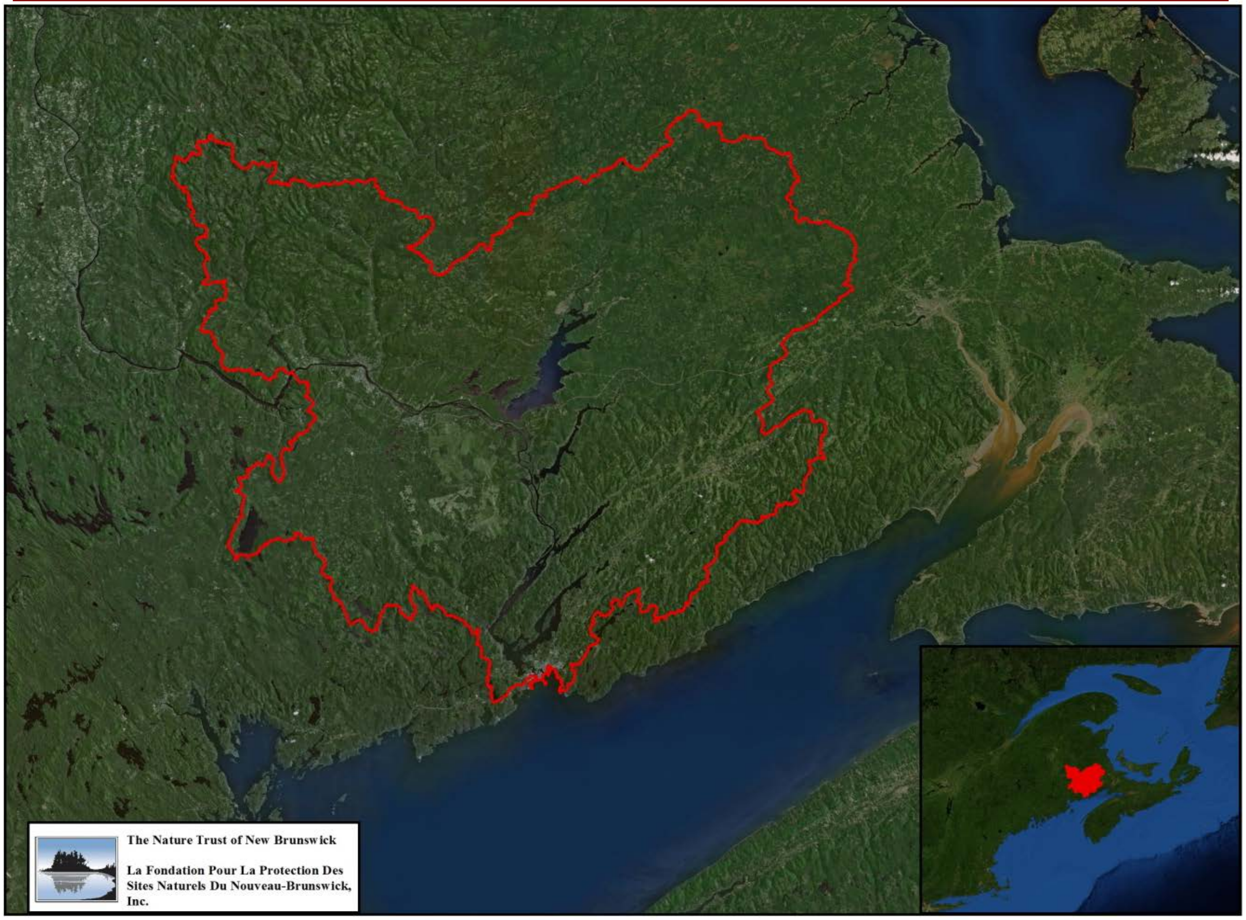
Lower St. John River Habitat Conservation Strategy



New Brunswick Eastern Habitat Joint Venture
Steering Committee
January 2015

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, following an ecosystem approach, 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.

A shared approach

HCSs and their bioregional boundaries are based on meaningful ecological units and important watershed boundaries. HCS bioregions are scaled in a way that captures regional conservation context, priorities, threats and conservation actions. They also are scaled to facilitate the implementation of conservation actions, from land securement to stewardship.

In the first section, 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 significance, with a focus on species at risk and other rare taxa, including Bird Conservation Region 14 priority birds (and also bird species making use of adjacent Marine Biogeographic Units, if applicable). 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.

The second section presents habitat prioritization based on uniqueness, representivity, and patch size. It also presents different perspectives on species-based prioritization by looking at various assemblages of species. Species-based prioritization relies on relative abundance maps derived from best available occurrence data for each species. The reader is cautioned that best available occurrence data for most species remains incomplete, to varying degrees, with availability being a function of survey timing and survey effort, leading to variable, but important bias in some related maps. As such, multi-species composite maps and all other maps derived from the individual species maps also are vulnerable to bias.

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. For various reasons, including introduced bias, the CVI map, priority habitat maps and various multi-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).

The second section also presents threats to conservation priority habitats and species. These are identified, assessed, and where possible, mapped at the bioregional scale.

In the third section, each HCS presents conservation and stewardship actions that organizations plan to undertake to mitigate identified threats and contribute to the conservation of habitats (and the species they host) over the course of a 5-year planning period. Though they cannot be considered comprehensive, actions are presented for each partner organization within a matrix structured according to IUCN categories.

In addition to presenting avenues for collaboration in the implementation of actions, this matrix presents gaps that can be interpreted as potential opportunities for development of new complementary conservation actions. It should be noted that conservation groups seeking government funding to undertake conservation actions within the bioregion (e.g., 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 New Brunswick Wildlife Trust Fund) are strongly encouraged to make specific reference to relevant information contained within the appropriate HCS.

No single map can provide decision support that aligns fully with all priorities of all conservation partners. As such, users of this and all other HCSs thus are encouraged to carefully consider the full suite of maps and information presented to obtain the decision support that is most appropriate to their needs.

Ecological context

The Lower St. John River (LSJR) bioregion is a hotspot for biodiversity in New Brunswick. Despite considerable anthropogenic change that has occurred in the region it has largely retained its rich complement of species, including numerous rare species, owing to its unique climate and geological history. The region contains a diverse assemblage of habitats, including rich and productive riparian areas, freshwater wetlands and some larger sized areas of relatively intact, mature forest that support significant numbers of migratory birds during breeding and non-breeding periods. Some healthy forests, certain unique wetlands and aquatic ecosystems are conserved, and protected using various legislative tools, toward development of a network of conservation lands (Fig. 1). Key decisions with biodiversity implications are well-informed by research, and coordinated private and public conservation actions have benefited some native species and systems.

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.

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 LSJR bioregion:

1. Riparian systems
2. Freshwater wetlands
3. Acadian forest mosaic
4. Grasslands/agro-ecosystems (fields and meadows)
5. Cliffs
6. Rocky outcrops
7. Sand and gravel beaches

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 (Figs. 2 and 3; see Appendix B, p. 149). 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 Fig. 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 (Figs. 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*) (Fig. 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 (Figs. 2 and 3) with the Conservation Value Index (CVI) maps (Figs. 4 and 5) when using this document for decision support. Also of value to the planning process are the species composite maps found in Figs. 24 – 34 (p. 63-73) 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 E (p. 168) presents a summary of the species presented in each map, and the datasets used to represent these species.

Threats

The following threats (following IUCN nomenclature) have been characterized within the LSJR bioregion:

Current:

1.1 Housing and urban areas
2.1 Annual and perennial non-timber crops
2.2 Wood and pulp plantations
2.4.2 Marine and freshwater aquaculture - industrial aquaculture (land-based)
3.2 Mining and quarrying
4.1 Roads and railroads (road fragmentation)
5.3 Logging and wood harvesting (incompatible forestry practices)
6.1 Recreational activities (off-highway vehicles)
7.2 Dams and water management/use (other aquatic barriers)
8.1.1 Invasive non-native/alien species/diseases - unspecified species (insects and diseases)
8.1.2 Invasive non-native/alien species/diseases - plants
8.1.2 Invasive non-native/alien species/diseases - predatory fish
8.2.2 Problematic native species/diseases - spruce budworm
8.4.2 Introduced genetic material – hatchery salmon

Emerging:

3.1 Oil and gas drilling
8.1.1 Invasive non-native/alien species/diseases - unspecified (insects and diseases)
11.1 Climate change and severe weather - habitat shifting and alteration

Conservation actions

The following summary presents the conservation actions undertaken by organizations working in the LSJR bioregion. A more detailed list of conservation actions, including links to the threats associated with each of the different conservation priority habitats, is presented in Table 11 (p. 84).

Government of New Brunswick Department of Natural Resources

- Will achieve Protected Natural Area designation of up to an additional 25 000 ha of significant habitat on Crown land within Ecoregion 5 & 7 by 2015.
- Monitor NCC properties annually for impacts from aquaculture sites and ATV use, and respond to any potential threats to biodiversity targets.
- Implement Ecoregion 5 & 7 conservation targets for 14 old forest communities and 6 old-forest wildlife habitats in the 2012-21 Crown forest management plan.
- On Crown land DNR will: maintain watercourse and wetland buffer zones, identify and conserve deer winter habitat, identify and conserve site-specific habitats for species at risk and other species (e.g., heron colonies).
- Participate annually in active recovery planning meetings for species at risk.

Department of National Defense Base Gagetown

- Will continue to implement habitat management and monitoring programs including water quality monitoring and the Base Gagetown Wetland Management Plan.

- Will continue to implement the protocol to wash/clean any vehicles and equipment prior to movement from one location to another to prevent the spread of invasive species.
- Will continue to implement habitat restoration programs for swallows, grassland birds, and other at-risk bird species.
- Will continue to implement species monitoring for large and small mammals, freshwater mussels, and fishes; will also continue established species recovery surveys for numerous at-risk species.
- Will continue to pursue management and monitoring-based external partnerships with the Canadian Forest Service, NB Museum, Bird Studies Canada, and the Oromocto River Watershed Association.

Bird Studies Canada

- Will continue to monitor wetland-dependent bird species, assess the effectiveness of EHJV conservation efforts, and encourage local wetland stewardship under the Maritime Marsh Monitoring Program.
- Will continue to monitor population levels of Chimney Swift at known roost sites through the citizen-science monitoring and conservation program: "Maritime Swift Watch Program".
- Will continue to hold community outreach workshops for Chimney Swifts ("Swift Night Out").

The Nature Trust of New Brunswick

- Will secure a minimum of four properties or 100 acres of private land containing species at risk habitat for permanent protection by 2015.
- Will work with landowners to develop and conclude voluntary stewardship agreements on private land which will address specific threats to habitats and species at risk.
- Will build partnerships with and support a network of stewardship-focused landowners with the NTNB Landowner Stewardship Program.
- Will continue to monitor known species at risk on all nature preserves within the bioregion.
- Share information and increase awareness about threats to SAR and provide stewardship tips for private landowners throughout the LSJR bioregion through the Power of Nature outreach program, the Landowner Stewardship Program, and public meetings / events.
- The NTNB will focus on using the LSJR Habitat Conservation Strategy and private land conservation tools to assist other conservation organizations and community groups to pursue local land stewardship (ex. Taymouth Community Association, Nashwaak Watershed Association, Bellisle Watershed Coalition etc.)

Nature Conservancy of Canada

- Prepare Interim Stewardship Statements within one year and Property Management Plans following NCC's approved Stewardship Performance Standards for secured properties.
- Implement critical Property Management Plan actions on NCC lands through 2018.
- Designate all NCC properties in the bioregion under the NB Protected Areas Act by 2018.
- Monitor NCC properties annually for impacts from ATV use and respond to any potential threats to biodiversity targets.
- Work with Environment Canada's Canadian Wildlife Service staff to identify appropriate groups/agencies to address necessary recovery actions to protect species at risk in the bioregion, and participate annually in active recovery planning meetings for species at risk.

Ducks Unlimited Canada

- Secure priority provincially significant floodplain wetland as opportunities arise.
- DUC will continue to invest in maintaining wetland water level management infrastructure in this area to an expected level of $50 000 annually.
- Continue efforts on restoring, creating and enhancing wetlands in the LSJR area which support the provincial wetland policy goal of no net loss of wetland function.
- In partnership with volunteer nest box stewards, Ducks Unlimited Canada will monitor, maintain, and distribute waterfowl nest boxes throughout the bioregion. There are roughly 1000 boxes in this area with new ones going up annually.
- DUC will continue to manage least bittern critical habitat and create more suitable habitat in known breeding areas when opportunities arise.
- Will continue to engage the public and landowners through established education and outreach programs such as the waterfowl nest box program, Project Webfoot, local Wetland Centres of Excellence, a landowner stewardship program, and outdoor classroom programs.

Government of Canada – Environment Canada

- Implement and enforce the Migratory Bird Convention Act, Canada Wildlife Act, Species at Risk Act, Canadian Environmental Protection Act, and promote the Federal Policy on Wetland Conservation.
- Offer support to ENGOs, communities, aboriginal organizations, and academia via employment programs, including the Science Horizons Youth Internship Program and the International Environmental Youth Corps.
- Offer support to ENGOs, communities, aboriginal organizations, and academia via Community Action Programs for the Environment, including work on habitat and ecological system conservation/stewardship through direct and in-kind support (e.g., EcoAction Community Funding Program, Environmental Damages Fund, National Conservation Plan – National Wetland Conservation Fund, National Conservation Plan – Gulf of Maine Initiative, Atlantic Ecosystem Initiatives, Ecological Gifts Program, Habitat Stewardship Program – Prevention Stream, Aboriginal Fund for Species at Risk – Prevention Stream).
- Offer support to ENGO and aboriginal organizations for work specifically on species at risk via the Habitat Stewardship Program and Aboriginal Fund for Species at Risk.
- Support the activities described within species at risk recovery documents for the completion of schedule of studies for the identification of critical habitat.
- Engage and consult with all partners in development of recovery documents for species at risk.
- Support the Eastern Habitat Joint Venture (EHJV), and provide science guidance to conservation partners on conservation actions and priorities for migratory birds, species at risk, and their habitats, including through development, refinement and implementation of this HCS and of the NB Bird Conservation Region 14 Strategy.
- Continue management activities associated with Portobello Creek NWA.
- Acquire property within the proposed boundaries of Portobello Creek NWA.
- Coordinate and/or conduct migratory bird surveys (e.g., 2 Eastern Waterfowl Survey monitoring plots, Triannual Winter Black Duck Survey, 7 active Breeding Bird Survey routes).

SOMMAIRE

La présente Stratégie de conservation des habitats (SCH) est le fruit de la collaboration entre les organisations membres du Comité directeur du Plan conjoint des habitats de l'Est (PCHE) du Nouveau-Brunswick et de groupes partenaires actifs dans le domaine de la conservation environnementale. Cette SCH fait partie d'une série de stratégies prévues pour englober tout le territoire géographique du Nouveau-Brunswick.

Les SCH ont pour but de répondre au besoin de mieux communiquer, coordonner et contribuer aux mesures de conservation prises par les organisations locales et régionales de conservation. En plus de fournir à ces groupes un soutien à la prise de décision, il est souhaité que l'élaboration de ces SCH créera des possibilités d'amélioration des partenariats, tout en reconnaissant que chaque organisation est guidée par la mission, la vision et les principes directeurs qui lui sont propres.

Une approche partagée

Les SCH et leurs frontières biorégionales sont fondées sur des unités écologiques significatives et les limites d'importants bassins hydrographiques. Les biorégions des SCH sont établies en tenant compte du contexte, des priorités, des menaces et des mesures de conservation propres aux régions. Elles sont aussi établies de manière à faciliter la mise en œuvre des mesures de conservation, allant de la protection à l'intendance de l'habitat.

Dans la première partie, chacune des SCH présente les descriptions, en termes généraux, de l'étendue spatiale et de la signification écologique de la biorégion, des systèmes écologiques dominants que l'on retrouve à l'intérieur de la biorégion, et des processus qui les façonnent. Chaque SCH présente aussi le rôle significatif d'importants habitats pour les espèces identifiées et dont la conservation est jugée importante, en mettant l'accent sur les espèces en péril et autres taxons rares, notamment les espèces aviaires prioritaires de la Région de conservation des oiseaux 14 (ainsi que les espèces d'oiseaux qui se servent des Unités biogéographiques marines adjacentes, le cas échéant). L'approche adoptée dans l'élaboration du texte se veut rigoureuse, mais non exhaustive, et met l'accent sur des références pertinentes vers des travaux plus détaillés et des études approfondies.

La deuxième partie présente les habitats par ordre de priorité en fonction du caractère unique, de la représentativité et de la dimension de la parcelle de territoire. Elle présente également différentes perspectives sur les priorités au niveau des espèces, en examinant des assemblages variés d'espèces. Cet ordre de priorité par espèces repose sur les cartes d'abondance relative issues des meilleures données d'occurrence pour chaque espèce. Le lecteur est avisé que les meilleures données d'occurrence disponibles pour la plupart des espèces demeurent incomplètes, à divers degrés, puisque l'accessibilité dépend du moment où les enquêtes sont faites et des efforts qui y sont consentis, ce qui mène à des biais variables, mais importants, sur certaines cartes connexes. Ainsi, les cartes composites multiespèces et toutes les autres cartes dérivées de cartes sur des espèces individuelles peuvent également être susceptibles à des biais.

Ultimement, la carte des habitats prioritaires (composite de tous les habitats) et la carte des espèces prioritaires (composite de toutes les espèces) sont combinées pour produire une carte de l'Index de la valeur de conservation (IVC) de la biorégion. Pour différentes raisons, incluant le biais évoqué, la carte de l'IVC, les cartes d'habitats prioritaires et les différentes cartes composites multiespèces peuvent présenter des perspectives contrastantes quant aux priorités spatiales. C'est une situation à laquelle on peut s'attendre, et cela témoigne de la réalité que des approches contrastantes en matière de conservation peuvent être requises pour la protection de différentes espèces et des habitats qui les accueillent (c.-à-d. l'acquisition de terres par opposition à l'intendance).

La deuxième partie présente également les menaces à la conservation des habitats et des espèces prioritaires. Celles-ci sont identifiées, évaluées et, lorsque possible, cartographiées à l'échelle biorégionale.

Dans la troisième partie, chaque SCH présente les mesures de conservation et d'intendance que les organisations prévoient entreprendre pour atténuer les menaces cernées et pour contribuer à la conservation des habitats (et des espèces qu'ils accueillent) au cours d'une période de planification de cinq ans. Bien qu'elles ne puissent être considérées comme un ensemble complet, les mesures sont présentées pour chaque organisation partenaire, à l'intérieur d'une matrice structurée tenant compte des catégories de l'Union internationale pour la conservation de la nature (UICN).

En plus de présenter des pistes de collaboration pour la mise en œuvre des mesures, cette matrice illustre les lacunes qui peuvent être interprétées comme des possibilités pour l'élaboration de nouvelles mesures de conservation complémentaires. Il faut remarquer que les groupes voués à la conservation sollicitant du financement gouvernemental afin de réaliser leurs mesures de conservation à l'intérieur d'une biorégion (p. ex. le Fonds autochtone pour les espèces en péril, le Programme d'intendance de l'habitat pour les espèces en péril, le Plan de conservation national – Le Fonds national de conservation des milieux humides, le Fonds en fiducie pour l'environnement du Nouveau-Brunswick et le Fonds de fiducie de la faune du Nouveau-Brunswick) sont fortement encouragés à se référer spécifiquement à l'information pertinente incluse dans la SCH appropriée.

Il n'existe aucune carte unique pouvant fournir tout le soutien à la prise de décision qui soit entièrement harmonisée avec toutes les priorités de tous les partenaires en conservation. Ainsi, on incite fortement les utilisateurs de cette SCH et de toutes les autres SCH à considérer sérieusement l'usage de la série complète de cartes et de l'information présentées pour obtenir le soutien à la prise de décision qui répond le mieux à leurs besoins.

Objectifs

Les objectifs de conservation établis pour orienter l'élaboration de cette SCH sont les suivants :

1) Déterminer les endroits qui revêtent de l'importance pour la conservation des habitats et des espèces prioritaires.
2) Établir, soutenir et améliorer les partenariats en conservation pour faciliter la prise de décision et mettre l'accent sur les efforts collectifs.
3) Maintenir des écosystèmes sains, intacts et entièrement fonctionnels, en tablant sur le travail de conservation existant réalisé par le partenariat, et en contribuant aux efforts pour acquérir des terres à des fins de conservation.

4) Appuyer la gestion et la protection de corridors entre les aires actuellement protégées et d'autres terres de conservation, par la protection des terres, par des partenariats et en étant proactif auprès de la communauté (c'est-à-dire, au niveau de l'intendance).
5) Appuyer le rétablissement de populations d'espèces en péril par des mesures de conservation collectives en partenariat, auxquelles contribuent également des ressources fédérales et provinciales concernant les espèces en péril.
6) Soutenir l'avancement d'un écosystème collaboratif et de recherches sur les espèces afin de contribuer à la prise de décision et à la planification.
7) Soutenir l'avancement du soutien à la communauté et la compréhension des valeurs de la biodiversité, ainsi que contribuer aux initiatives locales d'intendance.

Contexte écologique

La biorégion du Bas-Saint-Jean est un point chaud de la biodiversité au Nouveau-Brunswick. Malgré le changement anthropogénique considérable survenu dans la région, celle-ci a largement pu retenir sa riche composition d'espèces, notamment de nombreuses espèces rares, grâce à son climat et à son histoire géologique uniques. La région comporte un assemblage diversifié d'habitats, incluant de riches et productives zones riveraines, des terres humides d'eau douce, et quelques secteurs de bonne dimension relativement intacts comportant une forêt mature qui abrite un nombre significatif d'oiseaux migrateurs durant et en dehors des périodes de reproduction. Quelques forêts saines, certains milieux humides uniques et certains écosystèmes aquatiques sont conservés, et protégés via divers outils légaux, vers le développement d'un réseau amélioré de terres de conservation (figure 1). Les décisions clés concernant les conséquences pour la biodiversité sont fondées sur les résultats de recherches. De plus, la coordination des mesures de conservation privées et publiques s'est avérée bénéfique pour quelques espèces et systèmes indigènes. Des espèces en péril dans la biorégion peuvent très bien survivre quand la viabilité de leur habitat est évaluée et prise en charge par des mesures et des partenariats de conservation stratégiques et ciblés.

Conservation des habitats prioritaires

En se fondant sur les affinités des habitats des espèces rares, des espèces en péril et des espèces d'oiseaux devant être conservés en priorité, mais indépendamment des modèles spatiaux relatifs à l'occurrence des espèces, les sept types d'habitats suivants ont été cernés comme prioritaires quant à leur conservation dans la biorégion du Bas-Saint-Jean :

1. Systèmes riverains
2. Milieux humides d'eau douce
3. Mosaïque de la forêt acadienne
4. Prairies/agro-écosystèmes (champs et prés)
5. Falaises
6. Escarpements rocheux
7. Plages de sable et de gravier

Pour montrer comment on ne peut se fier à une seule carte pour fournir la « meilleure » réponse, deux versions de cartes ont été créées pour illustrer la position spatiale de l'ensemble des priorités quant à la conservation des habitats : l'une avec, et l'autre sans l'intégration des prairies et des agro-écosystèmes (figures 2 et 3, voir l'Annexe B, p. 149). Le besoin de produire ces deux versions émanait de la connaissance du fait que le type d'habitat que sont les prairies et les agro-écosystèmes, bien qu'importants, sont grandement anthropogéniques dans la biorégion et que, de façon inhérente, ils ont un haut degré de connectivité. L'intégration des prairies et les agro-écosystèmes dans l'ensemble, réduit la grande valeur reconnue des types d'habitats naturels, comme en témoigne la figure 2. Ces cartes composées des habitats prioritaires n'intègrent pas l'information sur les registres d'occurrence des espèces rares et en voie de disparition, ou des oiseaux qui sont une priorité en matière de conservation.

L'intégration subséquente des habitats et des espèces produit les cartes de l'Index de la valeur de conservation (IVC) pour la biorégion; l'une avec, et l'autre sans les prairies et les agro-écosystèmes (figures 4 et 5). La dernière carte IVC a été dressée sans les habitats des prairies et des agro-écosystèmes parce que les cotes élevées de l'IVC de l'extrant initiale découlaient de parcelles intrinsèquement plus grandes et bien reliées dans la biorégion du Bas-Saint-Jean. Comme telle, la carte IVC qui incluait les prairies et les agro-écosystèmes ne pouvait pas illustrer adéquatement l'importance relativement grande des autres parcelles d'habitats naturels dans la biorégion. L'IVC (excluant les prairies et les agro-écosystèmes) (figure 5) fournit donc un complément nécessaire à l'IVC initial, dans les cas où les habitats lourdement gérés ne sont pas considérés comme prioritaires en matière de conservation.

Il est recommandé au lecteur de comparer les cartes d'habitats prioritaires (figures 2 et 3) aux cartes de l'Index de la valeur de conservation (IVC) (figures 4 et 5) et d'en faire ressortir les différences, lorsqu'il utilise ce document comme soutien à la prise de décision. Les cartes comprenant les espèces de flore et de faune (figures 24 à 34, pages 67 à 77) sont également utiles dans le processus de planification. Elles fournissent toute l'information sur la répartition de 10 catégories distinctes de flore et de faune et assemblages qui constituent l'ensemble de l'information sur les espèces dans la présente analyse. En guise de complément à ces figures, le tableau 18 (à l'Annexe E, p. 168) dresse un résumé des espèces présentées sur chaque carte, ainsi que des ensembles de données utilisés pour représenter ces espèces.

Menaces

Les menaces suivantes (suivant la nomenclature de l'UICN) ont été caractérisées dans la biorégion du Bas-Saint Jean :

Actuelles

- 1.1 Habitations et zones urbaines
- 2.1 Cultures annuelles et pluriannuelles de produits autres que le bois
- 2.2 Plantations pour la production de bois et de pâte à papier
- 2.4.2 Aquaculture en mer et en eau douce - aquaculture industrielle
- 3.2 Exploitation de mines et de carrières
- 4.1 Routes et chemins de fer (fragmentation de routes)
- 5.3 Exploitation forestière et récolte du bois (pratiques d'exploitation forestière incompatibles)
- 6.1 Activités récréatives (véhicules hors route)
- 7.2 Barrages et mécanismes de gestion et d'utilisation de l'eau (autres barrières aquatiques)
- 8.1 Espèces envahissantes (insectes et maladies)

8.1.2 Espèces envahissantes - plantes
8.1.2 Espèces envahissantes - poissons prédateurs
8.2.2 Espèces indigènes problématiques/maladies - tordeuse des bourgeons de l'épinette
8.4.2 Introduction de matières génétiquement modifiées – écloseries de saumon

Émergentes
3.1 Forages pétroliers et gaziers
8.1.1 Espèces envahissantes/espèces exotiques/maladies - non-spécifiées (insectes et maladies)
11.1 Changements climatiques et conditions météorologiques extrêmes - déplacement et altération de l'habitat

Mesures de conservation

Le résumé suivant présente les mesures de conservation entreprises par les organisations qui travaillent dans la biorégion du Bas-Saint-Jean. Une liste plus détaillée des mesures de conservation et des liens aux menaces associées à chacun des habitats prioritaires est présentée dans le tableau 11 (p. 84).

Ministère des Ressources naturelles du Gouvernement du Nouveau-Brunswick

- Accorder en 2015, la désignation « Aire naturelle protégée », à 25 000 hectares de plus sur des terres de la Couronne situées à l'intérieur des écorégions 5 et 7, et représentant des habitats significatifs.
- Surveiller, sur une base annuelle, les propriétés de Conservation de la nature Canada (CNC) afin de constater l'impact des sites d'aquaculture et des véhicules tout-terrain, en plus de pallier toute menace pouvant nuire à l'atteinte des objectifs en matière de biodiversité.
- Mettre en œuvre les objectifs de conservation des écorégions 5 et 7 pour 14 communautés de forêt ancienne et 6 habitats de faune en forêt ancienne, dans le cadre du Plan de gestion des forêts de la Couronne élaboré en 2012-21.
- Sur les terres de la Couronne, le MRN va maintenir les zones tampons des cours d'eau et des milieux humides, déterminer et conserver les habitats d'hiver des chevreuils, déterminer et conserver les habitats sur des sites spécifiques pour les espèces en péril et d'autres espèces (p. ex. les colonies de hérons).
- Participer activement chaque année à des réunions de planification pour le rétablissement des espèces en péril.

Ministère de la Défense nationale - Base de Gagetown

- Poursuivre la mise en œuvre de la gestion des habitats et la surveillance des programmes, notamment la qualité de l'eau et le Plan de gestion des milieux humides à la base de Gagetown.
- Respecter le protocole de lavage de tout véhicule et équipement avant tout déplacement vers un autre endroit, pour éviter la propagation d'espèces envahissantes.
- Poursuivre la mise en œuvre des programmes de restauration des habitats pour les hirondelles, oiseaux des prairies et autres espèces d'oiseaux en péril.
- Poursuivre la mise en œuvre de la surveillance d'espèces comme les gros et petits mammifères, les moules d'eau douce et les poissons; et poursuivre les enquêtes de récupération déjà en cours pour plusieurs espèces en péril.
- Poursuivre partenariats externes axés sur la gestion et la surveillance, avec le Service canadien des forêts, le Musée du Nouveau-Brunswick, Études d'oiseaux Canada, et l'Association du bassin versant de la rivière Oromocto.

Études d’oiseaux Canada

- Poursuivre la surveillance des espèces d’oiseaux dépendant des milieux humides, évaluer l’efficacité des efforts de conservation du Plan conjoint des habitats de l’Est (PCHE), et encourager l’intendance des milieux humides locaux en vertu du Programme de surveillance des marais des Maritimes.
- Poursuivre la surveillance des niveaux de population du martinet ramoneur, aux sites de perchoirs connus, dans le cadre du Programme citoyen-science de surveillance et de conservation intitulé Programme de suivi du martinet dans les Maritimes.
- Poursuivre la tenue d’ateliers proactifs dans la communauté au bénéfice des martinets ramoneurs, intitulés « Swift Night Out ».

Fonds du Nouveau-Brunswick pour la nature

- Sécuriser un minimum de quatre propriétés ou 100 acres de terres privées comportant des habitats pour les espèces en péril, dans le but de les protéger entièrement en 2015.
- Travailler avec les propriétaires terriens pour développer et conclure des ententes d’intendance volontaire sur les terrains privés, qui s’attaqueront à des menaces spécifiques contre les habitats et espèces en péril.
- Mettre en place des partenariats et appuyer un réseau de propriétaires privés dans le cadre du Programme d’intendance des propriétaires terriens du Nouveau-Brunswick.
- Poursuivre la surveillance des espèces en péril connues dans toutes les réserves naturelles de la biorégion.
- Partager l’information et accroître la prise de conscience quant aux menaces pour les espèces en péril et transmettre des conseils et trucs aux propriétaires privés, à l’échelle de la biorégion du Bas-Saint-Jean, et ce, dans le cadre du Programme « Power of Nature Outreach », le Programme d’intendance des propriétaires terriens, et lors de rencontres ou d’événements publics.
- Mettre l’accent sur l’utilisation de la SCH du Bas-Saint-Jean et de nos outils de conservation des terres privées, afin d’aider les organisations de conservation et les groupes communautaires à poursuivre l’intendance locale (p. ex. l’Association de la communauté Taymouth, l’Association du bassin versant Nashwaak, la Coalition du bassin versant Belleisle).

Conservation de la nature Canada

- Préparer les énoncés intérimaires d’intendance dans un délai d’un an, et les plans de gestion des propriétés, à la suite de l’approbation des normes de rendement de l’intendance des propriétés sécurisées par Conservation de la nature Canada (CNC).
- Mettre en œuvre les mesures du Plan de gestion des propriétés concernant les terres de CNC jusqu’en 2018.
- Désigner toutes les propriétés de CNC dans la biorégion, en vertu de la *Loi sur les zones naturelles protégées* du Nouveau-Brunswick, d’ici 2018.
- Surveiller les propriétés de CNC, sur une base annuelle, quant l’incidence de l’usage des véhicules tout-terrain, et pallier toute menace potentielle pouvant nuire à l’atteinte des objectifs en matière de biodiversité.
- Travailler avec le personnel du Service canadien de la faune d’Environnement Canada pour identifier les groupes et agences appropriés afin de prendre les mesures de rétablissement nécessaires pour protéger les espèces en péril dans la biorégion, et participer chaque année aux réunions de planification pour la récupération des espèces en péril.

Canards illimités Canada

- Sécuriser les milieux humides des plaines inondables significatives et prioritaires dans la province, lorsque les occasions se présenteront.
- Continuer à investir dans le maintien de notre infrastructure dans cette région, au niveau prévu de 50 000 dollars, annuellement.
- Poursuivre les efforts dans la restauration, la création et l'amélioration des milieux humides dans le Bas-Saint-Jean, lesquels sont primordiaux pour appuyer l'objectif de la politique provinciale sur les milieux humides qui est de n'avoir aucune perte nette fonctionnelle du milieu humide.
- En partenariat avec les intendants bénévoles, surveiller, maintenir et distribuer des nichoirs de sauvagines dans la biorégion. Il y a environ 1 000 nichoirs dans cette région, et d'autres sont érigés chaque année.
- Poursuivre la gestion de l'habitat critique du petit blongios et créer un habitat encore plus adéquat dans les zones connues de reproduction, lorsque l'occasion se présentera.
- Poursuivre la mobilisation du public et des propriétaires terriens, par l'entremise de programmes d'éducation et de sensibilisation, comme le programme des nichoirs de sauvagines, le projet « Webfoot », les centres locaux d'excellence des milieux humides, un programme d'intendance pour les propriétaires terriens, et des programmes de classes en plein air.

Gouvernement du Canada – Environnement Canada

- Mettre en œuvre et mettre en application la *Loi sur la convention concernant les oiseaux migrateurs*, la *Loi sur les espèces sauvages du Canada*, la *Loi sur les espèces en péril*, la *Loi canadienne sur la protection de l'environnement*; et promouvoir la Politique fédérale sur la conservation des milieux humides.
- Offrir un soutien aux organisations environnementales non-gouvernementales (OENG), aux organisations autochtones et aux milieux universitaires par l'entremise de programmes d'emploi d'Environnement Canada, notamment le programme de stages pour les jeunes Horizons-Sciences et le Service écojeunesse international.
- Offrir un soutien aux organisations environnementales non-gouvernementales (OENG), aux organisations autochtones et aux institutions académiques par l'entremise du Programme d'action communautaire pour l'environnement, notamment le travail sur l'habitat et le système écologique en conservation et intendance grâce à un soutien direct et en nature (p. ex. le Programme de financement communautaire ÉcoAction, le Fonds pour dommages à l'environnement, le Plan de conservation national - le Fonds national de conservation des milieux humides, le Plan de conservation national – Initiative du Golfe du Maine, les Initiatives de l'écosystème de l'Atlantique, le Programme des dons écologiques du Canada, le Programme d'intendance de l'habitat – Volet prévention, le Fonds autochtone pour les espèces en péril – Courant Prévention).
- Offrir un soutien aux organisations environnementales non-gouvernementales (OENG) et aux organisations autochtones pour le travail spécifique sur les espèces en péril dans le cadre du Programme d'intendance sur les habitats et le Fonds autochtone pour les espèces en péril.
- Soutenir les activités décrites dans les documents de rétablissement des espèces en péril pour en vue de l'achèvement de la série d'études sur la détermination des habitats critiques.
- Engager et consulter tous les partenaires dans l'élaboration de documents sur le rétablissement des espèces en péril.

- Coordonner le Plan conjoint des habitats de l’Est (PCHE) et fournir une orientation scientifique aux partenaires sur les mesures de conservation et sur les priorités concernant les oiseaux migrateurs, les espèces en péril et leurs habitats, notamment par l’élaboration, le peaufinement et la mise en application de cette SCH et de la Stratégie du Nouveau-Brunswick pour la conservation des oiseaux dans la Région 14.
- Poursuivre les activités de gestion associées à la Réserve nationale de faune de Portobello Creek.
- Acquérir une propriété dans une aire d’intérêt de la Réserve nationale de faune de Portobello Creek.
- Coordonner et mener des enquêtes sur les oiseaux migratoires (p. ex. 2 parcelles de surveillance de l’Inventaire de la sauvagine de l’est, 1 Relevé hivernal triennal du canard noir, 7 parcours actifs du Relevé des oiseaux nicheurs).

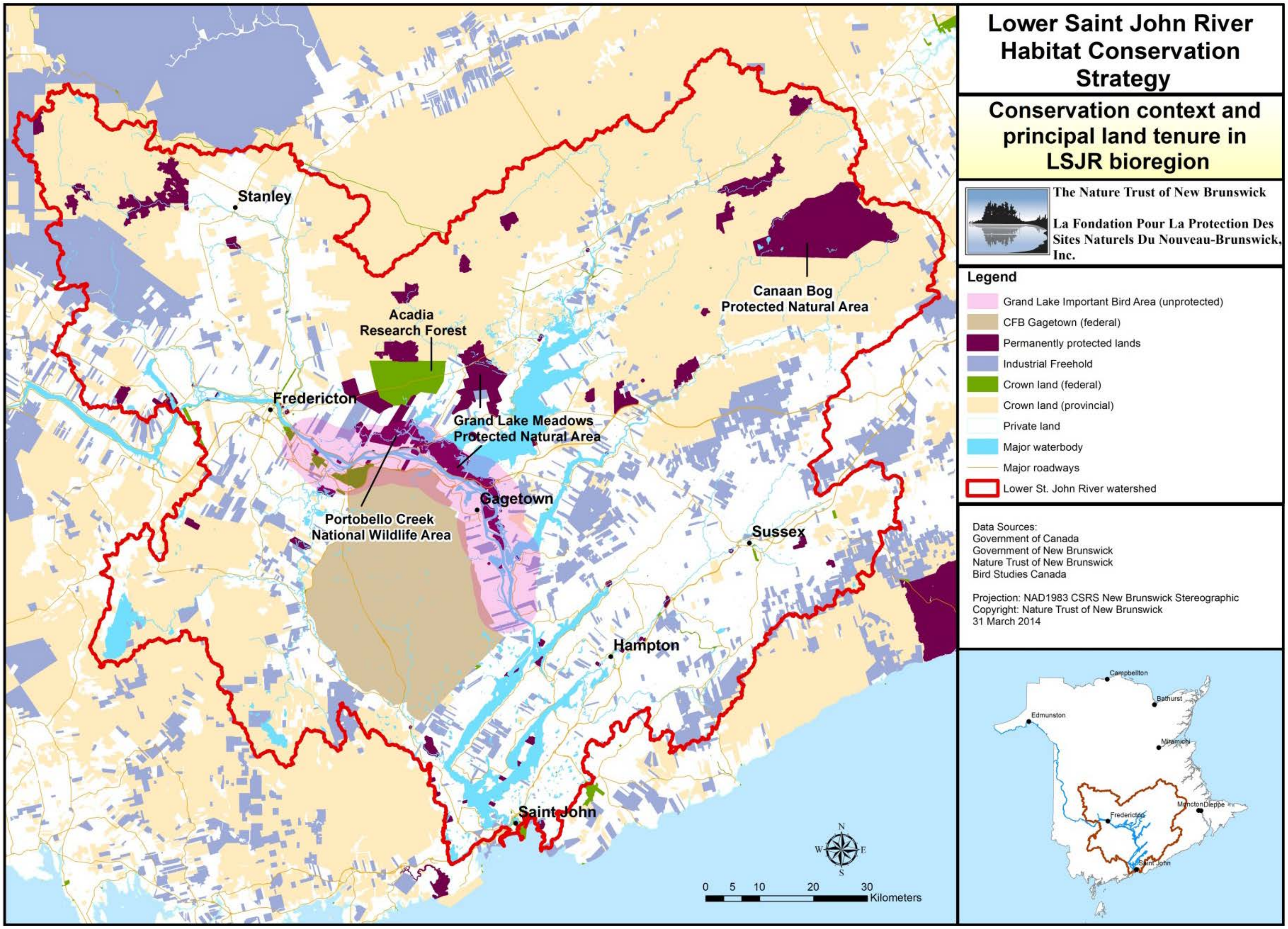


Fig. 1. **Conservation context and overall land tenure in the LSJR bioregion. Permanently protected land includes federal, provincial, and land trust holdings.**

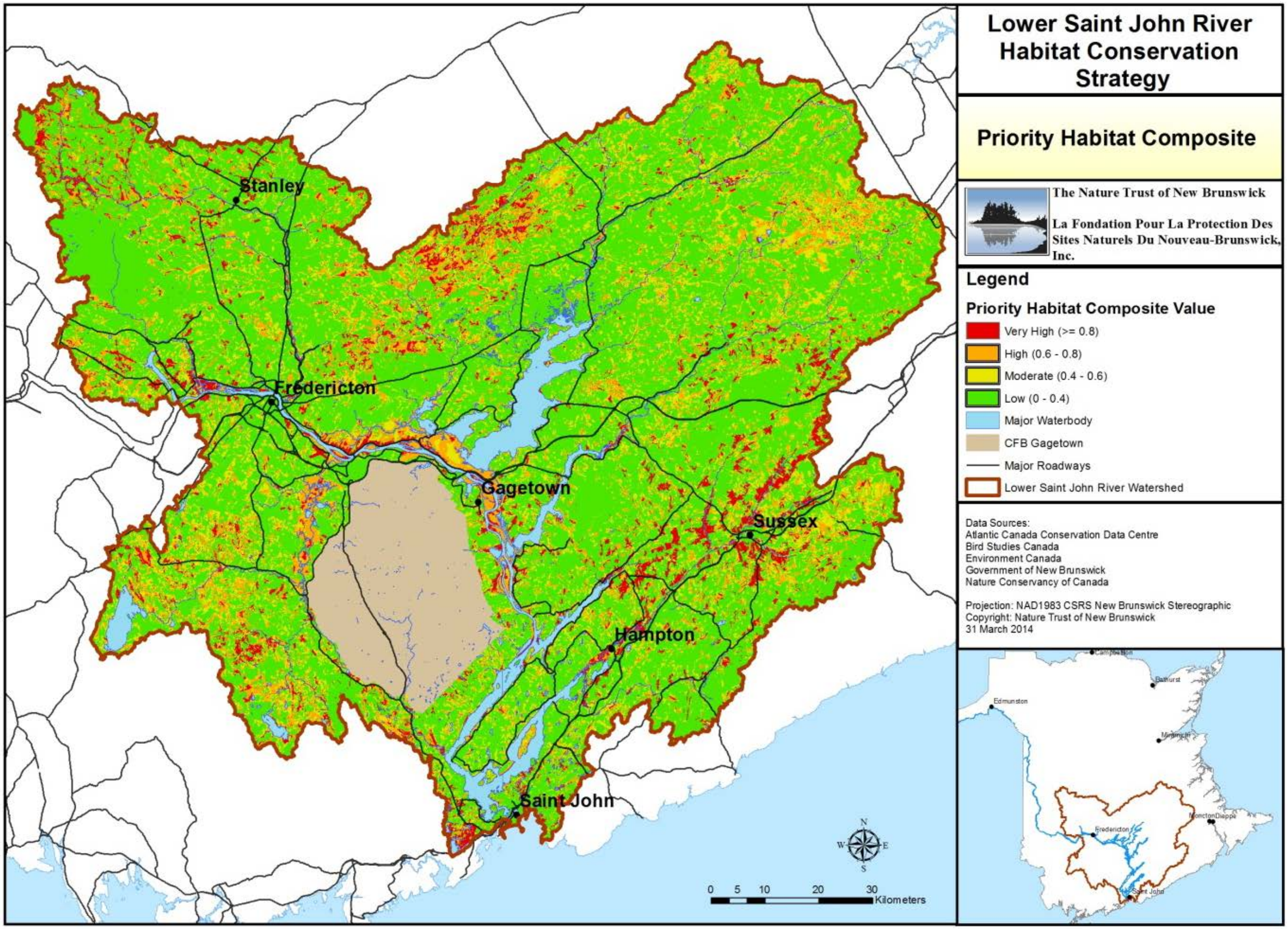


Fig. 2. Priority habitat composite for the LSJR bioregion (NOTE: High priority values for grassland/agro-ecosystems in this priority habitat composite map result from large, well-connected man-made agricultural lands in this bioregion).

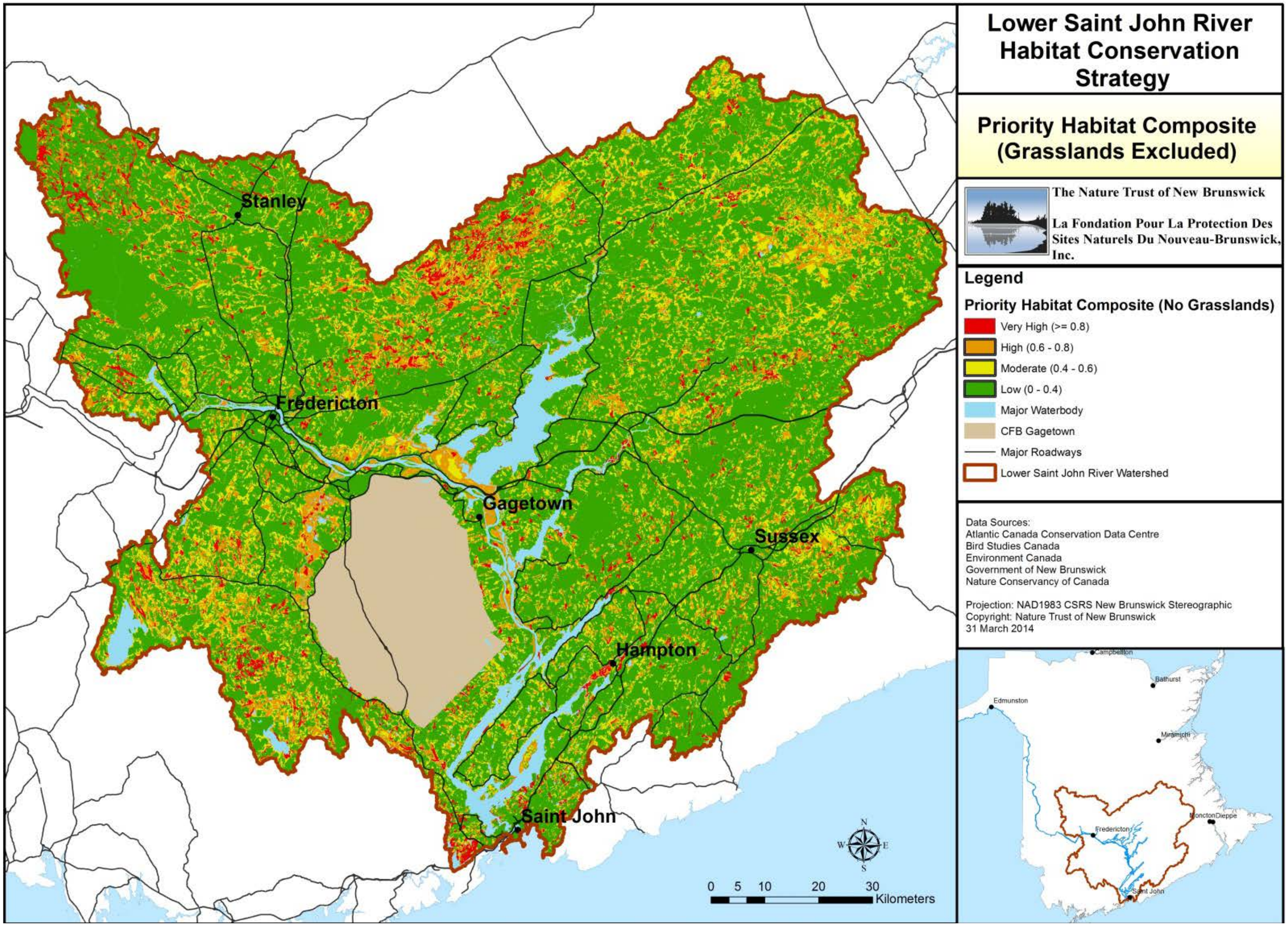


Fig. 3. Priority habitat composite for the LSJR bioregion (excluding grasslands/agro-ecosystems).

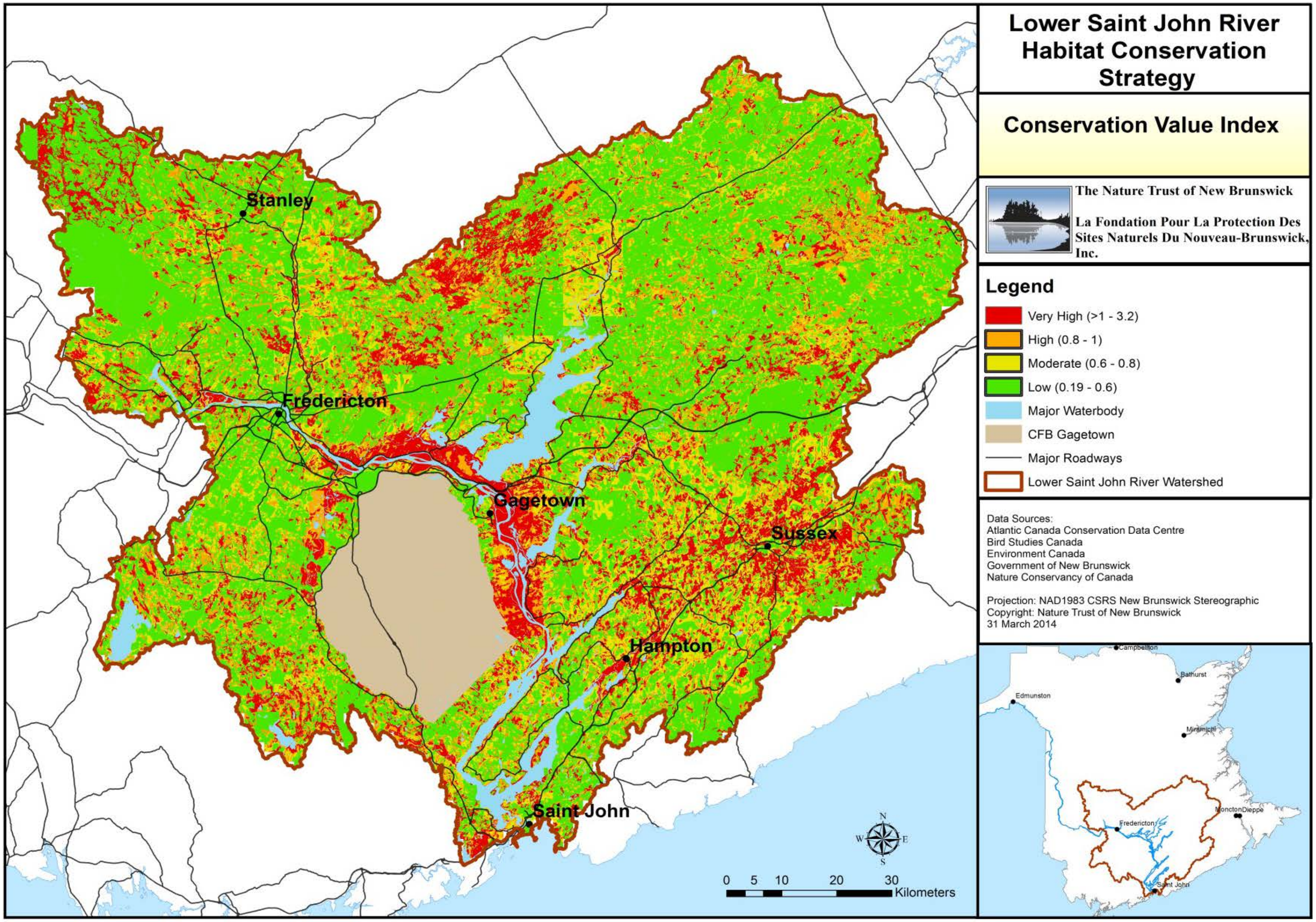


Fig. 4. Conservation Value Index for the LSJR bioregion (Note: high conservation value scores for grassland/agro-ecosystems in this CVI map result from large, well-connected man-made agricultural lands in this region).

