bioregion

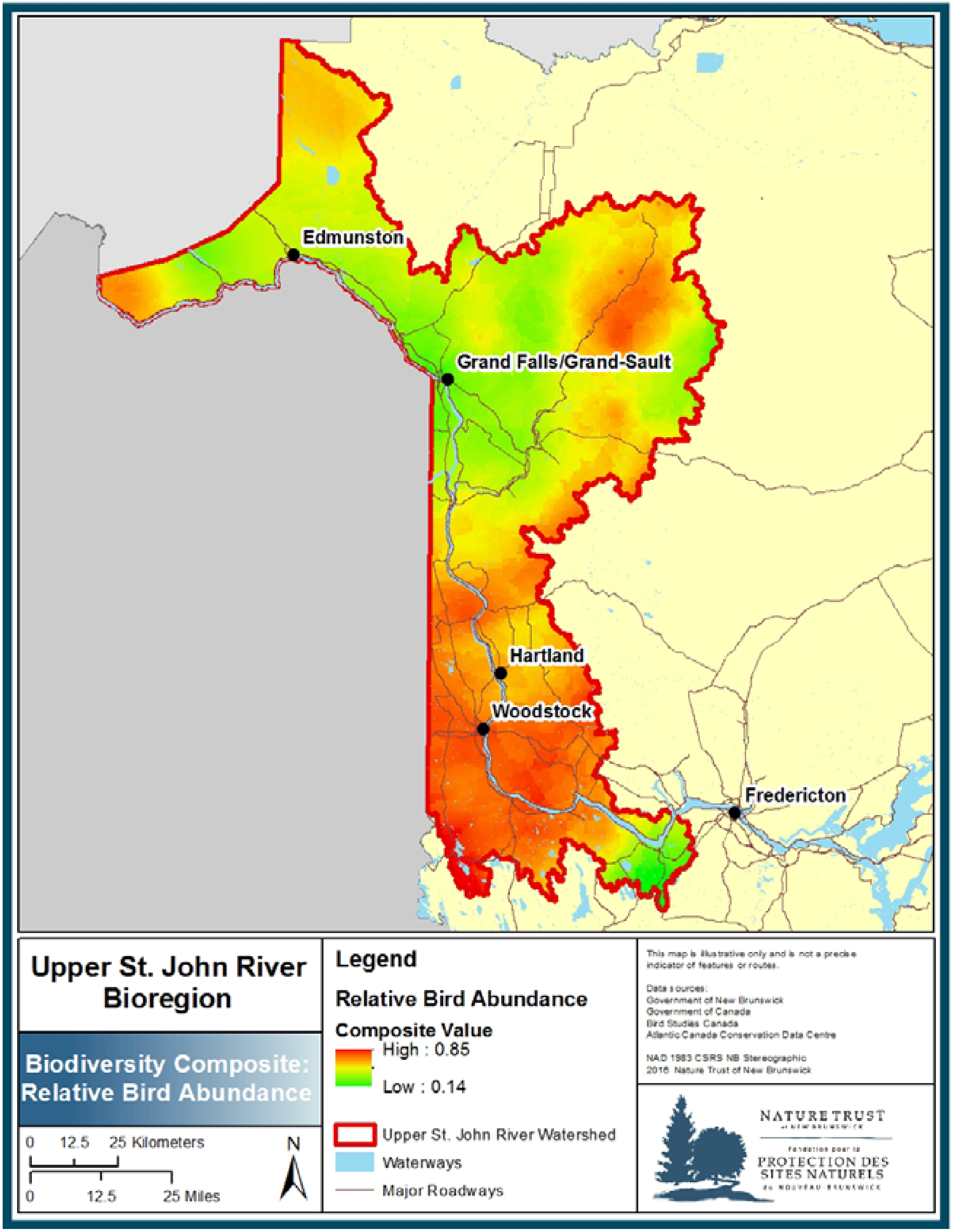

Fig. 32: Composite of relative abundance of Priority Bird Species in the Upper St. John River Bioregion

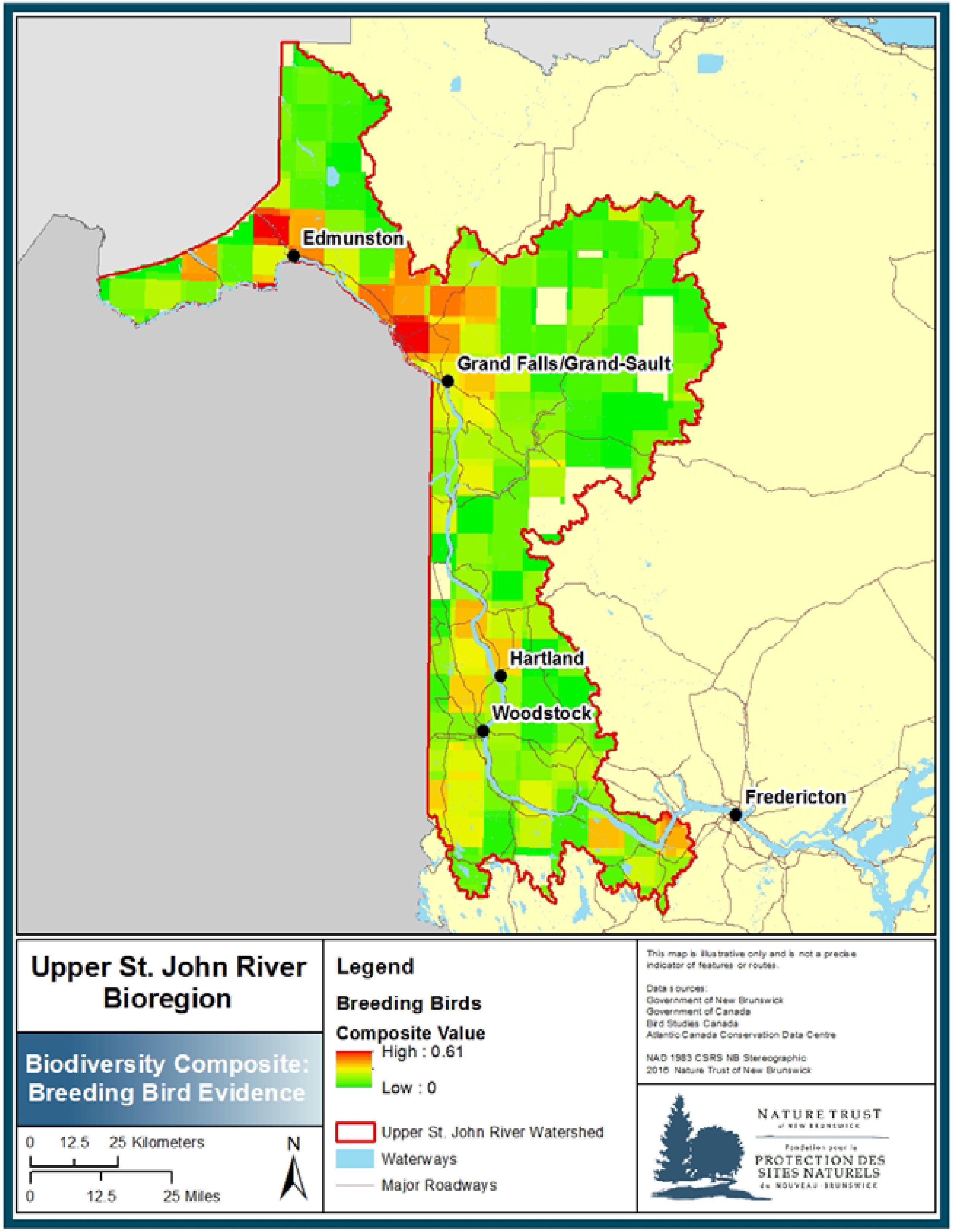

Fig. 33: Composite of Breeding evidence of Priority Bird Species in the Upper St. John River Bioregion

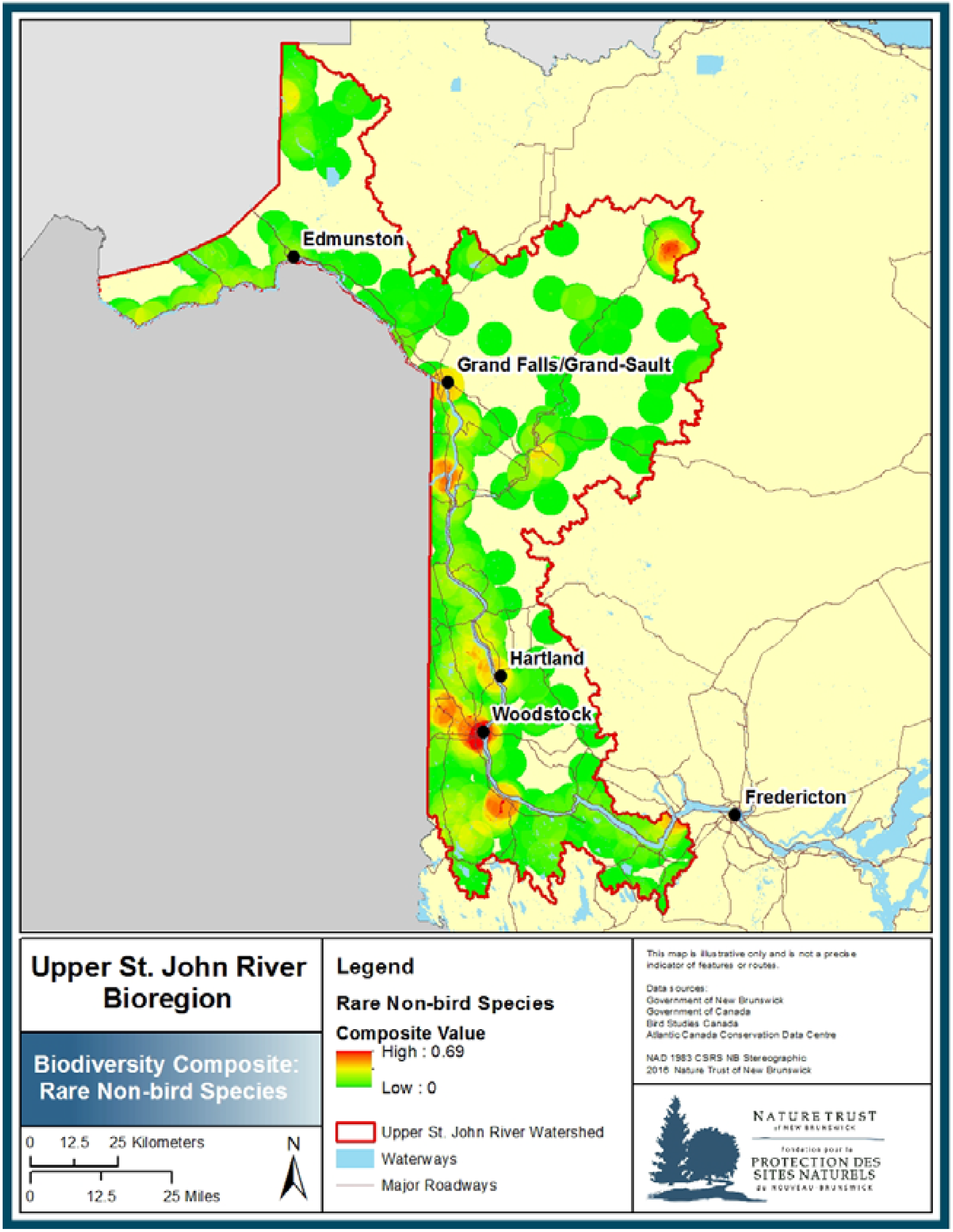

Fig. 34: Biodiversity Composite for all Rare Non-bird Species in the Upper St. John River Bioregion

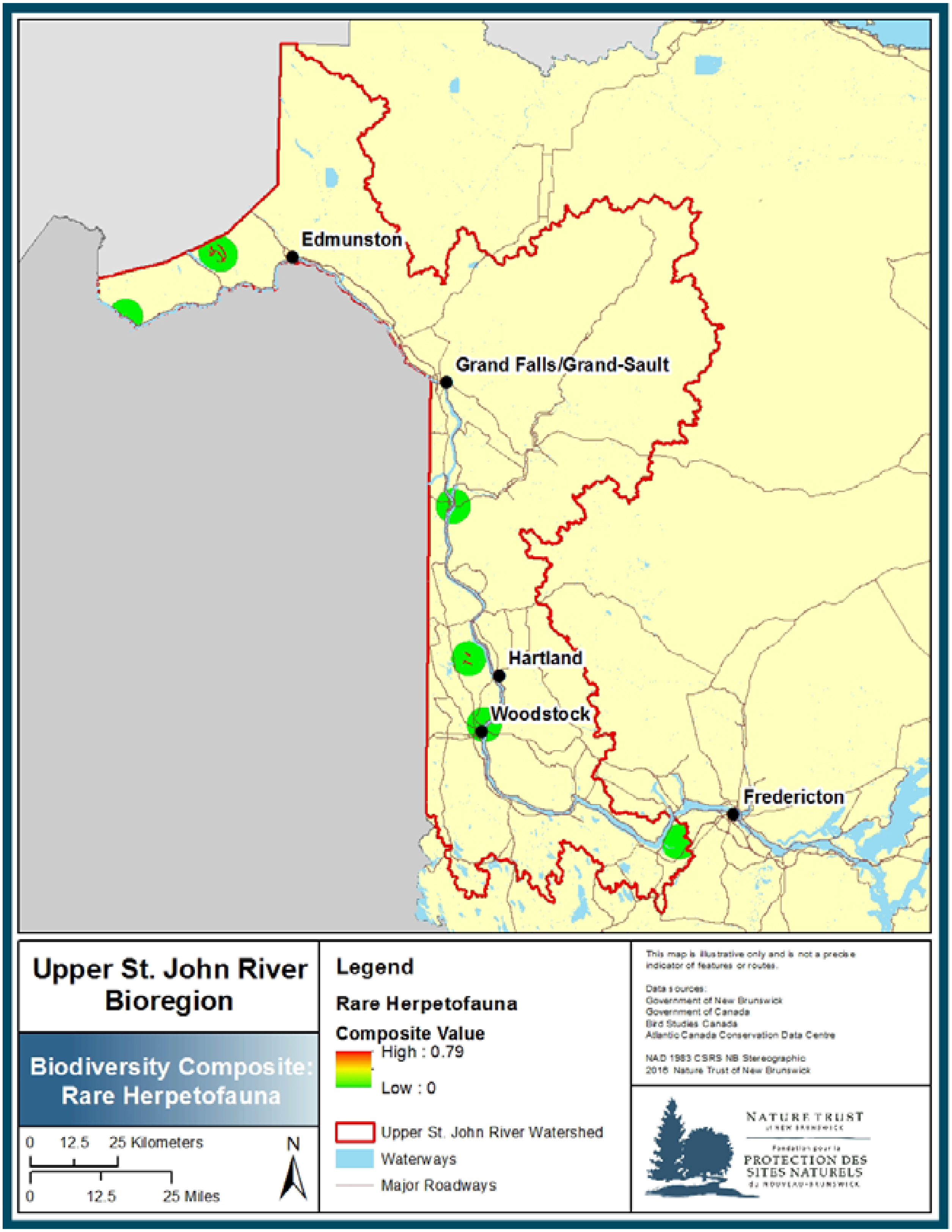

Fig. 35: Biodiversity Composite for Rare Herptofauna (Amphibians and Reptiles) Species in the Upper St. John River Bioregion

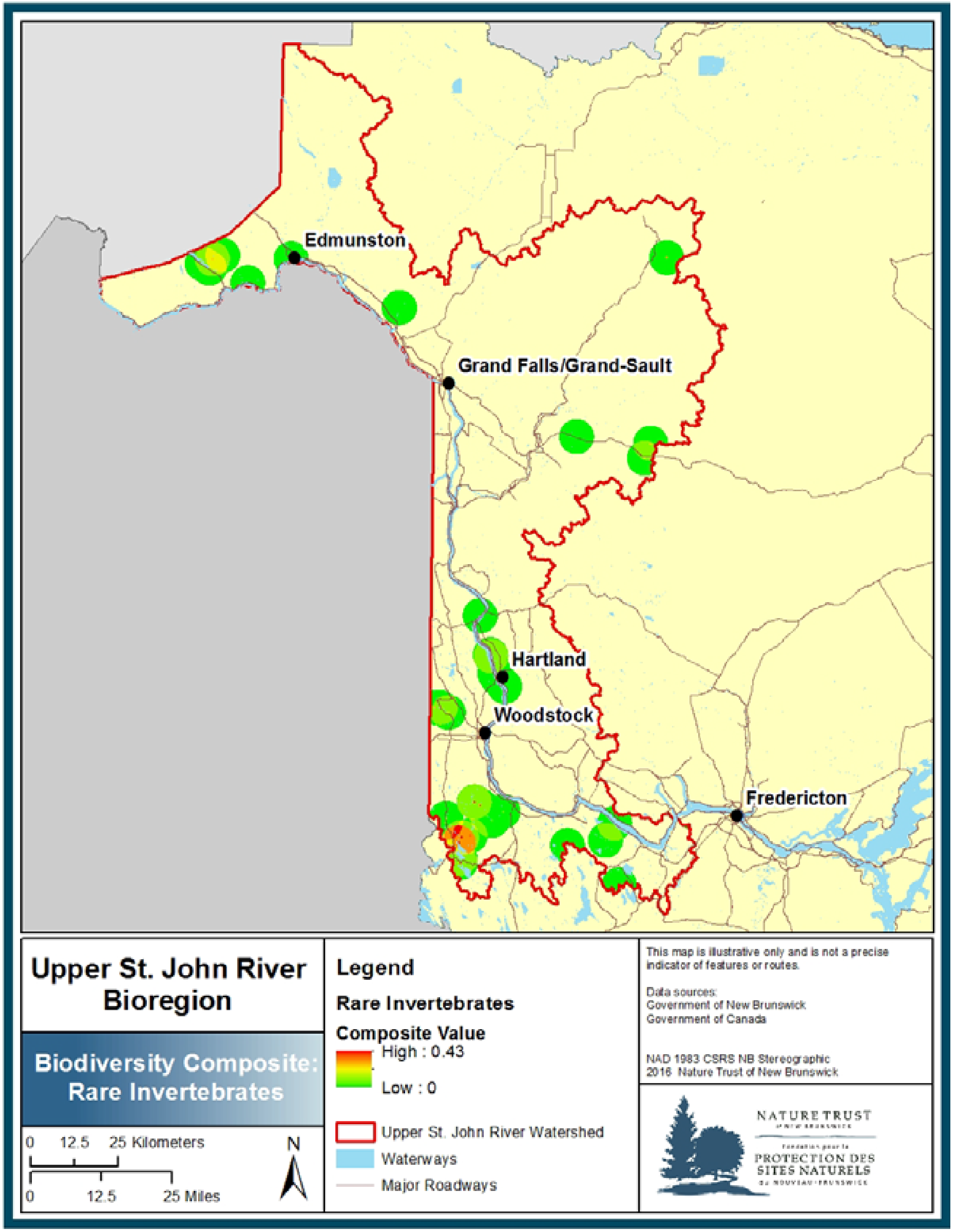

Fig. 36: Biodiversity Composite for Rare Terrestrial Invertebrate Species in the Upper St. John River Bioregion

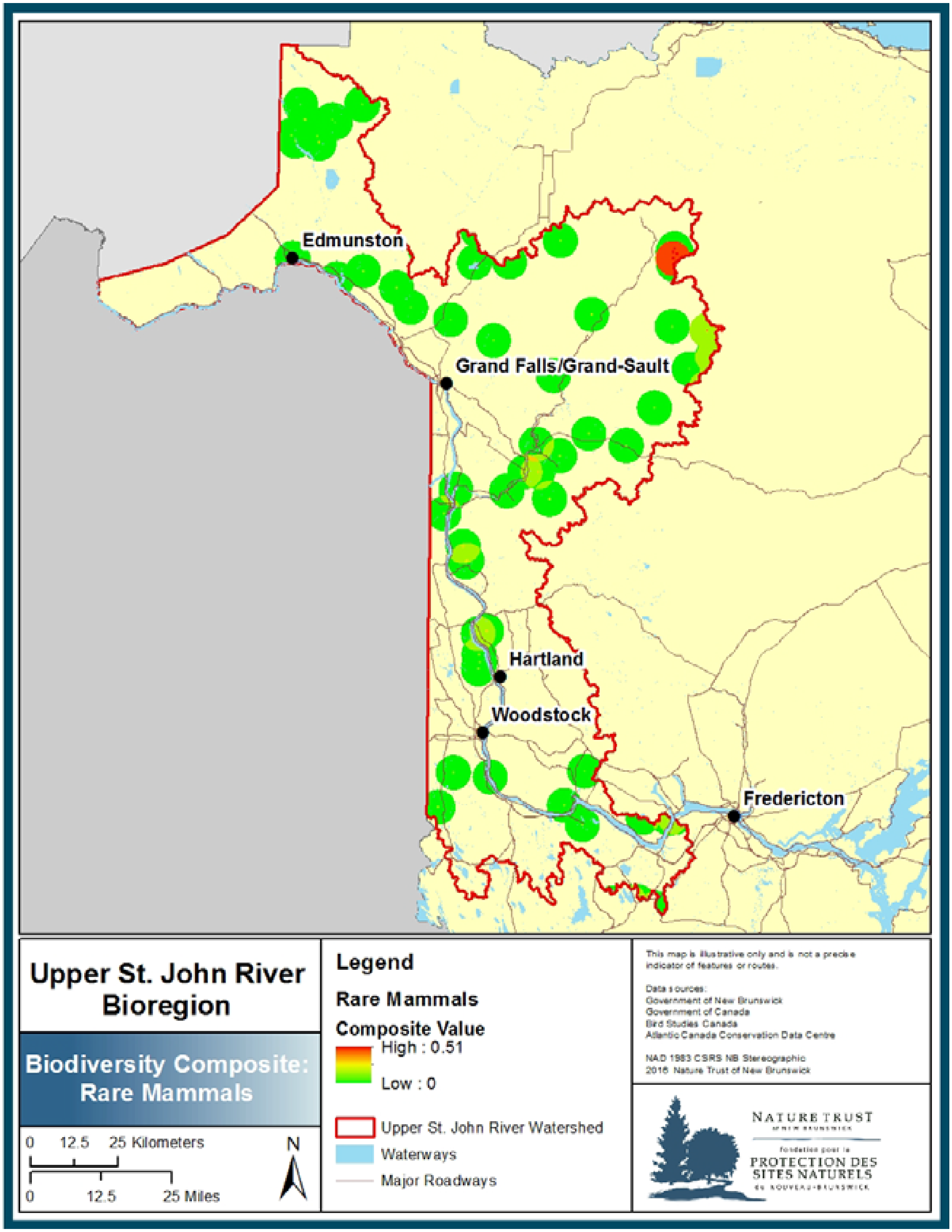

Fig. 37: Biodiversity Composite for Rare Mammal Species in the Upper St. John River Bioregion

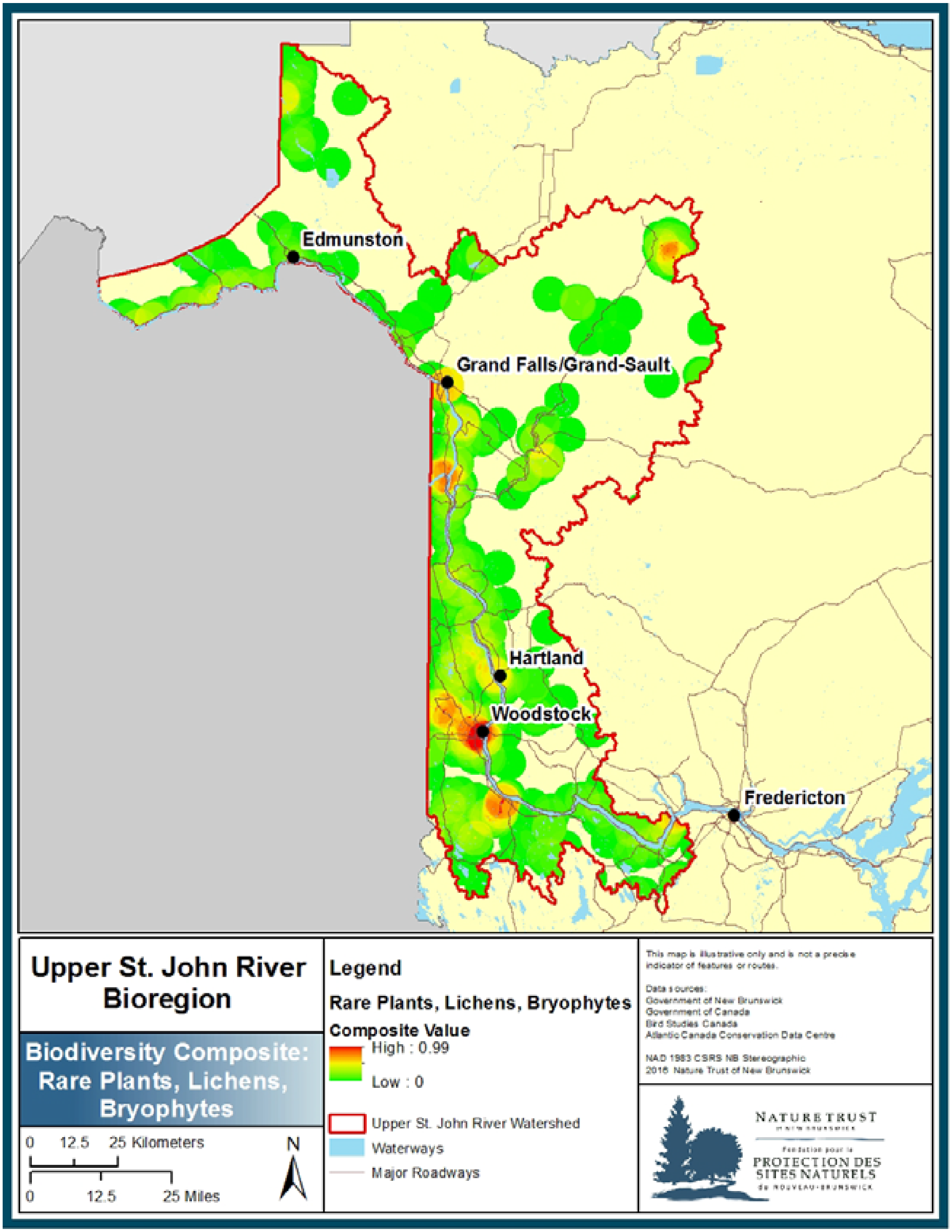

Fig. 38: Biodiversity Composite for Rare Vascular and Non-Vascular Plant Species in the Upper St. John River Bioregion

E. Conservation value index

A map depicting the spatial location of overall conservation priority habitat patches was developed based on available occurrence records of rare and endangered species, breeding evidence and relative abundance information of conservation priority birds, combined with the spatial location, extent and regional context of priority habitats. In this map, the habitat prioritization map (a composite of all habitats each with a score based on attributes of the defined habitat conservation priorities, which includes consideration of the uniqueness, representivity, and habitat patch size) and a species composite map (composite of all species, each with a score based on a kernel density estimation of the relative available evidence of occurrence in the bioregion) are combined to yield a Conservation Value Index (CVI) map of the bioregion.

