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Bird surveys (summer 2017) following habitat restoration work along three watercourses and in an agroforestry plot near Lake Saint-Pierre

Baie-du-Febvre Area

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1. Introduction

Lake Saint-Pierre and its floodplain, which is the most extensive in Quebec, are a key component of the St. Lawrence ecosystem. With more than 280 migratory and resident bird species and 78 fish species, the lake offers an exceptional natural environment which has received international recognition for its rich biodiversity (UNESCO Biosphere Reserve and RAMSAR site).

Agricultural activities have been carried out on the fertile floodplain of Lake Saint-Pierre for several centuries. Beginning in the second half of the 20th century, perennial crops were gradually replaced by annual crops, even in the lake's 2-year floodplain (Dauphin and Jobin, 2016). Agricultural practices associated with annual cropping have resulted in degradation of natural habitats and reduced the amount of habitat available for many wildlife species (Latendresse et al., 2008; Rioux et al., 2009). Grassland birds (Bobolink, Eastern Meadowlark, etc.), whose populations are in decline (NABCI, 2012), and waterfowl are among the species that have been adversely affected by the disappearance of wet meadows and the conversion of perennial crops to annual crops. The loss of plant substrates due to fall tillage creates soil erosion during high water periods and results in the destruction of key spawning and rearing grounds used by fish in the spring. This degradation has played a key role in the decline of the yellow perch population in Lake Saint-Pierre (Magnan et al., 2017). To date, roughly 5,000 hectares of potential yellow perch spawning habitat has been lost (TCRLSP, 2017).

With the aim of balancing agricultural activities and wildlife protection, an approach has been developed for restoring wildlife habitats on the shoreline of Lake Saint-Pierre (Groupe de travail « Intendance en milieu agricole : culture du littoral au lac Saint-Pierre », 2010). This approach involves stream maintenance (bank reshaping, planting, etc.) and conversion of annual crops back to perennial crops or natural grasslands. Work was carried out along three watercourses in the Baie-du-Febvre area in 2012 to restore fish habitat while also allowing adjacent land to be farmed. In parallel with this work, an agroforestry plot was developed at Ferme Bertco to assess the wildlife and agronomic benefits of intercropping traditional grain (or alfalfa) crops with rows of trees (oak, maple, poplar, walnut) spaced 40 m apart.

In the summer of 2012, bird surveys were conducted at these four sites in order to obtain a picture of the bird communities present before enhancement and restoration work began. A second survey was conducted in the summer of 2017, encompassing the three watercourses and the agroforestry plot, to assess the changes in the bird communities five years after the restoration work.

This approach is part of the project to restore the Lake Saint-Pierre shoreline, which is being carried out jointly by the Canadian Wildlife Service (CWS) of Environment and Climate Change Canada (ECCC) and the Quebec Department of Forests, Wildlife and Parks (MFFP), as part of the 2016–2021 programming for the St. Lawrence Action Plan (SLAP).

2. Methodology

2.1 Location and description of bird survey sites

The three watercourses covered in the surveys are located in the southeastern portion of the Lake Saint-Pierre floodplain, in the Baie-du-Febvre area. They are the Brielle River and Côté-Lefebvre and Blondin creeks. The agroforestry plot is located outside the 100-year floodplain, on land owned by Ferme Bertco. See Figure 1 for the locations of these sites.