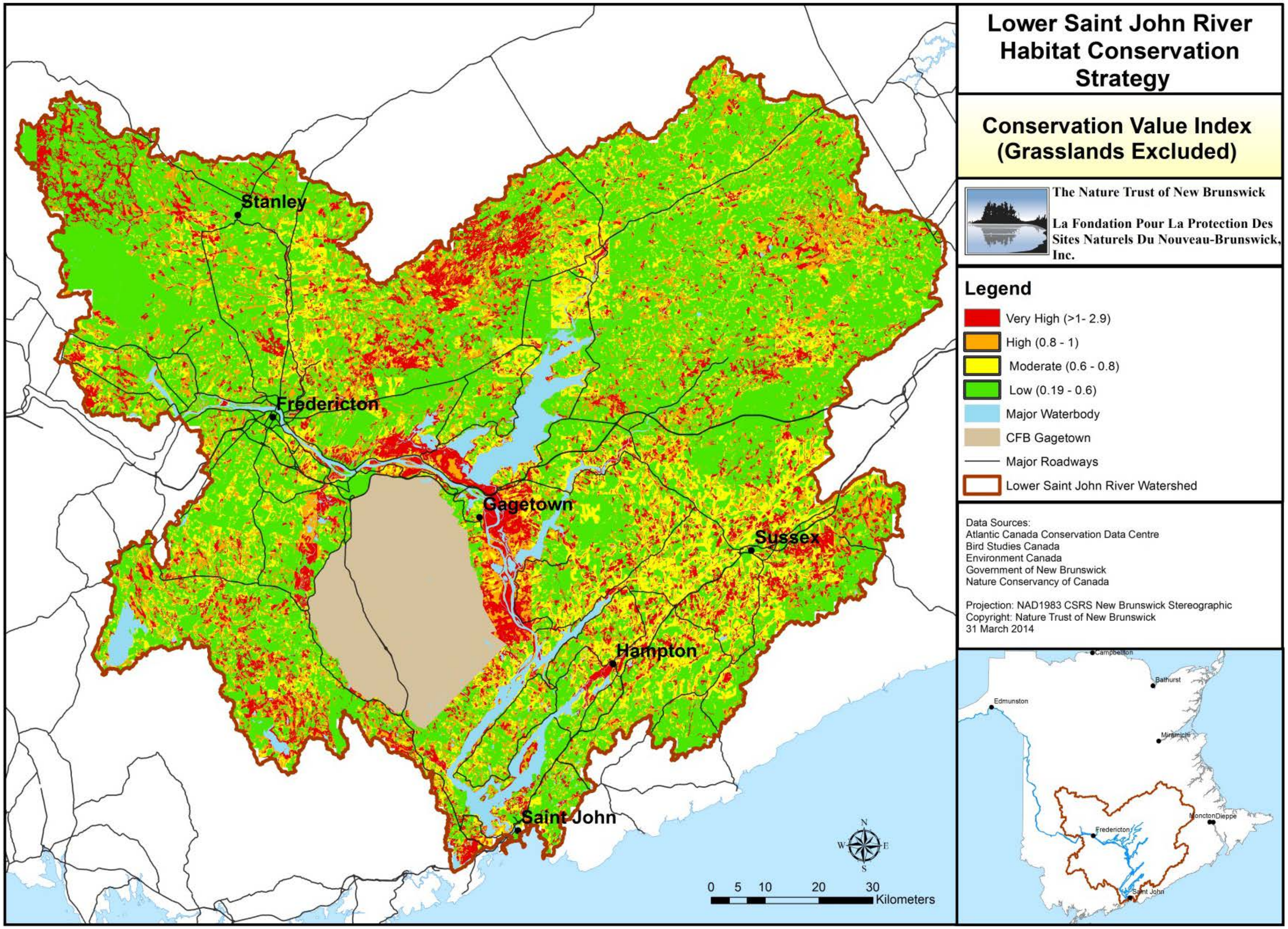


Fig. 5. Conservation Value Index for the LSJR bioregion (excluding grasslands/agro-ecosystems).

ACKNOWLEDGEMENTS

The primary authors of this document were Aaron Dowding, Nature Trust of New Brunswick, Alana Plummer, Environment Canada, and Denis Doucet, Environment Canada.

The New Brunswick (NB) Eastern Habitat Joint Venture Provincial Steering Committee would like to thank the following individuals for their input and advice into the development of this strategy:

Environment Canada – Canadian Wildlife Service: Al Hanson, Becky Whittam, Karel Allard, Michael Elliot, Matthew Mahoney, Paul Chamberland, Samara Eaton

National Defence – 5th Canadian Division Support Base Gagetown: Deanna McCullum

NB Department of Natural Resources: Dan Beaudette, Maureen Toner, Todd Byers, Scott Makepeace, Kevin Connor, and Steven Gordon

NB Department of Environment: Lee Swanson, Rob Capozi, and Mark McGarrigle

NB Department of Agriculture, Aquaculture, and Fisheries: Jim Goltz and Tom Byers

Bird Studies Canada: Becky Stewart, Margaret Campbell, and Laura McFarlane-Tranquilla

Atlantic Canada Conservation Data Centre: Sean Blaney, and David Mazerolle

Ducks Unlimited Canada: Adam Campbell and Jodie Hambrook

Nature Conservancy of Canada: Josh Noseworthy and Pat Nussey

Nature Trust of New Brunswick: Camilla Melrose and Renata Woodward

New Brunswick Museum: Stephen Clayden and Don MacAlpine

University of New Brunswick: Graham Forbes and Vince Zelazny

Thanks also to the official sponsors of the Maritimes Breeding Bird Atlas (Bird Studies Canada, Environment Canada - Canadian Wildlife Service, New Brunswick Department of Natural Resources, Nova Scotia Department of Natural Resources, Prince Edward Island Department of Agriculture and Forestry) for supplying Atlas data, and to the thousands of volunteer participants who gathered data for the project.

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1. CONSERVATION CONTEXT

A. Bioregion scope

Location and size

The Lower St. John River (LSJR) bioregion stretches from the Mactaquac Dam downstream to the city of St. John where the river empties into the Bay of Fundy (Fig. 6). The entire St. John River watershed covers approximately 55 000 km^2, 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 km^2 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. Similarly, the Reversing Falls constitutes a natural physical limit to the watershed at its outflow into St. John Harbour. Within these limits, the LSJR bioregion covers approximately 15 387 km^2 (1 538 680 ha) of land or about 20% of the total surface of New Brunswick. The area includes Grand Lake, its associated wetlands, as well as intact forest blocks, agricultural land, and riparian zones.

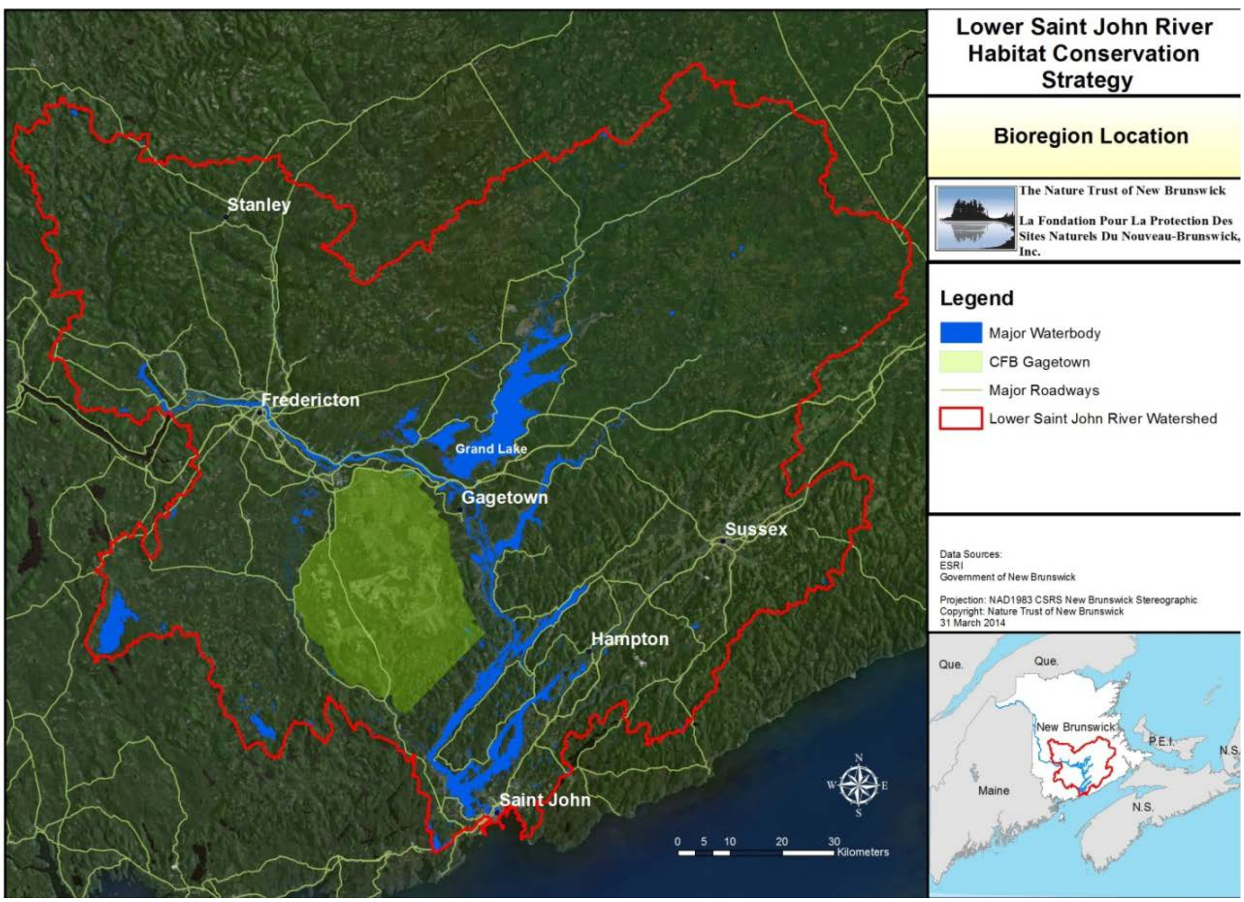

Fig. 6: Boundaries of the LSJR bioregion.

Boundary justification

The boundary for the LSJR Integrated Habitat Conservation Strategy is the result of a collaborative decision, with input from a number of government agencies, ENGOs and other individuals. This area was originally selected based on the density of SAR located within its watershed, the high number of human-induced threats, constraints to protection and/or other conservation options, and a high degree of stewardship potential.

The St. John River watershed is the largest in the Maritimes, being important for wildlife and plants, and is composed of a wide variety of habitats: riparian floodplains, alluvial islands, hardwood uplands, lakes, streams, bogs and fens. This area includes habitat for more than 260 resident, breeding, migrating and wintering bird species, with 40 of these being wetland obligate species. The St. John River itself provides an expansive corridor with resting and feeding stopover sites, especially for migrating species. Many federally at-risk and provincially significant bird species breed in the area.

Unfortunately, many sites providing habitat for species at risk are threatened by development and urbanization throughout the LSJR bioregion, more broadly within the watershed, and beyond. Wood Turtle was identified as another important target in the Atlantic Canada Regional Priority Statement for the Habitat Stewardship Program (HSP) and projects related to this and other species will inform stewardship activities required to address threats to this and many other priority species found in the LSJR bioregion (Environment Canada 2014).

In this HCS, attempts have been made where possible to present information related to species and habitat research and protection undertaken by the Department of National Defense (DND) 5th Canadian Division Support Base Gagetown. See Table 11 (p. 84) for a summary of planned conservation actions by DND Environmental Services staff to address the threats to habitats and species found on federal lands under their jurisdiction. The reader will find that activities including stream and wetland habitat restoration, terrestrial and aquatic species monitoring, and species research have a long history and are ongoing at Base Gagetown. The Eastern Habitat Joint Venture is committed to integrating additional habitat and species spatial data into future iterations of this HCS in order to provide a more complete representation of the LSJR bioregion landscape.

This HCS primarily targets terrestrial species. The treatment of aquatic species is cursory in this report because the Canadian Rivers Institute examined the St. John River's aquatic components in detail in 2011 (CRI 2011).

Table 1. Ecological land classification in the LSJR bioregion.

NAAP Subregion[1]	Environment Canada Ecoregion	NB DNR Ecoregion[2]	Ecodistrict[2]
Acadian Uplands	Southern New Brunswick Uplands, Maritime Lowlands	Grand Lake Lowlands	Aukpaque, Maquapit
		Valley Lowlands	Buttermilk, Cardigan, Yoho, Mount Pleasant, Kingston
		Eastern Lowlands	Castaway

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

Ecological significance

The LSJR bioregion is an area of New Brunswick with unique characteristics that make it attractive to people and wildlife. Habitat diversity within the LSJR bioregion is shown by the number of provincially delineated ecodistricts found within the three ecoregions partially contained within its borders (Table 1). Within the Valley Lowlands Ecoregion, the Buttermilk, Cardigan, Yoho, Mount Pleasant, and Kingston Ecodistricts all lay partially or wholly within the LSJR bioregion. In the Grand Lake Lowlands Ecoregion, the LSJR bioregion encompasses both the Aukpaque and Maquapit Ecodistricts, while small areas of the Castaway Ecodistrict of the Eastern Lowlands are also included (Zelazny 2007).

These three ecoregions are quite distinct, showing variation in topography, forest cover, and habitat features. The majority of the LSJR bioregion is low-lying, with shallow river valleys at just above sea level with more limited upland areas rising to 150 m in elevation. The bioregion also contains large trough-like depressions at Grand Lake and Washademoak Lake. The southernmost portion of the LSJR bioregion consists of more rugged topography, with undulating hills and valleys, and deep linear basins such as in the Kennebecasis Valley and Belleisle Bays areas, whereas a rolling pastoral landscape is found in the Sussex region (St. John River Society 2008). The shallow topography and flooding regime of the LSJR watershed create an area highly influenced by spring flooding; this periodic inundation creates vast flood-plains, replenishes soil nutrients, and shapes the diverse flood-dependent vegetation communities and productive wetlands (Zelazny 2007). Highly fertile land is found throughout the LSJR watershed with moist, rich alluvial soils dominating the river valley flood plains. Reddish acidic loams cover much of the study area and tend to be poorly-drained in flat topography; however, where well-drained they provide land suitable for farming (Zelazny 2007).

The LSJR bioregion supports a wide variety of tree species. The forests of the Grand Lake Lowlands are composed of mixed stands made up of red spruce, hemlock, red maple, white birch and aspen. Poorly drained uplands are dominated by black spruce, lower slopes are dominated by white pine, and flood plain areas are covered by species including silver maple, alder, poplar, and willow. Stands of mixed pine species are commonly found in well-drained stream and river valleys or ridges.

The area's flooding and shallow topographic profile creates a unique array of wetland habitats including swamps, marshes, fens, flooded meadows, shallow lakes and marsh islands. Owing to the tidal influence in the southernmost portions of the river, tidal wetlands including brackish marshes can be found. Wetland habitats, including the Hampton-Kennebecasis marsh, are important for birds and mammals, providing vital migrating and breeding grounds for common and rare species. Grand Lake Meadows, located west of Grand Lake is a provincially significant wetland, and is one of the most important staging areas during spring migration for inland waterfowl species in the Maritimes (Zelazny 2007). The lower reaches of the LSJR watershed also encompass significant lake systems, many of which are surrounded by marshlands or open water wetlands, including Grand Lake, Washademoak Lake, Belleisle Bay, Long Reach, and Kennebecasis Bay. Many of the features that constitute the basis for the ecological significance of the bioregion to regional flora and fauna have also made the area attractive to humans.

B. Ecological context

I. Priority species

The LSJR bioregion shows a remarkable concentration of significant floral and faunal species both in terms of quantity and in diversity (see Appendix A). *Priority species* are defined as any species with a

COSEWIC ranking or provincial ranking of Special Concern, Threatened, or Endangered, any BCR 14 priority bird species, any species with a ranking of S1 or S2, or any species with a ranking of S3 and a G ranking of 1, 2 or 3. A total of 301 priority species occur in the LSJR bioregion and the full list of these species is presented in Appendix A. Globally significant species and species at risk are presented separately (Tables 2 and 3, respectively).

Table 2. Globally significant species (G1-G3G4) in the LSJR bioregion.

COMMON NAME	SCIENTIFIC NAME	GRANK	COSEWIC and Provincial Rank
Shortnose Sturgeon	*Acipenser brevirostrum*	G3	SC
Atlantic Sturgeon	*Acipenser oxyrinchus*	G3	T
Cobblestone Tiger Beetle	*Cicindela marginipennis*	G2	E
Skillet Clubtail	*Gomphus ventricosus*	G3	E
Pygmy Snaketail	*Ophiogomphus howei*	G3	SC
Yellow Lampmussel	*Lampsilis cariosa*	G3G4	SC
Ghost Antler Lichen	*Pseudevernia cladonia*	G2G4	NAR
Anticosti Aster	*Symphyotrichum anticostense*	G3	T
Prototype Quillwort	*Isoetes prototypus*	G2G3	SC

E = Endangered
T = Threatened
SC = Special concern
NAR = Not at risk

Table 3. Federally-designated species at risk in the LSJR bioregion.

SPECIES	SCIENTIFIC NAME	COSEWIC RANK	HABITAT ASSOCIATION
Shortnose Sturgeon	*Acipenser brevirostrum*	SC	Rivers and lakes, riparian
American Eel	*Anguilla rostrata*	T	Freshwater rivers and lakes, marine waters
Atlantic Sturgeon	*Acipenser oxyrhinchus*	T	Rivers and attached lakes, riparian
Atlantic Salmon	*Salmo salar*	E	Rivers, riparian
Redbreast Sunfish	*Lepomis auritus*	DD	Rivers and lakes
Striped Bass	*Morone saxatalis*	T	Rivers, riparian
Yellow Lampmussel	*Lampsilis cariosa*	SC	Rivers and attached lakes, riparian
Eastern Wood-Pewee	*Contopus virens*	SC	Riparian, wetlands, swamp forest, old growth
Peregrine Falcon	*Falco peregrinus*	SC	Riparian, cliffs
Rusty Blackbird	*Euphagus carolinus*	SC	Riparian, wetlands, swamp forest
Short-eared Owl	*Asio flammeus*	SC	Grasslands, shrublands, large open marsh, fen, bog
Yellow Rail	*Coturnicops noveboracensis*	SC	Wetlands
Barn Swallow	*Hirundo rustica*	T	Anthropogenic habitats (fields), open areas

			(wetlands, waterbodies), colonial nester,
Bank Swallow	*Riparia riparia*	T	Riparian, steep open banks, anthropogenic habitats (sand and gravel pits)
Bobolink	*Dolichonyx oryzivorus*	T	Grasslands, wetlands
Canada Warbler	*Cardellina canadensis*	T	Swamp forest, wetlands, forest, old growth
Chimney Swift	*Chaetura pelagica*	T	Old forest, anthropogenic habitat (fields, etc.), colonial nester
Common Nighthawk	*Chordeiles minor*	T	Open forest, grasslands and anthropogenic habitats (barrens, burns, harvested areas)
Eastern Meadowlark	*Sturnella magna*	T	Fields
Eastern Whip-poor-will	*Antrostomus vociferus*	T	Open upland forest
Least Bittern	*Ixobrychus exilis*	T	Wetlands, Riparian
Olive-sided Flycatcher	*Contopus cooperi*	T	Wetlands, forest, open harvested areas
Wood Thrush	*Hylocichla mustelina*	T	Forest
Monarch Butterfly	*Danaus plexippus*	SC	Open meadow and wetland, riparian
Cobblestone Tiger Beetle	*Cicindela marginata*	E	Cobble/gravel beaches
Pygmy Snaketail	*Ophiogomphus howei*	SC	Rivers, riparian
Skillet Clubtail	*Gomphus ventricosus*	E	Rivers, riparian
Tri-coloured bat	*Perimyotis subflavus*	E*	Edge habitat along open areas, agricultural fields
Northern Myotis	*Myotis septentrionalis*	E*	Dense upland forest
Little Brown Myotis	*Myotis lucifugus*	E*	Forests, open aquatic habitat and fields (feeding),
Prototype Quillwort	*Isoetes prototypus*	SC	lakes
Butternut	*Juglans cinerea*	E	Hardwood forests, riparian
Wood Turtle	*Glyptemys insculpta*	T	Riparian
Snapping Turtle	*Chelydra serpentina*	SC	Riparian, wetlands

For a complete list of priority species found in the LSJR bioregion, see Appendix A
E = Endangered
T = Threatened
SC = Special Concern
NAR = Not at Risk
DD = Data Deficient

Birds

At least 82 bird priority species which occur in the LSJR bioregion have been retained as priority species for conservation/management action (Table 12, Appendix A). These species can be grouped into four large guilds based on their characteristics and the habitats they occupy: wetlands (e.g., marsh birds, waterfowl), forests (land birds), riparian/shoreline and grasslands. Freshwater wetlands constitute the habitat type with which the greatest proportion of priority species is associated. A total of at least 50 of the 82 priority species of birds (>61%) use this habitat assemblage during a portion of their life cycle. Further, 15 of the 82 bird priority species occurring in the bioregion have been designated as “at risk” by COSEWIC (Table 3).

Wide-ranging Mammals and forested habitats

Forest patch connectivity plays an important role in dispersal of species, including that of several wide-ranging and some more locally-occurring mammal species (Noss 1993; MacDonald and Clowater 2005). MacDonald and Clowater (2005) used a suite of mammal species as a basis for assessing ecological connectivity in the New Brunswick-Nova Scotia border region. Although the authors found this to be an important conservation issue in their study area, these findings have implications for the LSJR bioregion as well, particularly as they pertain to species dispersal. Species examined in McDonald and Clowater (2005) included wide ranging mammals such as Canadian Lynx (*Lynx canadensis*), Moose (*Alces americanus*) and Black Bear (*Ursus americanus*), as well as more near-ranging mammal species such as American Marten (*Martes americana*) and Northern Flying Squirrel (*Glaucomys sabrinus*). These species all depend on forested ecosystems for foraging and shelter, some requiring more mature to older stands or even features of other adjacent or nearby habitats. For instance, Moose require softwood and mixed-wood dominated cover during winter and emergent wetlands during summer (Parker 2003). Mature to older patches and stand types currently exist within the LSJR bioregion, although fragmentation limits connectivity between many forest patches (MacDonald and Clowater 2005). The mammal species that depend on old forest conditions seem to require structural diversity in particular. For example, American Marten and Northern Flying Squirrel require old coniferous and mixed-wood habitats, and connectivity between these mature forest patches is said to be important for the dispersal of these species (Smith et al. 2011). Linking large forest blocks through maintenance of mature cover in forest corridors is essential for maintaining genetic flow of these wide-ranging and more localized mammals throughout New Brunswick. Given the high degree of road fragmentation present in this bioregion, dispersal potential of various mammal species should be assessed to insure that this has not already been significantly impaired. Fig. 33 in the Actions section depicts composite values derived from available occurrence records of rare mammals found in the LSJR bioregion.

Bats

Three of seven bat species in New Brunswick are known to use caves as hibernacula during the winter months: the Tricolored Bat (*Perimyotis subflavus*), Little Brown Myotis (*Myotis lucifugus*) and the Northern Myotis (*Myotis septentrionalis*), all of which have recently been designated as endangered by COSEWIC (Forbes 2012a; 2012b; 2012c). While caves and calcareous areas have not been retained as a focal habitat in this habitat conservation strategy, there are caves and potential bat hibernacula present in the bioregion, especially nearer the Bay of Fundy, around the Sussex area (Broders et al. 2001). To date, most known hibernacula in NB are found in the New Brunswick Inner Bay of Fundy bioregion, including the only known occurrences of Tri-coloured bats that overwinter in the Maritimes outside of the Southwest Nova Bioregion (Broders et al. 2001). As of 2011, catastrophic declines of these three bat species have occurred within eastern Canada, resulting in >80% mortality within New Brunswick. The precipitous decline is attributed to White-nose Syndrome (WNS), caused by the fungus, (*Pseudogymnoascus destructans*) believed to have been introduced from Europe (Pikula et al. 2012; Blehert 2012). Infected individuals develop a white powdery fungus on exposed skin of the muzzle and wings, hence the name “White-nose Syndrome”.

From a conservation perspective, the protection and stewardship of caves and surrounding areas will help prevent additional stresses on potentially resistant bats, and should address the protection of cave entrances from vandalism and other human disturbance, as well as the protection of all lands above and around caves to maintain forest cover (Broders et al. 2001; G. Forbes, pers. comm.). It should be noted that bats (especially the migratory species) are more likely to be impacted by wind farms than birds and where such features exist, this needs to be carefully considered in analysing present and emerging threats and establishing conservation and recovery actions (Arnett et al. 2008; Baerwald and Barclay 2009). Refer to *Threats: Invasive insects and diseases* (p. 40) for a detailed description of White-nose Syndrome.

Fishes, Herpetofauna, and Rare Invertebrates

Riparian systems by definition encompass a broad suite of habitat types and correspondingly host the highest diversity of species of all broad priority habitat categories identified within the LSJR bioregion. The latter habitat types range from brackish and freshwater aquatic, to shrub wetlands and seepage areas, forested floodplains, grasslands and upland forest communities. The major river systems in the LSJR bioregion, and their tributaries, are particularly diverse due in part to the fact that the St. John River is the largest river in the Maritimes and experiences some of the warmest temperatures and greatest number of growing degree days, especially in the region from Fredericton to Grand Lake. A number of rare and at-risk species depend on aquatic habitats in the bioregion for part of their lifecycle. These include certain anadromous fish – species that spawn in freshwater but migrate to the ocean to feed, grow and mature (e.g. Striped Bass, Atlantic salmon, Short-nosed and Atlantic Sturgeon) and catadromous fish – those that spawn in saltwater but some (if not all), migrate to freshwater to feed, grow and mature, e.g. American Eel. The Inner Bay of Fundy population of Atlantic salmon is recognized as a distinct population that completes its lifecycle mostly within the bay and likely no further than the Gulf of Maine, making it ecologically and genetically distinct from other populations (DFO 2010; Lacroix 2013). A moderate number of these salmon still venture into some of the lower tributaries of the LSJR, notably the Hammond River. Populations of Inner Bay of Fundy Salmon have decreased substantially since the early 20th century and although the reasons for this decline are not yet well understood, it is believed to be linked to low marine survival.

The Wood Turtle, a semi-aquatic reptilian species and North American endemic, also depends on riparian habitats. Stream, lakes and ponds are used for mating and hibernation, while upland sites (within 300 m of a watercourse) are used for foraging and nesting (COSEWIC 2007a). Riparian shrub wetlands and forested riparian areas are considered the preferred terrestrial habitat for this species, although they are known to use a range of upland sites, including agricultural lands and roadside ditches. It is listed federally and provincially as a threatened species. Snapping Turtles, a COSEWIC species of special concern, are also found principally in riparian habitats and tend to be much more closely tied to water and wetlands than Wood Turtles, preferring relatively slow-flowing to stagnant, muddy to silt-bottomed watercourses and waterbodies (COSEWIC 2007a, 2008b). Fig. 31 in the Actions section presents a composite of rare amphibians and reptiles

Rare freshwater mussels found here include the COSEWIC-designated Yellow Lampmussel (*Lampsilis cariosa*). Also a mollusc, the regionally rare Squat Duskysnail (*Lyogyrus granum,* S2) is found in ponds and slow rivers at a few sites in the bioregion.

Among significant arthropod species, there are 5 significant butterfly species found in the LSJR, including the Banded Hairstreak (*Satyrium calanus*, S2), which is associated with Butternut and Red Oak, and the Juvenal's Duskywing (*Erynnis juvenalis*, S1), which is associated with oak stands. Butternut and Red Oak stands are rare in the Maritimes; indeed, Butternut is an endangered species. Banded Hairstreaks are mainly found from Fredericton to Woodstock, especially along trails where both Red Oak and Butternut occur, where they also can be found nectaring on plants such as Milkweed and Sweet Clover species (*Melilotus* spp.). New Brunswick's only record of Juvenal's Duskywing is from Welsford. Grey Hairstreak and Henry's Elfin are also found in the Welsford area. Of the 5 significant butterflies occurring in the bioregion, only the Monarch (Danaus plexippus) is listed by COSEWIC, and in Schedule 1 of SARA as a Species of Special Concern (COSEWIC 2010c). However, perhaps the group of invertebrates with the largest number of priority species is the Odonata (Dragonflies and Damselflies), with 11 species. Two species of dragonflies have been designated by COSEWIC. First, the Skillet Clubtail (*Gomphus ventricosus*), listed as endangered, and second, the Pygmy Snaketail (*Ophiogomphus howei*), listed as a Species of Special Concern and similarly listed in Schedule 1 of the federal Species at Risk Act (SARA).

The Cobblestone Tiger Beetle (Cicindela marginipennis), is designated as endangered under the federal Species at Risk Act (SARA). This species occurs only in two small regions of the province, both of which are within the St. John River watershed, with one site, Grand Lake, falling within the bounds of the bioregion (COSEWIC 2008a). Fig. 32 in the Actions section, presents a composite derived from records of occurrence of rare invertebrate species.

Flora

A total of 188 species of priority flora have been recorded in the bioregion to date. Of particular note, floral species at risk occurring in the bioregion include Butternut (*Juglans cinerea*), listed as endangered under SARA and associated with rich hardwood forests and the riparian zone, and the Anticosti Aster (*Symphyotrichum anticostense*), listed as threatened species under SARA, and associated with gravel and cobble beaches in the riparian zone of rivers. The Prototype Quillwort, an aquatic species listed as Special Concern by COSEWIC and under SARA, is also found in lakes within the bioregion. Indeed, nearly half of the priority floral species found here are associated with the rich riparian floodplain forests of the LSJR bioregion, and are especially concentrated in the section between Mactaquac and Gagetown. Fig. 34 in the Actions section on p 75 presents a composite based on records of occurrence of rare plants, lichens and bryophytes.

II. Protected Areas and Conservation Lands

According to the International Union for Conservation of Nature (IUCN), a protected area is *"a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values"* (Dudley 2008). Existing protected areas make up 3.7% of the LSJR bioregion, with varying degrees of protection and management intervention (Table 4; Fig. 7).

Federally protected lands within the bioregion include the Portobello Creek National Wildlife Area, established under the authority of the *Canadian Wildlife Act* and managed by Environment Canada (Table 4). This site provides protection to wildlife habitat, notably for priority migratory bird species, species at risk and other rare flora and fauna.

A number of important sites for conservation are managed by the Government of New Brunswick in the Lower St. John River bioregion. Of these, twenty two are Protected Natural Areas (Table 4), which are provincially-significant nature reserves protected under New Brunswick's Protected Natural Areas Act (2003). These areas cover 47,187 ha of land managed by the Government of New Brunswick Department of Natural Resources, and protect representative examples of New Brunswick's natural landscapes, rare or endangered species, and native biodiversity. The most prominent of these PNA's are the Canaan Bog northwest of Salisbury, and the Grand Lake Meadows PNA located southwest of Grand Lake. In 2014, fifteen new PNA's were created in the bioregion. The bioregion's new PNA's predominantly protect old forests and areas of high biodiversity that are underrepresented in their ecoregions; a small percentage of the new protected area also host wetland habitat.

The 550 ha Mactaquac Provincial Park falls partially within the boundaries of the bioregion (Table 4), and is managed by the Government of New Brunswick Department of Tourism and Parks to provide natural space and recreational opportunities.

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. The NCC has secured approximately 418 ha of wilderness in the bioregion (Table 4).
The New Brunswick Nature Trust (NBNT) is a conservation charity that works with private landowners to conserve ecologically significant habitat within New Brunswick through securement and conservation easements. The NBNT currently protects approximately 378 ha in the bioregion (Table 4).

While Important Bird Areas (IBAs) are not protected areas, they do recognize the importance of an area for birds. A portion of the LSJR (Sheffield/Jemseg) IBA overlaps with the Portobello Creek NWA, on the northern (eastern) shore of the St. John River (Fig. 7) bioregion. This IBA is recognised for its importance to waterbirds including waterfowl, nationally significant numbers of Black Tern, and globally significant estimated numbers of Yellow Rail (*Coturnicops noveboracensis*), a Special Concern species (IBA 2012; EC 2013e).

Table 4. Existing conservation lands in the LSJR bioregion.

Agency	Total protected Area (ha)	IUCN Protection Area Category
Ducks Unlimited Canada	**1 736.48**	Habitat and Species Management Areas, Protected Landscapes
Government of Canada	**2 147.82**	Wilderness Areas
Government of New Brunswick	**53 089.48**	Strict Nature Reserves, Wilderness Areas, Habitat Management Areas
Nature Conservancy of Canada	**412.34**	Protected Landscapes
Nature Trust of New Brunswick	**469.00**	Protected Landscapes
Total	**58 070.12**	

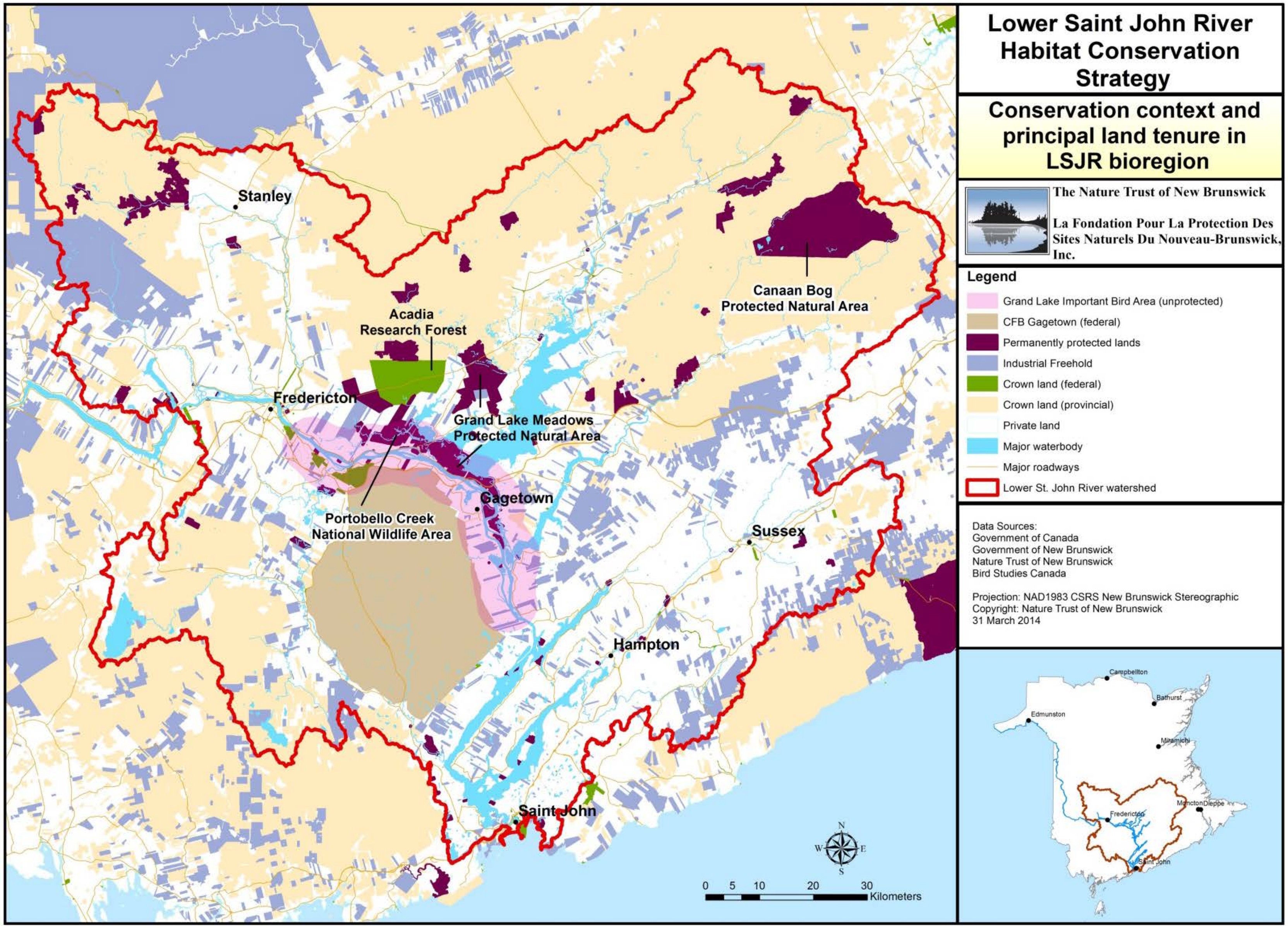

Fig. 7. Conservation context and overall land tenure in the LSJR bioregion (NOTE: Permanently protected land includes federal, provincial, and land trust holdings).

C. Social and Economic Context

The LSJR area has been part of the ancestral homeland to the Wolastoqiyik First Nation for over 10 000 years. Wolastoqiyik culture is deeply imbedded in the river and its surrounding lands and these people were the first stewards of the St. John River. Dating back as far as 400 years with the arrival of the first European settlers, the LSJR valley began a long history of commercial and industrial development and resource use (SJRA 2008). Industrial, cultural and recreational values within watershed reflect the rich heritage of First Nations, Acadian, Loyalist, and European residents (SJRA 2008).

Seventy percent of the entire river basin's population is concentrated in the LSJR bioregion, where two major urban centres and numerous small towns and villages are located (Munkittrick et al. 2006). With an increasing trend of residential development in the bioregion, pressure increases on undisturbed natural areas to become sites of human activity. Land clearing for settlement, agriculture, and forestry has dramatically transformed the landscape and changed the original condition of the Acadian forest (CRI 2011). Mining, quarrying, oil and gas extraction are all vital industries to the local and regional economy, but also place strain on the ability of the bioregion's ecosystems to support people and wildlife. The LSJR bioregion also boasts exceptional potential for recreation and river tourism, which are important both culturally and economically to the people of the area where boating, viewing of wildlife and scenery, hunting and fishing, cycling, hiking, rock climbing, and the arts are common activities (SJRS 2008).

2. HABITAT, THREAT, AND SPECIES SPATIAL PRIORITIZATION

A. Priority Habitat Types

Central to the Habitat Conservation Strategy is the identification of the different priority habitat types that host the priority species identified within the bioregion. Priority habitats are the native biological entities (i.e., ecological systems, communities and/or species[1]) that the HCS is aiming to conserve. Priority habitats are ddefined in a manner to enable links to the New Brunswick Forest Resource Inventory, taking into consideration the uncertainty surrounding species-habitat associations. Priority habitats identified for the bioregion encompass all priority species occurring in the bioregion, including BCR 14 and MBU 11 priority bird species, species at risk, S1-S2, and S3 with G1-G3 ranked species, and are broadly representative of the biodiversity of rare species within the bioregion. The process used to identify priority habitats in this bioregion included thorough research of literature, speaking with experts and iterative review with partners. Descriptions and status assessments of each of the seven priority habitat types are presented in this section.
The final suite of priority habitat types for the LSJR bioregion includes seven ecological systems:

[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.

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

Species: Types of species targets may include:

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

- Riparian systems
- Freshwater wetlands
- Acadian forest mosaic
- Grasslands/agro-ecosystems (fields and meadows)
- Cliffs
- Rocky outcrops
- Sand and gravel beaches

While some aquatic and marine species are mentioned in other portions of this strategy as being significant in this bioregion, a thorough and complete review of aquatic and marine priority species and priority habitats was not undertaken as part of this particular Habitat Conservation Strategy. This was mainly because the Canadian Rivers Institute took an in-depth look at the St. John River and its tributaries and all principal aquatic components in 2011, through "The St. John River: A State of the Environment Report" (CRI 2011).

Each of the priority habitat types are examined individually and described in the following section. A set of ranking criteria adapted from the Nature Conservancy of Canada's Northern Appalachian / Acadian Ecoregion Conservation Assessment are used to determine if an ecosystem is likely to be "absolutely critical to maintaining biodiversity in the region (Anderson et al. 2006)". These criteria are being used in the LSJR Habitat Conservation Strategy as they contribute to a more complete assessment of the seven priority habitat types selected. Ranking criteria examine the *size, condition, and landscape context* of a particular ecosystem to assess its ability to maintain regional biodiversity. High quality habitat should be of sufficient size and condition to provide ample resources for species to reproduce and thrive to maturity (Anderson et al. 2006). These habitats may also serve as refuges for rare or at risk species which are absent or less abundant in 'lower quality' examples of the same ecosystem type. The landscape context criteria estimates whether a habitat will persist into the next century and helps determines what types of threats are or will threaten its viability (Anderson et al. 2006). This index is a measure of the quality or intactness of the matrix surrounding the patch in question, or in the case of an entire landscape, an average score applied to the matrix surrounding all the intact patches.

Priority Habitat: Riparian Systems

Riparian systems are characterized as aquatic ecosystems, encompassing the gradient between riversides and their adjacent upland floodplains (Gregory et al. 1991). A variety of habitat types occur within riparian areas, where upland and floodplain forests, grasslands, herbaceous and woody wetlands, sandbars and oligotrophic – eutrophic freshwater systems interact through diverse biological, geological and hydrological processes to form complex ecosystems rich in biodiversity (Naiman et al. 1993). Accordingly, riparian zones are recognized as the most biodiverse, complex and dynamic non-marine ecosystems on the planet. Riparian areas are particularly sensitive to variation in the hydrological cycle and serve as good indicators of the environmental change. Riparian ecosystems also offer habitats for many species, function as filters between land and water, and serve as pathways for the dispersal and migration of organisms (Naiman and Décamps 1997). The riparian systems within the bioregion include all major rivers as delineated by the province and their respective headwaters buffered to 275 m. Riparian systems are mapped in Fig. 8.

The LSJR and its tributary rivers and streams are notable features having distinct ecological functions and vegetation communities (e.g., Silver Maple swamps). Annual spring flooding and prolonged inundation by flood waters creates highly fertile floodplain soils which host characteristic plant assemblages of flood-tolerant trees and shrubs (e.g., willow species, Dogwood, Speckled Alder), and emergent and submerged plants (Spike-rushes, Bulrush species, Pond-lily species, Pondweed species). These waterways also offer important adjacent riparian habitats that provide food, water, and shelter that support small mammals such as mice, voles, and shrews, as well as a wide variety of bird species. The LSJR bioregion encompasses a considerable portion of the St. John River's flood plain, where the bioregion's low topography allows the river to become broader, creating numerous chains of shifting alluvial islands (CRI 2011). A host of rare plants and diverse floral communities can be found on these islands in the LSJR bioregion, which also provide habitat for migratory waterfowl and some shorebirds (Zelazny 2007).

In summary, riparian systems within the LSJR bioregion host the largest diversity of species, including federally-listed anadromous and catadromous fish, BCR 14 priority bird species, COSEWIC-designated and/or SARA-listed invertebrates - including dragonflies, beetles and freshwater mussels, two SARA-listed turtles (Wood Turtle and Snapping Turtle), and a variety of rare, riparian-dependent flora. Over 814 230 ha of riparian habitat with a 275 m buffer have been identified within the bioregion according to the criteria described above, of which at least 278 840 ha or 34% has been anthropogenically altered. This number includes the 71 900 ha of riparian buffer within industrial freehold (forest industry) parcels, for which adequate forested buffer condition information is unavailable. Much of this area is presumed to have been affected by silvicultural practices. This measure also does not reflect the status of riparian areas within the borders of CFB Gagetown, estimated at 70 064 ha, equal to approximately 9% of the bioregion's riparian area. Agriculture and residential/cottage development are the primary threats to riparian systems, as well as incompatible forest harvesting, road fragmentation and watercourse barriers. Riparian systems provide important habitat for at least 133 priority species, i.e. 44% of the 301 priority species that occur in the bioregion; see Appendix A).

Many of the major tributaries of the LSJR feed into the larger wetland systems of the region; the Oromocto River Wetland Complex, and Washademoak Lake, are both good examples of this (Zelazny 2007). The productivity of the wetland systems in the LSJR bioregion is highly dependent on the flow of water from the tributaries of the St. John River, including the Little, Nashwaak, Oromocto, and Kennebecasis Rivers. Throughout the LSJR bioregion, large and small major lacustrine features provide important habitat for a variety of bird, mammal, and plant species; a high concentration of small and large lakes are found in the southern portion of the bioregion, particularly where granitic bedrock is common (Zelazny 2007). Grand Lake, Washademoak Lake, Belleisle Bay, Long Reach, and Kennebecasis Bay are significant features of the bioregion, all generally arranged in a north-easterly pattern as they follow the underlying bedrock structure (Zelazny 2007).

These sizeable water bodies - most notably Grand Lake - have an effect on the local climate, acting as a heat sink by absorbing and slowly releasing summer heat throughout the fall and winter seasons (Zelazny 2007). The resulting increase in the number of frost-free days (the greatest in the province) acts as one of the drivers of local plant species composition (Zelazny 2007). Rare plant communities and a diversity of rare plant species have been found along the shores of Maquapit, French, Indian, and Grand Lakes in locally unique freshwater beach and sandstone alvar habitats (Blaney 2010). Numerous bird species such as ducks and loons use inland water bodies for nesting, rearing, and foraging habitat. Once again, while this conservation plan does not specifically treat aquatic resources or species, the threats to species within the scope of this project are often linked to the watershed areas upstream of bodies.

Landscape Context Assessment (Riparian Systems): Poor

The average Landscape Context Index (LCI) for riparian systems in the LSJR bioregion is 59.3, which is considered poor. This value was calculated from NAAP data and methodology (Low 2003; Anderson et al. 2006). Approximately 66% of riparian buffers (within 275 m) contain intact natural cover, the remainder of cover types being mostly forest plantation in various stages of silviculture treatment, agriculture, and development. Historically, rich floodplains were cleared for agriculture and hydrological regimes were altered due to infilling of wetlands, road construction and preference of urban and rural development near watercourses. Erosion and sedimentation is of major concern where natural cover has been removed. Over 1 000 road-stream crossing points exist in the bioregion. These crossings range in size from major highways to abandoned forestry roads. These features represent potential aquatic barriers. The comprehensive analysis of the condition of stream-crossing structures (culverts, bridges) and the complete inventory of small dams and weirs were not undertaken for this report.

Condition Assessment (Riparian Systems): Fair

Existing intact riparian systems are thought to be in fair condition, but it was not possible to obtain a numerical value leading to a comparable measure using the NAAP methodology outlined in Anderson et al. (2006), which has been used in other HCS documents in the region. Although exotic species are present along watercourses, invasive species are generally not dominant, although a number of invasive species are emerging as major threats within the province, such as Glossy Buckthorn (*Frangula alnus*), Common Reed (*Phragmites australis*), Garlic Mustard (*Alliaria petiolata*) and Purple Loosestrife (*Lythrum salicaria*), all of which can have various degrees of negative impacts on riparian zones (P. Noel and D. Mazerolle, pers. comm.). Additionally, aquatic invasive species are of considerable concern, such as Smallmouth Bass (*Micropterus dolomieu*), Muskellunge (*Esox masquinongy*), and Chain Pickerel (*Esox niger*), the latter of which is considered a high threat (CWF 2003). These species are voracious predators and both directly prey upon and out-compete native fish species. Forest management practices require a 30 m buffer to watercourses, although limited harvesting within this buffer is allowed. Agriculture, however, is not subject to these restrictions and is known to cause aquatic and riverside degradation through direct erosion, causing sedimentation, runoff of pesticides and herbicides, increased water temperatures due to natural cover removal, and nutrient loading from fertilizers (Pavey 2005). Another condition factor which needs to be underlined is that when all riparian areas and their associated 275 m buffer are taken into account, approximately half of the bioregion is occupied by riparian systems. However, only 18 473.45 ha or 3% of riparian areas that meet the critical criteria for riparian zones as described by Anderson et al. (2006) currently have protected status.

Size Assessment (Riparian Systems): Good

Riparian systems cover a large portion of the bioregion due to the high concentration and extent of major river systems that occur here. The longest river is the St. John River at 146.77 km within the bioregion, with a drainage area (including its tributaries) of 1 538 680 ha. While the size is good, this also increases the importance of addressing the threats to this system.

Overall Assessment (Riparian Systems): Fair

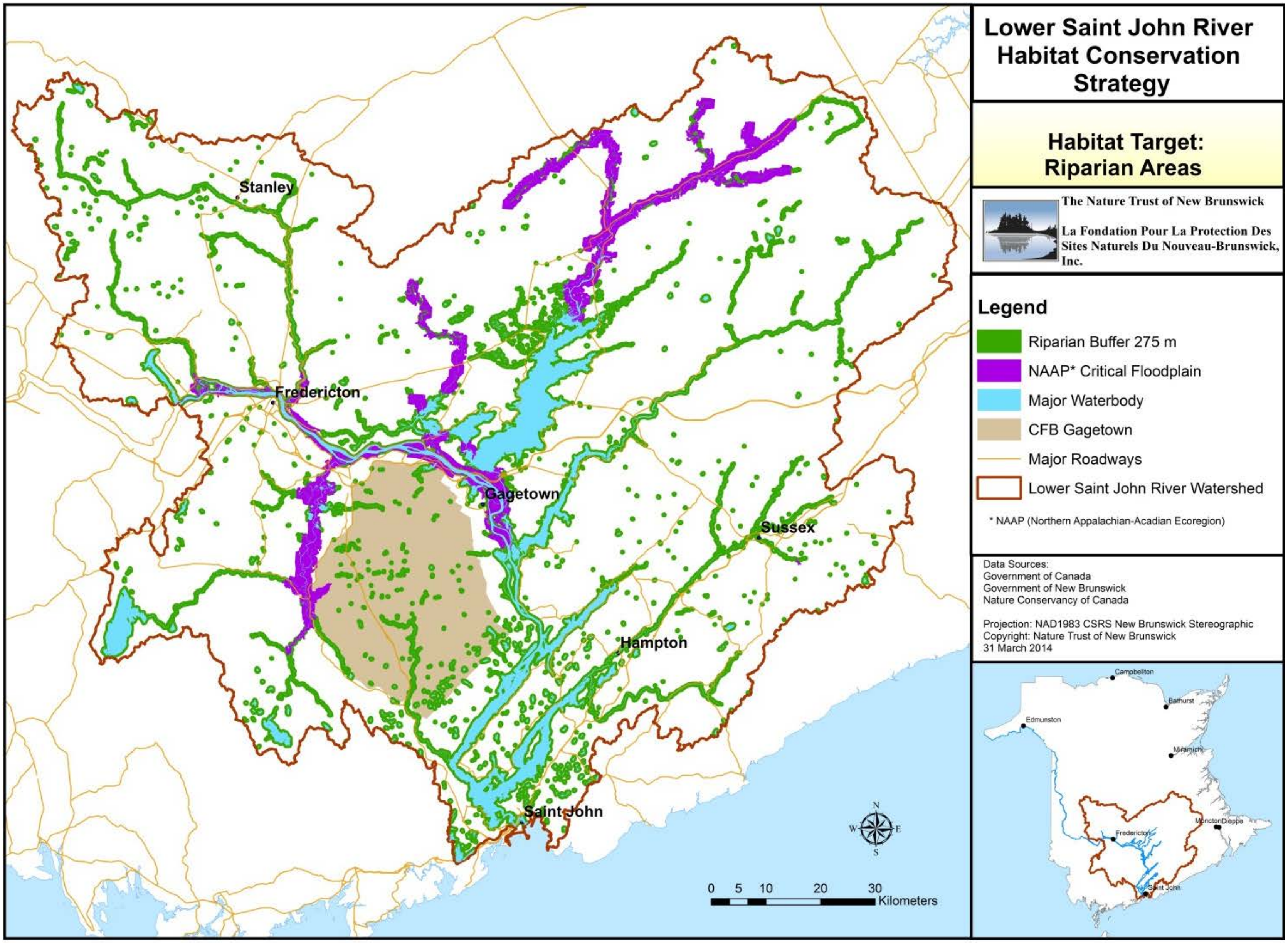

Fig. 8. Riparian areas in the LSJR bioregion.

Priority Habitat: Freshwater Wetlands

Owing to the distinct climate and lithic geology of each of the three Ecoregions within the LSJR, a wide variety of wetland types can be found in the watershed, including bogs, marshes, fens, swamps, riparian floodplains and forested wetlands; forested wetlands can be further sub-divided into shrub- and forest-dominated wetlands, as well as seasonal forest vernal pools. All freshwater wetlands, including critical occurrences from the NAAP (size >=20 ha; Anderson et al. 2006) are mapped in Fig. 9**.**

Shrub wetlands are the most common wetland type within the bioregion and mostly occur in riparian areas. Shrub wetlands provide habitat and breeding ground for a variety of floral and faunal species in the region. Freshwater wetlands of the LSJR bioregion provide habitat for many federally listed species-at-risk, including Wood Turtle, Yellow Rail, Snapping Turtle, Canada Warbler, Least Bittern and more. In total, 99 priority species have been identified that depend on freshwater wetland habitat within the bioregion, including 50 species of birds, 43 species of plants and 6 species of dragonfly , which is 33% of the 301 priority species found in the LSJR ; Appendix A). Within the Grand Lake Lowlands Eco-district, an especially high variety of wetland types are present. Extensive marshes and seasonally flooded floodplain meadows are prominent features along the St. John River and other significant tributaries (Zelazny 2007). This wetland diversity extends further south along the St. John River where the Hampton-Kennebecasis marsh exhibits emergent marshes, shallow open water, and treed swamps (Zelazny 2007). A feature that is particular to the Eastern Lowlands Ecoregion of this bioregion is its fairly extensive component of inland peatlands. While there is an active peat harvesting industry in other parts of the Eastern Lowlands outside the LSJR, this industry is not prevalent in the bioregion.