The Conservation Priority Index for the USJR is presented in **Fig. 39** (including grasslands / agro-ecosystems) and **Fig. 40** (excluding grasslands/agro-ecosystems). The latter CVI map was generated without grasslands/agro-ecosystems habitat patches because the high CVI scores of the initial output were driven by the inherently larger, well-connected agricultural patches in the bioregion. As such, the initial CVI map could not show well the high relative importance of the other natural habitat patches in the bioregion. The CVI (grasslands/agro-ecosystems excluded) (**Fig. 40**) thus provides a necessary complement to the initial CVI for occasions when heavily managed habitats are not considered a conservation priority.

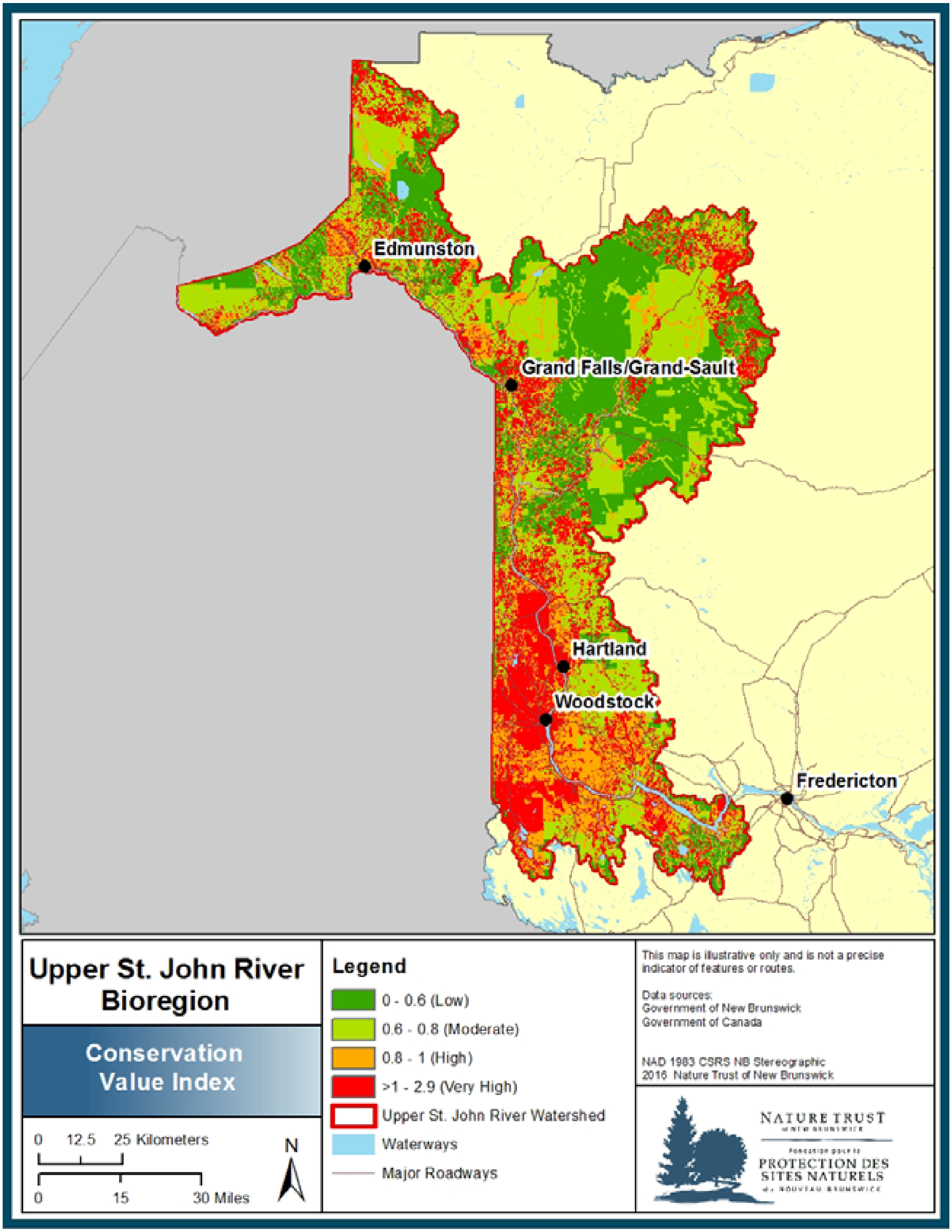

Fig. 39: Conservation Value Index for the Upper St. John River Bioregion (Including Grassland / Agro-ecosystems)

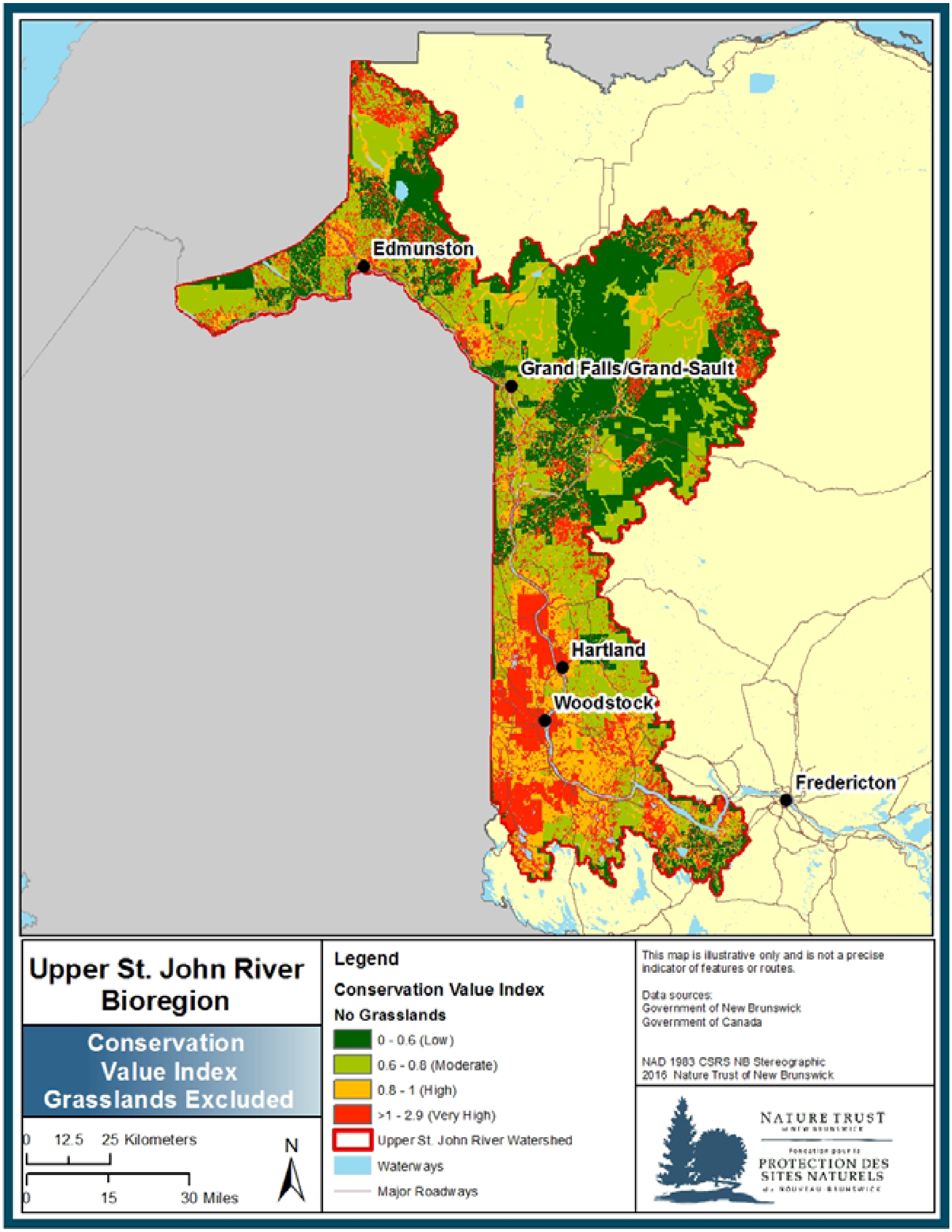

Fig. 40: Conservation Value Index for the Upper St. John River Bioregion (Excluding Grassland / Agro-ecosystems)

F. Conservation partner actions

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
1. Securement					
1.1 Resource & Habitat Protection The Nature Trust of New Brunswick will work with landowners to develop voluntary stewardship agreements on private land which will address specific threats to Species at Risk, rare species communities, and threatened ecosystems: key objectives are Appalachian hardwood forest stands, SAR habitat, old forest, and rare plant stations	BENEFICIAL	ALL	Threat-specific	Negotiate and conclude voluntary stewardship agreements or site management plans with a minimum of 10 property-owners annually and maintain regular contact with and provide support through the Nature Trust's Landowner Stewardship Program.	NTNB
1.1 Resource & Habitat Protection The Meduxnekeag River Association will co-operate with landowners to voluntarily conserve the natural riparian zone along the Meduxnekeag River and its wildlife and plant species.	BENEFICIAL	Riparian	Habitat degradation, development		MRA
1.1 Resource & Habitat Protection Through the Natural Areas Conservation Program, the Nature Conservancy will make available funding to support filling knowledge gaps in rare species communities and preservation of these sites in the region.	NECESSARY	ALL	Habitat loss, habitat degradation		NCC

[1] ***Critical:*** Conservation actions that, without implementation, would clearly result in the reduction of viability of a biodiversity target or the increase in magnitude of a critical threat within the next 5-10 years. Also includes research information that is needed before key decisions can be made on the management of biodiversity targets.

Necessary: Conservation actions that are needed to maintain or enhance the viability of biodiversity targets or reduce critical threats. Also includes research that will assist in decisions on management of biodiversity targets.

Beneficial: Conservation actions that will assist in maintaining or enhancing viability of biodiversity targets and reducing threats.

[2] Biodiversity Targets:

[3] Biodiversity threats: see

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
1.2 Site/Area Protection The Nature Trust of New Brunswick will pursue permanent protection of high conservation-value habitat within the Upper St. John River watershed as opportunities for land donation or purchase arise.	NECESSARY	Appalachian Hardwood Forest, riparian, beach	Habitat loss, development	NTNB will continue to place highest priority on protecting threatened habitats within the Upper St. John River Valley including confirmed Appalachian hardwood forest, river shoreline supporting rare plant communities, and unique sites supporting Species at Risk, rare species habitat, and old forest.	NTNB
1.2 Site/Area Protection The Nature Conservancy of Canada will pursue permanent protection of high conservation-value habitat within the Upper St. John River watershed as opportunities for land donation or purchase arise.	NECESSARY	Acadian Forest	Habitat loss, development	NCC will pursue conservation of Appalachian Hardwood Forest sites in the Upper St. John River Valley.	NCC
1.2 Site/Area Protection The Meduxnekeag River Association (MRA) will pursue permanent protection of high conservation-value habitat within the Canadian portion of the Meduxnekeag River watershed as opportunities for land donation or purchase arise.	CRITICAL	Appalachian Hardwood Forest, riparian	Habitat loss, development	The MRA will pursue acquisition of remnant Appalachian Hardwood Forest sites and their inherent biodiversity and natural beauty in the Canadian portion of the Meduxnekeag River watershed.	MRA
1.3 Site/Area Protection The Canadian Parks and Wilderness Society (CPAWS) with its partner organizations at Two Countries, One Forest is undertaking a collaborative conservation planning project for the Three Borders Region (NB, QC, ME). focused on maintaining	BENEFICIAL	ALL	Habitat loss, lack of connectivity	The Three Borders project is focused on maintaining functional landscape linkages at the ecosystem scale across provincial and international borders through collaborative public and private forest management, landuse planning, and cooperation among public and private sectors.	CPAWS, NCC, TNC, 2C1F
1.3 Site / Area Protection The Nature Trust has begun investigating options for large-scale working forest conservation easements on freehold land in New Brunswick, along with desired outcomes, conservation objectives, and partnership opportunities.	Necessary	Acadian Forest, riparian, wetland	Habitat loss, lack of connectivity, incompatible forestry practices	The purpose of this action is to contribute new protected lands to NB's existing protected lands network by increasing the amount of land managed for IUCN Category VI: Protected area with sustainable use of natural resources in the USJR region.	NTNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
2. Stewardship – Land/ Water Management					
2.1 Site Management Train voluntary preserve stewards to monitor Nature Trust properties annually for impacts from use and respond to any potential threats to biodiversity targets.	NECESSARY	ALL	Recreational use	Nature Trust properties are monitored annually for impacts from public use and response actions developed as necessary to address problems.	NTNB
2.2 Site Management The Nature Trust of New Brunswick will develop a spatial database of known and potential Appalachian Hardwood Forest sites throughout the USJR Bioregion and pursue voluntary stewardship and permanent protection of these sites.	NECESSARY	Riparian and Aquatic, Acadian Forest, Appalachian Hardwood Forest	Habitat loss and degradation, Loss of connectivity	• AHF spatial database to be completed by 2019 • Database of known sites and conservation status is under development • Identification of priority sites for acquisition or voluntary stewardship	NTNB
2.1 Site Management La Société d'aménagement de la rivière Madawaska et du lac Témiscouata inc. (SARM) conducts water quality monitoring for the Madawaska River and Lake Temiscouata, riparian habitat restoration at degraded sites, and water quality outreach work where appropriate in the region.	BENEFICIAL	Riparian and aquatic	Habitat loss and degradation	n/a	SARM
2.1 Site Management Ducks Unlimited Canada maintains several water control structures on managed properties in the USJR region; fish passage structures receive biannual engineering inspections and water level control structures are monitored at a minimum once annually.	BENEFICIAL	Freshwater wetland and aquatic	Habitat loss and degradation	• DUC-managed wetlands retain the functional characteristics required for providing waterbird breeding and staging habitat while also allowing for effective fish passage • Water level-control structures are maintained in an optimal state over the lifetime of the structure	DUC
2.1 Site Management NB Power has engaged the Canadian Rivers Institute to design a large multidisciplinary aquatic ecosystem study to support their	NECESSARY	Aquatic, riparian	Dams	The Mactaquac Aquatic Ecosystem Study (MAES) is a whole-river ecosystem study beginning with a multi-year assessment of the structure and function of a large river ecosystem, followed by a manipulation of flow, sediment load, and thermal	CRI, UNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s) [3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
decision-making process and subsequent regulatory requirements.				regime with consequential effects on the ecosystem, and then a multi-year period to monitor the recovery to a new river state. Research is focused in three key areas: 1. Whole River Ecosystem Studies examining the physical and biological structure and function of the river and the reservoir environments; 2. Fish Passage for diadromous species of concern/at risk; 3. Environmental Flows modelling and predictions for future river flows and management regimes.	
2.1 Site Management The Nature Conservancy of Canada is researching key knowledge gaps and developing mapping and resources to support aquatic connectivity	BENEFICIAL	Riparian and Aquatic	Habitat loss and degradation, loss of connectivity	• Assemble existing aquatic barrier assessments • Map barriers in the Bioregion • Prepare report on best practices for stream crossings	NCC
3. Stewardship - Species Management					

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
3.1 Species Management Nature Trust of New Brunswick and its partners and volunteer stewards will monitor target species and their habitat on Nature Trust preserves and easements.	BENEFICIAL	ALL	ALL	Collect baseline data for target species; Contribute to the detection of population trends over the long-term.	NTNB, Nature NB, ACCDC
3.1 Species Management The Société d'aménagement de la rivière Madawaska et du lac Témiscouata inc (SARM) undertake monitoring and population studies for Wood Turtle at various locations in the Madawaska River watershed including identified Critical Habitat.	BENEFICIAL	Riparian and aquatic, Acadian Forest, Agricultural	Habitat loss and degradation	• Track long-term trends throughout the study area and engage citizen scientists in tracking these trends	SARM
3.1 Species Management Species Monitoring: Maritime Swiftwatch Program. Bird Studies Canada delivers a citizen science monitoring and conservation program involving volunteers who steward Chimney Swifts and their habitat at known roost and nest sites throughout the Maritime Provinces.	NECESSARY	ALL	Monitoring Habitat loss and degradation, species loss	• Track long-term trends throughout province of NB for Chimney Swift populations, and man-made and natural roost/nest sites. • Engage citizen scientists in identifying and monitoring active chimney roost / nest sites – sites have been identified in the USJR at Plaster Rock and Saint Anne, NB.	BSC
3.1 Species Management The Nature Conservancy of Canada will research key knowledge gaps associated with invasive species, and target species through surveys, mapping and GIS modelling as appropriate	BENEFICIAL	ALL	Habitat degradation	• Develop plans to map IS distribution and spatial extent with partners • Assemble info re: best methods for IA control and develop eradication plans for target IS in the USJR Bioregion • Model active river area, and map significant floodplain communities and calcareous fen / cedar communities / AHF for parcel prioritization.	NCC
3.1 Species Management Nature NB is the provincial coordinator of the NB Important Bird Areas program and	BENEFICIAL	Acadian forest, wetland,	Species loss, habitat loss and	Updated species inventory and population trend data is used to support the management of threats to bird species and their habitats in the	Nature NB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
manages the IBA Caretakers for the Nepisiguit Highlands and Mt. Carleton IBAs. Caretakers track and report on changes to bird populations and habitats within these IBAs.		riparian	degradation	USJR Important Bird Areas by partner organizations in the province of New Brunswick.	
3.1 Species Management The Atlantic Canada Conservation Data Centre (ACCDC) continues to undertake biological field inventories of the significant natural habitats of the upper St. John River drainage, with a special focus on riparian habitats, calcareous wetlands and Appalachian hardwood forests.	BENEFICIAL	Appalachian hardwood forest, forested wetland, riparian, rock outcrop, beach	Species loss, habitat loss and degradation: forest harvesting and conversion	• Field work is focused on documenting rare species occurrences and identifying high-priority sites for conservation in support of the preservation of remaining examples of the rare species-rich and provincially significant plant communities along the tributary rivers of the Upper St. John River. • Recent biological inventories have been conducted for the Meduxnekeag River, Aroostook River, Big Presque Ile Stream, and Williamstown Lake area. • Data and survey reports are available through the ACCDC	ACCDC
3.1 Species Management The Maliseet Nation Conservation Council, through the Aboriginal Fisheries Strategy program coordinates….	NECESSARY	Aquatic	Species loss		MNCC
3.1 Species Management: The New Brunswick Museum (NBM) continues to conduct field research in this region of the province, including 2015 and 2016 Biota NB event taking place in the Nepisiguit PNA and Mt Carleton park. This broad-spectrum biodiversity field survey with a focus on insects, bryophytes, lichens, vascular plants, amphibians and reptiles, birds, and fishes will build the documented species inventory for these areas to support	BENEFICIAL	ALL	Species loss	• Increased field survey collections and improved documentation of the diversity, distribution, and habitats of the insects, plants, and fungi of New Brunswick • Information supporting a PNA management plan will be compiled	NBM

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
management planning.					
3.1 Species Management: NB Power releases water throughout the winter from headwater lakes in the Tobique River system via small dams at several upstream lake outlets. NB Power has agreed to modify the dam structures so that water is released from near the surface and is close to ambient temperature. This work is currently underway.	NECESSARY	Aquatic	Species loss, loss of genetic diversity	Notes: At present, water released from the bottom of these dams is slightly warmer than ambient, causing salmon eggs downstream to develop faster, hatch prematurely, and die (early hatch) as recorded and documented through research conducted by UNB Canadian Rivers Institute (Rick Cunjak lab). MOS: increased salmon survival and improved wild salmon returns following implementation of these modifications.	NB Power, DFO, NBSC, ASF, CRI
3.1 Species Management: NB Power will install a downstream passage structure at Tobique Narrows dam, which will allow for safe downstream passage of smolt (juveniles migrating to sea for the first time) and kelts (mature salmon that spawned the previous fall and overwintered in the river. The lack of safe downstream passage at the many dams along the St. John River contributes to a high proportion of mortality to the salmon population each year.	NECESSARY	Aquatic	Species loss, loss of genetic diversity	MOS: increased downstream salmon survival and improved wild salmon returns following construction of the downstream passage structure.	NB Power, DFO, NBSC, ASF
3.1 Species Management: Macataquac Biodiversity Facility captures wild emigrating smolts from the Tobique River and rears them to maturity on site. The majority are released for natural spawning above the Tobique dam while a small proportion are kept for artificial spawning to	CRITICAL	Aquatic	Species loss; barriers to upstream movement of species	Juvenile surveys (electrofishing); smolt population estimates are conducted annually	DFO, partnering with WFN, Tobique Salmon Protective Assoc.

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
produce juveniles for release on the Tobique River.					
3.1 Species Management: Mactaquac Biodiversity Facility manages fish passage for Atlantic salmon and gaspereau over the Mactaquac Dam; other species are released at a downstream site.	CRITICAL	Aquatic	Barriers to fish migration		DFO, NB Power
3.1 Species Management Bird Studies Canada continues to deliver the High Elevation Landbird Program in NB with a focus on Bicknell's Thrush and 9 other high elevation species across the Appalachian mountain range.	NECESSARY	Acadian forest	Species loss, habitat degradation and destruction	The program includes working with industry and government to conserve Bicknell's Thrush habitat, as well as monitoring and research efforts to track population trends as part of a regional and international project to track the species' range-wide recovery. MOS: long-term annual monitoring at 50 mountains, conduct surveys prior to scheduled forestry operations in documented habitat and achieve delayed cutting in breeding season, calculate pop. Trends for 10 species, 25% population increase over 2010 levels by 2060.	BSC
3.2 Species Recovery: Saint John River Management Advisory Committee is a DFO-lead management committee that is inclusive of Saint John River stakeholders that provides feedback and guidance for Atlantic salmon conservation and recovery actions on the Saint John River.	NECESSARY	Aquatic	Species loss		DFO

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s) [3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
3.2 Species Recovery: Participate annually in active recovery planning meetings for Species at Risk.	NECESSARY	ALL	ALL	MOS-I: Attend working group meetings for species recovery teams (annually) and support recovery strategies for Species at Risk. Establish working groups for other species at risk in the bioregion.	EC, GNB, EHJV partners
3.2 Species Recovery: Conduct waterfowl surveys in the bioregion, including breeding waterfowl surveys.	BENEFICIAL	Freshwater wetlands	ALL	Collect baseline data for breeding and wintering waterfowl species; Detection of population trends over the long-term.	EC PNB
3.2 Species Recovery: EHJV partners to undertake Habitat Supply Analysis at the provincial scale.	NECESSARY	ALL	ALL	This work constitutes an analysis of past, present, and future forest and wetland bird habitat supply on crown and private lands in New Brunswick.	GNB & EHJV partners
3.2 Species Recovery: Work with EC Canadian Wildlife Service (CWS) staff to identify appropriate groups / agencies to address necessary recovery actions to protect species at risk in the bioregion.	NECESSARY	ALL	Threat-specific 2.1.2	Best management practices are applied in priority habitats including wetlands, forests, identified critical habitat, and in grasslands/agro-ecosystems to protect grassland birds as well as monitoring species at risk in the bioregion.	EC GNB NCC NTNB
3.2 Species Recovery: Enhance data management and information on biodiversity in the bioregion through annual submission of species records to the Atlantic Canada Conservation Data Centre (ACCDC)	BENEFICIAL	ALL		MOS: Baseline and annual monitoring information of rare species is submitted to ACCDC every year.	ACCDC
3.2 Species Recovery: Continue to monitor known species at risk on all nature preserves within the bioregion.	NECESSARY	ALL		MOS: Species populations are monitored regularly by knowledgeable professionals on all nature preserves with known species at risk.	NTNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
3.2 Species Recovery: Strengthen partnership with Atlantic Conservation Data Centre (ACCDC) through annual submission of monitoring findings on conservation lands.	BENEFICIAL	ALL		MOS: baseline and annual monitoring information of rare species is submitted to ACCDC every year.	NCC EC Nature NB DUC PNB NTNB
4. Communications, Education and Awareness					
4.3 Awareness & Communications The Nature Trust of New Brunswick will continue to implement its Communications Strategy to raise awareness of the need for land conservation and by promoting the province's natural heritage through maintaining public access to Nature Trust preserves.	BENEFICIAL	ALL	n/a	MOS – a successful communications strategy will bring increased Nature Trust membership, improved social and traditional media coverage, and a general increase in conservation awareness among New Brunswickers over time.	NTNB
4.3 Awareness & Communications: Increasing awareness and education Nature Trust of New Brunswick will share information and increase awareness about threats to SAR and provide stewardship tips for private landowners throughout the bioregion via preserve steward training workshops.	BENEFICIAL	ALL		MOS: volunteer stewards and neighbouring landowners adjacent to Nature Trust preserves will participate in Nature Trust steward training workshops to increase their knowledge and capacity for managing sensitive species and habitat.	NTNB
4.3 Awareness & Communications Mactaquac Biodiversity Facility participates in the Fish Friends program (coordinated by NB Salmon Council), which supplies equipment and Atlantic salmon eggs for public school classrooms to rear to release as fry as an educational tool.	BENEFICIAL	Aquatic	Species loss, loss of genetic diversity	Average of 45 classes participate annually releasing fry into the Saint John River.	DFO, NBSC