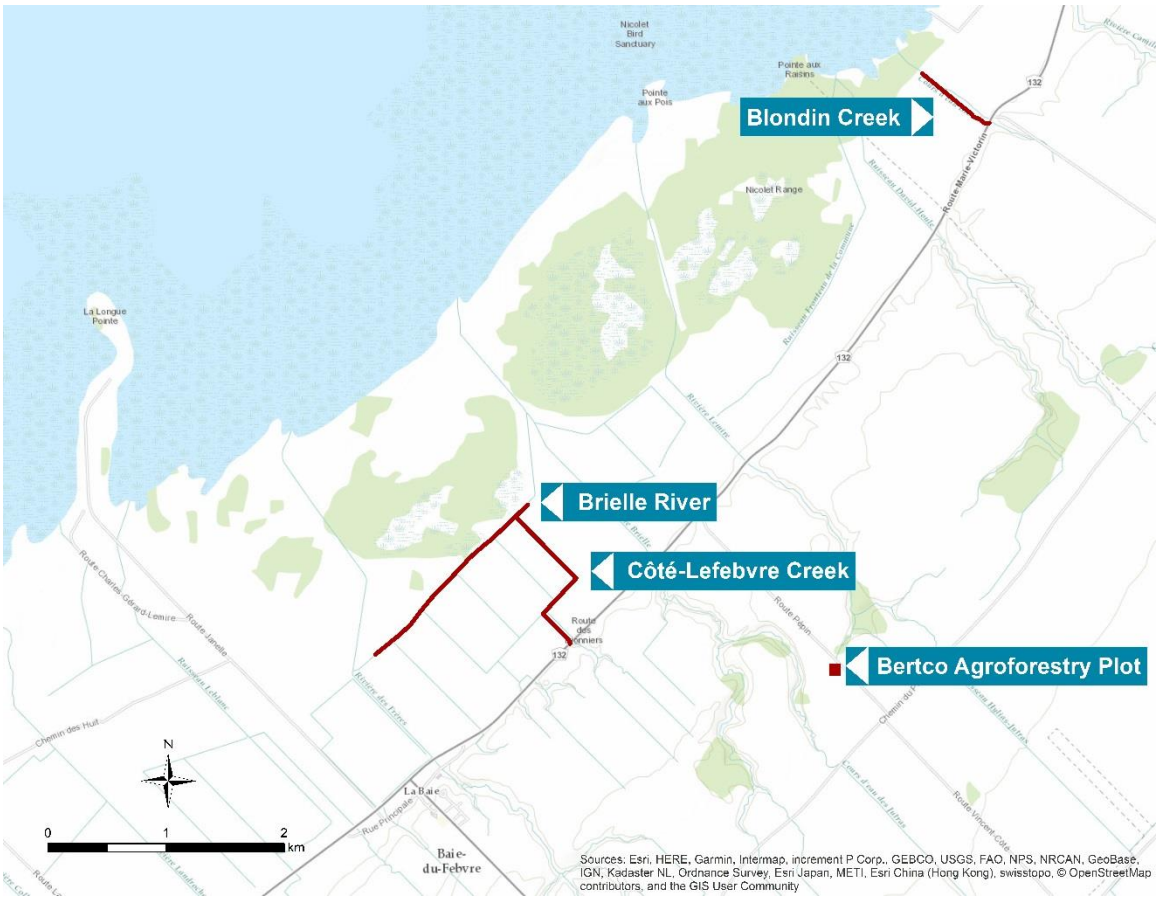

Figure 1. Locations of bird survey sites

2.1.1 Watercourses

The three watercourses that were targeted for restoration work in 2012 and subsequent monitoring are located on agricultural land (Figure 2). The restoration work included reshaping of banks and planting of trees and shrubs.