Historically, many freshwater wetlands were infilled and converted to agricultural land. In addition to this, road construction and human settlement have altered hydrologic flows across the landscape. Major wetland complexes are still present, however, and provide important breeding habitat and stopover sites for a wide range of wildlife species.

Landscape Context Assessment (Freshwater Wetlands): Fair

The average Landscape Context Index (LCI) for freshwater wetlands in the LSJR bioregion is 14.3, which is considered fair (calculated using NAAP data and methodology, Anderson et al., 2006 and Low, 2003). Approximately 9.4% of the bioregion land base is comprised of freshwater wetlands according to the provincial wetland database. It should be noted that the provincial database is based on visual delineation of wetlands and therefore greatly underestimates forested and shrub wetlands. Over 600 546 ha of freshwater wetland buffer habitat has been identified (275 m buffer) and approximately 70% of this has been altered by anthropogenic disturbance (179 876 ha of wetland buffer is covered by conservation value forest).

Condition Assessment (Freshwater Wetlands): Fair

New Brunswick currently has a Wetlands Protection Policy and regulations under the Clean Water Act which require permits for work in or around (within 30 m) of a provincially mapped wetland. Many forested wetlands, however, are not provincially identified and subsequently do not receive the same protection. The primary threats to freshwater wetlands are infilling for agriculture and development, as well as commercial forest harvesting within forested wetlands. Approximately 17 678.2 ha or 12.2 % of freshwater wetland habitat is currently within conservation lands. A number of invasive species are emerging as threats but are generally not dominant as of yet. Glossy Buckthorn and Phragmites are of particular concern as they are aggressive wetland invasive species (D. Mazerolle, pers. comm.).

Size Assessment (Freshwater Wetlands): Fair

The total freshwater wetland area in the LSJR bioregion is 144 837 ha, representing over 28 578 individual wetlands. The majority of these are forested wetlands, but there are also significant areas of shrub wetlands, bogs, fens, and freshwater marshes.

Table 5. Freshwater wetland type by area in the LSJR bioregion (source: Government of New Brunswick).

Wetland type	Area (ha)
Aquatic Bed	3 071.5
Bog	20 364.9
Fens	16 312.2
Freshwater Marsh	18 277.9
Forested Wetland	63 518.2
Shrub Wetland	23 285.3

Despite this, the average size of freshwater wetlands is only 5 ha, which is considered poor. Only 4% of freshwater wetland occurrences meet the NAAP critical size threshold of 20 ha, (Anderson et al. 2006). However, this does not account for wetland complexes connected through above and below-ground water flow and could be partially attributed to wetland data analysis and interpretation methods. The largest distinct wetland complex located in the Grand Lake Meadow PNA-Portobello Creek National Wildlife Refuge area is nearly 2 500 ha, and there are over 100 individual wetlands of over 100 ha throughout the bioregion. A more detailed examination of connected wetland systems throughout the bioregion reveals a number of highly complex and connected wetland regions; one system northwest of Grand Lake covers an area of over 11 500 ha.

Overall Assessment (Freshwater Wetlands): **Fair**

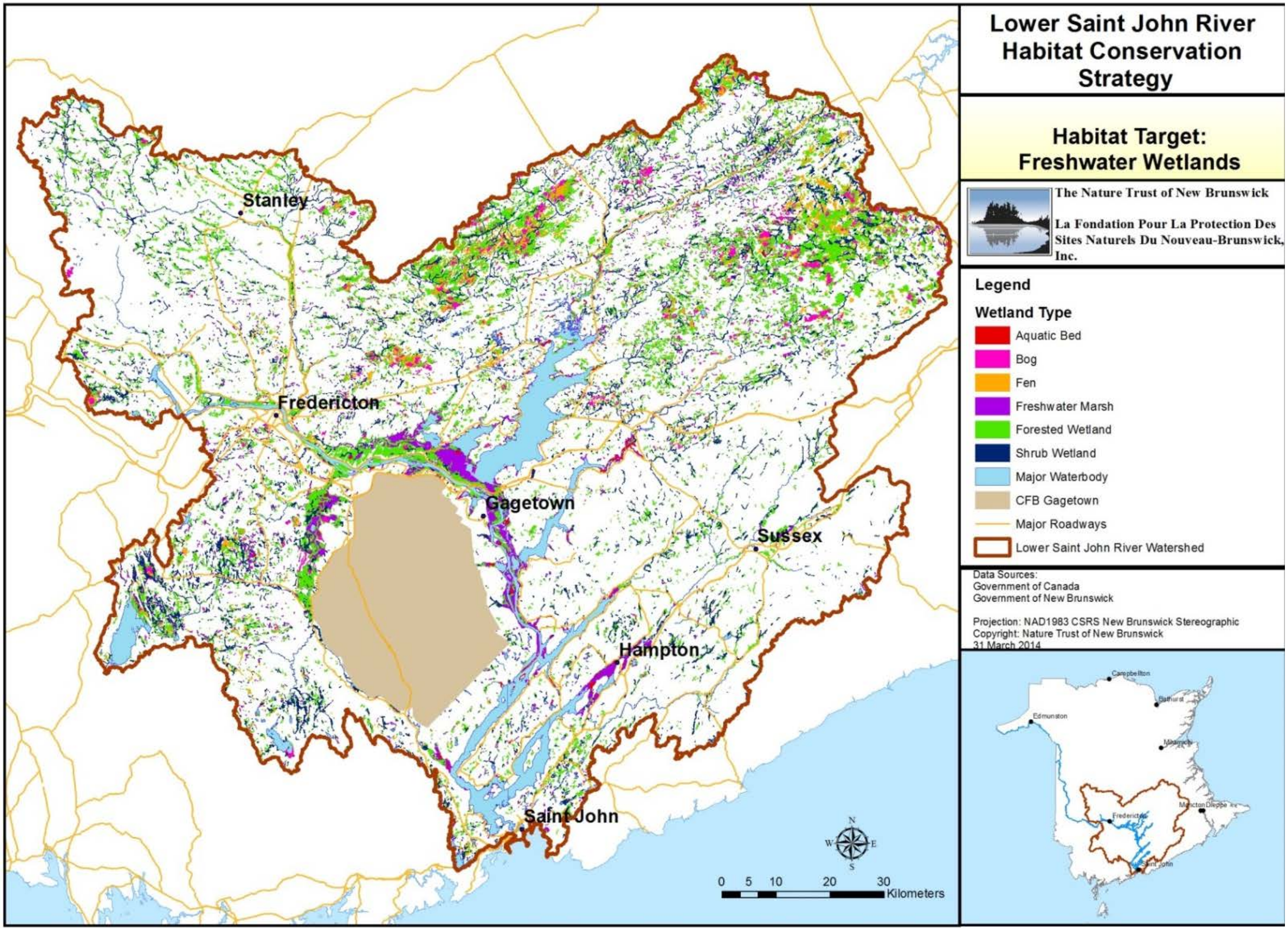

Fig. 9. Freshwater wetlands in the LSJR bioregion.

Priority Habitat: Acadian forest Mosaic

The Acadian forest mosaic refers to the diversity of forest stand types which occur across the bioregion. This includes old forest communities as defined by the New Brunswick Department of Natural Resources (NBDNR 2012), rare and unique forest communities, such as floodplain forests, identified by the Atlantic Canada Conservation Data Centre, forest of high conservation value as identified by NBDNR (presence of rare species, forest of exceptional quality) and NAAP delineated forest habitats and Acadian Old Forest Community types, depicted in Fig. 10. The Grand Lake Riparian Floodplain forest was classified as wetland for this analysis to ensure that its predominant ecological characteristic (prolonged presence of water) was not lost in the analysis. For a more complete illustration of these particular forest stands, please refer to the wetlands map in Fig. 9 (p. 18). The Acadian forest mosaic habitat also includes connectivity between core forest areas for dispersal of wide-ranging mammals such as moose and lynx.

The Acadian Forest is a unique forest region where boreal and temperate forest communities blend to create a highly diverse ecosystem. The World Wildlife Fund has designated the Acadian Forest as critically endangered due to the long history of settlement and land clearing that has occurred here, with only approximately 5% of the forest remaining in pre-settlement condition (Davis et al. 2013). Within the bioregion, at least 82 priority species use the various forest habitats (27 %; Appendix A). Old forest communities provide habitat for a variety of federally listed species, such as the Canada Warbler, Chimney Swift, and Olive-sided Flycatcher. Moreover, rare forest communities such as the Grand Lake Ecodistrict's special Riparian Floodplain forest are home to a diversity of rare and endangered species, such as the vast majority of the known Canadian population of the COSEWIC-listed Skillet Clubtail dragonfly, which spends a substantial part of its life cycle there (COSEWIC 2010). It is critical that both unique and representative forest communities are protected to ensure the continued population 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.

The Acadian forest type as a whole occupies the Maritime Provinces and some of northern New England and southern Quebec, including the study area. Acadian forest in New Brunswick originated approximately 10 000 years ago, after retreating ice from the last ice age allowed tree species to migrate northward. New Brunswick Acadian forest is composed of 32 native tree species. In the LSJR bioregion, the riparian floodplain forest includes an important proportion of regionally rare (and in some cases endangered) species, such as Butternut, but also regionally rare Bur Oak, in addition to the more typically representative species of the Acadian Forest - Red Spruce, Yellow Birch, Sugar Maple, and Eastern Hemlock (Conservation Council of NB 2009). Acadian forest tree species have the ability to reach a old age class, which is essential to some significant biota in the area. These species include, among others, the Northern flying squirrel, which prefer mature forest, as well as the American Marten, The Black-backed Woodpecker and American Three-toed Woodpecker, which prefer mature old-growth coniferous or mixed-wood forests (Atlantic Canada Conservation Data Centre 2013; Mosseler et al. 2003; Imbeau and Desrochers 2002).

Intact forests play a crucial role in the purification of air and water, and help maintain the integrity and health of the natural world by providing food and habitat to many species (Conservation Council of NB 2009). As noted previously, roughly one third of the priority species listed in the LSJR Habitat Conservation Strategy are forest-dependent or prefer forested habitats. Notable species that forested areas provide habitat for include: the Canada warbler, which live in forested wetlands; Henry's Elfin (*Callophrys henrici*), which live in open deciduous or pine forest; Eastern Leatherwood, which lives in hardwood or damp forest; and the Canada Lynx, which live in mature forest with dense undergrowth.

Of principal concern for maintaining the biological diversity of the Acadian forest is the preservation of mature forest patches that represent a late-succession stage of stand development (Fig. 5). A number of unique components distinguish mature forest from younger stands, for example shade-tolerant tree species of different age classes that reach at least 150 years of age, a multilayered and multispecies canopy, standing dead trees (snags), and downed woody debris (Mosseler et al. 2003; Watson 2001). Red Spruce, Sugar Maple, American Beech, Eastern Hemlock, Eastern White Pine and Yellow Birch are several tree species that dominate a late-succession forest type (Mosseler et al. 2003). Mature forest provides important unique habitat, structural diversity, and a source of energy for fungi and soil organisms, and also contributes to nutrient storage and cycling of the forest. The unique habitat that mature forest provides for species includes shelter, nesting, and foraging sites. Some important species for which these sites provide habitat are the Northern Myotis, Little Brown Myotis, White-Breasted Nuthatch, Bay-breasted Warbler, Cape May Warbler, Canada Lynx, Black-backed Woodpecker, and the American Three-toed Woodpecker (Mosseler et al. 2003; Nature Conservancy Canada 2008).

The LSJR watershed falls within three Ecoregions that consists of several different stands of mature forests. In the Grand Lake Lowlands Ecoregion, Currie Mountain is comprised of stands of Sugar Maple, Red Oak, Hemlock, and mature White Pine with a rich understory containing round leaved hepatica (Zelazny 2007). Odell Park in Fredericton protects stands consisting of Beech, Sugar Maple and 400-year-old Hemlock, while the Portobello Creek floodplain supports stands of mature, large Red Oak (Zelazny 2007). In the Valley Lowlands Ecoregion, Parlee Brook supports stands of mixed forest comprised of Hemlock, Red Spruce and mature Sugar Maple and beech. South of Stanley, along Hurlett Road in the Valley Lowlands Ecoregion, there is a Red Spruce and Eastern Hemlock dominated old growth stand (Zelazny 2007; Mosseler et al. 2003). The Eastern Lowlands Ecoregion, just south of the Sabbies River, supports stands of mature, large Eastern Hemlock with Trembling Aspen, Yellow Birch, Red Spruce, White Spruce and White Pine (Zelazny 2007).

Landscape Context Assessment (Acadian Forest Mosaic): Fair

It was not possible to calculate the average Landscape Context Index (LCI) for the forest habitat using the methodology from Low (2003). Based mainly on a summary GIS examination of connectivity, age-class structure and fragmentation of the habitat, the overall LCI rank is considered fair. Generally, the forest within the bioregion is rather fragmented and has been substantially reduced in extent as compared to its historical distribution. Within the larger landscape, connectivity is particularly restricted within the corridor between Fredericton and Saint John and possibly other areas.

Fire suppression has impacted the dynamic processes of conifer dominated areas throughout the range of the Acadian Forest (Mosseler et al. 2003). As well, common forest management practices (i.e. clearcutting, herbicide use, single-species plantations) have altered the age class structure in favor of young, even-aged forests dominated by boreal species, which are adapted to regenerating in large, open disturbances (termed “borealization”). Road density is high in the bioregion, which fragments forest patches, limiting dispersal for a significant proportion of species.

Condition Assessment (Acadian Forest Mosaic): Fair

Human influence over the past 200 years has simplified forest structure, composition and age class distribution resulting in a decline in old forest communities (Erdle and Sullivan 1998; Loo and Ives 2003). Of the current forest remaining within the bioregion, condition is generally good; although invasive species are present, no significant impacts on forest age-class structure or species composition have been observed within the bioregion due to this factor. Approximately 716,997 ha of the forested area within the bioregion is in a mature or over-mature age class, and 3% of these old forest communities meet the minimum patch sizes needed to support the various keystone species as determined by the New Brunswick Department of Natural Resources (see the appendices for a description of the analysis). Approximately 3.5% of forests within the bioregion are currently in conservation lands and most old forest community types are underrepresented in protected areas. Old pine and old tolerant hardwood stands for example are quite rare in existing protected areas. Additionally, approximately 7 280 ha of forested wetlands are under permanent protection, which represents 5% of the bioregion's total wetland area.

Size Assessment (Acadian Forest Mosaic): Fair

Mosseler et al. (2003) suggest that old forest communities (mature and over-mature) within the Acadian Forest used to occupy an estimated 50% of the land base of the Maritimes prior to European settlement. Of the 716 997 ha of forest within the Bioregion, 343 011 ha or 48.5% is currently classed as mature or over-mature, according to provincial forest inventory (Note: this does not include the 250 584 ha of land in CFB Gagetown and Industrial Freehold forest for which this analysis does not have readily-accessible forest cover data). Of these old forest patches, perhaps as much as 110 500 ha or 32% of the total forested area is in contiguous blocks greater than the minimum patch size of 375 ha. This does not take into account much of the road fragmentation caused by forestry roads, particularly those that are abandoned or in various stages of early regeneration. These large contiguous blocks are characterized as having highly irregular shapes, with a high degree of edge habitat. The forest blocks of 375 ha or more represent only 115 of the 17 752 contiguous forest blocks in the bioregion or 0.6%, suggesting that the remainder of the forest blocks are highly fragmented and variable size. Only 10% of old forest patches are 375 ha or greater, when examining specific forest community types on an individual basis. The 375 ha value is used within NBDNR’s Old Forest Habitat Definitions as the minimum patch size to capture breeding populations of all old-forest dependant species. Many of the old forest patches are isolated due to road fragmentation and harvesting practices between patches. The average old forest patch size is only 9 ha, which is an inadequate size to support many old forest dependant species, assuming connectivity between patches is available. The predominance of small old forest patches in the bioregion reflects the dominant harvesting regime and high road density as illustrated in Fig. 20 (p. 55).

Overall Assessment (Acadian Forest Mosaic): **Fair**

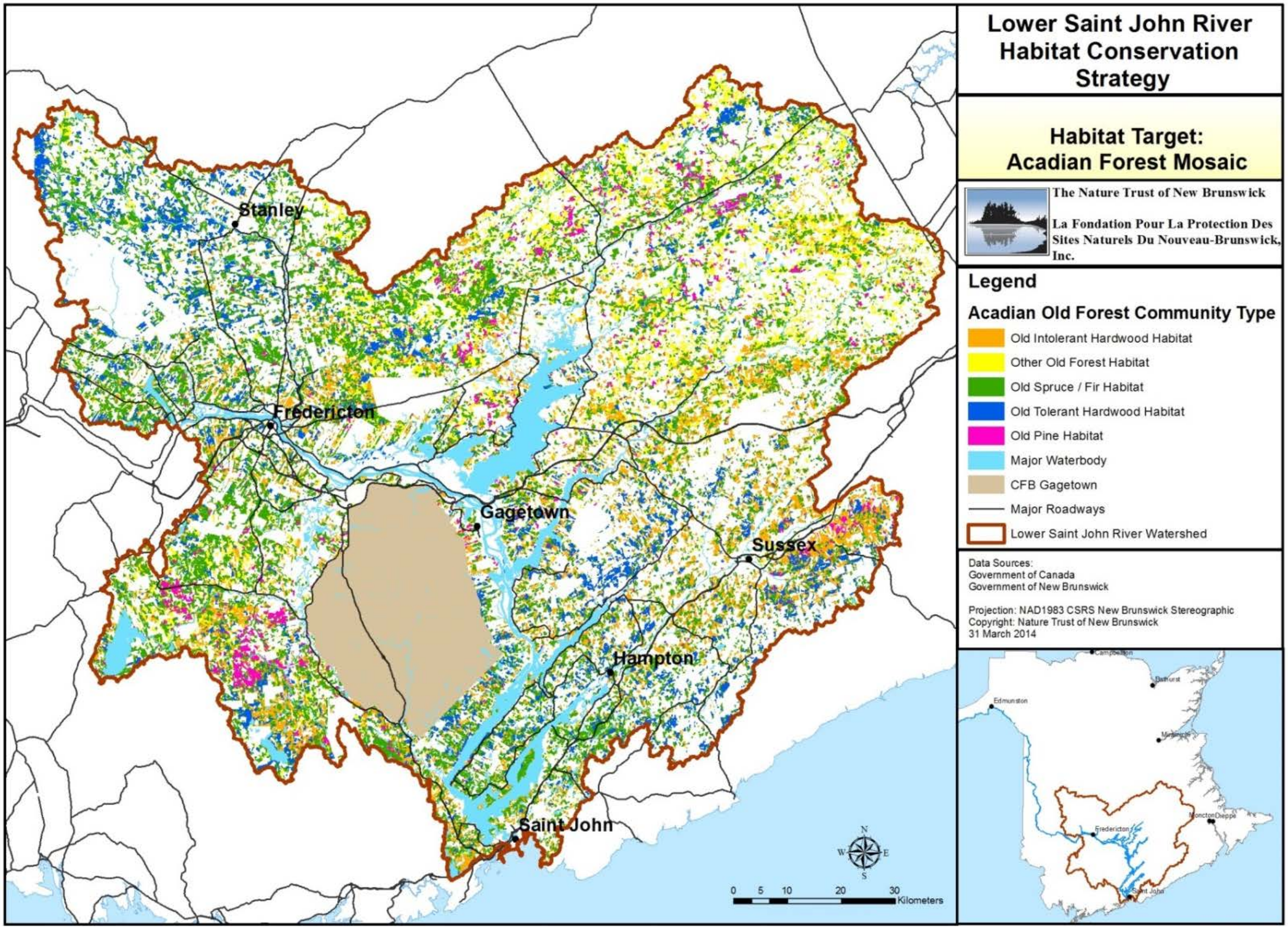

Fig. 10. Acadian forest mosaic in the LSJR Bioregion.

Priority Habitat: Grasslands/Agro-Ecosystems (fields and meadows)

Agro-ecosystems and open-fields in the LSJR bioregion and the province as a whole are man-made and managed habitats; prior to European arrival in the region, open-field habitats were restricted to sedge meadow, bog edges, coastal dunes and salt marsh. Human alteration and management of these habitats has presented both opportunities and challenges to the species dependent on open-field and grassland types of habitat. Hence, the term 'Grassland' in this HCS is used principally to maintain the conceptual link between grassland-dependent species and the habitat available that meets their requirements within this bioregion. These areas are included as a priority habitat type largely because they provide important seasonal habitat for numerous animal species, most notably for a diversity of birds. These areas play a critical role in supporting a variety of federally listed and BCR 14 priority species, in fact, many species have likely expanded their range into the region from elsewhere in North America since European colonization (Sabine 2010). Grasslands/agro-ecosystems habitat can be viewed in Fig. 11 and Fig. 12.

Grassland birds and many songbirds use agricultural fields and meadows as nesting grounds and other species that nest nearby often use fields for summer hunting and feeding. Birds of prey, such as certain hawk and owl species, use open fields as hunting grounds. A number of species-at-risk within the bioregion are grassland-dependant or use grasslands frequently, such as the Eastern Meadowlark, Common Nighthawk, Short-eared Owl, Barn Swallow and Bobolink. Notably, it is probable that Short-eared Owls are nesting specifically within the maintained grassland areas found within the boundaries of Canadian Forces Base Gagetown (MBBA 2010; J. St-Pierre, pers. comm.). A variety of non-grassland dependant species also use grasslands/agro-ecosystems for foraging and nesting, such as waterfowl, Wood Turtle, Upland Sandpiper, and Little Brown Myotis. Certain migratory bird species are known to forage in agricultural fields in autumn, and use flooded fields and meadows as stopover habitat, especially during migration (e.g., shorebirds and waterfowl). The greatest threats to grassland species using actively managed farm land are farming practices such as early mowing during the breeding season and pesticide application (Environment Canada 2013a). The conversion of fallow and hay field to more intensive row crop production can also threaten the viability of grasslands/agro-ecosystems for many bird, insect, and small mammal species. Though there has been some field conversion in New Brunswick, it is not presently considered to be a widespread activity (T. Byers, pers. comm.). Declines in grassland birds have been observed across North America and the rate of this decline exceeds that of any other bird guild (Environment Canada 2013a). In total, 46 priority species use grasslands/agro-ecosystems in the LSJR bioregion (15%; Appendix A).

Agricultural fields in the LSJR bioregion are clustered along major waterways including the St. John River, around the Grand Lake region, and are most heavily concentrated in the southeastern region, toward the agricultural hub of Sussex. Throughout the bioregion, farming practices are generally characterized by cattle and dairy farms, fruit operations, hay farming, and livestock farms. Land coverage for fields and meadows can include pasture, crop coverage, and fallow field (Dettmers 2006). This analysis does not distinguish between fields that are active and those that have gone fallow or are abandoned, and does not distinguish between types of farming practice.

Landscape Context Assessment (Grasslands/Agro-Ecosystems): Good

Condition Assessment (Grasslands/Agro-Ecosystems): Fair/Good / Unknown

Grasslands/agro-ecosystems in New Brunswick have been undergoing a period of change in recent years (2001-2006), with an increase of 269.5 % increase in corn production for grain (1,182 acres to 4,368 acres), 132.6 % increase in soybean production (810 acres to 1,884 acres), 84.2 % increase in canola production (481 acres to 886 acres) (Stats Can 2006). The availability of dependable agricultural land has also faced declines through of conversion to urban and residential land, and to shrub / forest regeneration (Vickery et al. 2000, Stats Can 2005). These trends indicate that the habitat provided by agro-ecosystems are at risk of being lost as these land conversions take place and represent a unique conservation opportunity in the province. The loss of these habitats will have potential impacts on species adapted to actively managed farmland, namely grassland-dependent birds such as bobolink, common nighthawk, and eastern meadowlark. Large areas of fallow field, pasture, and hayfield remain in active rotation throughout the traditionally-farmed river valleys and floodplains of the St. John River bioregion, however, a more detailed study of quality and availability of New Brunswick's grassland habitat would improve collective efforts to conserve these ecosystems and the species on which they are dependent.

The reproductive success of grassland birds is affected by modern farm practices such as earlier hay harvests and multiple-cutting harvest schedules. Modern producers are under pressure to provide high-quality, nutrition-rich feed which is only provided by more frequent hay cutting (T. Byers, pers. comm.). When hay crops are harvested earlier and at more frequent intervals (e.g., more than once a season) grassland-dependent birds do not have sufficient time to complete their nesting cycle (US Department of Agriculture, Natural Resources Conservation Service 2010; Nocera 2005). Haying and mowing of hayfields for green silage typically occurs during the breeding season for most grassland-dependent birds, causing destruction of nests and young, and removing protective vegetative cover (Nocera 2005). An enduring solution to these conflicting values has not yet been found, however, collaboration with agricultural producers may lead to innovation and species protection. Agricultural-conservation partnerships are currently being piloted in Ontario under the Bird-Friendly Certified Hay Program, to decrease the burden on producers who are willing to alter harvest schedules to benefit wildlife (Credit Valley Conservation 2014). Similar partnerships also present a conservation opportunity in New Brunswick.

Size Assessment (Grasslands/Agro-Ecosystems): Good

The grasslands/agro-ecosystems found in the LSJR bioregion are unique. Although agricultural lands are relatively common throughout the Maritimes, the lands found in the Grand Lake Ecodistrict experience the longest average growing season in the province (Zelazny 2007). In particular, conservation lands found in this area (such as Grand Lake Meadows) provide important habitat for breeding populations of rare and endangered grassland species. Approximately 63 700 ha of grasslands/agro-ecosystems habitat occur within the bioregion. These habitats are generally quite large and well-connected in areas such as along the lower St. John River floodplain between Mactaquac and Jemseg, and in the Sussex area. The average size is 10 ha and approximately 12 500 ha or 8% of grasslands/agro-ecosystems habitat is above the critical threshold of 100 ha, with the smallest patch less than one ha and the largest at approximately 445 ha. A connectivity analysis of these systems using spatial data was not conducted, but would be a useful exercise for land management planning in the region.

Overall Assessment (Grasslands/Agro-Ecosystems): **Good / Unknown**

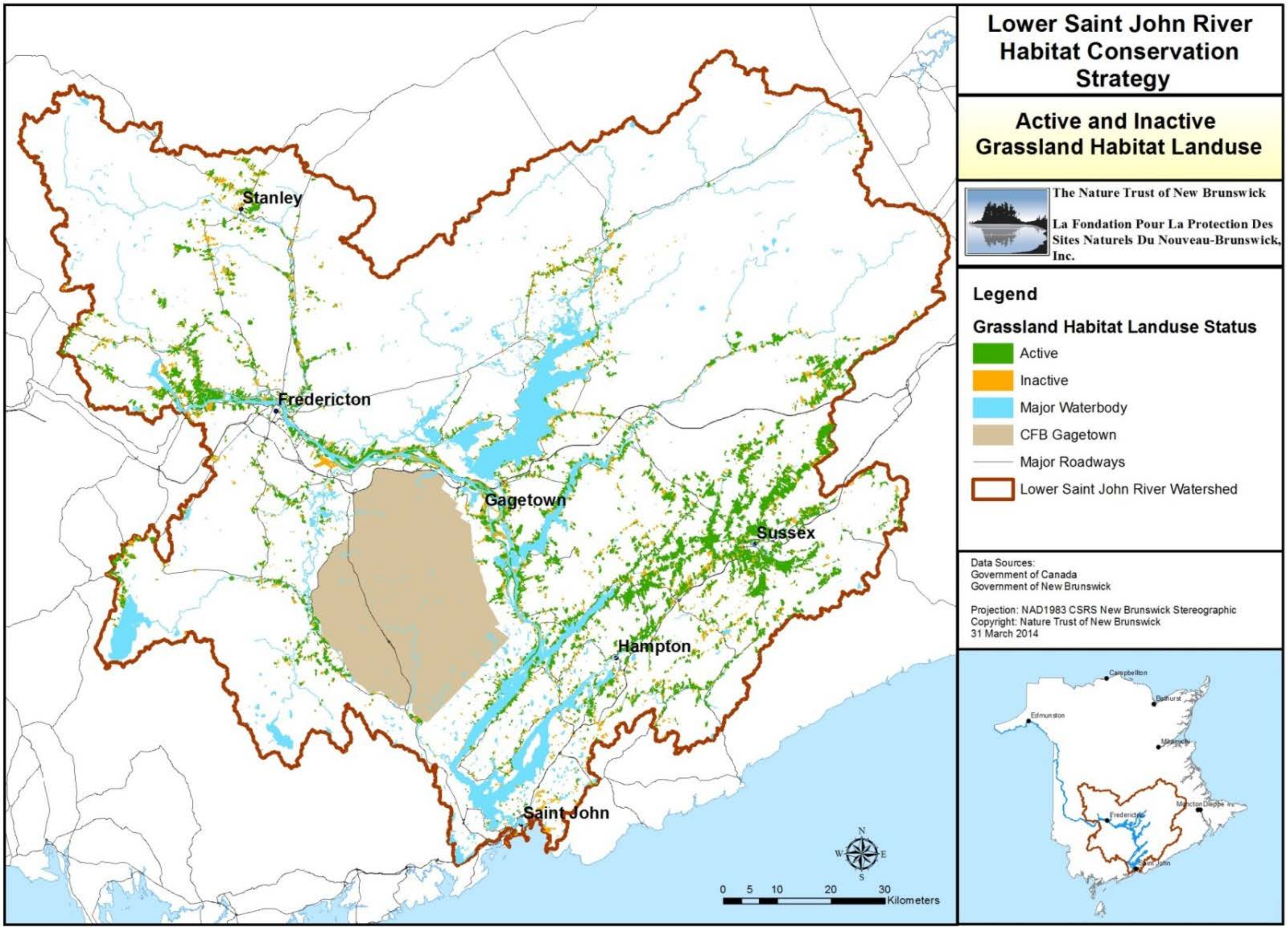

Fig. 11. Active and inactive grasslands/agro-ecosystems habitat in the LSJR bioregion.

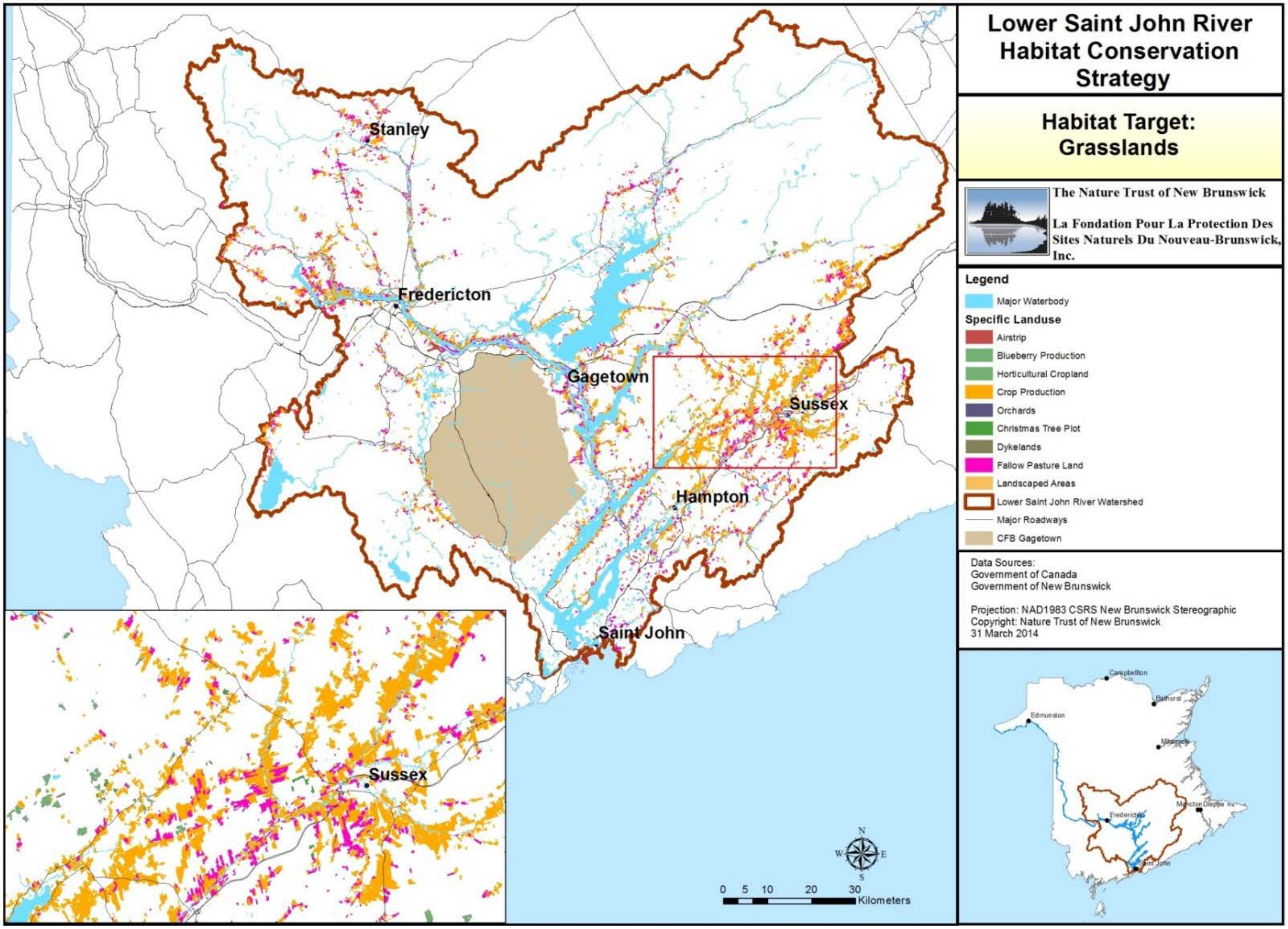

Fig. 12. Grasslands/agro-ecosystems by type in the LSJR bioregion.

Priority Habitat: Cliffs

Cliffs are defined as “precipitous rock faces which slough off rock fragments and shed water, while accumulating soil and nutrients at their bases” (Anderson et al. 2006). Areas of exposed rocky cliff are limited in New Brunswick and tend to be clustered along coastal areas, making these features somewhat rare in the LSJR Bioregion (Fig. 13). Cliff faces bestow a unique characteristic where present in the region, and local bedrock type contributes significantly to biotic communities in a particular location (Anderson 2006). They are ecologically significant ecosystems as they support a high number of rare and at risk species (Robinson 2010). For example, certain vascular plants thrive in cliff environments and Peregrine Falcons rely exclusively on these habitats for their breeding grounds. Cliffs also support a variety of swallow species (COSEWIC 2013a). Rolling granitic hills with steep cliff faces around the Nerepis River, and the volcanic intrusions in Kennebecasis and Bellisle Bay areas are good examples (Zelazny 2007). Conservation of these habitats will contribute to the health and conservation of at least 6 priority species, including one bird (Peregrine Falcon) and five species of plants (2%; Appendix A).

Landscape Context (Cliffs): Fair / Unknown

The average Landscape Context Index[2] (LCI) for cliffs in the Lower St. River Bioregion is 25.1 (calculated from NAAP data), which is considered fair. Although development is increasing provincially, the rugged terrain where the majority of cliffs within the bioregion occur has somewhat limited the amount of development there. The potential for development where cliffs occur in future is low.

Condition Assessment (Cliffs): Good

Within the bioregion, no cliffs are found in officially protected areas; however, a key 3 ha cliff site located near the town of Welsford is on CFB Base Gagetown property and is under Federal control and undergoes annual monitoring and restricted access. Access to this site is controlled by CFB Gagetown Range Control year round and an additional level of protection is added during the nesting season from April to August by declaring portions of the cliff absolutely out of bounds. An additional known Peregrine Falcon nesting site at Minister's Face on Long Island is under permanent protection as a Nature Trust of New Brunswick nature preserve (this habitat is not mapped as a cliff feature in the datasets used in the GIS analysis). Other cliff features are likely to exist throughout the bioregion yet remain inaccurately recorded or are unmapped in the currently available spatial datasets. This data gap presents a possible research opportunity with respect to the ecosystems and species dependent on cliff features of particular slope, size, and bedrock type.

Size Assessment (Cliffs): Good

The average size of cliffs in the bioregion is 7 ha. Although the average cliff is considerably less than the critical occurrence criteria, they are still considered in good condition. The cliffs within the bioregion represent 5% of the provincial total by area, and 100 % of these are considered critical (NAAP; Anderson et al. 2006).

Overall Assessment (Cliffs): **Good**

Priority Habitat: Rocky Outcrops

Much like vertical cliff faces, rocky outcrops are ecosystems defined by exposed rock, though they take a variety of forms and support diverse floral and faunal communities. A variety of ecosystem sub-types fall under this category: bare rock surfaces, soil islands, talus slopes, rocky ridges, and low and mid elevation rocky summits. Specific habitat conditions of a particular rock outcrop are driven by feature slope and aspect, bedrock geology, moisture availability, and soil depth. These conditions influence the presence of distinct vegetation communities, which can include shrubs, grasses, flowers, perennial and annual herbs, mosses, lichens, and wetland vegetation (Anderson et al. 2006). Rock outcrop ecosystems are typically open canopy features due to extensive rock cover, however, large trees and a closed forest canopy can be found in smaller boulder fields or small outcrops at lower elevations. Similarly, local habitat conditions drive animal communities within rock outcrops. Certain species of mammals (voles, shrews), amphibians (salamanders), and birds can use these habitat types. Locations of rocky outcrops within the bioregion can be found in Fig. 13.

Landscape Context Assessment (Rocky Outcrops): Fair

The average Landscape Context Index (LCI) for rocky outcrops in the Lower St. River Bioregion is 20.5 (calculated from NAAP data), which is considered fair.

Condition Assessment (Rocky Outcrops): Unknown

Within the bioregion, only 31 ha or 0.9 % of rocky outcrops are found in officially protected areas.

Size Assessment (Rocky Outcrops): Good

The average size of rocky outcrops in the bioregion is 2 ha, with the smallest being under 1 ha and the largest approximately 55 ha. Although the average outcrop is considerably less than the critical occurrence criteria, they are still considered in good condition. The rocky outcrops within the bioregion represent 46 % of the provincial total by area.

Overall Assessment (Rocky Outcrops): **Good**

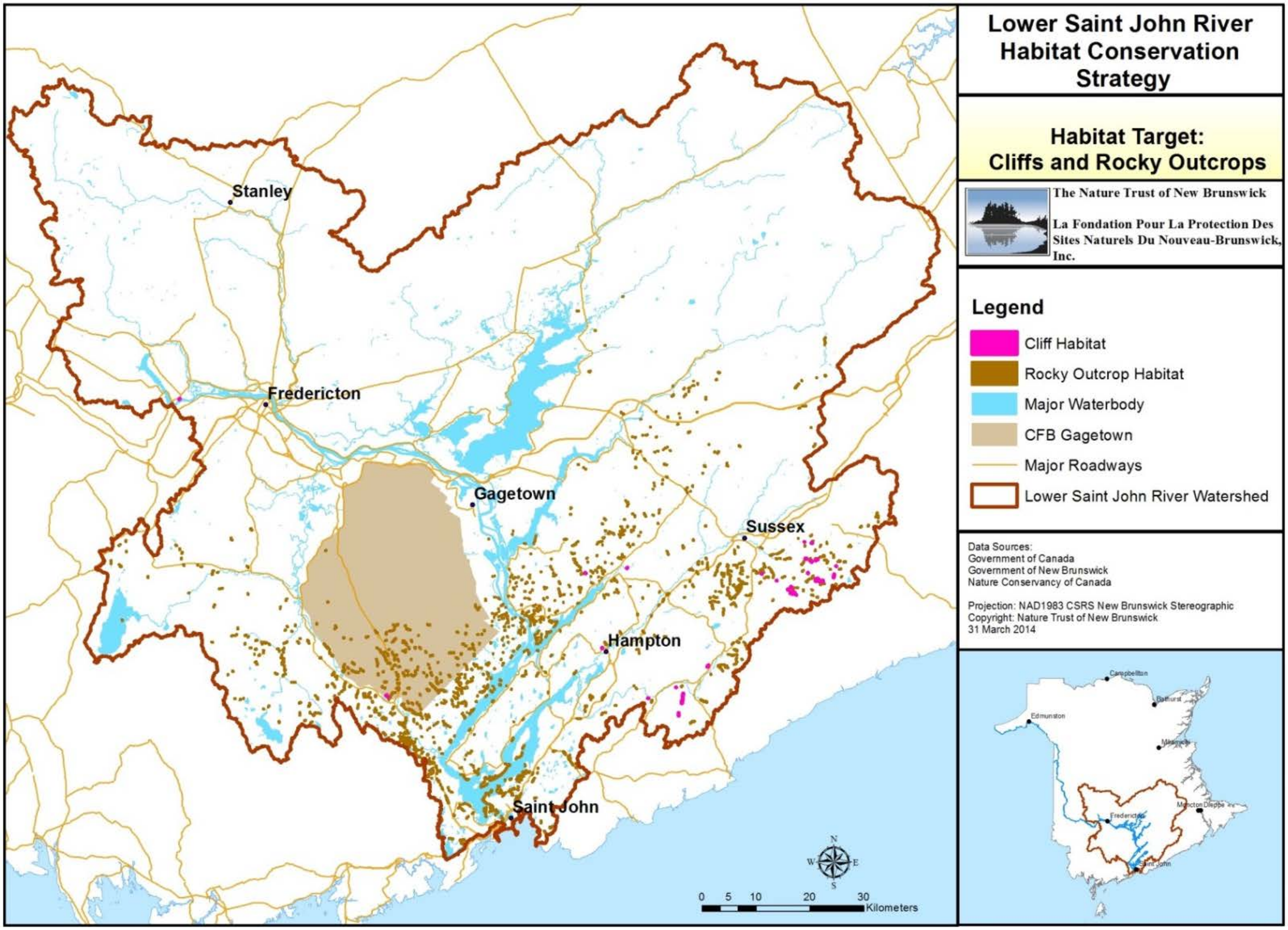

Fig. 13. Cliffs and rocky outcrops in the LSJR bioregion.

Priority Habitat: Sand and Gravel Beaches

Beaches as defined in the NAAP are "thick accumulations of unconsolidated waterborne, well-sorted sand and pebbles deposited on a shore, or in active transit along it" (Anderson et al. 2006). Natural freshwater beaches can support diverse aquatic and terrestrial biota. Such habitats along the many waterways and water bodies throughout the LSJR Bioregion support unique plant communities and numerous rare species (Fig. 14). These highly productive ecosystems are frequently replenished by wave action and high annual water level fluctuations, which distribute and deposit nutrients and organic matter (Strayer 2010). Along the shores of Grand Lake and its neighbouring lakes, seasonal water level fluctuations combined with warm and dry summertime temperatures create conditions that support a potentially unique vegetation community (Blaney 2009). In general, certain plant and vertebrate species (amphibians, turtles, terns, and waterfowl) rely almost exclusively on freshwater beach environments for at least part of their lifecycle (Strayer 2010). In the LSJR Bioregion, at least 27 priority species, i.e. 9% of the 301 priority species that occur in the bioregion, use beaches for at least part of their life cycle. Some species, such as the Cobblestone Tiger Beetle, are dependent on beaches for their survival (COSEWIC 2008a).

Landscape Context Assessment (Sand and Gravel Beaches): Fair

It was not possible to calculate the average Landscape Context Index (LCI) for beaches in the LSJR bioregion from NAAP data, but there is significant development in areas adjoining beaches. The actual LCI is therefore likely to only be fair to poor. Development is increasing provincially along both the coasts of marine areas and inland lakes. The New Brunswick Coastal Areas Protection Policy recommends restrictions on development in and around coastal habitats (NB-DOE 2002), but there is no legislative regulation.

Condition Assessment (Sand and Gravel Beaches): Fair

Given the relatively high occupancy along the shores of Grand Lake, many of the beaches in this region receive a fairly high level of foot traffic, as well as off-highway vehicle traffic. Very few invasive species have been documented within these habitats. Within the bioregion, 1 275 ha or 7 % of total beach habitat are in protected status.

Size Assessment (Sand and Gravel Beaches): Good

The average size of beaches in the bioregion is 73 ha. Although the average beach size is considerably larger than the critical occurrence criteria (>8 ha), the beaches in this area are relatively degraded. Beaches occupy only 1.8% of the total area in the bioregion, and their area represents less than 1% of the provincial total. Despite their small area, many of those around Grand Lake are potentially critical for the Cobblestone Tiger Beetle (NAAP; Anderson et al. 2006; COSEWIC 2008b).

Overall Assessment (Sand and Gravel Beaches): **Good**

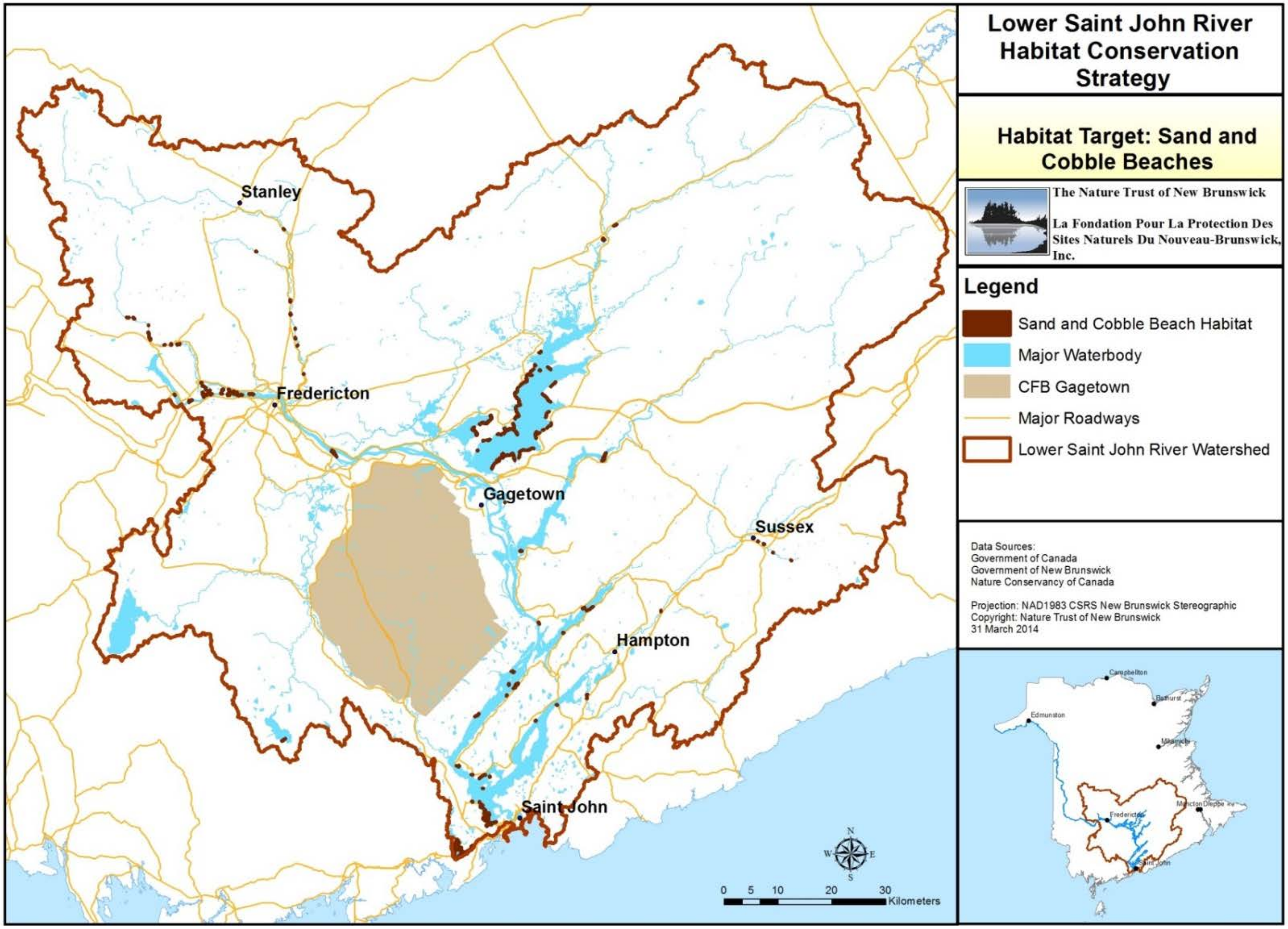

Fig. 14. Sand and gravel beaches in the LSJR bioregion.

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 biodiversity habitats. Threats impact the habitat's viability and/or key ecological attributes. Threats to the priority habitats were identified by the LSJR bioregion project team using past studies, local expert knowledge, and a review of the literature. The list of threats is considered comprehensive for the bioregion's biodiversity habitats, though other threats may be revealed through research or may emerge over time. 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 (Salafsky et al. 2008; IUCN-CMP 2012), with local descriptions. Table 6 provides a summary of the threats identified from the LSJR bioregion. Threat nomenclature is based on the IUCN classification of direct threats (IUCN-CMP 2008). The overall threat status for the LSJR bioregion is "high". The geographic extent of each identified threat is indicated, where known (Figs. 15 through 21, p. 50-56).

Table 6. Summary of threats to the LSJR bioregion biodiversity habitats, in order of severity (continued on p 33).

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*

Table 6 (continued). Summary of threats to the LSJR bioregion biodiversity habitats, in order of severity.

Threats[3] across habitats	Acadian Forest Mosaic	Riparian Systems	Freshwater Wetlands	Beaches	Grasslands / Agro-Ecosystems	Cliffs	Rocky Outcrops	Summary Threat Ranking
5.3 Logging and wood harvesting (incompatible forestry practices)	High	High	Medium					**High**
1.1 Housing and urban areas	Medium	High	Medium	Medium	Low			**Medium**
4.1 Roads and railroads (road fragmentation)	High	Medium	Medium					**Medium**
7.2 Dams and water management / use (other aquatic barriers)		High	Medium	Low				**Medium**
8.2.2 Problematic native species/diseases - spruce budworm	High	Medium						**Medium**
6.1 Recreational activities (off-highway vehicle use)		Medium		High				**Medium**
2.1 Annual and perennial non-timber crops		Medium	Medium		Medium			**Medium**
8.1.2 Invasive non-native / alien species / diseases - plants	Medium	Medium	Medium					**Medium**
8.1.1 Invasive non-native / alien species / diseases - unspecified species (*emerging*)	Medium	Low	Low					**Low**
2.2 Wood and pulp plantations	Medium	Low						**Low**
3.2 Mining and quarrying	Low	Unk.	Low					**Low**
8.1.2 Invasive non-native / alien species / diseases - predatory fish		Low						**Low**
8.4.2 Introduced genetic material - hatchery salmon		Low						**Low**
2.4.2 Marine and freshwater aquaculture - industrial aquaculture (land-based)		Unk.						**Unknown**
3.1 Oil and gas drilling (*emerging*)			Unk.					**Unknown**
11.1 Climate change and severe weather - habitat shifting and alteration (*emerging*)	Unk.							**Unknown**
Summary threat ratings, by habitat, and for the bioregion	**High**	**High**	**Medium**	**Medium**	**Low**			**High**

5.3 Logging and wood harvesting (incompatible forestry practices)
(Summary Threat Ranking: **Medium**)

This category of threat currently appears to be the most important in terms of both the number of priority species affected and the total amount of habitat (area in ha) under threat in the LSJR Bioregion. This is not surprising, as forest management activities are the main cause of change in the composition and structure of forests in New Brunswick, and that healthy forests in general harbour a large diversity of species.

Within the Acadian Forest, the dominant natural disturbance regime consists of gap dynamics, with stand-replacing disturbances (e.g., hurricane, fire) occurring only every several hundred to several thousand years (Mosseler et al. 2003). Over time, this evolved into forest associations that include long-lived, shade-tolerant species such as Red Spruce, Eastern Hemlock, White Pine, Sugar Maple, Beech, and Yellow Birch. In this disturbance mosaic, nearly constant canopy closure is maintained well beyond the life span of individual trees, providing habitat for a range of native species that depend on different forest stages. Following stand-replacing disturbances, forest succession typically begins with early-successional, shade-intolerant species with relatively short lifespans, which require full light, establish themselves quickly, and exhibit rapid growth. In the absence of repeated disturbances, they tend to be replaced over time by more long-lived, shade-tolerant species (NBDNR 2013).