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
4.3 Awareness & Communications Tourism: Mactaquac Biodiversity Facility is open to visitors in summer months providing guided tours and education about threats to Atlantic salmon and conservation practices.	BENEFICIAL	Aquatic	Species loss, loss of genetic diversity	Approximately 500 visitors visit the site annually.	DFO
4.3 Awareness & Communications The Nature Conservancy of Canada will hold public announcements to communicate key land acquisitions made by NCC.	BENEFICIAL	ALL	n/a	Anticipate two press conference announcements, four property tour / news releases over the course of five years.	NCC
4.3 Awareness & Communications The Nature Trust of New Brunswick will hold public announcements and Grand Opening events for all new nature preserves in the bioregion.	BENEFICIAL	ALL	n/a	Public participation and community attendance at all new Nature Preserve public announcements and Grand Opening events.	NTNB
5. Government Relations, Law & Policy					
5.1 Sub-national Level Legislation: DUC actively participates as a member of the provincial wetland policy long term strategy stakeholder review. DUC works closely with the Department of the Environment to deliver compensation needs, work with municipalities, evaluate policy needs, and improve permitting efficiency.	BENEFICIAL	Riparian systems Freshwater wetlands	Threat-specific	Wetland conservation policies are a top national priority of Ducks Unlimited.	DUC
5.1 National Level Legislation: EC Implements and enforces the Migratory Bird Convention Act, Canada Wildlife Act, Species at Risk Act, Canadian Environmental Protection Act, and promotes the Federal Policy on Wetland Conservation.	NECESSARY	ALL	Threat-specific	EC Implements and enforces the Migratory Bird Convention Act, Canada Wildlife Act, Species at Risk Act, Canadian Environmental Protection Act, and promote the Federal Policy on Wetland Conservation.	EC
5.2 Policies & Regulation: Canadian Parks and Wilderness Society (CPAWS) actively participates in the	CRITICAL	Acadian forest, Riparian	Habitat loss and degradation,	MOS: CPAWS continues to advocate for a return to 30% conservation forest (including buffer zones) on Crown Forest and for increasing the	CPAWS

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
campaign for the long-term protection of conservation zones and riparian buffer zones on New Brunswick Crown Forest by engaging policy makers, researchers, and the general public.		systems, Freshwater wetlands	species loss	total conserved landbase in New Brunswick to 17%.	
5.2 Policies & Regulation: The NB Salmon Council advocates for improved upland and riparian habitat management by adopting and advancing detailed policies on land use management as they relate to forestry, agriculture, mining, rural and urban development, and watercourse crossings of any kind (including power generation, pipeline, and transportation).	BENEFICIAL	All	Species loss, habitat degradation and destruction	MOS: The measure of success would be to observe enforcement of legislation and the adoption of progressive land use policy and effective Best Management Practices that protect the integrity of aquatic ecosystems within the North American spawning range of the wild Atlantic Salmon.	ASF
5.2 Policies & Regulations NB Department of Environment & Local Government will enact and enforce an updated Provincial Wetland Policy and Provincial Water Strategy.	NECESSARY	wetlands	Habitat loss, development		NB DELG
5.2 Policy and Regulations: CCNB continues to examine and evaluate impacts resulting from industrial activity (including pipelines, export terminals, tanker traffic, mining and oil and gas exploration) and presents recommendations for mitigating these impacts should this project proceed.	BENEFICIAL	ALL		MOS – a successful advocacy campaign would result in the consideration and adoption of operational recommendations presented to the National Energy Board and consideration and adoption of recommendations presented to the Government of New Brunswick regarding an independent Environmental Impact Assessment process and increased research in critical areas.	CCNB
5.2 Policy and Regulations: CCNB continues to undertake environmental policy review and makes recommendations to the following files: Canadian Environmental Protection Act, Canadian Environmental Assessment Act.	BENEFICIAL	Acadian Forest, Freshwater Wetlands, Riparian and Aquatic		MOS - a successful policy review campaign would result in the adoption of the amendments proposed by CCNB, which would strengthen these Acts and improve their ability to protect the habitats and species under their jurisdiction.	CCNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
5.2 Policy and Regulations: The Atlantic Salmon Federation works alongside government regulators an aquaculture and fishing industry representatives to improve protection of wild Atlantic salmon populations by encouraging stringent regulation, reporting, and enforcement of the federal Code of Containment and other industry regulations.	BENEFICIAL	Aquatic	Aquaculture impacts on wild populations		ASF
6. Livelihood, Economic & Other Incentives					
6.1 Linked Enterprises & Livelihood Alternatives CCNB Buy Local initiative	BENEFICIAL		Agricultural effluents	Database of local food and other products, available via website or app, to reduce consumption of carbon intensive products. Though social media and web blogs promote consumption of local products.	CCNB
6.1 Linked Enterprises & Livelihood Alternatives The Canadian Parks and Wilderness Society (CPAWS) is collaborating with other organizations, including the World Wildlife Fund (WWF), to lead and facilitate climate change adaptation planning among riverside communities in the Upper St. John Region.	NECESSARY	All	Riparian, Acadian Forest, Freshwater wetlands	MOS: the desired outcome of this project is meaningful collaboration among communities, Regional Service Commission North West planners, conservation organizations, and the public on the development and implementation of adaptation strategies and actions to help communities adapt and respond to the impacts of climate change in this region.	CPAWS, WWF
6.1 Linked Enterprises & Livelihood Alternatives The Nature Trust has developed educational tools, support products, and learning opportunities for landowners to promote sustainable management of woodlots, and the sensitive habitats, and Species at Risk on working private land. Encouraging rural livelihoods while protecting ecologically sensitive habitats and species.				These products and opportunities are made available to private citizens in the region through the Nature Trust's Landowner Stewardship Program – number of participants will be the primary MOS.	NTNB

Conservation Actions	Importance/ Associated Goals[1]	Biodiversity Habitat(s)[2]	Threat(s)[3]	Measures of Success (MOS)[4] / Notes	Organizational Lead
7. Philanthropy, Marketing and Capacity Building					
7.2 Alliance & Partnership Development: Continue to attend meetings to develop new, and enhance existing partnerships. EC will focus on the ongoing development of the USJR Habitat Conservation Strategy as a basis for decision support relating to funding and other habitat conservation activities, and to assist other conservation organizations and community groups through provision of decision support.	NECESSARY	ALL	ALL	Attend partnership meetings; provide stewardship or conservation planning support for habitat conservation initiatives.	EC
7.2 Alliance & Partnership Development: NTNB will continue to build and advance cross-border conservation partnerships and project / program collaboration with conservation groups and local communities.	BENEFICIAL	Riparian and aquatic, Acadian Forest, wetland,	Development	Increase in regional collaborative projects, improved information sharing and communication among groups, and increased land conservation along the St. John River valley.	NTNB

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5. APPENDICES

Appendix A: List of Abbreviations

Acronyms	Full reference
ATV	All-terrain-vehicle
ACCDC	Atlantic Canada Conservation Data Centre
BD	Beaches/Dunes
BSC	Bird Studies Canada
CAP	Conservation Action Planning
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DUC	Ducks Unlimited Canada
EC	Environment Canada
EHJV	Eastern Habitat Joint Venture
FM	Forest Mosaic
FW	Freshwater Wetland
IBA	Important Bird Area
IUCN-CMP	International Union for the Conservation of Nature and Natural Resources – Conservation Measures Partnership
LCI	Landscape Context Index
MBBA	Maritime Breeding Bird Atlas
MOS	Measure of Success
NAAP	Northern Appalachian - Acadian Ecoregional Plan
NABCI	North American Bird Conservation Initiative
NAWCA	North American Waterfowl Conservation Act
NB	New Brunswick
NB DNR	New Brunswick Department of Natural Resources
NB EHJV	New Brunswick Eastern Habitat Joint Venture
NWA	National Wildlife Area
OHV	Off Highway Vehicle
Pers. comm.	Personal Communication
Pers. obs.	Personal observation
SAR	Species at Risk

Appendix B: Glossary of Conservation and Biodiversity Ranks

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): is a national committee of experts that assesses and designates which wild species are in danger of disappearing from Canada. COSEWIC assigns the following status to species:

Extinct (EXT)	A species that no longer exists
Extirpated (EXP)	A species no longer existing in the wild in Canada, but occurring elsewhere in the wild
Endangered (END)	A species facing imminent extirpation or extinction throughout its range
Threatened (THR)	A species likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction
Special Concern (SC)	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events, but does not include an extirpated, endangered or threatened species
Not At Risk (NAR)	A species that has been evaluated and found to be not at risk
Data Deficient (DD)	A species for which there is insufficient information to support a status designation

Species at Risk (SAR): species designated as Endangered, Threatened or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or listed through provincial endangered species legislation.

Global Rank (G-RANK): the overall status of a species or ecological community is regarded as its "global" status; this range-wide assessment of condition is referred to as its global conservation status rank. Global conservation status assessments are generally carried out by NatureServe scientists with input from relevant natural heritage member programs (e.g., CDCs and NHICs) and experts on particular taxonomic groups, and are based on a combination of quantitative and qualitative information. The factors considered in assessing conservation status include the total number and condition of occurrences; population size; range extent and area of occupancy; short- and long-term trends in these previous factors; scope, severity, and immediacy of threats, number of protected and managed occurrences, intrinsic vulnerability and environmental specificity.

Global Ranks

Rank	Definition
GX	**Presumed Extinct** (species): Not located despite intensive searches and virtually no likelihood of rediscovery. **Eliminated** (ecological communities): Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.
GH	**Possibly Extinct** (species): Missing; known from only historical occurrences but still some hope of rediscovery. **Presumed Eliminated**: Historic, ecological communities)-Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered, but with the potential for restoration, for example, American Chestnut Forest.
G1	**Critically Imperilled**: At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	**Imperilled**: At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3	**Vulnerable**: At moderate risk of extinction due to a restricted range, relatively few populations

	(often 80 or fewer), recent and widespread declines, or other factors.
G4	**Apparently Secure**: Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	**Secure**: Common; widespread and abundant.

Variant Ranks

Rank	Definition
G#G#	**Range Rank:** A numeric range rank (e.g., G2G3) is used to indicate the range of uncertainty in the status of a species or community. A G2G3 rank would indicate that there is a roughly equal chance of G2 or G3 and other ranks are much less likely. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).
GU	**Unrankable**: Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Whenever possible, the most likely rank is assigned and a question mark qualifier may be added (e.g., G2?) to express minor uncertainty, or a range rank (e.g., G2G3) may be used to delineate the limits (range) of uncertainty.
GNR	**Unranked**: Global rank not yet assessed.
GNA	**Not Applicable**: A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

Rank Qualifiers

Rank	Definition
?	**Inexact Numeric Rank**: Denotes some uncertainty about the numeric rank (e.g. G3? - Believed most likely a G3, but some chance of either G2 or G4).
Q	**Questionable taxonomy**: Taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority.
C	**Captive or Cultivated Only**: At present extant only in captivity or cultivation, or as a reintroduced population not yet established.

Sub-national (Provincial) Rank (S-RANK): provincial ranks are used by natural heritage member programs to set conservation priorities for rare species and vegetation communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of a province. Comparison of global and provincial ranks, gives an indication of the status and rarity of an element in that province in relation to its overall conservation status, therefore providing insight into the urgency of conservation action for it in the province.

Subnational (S) Conservation Status Ranks

Status	Definition
SX	**Presumed Extirpated**: Species or community is believed to be extirpated from the province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH	**Possibly Extirpated** (Historical): Species or community occurred historically in the province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The SH rank is reserved for species or communities for which some effort has been made

	to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
S1	**Critically Imperilled**: Critically imperilled in the province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the province.
S2	**Imperilled**: Imperilled in the province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.
S3	**Vulnerable**: Vulnerable in the province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
S4	**Apparently Secure**: Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5	**Secure**: Common, widespread, and abundant in the province.
SNR	**Unranked**: Province conservation status not yet assessed.
SU	**Unrankable**: Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNA	**Not Applicable:** A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
S#S#	**Range Rank:** A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).

Appendix C: List of Significant Species for the Upper St. John River Bioregion with Coarse Resolution Habitat Associations

Scientific Name	Common Name	IUCN Status	COSEWIC Status	Provincial Status	G Rank	S Rank	Other Status	Coarse resolution Filter: Beaches	Grassland/ Agroecosystems	Rock Outcrop	Cliff	Acadian Forest Mosaic	Freshwater Wetlands	Riparian & Aquatic
Birds														
Accipiter cooperii	Cooper's Hawk	LC	NAR		G5	S1S2B						X		
Aegolius acadicus	Northern Saw-whet Owl (*acadicus*)	LC			G5	S4B,S4N	BCR14					X		
Aegolius funereus	Boreal Owl	LC					BCR14					X		
Anas clypeata	Northern Shoveler	LC			G5	S2B							X	
Anas rubripes	American Black Duck	LC			G5	S5BS4N	BCR14		X				X	X
Antrostomus vociferus	Eastern Whip-poor-will	LC	T				BCR14					X		
Asio flammeus	Short-eared Owl	LC	SC	Special Concern	G5	S3B	BCR14		X				X	
Bartramia longicauda	Upland Sandpiper	LC					BCR14		X					
Botaurus lentiginosus	American Bittern	LC			G4	S4B	BCR14						X	X
Branta canadensis canadensis	Canada Goose (North Atl. Pop)	LC					BCR14		X				X	X
Branta canadensis	Canada Goose (Atl. Pop)	LC			G5	SNAB,S4M	BCR14		X				X	X
Bucephala islandica	Barrow's Goldeneye (Eastern population)	LC	SC	Special Concern	G5	S2N	BCR14							X
Buteo lineatus	Red-shouldered Hawk	LC	NAR		G5	S2B						X	X	
Butorides virescens	Green Heron	LC			G5	S1S2B							X	X
Caprimulgus vociferus	Whip-Poor-Will	LC	T	Threatened	G5	S2B						X		
Catharus bicknelli	Bicknell's Thrush	VU "A2c+3c+4c;B1ab(i,ii,iii,iv,v)"	T	Threatened	G4	S2S3B	BCR14					X		
Catharus fuscescens	Veery	LC			G5	S4B	BCR14					X	X	X
Certhia americana	Brown Creeper	LC			G5	S5B	BCR14					X		
Chaetura pelagica	Chimney Swift	NT	T	Threatened	G5	S2S3B	BCR14		X			X	X	X
Charadrius vociferus	Killdeer	LC			G5	S3B	BCR14	X	X				X	X
Chlidonias niger	Black Tern	LC	NAR		G4	S2B							X	
Chordeiles minor	Common Nighthawk	LC	T	Threatened	G5	S3B	BCR14		X			X		
Cistothorus palustris	Marsh Wren	LC			G5	S2B							X	
Coccothraustes vespertinus	Evening Grosbeak	LC			G5	S3S4B,S4S5N	BCR14					X		
Coccyzus erythropthalmus	Black-billed Cuckoo	LC			G5	S4B	BCR14					X		
Colaptes auratus	Northern Flicker	LC			G5	S5B	BCR14					X	X	
Contopus cooperi	Olive-sided Flycatcher	NT	T	Threatened	G4	S3S4B	BCR14					X	X	
Contopus virens	Eastern Wood-Pewee	LC	SC	Special Concern	G5	S4B	BCR14					X	X	
Dolichonyx oryzivorus	Bobolink	LC	T	Threatened	G5	S3S4B	BCR14		X				X	
Empidonax traillii	Willow Flycatcher	LC			G5	S1S2B							X	

Scientific Name	Common Name	IUCN Status	COSEWIC Status	Provincial Status	G Rank	S Rank	Other Status	Coarse resolution Filter						
								Beaches	Grassland/ Agroecosystems	Rock Outcrop	Cliff	Acadian Forest Mosaic	Freshwater Wetlands	Riparian & Aquatic
Eremophila alpestris	Horned Lark	LC			G5	S2B		X	X					
Euphagus carolinus	Rusty Blackbird	VU A2cde+3cde+4cde	SC	Special Concern	G4	S3B	BCR14						X	
Falco peregrinus	Peregrine Falcon (*anatum/tundrius*)	LC	SC				BCR14				X			X
Fulica americana	American Coot	LC	NAR		G5	S2B							X	X
Gavia immer	Common Loon	LC	NAR		G5	S4B,S5MS4N	BCR14							X
Haemorhous purpureus	Purple Finch	LC			G5	S4S5B	BCR14					X		X
Haliaeetus leucocephalus	Bald Eagle	LC					BCR14					X	X	X
Hirundo rustica	Barn Swallow	LC	T	Threatened	G5	S3B	BCR14		X			X	X	X
Hylocichla mustelina	Wood Thrush	LC	T	Threatened	G5	S1S2B	BCR14					X		
Ixobrychus exilis	Least Bittern	LC	T	Threatened	G5	S1S2B	BCR14						X	X
Larus argentatus	Herring Gull	LC			G5	S5B,S5N	BCR14		X					X
Megaceryle alcyon	Belted Kingfisher	LC			G5	S5B	BCR14							X
Mergus serrator	Red-breasted Merganser	LC			G5	S3B,S4S5N	BCR14						X	X
Mniotilta varia	Black-and-white Warbler	LC			G5	S5B	BCR14							
Nycticorax nycticorax	Black-crowned Night-heron	LC			G5	S1S2B		X				X	X	X
Oxyura jamaicensis	Ruddy Duck	LC			G5	S1B,S4N							X	
Picoides arcticus	Black-backed Woodpecker	LC			G5	S4	BCR14					X		
Picoides dorsalis	American Three-toed Woodpecker	LC			G5	S3?	BCR14					X		
Pinicola enucleator	Pine Grosbeak	LC			G5	S3S3B,S4S5N	BCR14					X		
Pipilo erythrophthalmus	Rufous-sided Towhee	LC					BCR14		X				X	X
Poecile hudsonicus	Boreal Chickadee	LC			G5	S4	BCR14					X		
Pooecetes gramineus	Vesper Sparrow	LC			G5	S2B			X			X		
Porzana carolina	Sora	LC			G5	S4B	BCR14						X	X
Progne subis	Purple Martin	LC			G5	S1S2B			X				X	X
Rallus limicola	Virginia Rail	LC			G5	S3B	BCR14						X	
Riparia riparia	Bank Swallow	LC	T		G5	S3B	BCR14					X	X	X
Seiurus aurocapilla	Ovenbird	LC			G5	S5B	BCR14					X		
Setophaga americana	Northern Parula	LC			G5	S5B	BCR14					X	X	X
Setophaga caerulescens	Black-throated Blue Warbler	LC			G5	S5B	BCR14					X		
Setophaga castanea	Bay-breasted Warbler	LC			G5	S4B	BCR14					X		
Setophaga fusca	Blackburnian Warbler	LC			G5	S5B	BCR14					X		
Setophaga magnolia	Magnolia Warbler	LC			G5	S5B	BCR14					X		

Scientific Name	Common Name	IUCN Status	COSEWIC Status	Provincial Status	G Rank	S Rank	Other Status	Coarse resolution Filter						
								Beaches	Grassland/ Agroecosystems	Rock Outcrop	Cliff	Acadian Forest Mosaic	Freshwater Wetlands	Riparian & Aquatic
Setophaga palmarum	Palm Warbler	LC			G5	S5B	BCR14					X	X	
Setophaga ruticilla	American Redstart	LC			G5	S5B	BCR14					X	X	
Setophaga striata	Blackpoll Warbler	LC			G5	S4B	BCR14					X	X	
Setophaga virens	Black-throated Green Warbler	LC			G5	S5B	BCR14					X		
Sphyrapicus varius	Yellow-bellied Sapsucker	LC			G5	S5B	BCR14					X		
Sturnella magna	Eastern Meadowlark	LC	T	Threatened	G5	S1S2B	BCR14		X					
Tachycineta bicolor	Tree Swallow	LC			G5	S4B	BCR14	X	X				X	X
Toxostoma rufum	Brown Thrasher	LC			G5	S2B	BCR14					X	X	
Tringa solitaria	Solitary Sandpiper	LC			G5	S2B,S5M							X	
Vermivora chrysoptera	Golden-winged Warbler	NT	T				BCR14						X	
Vireo solitarius	Blue-headed Vireo	LC			G5	S5B	BCR14					X		
Wilsonia canadensis	Canada Warbler	LC	T	Threatened	G5	S3S4B	BCR14					X	X	
Zonotrichia albicollis	White-throated Sparrow	LC			G5	S5B	BCR14					X	X	
Amphibians/Fish/Mollusks														
Alasmidonta undulata	Triangle Floater	LC			G4	S2								X
Lepomis auritus	Redbreast Sunfish	LC	DD		G5	S3?								X
Prosopium cylindraceum	Round Whitefish				G5	S2								X
Invertebrates														
Aeshna clepsydra	Mottled Darner	LC			G4	S2							X	X
Aeshna juncea	Rush Darner				G5	S2							X	X
Boloria eunomia	Bog Fritillary				G5	S1S2							X	X
Callophrys henrici	Henry's Elfin				G5	S2						X		
Coenagrion interrogatum	Subarctic Bluet				G5	S2							X	X
Cupido comyntas	Eastern Tailed Blue				G5	S2			X					X
Danaus plexippus	Monarch		SC	Special Concern	G5	S3B			X					X
Enallagma vesperum	Vesper Bluet				G5	S2								X
Erora laeta	Early Hairstreak				GU	S1						X		
Gomphus vastus	Cobra Clubtail				G5	S2								X
Hetaerina americana	American Rubyspot				G5	S2							X	X
Lycaena dorcas	Dorcas Copper				G5	S1							X	
Lycaena dorcas claytoni	Clayton's Copper				G5T1	S1							X	X
Ophiogomphus colubrinus	Boreal Snaketail	LC			G5	S1S2								X
Ophiogomphus howei	Pygmy Snaketail	LC	SC	Special Concern	G3	S1								X
Satyrium calanus falacer	Banded Hairstreak				G5T5	S2			X			X		X
Somatochlora septentrionalis	Muskeg Emerald				G5	S1							X	

								Coarse resolution Filter						
Scientific Name	Common Name	IUCN Status	COSEWIC Status	Provincial Status	G Rank	S Rank	Other Status	Beaches	Grassland/ Agroecosystems	Rock Outcrop	Cliff	Acadian Forest Mosaic	Freshwater Wetlands	Riparian & Aquatic
Somatochlora tenebrosa	Clamp-Tipped Emerald				G5	S2							X	X
Mammals														
Lynx canadensis	Canadian Lynx	LC	NAR	Endangered	G5	S1						X		
Puma concolor pop. 1	Cougar - Eastern pop.	CR	DD	Endangered	G5THQ	SU,SH						X		
Microtus chrotorrhinus	Rock Vole	LC			G4	S1						X		
Sorex dispar	Long-tailed Shrew	LC	NAR		G4	S1						X		
Non-Vascular Plants														
Anomodon minor	Blunt-leaved Anomodon Moss				G5	S1						X		
Aphanorrhegma serratum	a Moss				G4G5	S1								X
Arctoa fulvella	a Moss				G3G5	S1				X	X	X		
Bryohaplocladium microphyllum	Tiny-leaved Haplocladium Moss				G5	S1						X		
Calliergon richardsonii	Richardson's Spear Moss				G4	S1				X	X		X	X
Campylium polygamum	a Moss				G5	S2							X	X
Cirriphyllum piliferum	Hair-pointed Moss				G5	S2							X	X
Dicranum bonjeanii	Bonjean's Broom Moss				G4G5	S1							X	
Didymodon ferrugineus	a moss				G5T5?	S1S2				X				X
Ditrichum pallidum	Pale Cow -hair Moss				G5	S1						X		X
Drummondia prorepens	a Moss				G5	S1						X		
Entodon brevisetus	a Moss				G4?	S1						X		
Fissidens bushii	Bush's Pocket Moss				G5	S2						X	X	X
Fissidens taxifolius	Yew -leaved Pocket Moss				G5	S1			X			X		X
Grimmia donniana	Donn's Grimmia Moss				G4G5	S1		X		X	X	X		X
Grimmia incurva	Black Grimmia				G4G5	S1				X	X	X		
Grimmia unicolor	a Moss				G4G5	S1		X						X
Huperzia selago	Northern Firmoss				G5	S1		X	X	X	X		X	
Hygrohypnum montanum	a Moss				G3G5	S1S2								X
Hypnum pratense	Meadow Plait Moss				G5	S2							X	X
Lophozia obtusa	Obtuse Notchw ort				G4G5	S1S3						X		X
Meesia triquetra	Three-ranked Cold Moss				G5	S1							X	
Physcomitrium pyriforme	Pear-shaped Urn Moss				G5	S2		X	X			X		X
Selaginella rupestris	Rock Spikemoss				G5	S1S2				X	X			X
Selaginella selaginoides	Low Spikemoss				G5	S2		X				X	X	X
Seligeria campylopoda	a Moss				G3G5	S1S2				X	X			X

Scientific Name	Common Name	IUCN Status	COSEWIC Status	Provincial Status	G Rank	S Rank	Other Status	Coarse resolution Filter						
								Beaches	Grassland/ Agroecosystems	Rock Outcrop	Cliff	Acadian Forest Mosaic	Freshwater Wetlands	Riparian & Aquatic
Sphagnum subfulvum	a Peatmoss				GNR	S1							X	
Splachnum pennsylvanicum	Southern Dung Moss				G4?	S1							X	
Splachnum sphaericum	Round-fruited Dung Moss				G3G5	S1S2							X	
Taxiphyllum deplanatum	Imbricate Yew-leaved Moss				G4G5	S2				X	X	X	X	
Tayloria serrata	Serrate Trumpet Moss				G4	S2						X	X	
Timmia megapolitana	Metropolitan Timmia Moss				G5	S1				X	X			X
Trichodon cylindricus	Cylindric Hairy-teeth Moss				G4G5	S1S2							X	X
Zygodon viridissimus var. rupestris	a moss				G5T5	S2				X	X	X		X
Vascular Plants														
Alisma subcordatum	Southern Water Plantain				G4G5	S1		X					X	X
Allium canadense	Canada Garlic				G5	S1								X
Allium tricoccum	Wild Leek				G5	S2						X		X
Alnus serrulata	Smooth Alder				G5	S2		X					X	X
Amerorchis rotundifolia	Small Round-leaved Orchis				G5	S2						X	X	
Anemone multifida	Cut-leaved Anemone				G5	S2		X		X	X			X
Antennaria parlinii	a Pussytoes				G5	S1			X	X				
Arabis drummondii	Drummond's Rockcress				G5	S2				X	X	X		
Arnica lonchophylla	Northern Arnica				G5	S1		X	X			X		X
Asplenium trichomanes	Maidenhair Spleenwort				G5	S2				X	X			
Botrychium lineare	Narrow-leaved Moonwort				G2?	SH			X	X		X		X
Botrychium minganense	Mingan Moonwort				G4G5	S2						X	X	
Botrychium oneidense	Blunt-lobed Moonwort				G4	S1						X	X	
Botrychium rugulosum	Rugulose Moonwort				G3	S1			X			X		
Callitriche hermaphroditica	Northern Water-starwort				G5	S2							X	X
Calypso bulbosa var. americana	Calypso				G5T5?	S2							X	
Canadanthus modestus	Great Northern Aster				G5	S1		X				X		X
Cardamine concatenata	Cut-leaved Toothwort				G5	S2		X		X		X	X	X
Carex bigelowii	Bigelow's Sedge				G5	S1				X	X			
Carex cephaloidea	Thin-leaved Sedge				G5	S1						X		X
Carex comosa	Bearded Sedge				G5	S1							X	X
Carex granularis	Limestone Meadow Sedge				G5	S2			X				X	X
Carex grisea	Inflated Narrow-leaved Sedge				G5?	S1						X		X
Carex gynocrates	Northern Bog Sedge				G5	S2						X	X	
Carex hirtifolia	Pubescent Sedge				G5	S2						X		X
Carex livida var. radicaulis	Livid Sedge				G5T5	S2							X	