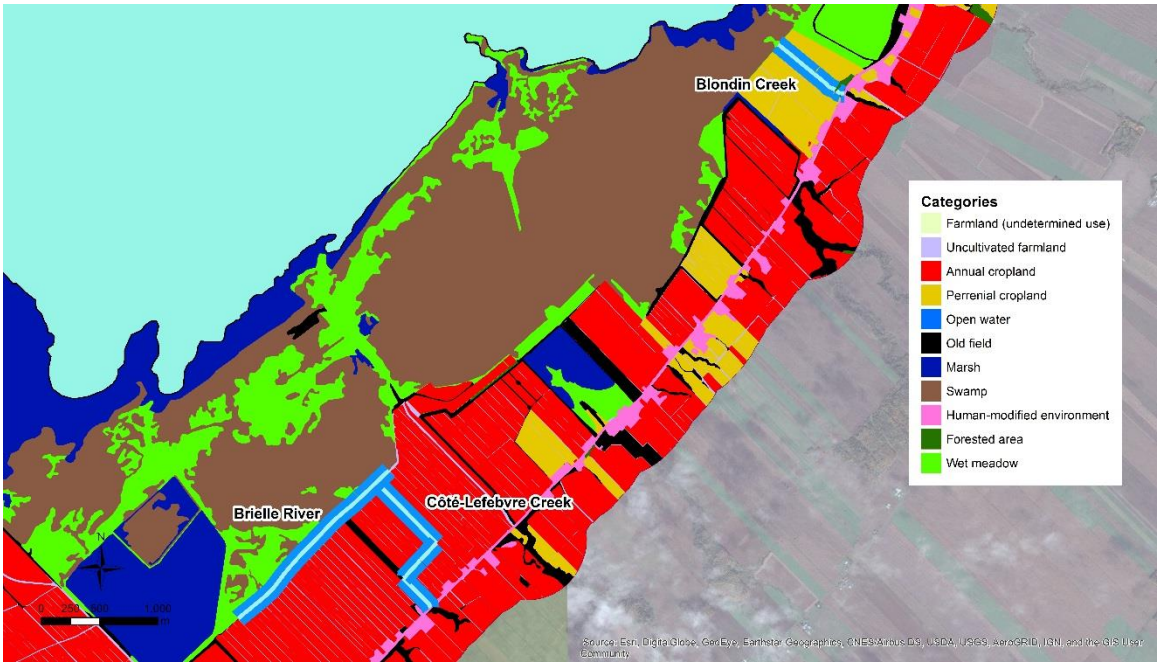

Figure 2. Land use around the three watercourses (100-year floodplain; Source: ECCC and MDDELCC, 2017)

Brielle River

The Brielle River, restored over a 2-km section, is located in the municipality of Baie-du-Febvre in the Nicolet-Yamaska RCM. Its north bank is bordered by Department of National Defence property and its south bank by annual cropland. It receives inflows from about 30 agricultural ditches. In June 2017, during the survey period, the fields adjacent to the watercourse were not tilled because they were still covered with flood water or still too wet because the water had receded only a short time before. The vegetation planted in the riparian strip in 2012 did not survive or was destroyed.

Côté-Lefebvre Creek

Côté-Lefebvre Creek, restored over a 1.4-km section, is located in the municipality of Baie-du-Febvre in the Nicolet-Yamaska RCM. This creek drains agricultural land on either side of Route 132 and empties into the Brielle River. The restored section of the creek is bordered only by annual crops. In June 2017, during the survey period, most of the fields adjacent to the creek were not tilled, because they were still covered with flood water or still too wet because the water had receded only a short time before. The vegetation planted in the riparian strip in 2012 did not survive or was destroyed.

Blondin Creek

Blondin Creek, restored over a 0.7-km section, is located between Route 132 and the National Defence property in the municipality of Nicolet (Nicolet-Yamaska RCM). Runoff from the agricultural land located south of Route 132 is the main source of inflows to this creek, which empties directly into Lake Saint-Pierre. The adjacent habitat consists of perennial crops and a small woodlot. In June, at the time of the surveys, the banks, including the riparian strip, were flooded along two thirds of the creek's length. The

vegetation planted as part of the restoration work in 2012 was still present; however, some walnut trees appeared to be desiccated.

2.1.2 Bertco agroforestry plot

The Bertco plot is located in the municipality of Baie-du-Febvre (Nicolet-Yamaska RCM), between Route 132 and Chemin du Pays Brûlé. It consists of 10 ha of enhanced land devoted to an agroforestry system consisting of rows of trees and of crops (Figure 3; Rivest et al., 2018). The intercropping system implemented at Ferme Bertco is a second-generation system, with 40-m spacing between the rows (spacing varies between 8 m and 15 m in first-generation systems, and between 25 m to 40 m in second-generation systems). In all, there are four rows of trees in which a high-value tree of moderate-growth (oak, maple or walnut) alternated with a fast-growing hybrid poplar, an approach that enables timber harvests to be spread over time (Rivest et al., 2018). On the strips of land between the rows of trees, a crop rotation system is applied, alternating between grains and legumes from year to year (in 2017, corn was grown). The plot is bordered by a woodlot to the north, by other annual crops and ravines to the east and south, and by a tamarack hedgerow to the west. The Ferme Bertco property, which is outside the 100-year floodplain, is not covered in the land-use mapping document (Cartographie de l'occupation du sol des basses-terres du Saint-Laurent) prepared by ECCC and ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC) [2017].