Following European arrival in the 17th century, human land use activities have significantly impacted the frequency, intensity, and magnitude of natural forest disturbance processes in New Brunswick. The Province of New Brunswick's forests have a history of extensive harvesting and do not exhibit the same complex forest structure, composition, and age class that they once did (Loo and Ives 2003). More recent industrial forestry practices such as extensive clear-cutting and monoculture plantations fail to mimic the bioregion's natural forest disturbance regime, which is primarily one of gap dynamics (Mosseler et al. 2003). Consequently, the current conditions of New Brunswick's forests no longer reflect the processes and structures produced by gap disturbance regimes. There has been a significant increase in relatively young, even-aged, early-successional forest types, while the abundance and age of shade-tolerant, late-successional forest types has declined (Loo and Ives 2003; Loo et al. 2010; Mosseler et al. 2003). Regenerating forest stands lack certain characteristics that are typical of old Acadian Forest stands. These include large-diameter trees, large woody debris, and canopy openings with consequent understory regeneration which regenerate well when there is a reduced presence of early-successional species (NBDNR 2013). Other native disturbance cycles such as spruce budworm infestations, however, occur in short 30-40 year cycles can have wide-spread impact on forests that are vulnerable due to their species and age composition (MacLean 1980). In this example, forests with a high percentage of balsam fir and low hardwood content are more vulnerable to defoliation and stand loss (MacLean 1980).

Harvesting practises not only threaten the overall diversity and state of the bioregion's forests, but they can also have significant consequences for adjacent freshwater ecosystems. See Fig. 21 (p. 56) for a summary of private, industrial and crown forest holdings. Complete removal of tree cover such as clear-cutting in close proximity to watercourses and wetlands can result in increased rates of erosion and water runoff, potentially leading to increased siltation and flooding of adjacent waters. Water runoff from industrial forestry practices can also carry pesticides and other biocides, which can negatively impact water quality and associated aquatic communities and species (Neary and Hornbeck 1994; McEachern 2003; Martin et al. 2000). Removal of tree cover directly adjacent to waterbodies reduces the ability of riparian areas to retain and filter water, can lead to bank destabilization further increasing erosion, and can reduce or eliminate tree shade and resulting temperature control benefits, leading to increases in water temperatures (McEachern 2003). This can negatively impact aquatic communities and species, particularly salmonids, which require deep pockets of oxygen-rich cold-water habitat, which they use as summer refugia (Brylinsky 2002). Riparian area harvesting also reduces the input of organic material to waterbodies, such as litterfall and coarse woody debris, which constitute an important source of nutrients and structural complexity (McEachern 2003).

Riparian buffers around lakes and streams that are protected from forestry activities have been widely used to mitigate the negative impacts of forestry on aquatic ecosystems (McEachern 2003). Currently, forest harvesting on private lands in New Brunswick within 30 m of a watercourse requires a permit. Additional restrictions exist in designated watersheds. Similar standards apply to harvesting practices on Crown Lands requiring a minimum of 30 m buffers and partial harvesting on perennial watercourses. Research on salamanders, turtles, and birds suggests much wider buffers are required to maintain habitat for terrestrial species (recommended 75-200 m, see McEachern 2003).

Along with riparian buffers, vernal pools also play an important role in forested ecosystems as freshwater wetlands. At present, these habitats are not captured within the provincial wetlands inventory; however, efforts are being made to protect vernal pools on Crown Lands and in the Unique Areas program for private land. Research suggests that protecting vernal pools within areas of active forestry operations and targeting these habitats for conservation action is beneficial to many rare plant species (DeMaynadier and Hunter 1998).

1.1 Housing and urban areas

(Summary Threat Ranking: **Medium**)

Given that this is one of the most densely populated bioregions in the Maritimes, it is not surprising that this category shows up as one of the important threats to a notable proportion of its priority species. In all, ten species of BCR 14 birds, two species of SARA-listed turtles, and three species of COSEWIC-designated and/or SARA-listed invertebrates found in the bioregion are threatened at various levels by habitat loss due to urban development or sprawl (COSEWIC 2007a, 2008a, 2008b, 2008c, 2010; Environment Canada 2013a).

The population of New Brunswick has grown relatively slowly over the last 30 years (696 403 in 1981 vs 751 171 in 2011, cf Statistics Canada 2011 Census of Population). During this period however there has been an important shift in population distribution patterns with the population in this bioregion becoming increasingly urban-centred. Consequently, despite the low rate of population growth, increasing residential and cottage development associated with changing population patterns is one of the most pervasive and impactful threats to habitat conservation priorities in the LSJR bioregion.

Most urban centres in New Brunswick are concentrated along its major river systems, mostly due to historical settlement patterns; therefore, these continuing threats to riparian systems are among the most intense (Fig. 16). Since the St. John River is the largest river in the province and the second largest in Eastern Canada, it follows that it has a long history of human presence on its shores (CRI 2011). The scope and intensity of this threat varies among species, but given the increasing demand for cottage and housing development along the bioregion's riparian systems and on lands traditionally used for agriculture, this threat is likely to continue to increase (Dick 1977). Development along inland water bodies tends to be linear, extending along the shoreline, which has a high potential for impacting riparian ecosystems, as it tends to interrupt the natural connections between aquatic environments and their adjacent terrestrial uplands. Specific activities associated with housing, cottage, and rural developments that threaten the bioregion's biodiversity include infilling, removal of natural vegetation cover, creation of lawns and gardens, and shorefront alterations (e.g., creation of artificial beaches, construction of docks and wharves). In particular, cottage development near important habitat for species of turtles, invertebrates at-risk and several priority bird species present in the bioregion is on the rise and is directly correlated with an increase in the occurrence of shoreline alterations (COSEWIC 2007a; 2008a; Environment Canada 2013b). This has the potential in a number of ways to negatively impact these priority species, and specifically riparian/aquatic species-at-risk through direct loss and degradation of their critical habitat. Also associated with shoreline development is the potential for nutrient-rich runoff and the introduction of invasive species, which also negatively impact sensitive shoreline ecosystems.

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 m 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., land use / land cover, dams, mines, watersheds), and electrical power infrastructure (i.e., utility corridors). Each 90 m 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. 16). The Human Footprint Index provides another useful perspective on land development pressures in the region (Woolmer et al. 2008).

4.1 Roads and railroads (road fragmentation)

(Summary Threat Ranking: **Medium**)

The ecological impacts of roads can be difficult to quantify, but a growing body of research makes a compelling link between roads and ecological degradation in terrestrial and aquatic ecosystems (Trombulak and Frissell 2000). Road construction has long been linked to habitat fragmentation and degradation. There is also research linking negative impacts to many wildlife species, including some invertebrates, such as butterflies (negative effects on species richness) and certain carabid beetles, herpetofauna, and some birds (Fahrig and Rytwinski 2009). It is also a major concern for wide-ranging mammals, such as moose and lynx (Beazley et al. 2004). Roads fragment landscapes and may act as physical barriers between interior patches of habitat. They have negative effects on biodiversity through direct mortality from road construction and vehicle collisions, behavioural modifications (e.g. avoidance), alterations of the physical and chemical environment and increased access to once inaccessible places for invasive species and human use. This includes improved access for off-highway vehicle use, poaching, and legal harvesting of wildlife (Trombulak and Frissell 2000). Road construction can also have a negative impact on freshwater wetlands as a result of changes to hydrology and direct loss of habitat (Saunders et al. 2001).

Vehicle mortality is a recognized threat for Wood Turtles and Snapping Turtles, particularly adult females and hatchlings, given the tendency of females to use roadsides as nest sites (COSEWIC 2007a, 2008b; Fahrig and Rytwinski 2009). Given the longevity and late maturation of turtles, their populations are particularly vulnerable to even small increases in adult mortality (COSEWIC 2007a, 2008b). In areas with high road densities, mortality of females can lead to male-biased population sex ratios (Steen and Gibbs 2002).

Road density and fragmentation is high within the bioregion due to the relatively high population density and resource extraction industries that occur here and is therefore considered a major threat (Fig. 20).

7.2 Dams and water management/use (other aquatic barriers)
(Summary Threat Ranking: **Medium**)

Approximately two-thirds of the world's freshwater flowing into oceans is blocked by large and small dams (Petts 1984; McCully 1996). The St. John River Basin hosts over 200 dams and water control structures (CRI 2011), with the largest barrier within the bioregion being Mactaquac Dam upstream of Fredericton, which acts as a power generation and flood control system (Wells 1999). There is currently no fishway at Mactaquac Dam, though some fish are trapped and trucked around the dam (Wells 1999). There are also numerous small dams located on tributaries of the St. John River in the bioregion (CRI 2011). It is estimated that there are several hundred and as many as several thousand sites within the bioregion that could be investigated for stream impairment and obstruction of fish passage in the form of compromised stream crossings and culverts, as well as stream bank instability and erosion. A detailed assessment of the most probable sites of impairment and the condition of these potential aquatic barriers has not been conducted. This significant data gap certainly warrants further study in order to develop a better understanding of the specific impacts of this threat to habitat and species. The effects of dam construction and operation can have both immediate and long term effects on long stretches of both upstream and downstream habitat. One of the most immediate effects is the decrease in aquatic connectivity (the network created by freshwater streams, rivers, and lakes as they flow into one another). Barriers along these aquatic networks can restrict or eliminate the movement of fish and other aquatic species up and down streams, and limit accessibility to suitable spawning, feeding, overwintering, and summer habitats (Fielding 2011). Within the bioregion, these networks are critically important to the success of a number of aquatic species, such as Atlantic salmon, Brook Trout, American Shad, and American Eel.

In addition to creating barriers for fish passage and reducing aquatic connectivity, the development of hydroelectric dams has the potential to adversely impact a number of the bioregion's most sensitive habitats and species. Dams impact freshwater ecosystems by altering the natural hydrology of river systems, including changes to flow regimes, water temperatures, sediment transport, and nutrient loads (Bednarek et al. 2001; Saunders et al. 2002; Nilsson and Berggren 2000). Concerns around dam infrastructure itself are also present. Not only can physical harm come to fish that fall over spillways, but turbine mortality is listed as a significant threat to species such as the American Eel (*Anguilla rostrata*), which emigrate into the Bay of Fundy and beyond as part of their lifecycle (COSEWIC 2012). Upstream of dams, the creation of reservoirs from water that once flowed downstream can lead to permanent terrestrial and riparian habitat loss (Nilsson and Berggren 2000), and lasting changes to species density (Nilsson et al. 1997). It is estimated that 44% of habitat once available to Atlantic Salmon upstream of the Mactaquac Dam has been lost due to damming activities (CRI 2011). Reservoirs created from damming activities can also cause changes to water temperatures, resulting in habitat favouring warm water fishes and encouraging further inundation by introduced species (CRI 2011). The creation of reservoirs also exacerbates predation on Atlantic Salmon by native and invasive species.

Biological communities and species are dependent on the availability of specific habitats, including riffles, pools, and cold water habitat. Flow regimes are fundamental in determining the physical characteristics of river and riparian habitat. Therefore, alteration of the natural flow regime downstream on damming activities affects the distribution and abundance of biodiversity within the river system (Bednarek et al. 2001; Holden 1979; Environment Canada 2013b). For example, both the Pygmy Snaketail (*Ophiogomphus howei*) and Skillet Clubtail (*Gomphus ventricosus*) are affected by soil erosion and sedimentation (COSEWIC 2008b, 2010a), processes that are exacerbated in ecosystems barred by dams. Predation of emigrating Atlantic salmon smolt by Smallmouth Bass, Striped Bass, Chain Pickerel, and Muskellunge has been documented around dam tailraces (Carr 2001; Blackwell and Juanes 1998).

8.2.2 Problematic native species/diseases
(Summary Threat Ranking: **Medium**)

Within the historic Acadian Forest, the dominant natural disturbance regime consists of gap dynamics, with most stand-replacing disturbances (e.g., hurricane, fire) occurring only every several hundred to several thousand years (Mosseler et al. 2003). Over time, this can evolve into forest associations typical of the Acadian Forest that include long-lived, shade-tolerant species such as Red Spruce, Eastern Hemlock, White Pine, Sugar Maple, Beech, and Yellow Birch.

A more frequent stand-replacing agent of disturbance for North American forests comes in the form of forest insects and pathogens. These species have the potential to affect larger areas than other forms of stand-replacing disturbances, like fire. While they can affect forest ecosystems, some of these species may also be crucial in maintaining the ecological integrity of forests (Logan et al. 2003).

One such native species is the eastern spruce budworm (*Choristoneura fumiferana*), which feeds on the foliage of balsam fir and various spruce species. Spruce budworm outbreaks occur approximately every 35 years, with the last outbreak collapse in New Brunswick in 1995. Since then, the NB Department of Natural Resource Forest Pest Management Group has documented increasing population growth trends, with the highest counts of moths from pheromone traps occurring in northern areas of New Brunswick (FPMS 2013). No defoliation was forecast in 2014, though populations continue to increase throughout the province (J. Gullison, pers. comm.). This could provide an opportunity to further study the species and its ecosystem level effects.

Sirococcus shoot blight is a native fungal disease affecting red pine. In southern New Brunswick this disease has been found to affect both mature red pine stands and plantations (J. Gullison, pers. comm.), and many assessed stands (23%) are at high risk of tree mortality over the next five years (NBDNR 2014). Disease symptoms include branch dieback and following successive attacks, tree mortality; wet weather in May and June appears to lead to an increase in these impacts. Red pine stands are not widespread in New Brunswick, and without natural regeneration caused by regular fire cycles, these stands are at increased risk of loss with the emergence of Sirococcus shott blight (J. Gullison, pers. comm.).

6.1 Recreational activities (off-highway vehicle use)
(Summary Threat Ranking: **Medium**)

With increased cottage and residential development along the bioregion's inland waters, there has been an associated increase in recreational activities, including the use of off-highway vehicles (OHV). Use of OHVs in sensitive ecosystems can lead to significant habitat degradation. It is a recognized threat to a number of the bioregion's sensitive ecosystems and certain species-at-risk, such as the Cobblestone Tiger Beetle. This beetle and the beaches and sand dunes it uses are particularly sensitive to OHV use (COSEWIC 2008a). Moreover, the use of OHVs can degrade or even destroy egg-laying habitat for salmonids (COSEWIC 2010b).

The use of OHVs in sensitive ecosystems, such as riparian areas (e.g., lakeshores), bogs and fens can severely damage these habitat types, leading to soil compaction, destruction of existing plants, and changes to drainage patterns and hydrology. This can result in long-term habitat loss for a number of sensitive species, such as turtles and dragonflies (COSEWIC 2007a, 2008b, 2008c, 2010a). Off-highway vehicle use is generally regarded as a widespread and significant threat to a number of the bioregion's habitat conservation priorities. The New Brunswick *Off-Trespass Act* prohibits the operation of an off-highway vehicle in or on a wetland, swamp or marsh, a watercourse, on beaches or a sand dune, with fines for infractions ranging from $172.50 to $604.50, with some infractions carrying an even higher penalty. The regulations are enforced by the New Brunswick Department of Public Safety, Off-road Vehicle Enforcement Unit; however, these infractions are difficult to enforce, particularly in remote areas.

2.1 Annual and perennial non-timber crops
(Summary Threat Ranking: **Medium**)

One of the primary threats to grassland-dependent species that use cultivated and managed areas are incompatible agriculture practices, such as cutting of hayfields during the breeding season (Environment Canada 2013a). For instance, many grassland birds do not have sufficient time to complete their nesting cycle, particularly when hay harvest is completed earlier and at more frequent intervals (US Department of Agriculture, Natural Resources Conservation Service 2010). The removal of natural vegetation in such anthropogenic habitats is also problematic, especially in riparian and wetland buffer zones. In addition to affecting water quality, the removal of natural vegetation associated with agricultural activities accelerates erosion and sedimentation; this can increase water temperatures due to a lack of cover, and decrease water quality, which have negative effects on aquatic ecosystems in or adjacent to open fields (Carpenter et al. 1998; Allan 2004; Henley et al. 2000). There are a number of federally listed and BCR 14 priority bird species within the bioregion that are strongly associated with this habitat type and require open fields for nesting and foraging habitat, especially agricultural hayfields (Environment Canada 2013a). Several of these grassland-associated species are exhibiting major continent-wide declines, including the Bobolink, Savannah Sparrow, Short-eared Owl, Rusty Blackbird, Barn Swallow, and Common Nighthawk (Environment Canada 2013a; NABCI 2012).
Timing of hay harvest can also threaten the survival of other, non-bird species at risk, such as the Wood Turtle, which face threats and mortality associated with farm machinery. Studies in Nova Scotia have shown that delaying the timing of hay harvesting beyond the breeding season (June to early July) and raising the height of mowers in riparian fields may reduce farm machinery related mortality of Wood Turtles. In addition, Wood Turtle activity is usually restricted to within 300 meters of the water's edge, thus maintaining a seasonal equipment free zone would significantly decrease mortality as well (Tingley et al. 2009).

Moreover, the loss of pasture land and hayfield to forest succession and cropland, as well as the loss of food sources and declines in prey availability (insects), or direct mortality as a result of pesticide use are also having effects on grassland-dependent birds and other species (Environment Canada 2013a; COSEWIC 2007a). Although the types of habitat required by grassland species are almost exclusively man-made in New Brunswick, they are declining in the province as the number of farms decreases (Environment Canada 2013a; Walls 2011). As a result of these changes occurring in their breeding habitat and threats in their wintering habitat abroad, many of these grassland-associated bird and non-bird species are declining. Figure 17 (p. 52) shows lands used for agricultural practices within the bioregion.

8.1.2 Invasive non-native/alien species/diseases – plants

(Summary Threat Ranking: **Medium**)

Within the LSJR bioregion, a number of invasive plant species have been identified as significant threats. A few species in particular have been identified as having the potential to severely impact natural systems here and in a wider context. Reed Canary-Grass (*Phalaris arundinacea*), a species known to displace native species, particularly in riparian floodplains and wetlands, is now known to occupy thousands of hectares in the St. John River floodplain and those of its tributaries (S. Blaney, pers. comm.). Glossy Buckthorn (*Frangula alnus*) is another aggressive invader that can grow in any open habitat including wetlands and open forests. Extensive tracts of land can be entirely colonized by this species, displacing all other native species (D. Mazerolle, pers. comm.). It is considered the most significant invasive plant in New Brunswick (NBISC 2012). The Common or "European" Reed *(Phragmites australis* ssp*. australis)* is an aggressive wetland invader and colonizer of disturbed areas such as roadside ditches (note: the native Common Reed [*Phragmites australis* ssp*. americanus]* also occurs in the bioregion). This variety grows in dense stands, is widespread and displaces native wetland vegetation (NBISC 2012). Woodland Angelica (*Angelica sylvestris*) is another invasive species of concern, although the threat is not as high as the Glossy Buckthorn. This species has been present in New Brunswick for many years but has recently begun spreading rapidly (NBISC 2012). It is an aggressive displacer of native vegetation and has most abundantly become established along the St. John River corridor (NBISC 2012; D. Mazerolle, pers. comm.).

8.1.1 Invasive non-native/alien species/diseases species - unspecified species

(Summary Threat Ranking: **Low**)

Invasive species are commonly cited as one of the most important threats to global native biodiversity (UNEP 2002; Hermoso et al. 2011). Estimates suggest that invasive species dominate 3% of the entire Earth's ice-free surface (Mack 1985). With new invasive species crossing geographic borders and established species' invasive potential increasing with the immigration of more individuals (Mooney and Cleland 2001), research indicates a rise in outbreaks of tree and forests pests and diseases (Boyd et al. 2013). International commerce has assisted the dispersal of species, and continued high volumes and new forms of trade may exacerbate the risk of invasive species spread (Boyd et al. 2013). Interceptions at ports indicate a high number of species landings (Haack 2001; Humble and Allen 2001; Majka and Klimaszewski 2004). The Maritime Provinces are especially vulnerable to adventive species given that these ports are often the first point of contact for ships carrying international goods. While only 1% of these species become established (Williamson 1996), this adds up over time. Invasive species are responsible for major economic losses (Pimentel et al. 2001) as well as dramatic changes to the habitats they occupy and the species with which they interact. Non-native insects and diseases are capable of modifying habitat and ecosystem function (Liebold et al. 1995; Fleming and Candau 1998; Castello et al. 1995). Furthermore, invasive species have been shown to impact native species via a variety of evolutionary pathways, i.e. competitive exclusion, niche displacement, hybridization, introgression, and extinction (Mooney and Cleland 2001). They are listed at the second greatest threat to species at risk in the US (Wilcove et al. 1998), with approximately ~42% of threatened and endangered species being affected through "competition with or predation by invasive species" (TNC 1996; Wilcove et al. 1998).

A number of invasive insect species are already present within the bioregion (Table 8). The European gypsy moth (*Lymantria dispar*) is a defoliator of over 200 hardwood tree species. The Balsam Woolly Adelgid (*Adelges piceae*) has yet to cause significant damage across the bioregion, but populations are expanding continuously. The Brown Spruce Longhorn Beetle (*Tetropium fuscum*), which attacks and kills spruce trees, is established in Halifax (Smith and Humble 2001), however, evidence has not been found for established populations in New Brunswick or the LSJR bioregion.

Several diseases are also found within New Brunswick with a subset found within the bioregion (Table 8). There is both a native and European strain of Scleroderris canker (*Gremmeniella abietina*) in North America. The latter is only found in Michigan (CFIA 2012a). The European strain is more virulent and attacks multiple hosts (CFIA 2012a). Positive detections have been found in New Brunswick, as well as other provinces and states in eastern North America (CFIA 2012a). This species is rated as very high risk by North American Forest Commission Exotic Forest Pest Information System (NAFC-ExFor). Its potential for establishment and spread outside of its native distribution is high. Likewise, because it targets host species of commercial value and has the potential to indirect impacts on a variety of species at risk, its economic and environmental impact potential is listed as high. The European larch canker is particularly harmful fungus that infects the indigenous tamarack. It is distributed throughout southern New Brunswick, central Nova Scotia and has more recently been identified on Prince Edward Island (Simpson and Harrison 1993). Likewise, Dutch elm disease and beech bark disease are distributed throughout Maritime Canada (Hurley et al. 2003). Butternut canker is a non-native fungal infection of butternut trees which causes necrosis of cambial tissue, disrupted nutrient flow, and eventual death. The disease is documented in Ontario, Quebec, and most recently in New Brunswick; in some US states upwards of 91% of live trees in all age classes have been affected (Environment Canada 2010). A genetically distinct population of butternut are found in New Brunswick, however, researchers have not determined if this population will prove more or less resistant to the canker (Environment Canada 2010).

First detected in North America in 2006 (Lorch et al. 2011), White-nose Syndrome (WNS) has caused widespread declines across northeastern North America, and Forbes (2012b) suggests that the predicted functional extirpation which is occurring in the northeastern United States will most likely occur with Canadian populations. WNS is hypothesized to cause starvation and dehydration by taxing bat energy reserves at a time when they would normally be inactive and hibernating. The bats are then forced to leave the hibernacula in search of food, and subsequently die of exposure (Carey et al. 2003; Turner et al. 2011). Any chance of bat population recovery will likely depend on the probability of certain individuals having a resistance to WNS and passing this resistance on to their offspring. Both banding and laboratory studies suggest that some individuals can survive exposure to WNS (Meteyer et al. 2011; Dobony et al. 2011), and it is believed that a similar situation occurred in Europe where WNS is present but bat mortality is low (Turner and et al. 2011).

Comprehensive information is lacking on how many invasive species currently impact the environment and the species around them. Regardless, the introduction of invasive species and diseases will remain a threat to native species and the broader ecosystems for years to come.

Table 7. Provincial and bioregional status of invasive insects and diseases in New Brunswick.

Species	Target Host	Provincial Status	Bioregional Status	Reference
		Insects		
European Gypsy Moth (*Lymantria dispar*)	Hardwoods and conifers	Present	Present	CFIA 2009
Brown Spruce Longhorn Beetle (*Tetropium fuscum*)	*Picea* spp. *Pinus* spp. *Abies* spp.	Present	Absent	CFIA 2009; Smith and Humble 2001
Balsam Woolly Adelgid (*Adelges piceae)*	*Abies* spp.	Present	Present	DNR 2013
		Diseases		
Butternut Canker (*Sirococcus clavigignenti-juglandacearum)*	*Juglans cinerea*	Present	Present	Env Can 2010
Scleroderris Canker (*Gremmeniella abietina*)	*Larix* spp. *Pinus* spp. *Picea* spp. *Abies* spp.	Present	Unknown	CFIA 2012a
European Larch Canker (*Lachnellula willkommii*)	*Larix* spp.	Present	Present	Simpson and Harrison 1993
Dutch Elm Disease (*Ophiostoma ulmi*)	*Ulmus* spp.	Present	Present	Hurley et al. 2003
Beech Bark Disease (*Neonectria faginata*)	*Fagus grandifolia*	Present	Present	Hurley et al. 2003
White-nose Syndrome (*Pseudogymnoascus destructans)*	*Perimyotis subflavus, Myotis lucifugus, Myotis septentrionalis*	Present	Present	Forbes 2012a, 2012c, 2012d

2.2 Wood and pulp plantations
(Summary Threat Ranking: **Low**)

Natural forest conversion to wood and pulp plantations is a common forestry practice in the bioregion. In general, forest plantations consist of even-aged stands of shade-intolerant, fast-growing softwood species for use in the pulp and paper industry. Locations of current plantations are given in Fig. 18 (p. 53). Native tree species used include Red Pine, Jack Pine, and Red, Black, and White Spruce as well as Balsam Fir for the Christmas tree industry. The conversion of natural forest to forest plantations has been found to reduce the number of species and the relative abundance of species of ecological importance common to natural forest stands (Betts et al. 2005). Such stands also face more frequent harvesting cycles have a reduced capacity to provide suitable habitat for native wildlife and support a diversity of species compared to natural forests. Guénette and Villard (in Betts et al 2005) found that at least 12 species of songbirds were negatively impacted by living in forest habitat with reduced stand diversity and frequent harvesting. The forest plantations within New Brunswick that have lower biodiversity value as compared to natural forest show a reduced abundance in snags, coarse woody debris and multiple canopy layers (Betts et al. 2005). Many rare or unknown species of fungi, bryophytes, and lichens that are a component of natural mature forests are also threatened by intensive harvesting practices (Betts et al 2005). At the landscape scale, plantation forestry creates a patchwork of harvested and regenerating stands which reduces the connected forest mosaic structure of natural forests (Betts et al. 2005). As a result, species requiring large home territory are unable to find suitable habitat across the landscape, and many individual stands are at a growth stage unsuitable as habitat for many other species. Moreover, as stands with reduced species diversity, plantation patches can also be more vulnerable to damage by insects, diseases, and wind further decreasing the resilience of forest habitat in plantations. Fig. 21 (p. 56) illustrates the distribution of crown, industrial freehold, and private forest management throughout the LSJR. These patterns indicate where differences in forest management practices are likely to be found in the bioregion.

3.2 Mining and quarrying
(Summary Threat Ranking: **Low**)

Threats from mining and quarrying relate to the permanent destruction of habitat from the construction of roads and processing facilities, erosion and sedimentation as a result of land clearing and disposal of debris, as well as soil and water contamination from chemical by-products that result from the processing of ores. According to the Fraser Institute's 2012/2013 Survey of Mining Companies, New Brunswick is rated as a jurisdiction with great potential for development and investment in Canada (Wilson et al. 2013). This survey indicates that New Brunswick's mining policies and investment potential are considered favourable by exploration managers. While the statistics in the report do not indicate a direct threat to ecosystems, the results do suggest that the impacts of mining operations should be considered a potential threat in the future.

There is a fairly long history of mining in the bioregion. Perhaps the most important mining activity has been the mining of coal in the Minto area, which began as early as the 17th century and was halted in 2009, due in part to the coal having a high sulphur and mercury content, and not being environmentally acceptable (Canadian Press ~The News 2009). A considerable part of the extraction was done through surface mining, including large-scale strip mining. While all mining operations have a disruptive effect on the environment, the sheer volume of material involved in strip mining makes the impact on the environment especially acute. Strip mining can severely erode the soil and reduce its fertility (Bell and Donnelly 2006). It has been shown to pollute waters and in some cases deplete underground water reserves; it scars or modifies the landscape, damages infrastructure such as roads, homes, and other structures; and it may destroy wildlife (Bell and Donnelly 2006). The dust and particles from mining roads, stockpiles, and lands disturbed by mining, coal or otherwise, are a significant source of air pollution (Hutchinson and Whitby 1974; Ghost and Magee 2000). This activity has undoubtedly had an effect on the land and watersheds in the immediate vicinity of Minto over a considerable span of time, but also on the LSJR watershed. It should be noted that the current status of these areas and their reclamation has not been assessed for the purpose of this strategy; however, it is likely something that needs addressing to insure long-term ecological health of the region. Indeed, information is lacking for the overall impact of these operations and the ecological health of these ecosystems in the Minto region; this data gap represents a potential research opportunity in order better assess this threat and its local impacts

There has also been potash mining in the Penobsquis area at McCullys Field near Sussex since 1981. The main mine has been operated by the Potash Corporation of Saskatchewan since 1993, when it took over the Potash Corporation of America's assets. Natural gas was also discovered on Potash Corporation of Saskatchewan property at Penobsquis in September, 2000 by Halifax based gas explorer Corridor Resources. The potash facility began using gas for the smelting process starting in April, 2003 and some of the natural gas extracted in the area is being obtained via high volume, slick water, horizontal hydraulic fracturing.

Along with regular disposal of brine and tailings from the mining operations, which are mainly used as backfill in the mine itself, there has been an on-going problem with in-flow (leakage) of brine in the mine: "Mine officials have been dealing with brine generated from an inflow into the underground workings since 1998. Underground drilling and grouting operations have been underway for some time as mitigating control measures. In 2007, increasing inflow rates prompted the implementation of an enhanced drill/grout program from surface into a fracture zone encountered above the salt structure at 389 m. In the fall, it was reported that inflow had stabilized. Brine from the inflow is collected and pumped to surface. Over 300 tanker truck loads of brine leave the mine site daily for the 38 km haul to PCS Inc.'s Cassidy Lake Division, where it is conveyed to a 35 km pipeline for disposal in the Bay of Fundy. Brine is also transported 70 km to the potash terminal in St. John for disposal in the Bay when required. PCS company officials report that mitigation costs associated with handling the inflow are expected to impact production and operational costs at the existing mine over the long term" (Webb 2009).

A new open-pit tungsten-molybdenum mine planned for Sisson Brook in the headwaters region of the Nashwaak River (100 km NW of Fredericton) could potentially have impacts on the St. John River and nearby habitats, and thus, could be an important emerging threat. This mine will have an overall Project Development Area of 1 253 ha, and will contain an open pit covering 145 ha with a depth of 300 to 370 m (Stantec 2013). The mine's Tailings Storage Facility will cover an area of approximately 751 ha holding a mixture of waste-rock and contaminated water, and will be constructed of on-site quarried rock (Stantec 2013). An average of six million m^3 per year of waste water will be generated (Stantec 2013). Up to 30 000 tons of ore are expected to be processed daily for the mine's lifespan of 27 years, which will require transport on local roads. Among the potential impacts of this project are the partial destruction of Bird Brook, West Napadogan Brook, and Sisson Brook, the threat of contamination of the Nashwaak River and St. John River following impoundment failure, and air and water quality contamination by arsenic leaching and increased heavy vehicle traffic (CCNB 2013). Fig. 19 (p. 54) indicates areas currently vulnerable to quarrying activities and lands under mining agreements.

8.1.2 Invasive non-native / alien species / diseases - predatory fish

(Summary Threat Ranking: **Low**)

Invasive species are of considerable concern within aquatic systems and are treated accordingly in the relevant literature (COSEWIC 2013b). Predatory fish species such as Smallmouth Bass (*Micropterus dolomieu*), Muskellunge (*Esox masquinongy*), and Chain Pickerel (*Esox niger*) are voracious predators, preying directly upon and outcompeting native species. All three species are present in the bioregion, but there appears to be sufficient habitat diversity to maintain wide fish biodiversity . They may also exert additional predation pressure on other taxa that make use of both aquatic habitat and adjacent riparian areas during their life cycle. The latter species especially is considered a high threat (CWF 2003).

8.4.2 Introduced genetic material - hatchery salmon

(Summary Threat Ranking: **Low**)

Farmed Atlantic salmon production in the Maritimes represents 39% of the overall Canadian Atlantic Salmon production and 90% of Atlantic salmon production in Maine is within 50 km of the US-Canada border (DFO 1999). Within the Maritimes, the Bay of Fundy may be home to the highest concentration of aquaculture sites in the world (Canadian Parliament, Senate 2001). Sea cages, where farmed grow-out salmon are raised prior to harvest, are in nearshore marine sites (DFO 1999), and no minimum distance from salmon rivers is currently established (Government of New Brunswick 1991; NB DAAF 2000). Escapees from aquaculture sites are expected to have the greatest impact on wild stocks in rivers closest to these sites (DFO 1999; Morris et al. 2008). The native stock at greatest risk from aquaculture escapes is the outer Bay of Fundy (oBoF) population of Atlantic salmon. The population has decreased to low levels and declines in juveniles have reduced its recovery potential (DFO 1999). Within the LSJR Bioregion, a large proportion of oBoF salmon productive habitat is located downstream of the Mactaquac Dam (DFO 1999). Aquaculture-origin salmon have been reported in 14 rivers in New Brunswick and Nova Scotia (DFO 1999). There is evidence of farmed salmon escaping marine aquaculture sites and ascending rivers as well as escaped juveniles entering directly into the rivers from freshwater hatcheries and either remaining in the rivers or migrating back to sea (DFO 1999; Carr and Whoriskey 2006; Morris et al. 2008; Jones et al. 2010; Jonsson and Jonsson 2011; Lacroix and Fleming 1998). For example, juvenile salmon escapees from freshwater hatcheries have been documented on the Nashwaak River (DFO 1999), and monitoring at the Mactaquac Dam on the St. John River has detected suspected aquaculture escapees at this location since 1990 (Jones et al. 2010). Though impacts on native salmon population from aquaculture operations are largely unknown in Atlantic Canada, growing evidence suggests significant negative impacts (DFO 1999; Porter 2005). One way in which salmon aquaculture operations has the potential to impact wild stocks is via genetic interaction. Interbreeding between wild and farmed stocks can lead to fitness-related changes and/or the loss of local adaptation (Bourret et al. 2011; Fraser et al. 2010; Fraser et al. 2008; Wappel 2003; Ford and Myers 2008). On the Magaguadavic River, introgression of escapees with wild stock has resulted in significant genetic changes to the wild population, which could result in wild stock that are less adaptive to their natural habitat (Bourret et al. 2011). We lack information on how widespread these genetic interactions may be because extensive surveys of rivers in the Maritimes have yet to be conducted (DFO 1999).

2.4.2 Industrial aquaculture (industrial land-based aquaculture)

(Summary Threat Ranking: **Unknown**)

Aquaculture is recognized globally as the primary means to meet increasing demands for seafood, given that global commercial fisheries are close to their production limits, and is the fastest growing animal food production system in the world (NSAF 2005). Despite the growth of this global industry, research investigating the possible effects of freshwater aquaculture activities on surrounding habitat and biotic communities is severely lacking, especially in Canada. Very few publications document the effects of freshwater aquaculture on the benthic habitat and biotic communities in this region and no published studies address possible effects on native fish communities, estimates of escapement or the survival of escapees.

Fifteen inland finfish commercial facilities are in operation in the bioregion. These facilities produce Atlantic salmon (*Salmo salar*), Atlantic Sturgeon (*Acipenser oxyrinchus*), Shortnose Sturgeon (*Acipenser brevirostrum)*, Rainbow Trout (*Oncorhynchus mykiss*), Arctic Charr (*Salvelinus alpinus*), and Brook Trout (*Salvelinus fontinalis)*. Possible effects of freshwater aquaculture are associated with the production and discharge of organic waste material (DFO 2006). Organic wastes from aquaculture sites are mainly composed of faecal matter and uneaten feed. Nutrient loading from the production and discharge of these waste materials has the potential to result in algal blooms, and hypoxic waters and sediments in areas surrounding these sites (DFO 2006). In general, lentic systems appear to recover more slowly from organic waste discharge than lotic ones (Doughty and McPhail 1995). An example from Scotland noted that significant changes to benthic communities below cages were still discernible three years after farming at that site ended (Doughty and McPhail 1995). In addition to issues surrounding nutrient loading, other potential effects of freshwater aquaculture activities are associated with the interaction between escapees and wild fish. Freshwater aquaculture escapees can predate on wild fish and complete with them for limited resources. Another concern is the potential for alteration of the genetic material of wild populations through interbreeding (See 8.3.1 Introduced genetic material – hatchery salmon). Within New Brunswick, there are policies governing the rearing of Rainbow Trout to minimize the risk or threat to native fish stocks (DAFA 2009). However, accidental releases from facilities can occur, increasing the risk of interactions, especially for those facilities located on or near river drainages.

Table 7. Provincial and bioregional status of invasive insects and diseases in New Brunswick.

II. Emerging threats

3.1 Oil and gas drilling

(Summary Threat Ranking: **Unknown**)

Extensive tracts of land have been leased, given full licence, or are currently under review, to oil and natural gas companies for exploration within the bioregion and elsewhere in the province. Over 567 867 ha of land (37% of bioregion) has currently been distributed between four companies, mostly in or around the Sussex to Petitcodiac corridor. These leases are depicted in Fig. 19 (p. 54). The primary method contemplated for oil and gas extraction is by hydraulic fracturing or “hydrofracking”, where liquid is forced into the ground under high pressure to release natural gas from shale deposits (Northrup 2010). Extracting hydrocarbons through the use of hydraulic fracturing techniques is controversial in New Brunswick and elsewhere for various reasons. In other jurisdictions, it has been linked to small earthquakes. These tremors are apparently caused by injecting fracking waste water into deep underground injection wells (Horton 2012). However, to date, there is no indication that such injection wells are contemplated for this region. Nevertheless, shale gas drilling and extraction can also contaminate both ground- and surface-water from both the chemicals used in the fracking process, accidental spills during their removal and transport to waste facilities, leakage form holding ponds, as well as those released as a result of the breakup of sub-surface shale (Entrekin et al. 2011). Moreover, and perhaps most importantly, there is the danger of failure of the cement well casing over time, which can lead to methane and frack-fluid migration into aquifers (Ingraffea 2013). Also, shale gas operations can release air pollutants and greenhouse gases (Howarth 2010; Howarth et al. 2011; 2012) and can result in extensive clearing of land for well-pads and infrastructure (Hein 2012).

Potential additional, indirect impacts of shale gas mining include further fragmentation from road development, erosion and sedimentation related to road degradation through increased industrial traffic (Adams et al. 2011). The threat of shale gas extraction using hydraulic fracturing and otherwise is considered unknown for the bioregion at this time. Although there are currently a few shale gas wells that have been drilled and hydraulically fractured in the bioregion using the newer, unconventional, slick water, horizontally drilled, high volume technique that is the most controversial, the industry is in its very early stages here and there are no major known or reported incidents that have occurred here associated with this practice. Based on problems that have occurred using these same techniques elsewhere, this type of drilling has the potential to be high risk to the environment if the industry proceeds unregulated on a larger scale.

8.1.1 Invasive non-native/alien species/diseases – unspecified
(Summary Threat Ranking: **High**)

With new invasive species crossing geographic borders and established species' invasive potential increasing with the immigration of more individuals (Mooney and Cleland 2001), research indicates that outbreaks of tree and forests pests and diseases are increasing the world over (Boyd et al. 2013). With that in mind, a number of invasive insect and diseases are being watched closely (Table 8).

One such species is the Emerald Ash Borer (*Agrilus planipennis*). This species is a highly destructive invasive insect that preys on all species of true ash trees. In the LSJR bioregion, ash trees are common along river systems and have also been planted in Fredericton to replace dead or dying elm trees. This species is currently not in the province but has been moving east from Ontario very rapidly and is expected to arrive in the near future (CFIA 2009).

Another insect species is the Hemlock Woolly Adelgid (*Adelges tsugae*). Based on climate projections, this species may spread throughout the North American hemlock distribution with little resistance (Dukes et al. 2009), resulting in faster declines in infected hemlocks (Pontius et al. 2002; 2006) and broad-scale ecosystem impacts.

Table 8. Emergent invasive insects and diseases with associated risk potential.

Species	Target Host	Positive Detection Locations *	Risk Potential**	Reference
		Insects		
European Woodwasp (*Sirex noctilio*)	*Pinus* spp. *Abies* spp. *Picea* spp.	Southern, ON; Lachute, QC; New York, US	Very High	CFIA 2009; Hoebeke et al. 2005; NBDNR 2013
Pine Shoot Beetle (*Tomicus piniperda*)	*Pinus* spp. *Picea* spp.	Great Lakes Region, ON; various municipalities in QC	Very High	CFIA 2009; Haack et al. 2000; NBDNR 2013
Asian Longhorn Beetle (*Anoplophora glabripennis*)	Aesculus spp. *Fraxinus* spp. *Hibiscus* spp. *Betula* spp. *Acer* spp.	Near Toronto, ON	Very High	CFIA 2009; NBDNR 2013
Emerald Ash Borer (*Agrilus planipennis)*	*Fraxinus* spp.	Southeastern, ON; Carignan, QC	Very High	CFIA 2009; NBDNR 2013
Asian Cedar Borer (*Callidiellum rufipenne*)	*Juniperus* spp. *Thuja* spp.	Massachusetts, Rhode Island, Connecticut, US	Very High	Maier 2007; Maier and Lemmon 2000
Black Pine Bark Beetle (*Hylastes ater*)	*Pinus* spp. *Abies* spp. *Larix* spp. *Picea* spp. *Thuja* spp.	Various US ports	Very High	Haack 2001
Red-haired Pine Bark Beetle (*Hylurgus ligniperda*)	*Pinus* spp.	New York, US; Various US ports	Very High	USDA Forest Service 2000; Haack 2001
European Spruce Bark Beetle (*Ips typographus*)	*Picea* spp.	Pennsylvania and New Jersey, US	Very High	Haack 2001;
Hemlock Wooly Adelglid (*Adelges tsugae*)	*Tsuga* spp.	Georgia to Maine, US	Not listed	CFIA 2009; NBDNR 2013
Beech Leaf-mining Weevil (*Orchestes fagi)*	*Fagus* spp.	Halifax, NS	Not listed	NBDNR 2013
		Diseases		
Oak Wilt (*Ceratocystis fagacearum*)	*Quercus* spp.	Maine, US	Not listed	CFIA 2012b
Thousand Cankers Disease (*Geosmithia morbida*)	*Juglans nigra*	Pennsylvania, US	Not listed	USDA 2013

* This is not a complete list of positive detection locations, only those locations close to New Brunswick and the LSJR bioregion.

**Based on North American Forest Commission Exotic Forest Pest Information System (NAFC-ExFor) risk ratings

11.1 Climate change and severe weather - habitat shifting and alteration
(Summary Threat Ranking: **Unknown**)

The Earth's climate is warming as a result of anthropogenic emissions of greenhouse gases, such as carbon dioxide, methane, and nitrous oxide, originating from the burning of fossil fuels and land-use change (i.e., climate change; US CCSP 2009). The rate of global climate change observed over the last two decades is already having significant and wide ranging effects on the Earth's ecosystems and wildlife, and presents increasing challenges for species' adaptation (Nicholls et al. 2007).

Climate change also has localized effects. In the Atlantic Provinces mean temperature and summer rainfall are expected to increase by $3^{o}C$ and 0% to 10% respectively by 2040 as a result of climate change (Bourque and Hassan 2008). Bourque and Hassan (2008) modeled anticipated tree species habitat redistribution in the Acadian Forest of eastern Canada as a result of climate change, and their preliminary projections suggest that boreal species such as Black Spruce and Balsam Fir will be limited to the cooler areas of the province and temperate hardwood species such as Yellow Birch and Red Oak, as well as White Pine, will benefit from climate change. In another study, Phillips and Laroque (2007) predicted variable growth rate responses for tree species by 2100. Growth rates of Eastern Hemlock are predicted to increase by 60%, while Eastern White Cedar growth rates are predicted to decrease by 75% (Phillips and Laroque 2007).

In aquatic habitats, climate change is predicted to influence the biodiversity and distribution of freshwater fish (Curry and Gautreau 2010). Currently, fish communities are dominated by cool- to cold-water species within the bioregion, and in the greater Atlantic Maritime Ecoregion (Curry and Gautreau 2010). However, climate change will likely lead to habitat loss for cold water fishes (Klassesn and Locke 2010) via a further reduction in the availability of summer thermal refugia habitat. Concurrently, increasing habitat availability for species more tolerant of temperature fluctuations (e.g. Yellow Perch and the invasive Smallmouth Bass and Chain Pickerel) may occur, resulting in changes to fish communities and biodiversity, and in the overall pole-ward movement of fish distributions (Klassen and Locke 2010).

The Atlantic coast has been shown to be highly sensitive to rises in sea-level and storm impacts (Shaw et al. 1998; Daigle 2006; Daigle 2011). With increasing global temperatures, sea-level rise is predicted to accelerate (Daigle 2011). Daigle (2011) predicted an increase in approximately 12 cm in sea-level in Saint John by 2025 (relative to 2000 levels). The degree to which the coastline of the LSJR bioregion may experience physical changes (flooding, erosion, beach and salt marsh migration) due to climate change and accelerated sea-level rise is predicted to be high along the Fundy cliffs and moderate along the shores the St. John River (Shaw et al. 1998).

Increases in sea-level can also increase the risk of saltwater intrusion, which may pose a serious threat to the Skillet Clubtail in Canada (COSEWIC 2010a). The only known habitat for this species in New Brunswick is found within the bioregion near Fredericton and whose northern movement is thought to be barred by the Mactaquac Dam (COSEWIC 2010a). Storms and flooding also poses a risk to many bird species through reductions in fecundity. Six SAR and five BCR 14 bird species are currently affected by storms and flood events. One BCR 14 bird species is currently affected by habitat degradation via the shifting and alteration of habitat.

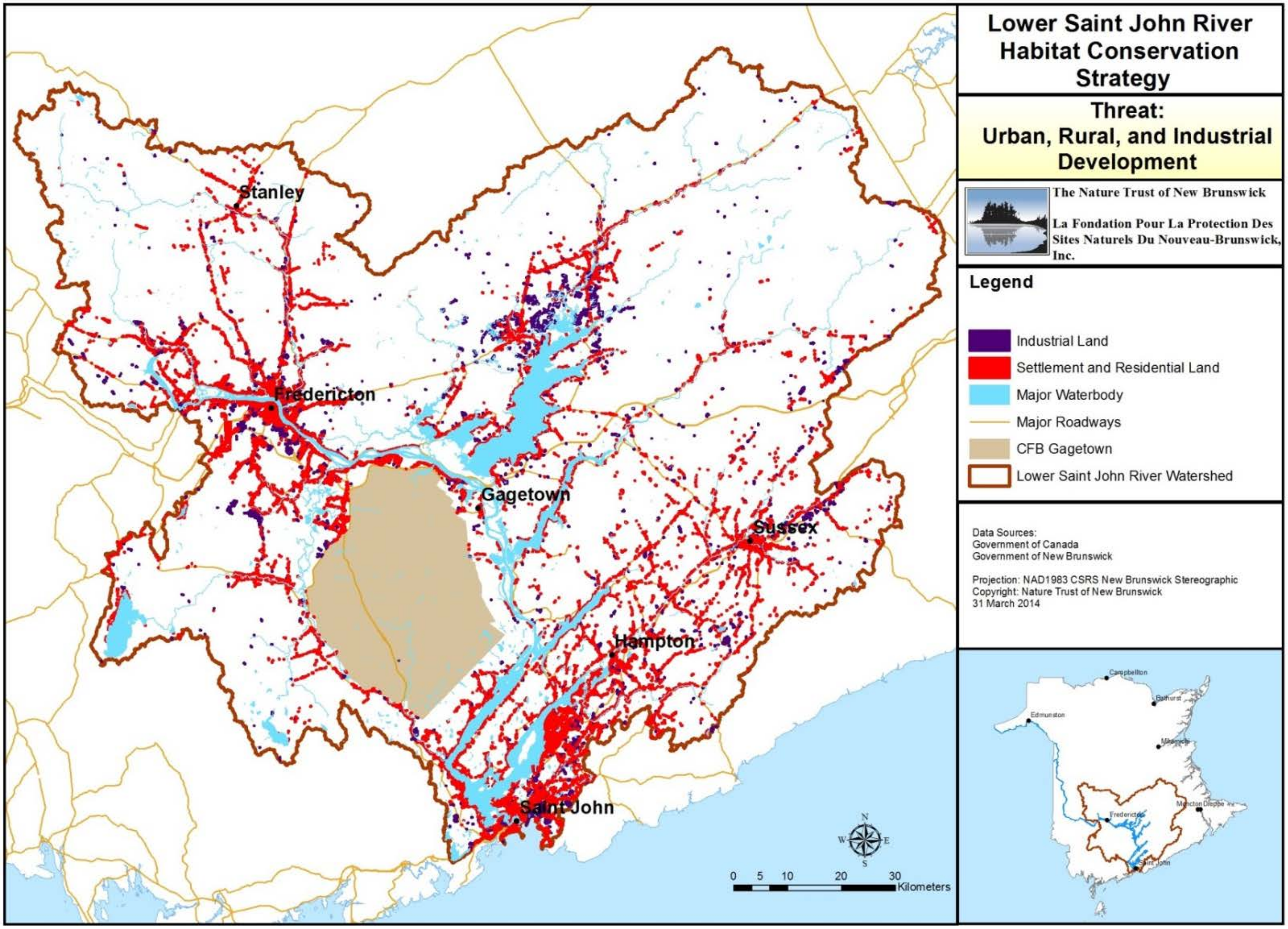

Fig. 15. Urban, rural and industrial development in the LSJR bioregion.

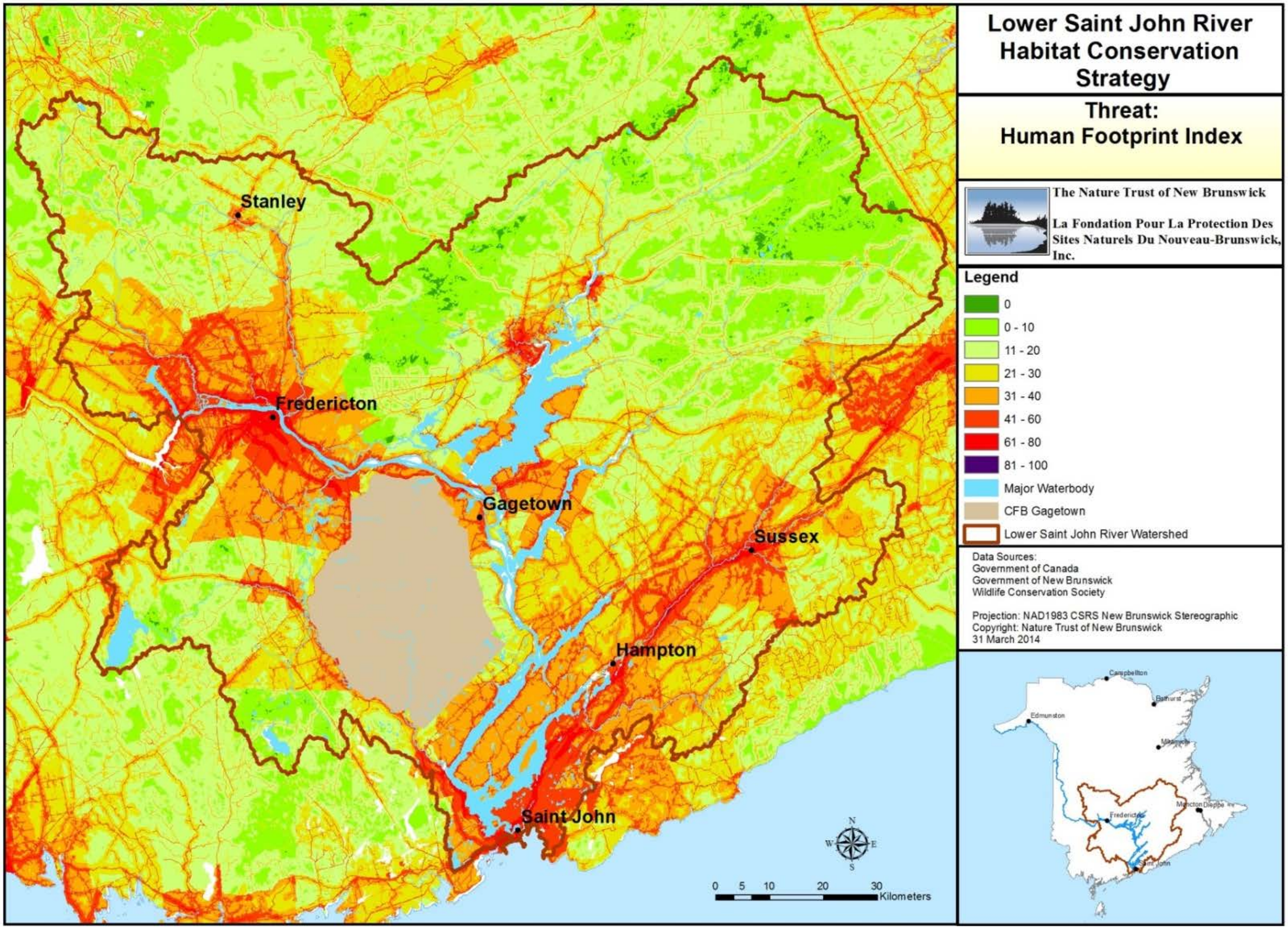

Fig. 16. Human Footprint Index in the LSJR bioregion.