Scientific Name	Common Name	IUCN Status	COSEWIC Status	Provincial Status	G Rank	S Rank	Other Status	Coarse resolution Filter						
								Beaches	Grassland/ Agroecosystems	Rock Outcrop	Cliff	Acadian Forest Mosaic	Freshwater Wetlands	Riparian & Aquatic
Carex merritt-fernaldii	Merritt Fernald's Sedge				G5	S1		X	X	X	X			
Carex norvegica ssp. inferalpina	Scandinavian Sedge				G5T5?	S1							X	X
Carex prairea	Prairie Sedge				G5	S2			X				X	X
Carex rostrata	Narrow-leaved Beaked Sedge				G5	S1S2		X	X				X	X
Carex sprengelii	Longbeak Sedge				G5	S2		X				X		X
Carex sterilis	Sterile Sedge				G4	S1							X	X
Carex tenuiflora	Sparse-Flowered Sedge				G5	S2							X	X
Carex viridula var. elatior	Greenish Sedge				G5TNR	S1		X					X	X
Castilleja septentrionalis	Northeastern Paintbrush				G5	S2		X		X	X			X
Cephalanthus occidentalis	Common Buttonbush				G5	S2		X					X	X
Chenopodium capitatum	Strawberry-blite				G5	S1								X
Cynoglossum virginianum var. boreale	Wild Comfrey				G5T4T5	S1						X		X
Cypripedium parviflorum var. makasin	Small Yellow Lady's-Slipper				G5T4T5	S2				X		X	X	X
Danthonia compressa	Flattened Oat Grass				G5	S1			X			X		
Decodon verticillatus	Swamp Loosestrife				G5	S1								X
Desmodium glutinosum	Large Tick-Trefoil				G5	S1				X	X	X		
Dichanthelium linearifolium	Narrow-leaved Panic Grass				G5	S2		X	X	X	X	X		X
Dirca palustris	Eastern Leatherwood				G4	S2						X		
Drosera anglica	English Sundew				G5	S1							X	
Drosera linearis	Slender-Leaved Sundew				G4	S1							X	X
Dryopteris clintoniana	Clinton's Wood Fern				G5	S1						X	X	
Elodea nuttallii	Nuttall's Waterweed				G5	S2								X
Elymus canadensis	Canada Wild Rye				G5	S2		X		X	X	X		X
Elymus hystrix var. bigeloviana	Spreading Wild Rye				G5T5?	S1			X			X		X
Epilobium coloratum	Purple-veined Willowherb				G5	S2?		X					X	X
Erigeron acris ssp. politus	Bitter Fleabane				G5T5	S1		X				X	X	X
Eriophorum gracile	Slender Cottongrass				G5	S2			X				X	
Festuca subverticillata	Nodding Fescue				G5	S1						X	X	X
Galearis spectabilis	Showy Orchis				G5	S2			X			X		X
Galium kamtschaticum	Northern Wild Licorice				G5	S2		X				X	X	X
Galium obtusum	Blunt-leaved Bedstraw				G5	S2?						X	X	
Galium trifidum ssp. subbiflorum	Three-petaled Bedstraw				G5T5	S1?							X	X
Hedeoma pulegioides	American False Pennyroyal				G5	S2			X	X	X	X		

Scientific Name	Common Name	IUCN Status	COSEWIC Status	Provincial Status	G Rank	S Rank	Other Status	Coarse resolution Filter						
								Beaches	Grassland/ Agroecosystems	Rock Outcrop	Cliff	Acadian Forest Mosaic	Freshwater Wetlands	Riparian & Aquatic
Helianthus decapetalus	Ten-rayed Sunflower				G5	S1		X				X	X	X
Hepatica nobilis var. obtusa	Round-lobed Hepatica				G5T5	S2						X		
Humulus lupulus var. lupuloides	Common Hop				G5T5	S1S2						X	X	X
Impatiens pallida	Pale Jewelweed				G5	S2		X				X		X
Isoetes prototypus	Prototype Quillwort		SC	Endangered	G2G3	S2		X						X
Juglans cinerea	Butternut		E	Endangered	G4	S1						X	X	X
Lemna trisulca	Star Duckweed	LC			G5	S2							X	X
Lonicera oblongifolia	Swamp Fly Honeysuckle				G4	S2							X	
Malaxis brachypoda	White Adder's-Mouth				G4Q	S1			X				X	
Nuphar lutea ssp. rubrodisca	Red-disked Yellow Pond-lily				G5T3T5	S2							X	X
Orobanche uniflora	One-Flowered Broomrape				G5	S2			X			X	X	X
Osmorhiza depauperata	Blunt Sweet Cicely				G5	S2						X	X	
Osmorhiza longistylis	Smooth Sweet Cicely				G5	S2?						X		
Oxytropis campestris var. johannensis	Field Locoweed				G5T4	S2		X		X				X
Pedicularis furbishiae	Furbish Lousewort	E	E	Endangered	G1G2	S1		X						X
Phryma leptostachya	American Lopseed				G5	S2						X		X
Platanthera flava var. herbiola	Pale Green Orchid				G4?T4Q	S1			X			X	X	X
Platanthera macrophylla	Large Round-Leaved Orchid				G5T4	S1						X	X	
Podostemum ceratophyllum	Horn-leaved Riverweed				G5	S2		X						X
Polygala sanguinea	Blood Milkwort				G5	S2			X		X			
Polygala senega	Seneca Snakeroot				G4G5	S2		X		X		X		X
Polygala verticillata var. verticillata	Whorled Milkwort				G5T5?	S1			X	X	X			
Potamogeton friesii	Fries' Pondweed				G4	S1								X
Potamogeton nodosus	Long-leaved Pondweed	LC			G5	S1								X
Potamogeton richardsonii	Richardson's Pondweed				G5	S2								X
Potamogeton vaseyi	Vasey's Pondweed				G4	S2								X
Pseudognaphalium macounii	Macoun's Cudweed				G5	S2			X			X		X
Pterospora andromedea	Woodland Pinedrops			Endangered	G5	S1						X		
Quercus macrocarpa	Bur Oak	LR/lc			G5	S2						X	X	X
Ranunculus lapponicus	Lapland Buttercup				G5	S1							X	
Ranunculus longirostris	Eastern White Water-Crowfoot				G5	S2							X	X
Rhynchospora capillacea	Slender Beakrush				G4	S1			X				X	X
Rosa acicularis ssp. sayi	Prickly Rose				G5T5	S1		X		X	X			X
Rumex aquaticus var. fenestratus	Western Dock				G5T5	S1S2		X					X	X
Salix candida	Sage Willow				G5	S2							X	

Scientific Name	Common Name	IUCN Status	COSEWIC Status	Provincial Status	G Rank	S Rank	Other Status	Coarse resolution Filter						
								Beaches	Grassland/ Agroecosystems	Rock Outcrop	Cliff	Acadian Forest Mosaic	Freshwater Wetlands	Riparian & Aquatic
Salix myricoides	Bayberry Willow				G4	S2?		X				X	X	X
Sanicula odorata	Clustered Sanicle				G5	S2						X	X	X
Sanicula trifoliata	Large-Fruited Sanicle				G4	S1						X		X
Saxifraga virginiensis	Early Saxifrage				G5	S1S2				X	X	X		X
Schizachyrium scoparium	Little Bluestem				G5	S2		X	X	X	X	X		X
Scrophularia lanceolata	Lance-leaved Figw ort				G5	S2						X		
Shepherdia canadensis	Soapberry				G5	S2		X		X				X
Sisyrinchium angustifolium	Narrow -leaved Blue-eyed-grass				G5	S1		X	X	X			X	X
Solidago altissima	Tall Goldenrod				G5	S2			X					
Solidago simplex var. racemosa	Sticky Goldenrod				G5T3?	S2				X	X			X
Spiranthes cernua	Nodding Ladies'-Tresses				G5	S2			X			X	X	X
Spiranthes lucida	Shining Ladies'-Tresses				G5	S2		X	X	X			X	X
Stuckenia filiformis ssp. alpina	Thread-leaved Pondw eed				G5T5	S2								X
Symphyotrichum anticostense	Anticosti Aster		T	Endangered	G3	S1S3						X		X
Symplocarpus foetidus	Eastern Skunk Cabbage				G5	S2		X					X	X
Triadenum virginicum	Virginia St John's-w ort				G5	S1							X	X
Triosteum aurantiacum	Orange-fruited Tinker's Weed				G5	S2						X		X
Vaccinium uliginosum	Alpine Bilberry				G5	S1		X						X
Verbena urticifolia	White Vervain				G5	S2		X	X					X
Viburnum lentago	Nannyberry				G5	S2			X					X
Viola canadensis	Canada Violet				G5	S1S2						X		X
Viola novae-angliae	New England Violet				G4	S2		X		X	X			X
Waldsteinia fragarioides	Barren Straw berry				G5	S1		X				X		X
Woodwardia virginica	Virginia Chain Fern				G5	S2							X	X

Appendix D: List of Significant Species for the Upper St. John River Bioregion with Fine Resolution Habitat Associations

Scientific Name	Common Name					Acadian Forest Mosaic				Freshwater Wetlands						Riparian & Aquatic Systems		Habitat Notes
		River Beaches	Agricultural / Grassland	Cliff	Rock Outcrop	Coniferous	Deciduous	Mixed	Appalachian Hardwood	Aquatic Bed	Bog	Fen	Forested Wetland	Freshwater Marsh	Shrub Wetland	Riparian Systems	Lakes	
Birds																		
Accipiter cooperii	Cooper's Hawk						X	X	X									
Aegolius acadicus	Northern Saw-whet Owl (*acadicus*)					X	X	X										Mature forest with open understory
Aegolius funereus	Boreal Owl					X												Boreal Forest
Anas clypeata	Northern Shoveler													X				
Anas rubripes	American Black Duck		X							X	X	X	X	X	X	X	X	Flooded areas in spring
Antrostomus vociferus	Eastern Whip-poor-will						X	X										Dry forest, with little understory
Asio flammeus	Short-eared Owl		X								X				X			Hay Fields
Botaurus lentiginosus	American Bittern													X	X	X		Shallow water, not densely vegetated
Branta canadensis	Canada Goose (Atl. Pop)		X											X	X	X		Lawns, golf courses
Bucephala islandica	Barrow's Goldeneye (Eastern population)																X	Alkaline lakes/ponds
Buteo lineatus	Red-shouldered Hawk					X	X	X	X				X					Moist woodlands
Butorides virescens	Green Heron											X	X	X	X	X		
Caprimulgus vociferus	Whip-Poor-Will					X	X	X	X									
Catharus bicknelli	Bicknell's Thrush					X		X	X									Spruce fir, Mixed HW-SW
Catharus fuscescens	Veery						X	X					X	X		X		Dense understory perferred
Certhia americana	Brown Creeper					X	X	X										Winter coniferous/summer mixed/deciduous
Chaetura pelagica	Chimney Swift		X			X	X	X	X					X		X		HW Forest
Charadrius vociferus	Killdeer	X	X											X		X		Vegetation <1inch
Chlidonias niger	Black Tern													X				Deep/shallow marsh
Chordeiles minor	Common Nighthawk		X			X	X	X	X									
Cistothorus palustris	Marsh Wren													X	X			Nest in reeds above water
Coccothraustes vespertinus	Evening Grosbeak					X	X	X										Mostly coniferous
Coccyzus erythropthalmus	Black-billed Cuckoo					X	X	X										More decidous than coniferous\
Colaptes auratus	Northern Flicker					X	X	X					X					
Contopus cooperi	Olive-sided Flycatcher					X		X			X		X					
Contopus virens	Eastern Wood-Pewee					X	X	X	X				X					Forest edges, TH, OG
Dolichonyx oryzivorus	Bobolink		X											X				Nests in Agricultural/Grasslands
Empidonax traillii	Willow Flycatcher													X	X			
Eremophila alpestris	Horned Lark	X	X															

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						Coniferous	Deciduous	Mixed	Appalachian Hardwood	Aquatic Bed	Bog	Fen	Forested Wetland	Freshwater Marsh	Shrub Wetland	Riparian Systems	Lakes	
Euphagus carolinus	Rusty Blackbird										X	X	X		X			Nest in shrubs/conifers near water
Falco peregrinus	Peregrine Falcon (*anatum/tundrius*)			X												X		Open landscapes with cliffs, cities with abundant rock pigeons
Fulica americana	American Coot													X			X	Deep Marsh, lakes
Gavia immer	Common Loon																X	Large, clear lakes
Haemorhous purpureus	Purple Finch					X		X								X		Along wooded streams, mostly coniferous/mixed forest
Haliaeetus leucocephalus	Bald Eagle					X	X	X					X			X		nest in trees close to water with fish
Hirundo rustica	Barn Swallow		X			X	X	X	X	X	X	X	X	X	X	X		Often nests in man-made structures
Hylocichla mustelina	Wood Thrush					X	X	X	X									
Ixobrychus exilis	Least Bittern											X		X	X		X	Shallow water
Larus argentatus	Herring Gull		X													X	X	Often around landfills, parking lots etc
Megaceryle alcyon	Belted Kingfisher															X	X	Clear water, with perches
Mergus serrator	Red-breasted Merganser													X		X	X	Breeds along wooded shorelines
Mniotilta varia	Black-and-white Warbler						X	X										Habitat highly varied during migration
Nycticorax nycticorax	Black-crowned Night-heron	X				X	X	X	X	X	X	X	X	X	X	X		Nest in wetlands
Oxyura jamaicensis	Ruddy Duck									X	X	X		X				
Picoides arcticus	Black-backed Woodpecker					X												Boreal/montane coniferous forest, often with burnt trees
Picoides dorsalis	American Three-toed Woodpecker					X												Often mature forests with dead standing trees, snags
Pinicola enucleator	Pine Grosbeak					X												Open coniferous forest
Poecile hudsonicus	Boreal Chickadee					X												
Pooecetes gramineus	Vesper Sparrow		X					X										SW, HW
Porzana carolina	Sora													X	X	X		Shallow wetlands with lots of emerging vegetation
Progne subis	Purple Martin		X							X					X	X	X	
Rallus limicola	Virginia Rail													X	X			Densely vegetated marshes
Riparia riparia	Bank Swallow					X	X	X	X				X			X		Cliffs/banks for nesting
Seiurus aurocapilla	Ovenbird						X	X										
Setophaga americana	Northern Parula					X	X	X					X			X		Mature forest along streams/swamps/other bottomlands, closely associated with epiphytic plants
Setophaga caerulescens	Black-throated Blue Warbler						X	X										Thick undergrowth
Setophaga castanea	Bay-breasted Warbler					X		X										Boreal spruce/fir forest
Setophaga fusca	Blackburnian Warbler					X		X										winters in montane forest
Setophaga magnolia	Magnolia Warbler					X		X										Nests often young spruce trees
Setophaga palmarum	Palm Warbler					X		X			X		X					Dense undergrowth, usually near water
Setophaga ruticilla	American Redstart					X	X	X	X				X					often near water, and in thickets

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Setophaga striata	Blackpoll Warbler					X		X							X			Breed Boreal forest (mostly spruce), winter in varied forests/thickets/shrublands
Setophaga virens	Black-throated Green Warbler					X		X										Boreal coniferous and transitional mixed forest
Sphyrapicus varius	Yellow-bellied Sapsucker						X	X										Younger trees for sap
Sturnella magna	Eastern Meadowlark		X															Wet low lying grasslands, 6acres big for territory
Tachycineta bicolor	Tree Swallow	X	X										X	X		X		
Toxostoma rufum	Brown Thrasher							X						X				Shrublands and Dense undergrowth
Tringa solitaria	Solitary Sandpiper									X	X	X	X	X	X			
Vireo solitarius	Blue-headed Vireo					X	X	X										Cool forests
Wilsonia canadensis	Canada Warbler							X			X		X		X			
Zonotrichia albicollis	White-throated Sparrow					X	X	X			X			X				Edges of bogs, marshes, opening in forests
Amphibians/Fish/Molluscs																		
Alasmidonta undulata	Triangle Floater															X	X	Moist rock substrate in/close to river/lake
Lepomis auritus	Redbreast Sunfish															X	X	
Prosopium cylindraceum	Round Whitefish															X	X	
Invertebrates																		
Aeshna clepsydra	Mottled Darner										X	X	X	X	X	X	X	
Aeshna juncea	Rush Darner										X	X	X	X	X		X	Still water
Boloria eunomia	Bog Fritillary										X	X		X		X	X	Edges of lakes
Callophrys henrici	Henry's Elfin						X	X										
Coenagrion interrogatum	Subarctic Bluet									X	X	X	X	X	X	X		Spaghnum mosses area
Cupido comyntas	Eastern Tailed Blue		X													X		Open, sunny areas, Roadsides, disturbed areas
Danaus plexippus	Monarch		X											X		X		Rail road, open areas
Enallagma vesperum	Vesper Bluet															X	X	Small lakes, slow miving streams
Erora laeta	Early Hairstreak						X	X										Mature beech-maple forest
Gomphus vastus	Cobra Clubtail															X	X	
Hetaerina americana	American Rubyspot												X		X	X		

						Acadian Forest Mosaic				Freshwater Wetlands						Aquatic		
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Lycaena dorcas	Dorcas Copper										X	X	X		X			Areas near to hosts Cinquefoils spp.
Lycaena dorcas claytoni	Clayton's Copper									X	X	X	X	X	X	X		
Ophiogomphus colubrinus	Boreal Snaketail															X		Clear fast streams/rivers with rocky/gravely beds
Ophiogomphus howei	Pygmy Snaketail															X		Big, clear, strong flowing rivers
Satyrium calanus falacer	Banded Hairstreak		X			X	X	X								X		Forest breeding, open areas feeding
Somatochlora septentrionalis	Muskeg Emerald										X	X						
Somatochlora tenebrosa	Clamp-Tipped Emerald									X	X	X	X	X	X	X		Slow moving water, if water is moving
Mammals																		
Lynx canadensis	Canadian Lynx					X	X	X	X									
Puma concolor pop. 1	Cougar - Eastern pop.					X	X	X	X									
Microtus chrotorrhinus	Rock Vole					X	X	X	X									
Sorex dispar	Long-tailed Shrew					X	X	X										
Non-Vascular Plants																		
Anomodon minor	Blunt-leaved Anomodon Moss						X											Bark, boulders, calcerous rock
Aphanorrhegma serratum	a Moss															X		Disturbed soil, trails etc, more likely in calcareous soil
Arctoa fulvella	a Moss			X	X			X										Moderate to High Elevation
Bryohaplocladium microphyllum	Tiny-leaved Haplocladium Moss						X	X	X									
Calliergon richardsonii	Richardson's Spear Moss			X	X						X	X	X	X		X		
Campylium polygamum	a Moss											X		X	X	X		Need humid conditions, not permanent flooding.
Cirriphyllum piliferum	Hair-pointed Moss							X					X	X	X	X		On soil, decaying wood, humus.
Dicranum bonjeanii	Bonjean's Broom Moss									X	X	X		X				

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Didymodon ferrugineus	a moss				X											X		Rock outcrops with moisture
Ditrichum pallidum	Pale Cow-hair Moss						X	X	X							X		Sandy /clay soil, rather dry, open or partly shaded habitats; low elevations
Drummondia prorepens	a Moss						X	X	X									Trunk of decidous trees
Entodon brevisetus	a Moss					X	X	X	X									Bark of HW, Rocks, Boulders, logs, stumps
Fissidens bushii	Bush's Pocket Moss						X	X	X				X	X	X	X		Bare/disturbed clayey soil
Fissidens taxifolius	Yew-leaved Pocket Moss		X				X	X	X							X		Moist substrate
Grimmia donniana	Donn's Grimmia Moss	X		X	X			X								X		Exposed acidic granite/sandstone
Grimmia incurva	Black Grimmia			X	X			X										On rocks or boulders, moderate to high elevation
Grimmia unicolor	a Moss	X														X	X	Splash zone
Huperzia selago	Northern Firmoss	X	X	X	X								X					Man made disturbed areas
Hygrohypnum montanum	a Moss															X		Periodically dry Rocks streamside
Hypnum pratense	Meadow Plait Moss											X	X	X		X		Calcerous sites
Lophozia obtusa	Obtuse Notchwort							X								X		on rocks, Moist forest
Meesia triquetra	Three-ranked Cold Moss								X			X	X					Hig ph fens

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Physcomitrium pyriforme	Pear-shaped Urn Moss	X	X				X	X	X							X		Disturbed soils
Selaginella rupestris	Rock Spikemoss			X	X											X		
Selaginella selaginoides	Low Spikemoss	X						X			X	X	X			X		Floodplains
Seligeria campylopoda	a Moss			X	X											X		Calcerous soil, on rocks
Sphagnum subfulvum	a Peatmoss										X	X						
Splachnum pennsylvanicum	Southern Dung Moss									X		X		X				On dung
Splachnum sphaericum	Round-fruited Dung Moss										X	X	X		X			on animal dung
Taxiphyllum deplanatum	Imbricate Yew-leaved Moss			X	X		X	X					X					Shaded areas, silicious/calcerous soil/rocks, base of trees
Tayloria serrata	Serrate Trumpet Moss							X			X	X						On soil/organic material, moist, sometimes calcerous
Timmia megapolitana	Metropolitan Timmia Moss			X	X											X		Bare soil close to river
Trichodon cylindricus	Cylindric Hairy-teeth Moss									X						X		Bare soil, acidic
Zygodon viridissimus var. rupestris	a moss			X	X			X								X		Tree trunks, rocks in areas with moisture
Vascular Plants																		
Alisma subcordatum	Southern Water Plantain	X									X	X	X	X	X	X		Shores, edges of wetlands
Allium canadense	Canada Garlic											X	X	X	X	X		Floodplains, moist forest
Allium tricoccum	Wild Leek						X	X	X							X		Floodplain, talus. Slopes
Alnus serrulata	Smooth Alder	X									X	X	X		X	X		Shoreline close/in water

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Amerorchis rotundifolia	Small Round-leaved Orchis					X		X				X	X	X				Often calcerous swamps
Anemone multifida	Cut-leaved Anemone	X		X	X											X		
Antennaria parlinii	a Pussytoes		X		X			X										Dry soil, rocks
Arabis drummondii	Drummond's Rockcress			X	X			X										Slope, talus, rocky areas
Arnica lonchophylla	Northern Arnica	X	X					X								X		Slopes, calcerous substrate
Asplenium trichomanes	Maidenhair Spleenwort			X	X													Rocky slopes. Subsp. Grow on either basic/acidc sites.
Botrychium lineare	Narrow-leaved Moonwort		X		X			X								X		Old disturbed sites, highly varied habitats
Botrychium minganense	Mingan Moonwort					X	X	X	X		X	X						
Botrychium oneidense	Blunt-lobed Moonwort							X				X	X	X	X			Acidic soil, wetland edges
Botrychium rugulosum	Rugulose Moonwort		X				X	X										Secondary forest
Callitriche hermaphroditica	Northern Water-starwort												X	X	X	X	X	Shallow water
Calypso bulbosa var. americana	Calypso										X		X					Mixedwood, coniferous swamp
Canadanthus modestus	Great Northern Aster	X					X	X								X		
Cardamine concatenata	Cut-leaved Toothwort	X			X		X	X	X				X			X		Rich alluvial HW, calcerous shorelines, floodplain
Carex bigelowii	Bigelow's Sedge			X	X													High elevation
Carex cephaloidea	Thin-leaved Sedge						X	X	X							X		Rich HW, floodplains
Carex comosa	Bearded Sedge									X	X	X	X	X	X	X	X	Also longs drifting on water
Carex granularis	Limestone Meadow Sedge		X							X	X	X	X	X	X	X		Disturbed areas
Carex grisea	Inflated Narrow-leaved Sedge						X	X								X		Alluvial, floodplan forest, sandy Ca rich soil
Carex gynocrates	Northern Bog Sedge					X		X			X	X	X		X			often found in Cedar swamp/calcerous swamp
Carex hirtifolia	Pubescent Sedge						X	X	X							X		Rich HW, calcerous rocky floodplains, rich undergrowth, thickets
Carex livida var. radicaulis	Livid Sedge											X			X			

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Carex merritt-fernaldii	Merritt Fernald's Sedge	X	X	X	X			X										Disturbed habitats, forest edges. Acidic substrate
Carex norvegica ssp. inferalpina	Scandinavian Sedge										X	X	X	X	X	X		
Carex prairea	Prairie Sedge		X									X	X	X	X	X		
Carex rostrata	Narrow-leaved Beaked Sedge	X	X							X	X	X	X	X	X	X		Wet substrate needed
Carex sprengelii	Longbeak Sedge	X					X	X	X							X		Rich alluvial HW, floodplain, calcerous banks/slopes, rich under growth
Carex sterilis	Sterile Sedge										X	X	X	X	X	X		Calcerous wetlands
Carex tenuiflora	Sparse-Flowered Sedge										X		X	X	X		X	Often associated with calcerous soil
Carex viridula var. elatior	Greenish Sedge	X										X				X		Rich fens, shores of lakes/rivers
Castilleja septentrionalis	Northeastern Paintbrush	X		X	X											X		Floodplain
Cephalanthus occidentalis	Common Buttonbush	X								X	X	X		X	X	X	X	Wetland margins, in water
Chenopodium capitatum	Strawberry-blite															X		Man made, disturbed areas
Cynoglossum virginianum var. boreale	Wild Comfrey						X	X	X							X		Rich HW, decidous, thickets
Cypripedium parviflorum var. makasin	Small Yellow Lady's-Slipper				X	X	X	X	X			X		X		X		Thickets, man made disturbance, edges of wetlands
Danthonia compressa	Flattened Oat Grass		X				X	X										Trails/Edges of forests, fields, man-made distrubances
Decodon verticillatus	Swamp Loosestrife												X	X	X	X		Edges of wetlands
Desmodium glutinosum	Large Tick-Trefoil			X	X		X	X	X									
Dichanthelium linearifolium	Narrow-leaved Panic Grass	X	X	X	X			X								X		Shoreline
Dirca palustris	Eastern Leatherwood					X	X	X	X									
Drosera anglica	English Sundew										X	X						Ca rich wetlands
Drosera linearis	Slender-Leaved Sundew										X	X	X			X		
Dryopteris clintoniana	Clinton's Wood Fern						X	X	X				X					Wet Forest/ forest swamp
Elodea nuttallii	Nuttall's Waterweed															X	X	Shallow water