Figure 3. Bertco agroforestry plot perimeter (Source: Google Earth 2017)

2.2 Bird survey method

The first phase of the work involved determining whether any species at risk frequented the sites to be surveyed. The presence of such species would have made it necessary to use survey methods adapted to species at risk or, if not already done, to make adjustments to the planned restoration work taking this information into account. Data from the Centre de données sur le patrimoine naturel du Québec (CDPNQ, 2017) were used for this purpose. Since no species at risk was found in the CDPNQ database, the work was planned without making any special adjustments in that regard.

The methods chosen for the bird surveys were designed to detect the majority of species present at the sites while also obtaining relative abundance data for most of the species.

2.2.1 Watercourses

The transect method was chosen for the bird survey along the three watercourses at Baie-du-Febvre and Nicolet. This involved counting all birds detected by walking slowly (2–3 km/h) along one side of the watercourse and recording all birds seen or heard nearby as well as in adjacent habitats. All individuals detected on either bank were recorded (Deschênes et al., 1999; Jobin et al., 2001).

For each bird detected, the observer was required to note the type of detection (visual [individual, nest or family group] or auditory [call or song]) and its sex (if possible). Only the behaviour most indicative of breeding was recorded for a given individual. Therefore, when a bird uttered both a call and a song, only the song, a territorial behaviour, was recorded. If this same individual was observed on a nest or accompanied by young, this is the information that was recorded because it enabled confirmation of breeding. When two or more birds were heard or seen simultaneously, they were treated as different individuals. The same is true in cases where detections were so far apart they could not involve a single individual. When in doubt, the observer treated the detection as a single bird. Birds feeding in flight (e.g., swallows) or flying within the habitat or over it were recorded and counted, whereas birds merely flying over the site without using it (e.g., vultures or gulls high in the air) were recorded but were not retained when the data were compiled.

The observer was required to note the location of each bird detected in relation to the watercourse (open water, bank, vegetated riparian strip or adjacent habitat). When a bird was detected in the vegetated riparian strip, the observer noted the plant composition, specifically whether it was dominated by trees, shrubs, herbaceous plants or a combination thereof. When a bird was recorded in the adjacent habitat, the observer specified the bird's position, that is, whether it was located within the first 25 m from the watercourse (immediately adjacent habitat) or farther than 25 m away (distant adjacent habitat); the type of habitat being used at the time was also recorded (Deschênes et al., 2003). The field sheet used is shown in Appendix A.

Maps of the sites to be surveyed were produced in advance and the geographic coordinates were provided on the maps (Appendix B), allowing the observer to determine his/her position in the field with a GPS. A single observer performed the counts. The sites

were visited twice, more than seven days apart, during the month of June 2017. The surveys were carried out between sunrise and 10:00 a.m. under ideal conditions (clear to partly cloudy skies, no rainfall, and no wind to light wind).

During data compilation, detections of individuals were converted to numbers of pairs in keeping with the following convention: a bird seen or heard (male or female) = 0.5 pair; a singing male, a nest or a family = 1 pair. Since the watercourses were visited twice, the highest value for a given species was retained (better indicator of the carrying capacity of the environment).

To simplify the presentation of results, the term “riparian zone” is used in the Results section to designate the zone including the water, bank, vegetated riparian strip and immediately adjacent habitat.

2.2.2 Bertco agroforestry plot

The protocol chosen for the survey of the agroforestry plot is based on the one used at the same site in 2012 during pre-restoration surveys. It involved counting all birds present in the plot by walking slowly (2–3 km/h) along transects spaced about 50 metres apart. All birds seen and heard were recorded on the field sheet produced for that purpose (Appendix C). Three transects were needed to cover the plot.

For each bird detected, the observer was required to note the type of detection (visual [individual, nest or family group] or auditory [call or song]) and its sex (if possible). Only the behaviour most indicative of breeding was recorded for a given individual (for more details on the method used to record birds detected, see the Watercourses section). The observer also recorded the position of each bird in relation to the plot (inside or outside the plot) as well as the habitat used.