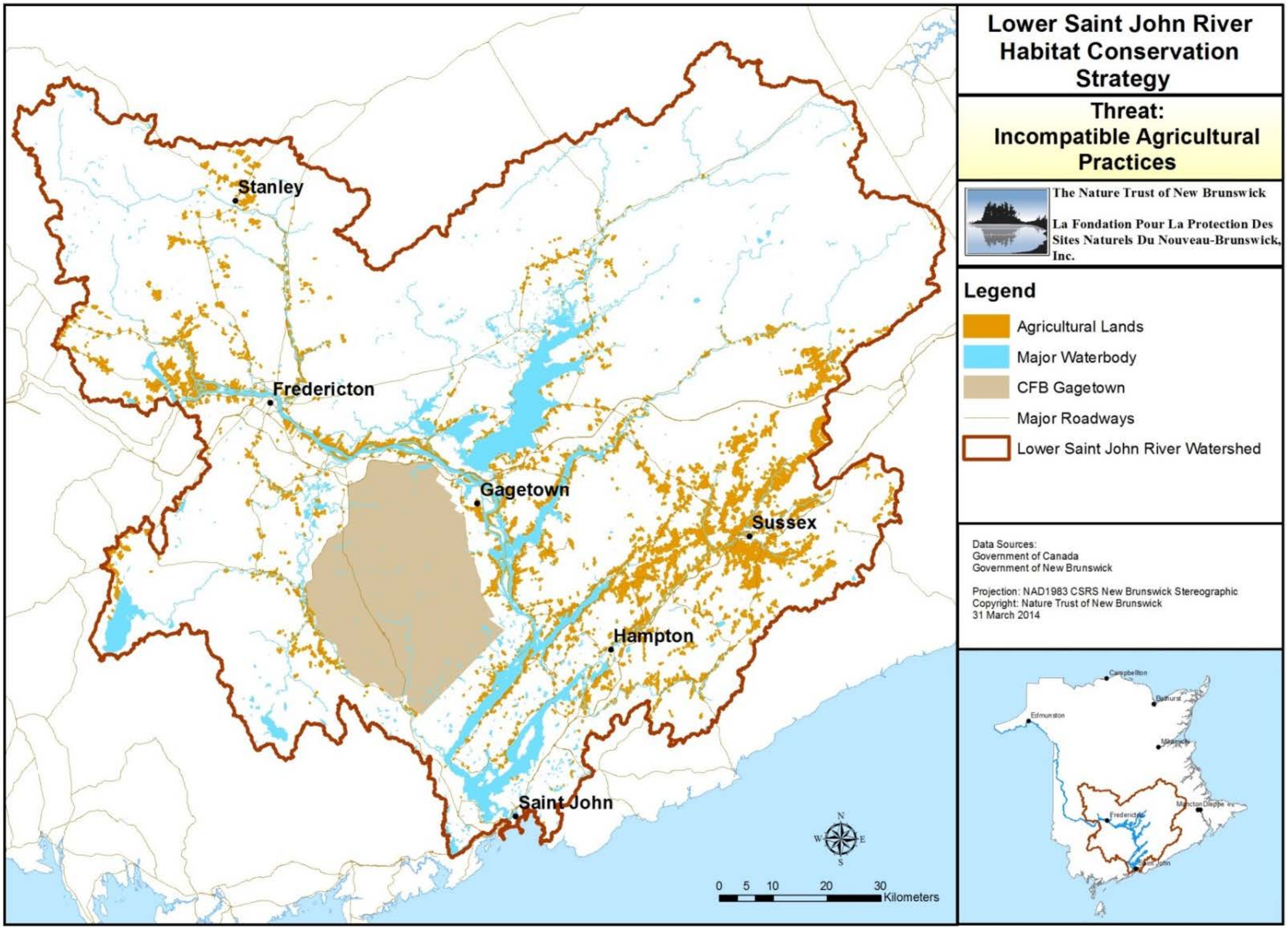

Fig. 17. Areas vulnerable to incompatible agricultural practices in the LSJR bioregion.

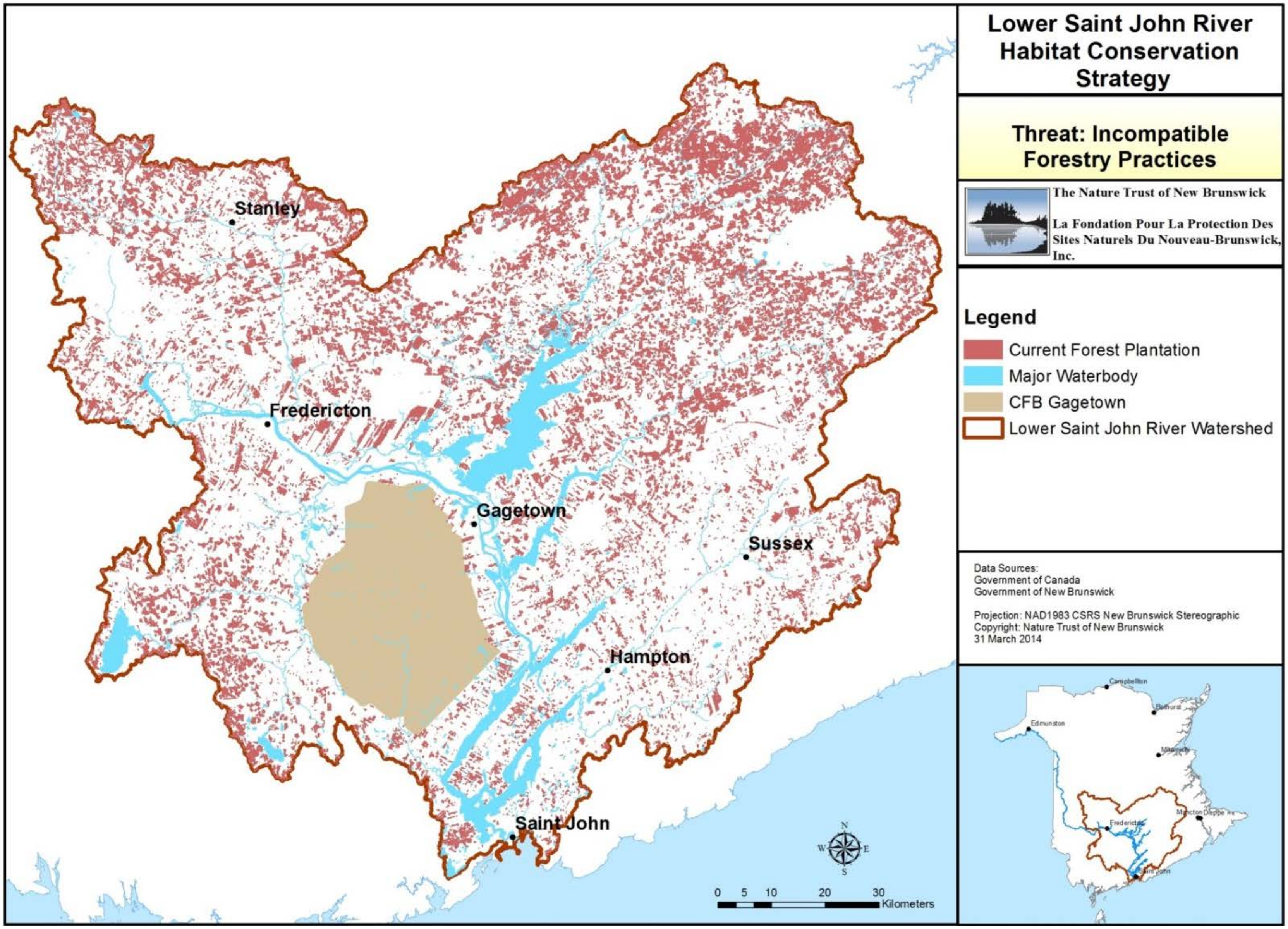

Fig. 18. Areas vulnerable to incompatible forestry practices in the LSJR bioregion.

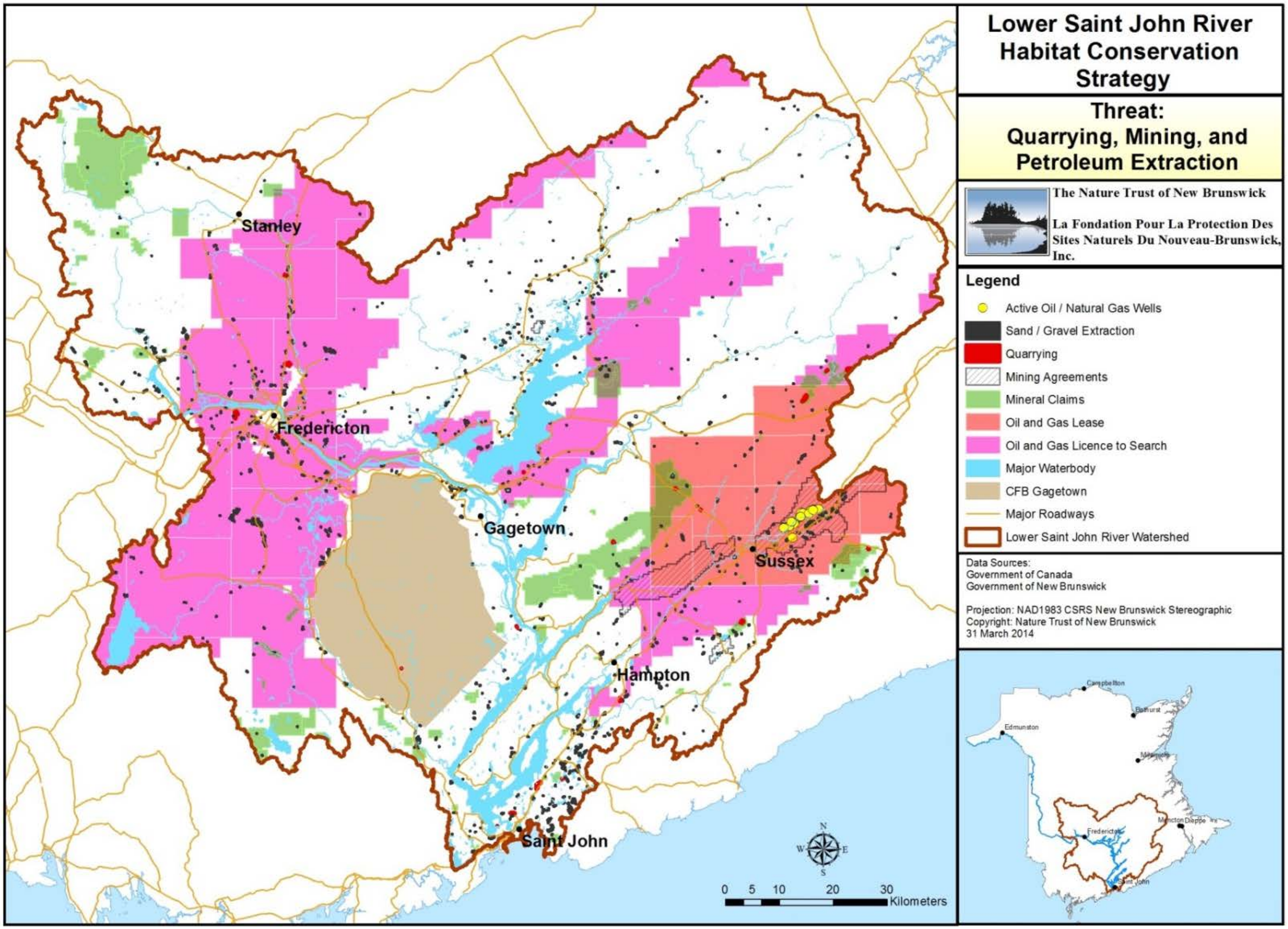

Fig. 19. Areas vulnerable to quarrying, mining and petroleum extraction activities in the LSJR bioregion.

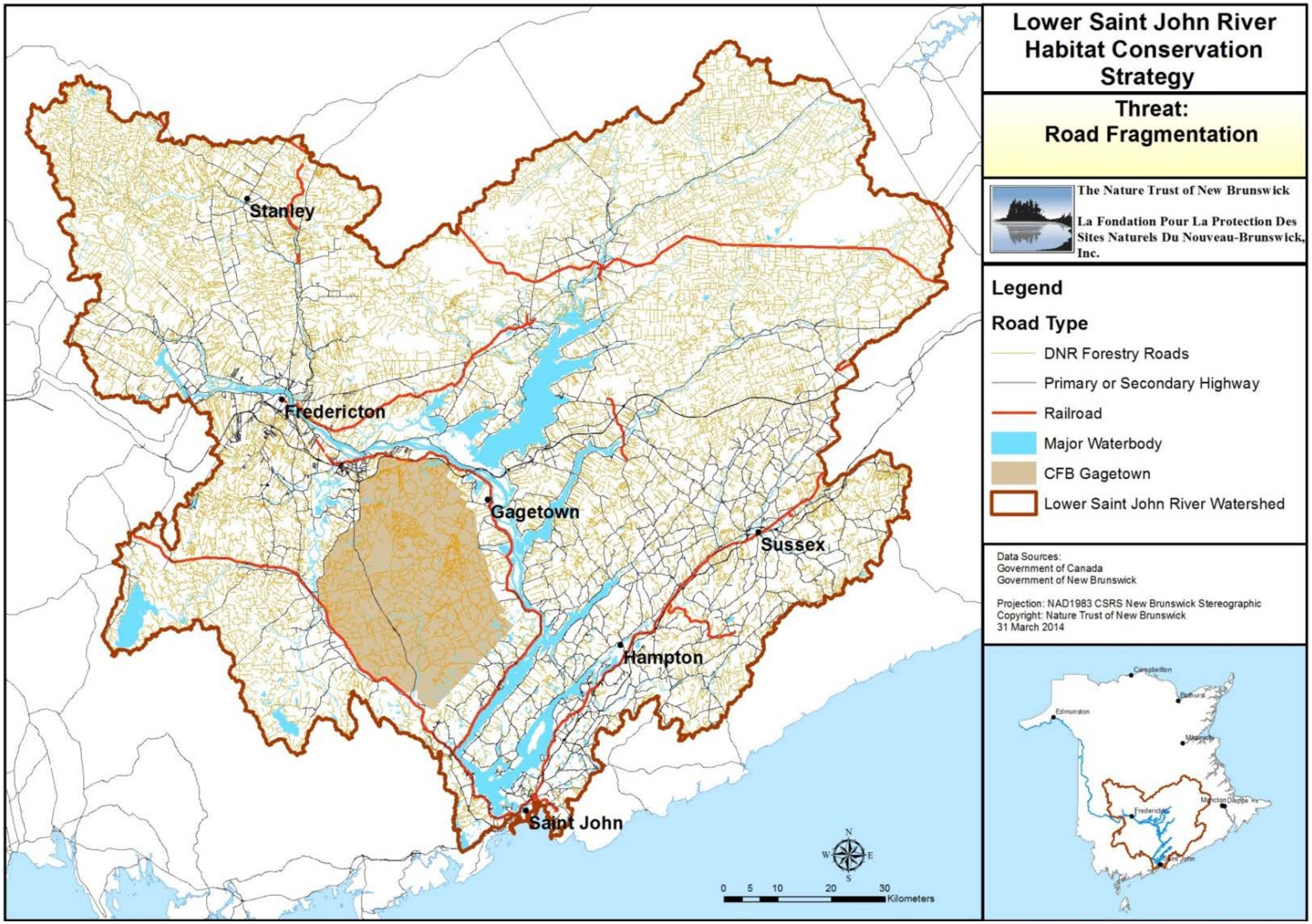

Fig. 20. Road fragmentation in the LSJR bioregion.

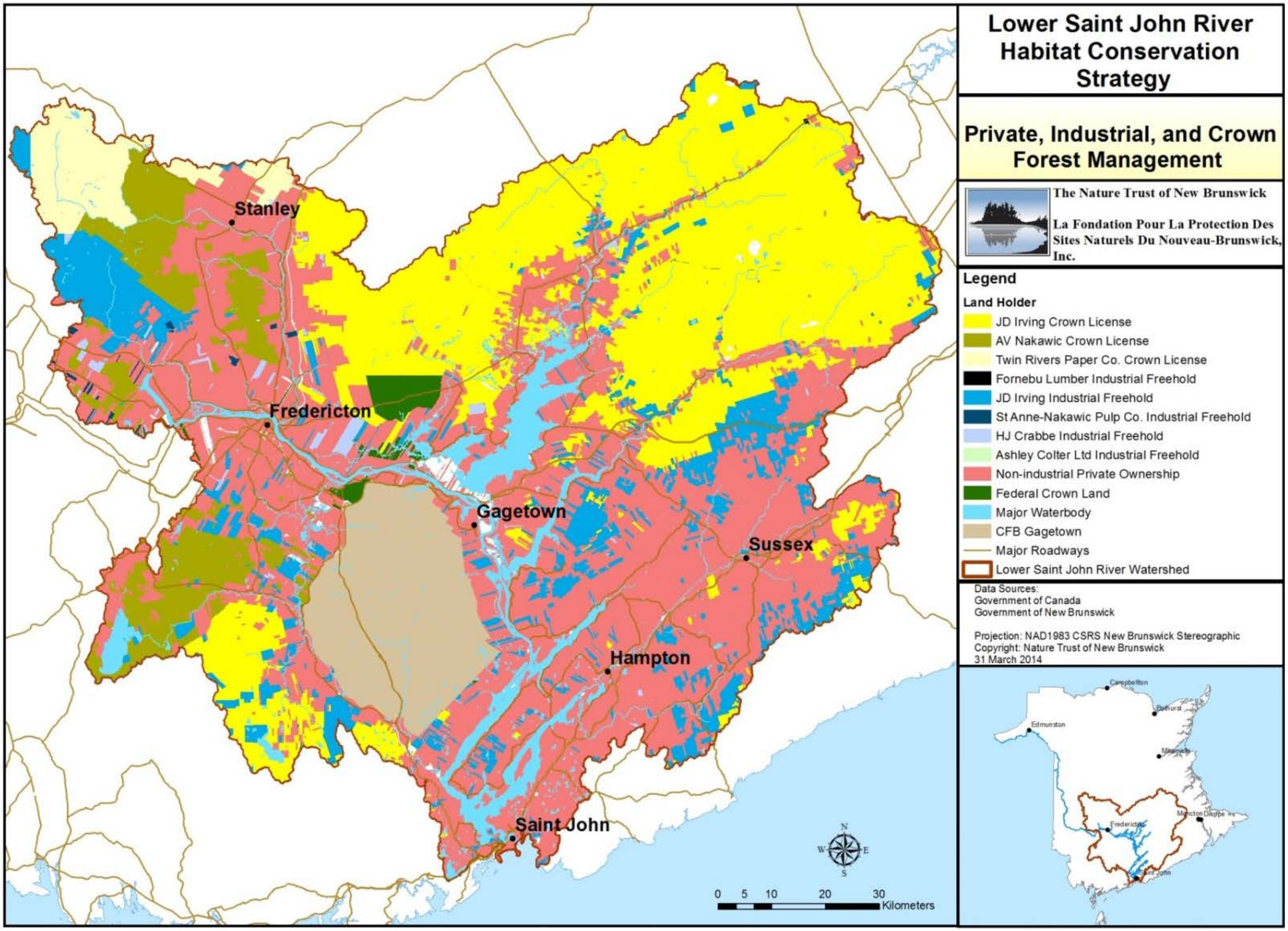

Fig. 21. Private, industrial and Crown Forest Management Zones in the LSJR bioregion.

C. Habitat spatial prioritization

As part of this Habitat Conservation Strategy, methodologies were developed to define and combine a series of priority habitats with priority species composites to identify areas within the LSJR 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 consulted, 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 threat 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 different approaches to conservation may be required for the conservation of different species and the habitats that host them (i.e. land acquisition versus stewardship).

<u>Habitat Classification and Data Pre-processing</u>

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 (e.g. 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 (e.g. 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 D (p. 160). 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. Oromocto River).

<u>Habitat Patch Weighting</u>

The process for assigning priority ranks to habitats 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 D (p. 160). 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.

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 D 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. Lower St. John River floodplain near Gagetown or Sussex), overshadowing the importance of wetlands and forests in these areas. Please refer to Fig. 22 (p. 59) and Fig. 23 (p. 60).

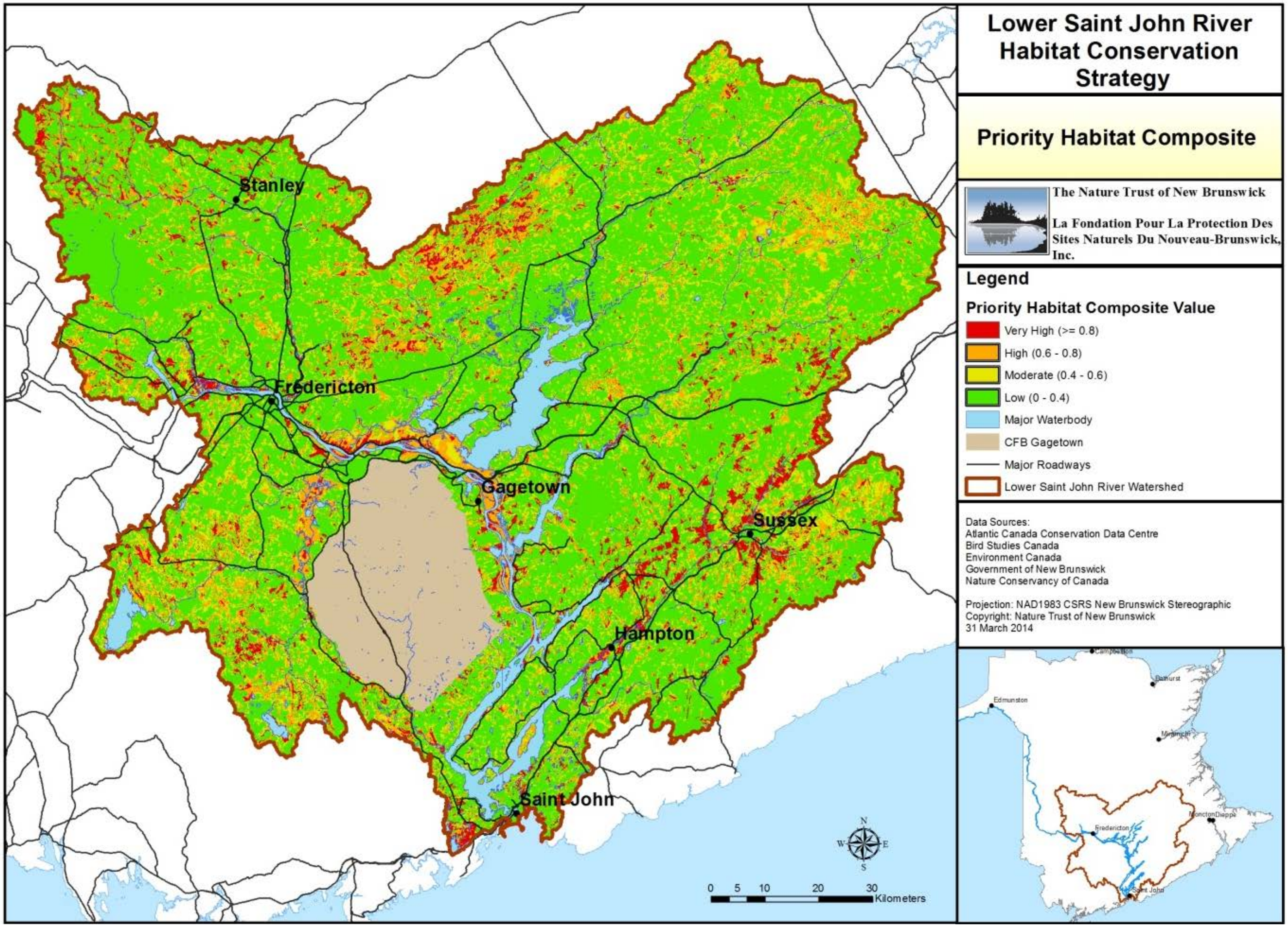

Fig. 22. Priority habitat composite for the LSJR bioregion.

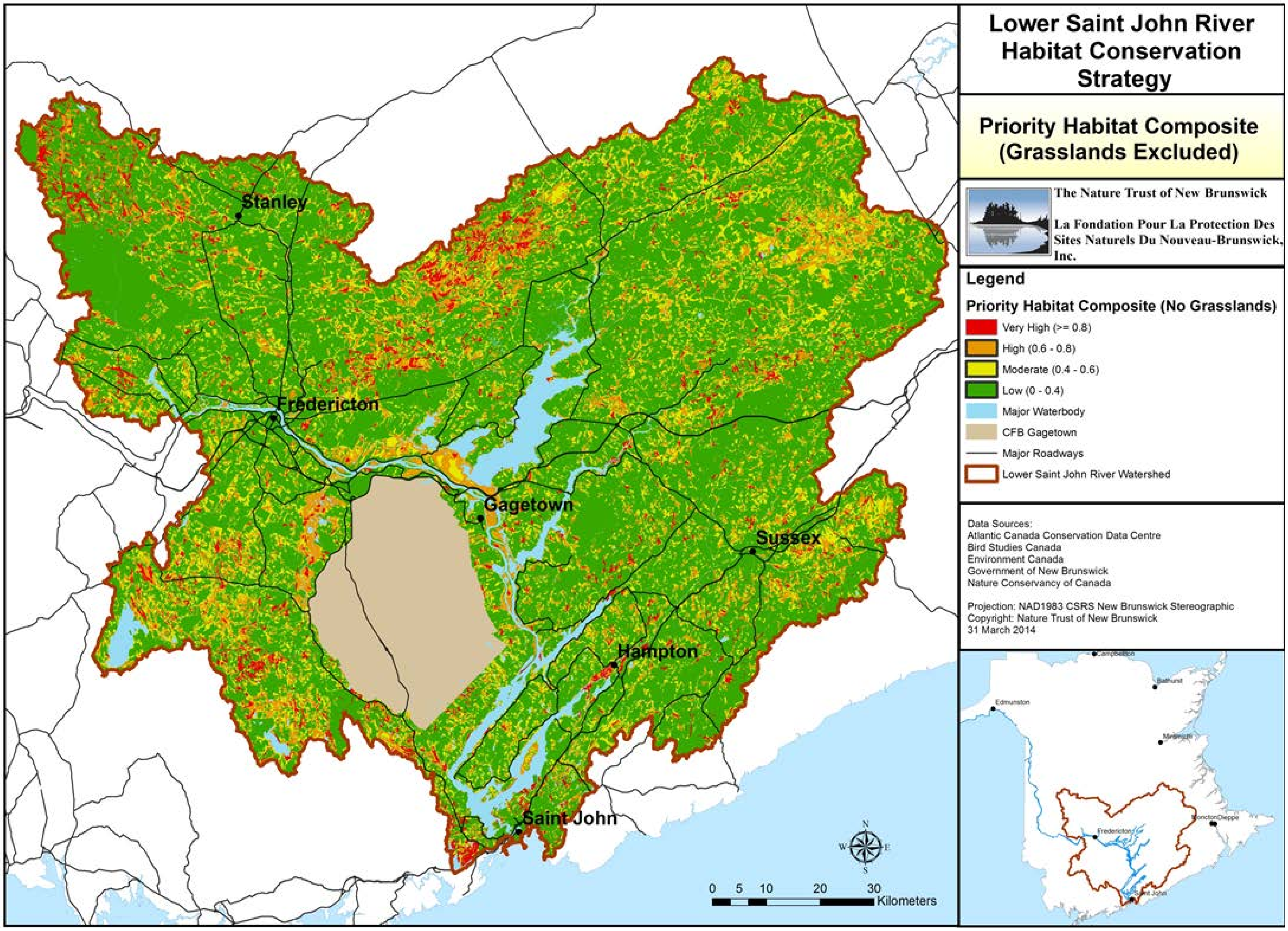

Fig. 23. Priority habitat composite for the LSJR bioregion (excluding grasslands/agro-ecosystems).

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. Ha

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 (Table 12) 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. 24). 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 (Figs. 24-34, p. 63-73). Table 9 (p. 62) 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 Table 12 in Appendix A, while a list of the datasets and species included in each species composite map are presented in Table 17 in Appendix E (p. 168). 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.

Table 9. Summary of all habitat, species and CVI composite maps for the LSJR bioregion.

Fig.	Composite	p.	Description of Map Contents
22	Habitat composite	59	All priority habitats, showing relative patch values,
23	Habitat composite (excluding grasslands/agro-ecosystems)	60	All priority habitats, showing relative patch values, grasslands/agro-ecosystems habitats excluded
24	Species composite of all priority species	63	All priority species of concern identified in the LSJR Habitat Conservation Strategy
25	Species composite of all species at risk	64	All species at risk known occurrences in the LSJR
26	Species composite of bird species at risk	65	All bird species at risk known occurrences in the LSJR bioregion
27	Species composite of non-bird species at risk	66	All non-bird species at risk known occurrences in LSJR bioregion
28	Species composite of the relative abundance of priority bird species	67	Relative abundance of birds across the LSJR bioregion
29	Species composite of the breeding evidence of priority bird species	68	Documented breeding evidence for birds breeding in the LSJR bioregion for which relative abundance measures could not be derived otherwise from point count data.
30	Species composite of rare non-bird species	69	Rare non-bird species known occurrences across the LSJR bioregion
31	Species composite of rare amphibians and reptiles	70	Rare Amphibians and reptiles known occurrences across the LSJR bioregion
32	Species composite of rare terrestrial invertebrates	71	Known occurrences of rare terrestrial invertebrates across the LSJR bioregion
33	Species composite of rare mammals	72	Known occurrences of rare mammals across the LSJR bioregion
34	Species composite of rare plants, lichens, and bryophytes	73	Known occurrences of rare plants, lichens, and bryophytes across the LSJR bioregion
35	Conservation Value Index	75	All priority habitats and all priority species
36	Conservation Value Index (excluding grasslands/agro-ecosystems)	76	All priority habitats, grasslands/agro-ecosystems excluded, and all priority species

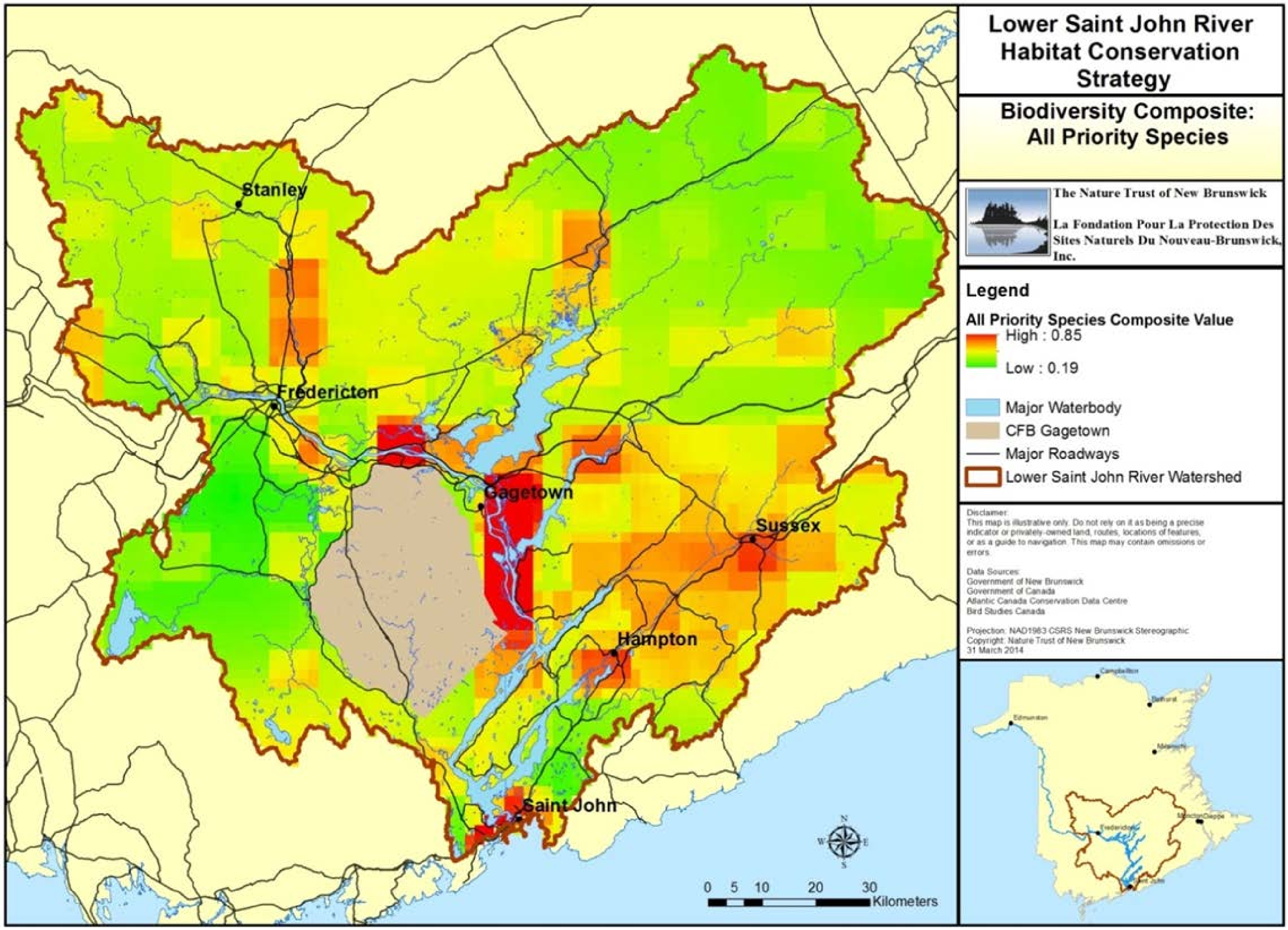

Fig. 24: Species composite of all priority species in the LSJR bioregion.

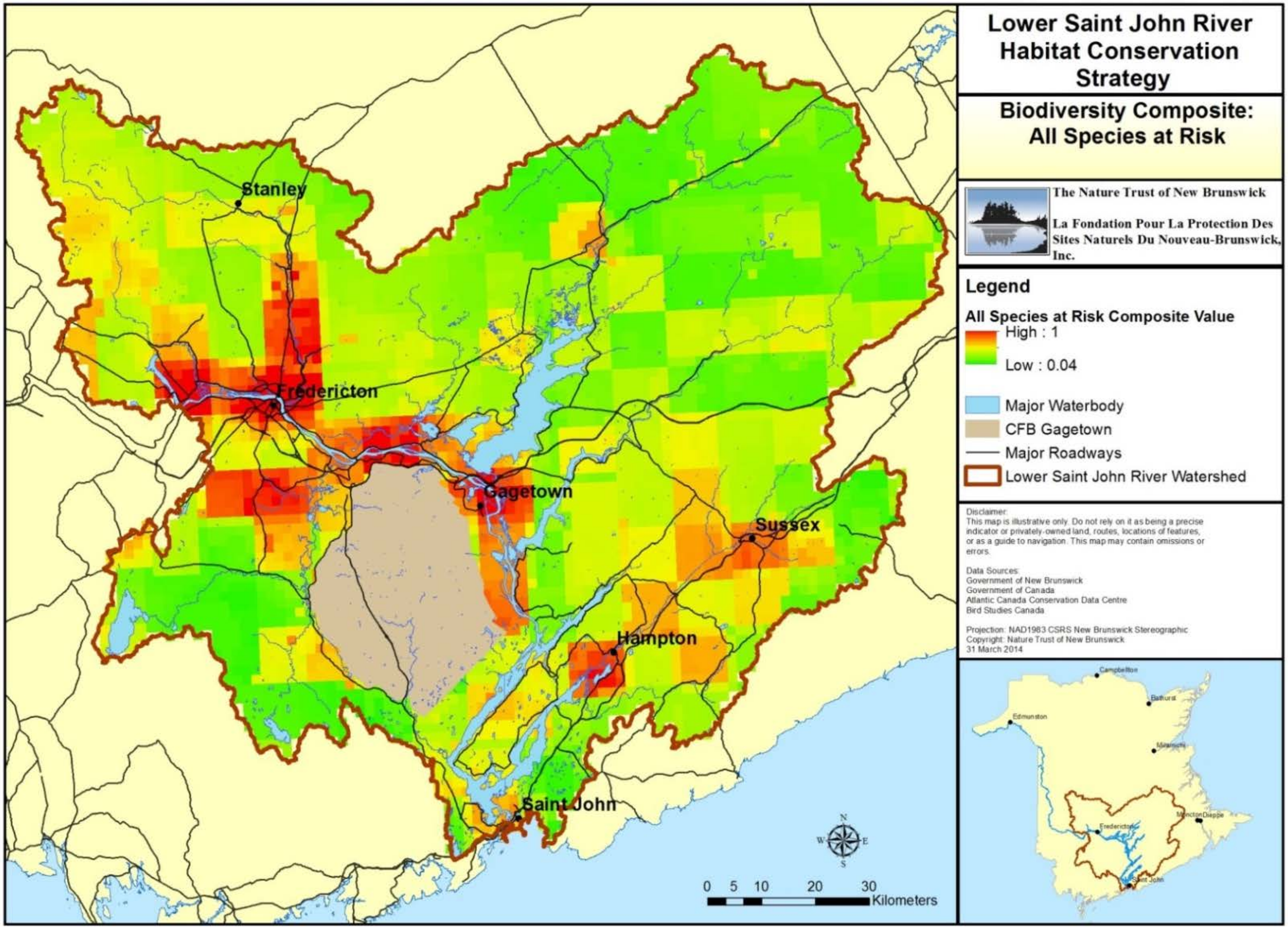

Fig. 25: Species composite of all COSEWIC-listed species at risk in the LSJR bioregion.

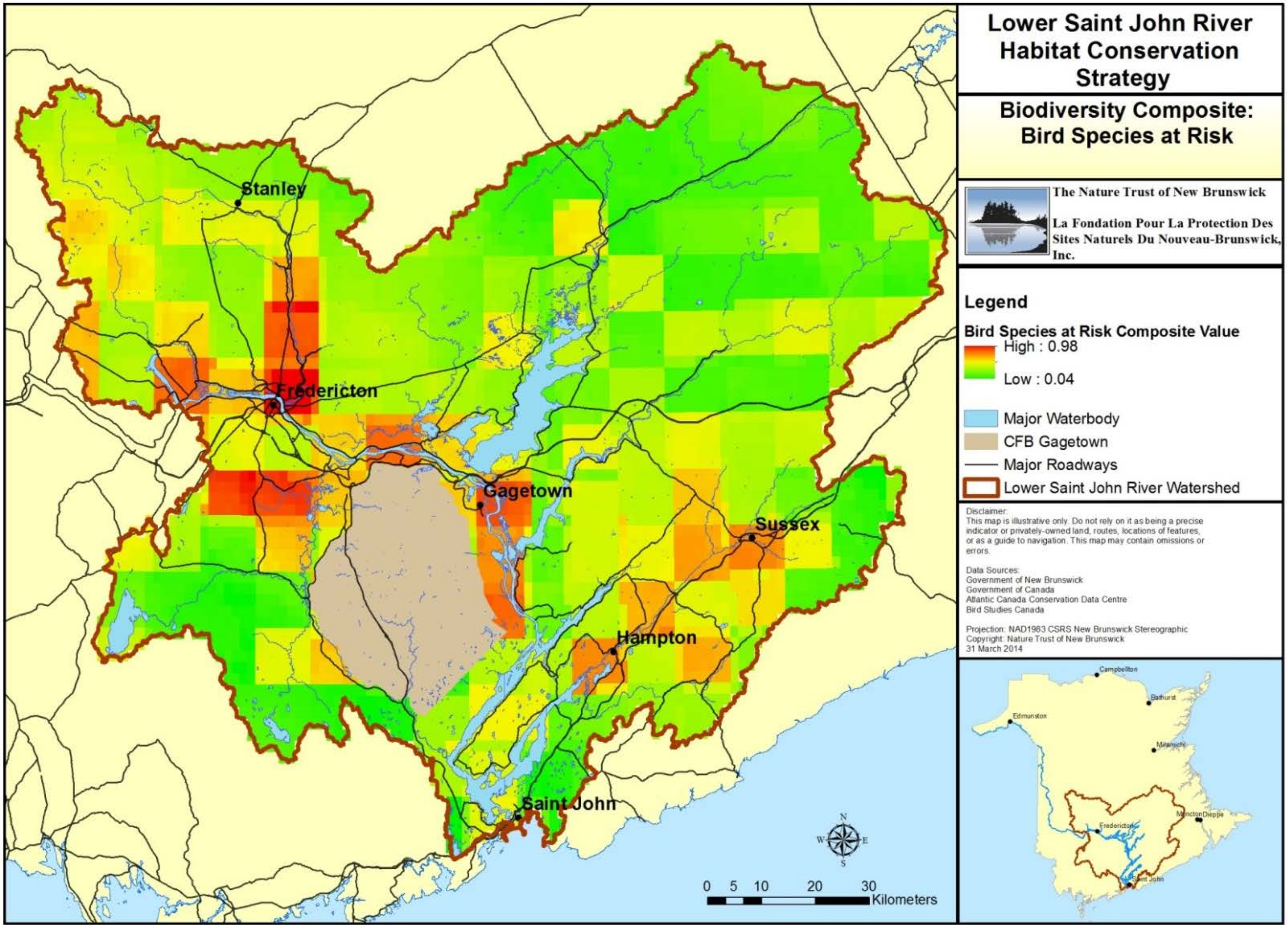

Fig. 26: Species composite of bird COSEWIC-listed species at risk in the LSJR bioregion.

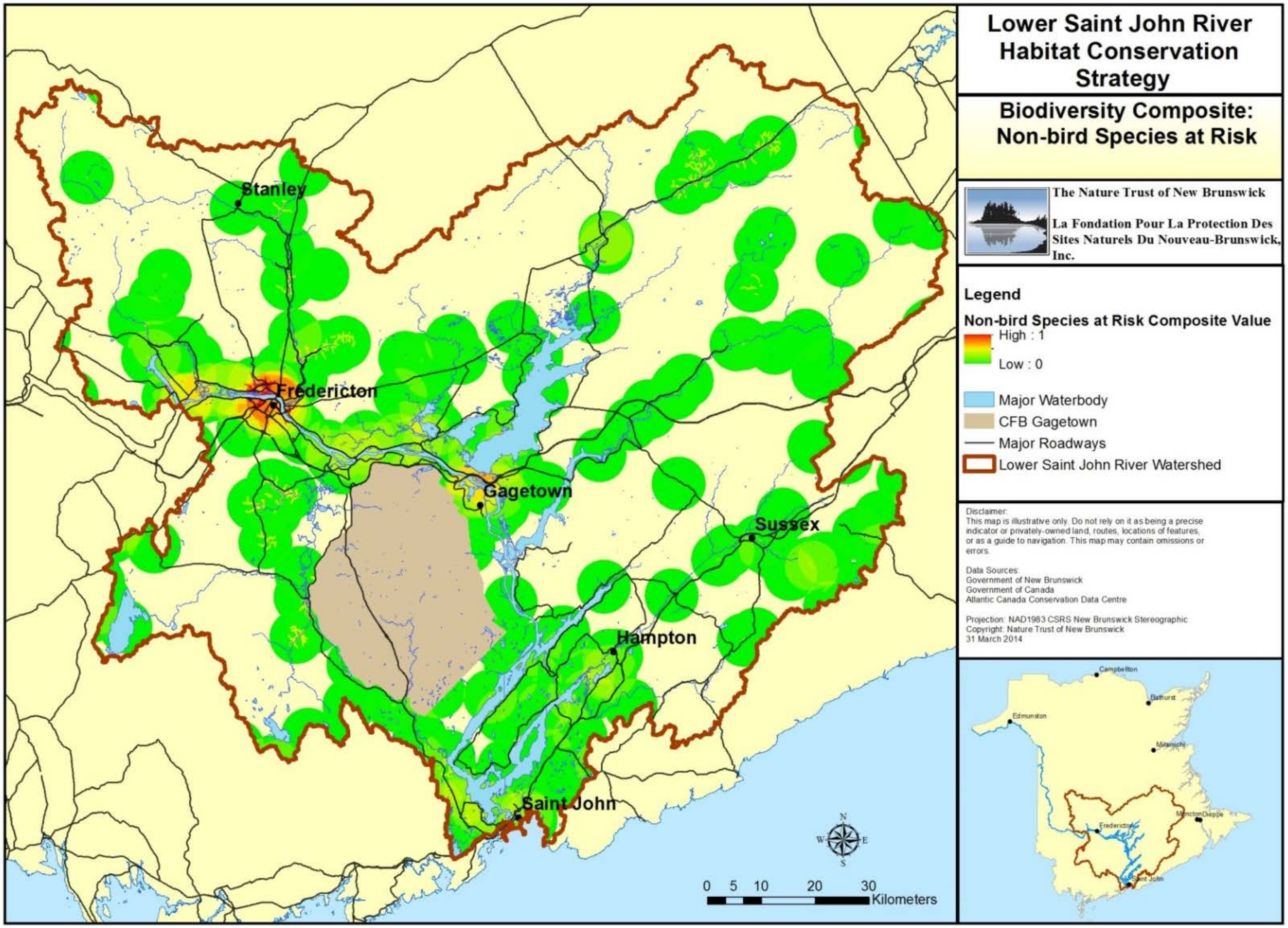

Fig. 27: Species composite of non-bird COSEWIC-listed species at risk in the LSJR bioregion.

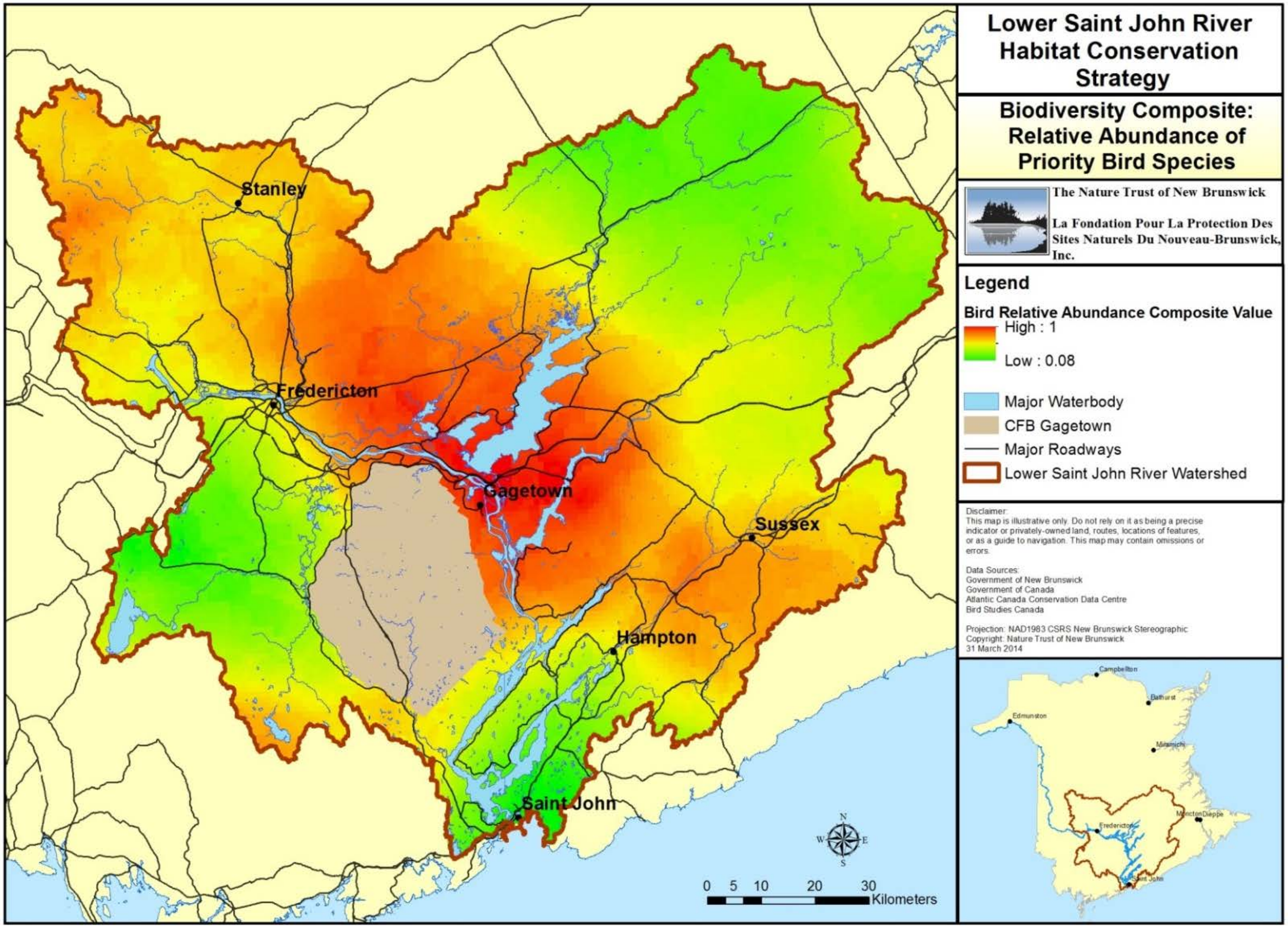

Fig. 28. Species composite of the relative abundance of priority bird species in the LSJR bioregion.