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Elymus canadensis	Canada Wild Rye	X		X	X		X	X								X		Moisture dependant
Elymus hystrix var. bigeloviana	Spreading Wild Rye		X				X	X	X							X		Floodplain Forests
Epilobium coloratum	Purple-veined Willowherb	X											X	X	X	X		Shores of rivers and lakes
Erigeron acris ssp. politus	Bitter Fleabane	X						X					X		X	X		Edge of moist and seepage areas
Eriophorum gracile	Slender Cottongrass		X								X	X	X		X			Calcerous wetlands
Festuca subverticillata	Nodding Fescue						X	X	X				X			X		Rich shaded alluvial HW
Galearis spectabilis	Showy Orchis		X				X	X	X							X		Rich understory, poor drainage soil, calcerous
Galium kamtschaticum	Northern Wild Licorice	X				X		X					X			X		
Galium obtusum	Blunt-leaved Bedstraw							X					X	X	X			Flood plains, water dependant
Galium trifidum ssp. subbiflorum	Three-petaled Bedstraw										X	X	X	X	X	X		
Hedeoma pulegioides	American False Pennyroyal		X	X	X			X										Dry soil, trails
Helianthus decapetalus	Ten-rayed Sunflower	X						X					X	X	X	X		Floodplain, mesic forest edges
Hepatica nobilis var. obtusa	Round-lobed Hepatica						X	X	X									Dry forests, often on calcerous soil
Humulus lupulus var. lupuloides	Common Hop							X					X		X	X		Man-made disturbance, floodplains
Impatiens pallida	Pale Jewelweed	X					X	X	X							X		
Isoetes prototypus	Prototype Quillwort	X															X	Shore/close to shore
Juglans cinerea	Butternut						X	X	X				X			X		Poor drainage, calcerous soil
Lemna trisulca	Star Duckweed													X		X	X	Quiet waters, Ca rich
Lonicera oblongifolia	Swamp Fly Honeysuckle									X	X	X	X	X	X			Calcerous wetlands, shoreline
Malaxis brachypoda	White Adder's-Mouth		X								X	X	X	X	X			Wet meadows
Nuphar lutea ssp. rubrodisca	Red-disked Yellow Pond-lily													X		X	X	Shallow, slow moving water
Orobanche uniflora	One-Flowered Broomrape		X					X						X	X	X		Man made areas

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Osmorhiza depauperata	Blunt Sweet Cicely							X					X					
Osmorhiza longistylis	Smooth Sweet Cicely						X	X	X									
Oxytropis campestris var. johannensis	Field Locoweed	X			X											X		Shoreline rivers/lakes
Pedicularis furbishiae	Furbish Lousewort	X														X		Ice scour zone, railway bed, periodically distrubed areas
Phryma leptostachya	American Lopseed					X	X	X	X							X		
Platanthera flava var. herbiola	Pale Green Orchid		X					X					X		X	X		Wet areas, alluvial forests
Platanthera macrophylla	Large Round-Leaved Orchid					X	X	X					X	X				Wet/mesic forest
Podostemum ceratophyllum	Horn-leaved Riverweed	X														X	X	Boulders/rocks in rapids of streams/rivers
Polygala sanguinea	Blood Milkwort		X	X														Man-made/distrubed areas/cliff base
Polygala senega	Seneca Snakeroot	X			X			X	X							X		Calcerous shores, railway beds
Polygala verticillata var. verticillata	Whorled Milkwort		X	X	X													Slopes, man made areas
Potamogeton friesii	Fries' Pondweed															X	X	Calcerous/brackish lakes, ponds
Potamogeton nodosus	Long-leaved Pondweed															X	X	In water
Potamogeton richardsonii	Richardson's Pondweed															X	X	Shallow-moderately deep close to shore, alkaline waters
Potamogeton vaseyi	Vasey's Pondweed															X	X	Quiet waters
Pseudognaphalium macounii	Macoun's Cudweed		X					X								X		Disturbed habitats, forest edges
Pterospora andromedea	Woodland Pinedrops					X	X	X										Steep slopes, humus rich areas
Quercus macrocarpa	Bur Oak						X	X	X				X			X		Bottomlands, calcerous/limestone soil, poor drainage
Ranunculus lapponicus	Lapland Buttercup										X	X	X	X				
Ranunculus longirostris	Eastern White Water-Crowfoot													X	X	X	X	Shallow water
Rhynchospora capillacea	Slender Beakrush		X									X	X	X	X	X		Shores, calcerous wet areas
Rosa acicularis ssp. sayi	Prickly Rose	X		X	X											X		Open rocky/cobbley shore

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Rumex aquaticus var. fenestratus	Western Dock	X												X	X	X	X	Silt sand/much shores
Salix candida	Sage Willow									X	X	X	X	X	X			Calcerous substrate
Salix myricoides	Bayberry Willow	X				X					X	X	X	X	X	X		Shores of rivers and lakes, moisture important
Sanicula odorata	Clustered Sanicle						X	X	X				X			X		Floodplains
Sanicula trifoliata	Large-Fruited Sanicle						X	X	X							X		Rich HW, floodplains
Saxifraga virginiensis	Early Saxifrage			X	X			X								X		Rocky slopes
Schizachyrium scoparium	Little Bluestem	X	X	X	X			X								X		distrubed areas, with rocks/boulders
Scrophularia lanceolata	Lance-leaved Figwort							X										Disturbed areas, edges of forest, sandy soil
Shepherdia canadensis	Soapberry	X			X											X		Shoreline gravelly to bouldery
Sisyrinchium angustifolium	Narrow-leaved Blue-eyed-grass	X	X		X								X		X	X		Shoreline
Solidago altissima	Tall Goldenrod		X															Man made, distrubed areas
Solidago simplex var. racemosa	Sticky Goldenrod			X	X											X		Gypsum cliff, talus
Spiranthes cernua	Nodding Ladies'-Tresses		X					X				X	X	X		X		Man made disturbed areas
Spiranthes lucida	Shining Ladies'-Tresses	X	X		X							X				X		Outcrops/boulders/rocks on shoreline/calcerous seeps
Stuckenia filiformis ssp. alpina	Thread-leaved Pondweed															X	X	Shallow water
Symphyotrichum anticostense	Anticosti Aster								X							X	X	Calcerous Soil
Symplocarpus foetidus	Eastern Skunk Cabbage	X								X	X	X	X	X	X	X		Associated with moisture
Triadenum virginicum	Virginia St John's-wort										X			X		X		Wetland edges
Triosteum aurantiacum	Orange-fruited Tinker's Weed						X	X	X							X		Rich HW associated with river/wet areas
Vaccinium uliginosum	Alpine Bilberry	X														X	X	Rocky shores, acidic
Verbena urticifolia	White Vervain	X	X													X		Floodplain/shoreline/distrubed areas
Viburnum lentago	Nannyberry		X										X		X	X		Floodplain/alluvial thicket/forest

						Acadian Forest Mosaic				Freshwater Wetlands						Aquatic		
Scientific Name	**Common Name**	**River Beaches**	**Agricultural / Grassland**	**Cliff**	**Rock Outcrop**	**Coniferous**	**Deciduous**	**Mixed**	**Appalachian Hardwood**	**Aquatic Bed**	**Bog**	**Fen**	**Forested Wetland**	**Freshwater Marsh**	**Shrub Wetland**	**Riparian Systems**	**Lakes**	**Habitat Notes**
Viola canadensis	Canada Violet							X	X							X		HW
Viola novae-angliae	New England Violet	X		X	X											X		Shoreline outcrops
Waldsteinia fragarioides	Barren Strawberry	X					X	X								X		And man-made or disturbed areas
Woodwardia virginica	Virginia Chain Fern										X	X		X	X	X	X	

Appendix E: All Permanently Conserved areas by agency, including applicable legislation

	Name	Legal Conservation	Area (ha)
Government of New Brunswick (38857.07 ha)	De la Republique Provincial Park	NB Parks Act	43.20536
	Mactaquac Provincial Park	NB Parks Act	155.2176
	Mount Carleton Provincial Park	NB Parks Act	8697.595
	Blue Mountain	PNA Legislation	2346.63
	Glazier Lake	PNA Legislation	70.1014
	McCoy Brook	PNA Legislation	59.7806
	Oak Mountain	PNA Legislation	93.0736
	Patchell Brook	PNA Legislation	138.154
	Eel River	PNA Legislation	240.493
	Hovey Hill	PNA Legislation	39.7009
	Two Mile Brook Fen	PNA Legislation	117.313
	Williamstown Lake	PNA Legislation	212.166
	Foley Island	PNA Legislation	6.94754
	Dionne Brook	PNA Legislation	1934.31
	Clarke Brook	PNA Legislation	194.992
	Connors Brook	PNA Legislation	1118.89
	Martial Brook	PNA Legislation	300.144
	Miller Brook	PNA Legislation	161.192
	Tamarack Brook	PNA Legislation	190.604
	Belone Brook	PNA Legislation	1835.57
	First Eel Lake	PNA Legislation	100.927
	Woodman	PNA Legislation	776.728
	McCarty Brook	PNA Legislation	132.276
	Carr Falls Brook	PNA Legislation	685.72
	Oven Rock Brook	PNA Legislation	1093.84
	Quisibis River	PNA Legislation	707.957
	Moose Valley Hill	PNA Legislation	1000.96
	Falls Brook	PNA Legislation	581.277
	Big Cedar Brook	PNA Legislation	96.3434
	Grew Brook	PNA Legislation	1770.33
	Shikatehawk Stream	PNA Legislation	51.5667
	Lakeville	PNA Legislation	61.718
	Mill Brook	PNA Legislation	105.115
	Pokiok Stream	PNA Legislation	1477.58
	Big Falls	PNA Legislation	439.007
	Nalaisk Mountain	PNA Legislation	480.111
	Green River North	PNA Legislation	464.494

	East Cloverdale	PNA Legislation	1088.04
	Smith Brook	PNA Legislation	59.8774
	Belleville	PNA Legislation	13.1187
	Greer Creek	PNA Legislation	215.438
	Becaguimec Stream	PNA Legislation	75.025
	Stickney	PNA Legislation	86.2828
	Little Cedar Brook	PNA Legislation	98.2913
	Nictau	PNA Legislation	16.0727
	Dead Creek	PNA Legislation	168.42
	Maxwell	PNA Legislation	741.537
	Pocowogamis Stream	PNA Legislation	64.9261
	Otter Brook	PNA Legislation	333.582
	Pokiok River	PNA Legislation	2233.72
	Porcupine Mountain	PNA Legislation	417.973
	Angle Hill Lake	PNA Legislation	435.986
	Howard Brook	PNA Legislation	658.993
	McCluskey Brook	PNA Legislation	12.5697
	Golden Ridge	PNA Legislation	69.2669
	Blind Gully Brook	PNA Legislation	428.339
	Indian Brook	PNA Legislation	326.396
	Risteen Brook	PNA Legislation	247.87
	Estey Wetlands	PNA Legislation	64.0021
	Ayers Lake Stream	PNA Legislation	122.27
	Oakland Mountain	PNA Legislation	91.8839
	Baker Brook	PNA Legislation	1704.74
	Adder Lakes	PNA Legislation	454.072
	Burgess Settlement	PNA Legislation	414.955
	Quisibis Mountain	PNA Legislation	156.941
	Demerchant Brook	PNA Legislation	49.3229
	River de Chute	PNA Legislation	25.1263
Meduxnekeag Valley Nature Preserve & Nature Conservancy of Canada (327.81 ha)	NGO	Fee Simple	1.0043
	Bell Flat Nature Preserve	Fee Simple	21.3768
	Meduxnekeag Valley Nature Preserve	Fee Simple / PNA Legislation	305.432

Nature Trust of New Brunswick (166.65 ha)	George M. Stirrett	Fee Simple	2.37175
	Arthur Kyle	Fee Simple	8.26103
	Inglenook Wetlands Nature Preserve	Fee Simple	29.9857
	Eagle's Eye Nature Preserve	Fee Simple	12.7481
	Beardsley Hill	Fee Simple	105.652
	Green Island Nature Preserve	Fee Simple / PNA Legislation	7.63018
Other (1.15 ha)	Private	Conservation Easement on title	0.441944
	Private	Conservation Easement on title	0.1474
	Private	Conservation Easement on title	0.212925
	Private	Conservation Easement on title	0.344482

Appendix F: Methodology for Conservation Actions Prioritisation

1. Purpose of Analysis

The prioritization methodology used in this report identified areas within the Upper St. John River Bioregion where conservation efforts should be concentrated. The goal is to achieve the best possible impact in the areas that are the most critical for the defined priority habitats while minimizing threats to those habitats.

2. Conservation Prioritization

The process for assigning priority ranks within the Upper St. John River Bioregion involved weighting (scoring) certain characteristics of the priority habitats higher than others. Wherever possible, weighting criteria included size (e.g. minimum patch size), representivity (by ecodistrict) and uniqueness (rarity within each ecodistrict and within the Bioregion). The methodology was deliberately designed to promote parcels of land that contained larger patches of priority habitats, those that were not adequately represented within current protected areas and rare/priority species and habitat occurrences. The more high quality priority habitats an area contained, the higher the priority rank it received. Promoting small extents of multiple priority habitats was avoided by selecting minimum size criteria for habitat-based biodiversity habitats. Higher scores were given to areas with larger patches of ecosystems selected as biodiversity habitats. All parcels of land that were 2 acres or smaller were removed from the prioritization analysis in order to avoid prioritizing developed areas. Existing protected areas and other conservation lands were included in the analysis.

3. Data Pre-Processing

All priority habitats were directly included in the prioritization analysis except cliffs. By nature, cliffs are linear features that do not lend themselves to spatial methodologies that allow for prioritization.

Target data sources

Freshwater wetlands – Six types of freshwater wetlands were located within the Bioregion according to the provincial wetland inventory: Bog, Fen, Freshwater Marsh, Aquatic Bed, Forested Wetland, and Shrub Wetland (WT = BO, FE, FM, AB, FW, SW, respectively). Any habitat patches in the NB DNR Forest inventory identified as being a "poor site" [SITEI = F (seasonally saturated or flooded), P (poorly drained site), or W (borderline forested wetlands)] were included in the wetland inventory for this analysis as being Forested Wetlands. The rationale for classifying “borderline forested wetland”, “poorly drained”, and “seasonally saturated” forest patches as wetlands rather than forest habitat in this analysis was to ensure that the dominant ecological characteristic (prolonged presence of water) for these areas was captured in the analysis. These sites tend to be found in interconnected shrub and forest wetland complexes, and along the river shorelines of the St. John River and its major tributaries (ex. Tobique River). All wetland patches were weighted according to patch size, uniqueness, and representivity scores.

- Acadian Forest Mosaic – using the provincial forest inventory, stand types were grouped together into communities using provincial community groupings. These groupings were further grouped into old forest communities using the following methods adapted from the provincial Old Forest Community definition guidelines (NBDNR, 2011):
    - All forest polygons tiles were merged together.
    - Only mature (M) and over-mature (O) were exported out using the L1DS field.

- All polygons with the following treatment attributes were selected and deleted using the L1TRT field (580 records):
  - Clear Cut (CC)
  - Plantation cleaning (CL)
  - Intermediate or semi-commercial thin (IT)
  - Commercial Thin (CT)
  - Fill Planting (FP)
  - Planting (PL)
  - Regeneration protection clear cut (RC)
  - Pre-commercial thinning (TI)
  - Two-pass cut (TP)
  - Family test (FP) and Progeny test (PT) sere selected for removal but had no records in the inventory.
- Old Forest Communities were queried and exported following the Provincial definitions:
  - **Old Tolerant Hardwood Habitat (OTHH)**
    - Tolerant Hardwood Pure (THP)
    - Tolerant Hardwood-Softwood (THSW)
    - Tolerant Hardwood-Intolerant Hardwood (THIH)
  - **Old Hardwood Habitat (OHWH)**[13]
    - Intolerant Hardwood Mix (IHMX)
  - **Old Pine Habitat (PINE)**
    - Red Pine (RP)
    - White Pine (WP)
  - **Old Spruce-Fir Habitat (OSFH)**[14]
    - Eastern Cedar (CE)
    - Eastern hemlock (EH)
    - Red Spruce (RS)
    - Black Spruce – moderate (BSM)[3]
    - White Spruce (WS)
    - Balsam Fir (BF)
    - Tolerant Softwood (TOSW)
    - Softwood – Tolerant Hardwood (SWTH)
    - Softwood Mix (SWMX)
  - **Other Old Forest Habitat (OOFH)**
    - Jack Pine (JP)
    - Tamarack (TL)
    - Black Spruce – poor (BSP)[3]
    - Black Spruce – wet (BSW)[15]

• *Riparian areas – Riparian areas were identified using two main sources: NAAP critical riparian areas and all river and stream systems as identified within the provincial watercourse and waterbody inventory. The LSJR bioregion includes an extensive network of low order streams, as such all of these*

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[13] The Old Hardwood Habitat group also includes the three communities within the OTHH group within the provincial definitions. However, these were removed to prevent overlap of polygons within our analyses.
[14] OSFH also included the "SP" veg community, which represents Spruce dominated habitat, although there is no reference to this category in the Provincial definitions.
[15] Black Spruce categories are based on landscape features as they relate to soil moisture. These categories are determined using the Wet-areas Mapping tool (BSW < 25cm DTW, BSP 25-100cm DTW, BSM > 100cm DTW).

features were included and buffered by 275 m based on the habitat requirements of the wood turtle (Burke and Gibbons 1995). All riparian areas were treated equally and assigned a score of 0.2.

- *Grasslands/agro-ecosystems – Grasslands were selected from the provincial non-forest inventory using the Primary Land Use classification AGR. This corresponds to lands classified as either cultivated land used for the production of crops including grains, or fallow pastureland. All map layer polygons were merged so that adjacent polygons were regarded as one unit. Grasslands/agro-ecosystems habitat was weighted according to patch size, but not representivity or uniqueness, as patch size is deemed to be the overriding factor for grassland bird habitat (Environment Canada 2013).*
- *Cliffs - The Nature Conservancy of Canada map layer for steep slopes was used to represent cliff features, with all identified areas assigned a ranking of 1 because of the relative rarity of this habitat type within the bioregion.*
- *Rocky outcrops – The New Brunswick Department of Natural Resources bedrock geology map layer was used to identify rocky outcrops. In addition, layers Modeled Ecosystems, Summits (TNC) and Rock Outcrops and Summit Scrub within the Northeast Terrestrial Habitat Map (TNC) was added to make the data set more complete. As these habitats are relatively scarce and isolated, and represent important habitat for certain species, for example lichens and mosses, all rocky outcrop areas were given a ranking of 1.*
- *Sand and gravel beaches - The National Topographic Database (NTD), (Geogratis) as well as the NB Department of Natural Resources Wetland layer was used to identify the sand and gravel beaches in the study area. The NTD "sand" layer was merged with any patches of land identified as "Beach" by their Wetland Code from the NB DNR Wetland layer. As these habitats are relatively scarce, highly susceptible to threat impacts, and potentially important for species at risk (including portions of critical habitat for certain species), all beach areas were weighted equally with a ranking of 1.*

Cleaning the Data

The first step prior to the prioritization analysis was to clean the GIS data before assignment of weights on the habitats was calculated. In order to avoid weighting polygons based on topographic errors, all polygons of the same habitat type were dissolved in ArcGIS to eliminate any insignificant boundaries between contiguous patches. The selected patches were then dissolved to form new contiguous polygons. Area of each patch was recalculated using "Calculate Geometry" and weights were then assigned based on the new area of the dissolved polygons.

Weighting the Data

For each habitat/biodiversity habitat, final scores between 0 and 1 were assigned, the latter representing completely suitable habitat for nested habitats. All NAAP critical habitat occurrences were assigned a value of 1. All other habitat occurrences (except for caves, calcareous areas and riparian areas – see below) were scored using a three-tiered equation (with the exception of grasslands, which were solely weighted on size criteria) that equally divides the scoring by habitat uniqueness, representivity and size.

Uniqueness

Conceptually, variations in enduring features across the landscape (geology, climate, topography and soils) can potentially result in different ecological attributes of a habitat type (for example, high elevation bogs host different specie assemblages than coastal blanket bogs). In order to address the potential differences of habitat types across the Bioregion, each habitat type was categorized by the ecodistrict in which it was located (see Zelazny 2007). To determine the uniqueness of each categorized habitat type across the Bioregion, two area based assessments were conducted (U_1 and U_2) as follows:

$$U1 = \mathbf{1} - \frac{\mathbf{HABITAT}_{In\_Ecodistrict\text{-}Within\text{-}StudyArea}}{\mathbf{HABITAT}_{In\text{-}StudyAreaTotal}}$$

$$U2 = \mathbf{1} - \frac{\mathbf{HABITAT}_{In\_StudyArea\_Total}}{\mathbf{ECOSYSTEM}_{In\_StudyArea\_Total}}$$

Where, **U1** = the area of the habitat (bog, fen, OOFH etc.) found only in the portion of the Ecodistrict in question that falls within the Study Area divided by the area of the Habitat found within the total study area.

U2 = the area of the habitat found in the total study area divided by the area of the Ecosystem found in the total study area

$$\text{Uniqueness} = \mathbf{(U_1 + U_2) / 2}$$

The equation for the Uniqueness Score should reflect this final equation[16].

This method of calculating uniqueness gives equal weighting to each of the 2 area based assessments. U_1 addresses the uniqueness of each categorized habitat as compared to all other occurrences of the same habitat within the Bioregion (for example, uniqueness of bogs along the Fundy coast as compared to all other bogs within the Bioregion), and U_2 addresses the uniqueness of the habitat type in general (for example, the uniqueness of bogs as compared to all other freshwater wetlands within the Bioregion).

For habitat types that are within their own habitat category (salt marsh, tidal flats, beaches, rocky shores), the U_2 equation was not relevant and the final uniqueness score for these habitats was based on the output of the U_1 equation.

<u>Representivity</u>

Using the enduring feature approach discussed above, representivity was calculated using two area based assessments (R_1 and R_2), as follows:

$$R1 = \frac{\mathbf{ECODISTRICT}_{In\text{-}StudyArea}}{\mathbf{ECODISTRICT}_{Total}}$$

$$R2 = \frac{\mathbf{HABITAT}_{In\_Ecodistrict\text{-}within\text{-}StudyArea}}{\mathbf{HABITAT}_{In\text{-}Ecodistrict}}$$

[16] Note all negative values = 0

Representivity = **1- (R_1/R_2)**

The equation for the Representivity Score should reflect this final equation.

Where, **R1** = the area of the Ecodistrict that falls within the boundaries of the USJR divided by the total area of the Ecodistrict

R2 = the area of the habitat (bog, fen, OOFH etc.) found only in the portion of the Ecodistrict in question that falls within the Study Area divided by the area of the habitat found within the entire Ecodistrict in question

This method of calculating representivity accounts for the total area each ecodistrict represents within the Bioregion boundary (R_1) and this number is prorated by the percent of habitat that occurs within the portion of the ecodistrict within the Bioregion. Conceptually, if both R_1 and R_2 are equal, than the habitat type is equally represented across the ecodistrict, both inside and outside the Bioregion boundary (*Representivity* = 0). If R_1 is smaller than R_2, than a higher proportion of habitat is located within the Bioregion portion of the ecodistrict, which results in a higher score (*Representivity* > 0). If R_1 is larger than R_2, than a lower proportion of habitat is located within the Bioregion portion of the ecodistrict than outside of it. This results in a negative score (*Representivity* < 0), meaning that the habitat type is more represented outside the Bioregion portion of the ecodistrict. All negative values are converted to 0.

Size[17]

Size is calculated for each occurrence of each habitat type across the Bioregion. For example, if the habitat met the minimum size criteria based on the NAAP (Anderson et al. 2006), it would receive a score of "1". If it was below the minimum size threshold, then it received a score from 0 to 0.99 depending on the size of the patch. The sliding scale was calculated by dividing the actual patch size by the minimum patch size. Patches of habitat that are close to the minimum patch size will receive a higher score than those which are smaller. Smaller patches are still used by many species and may offer other benefits other than nesting or breeding grounds; however the larger patches offer the greatest benefit to all species. See table F.1. below for a summary of size criteria used within the analysis.

$$\text{Size}^{18} = \frac{\textbf{HABITAT\_}_{\text{Patch\_Area}}}{\text{Ecosystem or } \textbf{Habitat\_}_{\text{Critical\_Area}}}$$

Table F.1. Minimum size criteria for each habitat type within the Upper St. John River Bioregion analysis.

Habitat	Data Source	Minimum Size (Hectares)	Size Score
Beaches	National Topographic	N/A	1

[17] All size calculations are in hectares
[18] Any score > 1 is taken as 1

	Database, NB DNR non-forested layer	(criteria = presence / absence)	
Rocky Outcrops	DNR bedrock geology NCC Summits LCC Outcrops & Summit Scrub	N/A (criteria = presence / absence)	1
Cliffs	NCC Steep Slopes	N/A (criteria = presence / absence)	1
Freshwater Wetlands	NB DNR Wetlands, NB DNR FRI Forest - wet site areas	20.2	Below minimum size = sliding scale to .99 Above minimum size = 1
Riparian Areas	NB DNR Watercourses and Waterbodies, NAAP Critical Floodplain Areas	N/A (criteria = presence / absence)	0.2
Grasslands	NB DNR Non-forested	50 (Environment Canada, 2013)	Below minimum size = sliding scale to 0.99 Above minimum size = 1
Acadian Forest Mosaic[19]	NB DNR FRI Forest		Below minimum size = sliding scale to 0.99 Above minimum size = 1
Tolerant Hardwood (OTHH)		40	
Intolerant Hardwood (OHWH)		30	
Spruce / Fir (OSFH)		375	
Pine (PINE)		10	
Other (OOFH)		375	

Final Habitat Weighting
The final score for each habitat type was calculated as:

$$Score = \frac{(Uniqueness + Representivity + Size)}{3}$$

This gives equal value to each of the uniqueness, representivity and size categories.