A single observer performed the counts. The sites were visited twice, more than seven days apart, during the month of June 2017. The surveys were conducted between sunrise and 10:45 a.m. under good conditions (clear to partly cloudy skies, little or no rainfall, and light wind).

During data compilation, detections of individuals were converted to numbers of pairs in keeping with the convention described in the Watercourses section.

3. Results and Discussion

3.1 Watercourses

3.1.1 Brielle River

Bird surveys could not be conducted along the Brielle River in 2017 owing to the high water levels. Although the river was overflowing its banks in a few places, the main reason the transect surveys could not be carried out was the high water levels in tributaries. Indeed, some 30 deep agricultural ditches empty into the restored section of the river. These ditches, which are perpendicular to the river and located every 50 m to 75 m along it, were impassable (even in waders) near their confluence with the Brielle River and crossing them necessitated walking up to 750 m farther upstream. Since the other survey sites had to be visited the same day, the survey of this watercourse was abandoned. It should be noted that one of the visits in 2012 was cut short for the same reason. Given the presence of these very deep ditches, a boat should be used for the next surveys, regardless of the water level in Lake Saint-Pierre.

3.1.2 Côté-Lefebvre Creek

Côté-Lefebvre Creek was visited twice, on June 22 and 29, 2017. The surveys were conducted between sunrise and 9:00 a.m. under ideal weather conditions. However, during the visit on June 29, large portions of the creek and the immediately adjacent habitat (0-25 m) were completely flooded. Therefore, the results obtained for this atypical year do not provide an accurate picture of the avifauna that normally uses this watercourse.

Côté-Lefebvre Creek (on the left) upstream of the Brielle River (parallel to the trees), June 29, 2017 (Photo: Alexandre Nicole)

In all, 14 species were observed during the surveys of Côté-Lefebvre Creek in 2017, including 10 that were using the riparian zone (water + bank + vegetated riparian strip + immediately adjacent habitat [0–25 m]) (Table 1). The banks and the immediately adjacent habitat had areas that were denuded, areas with herbaceous cover, and areas that were

still flooded. Without woody plants, the vegetated riparian strip lacked structural heterogeneity (as mentioned previously, the vegetation planted in 2012 did not survive). A bird density of only 8.7 pairs/km was recorded in the riparian zone of this creek—the lowest density obtained for all the watercourses included in the 2017 surveys (Nicole and Dauphin, 2018).

A similar number of species used the creek (4, in flight), the vegetated riparian strip (4) and the immediately adjacent habitat (5). The riparian strip showed a pair density slightly higher (3.8 pairs/km) that that of other areas in the riparian zone (2.8 and 1.9, respectively, for the adjacent habitat and the water). The five most abundant species were (in decreasing order): the Song Sparrow and the Tree Swallow; the Savannah Sparrow, the Spotted Sandpiper and the Common Grackle were tied for third place. These species accounted for 80% of the pairs observed. The Song Sparrow frequented the herbaceous riparian strip and the uncultivated fields. The Tree Swallow foraged while flying over the creek and fields. The Savannah Sparrow and the Spotted Sandpiper were observed in the herbaceous riparian strip, whereas the Common Grackle foraged in uncultivated areas. Spotted Sandpiper nesting was confirmed by the observation of a nest containing four eggs in the herbaceous riparian strip.

Spotted Sandpiper nest, June 29, 2017 (Photo: Alexandre Nicole)

The Snow Goose was observed flying over the creek. Only one Red-winged Blackbird pair was counted in the riparian zone. The American Robin and the Gadwall frequented annual cropland (the crop seeds had not yet germinated).

The 2012 data presented in Table 1 include the detections made along the Brielle River (excluding the National Defence property), which is not the case for the 2017 data. For this reason, a comparison of species richness and density cannot be made between 2012 and 2017. However, several differences can be noted between the two survey periods. For example, some of the species detected only in 2017 may have been attracted by the high water levels (Great Blue Heron, Snow Goose and Bald Eagle), whereas the absence in 2017 of species detected in 2012 can also be attributed to the flood waters. For example, two species that nest on or near the ground, the Horned Lark and the Swamp Sparrow, were detected only in 2012.