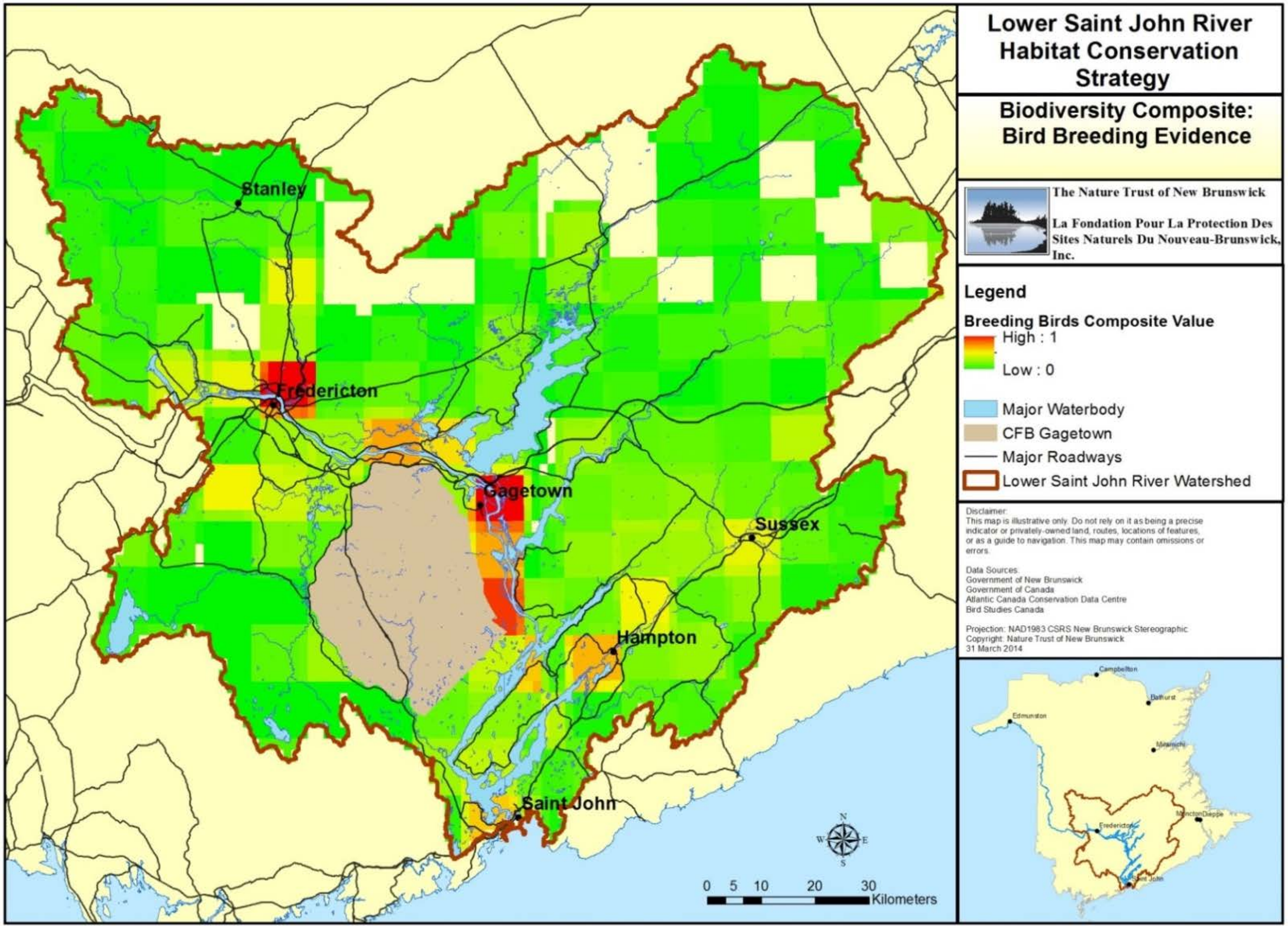

Fig. 29. Species composite of the breeding evidence of priority bird species in the LSJR bioregion.

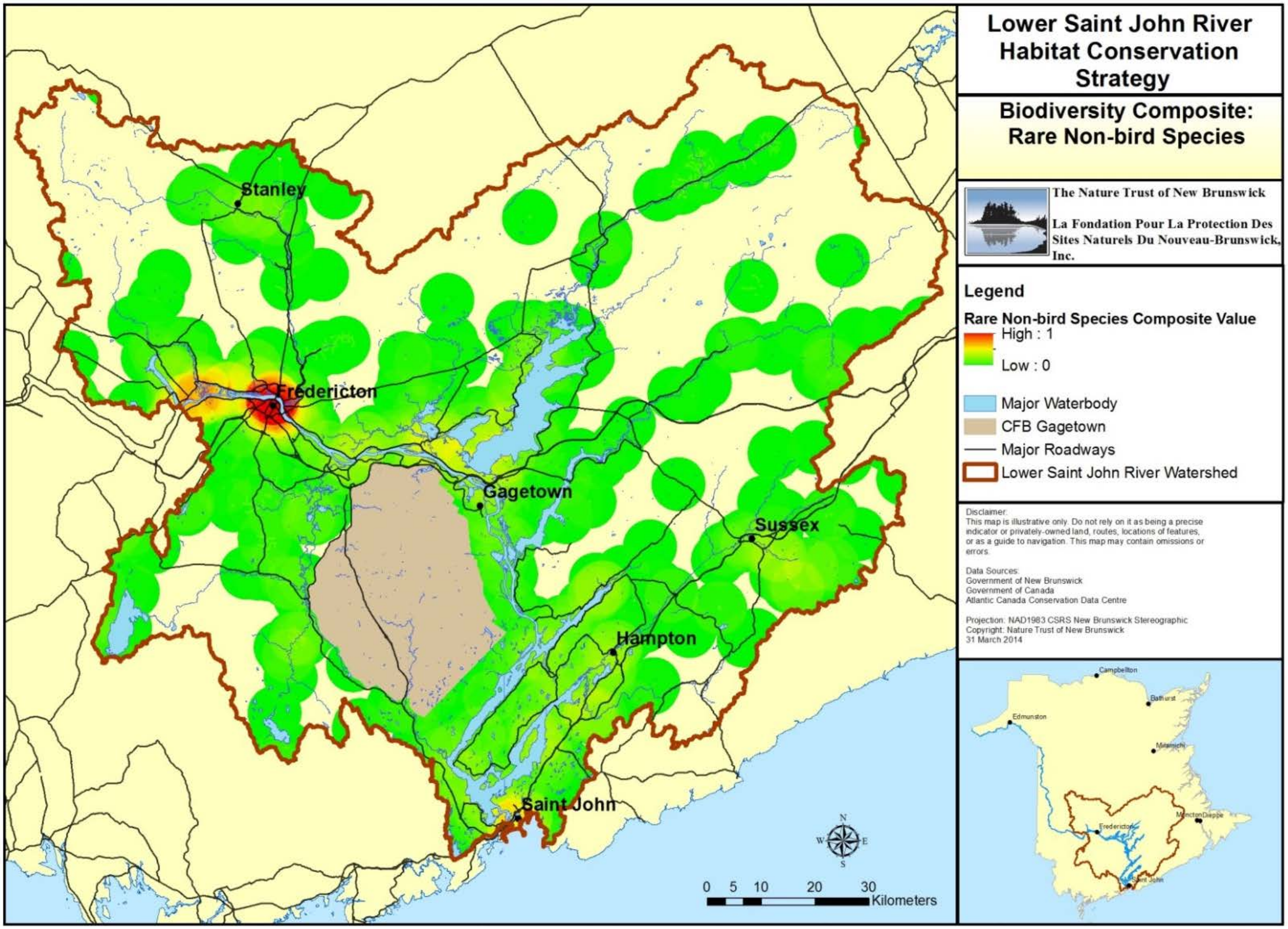

Fig. 30. Species composite of rare non-bird species in the LSJR bioregion.

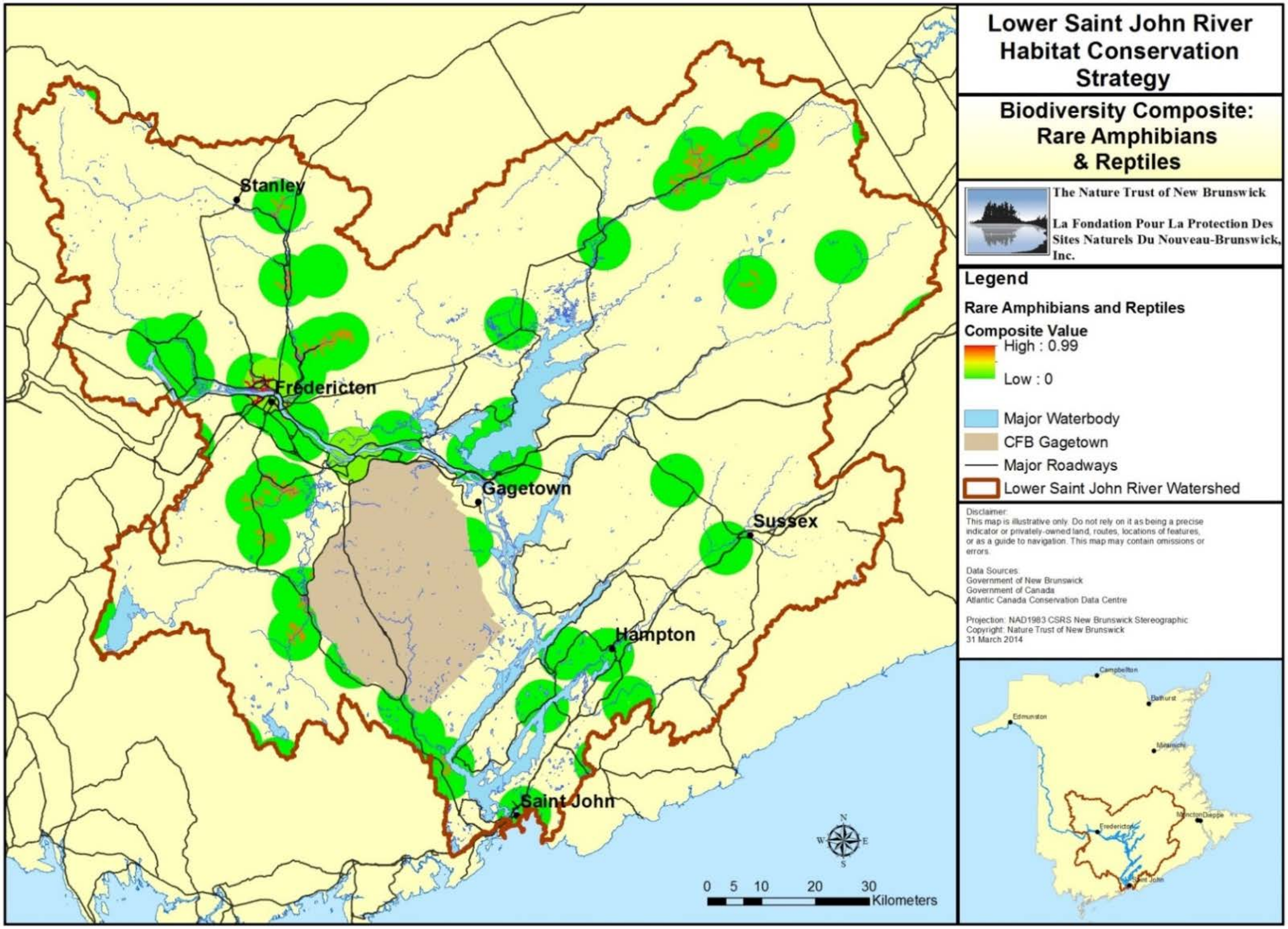

Fig. 31. Species composite of rare amphibians and reptiles in the LSJR bioregion.

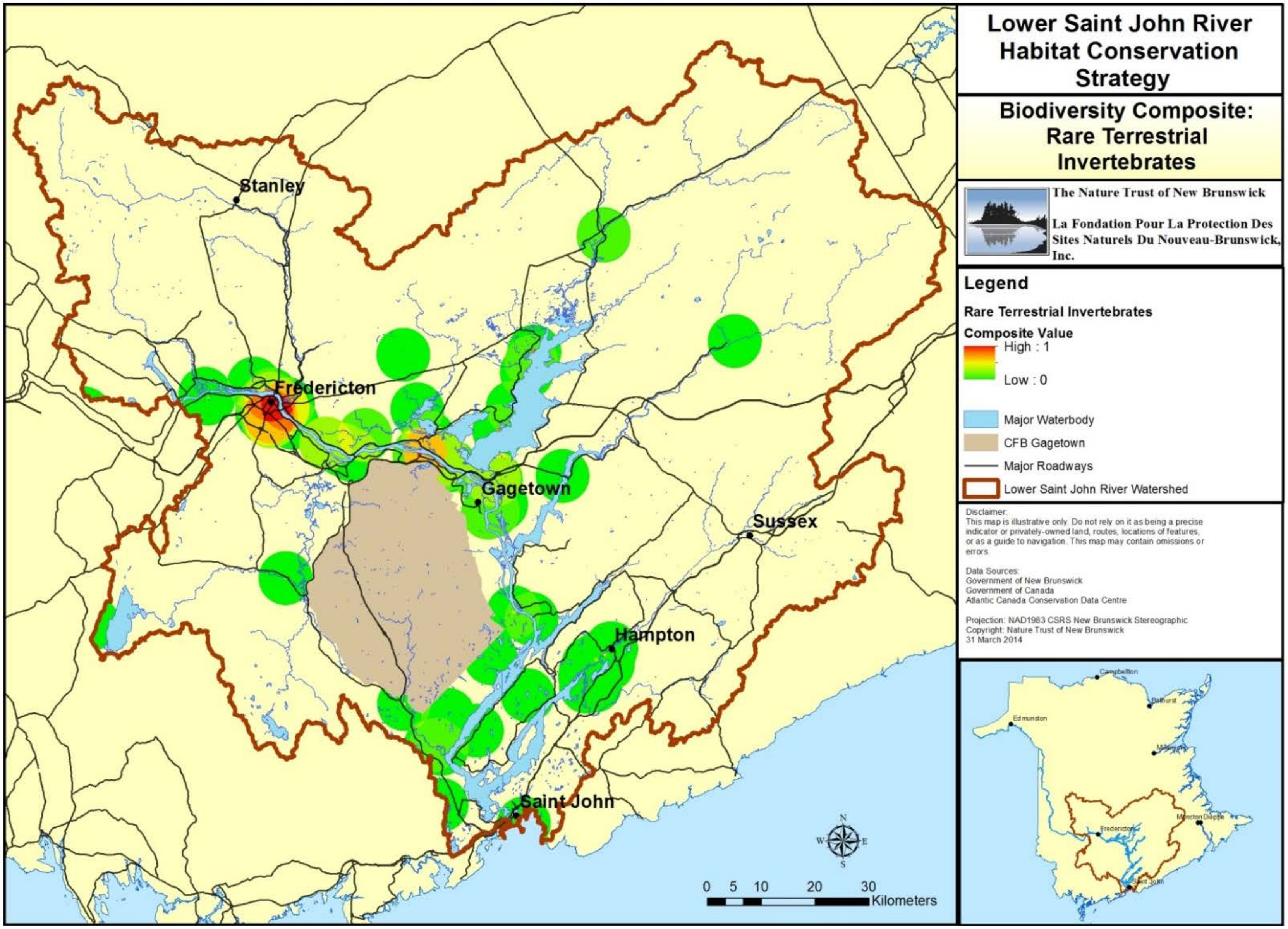

Fig. 32. Species composite of rare terrestrial invertebrates in the LSJR bioregion.

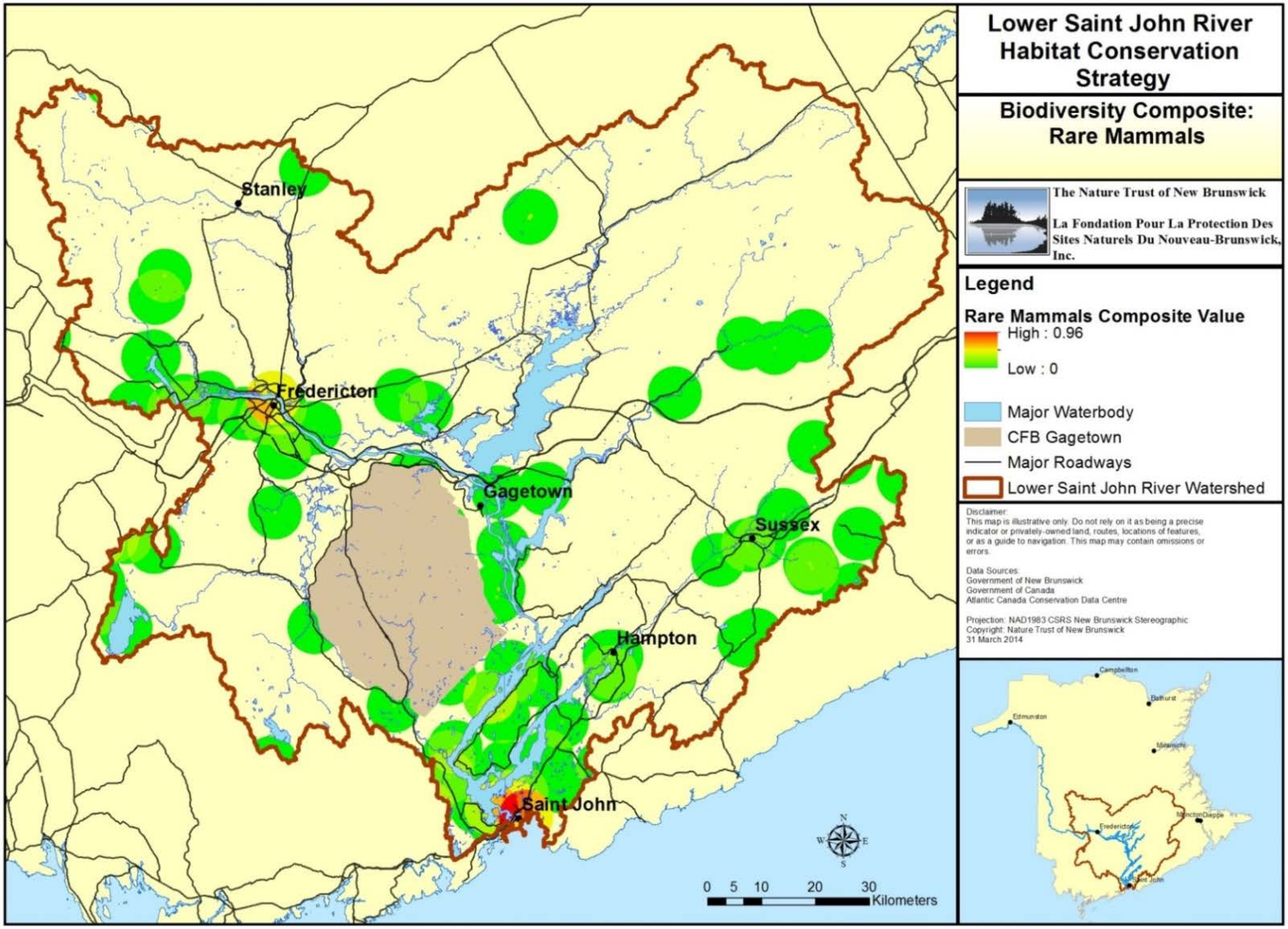

Fig. 33. Species composite of rare mammals in the LSJR bioregion.

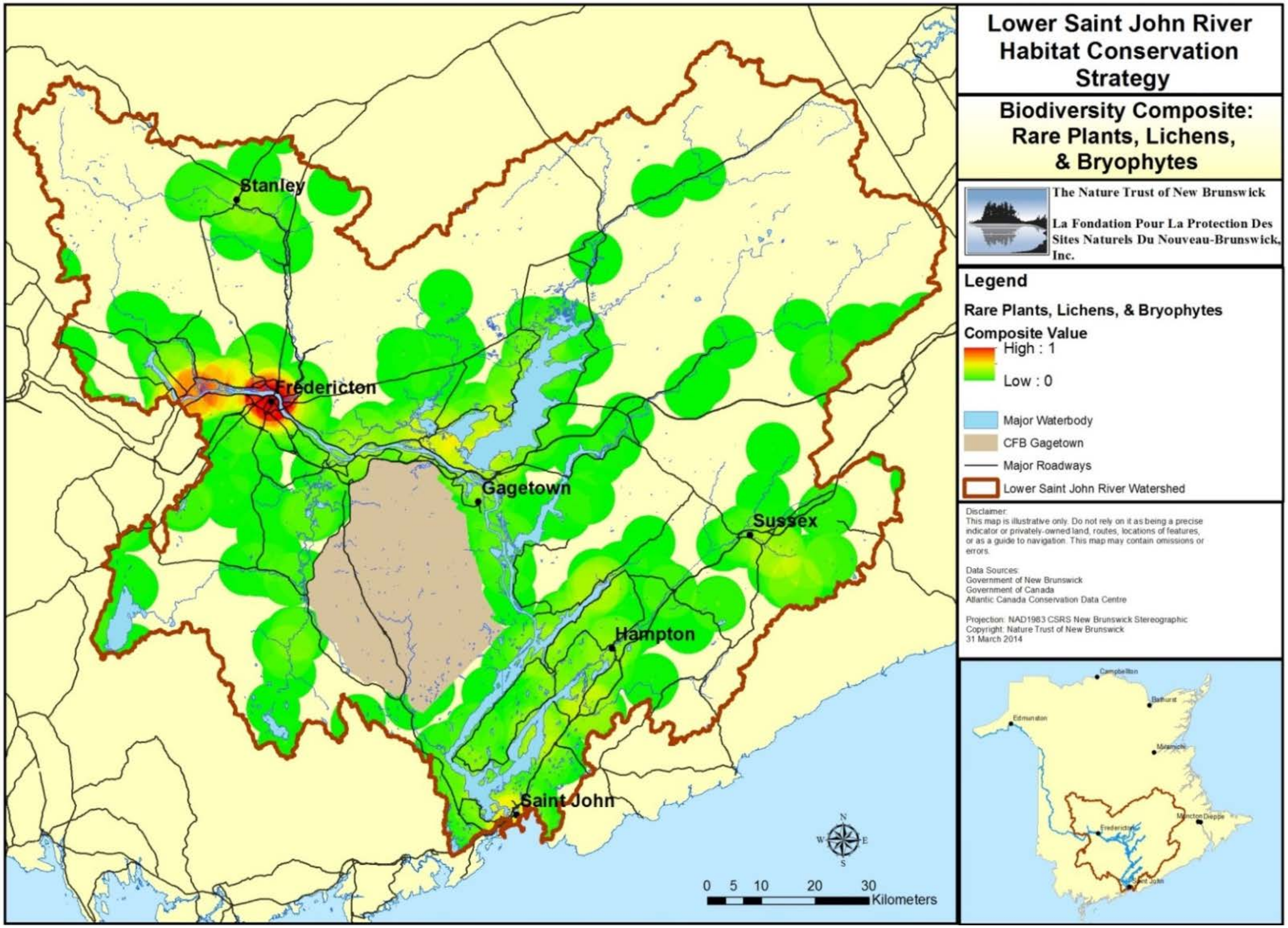

Fig. 34. Species composite of rare plants, lichens and bryophytes in the LSJR bioregion.

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 LSJR is presented in Fig. 35 (p. 75) (including grasslands/agro-ecosystems) and Fig. 36 (p. 76) (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. 36) thus provides a necessary complement to the initial CVI for occasions when heavily managed habitats are not considered a conservation priority. Table 10 provides a summary of the results of the CVI analysis (*grasslands/agro-ecosystems included*).

Table 10. Summary results for the Conservation Value Index for the LSJR bioregion, grasslands/agro-ecosystems included (does not include CFB Gagetown).

Conservation value	Ranking interval	Area (ha)	% of bioregion
Very high	≥1 - 3.23	205 669	13
High	0.8 - 1	195 719	12.7
Moderate	0.6 - 0.8	254 823	16.5
Low	0 - 0.6	754 288	49
Protected	N/A	58 070.12	3.7

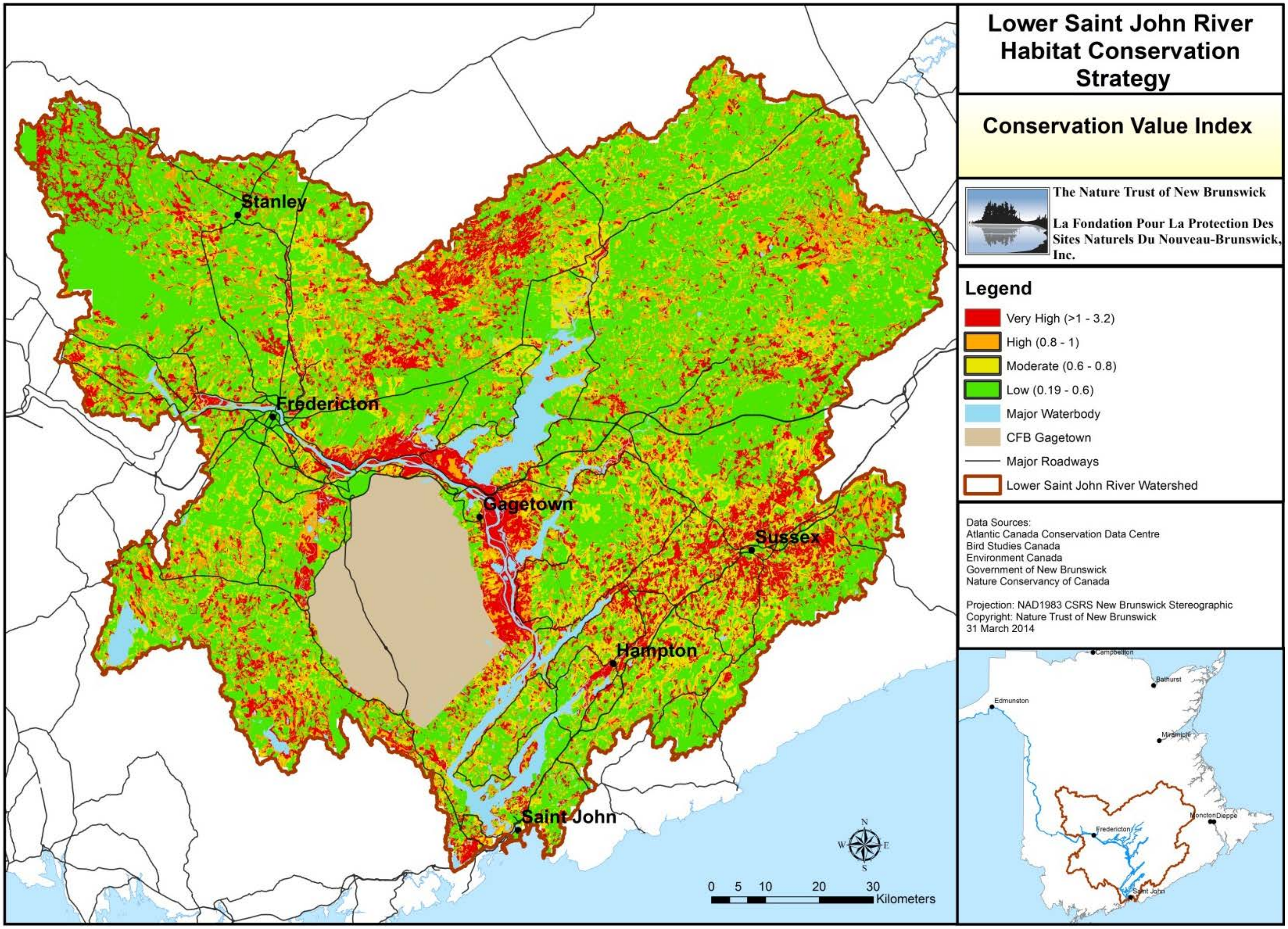

Fig. 35. Conservation Value Index for the LSJR bioregion.

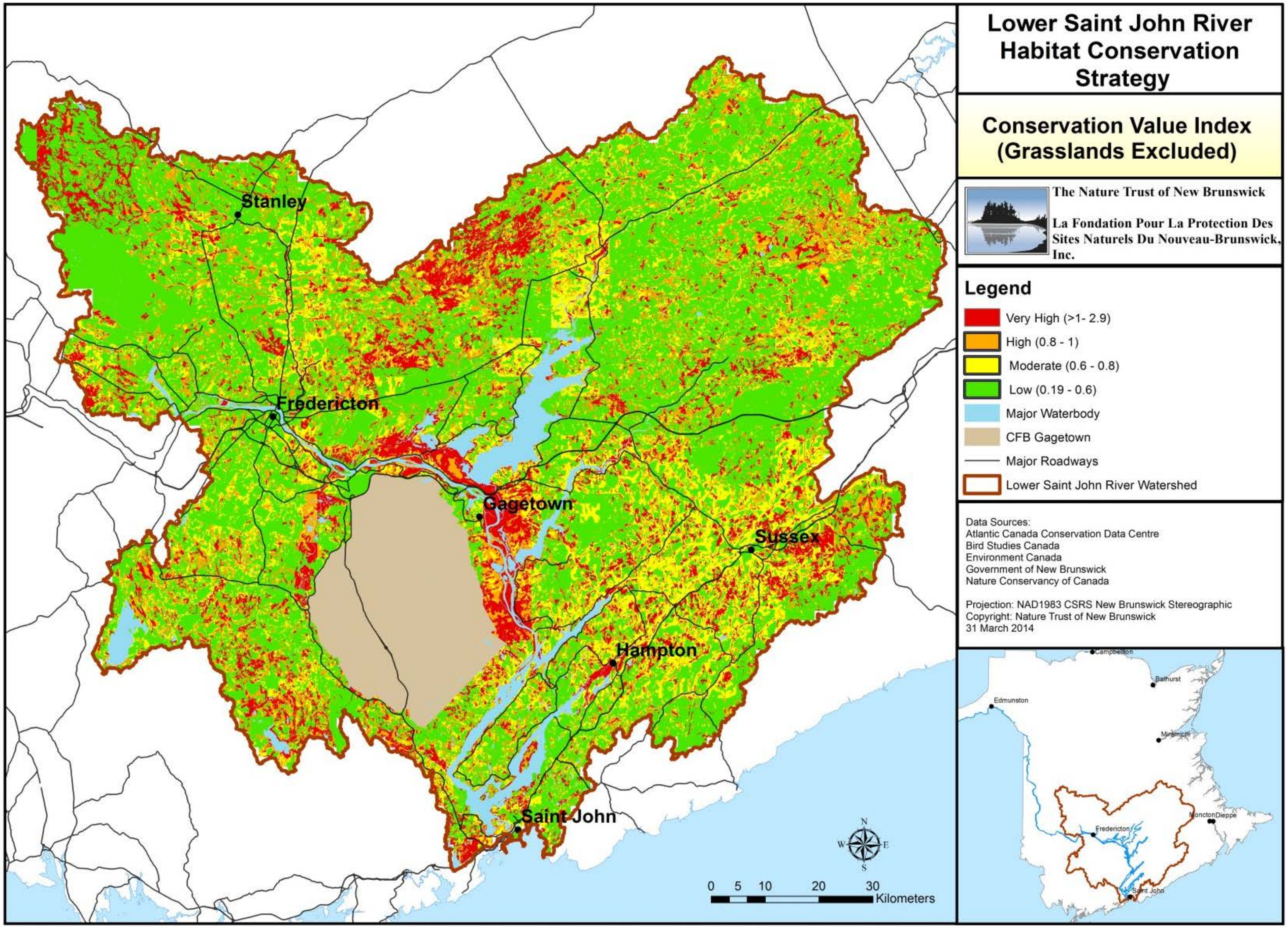

Fig. 36. Conservation Value Index (excluding grasslands/agro-ecosystems) for the LSJR bioregion.

3. CONSERVATION ACTIONS

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, following an ecosystem approach, 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.

A. 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.

B. Conservation partners

Environment Canada – Canadian Wildlife Service

The Canadian Wildlife Service has a mandate which focuses on migratory birds, species at risk and their habitats, and is centered on the implementation of the Migratory Bird Convention Act, Canada Wildlife Act, Species at Risk Act, Canadian Environmental Protection Act and the Federal Policy on Wetland Conservation. CWS identifies, designates and protects important habitats as National Wildlife Areas under the Canada Wildlife Act. Within the LSJR, bioregion, in addition to managing the Portobello Creek National Wildlife Area and conducting migratory bird surveys, CWS provides support for activities that benefit species at risk through its main funding programs, the Habitat Stewardship Program (HSP) and the Aboriginal Fund for Species at Risk (AFSAR). Additional funding resources include The HSP and AFSAR Prevention Stream (for species other than species at risk), and the National Conservation Plan – National Wetland Conservation Fund, the Gulf of Maine Initiative, and the Ecological Gifts Program. Environment Canada also funds the EcoAction Community Funding Program, the Atlantic Ecosystem Initiatives and Environmental Damages Fund. CWS works closely with its partners in development of recovery documents for species at risk and supports activities described within recovery documents for the completion of schedule of studies for the identification of critical habitat. CWS supports the EHJV, and provides science guidance to conservation partners on conservation actions and priorities for migratory birds, species at risk and their habitats, including involvement in the development, refinement and implementation of HCSs, and the NB Bird Conservation Region 14 Strategy.

CWS shares its migratory bird survey data and expertise to inform biodiversity and habitat conservation initiatives that contribute to meeting not only the CWS mandate but also the broader mandates and objectives of its conservation partners. CWS is supportive of the Habitat Conservation Strategy approach as it represents how species and habitat data can be compiled and assessed in ways that benefit a broader suite of conservation-oriented user-groups.

The Nature Trust of New Brunswick

The Nature Trust of New Brunswick (NTNB) is a charitable land trust dedicated to the acquisition of private lands in order to ensure that biological diversity is protected in perpetuity. Conserving habitat in the LSJR watershed is a primary focus of the NTNB, both through land acquisition, and by working with landowners to promote private land stewardship and species at risk awareness. The organization owns twelve properties within the watershed, several of which are notable for a presence of species at risk. Ministers Face, for example is the preserve at which the first discovery of the extremely rare wall-rue fern was made in New Brunswick. Boar`s Head Preserve supports the very rare Anticosti aster and the extremely rare maidenhair spleenwort. Some of the other preserves along the LSJR watershed support rare plants such as Brunet's milk vetch, Rand's goldenrod, Huron tansy, red milkwort, narrow-leaved gerardia, and the small-flowered gratiola. The organization continues to work with communities in the vicinity of these species at risk habitat to educate land owners and the general public about threats to these species, and the importance of protecting them. The Nature Trust of New Brunswick is now actively focusing on the high value conservation areas highlighted in this Habitat Conservation Strategy in order to take a strategic approach to conservation planning. The high conservation value areas identified in this HCS will be used to guide the organization's efforts to build partnerships and work closely with landowners to reduce threats to habitats and species by increasing the amount of private land permanently protected in the LSJR bioregion.

Bird Studies Canada

Bird Studies Canada (BSC) is Canada's national charitable organization dedicated to bird science, conservation and education. Since 1967, our mission has been to advance the understanding, appreciation, and conservation of wild birds and their habitats in Canada and elsewhere, through studies that engage the skills, enthusiasm, and support of our members, volunteers, and the interested public. In addition to engaging roughly 30,000 volunteer "Citizen Scientists" per year, BSC's work is facilitated and supported by federal, provincial, industry, and other NGO partnerships. In the Atlantic region, BSC's programs focus on bird population monitoring, species at risk and their associated habitats. Of particular interest to the LSJR watershed, we (1) coordinate with citizens to monitor annual population trends of owl species across NB (Nocturnal Owl Survey, 2001-present); (2) monitor and promote community and individual stewardship for roost and nest sites of Chimney Swifts (Maritimes Swiftwatch, 2010-present); and (3) monitor occurrence, population trends, and habitat associations of waterfowl and wetland-associated species (Maritimes Marsh Monitoring Program (MMMP), 2011-present). The latter program is of particular importance to the LSJR region, in that much of our work is concentrated in the freshwater wetlands of the Grand Lake region, but extends to saltwater wetlands at near Saint John, Saint George, and in the Musquash Marine Protected area. As well, the MMMP has been designed to provide a link between the EHJV's habitat conservation and restoration activities and waterfowl and wetland-associated species population goals. Currently in its 3rd year, this program has already made good progress identifying baseline numbers and developing acoustic monitoring protocols for wetland- associated species. We plan to incorporate a stronger citizen-science component to the MMMP, to encourage greater community engagement and stewardship of important wetlands in the Maritimes.

Canadian Parks and Wilderness Society New Brunswick Chapter (CPAWS NB)

Canadian Parks and Wilderness Society (CPAWS) is New Brunswick's voice for wilderness. Since 1963, CPAWS has worked to ensure that nature comes first in parks management, and that protected areas maintain and enhance Canada's wild nature. Our vision is that at least one-half of Canada's public lands, freshwater and ocean environments will remain permanently wild in the public trust. CPAWS' NB chapter was established in 2004 to: encourage the protection of New Brunswick's wild ecosystems in parks and protected areas; promote awareness and understanding of nature through education, appreciation and experience; and work co-operatively with governments, First Nations, businesses, other organizations and individuals to find solutions to nature conservation challenges. In the LSJR watershed, CPAWS NB is working with the public to ensure that protected natural areas on public land are managed to conserve the nature within them, and that public lands are managed to conserve ecosystem integrity, diversity and resilience.

The Canadian Rivers Institute

The Canadian Rivers Institute (CRI) is an internationally recognized research institute based out of the University of New Brunswick. The CRI network, comprised of a number of leading research scientists from across the country, work collaboratively towards advancing river, estuary, and watershed sciences. The CRI's multidisciplinary, cross-sectoral approach emphasizes research based on societal demands while addressing the challenges of sustaining, healthy aquatic ecosystems. This innovative model merges academic ideas-based and applied needs-based science to promote the rapid transfer of new knowledge to regulatory agencies to create effective public policy and provide technical guidance to provincial and federal agencies. The CRI provides these services to both the public and private sectors assisting them to address their unique aquatic health and management challenges.

The CRI has a long history of contributing to the ongoing research efforts in the St. John River watershed. In 2011, the CRI, in collaboration with New Brunswick Environmental Trust Fund, published the St. John River Report. This State of the Environment report was carried out in order to provide an accurate and concise picture of the environmental quality of this ecosystem. The report is a synthesis of recent and historical data information and ongoing studies regarding common indicators of freshwater environmental quality and also describes trends in the condition of these indicators along the St. John River.

The CRI has also been integral to Canadian Water Network's (CWN) Canadian Watershed Research Consortium, which aims to support regional efforts to design and use watershed-level cumulative effects monitoring frameworks structured to support decision-making in land use management, natural resource management, impact mitigation and others. The CRI has led a number of projects in the Saint John Harbour under the Consortium. The main research objective of the Saint John Harbour project is to build consistency in monitoring programs in the Saint John Harbour by understanding the spatial and temporal variability in sediment contaminants, macroinvertebrates and the best biosentinel species being determined by this project. The goal of the research is to design a long term monitoring program for the harbour that is recognized by regulators and users, and enable the incorporation of the information with partners and end users.

The Conservation Council of New Brunswick

The Conservation Council of New Brunswick (CCNB) has been a key advocate for water protection in the province of New Brunswick since its founding in 1969. CCNB was founded in response to the alarm felt by citizens, academics and naturalists to the pollution the St. John River was experiencing in the 50's and 60's. Siltation and wastewater discharge were top of mind issues when the new organization did a day-long teach-in at the Legislature in 1969. The quality of the St. John River has since increased tremendously with regulations enforcing standards for industrial wastewater and municipal effluent discharge.

CCNB currently has staff working in our Forest, Water, and Marine / Fundy Baykeeper programs. We also have a No Child Left Inside project working with elementary schools to facilitate the teaching of existing curriculum outside in nature. Current activities that tie in with the LSJR HCS include St. John River access mapping; participation in stakeholder processes to strengthen the wetland conservation policy; public education activities (including No Child Left Inside); advocacy for protective forestry policy; a campaign to ban shale gas developments; Intervention before CEAA on the Sisson Mine Project in the Nashwaak watershed; engagement on the proposed Energy East Pipeline including preparations to intervene before the NEB.

Department of National Defense:
5th Canadian Division Support Base Gagetown

In the 21st century, no military strategy can be considered complete unless it recognizes and manages the risks that damaging the environment will pose to the military's readiness. The Army's Environmental Strategy implicitly recognizes these risks and acknowledges our moral obligation to protect the environment, while offering a roadmap for the way ahead. Our direction today is "Restoring the Past, Protecting the Present and Sustaining the Future". The Army's commitment to environmental sustainable activities is not new; in fact, the Army has a mature and robust environmental programme with baseline funding and a history of formal environmental management dating back to 1994 for 5th Canadian Division Support Base Gagetown. What is new, however, is an enhanced commitment from the senior leadership to not only support environmental officers, but also insist on environmental factors being taken into account from the earliest planning stages though to operations.

As an institution with a long and storied history in Canada, the Army has a tradition of providing leadership and inspiration to the other Federal organizations and Canadians, and a continuing responsibility to do so. Its stance on environmental issues is no exception. The Army must, therefore, be above reproach in its environmental practises, a leader in both words and deeds. It must provide the generation of Canadians with further proof that the Army will continue to do the right thing for right reasons and this is no exception at Base Gagetown. Base Gagetown has been actively involved in species at risk surveying and monitoring since 2001; the information obtained from these investigations is used in the project and activity planning process to ensure protection of the species and successful implementation of DND mandate. The species at risk surveys are typically completed in partnerships with other government agencies (DNR, DFO, EC), Universities (UNBF, UNBSJ, RMC) and/or other specialized individuals or organizations such as the NB Museum, Bird Studies Canada, and the Canadian

Rivers Institute.

Base Gagetown has an active forest management plan where the Sustained Yield Area is 53,000 ha, the remainder of the base is divided between the Static Range Impact Areas (30,000 ha), the General, Mounted and Dismounted Manoeuvre Areas (20 000 ha) and the Unique Area, Nerepis Hills (7 000 ha). Permitted activities for all areas are described in detail in the Range Standing Orders. All watercourse and wetlands at Base Gagetown are subject to a minimum 30 meter buffer. In recent years, extensive work has been undertaken to reduce the impacts of infrastructure on aquatic habitat and species. Examples include improvements to and decommissioning of roads, trails and water crossings to reduce erosion and sedimentation and improve fish passage and aquatic habitat. Additionally a stream restoration project is undertaken annually. The base has been working with Ducks Unlimited Canada since 2005 on a project to construct and restore wetlands that have been impacted from historical training or development activities. To date approximately 130 ha of wetland has been created or restored.

The New Brunswick Museum

The New Brunswick Museum is engaged in extensive field research programs that target gaps in existing knowledge of the province's biodiversity. The museum also has a leading role as an archive for collections documenting the identity, distributions (past and present), and habitats of species in the province. Since 2009, a major focus of NBM research programs has been an annual "Bioblitz". This brings together a group of 40 or more taxonomic experts, graduate and summer students, and volunteers for two weeks of intensive, broad-spectrum, biodiversity studies in the province's Protected Natural Areas. The field studies are followed by months of identification, databasing, and archiving of collections, and preparation of results for publication. To date, the Bioblitz program has targeted the Jacquet River Gorge PNA (2009–2010), Caledonia Gorge PNA (2011–2012), and Grand Lake PNA (2013–2014). Its goal is to survey, over a period of 20 years, all ten of the larger PNAs that were established in 2003. The Grand Lake Bioblitz is also covering the adjoining Portobello Creek National Wildlife Area.

A sample of other current or recent research projects by NBM staff and research associates includes: impacts of the White-Nose Syndrome on NB bat populations; diversity of fungi in caves that serve as bati hibernacula in NB; diversity and ecology of lichens and allied fungi in cedar swamp-forests in the Maritime Provinces; diversity of lichenicolous fungi in Atlantic Canada; lichens as indicators of air quality in the greater Saint John region; aquatic mollusks and plants of the LSJR estuary; abundance and recruitment of the Freshwater Pearl Mussel in the Kennebecasis River; grasshopper diversity in the Maritime Provinces; genetic diversity and distributions of selected mammal species in eastern Canada. Preparation of the book *Biodiversity Assessment of the Atlantic Maritime Ecozone*, a major synthesis published by the National Research Council (NRC Press) in 2010, was coordinated at the NBM (with Dr. Donald McAlpine as lead co-editor); it includes 31 chapters authored by 51 specialists.

The NBM Geology and Palaeontology Section conducts extensive research on the rich fossil record of the province. It (i.e., its curator Dr. Randall Miller) conceived and spearheaded the Steinhammer Geopark in southern New Brunswick. This is the first UNESCO-recognized Global Geopark established in North America. It seeks to protect and interpret the rich geological heritage of the region, while contributing to its economic development. The NBM has a strong public education mandate that is fulfilled through its exhibition centre in the Market Square complex in Saint John, and through a wide range of outreach programs.

Kennebecasis Naturalists Society

The Kennebecasis Naturalist Society is based out of Sussex, NB. Members are primarily retired naturalists with an interest in birds or wildflowers. The group meets for an inside presentation 8 times a year, and schedule outings throughout the year. As an active member of the New Brunswick conservation community, the KNS hosts an active website, and participates in a number of monitoring and outreach programs, including: host of Nature NB's Festival of Nature (1995 and 2005); supporter of Nature NB's summer camp program, supporter and participant in Bird Studies Canada's Swift Watch Program in Sussex, roadside clean-up along a section of the Knightville Road, participant in the Christmas Bird Count, birding event hosted in Grand Manan on Victoria Day weekend (annually), assist with Nature NB's Biodiversity ESA update.

The Nature Conservancy of Canada

The Nature Conservancy of Canada is the nation's leading land conservation organization, working to protect our most important natural areas and the species they sustain. Since 1962 NCC and its partners have helped to protect more than 2.6 million acres (over 1 million hectares), coast to coast. NCC has been protecting land in New Brunswick since 1989 and has helped create over 30 nature reserves across the province. NCC owns and manages land at five sites in the LSJR. The largest reserve; Sunset Valley (260 ha) near Nerepis, consists of an ecologically significant array of wetlands, and medium-aged mixed wood forest. The reserve provides breeding and feeding grounds for a variety of migratory and resident wetland bird species, and supports rare and uncommon species of vascular plants. The 110 ha Shamper's Bluff Nature Reserve on the Kingston Peninsula is a diverse site consisting of impressive mature eastern white cedar and hemlock stands along with hardwood slopes, boggy ponds, rugged escarpments as well as areas of sandy and rocky shoreline. The 50 ha Bear Cave Mountain Reserve near Sussex features a cliff face which hosts rare bryophytes (*Taxiphlium deplamatum*, *Ditrichum flexicaule*, and *Thamnobryum alleghaniense)*. The forest at the base of the cliff is dominated by Sugar Maple, Beech, and White Ash. NCC also owns property on the St. John River at Lincoln, and a parcel in the Hampton Marshes floodplain.

St. John River Society

The St. John River Society is committed to the appreciation and wise use of the natural and cultural heritage of the St. John River in New Brunswick. The organization began in 1992 and since then has undertaken projects which help raise awareness about the importance and value of the river to the people who live and work along its length, the environment and ensuring that the river stays magnificent into the future. The St. John River Society has four programming pillars and undertakes projects which advance their aims: Recognition, Access, Education and Sustainable Management. The organization has recently undertaken projects to officially recognize the heritage value of the St. John River, as well as to protect and maintain heritage steamboat wharves along the lower river as part of the New Brunswick section of the Trans Canada Water Trail. In 2008 the St. John River Society undertook the "Watch Your Wake" campaign to help remind river users about sensitive areas along the river and how to preserve the significant natural habitats found along the river. This campaign targeted boaters and provided information about the unique ecology of the Jemseg River and how to enjoy this treasure without impact.

WWF Canada

Over a 5 year period, WWF will work in partnership with local organizations, scientific experts, communities, First Nations, government agencies and river stewards to advance two key objectives towards ensuring a resilient and healthy St. John: (1) Establishing a broadly shared vision and commitment, among diverse stakeholders, to engage in collaborative action to restore and sustain the health of the St. John River and its waters, and (2) bringing the best science to the table to develop an action plan that supports more natural flows for the river and its tributaries. WWF Canada will continue to organize events such as the St. John River Summit, the St. John River science workshop and other efforts, all of which aim to share ideas and find opportunities to improve freshwater protection and to improve our understanding of the river's health.

Ducks Unlimited Canada (DUC)

Land protection is a critical tool by which Ducks Unlimited conserves waterfowl habitat throughout North America. DU protects land through several means including acquisitions, conservation easements and revolving lands strategy: 1) Land acquisition - In special cases, where intact waterfowl habitat is at imminent risk, DU may seek to acquire the property. Once purchased, the habitat is restored & conservation easements are placed on the land to perpetually protect its resource values; 2) Easements - Conservation easements can meet the needs of interested owners of working farms, ranches, timberlands, sporting properties and recreational lands, who wish to protect valuable natural resources while retaining ownership of the property; and 3) Revolving land - In locations where wildlife habitat has been degraded & the land is for sale, DU will seek to acquire it. Once purchased, the habitat will be restored and easements will be placed on land to perpetually protect resource values.

DUC aims to develop initiatives to conserve existing coastal areas to protect molting, staging and wintering habitat; to maintain diverse habitat quality and quantity needed to sustain current breeding waterfowl numbers; to develop new initiatives that address problems of survival and recruitment of sea ducks; and to acquire wetland inventories and more complete waterfowl surveys to focus conservation programs.

D. Conservation partner actions

The remainder of this section focuses on the conservation actions planned to be undertaken by conservation partners active in the bioregion over the course of the next five year period. Table 11 identifies which organizations and government agencies are working to conserve priority habitats and significant species in the LSJR bioregion and lists those actions that are being and will be taken to target specific habitats and threats. Note that some actions, though important, may not directly address identified threats. Instead, these actions may advance important objectives, including monitoring, education and outreach, and partnerships. Readers are advised that this section is particularly important for planning purposes because this table presents opportunities to identify conservation action gaps and build partnerships strategically. Please note that action categories in this table are based on IUCN – CMP Unified Classification of Conservation Actions Needed (Version 2.0; Appendix G). Actions and measures of success are not listed in order of importance.

Table 11. Conservation actions and associated information for Eastern Habitat Joint Venture partners in the LSJR bioregion.

Conservation Actions*	Importance[4]/ Associated Conservation Goals (p. 77)	Biodiversity Habitat(s)[5]	Threat(s) addressed [6] / Objective	Measures of Success (MOS)[4] / Notes	Organizational Lead
1. Land/Water Protection					
1.1 Site Protection: *Secure a minimum of five properties or 100 acres of private land containing species at risk habitat for permanent protection by 2015.*	NECESSARY 1, 3, 5	ALL	1.1, 5.3, 4.1, 2.1.2, 6.1, 2.2, 2.4.2	MOS-I: A minimum of five properties or 100 acres (40 hectares) of land secured by 2015.	NTNB

[4]***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.

[5]Biodiversity Targets: Riparian systems, freshwater wetlands, Acadian forest mosaic, grasslands/agro-ecosystems, cliffs, rocky outcrops, and sand and gravel beaches.

[6]Biodiversity Threats: Housing and urban areas, annual and perennial non-timber crops, wood and pulp plantations, marine and freshwater aquaculture - industrial aquaculture, mining and quarrying, roads and railroads – road fragmentation, logging and wood harvesting – incompatible forestry practices, recreational activities – off-highway vehicles, dams and other aquatic barriers, invasive species – insects and diseases, invasive species – predatory fish species, introduced genetic material – hatchery salmon, oil and gas drilling, and climate change and severe weather – habitat shifting and alteration.

[4] Proposed implementation measures for NACP annual progress report. More detailed measures for some actions will be developed as part of action implementation or through Property Management Plans.