[19] For old forest communities, patch sizes were adapted from the Provincial Old Forest Community and Wildlife Habitat Definitions. The largest patch size for each community was used in the analysis to capture all species that were identified for each community type.

Buffer Weighting
Salt marsh and freshwater wetland habitat habitats were assigned buffers of 275m. Buffers were assigned the score of their respective habitat occurrence. Where 2 buffers overlapped, priority was given to the higher score, both within the same layer as well as between layers.

Species Analyses
As part of collaboration with the Canadian Wildlife Service and other conservation organizations within the Maritime region, a biodiversity composite was developed for New Brunswick. The objective of the composite was to determine “biodiversity hotspots” across the province, which was then used within the Bioregion boundary to determine areas of high conservation value. See Appendix K for a complete methodology of the New Brunswick Biodiversity Composite.

Combining the Data
Once all vector layers (shapefiles) and species composites (GRIDS) were prepared, each was converted into raster format using a cell size of 10m. A small cell size was based on the error of the data layers and was used in order to ensure the resolution of the data would not be generalized. All rasters were then overlaid and added together to give an overall scoring across the Bioregion (using the Cell Statistics tool). Each biodiversity habitat was weighted the same when the final score was calculated. Table F.1 shows the list of all rasters that were combined for prioritization with their respective scoring.

Post-hoc prioritization Analysis
A number of shapefile datasets were received as point layers. In order to include these in the prioritization analyses they were assigned buffers and given values following the table below:

Table E.2

Point Layer	Buffer Width (m)	Score and comments
ACCDC Communities	100	1; When overlaid on forest habitat values did not exceed 1.

Appendix G: Biodiversity Composite Methodology

Analyses rely on priority biodiversity species lists established by consensus according to objective selection criteria, recognising that important data gaps exist for several taxa. Specifically, species within these lists include ACCDC ranked S1, S2, or S3 with a G1, G2, or G3 ranking; BCR 14 "priority species" by province; COSEWIC Endangered, Threatened, and Special Concern. Species for which occurrence is considered accidental, specifically birds, were excluded from lists. Priority species habitat associations (where this information is available) can be considered for the purpose of more objective identification of priority habitats. In other words, tallies based on occurrence of priority species within certain habitat types can help inform the selection of habitat priorities if none are identified otherwise (see section on habitat data, below).

2.2 SPECIES DATA SOURCES

Data layers, data sources and data types used to describe species spatial distribution:

Data layers	Data source	Source data type
Occurrence of mammals, reptiles, amphibians, vascular plants, non-vascular plants, lichens, etc.	AC CDC	Points
Relative abundance of birds	MBBA point count	Points, counts
Breeding evidence of birds	MBBA breeding evidence	Polygons (10X10 km squares), breeding evidence categories
Occurrence and abundance of rare and colonial bird species	MBBA rare/colonial species	Points, counts
Occurrence and abundance of shorebirds	CWS Atlantic Canada Shorebird Survey database	Points, counts
Occurrence and abundance of colonial birds	CWS Atlantic Region Colonial Waterbird database	Points, counts
Occurrence and abundance of coastal waterfowl	CWS Atlantic Canada Coastal Waterfowl Survey database	Polygons (irregular blocks), counts
Occurrence of SAR critical habitat	CWS Atlantic Region Critical Habitat Mapping Database	Polygons (irregular)

Atlantic Canada Conservation Data Centre (ACCDC) data

Species Occurrence Data

The ACCDC dataset contains point data records for a large number of species occurring in Atlantic Canada (mostly Maritimes). Points within the ACCDC database with low geographic certainty, and species that were not appropriate for the analyses were excluded from the dataset. All records with higher geographic certainty (according to the ACCDC data) were retained and then classified into broad groups consisting of: Aquatic, Mammal, Bird, Reptile/Amphibian, Insect, or Plant. Next, G and S ranks for these species were assessed. Only species with a ranking of S1 or S2, or S3 with a global ranking of G1, G2 or G3, were retained. All species listed by COSEWIC were retained, regardless of their S or G rankings.

Species listed as BCR priority species were retained, regardless of S or G rankings. Those not already listed in the ACCDC were added to the list. However, information from the ACCDC dataset for BCR priority species was retained for analyses only if information could not be obtained via the original data sources (i.e., MBBA, CWS).

Habitat associations were determined (where possible) for each species, based on information within datasets, specific studies, or expert advice.

Maritimes Breeding Bird Atlas (MBBA) data

Point Count Data

During development of the Maritimes Breeding Bird Atlas, species relative abundance maps were derived from point data records originating primarily from priority squares (approximately ¼ of all squares in the Maritimes). These point count data were used by Bird Studies Canada to derive species relative abundance maps for the Maritimes on behalf of the Maritimes Breeding Bird Atlas. Methodologies for creating these relative abundance maps since have changed and this set will not be used within the publication.

Breeding Evidence Data

Confirmed = 0.5 (for each Atlas; max value of 1)
Probable = 0.3 (for each Atlas; max value of 0.6)
Possible = 0.1 (for each Atlas; max value of 0.2)

Rare/Colonial Species Data

Colonial buffer = 500 m

CWS data

Atlantic Canada Shorebird Survey Data

This dataset began as the Maritimes Shorebird Survey (MSS), following initial efforts by Canadian Wildlife Service employees to monitor migrating shorebirds at a limited number of sites. The program now enlists skilled volunteer contributors from throughout Atlantic Canada and now includes a small (and growing) number of sites in Newfoundland and Labrador. Repeated within-season surveys follow a defined protocol and typically occur during spring, summer and fall periods at established locations.

Atlantic Colonial Waterbird Data

This database contains records of individual colony counts, by species, for known colonies located in Atlantic Canada. Although some colonies are surveyed annually, most are visited much less frequently. Methods used to derive colony population estimates vary markedly among colonies and among species.

Atlantic Coastal Waterfowl Survey Data

This dataset is derived from aerial surveys of waterfowl (e.g., ducks and geese) occurring within coastal and inshore waters of Atlantic Canada, and organised within polygons rather than by points. The sampling unit for these databases is the coastal (and inshore) waterfowl ‘block’. Coastal waterfowl ‘block’ polygons were established at the beginning of these monitoring programs and have remained fixed over time. Polygon sizes differ geographically (within and among EC CWS Regions) and are irregularly shaped. ‘Blocks’ were initially designed to reflect prominent coastline features that separate coastal segments, inshore bays and estuaries, and thus define functionally distinct habitat units (for waterfowl). Records include counts of birds of each species observed within each polygon during each survey visit.

Although observers attempt to identify individuals or flocks of birds to species, this is not always possible. Incidental records (i.e., not gathered consistently) of other bird species, mostly marine, can be found within these databases. In particular, incidental records include coastal and inshore zone species not well captured through other surveys (e.g., loons, grebes, gulls, shorebirds, and cormorants).

Atlantic Region Species at Risk Critical Habitat Mapping

Mapping of Critical Habitat for Species at Risk in the Atlantic Region has involved identifying the unique aspects of each species' habitat and illustrating those elements through a GIS model. Through field work data and GIS applications, spatial reference that reflects the sensitivity of species and their respective habitats was created for 23 species. The model for the identification of Critical Habitat for Species at Risk will continue to be used to identify habitat for new species, as well as to refine the data available for existing Species at Risk.

SPECIES DATA STEPS

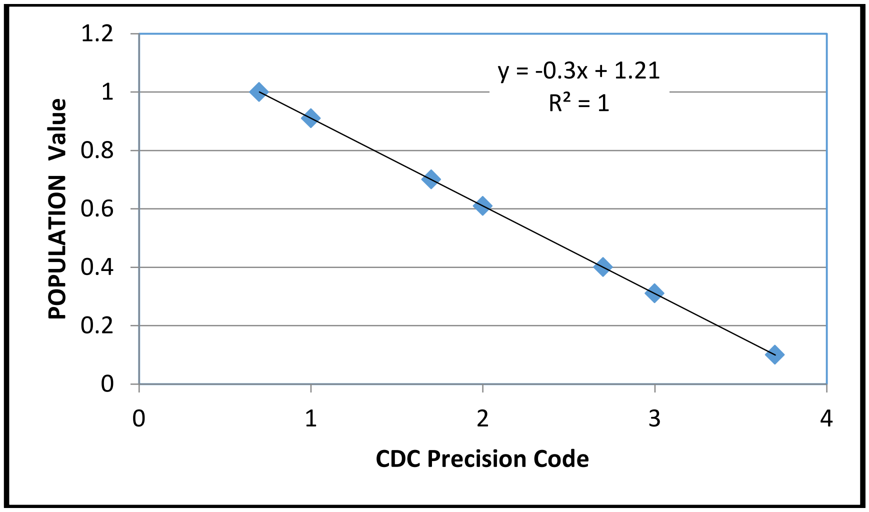
ACCDC data

1) Generate point process layers (shapefiles) for each species within the dataset. All records must have a CDC Precision Code value of 3.7 or less (see table 1).
2) Generate 'Primary Buffers' by conducting kernel density analysis for each species, using a 500 m radius, a 10m output cell size and the appropriate 'POPULATION' parameter value (see figure 1). This approach attributes more value to pixels closest to the centroid with more precise observations.

Table 1: ACCDC precision code, definitions, spatial context, unit size and range of values within the dataset.

prec	*common speech*	*example*	*unit size*	*literal range (m)*
6.0	within province	province	1000.0km	562.3 - 1778.3
5.7	in part of province	'NW NB'	500.0km	281.2 - 889.1
5.0	within in county	county	100.0km	56.2 - 177.8
4.7	within 50s of kilometers		50.0km	28.1 - 88.9
4.0	within 10s of kilometers	BBA grid	10.0km	5.6 - 17.8
3.7	within 5s of kilometers		5.0km	2.8 - 8.9
3.0	within kilometers	topo grid	1.0km	0.6 - 1.8
2.7	within 500s of meters		500.0m	281.2 - 889.1
2.0	within 100s of meters	ball field	100.0m	56.2 - 177.8
1.7	within 50s of meters		50.0m	28.1 - 88.9
1.0	within 10s of meters	boxcar	10.0m	5.6 - 17.8
0.7	within 5s of meters		5.0m	2.8 - 8.9
0.0	within meters ***NOT USED***	pace	1.0m	0.6 - 1.8
-1.0	within 10s of centimeters	fingernail	0.1m	0.1 - 0.2

Figure 1: Population values derived for the purpose of informing the kernel density point process using precision code values found within the ACCDC dataset. Linear equation can be used to populate a new attribute field with POPULATION value information.



3) Conduct buffer analysis to derive 'Secondary buffers' for each species, using a 5000 m radius. Use a fixed value of 0.2 for pixels within the secondary buffer.
4) Combine Primary and Secondary buffers for each species (at the provincial geographic scale) to create species rasters with pixel values ranging from 0 to 1 (Maritimes scale).
5) Overlay rasters from the suite of species to derive multi-species 'Biodiversity Composites'.

MBBA point count
1) These data can be used to represent the relative abundance of breeding priority bird species detected during the course of point count surveys.
2) Relative abundance rasters were derived from point count information by Bird Studies Canada.
3) Final decisions on quality and appropriateness of individual rasters were made 'a priori' by MBBA and BSC staff.
4) All rasters were reclassified such that values range between 0 and 1.

MBBA breeding evidence
1) These data can only be used to represent evidence of breeding of priority bird species as determined during the course of breeding evidence surveys. These data specifically were used for species not captured adequately during the course of point count surveys.
2) The highest level of breeding evidence was determined, by species, for each square, for each of two Atlas periods (1986-1991; 2006-2011).
3) Raster values were derived using this breeding evidence data according to following rules: Confirmed = 0.5; Probable = 0.3; Possible = 0.1.
5) Rasters for both Atlas periods were summed such that combined values for a given species range from 0 to 1.

MBBA rare and colonial
1) To represent breeding priority bird species
2) Use rare and colonial data records
3) Derive rasters using colonial data only for species not captured adequately in either point count or breeding evidence datasets.
4) Buffer colonies by 500 m
5) Values within buffer area given value of 1. Kernel density estimator, range from 0.2 to 1.
6) 'Rare' species records to be used 'a posteriori' for verification of specific areas and land parcels.

ACSS data: shorebirds

1) These data were used to represent predominantly non-breeding priority shorebird species surveyed during the spring or Fall migration periods.
2) Use species abundance data (counts, by shorebird survey site, by species)
3) Derive rasters using count data for species not captured adequately through other surveys.
4) Create rasters for each species such that combined values for a given species range from 0 to 1.

ACW data: colonial waterbirds

1) To represent non-breeding priority bird species
2) Use species abundance data (counts, by colony survey site, by species)
3) Derive rasters using count data for species not captured adequately through other surveys.
4) Create rasters for each species such that combined values for a given species range from 0 to 1.

AR SAR CH mapping data

1) To represent Atlantic Region Species at Risk for which Critical Habitat (CH) mapping has been initiated.
2) Map CH polygons, for Endangered and Threatened priority species, instead of using layers for species derived using other datasets.
3) Buffer CH polygons by 5 km
4) CH polygons given value of 0.8, surrounding buffer given value of 0.2, for a total ranking of 1 for CH polygons.

SPECIES DATA COMPOSITES

Results:

Overlaying the rasters for the suite of priority species creates a biodiversity composite. These biodiversity composites can be adapted to illustrate biodiversity hotspots, hotspots for particular suites of species, hotspots for species associated with target habitats (based on species-habitat matrices), etc.
NOTE: A batch processing tool was developed by NCC to automate steps 1) through 5), with the exception of establishing the target list of species considered.
Tool: The tool currently creates both Primary and Secondary buffers (rasters). The tool also normalizes the individual kernel density rasters (max value of 0.8) and adds to them the fixed primary buffer values (fixed value of 0.2), such that the total for each resulting species raster varies between 0-1.

Appendix H: Methodology for habitat viability assessments

Landscape Context Assessment

Landscape Context Index (LCI)

Habitats in assessment: Cliffs, Rock Outcrops

Shapefiles used: Modelled Ecosystem Steep Slopes (Cliffs)
Modelled Ecosystem Summits (Rock outcrops)

The following steps are applicable to both shapefiles mentioned above.
Add field to attribute table (Area_ha).
Calculate Geometry hectares (ha), use statistics to find the sum for the field (Area_ha).
Query the LCI1 field with:
LCI1 <20
Use statistics to find the sum of the queried attributes for the field (Area_ha).

Proportion of LCI < 20 = Area_ha LCI query/ Total Area_ha x 100

Landscape Context Index source

Definition from: Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.

Found at: https://easterndivision.s3.amazonaws.com/Geospatial/ConditionoftheNortheastTerrestrialandAquaticHabitats.pdf

Definition

"The Landscape Context Index (LCI) quantifies the degree of human conversion of natural landcover in the immediate neighborhood of that cell on the landscape. Why is Landscape Context Important? The local context of a habitat patch has a large influence on the viability, reproductive success, and quality of the available food and shelter resources to the wildlife and plants within the patch, but the individual species dynamics are complex (Tewksbury et al. 2006)[20]. It often appears that the smaller the habitat patch, the more dependent it is on the surrounding landscape for species inputs and processes, but exactly how the interactions work between the quality of a patch of habitat and the character of the landscape surrounding it is not well understood (Forman 1995, Lindenmayor and Fischer 2006)[21+22]. The landscape processes that sustain a habitat patch vary in space and time. Consider, for example the degradation of a pine barren habitat when fire regimes are altered, or the changes in the quality and composition of dune habitats when coastal revetments alter long-shore sand flows. Additionally, habitats differ in their landscape dependence, and some, such as raised bogs, perched wetlands, and

[20] Tewksbury J., L. Garner, S.Garner, J.D. Lloyd, V. Saab, and T. E. Martin 2006. Tests of Landscape Influence: nest predation and brood parastism in fragmented ecosystems. Ecology 87:759–768. http://dx.doi.org/10.1890/04-1790

[21] Forman, R.T.T. 1995. Land mosaics: the ecology of landscapes and regions. Cambridge University Press, Cambridge.

[22] Lindenmayor, D. and Fischer, J. 2006. Habitat fragmentation and Landscape change. Island Press. 352 pp.

rocky summits may be more dependent on atmospheric inputs for water and nutrients than on the surrounding landscape (Mitsch and Gosselink 2000)[23].

NatureServe and the Natural Heritage network use a measure of landscape context as a factor in estimating the viability of a rare species or community, along with measures of size and condition. Based on this, The Nature Conservancy used the LCI metric as criteria for portfolio site selection after it was found to correlate closely to field estimates for landscape context provided by the Natural Heritage inventory records. The metric is most useful to small-patch habitats. Methods This measure quantifies the relative amount of development, agriculture, quarries, roads, or other fragmenting features within an area directly surrounding each 30m cell of land. It is similar to the local connectedness metric, but searches a much smaller (about 1 km) area to provide an estimate of the isolation of, and current encroachments on, the cell. Base data layers included roads, high intensity developed lands, low intensity developed lands, agriculture, quarries, and natural cover. A LCI below 20 indicates that the occurrence is surrounded primarily by natural cover. Higher LCIs indicate increasing amounts of roads, development, and agriculture. The metric values range from 0 to 400 (Figure 9). The context of the landscape around an occurrence will affect the health and survival of the occurrence. The Northeast Terrestrial and Aquatic Geospatial Condition Analysis The Nature Conservancy – Eastern Conservation Science – 99 Bedford St – Boston MA 02111 29 We used the 2001 National Landcover Dataset (NLCD) for the region as the base data for this metric, a grid of 30 meter cells (Homer et al. 2007)[24].

We simplified the dataset by reclassifying landcover codes to 5 ranked values, integers from 0 to 400, indicating degree of landcover conversion (Table 10). Table 10. Simplification of the NLCD 2006 to five landcover codes for use in the landscape context index. Landcover codes Landcover description Reclassified to: 11 water 0 (natural) 21/22 low intensity developed 300 (low intensity devel'd) 23/24 med-high intensity residential/ 400 (med to high intensity developed) 31 open bare 0 (natural) 41/42/43 decid/conif/mixed forest 0 (natural) 52/71 shrublands/grasslands 0 (natural) 81/82 Pasture/hay & cropland 200 (agricultural) 90 forested wetland 0 (natural) 95 emergent wetland 0 (natural). We used a grid "focalmean" on the reclassified landcover data for a 1000 acre circular window. This procedure assigns to each cell in the output grid an average of the reclassified landcover values (which, again, range from 0/natural to 400/intensely developed) for all cells within a 1140m radius of that cell. For each minor road bounded block we calculated zonal statistics for the landscape context index grid to determine the average landscape context index value for the minor road bounded block."

Landscape Connectedness source
Habitats in assessment: Cliffs, Rock Outcrops, Acadian Forest (NETHM layer), Wetlands, Riparian
Shapefile issued: Connectedness (Anderson et al 2013)
Northeastern Terrestrial Habitat map (Clip to queried forest layers)
Cliffs_USJR
Rock Outcrops_USJR
Wetlands_USJR
Riparian_USJR
Export Connectedness map to correct to projection (NAD 1983 CSRS New Brunswick Stereographic)

[23] Mitsch, W.J. and J.G. Gosselink. 2000. The values of wetlands: importantce of scale and landscape setting. Ecological Economics 35(1) pp 25–33
[24] Homer, C., Dewitz, J., Fry, J., Coan, M., Hossain, N., Larson, C., Herold, N., McKerrow, A., VanDriel, J.N., and Wickham, J. 2007. Completion of the 2001 National Landcover Database for the Conterminous United States. *Photogrammetric Engineering and Remote Sensing*, Vol. 73, No. 4, pp 337-341.

Convert the Connectedness Raster to Polygon, limiting to USJR boundary.
Add field into attribute table ConCd.
The calculation for this field was made as follows:
ConCd = -(GrdCd)+100
The scores where than classified into 5 fields as:
0-25 Very Good
26-50 Good
51-75 Fair
76-100 Poor

Clip Connectedness polygon layer to individual habitats.
Add field, Area_ha and Calculate Geometry as Area in Hectares (ha)
Query ConCd field: ConCd > 25
Use the statistics on the Area_ha field to calculate the sum for the queried attribute.

Proportion connectedness = Area_ha from Query / total area for habitat x 100

Landscape Connectedness source
Definition from: Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.

Found at:
"https://easterndivision.s3.amazonaws.com/Geospatial/ConditionoftheNortheastTerrestrialandAquaticHabitats.pdf

Definition
An estimate of the degree of permeability, or conversely the degree of resistance, surrounding each cell in the region. We summarized this metric into a habitat connectedness index. Why is Local Connectedness Important? The natural world constantly rearranges, and climate change is expected to accelerate natural dynamics, shifting seasonal temperature and precipitation patterns and altering disturbance cycles of fire, wind, drought, and flood. To stay in synch with these changes wildlife and plant populations need to adjust their ranges, migrating and re-establishing in more favorable conditions. Most of this movement is expected to take place in local neighborhoods (e.g. shifting from a hot southern slope to a cool north facing cove) but over time some shifts will happen on a larger scale. During rapid periods of climate change in the Quaternary, when the landscape was highly connected by continuous natural cover, there were many shifts in species distributions, but few extinctions (Botkin et al. 2007)[25]. Now, however, pervasive landscape fragmentation disrupts ecological processes and impedes the ability of many species to respond, move, or adapt to changes. The concern is that broad-scale degradation will result from the impaired ability of nature to adjust to rapid change, creating a world dominated by depleted environments and weedy generalist species. The Northeast and Mid-Atlantic region is crisscrossed by over 732,000 miles of roads, enough to circle the earth 29 times. Not surprisingly, fragmentation, combined with habitat loss, poses one of the greatest challenges to conserving biodiversity in a changing climate. The need to maintain connectivity has emerged as a point

[25] Botkin, D.B., Saxe, H. Araujo, M.B., Betts, R., Bradshaw, R.H.W., Cedhagen, T., Chasson, P, Dawson, T.P., Etterson, J.R., Faith, D.P. Ferrier, S., Guisan, A., Hansen, A.S., Hilbert, D.W., Loehle, C., Margules, C. 2007. Forcasting the Effects of Global Warming on Biodiversity. BioScience. Vol. 57 No. 3.

of agreement among scientists (Heller and Zavaleta 2009,)[26]. We prefer the term 'permeability' instead of 'connectivity' because the metric is not based on individual species movements, but is a measure of landscape structure: the hardness of barriers, the connectedness of natural cover, and the arrangement of land uses. It is defined as the degree to which regional landscapes, encompassing a variety of natural, semi-natural and developed landcover types, will sustain ecological processes and be conducive to the movement of organisms (modified from Meiklejohn et al. 2010)[27]. Maintaining a permeable landscape, in conjunction with protecting and restoring sufficient areas of high quality habitat, should facilitate the persistence of species. The Northeast Terrestrial and Aquatic Geospatial Condition Analysis 20 The Nature Conservancy – Eastern Conservation Science – 99 Bedford St – Boston MA 02111.

Methods

We used a resistant kernel algorithm designed to measure the connectedness of a focal cell to its ecological neighborhood when the cell is viewed as a source of movement radiating out in all directions. (Compton et al. 2007)[28]. It was built on the assumption that the permeability of two adjacent cells increases with their ecological similarity and decreases with their contrast. Contrasting elements were scored with resistance weights to reflect differences in structure, composition, degree of development, or use. The theoretical spread of a species or process outward from a focal cell is a function of the resistance values of the neighboring cells and their distance from the focal cell, out to a maximum distance of three kilometers. Our resistance surface was based on a classified land use map with roads and railroads embedded into the grid (NLCD 2001, Tele Atlas North America 2012). We simplified the landcover into six basic elements and assigned resistance weights to each category based on a version of Compton's (2007) similarity index, where natural land was given the lowest resistance weight (10) and high intensity developed land was given the highest weight (100). Minor roads were overlaid on the grid and added 10 points of resistance to the cell containing them. We tested the sensitivity of the outcomes to the resistance weights by running the analysis for three test areas, and systematically changing the weights. The final weights were as follows (NLCD classes in parenthesis): 10 = natural lands and water (evergreen, deciduous, and mixed forest, shrub/scrub, grassland, woody and herbaceous wetland, water); 50 = non-natural barrens (barren); 80 = agricultural or modified lands (pasture, cultivated); 90 = low intensity development (developed open space, low intensity developed); 100 = high intensity development (medium intensity developed, high intensity developed, major roads). We aggregated the 30 m resistance surface to a grid of 90 meter cells to reduce the considerable processing time, before running the resistant kernel algorithm and computing the score for each cell. Cell scores ranged from 0 to 1 and were converted to a scale of 0 to 100 for comparability with low scores for highly fragmented and high scores for high local connectedness.

Ice Scour assessment

Habitats in assessment: Beaches

Shapefiles used:	NB DNR Non-Forest clipped to USJR
	Beaches_USJR

Query out Ice scour attribute from Non-Forest Layer: SLU = RF
Clip queried layer to beach layer

[26] Heller, N.E. and Zavaleta E.S. 2009. Biodiversity management in the face of climate change: A review of 22 years of recommendations. Biological Conservation 142; 14-32.
[27] Meiklejohn, K., Ament, R. and Tabor, G. 2010. Habitat Corridors & Landscape Connectivity: Clarifying the Terminology. Center For Large Landscape Conservation. www.climateconservation.org.
[28] Compton, B.W, McGarigal, K, Cushman S.A. and L.G. Gamble. 2007. A resistant-kernel model of connectivity for amphibians that breed in vernal pools. Conservation Biology 21: 78-799.

Add field (Area_ha) and calculate geometry (area in hectares)
Use statistics to find sum in Area_ha

Proportion beaches influenced by ice scour = Area_ha (clipped layer)/area beaches (total) x 100

Natural habitat embeddedness
Habitats in assessment: Grassland, Cliffs, Rock Outcrops, Acadian Forest Mosaic, Freshwater Wetlands, Riparian & Aquatic Systems
Shapefiles used: Grassland_USJR (100m Fletcher 2005)
Cliffs_USJR (100m)
Rock Outcrops_USJR (100m)
Acadian Forest Mosaic_USJR (100m)
Freshwater Wetlands_USJR (200m Jones et al. 1988)
Riparian_USJR (200m Jones et al. 1988)

Buffer all layers to the distance indicated in parenthesis.
Clip NETHM to all layers to acquire habitats associated with it.