Table 1. Mean relative abundance per km of shoreline and habitats used by birds: Côté-Lefebvre Creek and adjacent habitats, 2017 and 2012

		2017							2012[6]		
		Watercourse and riparian strip[2]		Adjacent habitat 0 m-25 m		Total riparian zone[4]	Adjacent habitat > 25 m		Watercourse and riparian strip[2]	Adjacent habitat 0 m-25 m	Total riparian zone[4]
Code[1]	Species	Mean abundance Pairs/km (individuals/km)	Habitat[3]	Mean abundance Pairs/km (individuals/km)	Habitat[5]	Mean abundance Pairs/km (individuals/km)	Mean abundance Pairs/km (individuals/km)	Habitat[5]	Mean abundance Pairs/km (individuals/km)	Mean abundance Pairs/km (individuals/km)	Mean abundance Pairs/km (individuals/km)
T	American Goldfinch									0.44 (0.88)	0.43 (0.88)
S	American Robin			0.35 (0.70)	UF	0.35 (0.70)	0.69 (1.38)	HU		0.44 (0.88)	0.44 (0.88)
X	Bald Eable						0.35 (0.70)	In flight			
H	Barn Swallow								0.15 (0.30)		0.15 (0.30)
H	Black Tern	0.35 (0.70)	In flight (over water)			0.35 (0.70)			0.44 (0.88)		0.44 (0.88)
T	Brown-headed Cowbird								0.15 (0.30)	0.58 (1.16)	0.73 (1.46)
H	Common Grackle	0.35 (0.70)	In flight (over water)	0.35 (0.70)	UF	0.69 (1.38)	1.04 (2.08)	UF; HU	0.15 (0.30)	0.73 (1.46)	0.87 (1.74)
H	Downy Woodpecker								0.15 (0.30)		0.15 (0.30)
H	Gadwall			0.35 (0.70)	UF	0.35 (0.70)	0.69 (1.38)	WM	0.58 (1.16)	0.44 (0.88)	1.02 (2.04)
X	Great Blue Heron						0.35 (0.70)	In flight			
T	Horned Lark									0.58 (1.16)	0.58 (1.16)
DD	Killdeer						1.39 (2.78)	UF		0.73 (1.46)	0.72 (1.46)
T	Mallard								0.29 (0.58)	5.81 (11.62)	6.10 (12.20)
S	Mourning Dove						0.69 (1.38)	HU		0.44 (0.88)	0.44 (0.88)
X	Purple Martin								0.44 (0.88)		0.44 (0.88)
C	Red-winged Blackbird	0.35 (0.70)	H			0.35 (0.70)			0.73 (1.46)	1.45 (2.90)	2.18 (4.36)
T	Savannah Sparrow	0.69 (1.38)	H			0.69 (1.38)	0.69 (1.38)	UF; OF		0.29 (0.58)	0.29 (0.58)
X	Snow goose	0.35 (0.70)	In flight (over water)			0.35 (0.70)					
T	Song Sparrow	2.08 (4.16)	H	1.39 (2.78)	UF	3.47 (6.94)	1.39 (2.78)	UF; OF	1.45 (2.90)	0.87 (1.74)	2.33 (4.66)
NF	Spotted Sandpiper	0.69 (1.38)	H			0.69 (1.38)			0.44 (0.88)	0.87 (1.74)	1.31 (2.62)
T	Swamp Sparrow								0.29 (0.58)		0.29 (0.58)
H	Tree Swallow	1.04 (2.08)	Flight (over water)	0.35 (0.70)	UF	1.39 (2.78)			0.15 (0.30)	0.87 (1.74)	1.02 (2.04)
H	Wood Duck								0.29 (0.58)		0.29 (0.58)
	Total 2017: 14 species		**Vegetated riparian strip only**								
	Total	5.90 (11.80)	3.81 pairs	2.78 (5.56)		8.68 (17.36)	7.29 (14.58)		5.67 (11.34)	14.53 (29.06)	20.20 (40.40)
	Number of species	8	4	5		10	9		14	14	20

[1] Code = Category of breeding evidence observed (using the codes from the Québec Breeding Bird Atlas). Descriptions of the categories appear in Appendix E

[2] Watercourse and riparian strip = water + bank + vegetated riparian strip if present.