1.1 Site Protection: *Province of New Brunswick to achieve Protected Natural Area designation of up to an additional 25 000 ha of significant habitat on Crown land within Bioregion 5 & 7 by 2015. Presently there are 58 000 hectares of Crown PNA in Bioregion 5 & 7.*	CRITICAL 1, 2, 3, 5, 6	Acadian forest mosaic Freshwater wetlands Riparian systems	1.1, 5.3, 4.1, 7.2, 2.1.2, 6.1, 3.1, 3.2, 2.2, 2.4.2	Up to 25,000 ha of additional significant habitat on Crown land was placed under the provincial Protected Natural Areas Act by 2015.	PNB
1.1 Site Protection: *Secure priority provincially significant floodplain wetland as opportunities arise.*	BENEFICIAL 1, 3, 4, 5	Riparian systems Freshwater wetlands	1.1, 5.3, 4.1, 2.1.2, 2.2, 2.4.2	Ducks Unlimited owns and protects properties throughout the LSJR bioregion. The majority of these land holdings targets floodplain wetlands and associated uplands. Several of the properties are on islands, with almost complete ownership of some islands.	DUC
1.1 Site Protection: *Secure priority significant floodplain forest-wetland complex as opportunities arise.*	NECESSARY 1, 3, 4, 5	Riparian systems Freshwater wetlands	1.1, 5.3, 4.1, 7.2, 2.1.2, 6.1, 3.1, 3.2, 2.2, 2.4.2	EC owns, manages and protects properties that constitue the Portobello Creek NWA. Adjacent properties within the Area of Interest are acquired opportunistically and when resources are available. Some of these land holdings contain floodplain wetlands and associated uplands.	EC

1.2 Resource & Habitat Protection: *Work with landowners to develop and conclude voluntary stewardship agreements on private land which will address specific threats to habitats and species at risk.*	BENEFICIAL 1, 2, 3, 4, 7	ALL	Threat-specific	*Negotiate and conclude voluntary stewardship agreements with a minimum of 10 landowners or 500 acres of private land.*	NTNB
1.2 Resource & Habitat Protection: *Unique Areas protection - The Oromocto River Watershed Association worked with JD Irving Ltd to have the Carrow Falls area and trails, and the Hemlock Grove area and trails protected under the Unique Areas Program. Public Access is permitted, and official trail agreements are under development.*	BENEFICIAL 1, 3, 4, 7	Acadian forest mosaic Riparian systems	1.1, 5.3, 4.1, 2.2, 2.4.2		ORWA
2. Land/ Water Management - Stewardship					
2.1 Site / Area Management: *Prepare Interim Stewardship Statements within one year and Property Management Plans following NCC's approved Stewardship Performance Standards for secured properties.*	NECESSARY 3, 5	ALL	Threat-specific	MOS-I: Interim Stewardship Statements (ISS) were completed within one year of closing for all secured properties. Baseline Inventories were completed and Property Management Plans (PMP) developed according to NCC policy and standards.	NCC

2.1 Site / Area Management: *Implement critical Property Management Plan actions on NCC lands through 2018.*	CRITICAL 3, 5	ALL	1.1, 5.3, 4.1, 7.2, 2.1.2, 6.1, 2.2, 2.4.2	MOS-I: Critical Property Management Plan actions were implemented on all NCC-owned properties, both newly acquired and previously owned between 2013 - 2018.	NCC
2.1 Site / Area Management: *Designate all NCC properties in the bioregion under the NB Protected Areas Act by 2018.*	CRITICAL 1, 3, 5	ALL	1.1, 5.3, 4.1, 7.2, 2.1.2, 6.1, 3.1, 3.2, 2.2, 2.4.2	MOS-I: All NCC owned properties in the bioregion are placed under the Protected bioregions legislation by 2018.	NCC
2.1 Site / Area Management: *Promote best management practices to prevent impacts on rivers and riparian areas.*	NECESSARY 3, 4, 7	ALL	Threat-specific	MOS-I: NGOs to promote best management for agriculture, development and other activities in the watershed.	NGOs, watershed groups
2.1 Site / Area Management: *EC manages 2 084 ha of floodplain forest-wetland complex within the Portobello Creek NWA. A management plan for the NWA will be completed by 2015.*	NECESSARY 3, 5	ALL	1.1, 5.3, 4.1, 7.2, 2.1.2, 6.1, 3.1, 3.2, 2.2, 2.4.2	The area provides important production, staging and migration habitat for waterfowl. It is one of the most naturally productive sites in the Atlantic Provinces and in addition to the more common waterfowl species it is one of the few locations hosting significant breeding populations of cavity nesting species. The flood plain forest and adjoining wooded uplands afford habitat for a variety of songbirds and large mammals such as Moose, White-tailed Deer and Black Bear.	EC

2.1 Site / Area Management: *DUC manages hundreds of acres on freshwater wetland habitat occurring on private, crown and our own lands. Continue to invest in maintaining our infrastructure in this area to an expected level of $50k annually.*	NECESSARY 3, 5	Freshwater wetlands	1.1, 5.3, 4.1, 7.2, 2.1.2	Maintained water on the floodplain provides critical habitat for many wetland dependant species. This area continues to be one of the most productive management areas for waterfowl in the province. MOS-I: Fish ladders and other DUC structures evaluated and any suggested improvements implemented by 2018.	DUC
2.1 Site / Area Management: *Maritimes Marsh Monitoring Program (BSC) works to:* *-assess effectiveness of EHJV conservation efforts through monitoring of wetland-dependent species and habitats* *- develop citizen science outreach toolkit to encourage local stewardship of freshwater and saltwater wetland habitats*	NECESSARY 2, 3, 6, 7	Riparian wystems Freshwater wetlands	Monitoring		BSC & EHJV partners
2.1 Site / Area Management: *Department of National Defense (DND) Habitat management and monitoring* *-Various water quality studies and monitoring programs* *- Fisheries and aquatic habitat management plan* *- Base Gagetown Wetland Management Plan* *- Minimum 30m buffer maintained on all watercourses and wetlands*	NECESSARY 2, 3, 4, 6	ALL	Monitoring 1.1, 5.3, 4.1, 7.2, 2.1.2, 6.1, 3.1, 3.2, 2.2, 2.4.2		DND

2.1 Site Management: *Monitor NCC properties annually for impacts from ATV use and respond to any potential threats to biodiversity targets.*	NECESSARY 2, 3, 4, 5, 6	ALL	Monitoring 6.1	NCC waterfront properties are monitored annually for impacts from ATV use and response actions developed as necessary to address problems. Public information related to development/expansion of the aquaculture industry in the Bioregion was reviewed at least once every two years to evaluate future threat.	NCC PNB EC
2.1 Site Management: Implement Ecoregion 5 & 7 conservation targets for 14 old forest communities and 6 old-forest wildlife habitats in the 2012 Crown forest management plan.	NECESSARY 1, 3, 5, 6	Acadian forest mosaic Riparian systems	1.1, 5.3, 4.1, 7.2, 2.1.2, 6.1, 3.2, 2.2, 2.4.2	Implement Ecoregion 5 & 7 conservation targets for 14 old forest communities and 6 old-forest wildlife habitats in the 2012 Crown forest management plan.	PNB
2.1 Site Management: Consider the integrity of priority habitats in PNB land use decision processes for Crown and private lands and waters.	NECESSARY 1, 3, 4	ALL	1.1, 1.3, 2.1, 2.1.2, 2.4.2, 3.2, 3.3, 5.3, 6.1, 6.1.2	Population and habitat monitoring indicates stable or improving conditions.	PNB
2.2 Invasive/Problematic Species Control *Control the expansion of invasive species in the bioregion and try to prevent the introduction of new invasive species through public education and targeted outreach to land owners and land managers.*	NECESSARY 1, 2, 3, 6, 7	ALL	8	MOS –I: New Brunswick Invasive Species Council (NBISC), held a minimum of two meetings per year. The public was made aware of existing and potential threats of invasive species though NBISC website and media interviews. Specific issues were addressed with the responsible land owner or land manager.	NBISC

2.2 Invasive/Problematic Species Control *Atlantic Advisory Committee for Introduced Forest Pests (AACIFP) which is a multi-agency committee with federal, provincial and municipal representation that addresses forest health issues around invasive forest pests. Meets at a minimum annually to discuss current or potential hazards and coordinates actions to manage threats.*	BENEFICIAL 2, 6	Acadian forest mosaic	8	MOS: Minimum one annual meeting to discuss current or potential hazards and coordinate threat management actions.	ASCIFP
2.2 Invasive/Problematic Species Control *DND has a protocol to wash/clean any vehicles and equipment prior to movement from one location to another to prevent the spread of invasives. There are no known invasives on the base that are not known from surrounding areas*	NECESSARY 7	ALL	8		DND

2.3 Habitat and Natural Process Restoration: *Habitat Restoration* *- swallow habitat /nest relocation* *- grassland bird habitat availability survey: short-eared owl, bobolink, upland sandpiper, vesper sparrow (2010)* *- habitat suitability mapping for short-eared owl, least bittern, yellow rail, red shouldered hawk, Canada warbler, bicknells thrush, rusty blackbird, chimney swift, common nighthawk, whip-poor-will, olive sided flycatcher, peregrine falcon.*	CRITICAL 1, 2, 5, 6	Grasslands /agro-ecosystems Freshwater wetlands Cliffs	Monitoring Threat-specific		DND
2.3 Habitat and Natural Process Restoration: *Wetland Restoration efforts are currently focused on offsetting permitted wetland loss. The St. John River is a key area where some wetlands are under development pressure. Continued efforts on restoring, creating and enhancing wetlands in this area are critical to supporting the provincial wetland policy goal of no net loss of wetland function.*	CRITICAL 1, 2, 6, 7	Riparian systems Freshwater wetlands	1.1, 5.3, 4.1, 2.1.2, 6.1, 3.2, 2.2, 2.4.2	An inventory of suitable wetland restoration sites will continue to focus here and restoration will take place when needed to offset permitted loss.	DUC

2.3 Habitat and Natural Process Restoration: *Canadian Forests International runs Sackville, NB's Native Tree Nursery and continues to grow and plant trees within the Sackville community and throughout NB. Trees selected are those traditionally found in the Acadian Forest and will help increase natural forest diversity.*	NECESSARY 7	Acadian forest mosaic	5.3	MOS-I: CFI will restore 8 ha per year over in the next five years (to 2018) of Acadian Forest habitat.	CFI
3. Species Management					
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 1, 2, 5, 6	ALL	Monitoring	MOS-I: Baseline and annual monitoring information of rare species is submitted to ACCDC every year.	ACCDC
3.2 Species Recovery: *Monitoring for multiple species* *- Annual deer and moose population estimates ongoing since 2003* *- Large mammal usage of underpasses on highway 7* *- Small mammal track transects* *- Identification of seven species of mussels have been identified in base waters (no yellow lampmussels)*	NECESSARY 1, 6	ALL	Monitoring		DND

3.2 Species Recovery: *Species Surveys: multiple species* *- fish species surveys have been conducted and streams and lakes; SAR recorded: Striped Bass, Atlantic Salmon, redbreast sunfish and American Eel* *- Aquatic benthic macroinvertebrate surveys (annual)*	NECESSARY 1, 6	ALL	Monitoring		DND
3.2 Species Recovery: *DND has a Species at Risk Work Plan, that is developed with and approved by EC CWS*	BENEFICIAL 1, 2, 6	ALL	Threat-specific		DND
3.2 Species Recovery: *Continue to monitor known species at risk on all nature preserves within the bioregion.*	NECESSARY 5, 6, 7	ALL	Monitoring	MOS: Species populations are monitored regularly by knowledgeable professionals on all nature preserves with known species at risk.	NTNB
3.2 Species Recovery: *Strengthen partnership with Atlantic Conservation Data Centre (ACCDC) through annual submission of monitoring findings on conservation lands.*	BENEFICIAL 2, 5, 6	ALL	Monitoring	Baseline and annual monitoring information of rare species is submitted to ACCDC every year.	NCC EC Nature NB DUC PNB NTNB
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 1, 2, 5, 6	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.	NCC EC NBNT PNB

3.2 Species Recovery: *Conduct waterfowl surveys in the bioregion, including breeding waterfowl surveys (Eastern Waterfowl Survey) and wintering waterfowl surveys (Triannual American Black Duck "Winter" Survey).*	BENEFICIAL 1, 6	Freshwater wetlands	Monitoring	Baseline data for breeding and wintering waterfowl species; Detection of population trends over the long-term.	EC PNB
3.2 Species Recovery: *EC to continue least bittern monitoring at critical habitat locations.*	BENEFICIAL 5, 6	Freshwater wetlands	Monitoring	Baseline data for breeding Least Bittern and its habitat.	EC
3.2 Species Recovery: *EC to continue coordinating the Breeding Bird Survey and ensure that 7 BBS routes continue to be surveyed.*	BENEFICIAL 2, 6	ALL	Monitoring	Baseline data for multiple species of breeding birds in multiple habitat types.	EC
3.2 Species Recovery: *EHJV partners to undertake Habitat Supply Analysis at the provincial scale.*	NECESSARY 1, 2, 3, 4, 5, 6	ALL	Monitoring	This work constitutes an analysis of past, present, and future forest and wetland bird habitat supply on crown and private lands in New Brunswick.	PNB & EHJV partners
3.2 Species Recovery: *Species Monitoring: wetland-dependent species* *Maritimes Marsh Monitoring Program (BSC) surveys for waterfowl and other wetland-dependent species (eg. widgeon, Yellow Rail, American Bittern, (2012-present) in LSJR and other EHJV priority areas*	NECESSARY 1, 6	Riparian systems Freshwater wetlands	Monitoring	Improved information on variables that affect detection probability of wetland species, with recommendations for survey protocols; Baseline data for secretive wetland species; Detection of population trends over the long-term. Results communicated annually to EHJV partners.	BSC & EHJV partners

3.2 Species Recovery: *Species Monitoring: Chimney swifts* *-BSC continues work with Maritime Swiftwatch, coordinating province-wide population counts, monitoring priority roost sites, and identifying new roost sites in LSJR and other areas in the Maritimes*	NECESSARY 1, 6	ALL	Monitoring	Annual population monitoring and results communicated to partners	BSC
3.2 Species Recovery: *Species Monitoring: Nocturnal Owl Survey (Bird Studies Canada) – ongoing since 2001; occurs throughout the Maritimes but includes LSJR*	NECESSARY 1, 6	ALL	Monitoring	Annual population monitoring and results communicated to partners	BSC, NBDNR
3.2 Species Recovery: *EHJV Partners to participate in BSC Maritime Swift Watch Program:* Continue to systematically monitor population levels of Chimney Swift at known roost sites through a citizen-science monitoring and conservation program that brings together volunteers and community groups to act as stewards for Chimney Swift and their habitat, to advance knowledge of nesting ecology, and to increase awareness of this species at risk in the Maritimes. Continue to solicit the public for sightings of Chimney Swift and Chimney Swift nest locations.	BENEFICIAL 1, 5, 6, 7		Monitoring 1.1, 1.2		BSC, Environment Canada, other EHJV partners

3.2 Species Recovery: *In partnership with volunteer nest box stewards Ducks Unlimited Canada monitors, maintains, and distributes waterfowl nest boxes throughout the bioregion. There are roughly 1000 boxes in this area with some new ones going up annually.*	BENEFICIAL 1, 2, 7	Riparian systems Freshwater wetlands	Monitoring 5.3.4	MOS-I: Since our efforts in the mid 90s we have observed more an increase in the wood duck populations estimates in this area. Monitoring records indicate waterfowl occupancy rates as high as 70% and 100% by some wildlife.	DUC
3.2 Species Recovery: *DUC to continue management identified as least bittern critical habitat and create more suitable habitat in known breeding areas when opportunities arise*	NECESSARY 1, 3, 5	Freshwater wetlands	Monitoring 7.2	MOS-I: undetermined acres of suitable breeding habitat for least bittern protected or created by 2018.	DUC
3.2 Species Recovery: *Bird species surveys* *-nocturnal owl survey (2004-present)* *-hawk/woodpecker survey* *-Rusty Blackbird survey (2010-present)*	NECESSARY 1, 6	ALL	Monitoring		DND
3.2 Species Recovery: *Peregrine Falcon* *- Protection of peregrine falcon nesting wall faces by incorporation into Range Standing Orders and patrols by Range Control*	NECESSARY 1, 5	ALL	Monitoring 6.1, 6.2		DND

3.2 Species Recovery: *Wood Turtle* *- Have been actively monitoring wood turtle since 2001 and are currently working with EC and DNR on the identification and protection of critical habitat*	NECESSARY 1, 2, 5, 6	ALL	Monitoring		DND
3.2 Species Recovery: *Aquatic species monitoring* *- ORWA monitors 8 tributaries in the Oromocto Watershed for Atlantic Salmon Parr and Smolt* *- ORWA monitors 10 streams annually for water quality* *- gaspereau migration is monitored and an analysis of the over-fishing of this species in the Oromocto River is underway*	NECESSARY 1, 5, 6	Freshwater wetlands Riparian systems (Aquatic)	Monitoring		ORWA
3.2 Species Recovery: *NB Museum conducted research on biodiversity in Grand Lake Meadows PNA in 2013 and 2014 (Bio-Blitz and other activities)*	BENFICIAL 1, 2, 5, 6, 7	Acadian forest mosaic Freshwater wetlands Riparian systems	Monitoring	MOS-I: Research, Bio-Blitz was conducted and biodiversity results were communicated to partners to guide future conservation, management and threat abatement strategies.	NB Museum
4. Communications, Education and Awareness					

4.3 Awareness & Communications: *Public outreach Private landowners in LSJR focus areas will be contacted via direct mail and in-person visits to facilitate the building of partnerships for conservation.*	BENEFICIAL 1, 2, 7	ALL	Outreach and education	NTNB has identified seven focus areas throughout the bioregion, and specific properties within these areas that have high-priority habitats or confirmed / possible species at risk presence. A database of over 750 private landowners, with more than 1000 properties identified as potential targets for private stewardship action. Nearly 700 individual landowners were contacted by mail in 2014. Those that were not contacted initially will be contacted in subsequent years.	NTNB
4.3 Awareness & Communications: *Increasing Awareness and Education NTNB will share information and increase awareness about threats to SAR and provide stewardship tips for private landowners throughout the LSJR bioregion.*	BENEFICIAL 1, 2, 7	ALL	Outreach and education	MOS: Stewardship factsheets for habitats and species at risk (SAR) have been developed with assistance from the NB Department of Natural Resources, Environment Canada, and NB Museum. These factsheets will be distributed at public events, and during private landowner meetings and stewardship agreement negotiations.	NTNB

4.3 Awareness & Communications: *Public outreach and education Oromocto River Watershed Assoc. (ORWA) has a student-focused fly fishing program and has numerous schools participating in the Fish Friends Program which educates youth about healthy streams and fish ecology.*	BENEFICIAL 7	Freshwater wetlands Riparian systems (Aquatic)	Outreach and education		ORWA
4.3 Awareness & Communications: *DUC to reach out to approximately 2000 school youth yearly through the Project Webfoot.*	BENEFICIAL 7	ALL	Outreach and education	MOS-I: Elementary school youth from Grades 4-6 are given the opportunity to apply their learning and connect with nature through the interactive and education al outreach program provided by DUC's Project Webfoot.	DUC
4.3 Awareness & Communications: *Two new Wetland Centres of Excellence will be designated at secondary schools by DUC and supported with Community partners.*	BENEFICIAL 2, 7	Riparian systems Freshwater wetlands	Outreach and education	MOS-I: DUC will designate two secondary schools within Fredericton and Saint John to participate in conservation action projects and steward wetland habitat in their area.	DUC

4.3 Awareness & Communications: *DUC will continue to deliver hands-on environmental education programs at its Conservation Centre and be open to the public to learn more about biodiversity and wetland conservation through an interactive display area and outdoor classroom reaching over 5000 participants.*	BENEFICIAL 2, 7	ALL	Outreach and education	MOS-l: DUC operates a conservation centre within Fredericton along the St. John River which is open to the public and engages schools to attend programs and organizes local community events.	DUC
4.3 Awareness & Communications: *DUC delivers a landowner program that provides information and workshops to landowners who have restored wetlands on their property which includes approx. 300 landowners in the bioregion.*	BENEFICIAL 1, 2, 7	Freshwater wetlands Riparian systems Acadian forest mosaic	Outreach and education	MOS-I: Landowners receive biannual newsletters with conservation information and engagement opportunities such as habitat enhancement and stewardship. Landowners are also invited to various events and activities.	DUC
4.3 Awareness & Communications: *Demonstrate restoration strategies appropriate to the Acadian Forest Ecosite and associated forest groups while providing complimentary educational opportunities that foster the return of a late-succession, uneven-aged forest conditions on private and public forestland throughout the region.*	BENEFICIAL 7	Acadian forest mosaic	Outreach and education	MOS–I: Canadian Forests International (CFI) endeavour to offer workshops annually on Acadian Forest restoration and best management techniques in riparian areas for 200 participants per year over the next five years (to 2018).	CFI

4.3 Awareness & Communications: *Demonstrate and build community capacity for restoration and conservation of waterways intersecting farm and forest land; and demonstrate agriculture systems that maintain the ecological integrity of working lands by protecting waterways, conserving soil, and promoting beneficial wildlife.*	BENEFICIAL 7	Acadian forest mosaic Freshwater wetlands Riparian systems	Outreach and education	MOS–I: Canadian Forests International (CFI) endeavour to offer workshops annually on Acadian Forest restoration and best management techniques in riparian areas for 200 participants per year over the next five years (to 2018).	CFI
4.3 Awareness & Communications: *CCNB will produce interactive web based map of public access points to the St. John River to promote and encourage appropriate use of the River.*	BENEFICIAL 7	ALL	Outreach and education 6.1	MOS-I: CCNB will release map and report Spring 2014.	CCNB
4.3 Awareness & Communications: *Through its No Child Left Inside project CCNB will conduct workshops and develop nature trails and other outdoors learning spaces on and near school grounds to promote teaching of existing curriculum outside in nature.*	BENEFICIAL 2, 7	ALL	Outreach and education	MOS-I: Will work with 2-3 K-5 or K-8 schools in the bioregion annually.	CCNB
4.3 Awareness & Communications: *BSC holds community outreach workshops for Chimney Swifts ("Swift Night Out")*	BENEFICIAL 7	ALL	Outreach and education	Increased community and individual volunteer involvement with the program	BSC

4.3 Awareness & Communications: *EC will present information on the Portobello Creek National Wildlife Area within the Wildlife Habitat - Protected Areas section of the EC website to enhance awareness and appropriate use of the NWA.*	BENEFICIAL 7	ALL	Outreach and education	EC Website online and up-to-date.	EC
5. Government Relations, Law and Policy					
5.1.2 National Level Legislation: *Contribute to national or launch unique advocacy and/or education campaigns concerning changes to the Fisheries Act, Navigable Waters Protection Act, the National Energy Board Act and other relevant legislation as necessary. Seek to intervene before the NEB concerning the proposed Energy East Pipeline.*	BENEFICIAL 1, 7	ALL	Threat-specific		CCNB
5.1.2 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 5, 7	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
5.1.2 National Level Legislation: *DND holds the mineral rights to the base property, it is therefore unlikely that the area will be developed for oil/gas*	BENEFICIAL 3	ALL	3		DND

5.1.3 Sub-national Level Legislation: *Contribute to provincial or launch unique advocacy and/or education campaigns concerning the Wetlands Conservation Policy, Crown Lands and Forests Act, and other relevant legislation as necessary. Continue to participate in the Energy Institute, especially concerning shale gas development.*	BENEFICIAL 2, 5, 6	ALL	Threat-specific		CCNB
5.1.4 Sub-national Level Legislation: *DUC actively participates as a member of the provincial wetland policy long term strategy stakeholder review. We work closely with the Department of the Environment to deliver compensation needs, work with municipalities, evaluate policy needs, and improve permitting efficiency.*	BENEFICIAL 1, 2, 7	Riparian systems Freshwater wetlands	Threat-specific	Wetland conservation policies are a top national priority of Ducks Unlimited.	DUC
7. External Capacity Building					

7.2 Alliance & Partnership Development: *Attend existing partnership meetings and any local conservation partner meetings on on-going basis to build and strengthen partnerships. The NTNB will focus on using the LSJR Habitat Conservation Strategy and our private land conservation tools to assist other conservation organizations and community groups to pursue local land stewardship (ex. Taymouth Community Association, Nashwaak Watershed Association, Kennebecasis Watershed Restoration Committee etc)*	NECESSARY 1, 2, 3, 5, 7	ALL	Partnerships	MOS-I: Attend partnership meetings; provide stewardship or conservation planning support for local land conservation initiatives.	NTNB
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 LSJR 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 1, 2, 3, 4, 5, 6, 7	ALL	Partnerships	Attend partnership meetings; provide stewardship or conservation planning support for habitat conservation initiatives.	EC

7.2 Alliance & Partnership Development: *External partnership DND* *- Butternut stand identifications and health assessments with Canadian Forest Service, have developed a model to predict where butternut may be found, extensive ground truthing and refinement of the model; continuing to work with CFS on genetic level research; (2006 to present)* *- Worked with NB Museum on Ghost Antler Lichen and research for other rare or uncommon lichens (2010 to present)* *- Member of the St. John River Management Advisory Committee* *- Representation on the board of directors Oromocto River Watershed Association* *- Assist with the NBSC Fish Friends program. Over 1000 students have participated in Fish Friends field days at Base Gagetown.* *- participated in 2nd Maritimes Breeding Bird Atlas with Bird Studies Canada* *- participated in Maritimes Marsh Monitoring Program (2011 to present)*	BENEFICIAL 1, 2, 5, 6, 7	ALL	Partnerships		DND

7.2 Alliance & Partnership Building *Oromocto River Watershed Association (ORWA) will develop voluntary agreements with private landowners and partner with municipalities, UNB, NB Trails, DU etc to secure public access and install public access trails to eight unique sites with three additional planned for 2014-2015 (ongoing)*	BENEFICIAL 1, 2, 3, 7	Acadian forest mosaic Riparian systems	Partnerships		ORWA

*** Categories based on IUCN – CMP Unified Classification of Conservation Actions Needed (Version 2.0). Actions and MOS are not listed in order of importance.**

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5. APPENDICES

Appendix A. Priority species in the LSJR

Table 12. Priority species in the LSJR.

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
American Bittern	*Botaurus lentiginosus*		S4B	G4	1		Y	y						
American Black Duck	*Anas rubripes*		S5B, S4N	G5	1		Y	y			y			
American Coot	*Fulica americana*	NAR	S2B	G5			Y	y						
American Redstart	*Setophaga ruticilla*		S5B	G5	1		Y	y	y		y			
American Three-toed Woodpecker	*Picoides dorsalis*		S3?	G5	1			y	y	y				
American Woodcock	*Scolopax minor*		S5B	G5	1									
Bald Eagle	*Haliaeetus leucocephalus*	NAR	S3B	G5	1		Y	y	y		y			
Bank Swallow	*Riparia riparia*		S3B	G5	1		Y	y			y			y
Barn Swallow	*Hirundo rustica*	T	S3B	G5	1			y			y			
Bay-breasted Warbler	*Setophaga castanea*		S4B	G5	1		Y		y					
Belted Kingfisher	*Megaceryle alcyon*		S5B	G5	1		Y	y	y					
Black Tern	*Chlidonias niger*	NAR	S2B	G4	1		Y	y						
Black-backed	*Picoides*		S4	G5	1				y	y				

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Woodpecker	*arcticus*													
Black-billed Cuckoo	*Coccyzus erythropthalmus*		S4B	G5	1				y					
Blackburnian Warbler	*Dendroica fusca*		S5B	G5	1				y	y				
Black-throated Blue Warbler	*Dendroica caerulescens*		S5B	G5	1				y	y				
Black-throated Green Warbler	*Setophaga virens*		S5B	G5	1				y					
Blue-headed Vireo	*Vireo solitarius*		S5B	G5	1		Y	y	y	y				
Bobolink	*Dolichonyx oryzivorus*	T	S3S4 B	G5	1			y			y			
Boreal Chickadee	*Poecile hudsonicus*		S4	G5	1				y					
Brown Thrasher	*Toxostoma rufum*		S2B	G5					y		y			
Canada Goose	*Branta canadensis*		SNA B, S4M	G5	1		Y	y			y			
Canada Warbler	*Wilsonia canadensis*	T	S3S4 B	G5	1		Y	y	y	y				
Cape May Warbler	*Setophaga tigrina*		S4B	G5	1				y					
Chimney Swift	*Chaetura pelagica*	T	S2S3 B	G5	1									
Common Goldeneye	*Bucephala clangula*		S4B, S5M,	G5	1		y	y						

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
			S4N											
Common Loon	*Gavia immer*		S4B, S5M, S4N	G5	1		y	y						
Common Moorhen	*Gallinula chloropus*		S1S2 B	G5			y	y						
Common Nighthawk	*Chordeiles minor*	T	S3B	G5	1			y	y					
Common Tern	*Sterna hirundo*	NAR	S3B	G5	1		y							y
Cooper's Hawk	*Accipiter cooperii*	NAR	S1S2 B	G5					y					
Eastern Kingbird	*Tyrannus tyrannus*		S3S4 B	G5	1		y	y			y			
Eastern Meadowlark	*Sturnella magna*	T	S1S2 B	G5	1									
Eastern Whip-poor-will	*Caprimulgus vociferus*	T	S2B	G5	1									
Eastern Wood-Pewee	*Contopus virens*	SC	S4B	G5	1		y	y	y	y				
Evening Grosbeak	*Coccothraustes vespertinus*		S3S4 B,S4 S5N	G5	1				y					
Gadwall	*Anas strepera*		S2B	G5				y						
Greater Scaup	*Aythya marila*		S1B, S2N	G5			y	y						
Green Heron	*Butorides virescens*		S1S2 B	G5	1		y	y						
Green-winged Teal	*Anas coralinensis*		S4S5 B	G5	1			y			y			

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Horned Lark	*Eremophila alpestris*		S2B	G5			y	y						
House Wren	*Troglodytes aedon*		S1B	G5										
Killdeer	*Charadrius vociferus*		S3B	G5	1		y	y			y			y
Least Bittern	*Ixobrychus exilis*	T	S1S2 B	G5	1		y	y						
Long-eared Owl	*Asio otus*		S2S3	G5				y	y					
Magnolia Warbler	*Setophaga magnolia*		S5B	G5	1				y					
Mallard	*Anas platyrhynchos*		S5B, S4N	G5	1		y	y			y			
Marsh Wren	*Cistothorus palustris*		S2B	G5			y	y						
Nelson's Sparrow	*Ammodramus nelsoni*		S4B	G5	1		y	y			y			
Northern Goshawk	*Accipiter gentilis*		S4	G5	1				y					
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*		S1S2 B	G5										
Northern Shoveler	*Anas clypeata*		S2B	G5				y						
Olive-sided Flycatcher	*Contopus cooperi*	T	S3S4 B	G4	1			y	y					
Peregrine Falcon (anatum)	*Falco peregrinus pop. 1*	SC	S1B	G4T 4	1		y		y			Y		

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Pied-billed Grebe	*Podilymbus podiceps*		S4B	G5	1		y	y						
Pine Grosbeak	*Pinicola enucleator*		S2S3 B,S4 S5N	G5					y					
Purple Finch	*Carpodacus purpureus*		S4S5 B	G5	1				y					
Purple Martin	*Progne subis*		S1S2 B	G5										
Red-shouldered Hawk	*Buteo lineatus*	NAR	S2B	G5	1				y					
Ring-necked Duck	*Aythya collaris*		S5B	G5	1		y	y						
Rose-breasted Grosbeak	*Pheucticus ludovicianus*		S4B	G5	1			y	y	y				
Ruffed Grouse	*Bonasa umbellus*		S5	G5	1				y					
Rusty Blackbird	*Euphagus carolinus*	SC	S3B	G4	1		y	y	y					
Sedge Wren	*Cistothorus platensis*	NAR	S1B	G5				y						
Short-eared Owl	*Asio flammeus*	SC	S3B	G5	1				y					
Solitary Sandpiper	*Tringa solitaria*		S2B, S5M	G5	1			y	y					
Sora	*Porzana carolina*		S4B	G5	1		y	y						
Spotted Sandpiper	*Actitis macularius*		S4B	G5	1		y	y						

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Tree Swallow	*Tachycineta bicolor*		S4B	G5	1		y	y			y			
Upland Sandpiper	*Bartramia longicauda*		S1B	G5			y				y			
Veery	*Catharus fuscescens*		S4B	G5	1			y	y		y			
Vesper Sparrow	*Pooecetes gramineus*		S2B	G5			y							
Virginia Rail	*Rallus limicola*		S3B	G5	1			y						
White-breasted Nuthatch	*Sitta carolinensis*		S5	G5	1				y					
White-throated Sparrow	*Zonotrichia albicollis*		S5B	G5	1				y					
Willow Flycatcher	*Empidonax traillii*		S1S2 B	G5			y	y						
Wilson's Phalarope	*Phalaropus tricolor*		S1B	G5			y	y						
Wilson's Snipe	*Gallinago delicata*		S4B	G5	1		y	y			y			
Wood Duck	*Aix sponsa*		S4B	G5	1			y	y	y				
Wood Thrush	*Hylocichla mustelina*	T	S1S2 B	G5	1			y	y					
Yellow Rail	*Coturnicops noveboracensis*	SC	S1?B	G4	1			y						
Yellow-bellied Sapsucker	*Sphyrapicus varius*		S5B	G5	1				y	y				

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Blue Dasher	*Pachydiplax longipennis*		S1	G5				y						
Boreal Snaketail	*Ophiogomphus colubrinus*		S1S2	G5			y							
Cobblestone Tiger Beetle	*Cicindela marginipennis*	E	S1?	G2										y
Juvenal's Duskywing	*Erynnis juvenalis*		S1	G5										
Maritime Ringlet	*Coenonympha nipisiquit*	E	S1	G1										
Pygmy Snaketail	*Ophiogomphus howei*	SC	S1	G3			y	y						
Skillet Clubtail	*Gomphus ventricosus*	E	S1	G3				y						
Banded Hairstreak	*Satyrium calanus*		S2	G5										
Clamp-Tipped Emerald	*Somatochlora tenebrosa*		S2	G5										
Cobra Clubtail	*Gomphus vastus*		S2	G5				y						
Fragile Forktail	*Ischnura posita*		S2	G5				y						
Gray Hairstreak	*Strymon melinus*		S2	G5										
Henry's Elfin	*Callophrys henrici*		S2	G5										
Lilypad Clubtail	*Arigomphus furcifer*		S2	G5				y						
Monarch	Danaus plexippus	SC	S3B	G5			y	y			y			y

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Mottled Darner	*Aeshna clepsydra*		S2	G4				y						
Spine-crowned Clubtail	*Gomphus abbreviatus*		S2S3 ?	G3G 4				y						
Swamp Spreadwing	*Lestes vigilax*		S2S3	G5				y						
Canada Lynx	*Lynx canadensis*	NAR	S1	G5					y					
Silver-haired Bat	*Lasionycteris noctivagans*		S1?	G5					y					
Long-tailed Shrew	*Sorex dispar*	NAR	S1	G4					y					
Big Brown Bat	*Eptesicus fuscus*		S2?	G5					y					
Tri-coloured Bat	*Perimyotis subflavus*	E*	S2?	G5					y					
Hoary Bat	*Lasiurus cinereus*		S2?	G5					y					
Red Bat	*Lasiurus borealis*		S2?	G5					y					
Northern Myotis	*Myotis septentrionalis*	E*	S2	G4					y					
Little Brown Myotis	*Myotis lucifugus*	E*	S4	G5					y					
a macro-lichen	*Sphaerophorus globosus*		S2S3	G4G 5									y	

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
a moss	*Anomobryum filiforme*		S1?	G4G5									y	
a Moss	*Anomodon minor*		S1	G5					y					
a Moss	*Anomodon tristis*		S1S2	G5					y				y	
a Moss	*Anomodon viticulosus*		S1	G5									y	
a Moss	*Brachythecium digastrum*		S1S2	G4?					y				y	
a Moss	*Bryum muehlenbeckii*		S1	G4G5			y							
a Moss	*Bryum pallescens*		S1S2	G5			y						y	
a Moss	*Calliergon trifarium*		S1	G4			y							
a Moss	*Calliergonella cuspidata*		S2S3	G5				y						
a Moss	*Campylium radicale*		S1S2	G3G5							y			
a Moss	*Cirriphyllum piliferum*		S2	G5										
a Moss	*Dichelyma falcatum*		S1	G4G5			y		y					
a Moss	*Dicranum bonjeanii*		S1	G4G5									y	
a moss	*Didymodon ferrugineus*		S1S2	G5T5?				y					y	
a Moss	*Ditrichum*		S1	G5										

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
	pallidum													
a Moss	*Ephemerum serratum*		S2S3	G4							y			
a Moss	*Eurhynchium hians*		S1	G5				y						
a Moss	*Fontinalis antipyretica*		S1?	G5			y							
a Moss	*Homomallium adnatum*		S1	G3G5			y							
a Moss	*Hygrohypnum bestii*		S1S2	G4			y							
a Moss	*Hypnum pratense*		S2	G5				y						
a Moss	*Physcomitrium immersum*		S2	G4			y							
a Moss	*Plagiomnium rostratum*		S1S2	G5			y						y	
a Moss	*Pleuridium subulatum*		S3	G5					y					
a Moss	*Pseudotaxiphyllum distichaceum*		S1	G4G5					y					
a Moss	*Rhytidium rugosum*		S1	G5									y	
a Moss	*Scorpidium scorpioides*		S2	G4G5			y							
a Moss	*Seligeria diversifolia*		S1S2	G2G3			y					y	y	
a Moss	*Seligeria*		S1	G4?			y							

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
	recurvata													
a Moss	*Syntrichia ruralis*		S1	G5									y	
a Moss	*Thamnobryum alleghaniense*		S2	G5?			y						y	
a Moss	*Timmia norvegica*		S1	G4?			y							
a Moss	*Tortula mucronifolia*		S1S2	G5									y	
a Peatmoss	Sphagnum angermanicum		S1S2	G3G4				y						
a Peatmoss	Sphagnum lescurii		S3?	G5				y						
Acadian Quillwort	*Isoetes acadiensis*		S2S3	G3Q			y							y
Alpine Cliff Fern	*Woodsia alpina*		S2	G4								y	y	
Alpine Sweet-vetch	*Hedysarum alpinum*		S3	G5			y							
American False Pennyroyal	*Hedeoma pulegioides*		S2	G5							y			y
American Lopseed	*Phryma leptostachya*		S2	G5					y					
American Yellow Rocket	*Barbarea orthoceras*		S2	G5							y			y
Anticosti Aster	*Symphyotrichum anticostense*	T	S3	G3			y							y
Arching	*Rubus*		S2?	G4?			y	y						

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Dewberry	*recurvicaulis*													
Arrow-Leaved Violet	*Viola sagittata var. ovata*		S1	G5T5										y
Auricled Twayblade	*Listera auriculata*		S2S3	G3G4			y							
Awned Flatsedge	*Cyperus squarrosus*		S2	G5			y							y
Back's Sedge	*Carex backii*		S1	G4			y						y	
Blood Milkwort	*Polygala sanguinea*		S2	G5							y			
Blue-stemmed Goldenrod	*Solidago caesia*		SX	G5					y					
Blunt-leaved Bedstraw	*Galium obtusum*		S2?	G5			y							
Blunt-lobed Moonwort	*Botrychium oneidense*		S1	G4Q				y						
Bog Fern	*Thelypteris simulata*		S1S2	G4G5				y						
Bog Yellow-eyed-grass	*Xyris difformis*		S1	G5			y							
Brewer's Whitlow-grass	*Draba breweri var. cana*		S1	G5									y	
Bur Oak	*Quercus macrocarpa*		S2	G5							y			
Butternut	*Juglans cinerea*	E	S3	G4			y		y					
Buttonbush Dodder	*Cuscuta cephalanthi*		S1?	G5				y						
Calypso	*Calypso bulbosa var.*		S2	G5T5?				y						

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
	americana													
Canada Garlic	*Allium canadense*		S1	G5									y	
Canada Honewort	*Cryptotaenia canadensis*		SX	G5					y					
Canada Lousewort	*Pedicularis canadensis*		S1	G5			y							
Canada Rice Grass	*Piptatherum canadense*		S2	G5			y							y
Canada Wild Rye	*Elymus canadensis*		S2	G5			y							y
Carey's Smartweed	*Polygonum careyi*		S2	G4			y				y			
Case's Ladies'-Tresses	*Spiranthes casei*		S1	G4										
Common Buttonbush	*Cephalanthus occidentalis*		S2	G5			y	y						
Common Hop	*Humulus lupulus var. lupuloides*		S1S2	G5T5							y			
Creeping Rush	*Juncus subtilis*		S1	G4			y	y						
Cut-leaved Anemone	*Anemone multifida*		S2S3	G5			y						y	
Disguised St John's-wort	*Hypericum dissimulatum*		S2	G5			y	y						
Ditch Stonecrop	*Penthorum sedoides*		S2S3	G5			y							
Downy Rattlesnake-	*Goodyera pubescens*		S1	G5					y					

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Plantain														
Drummond's Rockcress	*Arabis drummondii*		S2	G5									y	
Early Saxifrage	*Saxifraga virginiensis*		S1S2	G5								y	y	
Eastern Cudweed	*Pseudognaphalium obtusifolium*		S1	G5										y
Eastern Leatherwood	*Dirca palustris*		S2	G4				y	y					
Eastern Skunk Cabbage	*Symplocarpus foetidus*		S2	G5			y							
Egg Flapwort	*Jungermannia obovata*		S1	G4G5			y							
Elegant Milk-vetch	*Astragalus eucosmus*		S2	G5			y							
Field Locoweed	*Oxytropis campestris var. johannensis*		S2	G5T4			y							y
Five-angled Dodder	*Cuscuta pentagona*		S1	G5			y							y
Fleshy Hawthorn	*Crataegus succulenta*		S2	G5										
Floating Crystalwort	*Riccia fluitans*		S1	G5			y	y	y		y			
Forked Panic Grass	*Dichanthelium dichotomum*		S1	G5										
Fragrant Green Orchid	*Platanthera huronensis*		S2?	G5T5?			y							

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Fringed Milkwort	*Polygala paucifolia*		S2	G5					y					
Garber's Sedge	*Carex garberi*		S2	G5			y							
Herb Robert	*Geranium robertianum*		S2S3	G5					y					
Hop Flatsedge	*Cyperus lupulinus*		S1	G5										y
Howell's Pussytoes	*Antennaria howellii ssp. petaloidea*		S1	G5T3T5					y		y			
Indian Wild Rice	*Zizania aquatica var. aquatica*		S2	G5T5			y	y						
Inflated Narrow-leaved Sedge	*Carex grisea*		S1	G5?			y	y	y					
Jones' Hawthorn	*Crataegus jonesiae*		S1	G4G5							y			
Kalm's Hawkweed	*Hieracium kalmii*		S1	G5							y			
Labrador Bedstraw	*Galium labradoricum*		S2S3	G5			y							
Lance-leaved Arnica	*Arnica lanceolata*		S3	G3			y							
Lance-leaved Figwort	*Scrophularia lanceolata*		S2	G5							y			
Large Round-Leaved Orchid	*Platanthera macrophylla*		S1	G5T4					y					

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Large-Fruited Sanicle	*Sanicula trifoliata*		S1	G4				y						
Laurentian Bladder Fern	*Cystopteris laurentiana*		S1	G3							y			
Lesser Brown Sedge	*Carex adusta*		S2S3	G5										
Limestone Meadow Sedge	*Carex granularis*		S2	G5										
Little Bluestem	*Schizachyrium scoparium*		S2	G5			y							y
Livid Sedge	*Carex livida var. radicaulis*		S2	G5T5										
Long-beaked Sedge	*Carex sprengelii*		S2	G5?					y					
Long-bracted Frog Orchid	*Coeloglossum viride var. virescens*		S2	G5T5							y			
Long-leaved Starwort	*Stellaria longifolia*		S2	G5					y		y			
Low Flatsedge	*Cyperus diandrus*		S1	G5			y	y						
Low Spikemoss	*Selaginella selaginoides*		S2	G5				y						
Luminous Moss	*Schistostega pennata*		S1S2	G3G4										
Lyell's Ribbonwort	*Pallavicinia lyellii*		S1	G5										
Macoun's Cudweed	*Pseudognaphalium macounii*		S2	G5							y			

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Maidenhair Spleenwort	*Asplenium trichomanes*		S2	G5									y	
Maple-leaved Goosefoot	*Chenopodium simplex*		S1	G5							y			
Marsh Notchwort	*Lophozia laxa*		S1	G4				y						
Menzies' Rattlesnake-plantain	*Goodyera oblongifolia*		S2	G5?				y						
Montane Notchwort	*Lophozia alpestris*		S1	G5			y							y
Narrow-Leaved Gentian	*Gentiana linearis*		S2	G4G5				y						
Narrow-leaved Panic Grass	*Dichanthelium linearifolium*		S2	G5			y	y						
Nees' Pouchwort	*Calypogeia neesiana*		S1S3	G5										
New England Blue Violet	*Viola novae-angliae*		S2	G4Q									y	
New York Aster	*Symphyotrichum novi-belgii var. crenifolium*		S2?	G5TNR										
Nodding Ladies'-Tresses	*Spiranthes cernua*		S2	G5							y			
Northern Adder's-tongue	*Ophioglossum pusillum*		S2S3	G5							y			

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
One-Flowered Broomrape	*Orobanche uniflora*		S2	G5			y		y					
Orange-fruited Tinker's Weed	*Triosteum aurantiacum*		S2	G5					y					
Pale Dogwood	*Cornus obliqua*		S2	G5			y		y					
Panicled Hawkweed	*Hieracium paniculatum*		S1	G5					y					
Parlin's Pussytoes	*Antennaria parlinii*		S1	G5?					y					
Pennsylvania Blackberry	*Rubus pensilvanicus*		S2?	G5							y			
Pinnate Scalewort	*Porella pinnata*		S1S3	G5			y	y						
Poison Ivy	*Toxicodendron radicans*		S2?	G5			y		y					
Prototype Quillwort	*Isoetes prototypus*	SC	S2	G2G 3				y						
Pubescent Sedge	*Carex hirtifolia*		S2	G5			y	y	y					
Purple-veined Willowherb	*Epilobium coloratum*		S2?	G5			y	y						y
Red Pigweed	*Chenopodium rubrum*		S2	G5			y							y
River Bulrush	*Schoenoplectus fluviatilis*		S2S3	G5				y						
Rock Spikemoss	*Selaginella rupestris*		S1S2	G5								y	y	
Rock Whitlow-Grass	*Draba arabisans*		S1	G4								y	y	

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Rough Dropseed	*Sporobolus compositus*		S1	G5			y							
Rough Hawthorn	*Crataegus scabrida*		S2	G5?					y					
Round-headed Bush-clover	*Lespedeza capitata*		S1	G5			y							y
Round-lobed Hepatica	*Hepatica nobilis var. obtusa*		S2	G5T5					y					
Russet Sedge	*Carex saxatilis*		S1	G5			y							
Seabeach Dock	*Rumex pallidus*		S2S3	G4			y							
Shining Ladies'-Tresses	*Spiranthes lucida*		S2	G5			y							
Slender Agalinis	*Agalinis tenuifolia*		S1	G5							y			
Slender Beakrush	*Rhynchospora capillacea*		S1	G4			y	y						
Slender Cottongrass	*Eriophorum gracile*		S1	G5							y			
Slender Splachnum	*Tayloria serrata*		S2	G4			y							
Small White Aster	*Symphyotrichum racemosum*		S2	G4G5			y							
Small-flowered Agalinis	*Agalinis paupercula var. borealis*		S1	G5T4?			y							
Small-	*Cardamine*		S1	G5T									y	

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
flowered Bittercress	*parviflora var. arenicola*			5										
Small-spike False-nettle	*Boehmeria cylindrica*		S2	G5				y						
Smooth Alder	*Alnus serrulata*		S2	G5			y	y						
Smooth Sweet Cicely	*Osmorhiza longistylis*		S2?	G5										
Southern Dung Moss	*Splachnum pennsylvanicu m*		S1	G4?				y						
Southern Twayblade	*Listera australis*		S2	G4					y					
Southern Water Plantain	*Alisma subcordatum*		S1	G4G 5			y	y						
Spotted Coralroot	*Corallorhiza maculata*		S2S3	G5				y	y					
Spreading Wild Rye	*Elymus hystrix var. bigeloviana*		S1	G5T 5?			y	y						
Spurred Threadwort	*Cephaloziella elachista*		S1	G4										
Starved Panic Grass	*Dichanthelium depauperatum*		S2S3	G5			y							y
Sterile Sedge	*Carex sterilis*		S1	G4			y							
Sticky Goldenrod	*Solidago simplex ssp. randii*		S2	G5T 3?			y							y
Strawberry-	*Chenopodium*		S1	G5			y				y			

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
blite	*capitatum*													
Swamp Beggarticks	*Bidens discoidea*		S1	G5			y	y						
Sweet Wood Reed Grass	*Cinna arundinacea*		S1	G5			y	y						
Tall Goldenrod	*Solidago altissima*		S2	G5										y
Ten-rayed Sunflower	*Helianthus decapetalus*		S1	G5			y		y					
Tubercled Orchid	*Platanthera flava var. herbiola*		S1	G4T 4Q			y				y			
Tufted Love Grass	*Eragrostis pectinacea*		S2?	G5			y							y
Urn Moss	*Physcomitrium pyriforme*		S2	G5							y			
Virginia Chain Fern	*Woodwardia virginica*		S2	G5				y						
Virginia Mountain Mint	*Pycnanthemum virginianum*		S1	G5									y	
Virginia St John's-wort	*Triadenum virginicum*		S1	G5			y							y
Wallrue Spleenwort	*Asplenium ruta-muraria var. cryptolepis*		S1	G5T 5			y							y
Western Dock	*Rumex aquaticus var. fenestratus*		S1S2	G5T 5							y			

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
White Adder's-Mouth	*Malaxis brachypoda*		S1	G4Q				y						
White Cut Grass	*Leersia virginica*		S2	G5			y	y						
White Mountain Saxifrage	*Saxifraga paniculata ssp. neogaea*		S1	G5T5?									y	
White Vervain	*Verbena urticifolia*		S2	G5							y			
White-tinged Sedge	*Carex albicans var. emmonsii*		S2	G5T5			y	y						
Whorled Yellow Loosestrife	*Lysimachia quadrifolia*		S1	G5			y	y	y					
Wild Leek	*Allium tricoccum*		S2	G5					y					
Woodland Pinedrops	*Pterospora andromedea*		S1	G5										
Yellow Lady's-slipper	*Cypripedium parviflorum var. makasin*		S2	G5T4Q			y		y					
Northern Dusky Salamander	*Desmognathus fuscus*	NAR	S3	G5			y							
Wood Turtle	*Glyptemys insculpta*	T	S3	G4			y							
Snapping	*Chelydra*	SC	S4	G5			y							

Common Name	Species Name	COSEWIC Rank	S-rank	G-rank	BCR Priority	Aquatic	Riparian	Wetland	Forest	Old Forest	Fields/ meadows	Cliffs	Rocky outcrop	Beach
Turtle	*serpentina*													
American Eel	*Anguilla rostrata*	SC	S5	G4		y								
Shortnose Sturgeon	*Acipenser brevirostrum*	AC	S2	G3		y								
Atlantic Salmon	*Salmo salar*		S2	G5		y								
Atlantic Sturgeon	*Acipenser oxyrinchus*	T	S3	G5		y								
Striped Bass	*Morone saxatilis*	T	S2	G5		y								
Round Whitefish	*Prosopium cylindraceum*		S2	G5		y								

Appendix B. Methods for generating the species and biodiversity composites

The methods used for the GIS analysis were established in a collaborative, iterative manner, through close communication with Canadian Wildlife Services (CWS) and Nature Conservancy Canada (NCC), with input and consultation with relevant experts from ACCDC, Bird Studies Canada (BSC) and New Brunswick provincial government. For as much of the data as possible the layers were gathered or generated for the full extent of the province, and then clipped to the LSJR study area, in order to avoid having to repeat work for other conservation plans in the future.

The data used in the analysis were of two broad categories: species location data, and habitat data. The specific habitat data used in the analysis were chosen based on the habitat requirements and preferences of the species chosen as target species.

1. **Species data**

Analyses rely on lists of priority species established by consensus according to objective selection criteria. Initially, only species at risk were chosen as targets for the analysis, but concerns were raised early in the planning of the project by stakeholders that this would result in a final product that was too limited in scope to be relevant to a wide group of stakeholders. Additionally, it was felt that a focus only on species at risk would mean that important species might be missed, resulting in a conservation plan that didn't capture the true diversity of habitats and species in the study area.

Multiple sources of species data were included in the analysis. These included point data from the ACCDC, occurrence and abundance data from BSC's Maritime Breeding Bird Atlas, as well as CWS's Colonial Waterbirds and Coastal Waterfowl databases.

The ACCDC database was used as the starting point for producing the list of species of interest for the study. The list was limited to species that adhered to the following criteria:

- Ranked as S1 or S2, or as S3 with a G1, G2 or G3 ranking
- Identified as a BCR priority species (14 for New Brunswick)
- Identified by COSEWIC as Endangered, Threatened or of Special Concern

Aquatics species and species occurring accidentally were also removed, as well as any data points with a geographic uncertainty greater than 5 km. All of the remaining species were then grouped into broad categories: Birds, Reptiles and Amphibians, Mammals, Invertebrates, Aquatic Species, and Plants.

The habitat preference for each species on the list was identified, in either broad or very general terms, depending on the species preferences, as well as the information known for each species. These habitat preferences were then summarized in order to identify broad habitat types that would accommodate the needs of the vast majority of the species.

One of the goals of the GIS analysis was to create biodiversity composite layers, which combine suites of available species occurrence data into spatial layers. The collation of data from such a large number of sources represents a new phase in collaboration and data availability, and means that other groups will avoid having to redo work already completed, and that all groups are working with all of the data available. The layers and data types and sources compiled into the biodiversity composite layers are summarized in Appendix E.