Add field Area_ha, calculate geometry in Hectares within all layers that where buffered and clipped to NETHM ("Habitatname"_Buff_hab)

Query the following in "Habitatname"_Buff_hab:
MACR_2015 = Boreal Upland Forest OR MACR_2015 = Cliff and Talus OR MACR_2015 = Emergent Marsh OR MACR_2015 = Large River Floodplain OR MACR_2015 = Northern Harwood & Conifer Forest OR MACR_2015 = Northern Swamp OR MACR_2015 = Outcrop & Summit Scrub OR MACR_2015 = Water OR MACR_2015 = Wet Meadow/Shurb Marsh OR MACR_2015 = Ruderal Shrubland/Grassland

Use statistics to find sum from Area_ha field for all "Habitatname"_Buff_hab
Delete query and find total area with statistics and sum for all "Habitatname"_Buff_hab

Proportion Natural =
(Area Queried "Habitatname"_buff_hab) / (Total area unqueried "Habitatname"_Buff_hab) x 100m

<u>Condition</u>
Proportion in permanently conserved lands
Habitats assessed: Beaches, Cliffs, Rock Outcrops, Acadian Forest Mosaic (NETHM), Freshwater Wetlands, Riparian
Shapefiles Used: Beaches_USJR
Cliffs_USJR
Rock Outcrops_USJR
Acadian Forest (NETHM)_USJR
Freshwater Wetlands_USJR
Riparian_USJR
Conserved lands_USJR

Add field Area_ha to all layers, calculate geometry as Area in hectares in this field.
Query Conserved lands_USJR: 'Permanent' = 'Y'

Clip Conserved lands layer to “habitat”_USJR to get “Habitat”_Cons_USJR

Calculate Area_ha with statistics sum in “Habitat”_Cons_USJR and in “Habitat”_USJR

Proportion of habitat in Conserved lands =
Area_ha “habitat”_Cons_USJR/Total Area “Habitat”_USJR x 100

Presence of Cobblestone Tiger Beetle for Beaches assessment
Habitat assessed: Beaches
Shapefiles used: Beaches_USJR
SAR (year) clipped to USJR (SAR_USJR)

Query SAR Comnam = Cobblestone Tiger Beetle
Select by location SAR within Beach habitats
View only selected in attribute table, statistics on Area_ha attribute gives area of beach habitats that CTB occurs on.

Proportion of area CTB are present in = Area_ha CTB/Total beach Area_ha x 100

Proportion of Total Grassland / Agro-ecosystems viable
Habitat assessed: Grassland
Shapefiles used: Grassland_USJR

Find total Area_ha Grassland_USJR: Area_ha field, statistics, sum
Total Area_ha from Agr_USJR Viable (as calculated above in Unviable: Viable ratio)

Proportion of total Grassland viable = Viable_ha/Total_ha Grassland_USJR x 100

Proportion viable to Grassland birds
Habitat assessed: Grassland
Shapefile used: Agr_USJR

Query: SLU = (FP AND (SLU = CL and Status = I)) AND Area_ha >30
Bobolink breeding habitat is suggested as a minimum of 30 hectares. Note that not all grassland species needs this large of a size. The Eastern Meadowlark for instance uses 5 hectares. However, research suggests the larger the size is the higher proportion (Ribic et al. 2009) of it gets used by a variety of Grassland birds. Bobolink is the threshold between fair and good here.

Find the area with Statistics and sum on Area_ha field

Proportion of viable habitat, viable to grassland birds =
Area_ha viable to Grasslandbirds/ Viable area_ha x 100

Proportion of Old/Mature forest of total habitat
Habitat assessed: Acadian Forest Mosaic
Shapefile used: Acadian Forest Mosaic (NETHM)
Acadian Forest Mosiac_USJR (critical)

Use statistics to find total area for both layers, with sum.

Proportion = Old/Mature Area_ha (sum) / Area_ha NETHM (sum) x 100

Size

Viability for CTB
Habitat assessed: Beaches
Shapefiles used: Beaches_USJR

Query Beaches_USJR: Area_ha > 0.008
Proportion = Area_ha (viable) / total Area_ha x 100

Proportion Old/Mature Forest meeting NB DNR Regulation of 375 hectares
Habitat assessed: Acadian Forest Mosaic
Shapefile used: Acadian Forest Mosiac_USJR (critical)

Query Area_ha > 375
Find area for query and without query for the Acadian Forest Mosiac_USJR (critical)

Proportion = Sum Queried Area_ha / Total Area_ha x 100

NB DNR forest management regulation status Old/mature forest require a 375ha patch size to maintain the viability of the forest.

Proportion meeting Critical Threshold size
Habitats assessed: Grassland, Cliffs, Rock Outcrops, Freshwater Wetland, Riparian
Shapefiles used: Grassland_USJR
Rock outcrop_USJR
Cliffs_USJR
Freshwater Wetland_USJR
Riparian_USJR

Query “Habitat”_USJRwith: Area_ha > Critical Threshold

Critical Thresholds for habitats are as follows:
Grassland: 50 hectares (Environment Canada 2013)
Rock Outcrop : 12 hectares (Anderson et al . 2006)
Cliffs: 10 hectares (Anderson et al. 2006)
Freshwater wetland: 20 hectares (Anderson et al. 2006)
Riparian: 40 hectares (Anderson et al. 2006)

Proportion = Sum of queried Area_ha field / sum total habitat Area_ha x 100

<u>Calculation of the Critical Threshold Size</u>
Size of the occurrence:
“Acreage thresholds for ecosystems were based on the minimum dynamic area needed for an occurrence to absorb and recover from typical disturbances. Additionally, we used the minimum area requirements of associated species and the average territory size of breeding females. The latter

allowed us to estimate whether a given species would likely be present and whether there was physical space for at least 25 breeding territories to allow the population to persist (Figure 1 and 2) Details on this approach may be found in Anderson (1999).

Figure 1. Scaling factors for matrix forming forest in the Northern Appalachian / Acadian ecoregion. A 25,000 area forest block, represented by the larger grey circle, should be accommodating of all the factors to its left.

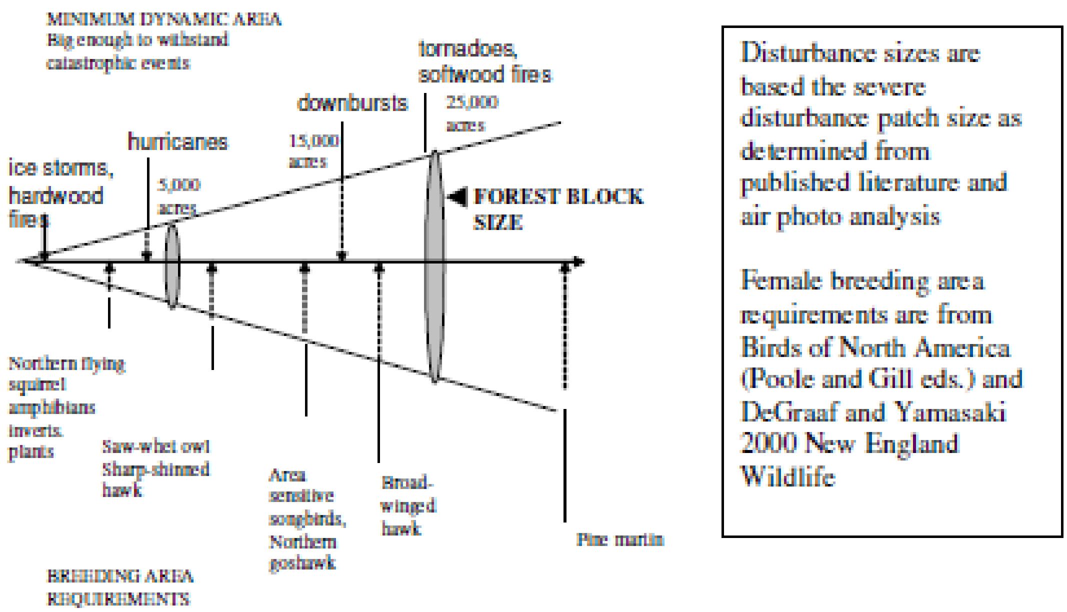
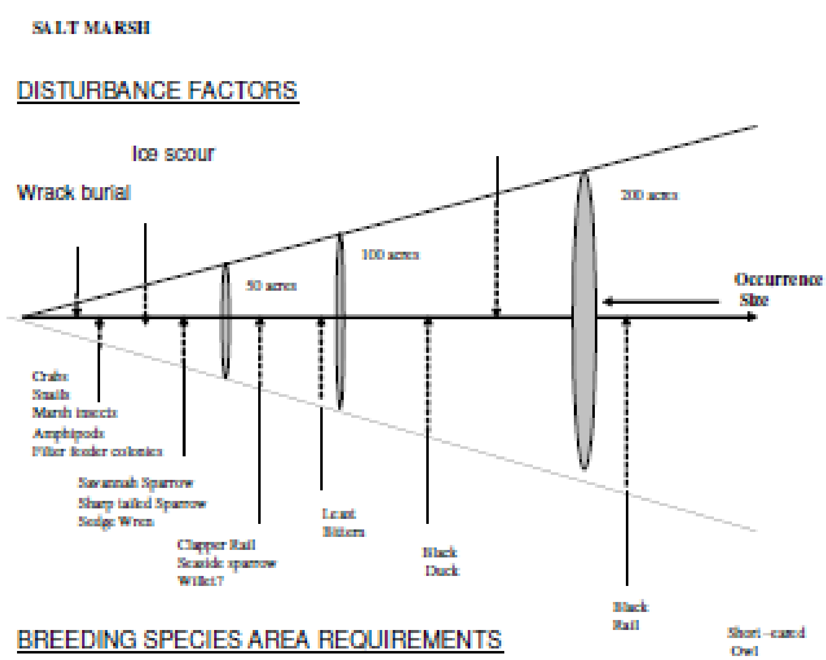
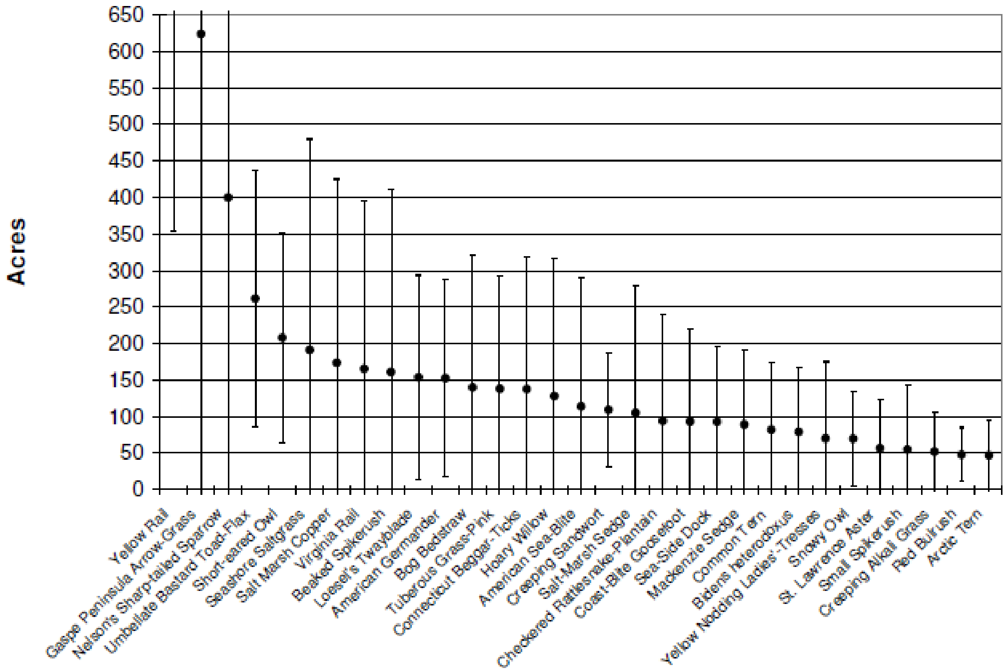


Figure 2. Minimum dynamic area and breeding territory sizes for Northern Appalachian salt marshes.



Using ground survey information, we assembled evidence on the relationship between occurrence size and species presence by calculating the average size of an ecosystem occurrence in which a particular species, or group of species had been found (Figure 3)."

Figure 3. The average size and size range of coastal bogs and salt marshes where confirmed occurrences of characteristic species were found. Data from Canadian CDC programs and Maine Natural Heritage program, restricted to species with 3 or more occurrence and a location precision of 0 to 3. The grand average was 188 acres.



Appendix I: Methods for assessing Scope of Threats

Scope of Habitat types

Freshwater wetlands

Freshwater wetlands Forested wetlands - Clip to wetlands HABITAT = Borea-Laurentian_Acadian Basin fen, Boreal-Laurentian Bog, Boreal wet conifer forest, Cold Temperate northern conifer swamp, Laurentian-Acadian alkaline confier-hardwood swamp, Laurentian-acadian alkaline fen, Laurentian-Acadian freshwater marsh, Laurentian-Acadian large river floodplain forest, Laurentian-Acadian wet meadow-shrub swamp, Northern Appalachian-Acadian Conifer-hardwood Acidic swamp, Unknown wetland type (Canada) from TNC (The Nature Conservancy 2005).
Combined the TNC layer wetlands with the Non-F wetlands: Clip DNR forest resource inventory to USJR, Same with DNR wetlands.
Query as follows: DNR Forest Resource inventory: Query: OR ""SITEI"" = 'F' OR ""SITEI"" = 'P' OR ""SITEI"" = 'W'
DNR wetlands: Query: ""WC"" = 'AB' OR ""WC"" = 'BO' OR ""WC"" = 'FE' OR ""WC"" = 'FW' OR ""WC"" = 'SB' OR ""WC"" = 'FM'

Export DNR wetland: USJR_FW_Wetl

Export DNR forest Resource Inventory: USJR_Forested_wetl.

In Forested_wetl add field WC, add data to this field “FW” (Forested Wetland)

Merge: USJR_FW_Wetl with USJR_Forested_wetl to create USJR_wetlands, merge and dissolve layers. Add Size field, calculate geometery as Area_ha. Buffer freshwater wetlands by 275 m to account for habitat needs of all turtle species (Environment Canada, Ontario Ministry of Natural Resources, and Ontario Ministry of Environment, 1998) including the threatened wood turtle (Environment Canada 2016).

Riparian & Aquatic Systems

Hydrographic Network 2015 (Service NB data catalogue), polygon and the line. Created a buffer for each, then merged and dissolved them. Streams and was buffered by 275 m to account for habitat needs of all turtle species (Environment Canada, Ontario Ministry of Natural Resources, and Ontario Ministry of Environment, 1998) including the threatened wood turtle, which has a recommended buffer of 200 m (Environment Canada 2016).

Acadian Forest "USJR Forest TNC habitat (The Nature Conservancy 2005) =
Acadian Low Elevation Spruce-Fir-Hardwood Forest
Acadian Sub-Boreal Spruce Flat
Boreal Highland/Northern Balsam Fir Forest
Cold Temperate Northern/Higher Elevation Conifer Forest
Early Seral (Intolerant) Forest- Canada
Karst Forest- Canada
Laurentian-Acadian Large River Floodplain
Laurentian-Acadian Northern Hardwood Forest
Laurentian-Acadian Northern Pine-(Oak) Forest
Laurentian-Acadian Pine-Hemlock-Hardwood Forest

Laurentian-Acadian Red Oak-Northern Hardwood Forest
Old Field Forest
Plantation Forest"

Grassland Birds
Bobolink and Barn swallow as representatives, according to population numbers according to Adam Smith, Senior Biostatistician Canadian Breeding Bird Survey

Beach
See methods in appendix H

Cliffs
See methods in appendix H

Rock Outcrops
See methods in appendix H

Scope of Threats

1.1.1 Housing, cottage and rural development
NB Non-forest Resource Inventory (NB DERD 2017) SLU = OC, RU, UR; Occupied, Rural settlements, Urban settlements, respectively. Clip to applicable habitat layer. Add Size field, calculate geometery as Area_ha.

2.1.1 Annual and Perennial Non-timber Crops
Annual Crop Inventory (Agriculture and Agri-Food Canada 2015). Query GRIDCODE = Grassland (110), Pasture/forages (122), Fallow (131), Barley (133), Other grains (134), Oats (136), Rye (137), Wheat (140), Corn (147), Canola (153), Sunflower (157), Soybeans (158), Vegetables (175), Potatoes (177), Sugarbeets (178), Berries (181), Cranberry (183), Hops (191), Buckwheat (195). Clip to applicable habitat layer, Add Size field, Calculate geometery as Area_ha.

2.1.2 Incompatible agricultural practises
The suite of grassland birds in the USJR (Environment Canada 2013a) can broadly be divided into ground-nesters and aerial insectivores. Experts suggested Bobolink and Barn swallow as a representative grassland ground-nester and aerial insectivore, respectively (MacFarlane Tranquilla 2017, Nocera 2017). Bobolink have large patch size requirements (>30 ha; Herkert 1994) and so should encompass other bird species with smaller area requirements and Barn swallow are the most closely-tied to agricultural landscapes of the aerial insectivores (MacFarlane Tranquilla 2017, Nocera 2017).

2.2.1 Wood and pulp plantations
TNC layer extract 'Plantation forest' (The Nature Conservancy 2005) from Habitat field for the USJR, merge with Non-forest Resource Inventory (NB DERD 2017), SLU = CT (Christmas trees). Clip to applicable habitat layer. Add Size field, calculate geometery as Area_ha.

3.2.1 Mining and Quarrying
Non-forest Resource Inventory (NB DERD 2017) SLU = GP, MI, PB, QU. Clip to applicable habitat layer. Add Size field, calculate geometery as Area_ha.

4.1.1 Road fragmentation
Roads layer 2011, Select Code =F1 (Primary forest road), F2 (Secondary forest road), F3 (Tertiary or limited access forest road), F4 (Logging roads built within harvest blocks), F5 (Poor access roads with a visible road surface), F6 (Abandoned roads with a poorly defined road surface), P1 (Primary DOT highway), P2 (Secondary DOT highway), P3 (Non-Crown DOT-serviced road), RR (Railroad), AR (Abandoned railroad that are not part of trail system). Exclude TL (Trails, including abandoned railroads converted to trails) as they are part of 6.1.1. Assign the following widths to different levels of roads according to the Fundy Model Forests (Betts and Forbes 2005): 4-lane highway 120 m (60 m buffer), P1 37.5 m (18.75 m buffer), P3 27.5 m (13.75 m buffer), F1 and P2 30 m (15 m buffer), F2 22 m (11 m buffer), F3 6.7 m (3.35 m buffer), F4 6 m (3 m buffer), F5-F9 0 m. Assign the width of AR as 7.32 m (buffer 3.66 m), based on the width of gravel pad (CN's Engineering Specifications, Appendix A; 24 feet) and the width of RR as 30.48 m (15.24 m buffer) based on CP's website: http://www.cpr.ca/en/community/living-near-the-railway. For effect size (Forman 2000), Fundy Model Forest methods (Betts and Forbes 2005) was used: 4-lane highway by 810 m (405 m buffer), P1 and P2 305 m (152.5 m buffer), P3 200 m (100 m buffer), F1 and F2 50 m (25 m buffer), F3, F4, F9 0 m. AR and RR as 7.32 m (buffer 3.66 m) and 30.48 m (15.24 m buffer), as effect sizes for these were unavailable. Clip to applicable habitat layer. Add Size field, calculate geometery as Area_ha.
Grassland birds road fragmentation
Roads layer 2011, 10 x 10 km Atlas squares in which their Bobolink and Barn Swallow breeding was Confirmed, Probable or Possible in the most recent atlas (Maritimes Breeding Bird Atlas 2016). To assess patch sizes of pasture/forage, I used the 2015 Annual Crop Inventory layer. Select pasture/forage, erase roads layer from that, multipart to singlepart, calculate hectares of patches, select patches >=30 hectares as this is on the lower threshold of patch size that Bobolink require (Herkert 1994).

5.3.1 Incompatible forestry practises
TNC layer Query Habitat field = Early Seral (Intolerant) Forest, Canada, Shrubland/grassland; mostly ruderal shrublands, regenerating clearcuts. NB Forest Resource Inventory (NB DERD 2017): L1TRT field = CC, TP, RC, CT, IT, PT according to HCS methodology, exclude fields used for plantations to avoid bias. Merge these two layers then clip to applicable habitat layer, Add Size Field, calculate geometery as Area_ha.

6.1.1 Recreational Activities
NB Hiking (2017) trails for the USJR and trails Trans Canada Trail (2017). ATV trails (NB ATV Federation 2017) 2011 Roads layer, code ='TL' = Trails, including abandoned railroads converted to trails) buffered by 3 m. Clip to applicable habitat layer. Add Size field, calculate geometry as Area_ha.

7.2.1 Dams and other aquatic barriers
Erase waterbody polygons from stream line layer. Intersection of all roads and streams.

8.1.1 Invasive aquatic species
[Representatives: Smallmouth bass, muskellenge] Distribution change according to CRI State of the Rivers Report 2011.

8.1.2 Invasive terrestrial species (Including non-native tree diseases)
Expert opinion. D. Mazerolle. [Representatives = Woodland Angelica, Garlic Mustard, Purple Loosestrife, Japanese Knotweed].

9.3.1 Agriculture Effluents (i.e., spraying)

Some crops require more chemical input than others. Potatoes are the most demanding, requiring fungicide, insecticide, herbicide and desiccant. Other crops come after, with pasture and forages likely not being sprayed (Kinnie and McCully 2017).

9.3.2 Forestry Effluents

Forest Resource Inventory (NB DERD). Clip TRT= PL AND TRTYR=2010,2009,2008,2007,2006 as herbicide is applied within the first 5 years of a previous clearcut to suppress hardwoods

Appendix J: Annotated Threat Assessment Table with references

Targets/Threats	1.1.1 Housing, cottage and rural development	2.1.1 Annual and Perennial Non-timber Crops
Freshwater wetlands Forested wetlands	Scope: Low. 1.34% of wetlands and their 275 m buffer have been converted to housing, cottage and rural development.	Scope: Low. 7.05% wetlands and 275 m buffer have been converted to agricultural land.
	Severity: Very high. Threat likely to destroy or eliminate the target. The amount of urban land use upstream showed a strong negative relationship with biotic integrity and, to a lesser extent, with habitat quality. Watersheds with more than 20% urban land scored poor to very-poor on the Index of Biotic Integrity (Wang et al. 2011).	Severity: Very high. Threat likely to destroy or eliminate the target (Wang et al. 2011)
	Irreversibility: Very high. Effects of the threat cannot be reversed, without major input of time effort and currency.	Irreversibility: High. Draining of wetlands for agriculture would take 21-100 years to reverse.
Riparian and aquatic systems	Scope: Low. 1.56% of riparian buffers (275 m surrounding rivers and streams) have been developed.	Scope: Low. 4.56% of riparian buffers (275 m surrounding rivers and streams) have been converted to agricultural land.
	Severity: Very high as within the scope of this threat no riparian buffer remains. The amount of urban land use upstream showed a strong negative relationship with biotic integrity and, to a lesser extent, with habitat quality. Watersheds with more than 20% urban land scored poor to very-poor on the Index of Biotic Integrity (Wang et al. 2011).	Severity: Very high. Threat likely to impact target serverly (Wang et al. 2011)
	Irreversibility: Very high as the effects of the threat cannot be reversed. Effects of the threat cannot be reversed, without major input of time effort and currency.	Irreversibility: High. Riparian buffers would take 21-100 years (Harding et al. 1998, Kauffman et al. 1997).
Acadian forest	Scope: low at 1.39% has been developed	Scope: Low. Land cleared for agriculture occupies 9.09% of historical forest extent.
	Severity: Very High. Urbanization one of the largest threats to biodiveristy (McKinney 2002).	Severity: Very high. Threat likely to destroy or eliminate the target. Converting forest to agricultural land will change the system distinctly.
	Irreversibility: Very High. Effects of the threat cannot be reversed, without major input of time effort and currency.	Irreversibility: Very High. Though abandoned agricultural fields will return to forest, this forest is often made up of Balsam fir and intolerant hardwoods, which is not the original state. This would be considered one of the first successional stages in forest dynamics which will last a few decades. Returning the forest to it's original state would take 100+ years (Loo and Ives 2003). The recovery would also depend on the viability of the forest seed bank within the soil (Moore and Wein 1977).
Appalachian Hardwood Forest	Scope: Unknown	Scope: Unknown
	Severity: Very High (Complete removal of community structure, conversion to hard surfaces)	Severity: Very high. Using Acadian Forest as a proxy for this forest type.
	Irreversibility: Very High (Complete removal of community structure, conversion to hard surfaces)	Irreversibility: Unknown
Grassland birds (Bobolink and Barn Swallow representatives)		
Beach	Scope: Low considering all beach areas occur within riparian zones, and the scope for Riparian is low, in addition beaches in NB are classified as Undevelopeble land. (Use riparin habitat as a proxy for all beaches as all beach areas occur within riparian zones, and the scope for Riparian is low)	
	Severity: Very high as within the scope of this threat no beach habitat remains. Using Riparian habitat as an indicator for beaches, as beaches are part of the riparian habitat (Wang et al. 2011). The amount of urban land use upstream showed a strong negative relationship with biotic integrity and, to a lesser extent, with habitat quality. Watersheds with more than 20% urban land scored poor to very-poor on the Index of Biotic Integrity.	
	Irreversibility: Very high as the effects of the threat cannot be reversed. Effects of the threat cannot be reversed, without major input of time effort and currency.	
Cliffs	Scope: Low - no records	
	Severity: Unknown	
	Irreversibility: Very high. Effects of the threat cannot be reversed, without major input of time effort and currency.	
Rock Outcrops	Scope: Low - no records	
	Severity: Unknown	
	Irreversibility: Very high. Effects of the threat cannot be reversed, without major input of time effort and currency.	