[3] W = water; B = bank; H = herbaceous cover; S = shrub cover; T = tree cover.

[4] Total riparian zone = water + bank + riparian strip + adjacent habitat (0 m–25 m).

[5] Habitat codes: AC = annual cropland; PC = perennial cropland; OW = open water; OF = old field; FH = farm hedgerow; MA = marsh; SW = swamp; HU = human-modified environment; FO = forested area; WM = wet meadow; UF = uncultivated farmland .

[6] Note: There are some discrepancies between the 2012 values provided here and the data published in the report (Jobin 2015), due to the fact that some adjustments had to be made to the original data.

The species recorded in the distant adjacent habitat (> 25 m) provide an indication of the avifauna that use the landscape around Côté-Lefebvre Creek. In all, nine species were observed in these habitats consisting of uncultivated fields (with annual crop residues) and human-modified habitat (two dwellings near Route 132). In June 2017, all the fields were still bare or covered with flood waters. A few farmers had carried out seeding in the fields along Route 132, but the crop seeds had not yet germinated. A number of species were observed foraging in these habitats, i.e., the Song Sparrow, the Savannah Sparrow, the Great Blue Heron, the Killdeer and the Common Grackle; nesting evidence was also obtained for the Killdeer. The Gadwall was detected in a wet meadow; the Bald Eagle (species designated vulnerable in Quebec) was observed flying low over the fields. The American Robin, the Common Grackle and the Mourning Dove were observed near the dwellings.

Species observed more than 25 m from the watercourse were not recorded during the 2012 surveys, therefore no comparison can be made with the 2017 results for the more distant adjacent habitats.

Four species flew over the site without stopping: the Mallard (1 individual), the American Goldfinch (2 individuals), the American Crow (1 individual) and the Little Gull (1 individual, with a few mentions at Lake Saint-Pierre in the spring of 2017).

3.1.3 Blondin Creek

Blondin Creek was surveyed twice, on June 22 and 29, 2017. The surveys were carried out between sunrise and 10:00 a.m. under ideal weather conditions. However, during both visits, the creek was overflowing its banks over about two thirds of its length, and in the last 100 m birds had to be counted from a fixed point, as it was impossible to follow the transect as far as the National Defence property because of the high water level.

Blondin Creek, June 22, 2017. The creek was overflowing its banks over about two thirds of its length. (Photo: Alexandre Nicole)

In all, 31 species were detected during the Blondin Creek surveys, 21 of them were using the riparian zone (water + bank + vegetated riparian strip + immediately adjacent habitat).

The creek was used by six species; the vegetated riparian strip (which included herbaceous plants, shrubs and trees) and the immediately adjacent habitat (perennial cropland) were each used by eight species. The greatest pair density was found in the vegetated riparian strip: 20.7 pairs/km of shoreline, versus 12.86 pairs/km for the watercourse and 13.6 pairs/km for the immediately adjacent habitat (Table 2).

The most abundant species in the riparian zone, in descending order, were the Red-winged Blackbird, the Swamp Sparrow and the Mallard, with the Wilson's Snipe, the Song Sparrow and the Black Tern tied for fourth place, and the Green-winged Teal in fifth. Together, they represented 65% of the pairs observed. Among these seven species, three were seen in the watercourse (Mallard, Green-winged Teal and Black Tern, the latter in flight), two were more abundant or present only in the vegetated riparian strip (Red-winged Blackbird and Wilson's Snipe) and two were equally abundant in the riparian strip and in the immediately adjacent habitat (Song Sparrow and Swamp Sparrow).

A third waterfowl species, the Northern Shoveler, was also observed in the watercourse. Tree Swallows and Barn Swallows (designated Threatened in Canada) foraged while flying over it. The vegetated riparian strip was also used by the American Robin, the Common Yellowthroat, the Northern Flicker and the Virginia Rail. The immediately adjacent habitat consisted of two habitats: perennial cropland (sometimes flooded), which was frequented by the Swamp Sparrow, the Red-winged Blackbird, the Great Blue Heron and the Sora, and treed swamps (including flooded forest), frequented by the Song Sparrow, the Yellow Warbler, the Eastern Wood-Pewee (designated Special Concern in Canada) and the Warbling Vireo.