Table 13. Layers and data sources

Data layers (Individual species rasters)	Data source	Source data type
Occurrence of mammals, reptiles, amphibians, vascular plants, non-vascular plants, lichens, etc.	AC CDC	Points
Relative abundance of breeding bird species detected by point count	MBBA point count	Points, counts
Breeding evidence of bird species for which point count data are unavailable or insufficient to generate relative abundance maps	MBBA breeding evidence	Polygons (10X10 km squares), breeding evidence categories
Occurrence and abundance of rare and colonial breeding bird species (specifically to map non-waterbird colonies)	MBBA rare/colonial species	Points, counts
Occurrence and abundance of shorebirds (non-breeding migratory flocks)	Atlantic Canada Shorebird Survey database	Points, counts
Occurrence and abundance of colonial waterbirds	Atlantic Region Colonial Waterbird database	Points, counts
Occurrence and abundance of coastal waterfowl (non-breeding and migratory flocks)	Atlantic Canada Coastal Waterfowl Survey database	Polygons (irregular blocks), counts
Occurrence of SAR critical habitat	Atlantic Region Critical Habitat Mapping Database	Polygons (irregular)

2. ACCDC Species occurrence data

The ACCDC dataset contains point data records for a large number of species occurring in Atlantic Canada (mostly Maritimes). The methods used to prepare these data for inclusion in the final Biodiversity Composite are described below, with a more detailed description of step-by-step methods presented in Appendix C

All of the bird data points were removed, as bird species are more adequately represented by other data sources. This was done to avoid duplication of data, and to avoid the over-emphasis of species represented by multiple data sources.

The goals of this analysis were to generate species-specific raster layers based on the geographic precision of the points. Originally, the points were buffered based on their geographic precision, so points with a low geographic precision were buffered with a large buffer with a low score. This method leads to artificially overweighting areas where two low precision buffers overlapped, and so a two-layer buffering method was used to avoid this.

The primary buffer was generated using a kernel density analysis, based on the ACCDC precision code included in the data (Table 14, p. 151).

The precision codes were recalculated so that they ranged from 0 to 0.8. Points with a higher geographic certainty were given a higher rank, recorded as a new field (titled Population) (Fig. 37). These points were then buffered using a kernel density analysis for each individual species, using a 500 m radius, a

100 m output cell size and the appropriate 'POPULATION' parameter value. This approach attributes more value to pixels closest to the centroid with more precise observations.

The kernel density analysis tool could not function for species for which there was only one occurrence in the province. These 59 species were grouped into larger categories (Bryophytes, Insects, Lichen, Vascular Plants) rather than removing them from the analysis altogether. The species and their groupings are show in Table 12 (Appendix A).

This analysis resulted in raster layers for each of the species in the ACCDC database with pixel values ranging from 0 to 0.8.

Table 14. 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

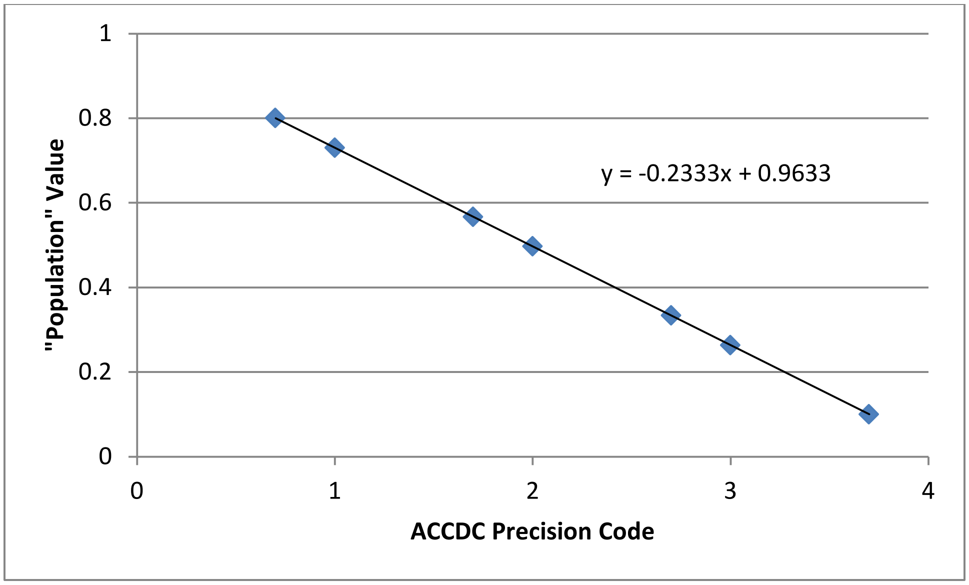


Fig. 37. Population values derived for the purpose of informing the kernel density point process using precision code values within the ACCDC dataset (Linear equation can be used to populate a new attribute field with POPULATION value information).

The secondary buffers were also generated for each individual species. Each point was buffered to 5000 m, and the entire area of the buffer was given a ranking of 0.2. For species for which critical habitat has been identified, the habitat polygons were also given a ranking of 0.2. These layers were then converted into raster layers with a pixel size of 10m

The primary and secondary buffer rasters for each species were then added, to create a single layer for each species, with areas ranked from 0-1 based on the presence of the given species. These individual species layers were then added to create a single layer for all species, and then reclassified so the values ranged from 0-1. This final layer shows areas of multispecies biodiversity, although it doesn't include bird species.

3. 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. All future iterations of Integrated Habitat Conservation Strategies (post March 31, 2013) must request and apply relative abundance maps as published by the Maritimes Breeding Bird Atlas.

Breeding Evidence Data
Confirmed = 0.5 (for each Atlas)
Probable = 0.3 (for each Atlas)

Possible = 0.1 (for each Atlas)
Rare/Colonial Species Data
Colonial buffer = 500 m

Data steps (*MBBA Point Count*):
1) Breeding priority bird species
2) Use species relative abundance rasters derived from point count information by Bird Studies Canada.
3) Decision on quality and appropriateness of individual rasters determined ‘a priori’ by MBBA and BSC staff.
4) Reclassify range to vary between 0 and 1 (Maritimes scale).

Data steps (*MBBA Breeding Evidence*):
1) Breeding priority bird species
2) Use species breeding abundance data (highest level breeding evidence, by square, by species)
3) Derive rasters using breeding evidence data for species not captured adequately through point counts.
4) Create raster values according to following rules: Confirmed = 0.5, Probable = 0.3, Possible 0.1
5) Create rasters for each Atlas such that combined values for a given species range from 0 to 1.

Data steps (*MBBA Rare and Colonial*):
1) 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.

4. 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.

Data steps:
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.

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 censused annually, most are visited much less frequently. Methods used to derive colony population estimates vary markedly among colonies and among species.

Data steps:
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.

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.

Data steps:
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.

5. Biodiversity Composite Layer and Species Data Composites

Overlaying the rasters for the suite of priority species creates a biodiversity composite spanning provincial jurisdictions (as BCR priority bird lists are established at the provincial scale). 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 Randall at NCC NL 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.

6. Conservation Value Index

The habitat prioritization layers (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 prioritization 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. A simple feature to raster conversion was made for each priority habitat, with the overall patch scores acting as the field used to assign values to the raster cells. To create the CVI, these habitat rasters were compiled with the species rasters using an additive function in the raster calculator yielding a single raster layer having cells with a combined value of species and habitat prioritization scoring.

Appendix C. ACCDC data methods

1. Pre-run Methods

1) Delete all Bird data points (this data will be supplemented from other sources)
2) Delete all points that have a precision value [PREC] > 3.7
3) Remove all points that do not meet the following criteria:

GRank	NProt	SProt	SRank
G1	SC (Special Concern)	Endangered	S1
G1G2	T (Threatened)	Reg. Endangered	S1?
G1G2Q	E (Endangered)		S1S2
G2			S1S2N
G2?			S2
G2G3			S2?
G3			
G3?			
G3?Q			
G3Q			

4) Identify species that have numeric values or "." within the MCODE field and change these names accordingly. Below is an example using the NB dataset:

Species	MCODE	New MCODE
Humpback Whale - Western North Atlantic pop.	MEGAno.2	MEGAnova
Woodland Caribou (Atlantic-Gaspésie pop.)	RANGta.2	RANGtara
Atlantic Salmon - Inner Bay of Fundy pop.	SALMsa.1	SALMsaFD
Bathurst Aster - Bathurst pop.	SYMPsu.B	SYMPsuBT

2. Kernel Density Caveats and Solutions

The Kernel density tool in Arc10 cannot run on points under the following scenarios:

i) A species is represented by a single point in the database
ii) A species has 2 or more points which all have the exact same spatial extent (one on top of the other)

There are 2 recommended solutions to this issue depending on the level of accuracy needed from the model output. The first method involves grouping species together, as described below:

5) Identify species that are only represented by 1 point occurrence in the dataset using the summarize tool within the MCODE field. The NB list (n=59) is below:

MCODE	New MCODE	Scientific Name	Common Name
ALOIrigi	BRYOgrp	Aloina rigida	Aloe-Like Rigid Screw Moss
ANOMtris	BRYOgrp	Anomodon tristis	a Moss
APHAserr	BRYOgrp	Aphanorrhegma serratum	a Moss
BRYUmueh	BRYOgrp	Bryum muehlenbeckii	a Moss
CALLtrif	BRYOgrp	Calliergon trifarium	a Moss
CAMPradi	BRYOgrp	Campylium radicale	a Moss
CAMPsaxi	BRYOgrp	Campylostelium saxicola	a Moss
CINCstyg	BRYOgrp	Cinclidium stygium	a Moss

DICHfalc	BRYOgrp	Dichelyma falcatum	a Moss
DICRcris	BRYOgrp	Dicranoweisia crispula	a Moss
DIDYrigr	BRYOgrp	Didymodon rigidulus var. gracilis	a moss
DREPcapi	BRYOgrp	Drepanocladus capillifolius	Brown Moss
ENTObrev	BRYOgrp	Entodon brevisetus	a Moss
GRIMlong	BRYOgrp	Grimmia longirostris	a Moss
GRIMunic	BRYOgrp	Grimmia unicolor	a Moss
HOMOadna	BRYOgrp	Homomallium adnatum	a Moss
KIAEstar	BRYOgrp	Kiaeria starkei	Alpine Broom Moss
MEEStriq	BRYOgrp	Meesia triquetra	a Moss
PALUsqua	BRYOgrp	Paludella squarrosa	a Moss
PLATlesc	BRYOgrp	Platylomella lescurii	a Moss
POHLelon	BRYOgrp	Pohlia elongata	a Moss
PSEUtect	BRYOgrp	Pseudoleskeella tectorum	a Moss
RHYTlore	BRYOgrp	Rhytidiadelphus loreus	a Moss
SPHAmacr	BRYOgrp	Sphagnum macrophyllum	Sphagnum
SPLAspha	BRYOgrp	Splachnum sphaericum	Globe-Fruited Splachnum
SYNTrura	BRYOgrp	Syntrichia ruralis	a Moss
TAXIdepl	BRYOgrp	Taxiphyllum deplanatum	a Yew-Moss
TIMMnorv	BRYOgrp	Timmia norvegica	a Moss
TORTcern	BRYOgrp	Tortula cernua	Narrow-Leafed Chain-Teeth Moss
TORTobtu	BRYOgrp	Tortula obtusifolia	a Moss
ZYGOvivi	BRYOgrp	Zygodon viridissimus var. viridissimus	a Moss
CELImart	INSEgrp	Celithemis martha	Martha's Pennant
ERYNjuve	INSEgrp	Erynnis juvenalis	Juvenal's Duskywing
BRYObico	LICHgrp	Bryoria bicolor	a Lichen
COCCpalm	LICHgrp	Coccocarpia palmicola	a lichen
COLLlept	LICHgrp	Collema leptaleum	a lichen
DEGEplum	LICHgrp	Degelia plumbea	Blue Felt Lichen
ERIOmoll	LICHgrp	Erioderma mollissimum	Vole Ears
ERIOpedi	LICHgrp	Erioderma pedicellatum (Atlantic pop.)	Boreal Felt Lichen - Atlantic pop.
FUSCahln	LICHgrp	Fuscopannaria ahlneri	a lichen
NEPHarct	LICHgrp	Nephroma arcticum	a lichen
PELTmala	LICHgrp	Peltigera malacea	a Dog's tooth Lichen
RAMApoll	LICHgrp	Ramalina pollinaria	Powdery Twig Lichen
STERsubc	LICHgrp	Stereocaulon subcoralloides	a lichen
UMBIvell	LICHgrp	Umbilicaria vellea	a Rocktripe Lichen
BOTRline	VASCgrp	Botrychium lineare	Narrow-leaved Moonwort

CALAstin	VASCgrp	Calamagrostis stricta ssp. inexpansa	Slim-stemmed Reed Grass
CALLterr	VASCgrp	Callitriche terrestris	Terrestrial Water-Starwort
CAREatat	VASCgrp	Carex atlantica ssp. atlantica	Atlantic Sedge
CRATmacr	VASCgrp	Crataegus macrosperma	Big-Fruit Hawthorn
CRATsucc	VASCgrp	Crataegus succulenta	Fleshy Hawthorn
CYNOvirg	VASCgrp	Cynoglossum virginianum	Wild Comfrey
MINUgroe	VASCgrp	Minuartia groenlandica	Greenland Stitchwort
POLYvivi	VASCgrp	Polygonum viviparum	Alpine Bistort
PROSpect	VASCgrp	Proserpinaca pectinata	Comb-leaved Mermaidweed
SOLIsimo	VASCgrp	Solidago simplex var. monticola	Sticky Goldenrod
STUCfili	VASCgrp	Stuckenia filiformis	Thread-leaved Pondweed
SYMPprae	VASCgrp	Symphyotrichum praealtum	Willow-leaved Aster

The second method involves either duplicating points that only occur once in the dataset, and/or shifting points that exactly overlap. Note that overlapping points do not need to be shifted if other points of the same species are located elsewhere (spatially separated).

3. Post-run Methods

1) Priority species habitat analysis
    a. Identify non-bird species with priority habitat polygon layers. For the New Brunswick dataset these species are:

MCODE	Common Name
GLYPinsc	Wood Turtle
COENnipi	Maritime Ringlet
SYMPlaur	Gulf of St. Lawrence Aster
CICImarg	Cobblestone Tiger Beetle

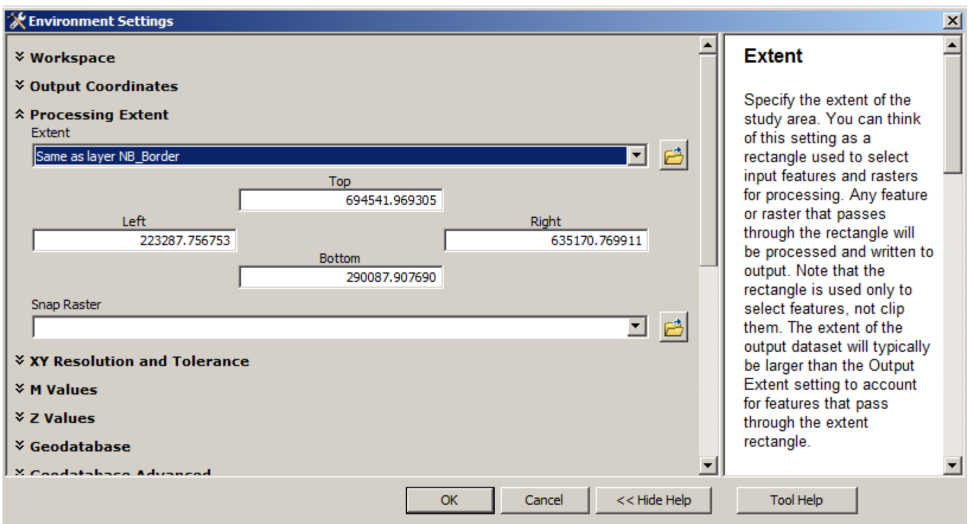
    b. Add a field to each of the priority habitat polygons (field name: VALUE; Type: Float) and assign a value of 1 to all polygons.
    c. Convert all priority habitat polygons to raster using the VALUE field and a cell size of 10 (you may need to convert this raster to a floating point GRID using the "Float" tool in Spatial Analyst).
    d. Within raster calculator, add habitat rasters and model output rasters together for each species separately using the conditional statement below. Make sure the environment settings are set to the provincial boundary for the "Extent" and the "Mask" (see Figs. at the end of this document). The following equation must be used in raster calculator to get the desired output, replacing the raster names in " " with the equivalent rasters in your analysis:

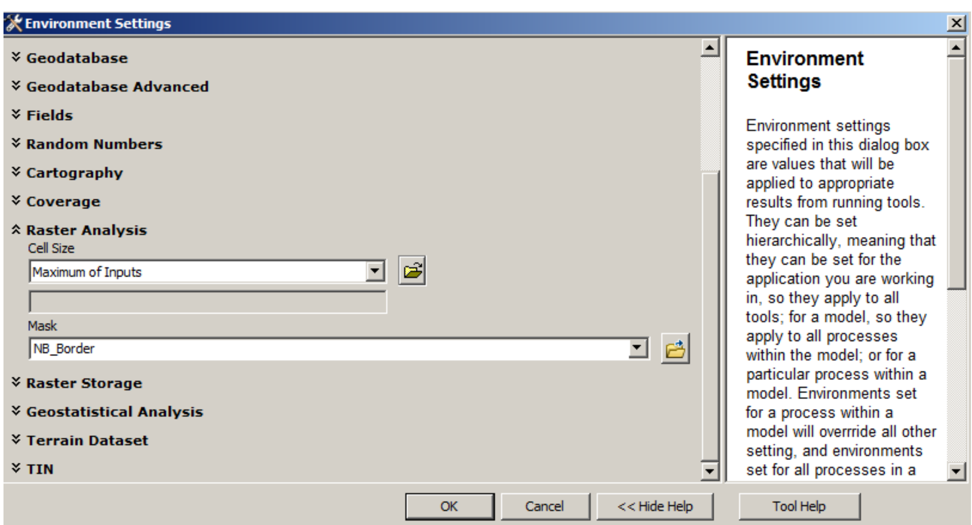
```
Con(IsNull("HabitatRASTER"),"ModelRASTER",("HabitatRASTER" + "ModelRASTER"))
```

e. The output of the above equation will have values greater than 1. To set the values between 0.2 -1 use the following equation in Raster Calculator by replacing “output” with the actual output raster from the step above (save this output in the folder with all other species rasters that will be combined for the final composite):

Con("output" > 1,1,"output")

f. Once all priority habitats have been included in their respective species rasters, the final composite is calculated using the Cell Statistics tool. Add all species to the tool, and make sure “Ignore NoData” is checked. The statistic column should be set to “Sum”. In the environment settings, ensure the provincial border is set for the “Extent” and “Mask”. See below for figures:





Appendix D: Habitat prioritization methodology

Purpose of Analysis

The prioritization methodology used in this report identified areas within the LSJR 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. The list of target species derived from the ACCDC database, with the addition of BCR species, was the basis for determining the target habitats for prioritization. The habitat associated with each species was identified, which were then compiled into group of general habitat types that capture the needs of the vast majority of targeted species in the LSJR. A full list of target species and their associated habitats is presented in Appendix A, Table 12. A list of the priority habitats and a description of how geographic data is presented in each of the priority habitat maps as well as an output of the spatial representation of the data is presented in the *Data Preprocessing* section.

1. Conservation Prioritization

The process for assigning priority ranks within the LSJR 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. Existing protected areas and other conservation lands were not included in the analysis.

2. Data Pre-Processing and Habitat Classification

All priority habitats were directly included in the prioritization analysis.

Target data sources

- *Acadian forest mosaic* – using the NBDNR Forest Resource Inventory spatial dataset, 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 NBDNR Old Forest Community and Old-Forest Wildlife Habitat Definitions for New Brunswick guidelines (NBDNR 2012) and weighted according to patch size, uniqueness, and representivity scores:
    - All forest polygons tiles were merged together.
    - Only mature (M) and over-mature (O) were exported out using the L1DS (Development Stage) field.
    - All polygons with the following treatment attributes were selected and deleted using the L1TRT (Silvicultural Treatment) field:
        - 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, again following guidelines set out in the NBDNR Old Forest Community and Old-Forest Wildlife Habitat Definitions for New Brunswick (NBDNR 2012):
        - Old Tolerant Hardwood Habitat (OTHH)
            - Tolerant Hardwood Pure (THP)
            - Tolerant Hardwood-Softwood (THSW)
            - Tolerant Hardwood-Intolerant Hardwood (THIH)
        - Old Hardwood Habitat (OHWH)[7]
            - Intolerant Hardwood Mix (IHMX)
        - Old Pine Habitat (PINE)
            - Red Pine (RP)
            - White Pine (WP)
        - Old Spruce-Fir Habitat (OSFH)[8]
            - 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)[9]

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

[7] 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.
[8] OSFH also included the "SP" veg community, which represents Spruce dominated habitat, although there is no reference to this category in the Provincial definitions.
[9] 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).

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. Oromocto River). All wetland patches were weighted according to patch size, uniqueness, and representivity scores.

- *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 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 2013d).
- *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. 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), accessed through 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. Using both data sources provided a more comprehensive inventory of beach habitat along the major riverine and lake habitats in the bioregion. 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.

<u>Cleaning the Data</u>

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.

<u>Weighting the Data</u>

For each habitat/biodiversity habitat, final scores between 0 and 1 were assigned, the latter representing completely suitable habitat for nested habitats. Wetland and Acadian forest mosaic habitat occurrences were scored using a three-tiered equation that equally divides the scoring by habitat uniqueness, representivity, and size. All other habitat types were weighted according to size or presence / absence as noted above.

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:

$$U_1 = 1 - \left(\frac{Habitat_{NA-Ecodistrict}}{Habitat_{NA-Total}} \right)$$

$$U_2 = 1 - \left(\frac{Habitat_{NA-Total}}{Ecosystem_{NA-Total}} \right)$$

Where *Habitat* refers to the specific form of habitat such as a Bog, nested within the overall Freshwater wetlands *Ecosystem*. Subscript *NA-Ecodistrict* denotes the portion of ecodistrict area that is within the Bioregion boundary and subscript *NA-Total* denotes the total area within the Bioregion. The final uniqueness score is calculated as:

$$Uniqueness = \frac{(U_1 + U_2)}{2}$$

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 (grasslands/agro-ecosystems), 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.

Representivity

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

$$R_1 = \frac{Ecodistrict_{NA}}{Ecodistrict_{Total}}$$

$$R_2 = \frac{Habitat_{NA-Ecodistrict}}{Habitat_{Ecodistrict}}$$

Where *Ecodistrict* refers to the land area in total (subscript *Total*) and that portion of land area within the Bioregion (subscript *Bioregion*) for each ecodistrict. The subscript *Ecodistrict* refers to the total amount of each habitat within the ecodistrict, regardless of the proportion that is within the Bioregion boundary. The final representivity score is calculated as:

$$Representivity = 1 - \left(\frac{R_1}{R_2} \right)$$

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, then 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

Size is calculated for each occurrence of all habitat types across the Bioregion. For example, if the habitat met the minimum size criteria based on literature review and consensus, it would receive a size 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 15 below for a summary of size criteria used within the analysis.

Table 15. Minimum size criteria for each habitat type within the LSJR analysis.

Habitat	Data Source	Minimum Size (ha)	Size Score
Beaches	National Topographic Database, NBDNR non-forested layer	N/A (criteria = presence / absence)	1
Rocky outcrops	NBDNR bedrock geology	N/A (criteria = presence / absence)	1
Cliffs	NCC Steep Slopes	N/A	1

		(criteria = presence / absence)	
Freshwater wetlands	NBDNR Wetlands, NBDNR FRI Forest - wet site areas	20.2	Below minimum size = sliding scale to .99 Above minimum size = 1
Riparian Areas	NBDNR Waterways and Waterbodies, NAAP Critical Riparian Areas	N/A (criteria = presence / absence)	0.2
Grasslands/agro-ecosystems	NBDNR Non-forested	50 (Environment Canada 2013)	Below minimum size = sliding scale to 0.99 Above minimum size = 1
Acadian forest mosaic[10] Tolerant Hardwood (OTHH) Intolerant Hardwood (OHWH) Spruce / Fir (OSFH) Pine (PINE) Other (OOFH)	NBDNR FRI Forest	 40 30 375 10 375	Below minimum size = sliding scale to 0.99 Above minimum size = 1

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.

<u>Species Analyses</u>
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 Appendices B and C for a complete methodology of the New Brunswick Biodiversity Composite.

<u>Combining the Data</u>
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

[10] 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.

overlaid and added together to give an overall scoring across the Bioregion (using the Cell Statistics tool). Each biodiversity habitat was weighted on a scale of 0 to 1 when the final score was calculated. Table shows the list of all rasters that were combined for prioritization with their respective scoring.

Table 16. List of rasterized layers used in the Bioregion analysis with their respective scoring.

Prioritization Raster	Scoring Values
Beaches	1
Rocky outcrops	1
Cliffs	1
Acadian forest mosaic	0.001 - 1
Freshwater wetlands	0.001 - 1
Riparian areas	0.2
Grasslands/agro-ecosystems	0.001 - 1
General biodiversity species composite	0.18 - 1
Species-at-risk composite	0.2 - 1

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:

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

RESULTS

The results of the final prioritization (Fig. 35, p. 75) seem to be consistent with firsthand knowledge of conditions across the LSJR bioregion, although the results of this analysis should be used in combination with field visits and local knowledge. Very discernible patterns emerge with respect to the Very High and High priority areas, most notably with the wetland and floodplain habitats of the Oromocto River - Grand Lake Meadows-Gagetown Islands regions. Similarly, broad wetland complexes appear to rank highly in this analysis in the central north part of the bioregion, as well as a broad forested and agricultural area around Sussex which stands out prominently. These patterns should be regarded relative, and would be most appropriately used to compare the conservation priority for habitats of the same type to one another, but not the absolute ecological value or quality of a habitat. Low conservation value rank does not indicate that an area is of little conservation value; rather it is of lesser conservation value than Very High or High-ranked areas.

Summary Table

Table 17. Summary results for the Conservation Value Index for the LSJR bioregion, grasslands/agro-ecosystems included (does not include CFB Gagetown).

Conservation value	Value interval	Area (ha)	Approximate % of bioregion
Very High	=>1 - 3.23	205 669	13.0
High	0.8 - 1	195 719	12.7
Moderate	0.6 - 0.8	254 823	16.5
Low	0 - 0.6	754 288	49.0
Protected	N/A	58 070	3.7

APPENDIX E: Summary of species and data sources for species composites (Figs. 24-34).

Priority Species			Species Data Source						Map Name										
Common Name	**Species Name**	**COSEWIC Rank**	AC CDC DATABASE 2012	CWS Critical Habitat Mapping Database 2013	MBBA Relative Abundance Raster Data Feb 2013	MBBA Breeding Evidence Data 1990; 2010	CWS Atlantic Canada Shorebird Survey Database 2012	CWS Atlantic Coastal Waterfowl Survey Database 2012	**All Priority Species (Fig. 24)**	**All SAR (Fig. 25)**	**Bird SAR (Fig. 26)**	**Non-bird SAR (Fig. 27)**	**Relative Abundance of Priority Birds (Fig. 28)**	**Bird Breeding Evidence (Fig. 29)**	**Rare Non-bird Species (Fig. 30)**	**Rare Amphibians/Reptiles (Fig. 31)**	**Rare Terr. Invertebrates (Fig. 32)**	**Rare Mammals (Fig. 33)**	**Rare Plants, Lichens, Bryophytes (Fig. 34)**
Birds																			
American Bittern	*Botaurus lentiginosus*					x			x					x					
American Black Duck	*Anas rubripes*				x				x				x						
American Coot	*Fulica americana*					x			x					x					
American	*Setophaga*				x				x				x						

Redstart	*ruticilla*																		
American Three-toed Woodpecker	*Picoides dorsalis*					**x**			**x**					**x**					
American Woodcock	*Scolopax minor*					**x**			**x**					**x**					
Bald Eagle	*Haliaeetus leucocephalus*				**x**				**x**				**x**						
Bank Swallow	*Riparia riparia*				**x**				**x**				**x**						
Barn Swallow	*Hirundo rustica*	T				**x**			**x**	**x**	**x**			**x**					
Bay-breasted Warbler	*Setophaga castanea*			**x**					**x**										
Belted Kingfisher	*Megaceryle alcyon*			**x**					**x**										
Black Tern	*Chlidonias niger*						**x**		**x**										
Black-backed Woodpecker	*Picoides arcticus*					**x**			**x**					**x**					
Black-billed Cuckoo	*Coccyzus erythropthalmus*					**x**			**x**					**x**					
Blackburnian Warbler	*Dendroica fusca*				**x**				**x**				**x**						
Black-throated Blue Warbler	*Dendroica caerulescens*				**x**				**x**				**x**						
Black-throated Green Warbler	*Setophaga virens*				**x**				**x**				**x**						
Blue-headed Vireo	*Vireo solitarius*				**x**				**x**				**x**						
Bobolink	*Dolichonyx oryzivorus*	T				**x**			**x**	**x**	**x**			**x**					
Boreal Chickadee	*Poecile hudsonicus*			**x**					**x**										

Brown Thrasher	*Toxostoma rufum*					x			x					x					
Canada Goose	*Branta canadensis*							x	x										
Canada Warbler	*Wilsonia canadensis*	T			x				x	x	x		x						
Cape May Warbler	*Setophaga tigrina*					x			x					x					
Chimney Swift	*Chaetura pelagica*	T				x			x	x	x			x					
Common Goldeneye	*Bucephala clangula*					x			x					x					
Common Loon	*Gavia immer*				x				x				x						
Common Moorhen	*Gallinula chloropus*					x			x					x					
Common Nighthawk	*Chordeiles minor*	T				x			x					x					
Common Tern	*Sterna hirundo*				x				x				x						
Cooper's Hawk	*Accipiter cooperii*					x			x					x					
Eastern Kingbird	*Tyrannus tyrannus*					x			x					x					
Eastern Meadowlark	*Sturnella magna*	T				x			x	x	x			x					
Eastern Whip-poor-will	*Caprimulgus vociferus*	T				x			x	x	x			x					
Eastern Wood-Pewee	*Contopus virens*	SC			x				x				x						
Evening Grosbeak	*Coccothraustes vespertinus*				x				x				x						
Gadwall	*Anas strepera*					x			x					x					

Greater Scaup	*Aythya marila*					x			x					x					
Green Heron	*Butorides virescens*					x			x					x					
Green-winged Teal	*Anas coralinensis*				x				x				x						
Horned Lark	*Eremophila alpestris*					x			x					x					
House Wren	*Troglodytes aedon*					x			x					x					
Killdeer	*Charadrius vociferus*					x			x					x					
Least Bittern	*Ixobrychus exilis*	T		x		x			x	x	x								
Long-eared Owl	*Asio otus*					x			x					x					
Magnolia Warbler	*Setophaga magnolia*				x				x				x						
Mallard	*Anas platyrhynchos*				x				x				x						
Marsh Wren	*Cistothorus palustris*					x			x					x					
Nelson's Sparrow	*Ammodramus nelsoni*					x			x					x					
Northern Goshawk	*Accipiter gentilis*					x			x					x					
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*					x			x					x					
Northern Shoveler	*Anas clypeata*					x			x					x					
Olive-sided Flycatcher	*Contopus cooperi*	T			x				x	x	x		x						
Peregrine Falcon (anatum)	*Falco peregrinus pop. 1*	SC				x			x	x	x			x					

Pied-billed Grebe	*Podilymbus podiceps*					x			x					x					
Pine Grosbeak	*Pinicola enucleator*				x				x				x						
Purple Finch	*Carpodacus purpureus*				x				x				x						
Purple Martin	*Progne subis*					x			x					x					
Red-shouldered Hawk	*Buteo lineatus*					x			x					x					
Ring-necked Duck	*Aythya collaris*				x	x			x				x	x					
Rose-breasted Grosbeak	*Pheucticus ludovicianus*				x				x				x						
Ruffed Grouse	*Bonasa umbellus*				x				x				x						
Rusty Blackbird	*Euphagus carolinus*	SC			x				x	x	x		x						
Sedge Wren	*Cistothorus platensis*					x			x					x					
Short-eared Owl	*Asio flammeus*	SC				x			x	x	x			x					
Solitary Sandpiper	*Tringa solitaria*				x				x				x						
Sora	*Porzana carolina*					x			x					x					
Spotted Sandpiper	*Actitis macularius*				x				x				x						
Tree Swallow	*Tachycineta bicolor*				x				x				x						
Upland Sandpiper	*Bartramia longicauda*					x			x					x					
Veery	*Catharus fuscescens*				x				x				x						

Vesper Sparrow	*Pooecetes gramineus*				x				x				x						
Virginia Rail	*Rallus limicola*					x			x					x					
White-breasted Nuthatch	*Sitta carolinensis*					x			x					x					
White-throated Sparrow	*Zonotrichia albicollis*				x				x				x						
Willow Flycatcher	*Empidonax traillii*					x			x					x					
Wilson's Phalarope	*Phalaropus tricolor*					x			x					x					
Wilson's Snipe	*Gallinago delicata*				x				x				x						
Wood Duck	*Aix sponsa*				x				x				x						
Wood Thrush	*Hylocichla mustelina*	T				x			x	x	x			x					
Yellow Rail	*Coturnicops noveboracensis*	SC				x			x	x	x			x					
Yellow-bellied Sapsucker	*Sphyrapicus varius*				x				x				x						
Invertebrates																			
Blue Dasher	*Pachydiplax longipennis*		x						x						x		x		
Boreal Snaketail	*Ophiogomphus colubrinus*		x						x						x		x		
Cobblestone Tiger Beetle	*Cicindela marginipennis*	E	x						x	x		x			x		x		
Juvenal's Duskywing	*Erynnis juvenalis*		x						x						x		x		
Maritime Ringlet	*Coenonympha nipisiquit*	E	x						x	x		x			x		x		

Pygmy Snaketail	*Ophiogomphus howei*	SC	x						x	x		x			x		x		
Skillet Clubtail	*Gomphus ventricosus*	E	x						x	x		x			x		x		
Banded Hairstreak	*Satyrium calanus*		x						x						x		x		
Clamp-Tipped Emerald	*Somatochlora tenebrosa*		x						x						x		x		
Cobra Clubtail	*Gomphus vastus*		x						x						x		x		
Fragile Forktail	*Ischnura posita*		x						x						x		x		
Gray Hairstreak	*Strymon melinus*		x						x						x		x		
Henry's Elfin	*Callophrys henrici*		x						x						x		x		
Lilypad Clubtail	*Arigomphus furcifer*		x						x						x		x		
Monarch	Danaus plexippus	SC	x						x	x		x			x		x		
Mottled Darner	*Aeshna clepsydra*		x						x						x		x		
Spine-crowned Clubtail	*Gomphus abbreviatus*		x						x						x		x		
Swamp Spreadwing	*Lestes vigilax*		x						x						x		x		
Mammals																			
Canada Lynx	*Lynx canadensis*		x						x						x			x	
Silver-haired Bat	*Lasionycteris noctivagans*		x						x						x			x	
Long-tailed Shrew	*Sorex dispar*		x						x						x			x	

Big Brown Bat	*Eptesicus fuscus*		x						x						x			x	
Tri-coloured Bat	*Perimyotis subflavus*	E*	x						x	x		x			x			x	
Hoary Bat	*Lasiurus cinereus*		x						x						x			x	
Red Bat	*Lasiurus borealis*		x						x						x			x	
Northern Myotis	*Myotis septentrionalis*	E*	x						x	x		x			x			x	
Little Brown Myotis	*Myotis lucifugus*	E*	x						x	x		x			x			x	
Vegetation																			
a macro-lichen	*Sphaerophorus globosus*		x						x						x				x
a moss	*Anomobryum filiforme*		x						x						x				x
a Moss	*Anomodon minor*		x						x						x				x
a Moss	*Anomodon tristis*		x						x						x				x
a Moss	*Anomodon viticulosus*		x						x						x				x
a Moss	*Brachythecium digastrum*		x						x						x				x
a Moss	*Bryum muehlenbeckii*		x						x						x				x
a Moss	*Bryum pallescens*		x						x						x				x
a Moss	*Calliergon trifarium*		x						x						x				x
a Moss	*Calliergonella cuspidata*		x						x						x				x

a Moss	*Campylium radicale*		**x**						**x**						**x**				x
a Moss	*Cirriphyllum piliferum*		**x**						**x**						**x**				x
a Moss	*Dichelyma falcatum*		**x**						**x**						**x**				x
a Moss	*Dicranum bonjeanii*		**x**						**x**						**x**				x
a moss	*Didymodon ferrugineus*		**x**						**x**						**x**				x
a Moss	*Ditrichum pallidum*		**x**						**x**						**x**				x
a Moss	*Ephemerum serratum*		**x**						**x**						**x**				x
a Moss	*Eurhynchium hians*		**x**						**x**						**x**				x
a Moss	*Fontinalis antipyretica*		**x**						**x**						**x**				x
a Moss	*Homomallium adnatum*		**x**						**x**						**x**				x
a Moss	*Hygrohypnum bestii*		**x**						**x**						**x**				x
a Moss	*Hypnum pratense*		**x**						**x**						**x**				x
a Moss	*Physcomitrium immersum*		**x**						**x**						**x**				x
a Moss	*Plagiomnium rostratum*		**x**						**x**						**x**				x
a Moss	*Pleuridium subulatum*		**x**						**x**						**x**				x
a Moss	*Pseudotaxiphyllum distichaceum*		**x**						**x**						**x**				x

a Moss	*Rhytidium rugosum*		x						x						x				x
a Moss	*Scorpidium scorpioides*		x						x						x				x
a Moss	*Seligeria diversifolia*		x						x						x				x
a Moss	*Seligeria recurvata*		x						x						x				x
a Moss	*Syntrichia ruralis*		x						x						x				x
a Moss	*Thamnobryum alleghaniense*		x						x						x				x
a Moss	*Timmia norvegica*		x						x						x				x
a Moss	*Tortula mucronifolia*		x						x						x				x
a Peatmoss	Sphagnum angermanicum		x						x						x				x
a Peatmoss	Sphagnum lescurii		x						x						x				x
Acadian Quillwort	*Isoetes acadiensis*		x						x						x				x
Alpine Cliff Fern	*Woodsia alpina*		x						x						x				x
Alpine Sweet-vetch	*Hedysarum alpinum*		x						x						x				x
American False Pennyroyal	*Hedeoma pulegioides*		x						x						x				x
American Lopseed	*Phryma leptostachya*		x						x						x				x
American Yellow Rocket	*Barbarea orthoceras*		x						x						x				x

Anticosti Aster	*Symphyotrichum anticostense*	T	x						x	x		x			x				x
Arching Dewberry	*Rubus recurvicaulis*		x						x						x				x
Arrow-Leaved Violet	*Viola sagittata var. ovata*		x						x						x				x
Auricled Twayblade	*Listera auriculata*		x						x						x				x
Awned Flatsedge	*Cyperus squarrosus*		x						x						x				x
Back's Sedge	*Carex backii*		x						x						x				x
Blood Milkwort	*Polygala sanguinea*		x						x						x				x
Blue-stemmed Goldenrod	*Solidago caesia*		x						x						x				x
Blunt-leaved Bedstraw	*Galium obtusum*		x						x						x				x
Blunt-lobed Moonwort	*Botrychium oneidense*		x						x						x				x
Bog Fern	*Thelypteris simulata*		x						x						x				x
Bog Yellow-eyed-grass	*Xyris difformis*		x						x						x				x
Brewer's Whitlow-grass	*Draba breweri var. cana*		x						x						x				x
Bur Oak	*Quercus macrocarpa*		x						x						x				x
Butternut	*Juglans cinerea*	E	x						x	x		x			x				x
Buttonbush Dodder	*Cuscuta cephalanthi*		x						x						x				x
Calypso	*Calypso bulbosa var. americana*		x						x						x				x

Canada Garlic	*Allium canadense*		x						x						x				x
Canada Honewort	*Cryptotaenia canadensis*		x						x						x				x
Canada Lousewort	*Pedicularis canadensis*		x						x						x				x
Canada Rice Grass	*Piptatherum canadense*		x						x						x				x
Canada Wild Rye	*Elymus canadensis*		x						x						x				x
Carey's Smartweed	*Polygonum careyi*		x						x						x				x
Case's Ladies'-Tresses	*Spiranthes casei*		x						x						x				x
Common Buttonbush	*Cephalanthus occidentalis*		x						x						x				x
Common Hop	*Humulus lupulus var. lupuloides*		x						x						x				x
Creeping Rush	*Juncus subtilis*		x						x						x				x
Cut-leaved Anemone	*Anemone multifida*		x						x						x				x
Disguised St John's-wort	*Hypericum dissimulatum*		x						x						x				x
Ditch Stonecrop	*Penthorum sedoides*		x						x						x				x
Downy Rattlesnake-Plantain	*Goodyera pubescens*		x						x						x				x
Drummond's Rockcress	*Arabis drummondii*		x						x						x				x
Early Saxifrage	*Saxifraga virginiensis*		x						x						x				x

Eastern Cudweed	*Pseudognaphalium obtusifolium*		**x**						**x**						**x**				x
Eastern Leatherwood	*Dirca palustris*		**x**						**x**						**x**				x
Eastern Skunk Cabbage	*Symplocarpus foetidus*		**x**						**x**						**x**				x
Egg Flapwort	*Jungermannia obovata*		**x**						**x**						**x**				x
Elegant Milk-vetch	*Astragalus eucosmus*		**x**						**x**						**x**				x
Field Locoweed	*Oxytropis campestris var. johannensis*		**x**						**x**						**x**				x
Five-angled Dodder	*Cuscuta pentagona*		**x**						**x**						**x**				x
Fleshy Hawthorn	*Crataegus succulenta*		**x**						**x**						**x**				x
Floating Crystalwort	*Riccia fluitans*		**x**						**x**						**x**				x
Forked Panic Grass	*Dichanthelium dichotomum*		**x**						**x**						**x**				x
Fragrant Green Orchid	*Platanthera huronensis*		**x**						**x**						**x**				x
Fringed Milkwort	*Polygala paucifolia*		**x**						**x**						**x**				x
Garber's Sedge	*Carex garberi*		**x**						**x**						**x**				x
Herb Robert	*Geranium robertianum*		**x**						**x**						**x**				x
Hop Flatsedge	*Cyperus lupulinus*		**x**						**x**						**x**				x
Howell's Pussytoes	*Antennaria howellii ssp.*		**x**						**x**						**x**				x

	petaloidea																		
Indian Wild Rice	*Zizania aquatica var. aquatica*		**x**						**x**						**x**				x
Inflated Narrow-leaved Sedge	*Carex grisea*		**x**						**x**						**x**				x
Jones' Hawthorn	*Crataegus jonesiae*		**x**						**x**						**x**				x
Kalm's Hawkweed	*Hieracium kalmii*		**x**						**x**						**x**				x
Labrador Bedstraw	*Galium labradoricum*		**x**						**x**						**x**				x
Lance-leaved Arnica	*Arnica lanceolata*		**x**						**x**						**x**				x
Lance-leaved Figwort	*Scrophularia lanceolata*		**x**						**x**						**x**				x
Large Round-Leaved Orchid	*Platanthera macrophylla*		**x**						**x**						**x**				x
Large-Fruited Sanicle	*Sanicula trifoliata*		**x**						**x**						**x**				x
Laurentian Bladder Fern	*Cystopteris laurentiana*		**x**						**x**						**x**				x
Lesser Brown Sedge	*Carex adusta*		**x**						**x**						**x**				x
Limestone Meadow Sedge	*Carex granularis*		**x**						**x**						**x**				x
Little Bluestem	*Schizachyrium scoparium*		**x**						**x**						**x**				x
Livid Sedge	*Carex livida var. radicaulis*		**x**						**x**						**x**				x
Long-beaked Sedge	*Carex sprengelii*		**x**						**x**						**x**				x

Long-bracted Frog Orchid	*Coeloglossum viride var. virescens*		**x**						**x**						**x**				x
Long-leaved Starwort	*Stellaria longifolia*		**x**						**x**						**x**				x
Low Flatsedge	*Cyperus diandrus*		**x**						**x**						**x**				x
Low Spikemoss	*Selaginella selaginoides*		**x**						**x**						**x**				x
Luminous Moss	*Schistostega pennata*		**x**						**x**						**x**				x
Lyell's Ribbonwort	*Pallavicinia lyellii*		**x**						**x**						**x**				x
Macoun's Cudweed	*Pseudognaphalium macounii*		**x**						**x**						**x**				x
Maidenhair Spleenwort	*Asplenium trichomanes*		**x**						**x**						**x**				x
Maple-leaved Goosefoot	*Chenopodium simplex*		**x**						**x**						**x**				x
Marsh Notchwort	*Lophozia laxa*		**x**						**x**						**x**				x
Menzies' Rattlesnake-plantain	*Goodyera oblongifolia*		**x**						**x**						**x**				x
Montane Notchwort	*Lophozia alpestris*		**x**						**x**						**x**				x
Narrow-Leaved Gentian	*Gentiana linearis*		**x**						**x**						**x**				x
Narrow-leaved Panic Grass	*Dichanthelium linearifolium*		**x**						**x**						**x**				x
Nees' Pouchwort	*Calypogeia neesiana*		**x**						**x**						**x**				x
New England Blue	*Viola novae-*		**x**						**x**						**x**				x

Violet	*angliae*																		
New York Aster	*Symphyotrichum novi-belgii var. crenifolium*		**x**						**x**						**x**				x
Nodding Ladies'-Tresses	*Spiranthes cernua*		**x**						**x**						**x**				x
Northern Adder's-tongue	*Ophioglossum pusillum*		**x**						**x**						**x**				x
One-Flowered Broomrape	*Orobanche uniflora*		**x**						**x**						**x**				x
Orange-fruited Tinker's Weed	*Triosteum aurantiacum*		**x**						**x**						**x**				x
Pale Dogwood	*Cornus obliqua*		**x**						**x**						**x**				x
Panicled Hawkweed	*Hieracium paniculatum*		**x**						**x**						**x**				x
Parlin's Pussytoes	*Antennaria parlinii*		**x**						**x**						**x**				x
Pennsylvania Blackberry	*Rubus pensilvanicus*		**x**						**x**						**x**				x
Pinnate Scalewort	*Porella pinnata*		**x**						**x**						**x**				x
Poison Ivy	*Toxicodendron radicans*		**x**						**x**						**x**				x
Prototype Quillwort	*Isoetes prototypus*	SC	**x**						**x**	**x**		**x**			**x**				x
Pubescent Sedge	*Carex hirtifolia*		**x**						**x**						**x**				x
Purple-veined Willowherb	*Epilobium coloratum*		**x**						**x**						**x**				x
Red Pigweed	*Chenopodium rubrum*		**x**						**x**						**x**				x
River Bulrush	*Schoenoplectus fluviatilis*		**x**						**x**						**x**				x

Rock Spikemoss	*Selaginella rupestris*		**x**						**x**						**x**				x
Rock Whitlow-Grass	*Draba arabisans*		**x**						**x**						**x**				x
Rough Dropseed	*Sporobolus compositus*		**x**						**x**						**x**				x
Rough Hawthorn	*Crataegus scabrida*		**x**						**x**						**x**				x
Round-headed Bush-clover	*Lespedeza capitata*		**x**						**x**						**x**				x
Round-lobed Hepatica	*Hepatica nobilis var. obtusa*		**x**						**x**						**x**				x
Russet Sedge	*Carex saxatilis*		**x**						**x**						**x**				x
Seabeach Dock	*Rumex pallidus*		**x**						**x**						**x**				x
Shining Ladies'-Tresses	*Spiranthes lucida*		**x**						**x**						**x**				x
Slender Agalinis	*Agalinis tenuifolia*		**x**						**x**						**x**				x
Slender Beakrush	*Rhynchospora capillacea*		**x**						**x**						**x**				x
Slender Cottongrass	*Eriophorum gracile*		**x**						**x**						**x**				x
Slender Splachnum	*Tayloria serrata*		**x**						**x**						**x**				x
Small White Aster	*Symphyotrichum racemosum*		**x**						**x**						**x**				x
Small-flowered Agalinis	*Agalinis paupercula var. borealis*		**x**						**x**						**x**				x
Small-flowered Bittercress	*Cardamine parviflora var. arenicola*		**x**						**x**						**x**				x

Small-spike False-nettle	*Boehmeria cylindrica*		**x**						**x**						**x**				x
Smooth Alder	*Alnus serrulata*		**x**						**x**						**x**				x
Smooth Sweet Cicely	*Osmorhiza longistylis*		**x**						**x**						**x**				x
Southern Dung Moss	*Splachnum pennsylvanicum*		**x**						**x**						**x**				x
Southern Twayblade	*Listera australis*		**x**						**x**						**x**				x
Southern Water Plantain	*Alisma subcordatum*		**x**						**x**						**x**				x
Spotted Coralroot	*Corallorhiza maculata*		**x**						**x**						**x**				x
Spreading Wild Rye	*Elymus hystrix var. bigeloviana*		**x**						**x**						**x**				x
Spurred Threadwort	*Cephaloziella elachista*		**x**						**x**						**x**				x
Starved Panic Grass	*Dichanthelium depauperatum*		**x**						**x**						**x**				x
Sterile Sedge	*Carex sterilis*		**x**						**x**						**x**				x
Sticky Goldenrod	*Solidago simplex ssp. randii*		**x**						**x**						**x**				x
Strawberry-blite	*Chenopodium capitatum*		**x**						**x**						**x**				x
Swamp Beggarticks	*Bidens discoidea*		**x**						**x**						**x**				x
Sweet Wood Reed Grass	*Cinna arundinacea*		**x**						**x**						**x**				x
Tall Goldenrod	*Solidago altissima*		**x**						**x**						**x**				x

Ten-rayed Sunflower	*Helianthus decapetalus*		x						x						x				x
Tubercled Orchid	*Platanthera flava var. herbiola*		x						x						x				x
Tufted Love Grass	*Eragrostis pectinacea*		x						x						x				x
Urn Moss	*Physcomitrium pyriforme*		x						x						x				x
Virginia Chain Fern	*Woodwardia virginica*		x						x						x				x
Virginia Mountain Mint	*Pycnanthemum virginianum*		x						x						x				x
Virginia St John's-wort	*Triadenum virginicum*		x						x						x				x
Wallrue Spleenwort	*Asplenium ruta-muraria var. cryptolepis*		x						x						x				x
Western Dock	*Rumex aquaticus var. fenestratus*		x						x						x				x
White Adder's-Mouth	*Malaxis brachypoda*		x						x						x				x
White Cut Grass	*Leersia virginica*		x						x						x				x
White Mountain Saxifrage	*Saxifraga paniculata ssp. neogaea*		x						x						x				x
White Vervain	*Verbena urticifolia*		x						x						x				x
White-tinged Sedge	*Carex albicans var. emmonsii*		x						x						x				x
Whorled Yellow	*Lysimachia*		x						x						x				x

Loosestrife	*quadrifolia*																		
Wild Leek	*Allium tricoccum*		**x**						**x**						**x**				x
Woodland Pinedrops	*Pterospora andromedea*		**x**						**x**						**x**				x
Yellow Lady's-slipper	*Cypripedium parviflorum var. makasin*		**x**						**x**						**x**				x
Reptiles and amphibians																			
Northern Dusky Salamander	*Desmognathus fuscus*		**x**						**x**						**x**	**x**			
Wood Turtle	*Glyptemys insculpta*	T	**x**						**x**	**x**		**x**			**x**	**x**			
Snapping Turtle	*Chelydra serpentina*	SC	**x**						**x**	**x**		**x**			**x**	**x**			
Fish																			
American Eel	*Anguilla rostrata*	SC	**x**						**x**	**x**		**x**			**x**				
Shortnose Sturgeon	*Acipenser brevirostrum*	AC	**x**						**x**	**x**		**x**			**x**				
Atlantic Salmon	*Salmo salar*		**x**						**x**						**x**				
Atlantic Sturgeon	*Acipenser oxyrinchus*	T	**x**						**x**	**x**		**x**			**x**				
Striped Bass	*Morone saxatilis*	T	**x**						**x**	**x**		**x**			**x**				
Round Whitefish	*Prosopium cylindraceum*		**x**						**x**	**x**					**x**				

Appendix F: IUCN Threats Classification Scheme (Version 3.2; taken directly from the IUCN website)

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 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

8 Invasive & other problematic species, genes & diseases

- 8.1 Invasive non-native/alien species/diseases
  - 8.1.1 Unspecified species
  - 8.1.2 Named species
- 8.2 Problematic native species/diseases
  - 8.2.1 Unspecified species
  - 8.2.2 Named species
- 8.3 Introduced genetic material
- 8.4 Problematic species/diseases of unknown origin
  - 8.4.1 Unspecified species
  - 8.4.2 Named species
- 8.5 Viral/prion-induced diseases
  - 8.5.1 Unspecified "species" (disease)
  - 8.5.2 Named "species" (disease)
- 8.6 Diseases of unknown cause

9 Pollution

- 9.1 Domestic & 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 Habitat shifting & alteration
11.2 Droughts
11.3 Temperature extremes
11.4 Storms & flooding
11.5 Other impacts

12 Other options
12.1 Other threat

Appendix G: 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 - click feedback.

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