Targets/Threats	2.1.2 Incompatible agricultural practises	2.2.1 Wood and pulp plantations: Plantation field in the LCC
Freshwater wetlands Forested wetlands		Scope: Low. 5.82% of wetland and 275 m buffer have been converted to plantations.
		Severity: Very high. Any conversion of wetland to plantation would severly change functioning (Freedman et al. 1994).
		Irreversibility: High. Functionally will take 21-100 years to return to wetland even with active restoration.
Riparian and aquatic systems		Scope: Low. 4.75% of riparian buffers (275 m around rivers and streams) have been converted to plantations.
		Severity: Very high, monoculture or two species plantations. Change the riparian habitats to a high degree within the scope (Freedman et al. 1994).
		Irreversibility: High. (Effects dependent on habitat within Riparian area)Fforest high, Agr high, Wetland High, all with active restoration
Acadian forest		Scope: Low. 5.8% of forest has been converted to plantations.
		Severity: Very high. Monoculture or two species plantations change the Acadian forest to a high degree (Freedman et al. 1994).
		Irreversibility: High. It would take 21-100 years to return to late-successional Acadian forest.
Appalachian Hardwood Forest		Scope: Unknown
		Severity: Very High. Monoculture or two species plantations change the Acadian forest to a high degree (Freedman et al 1994).
		Irreversibility: Unknown
Grassland birds (Bobolink and Barn Swallow representatives)	Scope: High. 26.4- 57.8 % of fall-flight Bobolink in BCR 14 have been modeled to be killed by mowing (Renfrew et al. 2015, Joe Nocera, UNB, personal communication).	
	Severity: Very high. Average mortality rate of 94% in young Bobolinks (eggs and nestlings combined) because of mowing and associated after effects (Bollinger et al. 1990). Incubating adults are also occasionally killed by mowing (Tews et al. 2013).	
	Irreversibility: Medium. Effects of the threat can be reversed with a reasonable commitment of resources. Farmers may need subsidies to delay haying or implement rotational grazing.	
Beach		
Cliffs		Scope: Low 0.1%
		Severity: Unknown
		Irreversibility: Unknown
Rock Outcrops		Scope: Low 2.6 %
		Severity: Unknown
		Irreversibility: Unknown

Targets/Threats	3.2.1 Mining and Quarrying	4.1.1 Road fragmentatation
Freshwater wetlands Forested wetlands	Scope: Low. 0.2% of of wetlands (and 275 m buffer) have been converted to mines and quarries.	Scope: Medium. 10.4% of wetland buffer impacted by road effects.
	Severity: Very high as it will permanently alter the soil structure and/or remove topsoil.	Severity: Medium. "We concluded that chloride concentrations in ponds due to application of de-icing salts, influenced community structure by excluding salt intolerant species" (Collins and Russell 2009). Roads around wetlands kill snapping and painted turtles (Steen and Gibbs 2004).
	Irreversibility: Very high, without original soil structure impact of this activity would be very difficult to reverse	Irreversibility: High. It would take 21-100 years to functionally restore wetlands.
Riparian and aquatic systems	Scope: Low. 0.2% of riparian buffers have been converted to mines and quarries.	Scope: Medium. Road effects impact 10.5% of riparian buffer.
	Severity: Very high as it will permanently alter the soil structure and/or remove topsoil.	Severity: Medium. Accidental mortality from roads is the main threat to Wood Turtle (SARA, 2016). Roads of all types cause mortality during construction, mortality from collision with vehicles, modification of animal behaviour, alteration of physical environment, input of chemicals (road salt), spread of exotics, encourages more use by people (Trombulak and Frissell, 2000).
	Irreversibility: Very high, without original soil structure impact of this activity would be very difficult to reverse	Irreversibility: High. It would take 21-100 years to restore riparian buffers.
Acadian forest	Scope: Low. 0.18% of historic forest cover converted to mines and quarries.	Scope: Medium. Road effects impact 9.7% of forest. In addition, road density in forest is 1.84 km/km2. This is 3x the density recommended for the Fundy Model Forest (Betts and Forbes 2005).
	Severity: Very High, removes all above ground communities	Severity: Medium. Roads within forests cause mortality during construction, mortality from automobile traffic, alter habitat, fragment habitat, act as corridors for exotics, cause erosion, and add sound, andair pollution (Betts and Forbes, 2005).
	Irreversibility: Very high removing topsoil and bedrock will change system permanently	Irreversibility: Medium. Forest road decommisionning is possible with a reasonable commitment to funds. Involves use of heavy equipment to remove water crossings to maintain natural hydrology and acceptable re-contouring of road approaches and ripping sections of road (Gov of Manitoba, Forestry Road Management, 2012).
Appalachian Hardwood Forest	Scope: Unknown	Scope: Unknown
	Severity: Unknown	Severity: Unknown
	Irreversibility: Very High (Complete removal of community structure,through soil extraction/high disturbance)	Irreversibility: Very High on paved roads. Unlikely to be returned to a natural state
Grassland birds (Bobolink and Barn Swallow representatives)		Scope: High. 69.3 % of potential Bobolink habitat patches (pasture and forage fields) were < 30 hectares, and thus less attractive to Bobolink (Heckert, 1994). This was partly due to road fragmentation and partly due to farmers planting different crop types in ajoining fields. Road density in Bobolink-occupied atlas squares is 1.57 km/km2. Road density in Barn Swallow- occupied atlas squares is 1.62 km/km2.
		Severity: High as 69.3 % of patches classified as pasture/forages in the 2015 Annual Crop Inventory were < 30 hectares, and thus less attractive to Bobolink (Heckert, 1994). This was partly due to road fragmentation and partly because of farmers planting different crop types in ajoining fields. [67349.2 total hectares in pasture/forage; 20687.3 ha in patches >=30 ha; 46661.9 ha in patches < 30 ha]. Roads impact grassland birds by causing mortality through vehicle collisons, fragmenting their habitat, impeding dispersal, and generates air, light, and sound pollution (Bishop and Brogan, 2013). Habitat fragmentation may further provide access for nest predators along edges (COSEWIC 2010). Barn Swallow occasionally nest in culverts and below bridges along roads, and are thus occasionally hit by cars (Brown and Brown, 1999, BNA account).
		Irreversibility: Very high on paved roads. Road decommisioning farm tracks to return to farm fields would high because of soil compaction.
Beach	Scope: Low - no records	
	Severity: Very High. High impact on the environment regardless of habitat types	
	Irreversibility: Very high. Substrate removal will be very difficult and time consuming to replace.	
Cliffs	Scope: Low - no records	
	Severity: Very High. High impact on the environment regardless of habitat types	
	Irreversibility: Very high. Substrate removal will be very difficult and time consuming to replace.	
Rock Outcrops	Scope: Low 0.1%	
	Severity: Very High. High impact on the environment regardless of habitat types	
	Irreversibility: Very high. Substrate removal will be very difficult and time consuming to replace.	

Targets/Threats	5.3.1 Incompatible forestry practises	6.1.1 Recreational Activities (i.e., NB FED ATV trails, hiking trails)
Freshwater wetlands Forested wetlands	Scope: Medium. 27.58% of wetlands and their buffers contain clearcuts.	Scope: Low. Scope of ATV and hiking trails in wetlands and buffers is 0.08%.
	Severity: Very high, clear-cutting has a negative impact on wetland functioning and biodiversity (Betts and Forbes 2005)	Severity: Medium. ATV's driving through wetland moderately degrade the ecosystem (Ouren et al. 2007)
	Irreversibility: Very high. It would take 100+ years to restore wetlands in clearcuts.	Irreversibility: Low. Effects of threat are easily reversible within 0-5 years.
Riparian and aquatic systems	Scope: Medium. 22.81% of riparian buffer has been clearcut.	Scope: Low. Scope of ATV and hiking trails in riparian buffers is 0.1%.
	Severity: Very high, clear-cutting has a negative impact on riparian functioning and biodiversity (Betts and Forbes 2005)	Severity: Medium. Likely to only slightly degrade riparian buffers. Can destroy wood turtle nest sites (COSEWIC 2016). Can also eliminate rare understory plants (COSEWIC 2011)
	Irreversibility: High. It will take 21-100 year to re-establish riparian buffer.	Irreversibility: Low. Effects of threat are easily reversible within 0-5 years.
Acadian forest	Scope: Medium at 25.4%	Scope: Low. Scope of ATV and hiking trails in forest is 0.08%.
	Severity: Very high, Clear cutting removes all forest (Betts and Forbes 2005)	Severity: Low. Likely to only slightly degrade forest. Can also eliminate rare understory plants.
	Irreversibility: High. It will take 21-100 to become late-successional Acadian forest, even with active restoration.	Irreversibility: Low. Effects of threat are easily reversible within 0-5 years.
Appalachian Hardwood Forest	Scope: Unknown	Scope: Unknown
	Severity: Very high. Data difficeint therefor used forest as a proxy indicator (Betts and Forbes 2005).	Severity: Unknown
	Irreversibility: Unknown	Irreversibility: Unknown
Grassland birds (Bobolink and Barn Swallow representatives)		
Beach		Scope: Low
		Severity: High. Cobblestone Tiger Beetle disturbance caused population decline in Grand Lake area (COSEWIC 2013)
		Irreversibility: Medium, as long as species do not get locally extrapated (COSEWIC 2013)
Cliffs	Scope: Low 2.9%	
	Severity: Very high. Data difficeint therefor used forest and riparain as a proxy indicator	
	irreversibility: High. Data difficeint therefor used forest and riparain as a proxy indicator	
Rock Outcrops	Scope: Low 7.6%	
	Severity: Very high. Data difficeint therefor used forest and riparain as a proxy indicator	
	irreversibility: High. Data difficeint therefor used forest and riparain as a proxy indicator	

Targets/Threats	7.2.1 Dams and other aquatic barriers	8.1.1 Invasive aquatic species [Representatives =Smallmouth bass, muskellenge]
Freshwater wetlands Forested wetlands	Scope: Low. 2.4 % of wetlands and their 275 m buffer are covered by roads.	
	Severity: High. 60-76% of culverts have some kind of barrier to fish passage (Petitcodiac Watershed Alliance 2015). Aquatic barriers that are blocked may interrupt hydrology between wetlands and may cause discontinuous areas to be lost.	
	Irreversibility: Medium for culvert replacement to open-bottom culverts (Petitcodiac Watershed Alliance 2015).	
Riparian and aquatic systems	Scope: High. All major streams/rivers in the USJR region are impacted by 85 dams.	Scope: High. Both small mouth bass and muski have extended their ranges
	Severity: High. 60-76% of culverts have some kind of barrier to fish passage (Petitcodiac Watershed Alliance 2015). Dams affect natural spring freshet of rivers, which impacts ecology of riparian species.	Severity: Medium (Smallmouth bass very high (Valois et al. 2009), Muskie low impact on salmon. Impact on system not investigated Kidd 2007)
	Irreversibility: High. Dams can be removed, but it is not practically affordable. Medium for culverts as effects can be reversed with a reasonable commitment of resources (Petitcodiac Watershed Alliance 2015).	Irreversibility: Medium, removal of invasive fish species from the system. studies on Smallmouth bass show long term number reductions year after year to be effective (Weidel et al. 2007)
Acadian forest		
Appalachian Hardwood Forest		
Grassland birds (Bobolink and Barn Swallow representatives)		
Beach	Scope: Low	
	Severity: Water level cahgnes could completely alter this ecosystem.	
	irreversibility: High	
Cliffs		
Rock Outcrops		

Targets/Threats	8.1.2 Invasive terrestrial species [Representatives = Woodland Angelica, Garlic Mustard, Purple Loosestrife, Japanese Knotweed]. Include non-native tree diseases too.	9.3.1 Agriculture Effluents (i.e., spraying)
Freshwater wetlands Forested wetlands	Scope: Low. Invasives likely have invaded 1-10% of wetlands (Mazerolle 2017).	Scope: Low. 2.32% of 275 m wetlands and buffer have been converted to agricultural land that receive chemical inputs (i.e., not pastures or forage fields).
	Severity: High. Glossy Buckthorn an emerging threat. It's fruits are dispersed by birds and it thrives in acidic conditions so it has the potential to seriously degrade wetlands. It also invades riparian zones and forest (Mazerolle 2017).	Severity: Medium. Spraying degrades aquatic animal communities (Relyea et al. 2005a,b).
	Irreversibility: High. Once an invasive plant is established, it is very hard to eradicate from the landscape (Delbart et al. 2012)	Irreversibility: High. Effects of the threat can technically be reversed, but it is not practically affordable.
Riparian and aquatic systems	Scope: low. Invasives likely have invaded 1-10% of riparian buffers. Garlic	Scope: Low. 2.44% of riparian buffers (275 m surrounding rivers and streams) have
	Severity: High. Reed Canary Grass is a major driver of change in the riparian zone along the St. John River. It covers up rare gravel habitats exposed by shifting river levels that are home to rare plant species (David Mazerolle-ACCDC (2017)). This could include honewort, Anticosti Aster and Furbish's lousewort. Dutch elm	Severity: Medium. Spraying degrades aquatic animal communities (Gray et al. 2005, Relyea et al. 2005a,b).
	Irreversibility: High. Once an invasive plant is established, it is very hard to eradicate from the landscape (Apfelbaum and Sams 1987)	Irreversibility: High. Effects of the threat can technically be reversed, but it is not practically affordable.
Acadian forest	Scope: Low. Invasives likely have invaded 1-10% of riparian buffers.	
	Severity: High. Garlic Mustard outcompetes rare Appalachian Hardwood understory plants (Mazerolle 2017, Jim Goltz 2017). Beech bark disease destroys its host plant.	
	Irreversibility: High. Once an invasive plant is established, it is very hard to eradicate from the landscape (Drayton and Primack 1999).	
Appalachian Hardwood Forest	Scope: Unknown	
	Severity: Unknown	
	Severity: High. Garlic Mustard outcompetes rare Appalachian Hardwood understory plants (Mazerolle 2017, Jim Goltz 2017).Beech bark disease destroys its host plant.	
Grassland birds (Bobolink and Barn Swallow representatives)		Scope: High. 60.5% of Bobolink-appropriate habitat patches (pasture/forage fields > 30 ha) were within 20 m of another crop type that would have been sprayed. Assumption: we don't expect spraying to occur on pastures and forage fields, but chemical inputs are applied to all other crop types (Kevin McCully and Bruce Kinnie, NB DAF, personal communication).
		Severity: High. Insectides negatively impact the primary food source for aerial insectivores like Barn Swallow as well as for Bobolink, which feed on insects (57%) and plant matter (43%). Nestlings are fed exclusively insects (COSEWIC 2010c).
		Irreversibility: High. Effects of the threat can technically be reversed, but it is not practically affordable. Potato farming in particular, which represents the 20% of the agricultural area in the USJR in any given year, is especially dependant on fungicides, pesticides, herbicides, and dessicants to combat late blight, aphids, and Colorado potato beetle (Kinnie and McCully 2017).
Beach	Scope: Medium	
	Severity: High Reed canary grass major invasive (Mazerolle 2017).	
	Irreversibility: High, eradication very difficult. Riparian habitat used as an indicator for beach invasive plant irreversibility.	
Cliffs	Scope: Low	
	Severity: Medium. Though not present in the area yet dog strangling vine is a major invader, that can take over ecosystems (Mazerolle 2017).	
	Irreversibility: High. Eradication very difficult	
Rock Outcrops	Scope: Low.(Mazerolle 2017).	
	Severity: High. Though not present in the area yet dog strangling vine is a major invader, that can take over ecosystems (Mazerolle 2017).	
	Irreversibility: High. Eradication very difficult	

Targets/Threats	9.3.2 Forestry Effluents
Freshwater wetlands Forested wetlands	Scope: Low. 0.74% of wetlands and their 275 m buffer overlap with plantations planted in the last 5 years. Footprint of recent plantations used as a serrogate for forestry effluents because they are sprayed with herbicide between year 0-5 of planting.
	Severity: Medium. Spraying degrades aquatic animal communities (Relyea et al. 2009).
	Irreversibility: Low. The effects of the threat are easily reversible (Wojtaszek et al. 2004; Thompson et al. 2004; Chen et al. 2004).
Riparian and aquatic systems	Scope: Low. 0.38% of riparian buffers overlap with plantations planted in the last 5 years.
	Severity: Medium. Spraying degrades aquatic animal communities, particularily amphibians (Relyea et al. 2009).
	Irreversibility: Low. The effects of the threat are easily reversible (Wojtaszek et al. 2004; Thompson et al. 2004; Chen et al. 2004).
Acadian forest	Scope: Low. 0.55% of forest overlaps with plantations planted in the last 5 years.
	Severity: Low. Review found species richness of vasular plants unaffected by glyphosate (Sullivan and Sullivan 2003), perhaps because communities rebound quickly following application (Miller and Miller 2004).
	Irreversibility: Low (Sulivan et al. 1996; Sullivan and Sullivan 2003; Miller and MIller 2004).
Appalachian Hardwood Forest	Scope: Unknown
	Severity: Unknown
	Irreversibility: Unknown
Grassland birds (Bobolink and Barn Swallow representatives)	
Beach	
Cliffs	
Rock Outcrops	

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Appendix K: Threats Classification Scheme - CMP Direct Threats Classification v 2.0

The hierarchical structure of the threat types as listed on the species Fact Sheets is shown here.
Direct threats are the proximate human activities or processes that have impacted, are impacting, or may impact the status of the taxon being assessed (e.g., unsustainable fishing or logging). Direct threats are synonymous with sources of stress and proximate pressures.

In using this hierarchical classification of causes of species decline, Assessors are asked to indicate the threats that triggered the listing of the taxon concerned at the lowest level possible. These threats could be in the past ("historical, unlikely to return" or "historical, likely to return"), "ongoing", and/or likely to occur in the "future", using a time frame of three generations or ten years, whichever is the longer (not exceeding 100 years in the future) as required by the Red List Criteria. The 'Major Threats' referred to in the 'Required and Recommended Supporting Information for IUCN Red List Assessments', are threats coded as having High or Medium impacts (see threat impact scoring below).

The attached working document provides a list of the threat types with definitions, examples of the threats and guidance notes on using the scheme. Comments on the Threats Classification Scheme are welcome - click feedback.

Note: Any analysis of the threats should preferably take into account the timing, scope and severity of the threats (threat impact scores) and also how the threats impact the taxa concerned as recorded by the stresses. These additional attributes, with the exception of the impact scores, are displayed on the Red List web site for instances where this information has been coded.

1. Residential & commercial development

1.1 Housing & Urban areas
1.2 Commercial & Industrial areas
1.3 Tourism & Recreation areas

2. Agriculture & aquaculture

2.1 Annual & perennial non-timber crops
- 2.1.1 Shifting agriculture
- 2.1.2 Small-holder farming
- 2.1.3 Agro-industry farming
- 2.1.4 Scale Unknown/Unrecorded

2.2 Wood & Pulp plantations
- 2.2.1 Small-holder plantations
- 2.2.2 Agro-industry plantations
- 2.2.3 Scale Unknown/Unrecorded

2.3 Livestock farming & ranching
- 2.3.1 Nomadic grazing
- 2.3.2 Small-holder grazing, ranching or farming
- 2.3.3 Agro-industry grazing, ranching or farming
- 2.3.4 Scale Unknown/Unrecorded

2.4 Marine & freshwater aquaculture

2.4.1 Subsistence/artisinal aquaculture
2.4.2 Industrial aquaculture
2.4.3 Scale Unknown/Unrecorded

3. Energy production & mining
3.1 Oil & gas drilling
3.2 Mining & quarrying
3.3 Renewable energy

4. Transportation & service corridors
4.1 Roads & railroads
4.2 Utility & service lines
4.3 Shipping lanes
4.4 Flight paths

5. Biological resource use
5.1 Hunting & collecting terrestrial animals
5.1.1 Intentional use (species being assessed is the target)
5.1.2 Unintentional effects (species being assessed is not the target)
5.1.3 Persecution/control
5.1.4 Motivation Unknown/Unrecorded

5.2 Gathering terrestrial plants
5.2.1 Intentional use (species being assessed is the target)
5.2.2 Unintentional effects (species being assessed is not the target)
5.2.3 Persecution/control
5.2.4 Motivation Unknown/Unrecorded

5.3 Logging & wood harvesting
5.3.1 Intentional use: subsistence/small scale (species being assessed is the target) [harvest]
5.3.2 Intentional use: large scale (species being assessed is the target) [harvest]
5.3.3 Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest]
5.3.4 Unintentional effects: large scale (species being assessed is not the target) [harvest]
5.3.5 Motivation Unknown/Unrecorded

5.4 Fishing & Harvesting aquatic resources
5.4.1 Intentional use: subsistence/small scale (species being assessed is the target) [harvest]
5.4.2 Intentional use: large scale (species being assessed is the target) [harvest]
5.4.3 Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest]
5.4.4 Unintentional effects: large scale (species being assessed is not the target) [harvest]
5.4.5 Persecution/control
5.4.6 Motivation Unknown/Unrecorded

6. Human intrusions & disturbance
6.1 Recreational activities
6.2 War, civil unrest & military exercises

6.3 Work & other activities

7. Natural system modifications

7.1 Fire & fire suppression
- 7.1.1 Increase in fire frequency/intensity
- 7.1.2 Suppression in fire frequency/intensity
- 7.1.3 Trend Unknown/Unrecorded

7.2 Dams & water management/use
- 7.2.1 Abstraction of surface water (domestic use)
- 7.2.2 Abstraction of surface water (commercial use)
- 7.2.3 Abstraction of surface water (agricultural use)
- 7.2.4 Abstraction of surface water (unknown use)
- 7.2.5 Abstraction of ground water (domestic use)
- 7.2.6 Abstraction of ground water (commercial use)
- 7.2.7 Abstraction of ground water (agricultural use)
- 7.2.8 Abstraction of ground water (unknown use)
- 7.2.9 Small dams
- 7.2.10 Large dams
- 7.2.11 Dams (size unknown)

7.3 Other ecosystem modifications

7.4 Removing / Reducing Human Maintenance

8. Invasive & other problematic species, genes & diseases

8.1 Invasive non-native/alien plants & animals
- 8.1.1 Unspecified species
- 8.1.2 Named species

8.2 Problematic native Plants & Animals
- 8.2.1 Unspecified species
- 8.2.2 Named species

8.3 Introduced genetic material

8.4 Pathogens & Microbes
- 8.4.1 Unspecified species
- 8.4.2 Named species

9. Pollution

9.1 Household & urban waste water
- 9.1.1 Sewage
- 9.1.2 Run-off
- 9.1.3 Type Unknown/Unrecorded

9.2 Industrial & military effluents
- 9.2.1 Oil spills
- 9.2.2 Seepage from mining

9.2.3 Type Unknown/Unrecorded

9.3 Agricultural & forestry effluents
- 9.3.1 Nutrient loads
- 9.3.2 Soil erosion, sedimentation
- 9.3.3 Herbicides and pesticides
- 9.3.4 Type Unknown/Unrecorded

9.4 Garbage & solid waste

9.5 Air-borne pollutants
- 9.5.1 Acid rain
- 9.5.2 Smog
- 9.5.3 Ozone
- 9.5.4 Type Unknown/Unrecorded

9.6 Excess energy
- 9.6.1 Light pollution
- 9.6.2 Thermal pollution
- 9.6.3 Noise pollution
- 9.6.4 Type Unknown/Unrecorded

10. Geological events

10.1 Volcanoes
10.2 Earthquakes/tsunamis
10.3 Avalanches/landslides

11. Climate change & severe weather

11.1 Ecosystem Encroachment
11.2 Changes in Geochemical regimes
11.3 Changes in Temperature regimes
11.4 Changes in Precipitation & Hydrological regimes
11.5 Sever / Extreme Weather Events

12. Other options

12.1 Other threat

Appendix L: IUCN Conservation Actions Classification Scheme (Version 2.0; taken directly from the IUCN website)

The hierarchical structure for the Conservation Actions Needed as show on the species Fact Sheets is provided here.

Assessors are asked to use this Classification Scheme to indicate the conservation actions or measures that are needed for the plant or animal concerned. In suggesting what actions are needed, assessors are asked to be realistic and not simply select everything. The selection should be for those actions that are most urgent, significant and important; and that they could realistically be achieved within the next five years. The actions needed should also be informed by the conservation actions already in place.

The attached working document provides a list of the conservation actions needed with definitions, examples of the actions and guidance notes on using the scheme. Comments on the Conservation Actions Needed Classification Scheme are welcome.

1. Land/water protection
1.1 Site/area protection
1.2 Resource & habitat protection

2. Land/water management
2.1 Site/area management
2.2 Invasive/problematic species control
2.3 Habitat & natural process restoration

3. Species management
3.1 Species management
- 3.1.1 Harvest management
- 3.1.2 Trade management
- 3.1.3 Limiting population growth

3.2 Species recovery

3.3 Species re-introduction
- 3.3.1 Reintroduction
- 3.3.2 Benign introduction

3.4 Ex-situ conservation
- 3.4.1 Captive breeding/artificial propagation
- 3.4.2 Genome resource bank

4. Education & awareness
4.1 Formal education
4.2 Training
4.3 Awareness & communications

5. Law & policy
5.1 Legislation

5.1.1 International level
5.1.2 National level
5.1.3 Sub-national level
5.1.4 Scale unspecified

5.2 Policies and regulations

5.3 Private sector standards & codes

5.4 Compliance and enforcement
5.4.1 International level
5.4.2 National level
5.4.3 Sub-national level
5.4.4 Scale unspecified

6. Livelihood, economic & other incentives
6.1 Linked enterprises & livelihood alternatives
6.2 Substitution
6.3 Market forces
6.4 Conservation payments
6.5 Non-monetary values

Appendix M: Data sources for spatial data

Shapefile Name	Online source	Original Source
Ecodistricts, ecosites	GeoNB	NB Department Energy and Resource Development
Bedrock Geology	GeoNB	NB Department of Energy and Mines
Forest	GeoNB	NB Department Energy and Resource Development
Non-Forest	GeoNB	NB Department Energy and Resource Development
Wetlands	GeoNB	NB Department Energy and Resource Development
NB Hydrographic Network	GeoNB	NB Department Energy and Resource Development
NB Road Network	GeoNB	Service New Brunswick
DNR Waterbody	GeoNB	NB Department Energy and Resource Development
National Topographic Database	Geogratis	Government of Canada Natural Resources
Local Connectedness, Unstratified, Northern Appalachians	Databasin.org (2C1F)	The Nature Conservancy - Eastern Conservation Science
Modeled Ecosystems, Summits	Databasin.org (2C1F)	The Nature Conservancy (TNC) Eastern Region Conservation Science
Modeled Ecosystems, Steep slopes	Databasin.org (2C1F)	The Nature Conservancy (TNC) Eastern Region Conservation Science
Norteast Terrestrial Habitat Map	Conservationgateway.org	The Nature Conservancy
SAR		ACCDC
Priority Species	Direct from ACCDC	ACCDC
Dams (NB Hydrographic network)	GeoNB	NB Department Energy and Resource Development
Intersections		Department of Fisheries and Oceans