In 2012, 16 species were observed and a density of 40 pairs/km (excluding the flock of Common Grackles) was calculated for the riparian zone (Table 2). The number of species and the pair density were lower in the 2012 survey than in 2017 (21 species and 49 pairs/km). Three of the five species that had been the most abundant in 2012 were still in the top five in 2017: the Red-winged Blackbird, the Swamp Sparrow and the Wilson's Snipe. Densities of these three species were very similar from one survey period to the next. The main difference between the 2012 and 2017 results involves water birds, marsh birds and ground-nesting species. Fewer waterfowl species were observed in the watercourse in 2012 (1, compared to 3 in 2017), and the Sora and the Virginia Rail, which are associated with marshes, were not seen at all in the riparian zone in 2012. On the other hand, the Savannah Sparrow and the Bobolink (designated Threatened in Canada), two ground-nesting species, were not observed in the riparian zone in 2017, although they had been in 2012. The high water levels in 2017 made it impossible for them to nest close to the watercourse.

Table 2. Mean relative abundance per kilometre of shoreline and habitats used by birds: Blondin Creek and adjacent habitats, 2017 and 2012

Code[1]	Species	2017							2012[6]		
		Watercourse and riparian strip[2]		Adjacent habitat 0 m-25 m		Total riparian zone[4]	Adjacent habitat > 25 m		Watercourse and riparian strip[2]	Adjacent habitat 0 m-25 m	Total riparian zone[4]
		Mean abundance Pairs/km (individuals/km)	Habitat[3]	Mean abundance Pairs/km (individuals/km)	Habitat[5]	Mean abundance Pairs/km (individuals/km)	Mean abundance Pairs/km (individuals/km)	Habitat[5]	Mean abundance Pairs/km (individuals/km)	Mean abundance Pairs/km (individuals/km)	Mean abundance Pairs/km (individuals/km)
T	American Bittern						1.43 (2.86)	MA			
H	American Goldfinch						0.71 (1.42)	OF			
AT	American Robin	1.43 (2.86)	H			1.43 (2.86)			0.71 (1.42)	1.43 (2.86)	2.14 (4.28)
S	Baltimore Oriole						1.43 (2.86)	SW		0.71 (1.42)	0.71 (1.42)
H	Barn Swallow	0.71 (1.42)	In flight (over water)			0.71 (1.42)				0.71 (1.42)	0.71 (1.42)
H	Black Tern	2.86 (5.72)	In flight (over water)			2.86 (5.72)					
T	Bobolink									2.14 (4.28)	2.14 (4.28)
H	Common Grackle	1.43 (2.86)	In flight			1.43 (2.86)			2.86 (5.72)	53.57 (107.14)	56.43 (112.86)
JE	Common Raven						1.43 (2.86)	HU			
T	Common Yellowthroat	1.43 (2.86)	S+T			1.43 (2.86)	1.43 (2.86)	OF			
S	Eastern Kingbird						1.43 (2.86)	SW	0.71 (1.42)		0.71 (1.42)
T	Eastern Wood-Pewee			1.43 (2.86)	SW	1.43 (2.86)	2.86 (5.72)	FO; SW			
AT	European Starling	0.71 (1.42)	In flight			0.71 (1.42)				4.29 (8.58)	4.29 (8.58)
X	Great Blue Heron			0.71 (1.42)	PC	0.71 (1.42)					
P	Green-winged Teal	2.14 (4.28)	W			2.14 (4.28)					
H	Malllard	4.29 (8.58)	W			4.29 (8.58)			1.43 (2.86)		1.43 (2.86)
T	Marsh Wren						2.86 (5.72)	PC; MA	1.43 (2.86)		1.43 (2.86)
S	Northern Flicker	0.71 (1.42)	H+S+T			0.71 (1.42)					
P	Northern Shoveler	1.43 (2.86)	W			1.43 (2.86)					
T	Pied-billed Grebe						1.43 (2.86)	MA; SW			
AT	Red-winged Blackbird	8.57 (17.14)	H+S; H+S+T	2.86 (5.72)	PC	11.43 (22.86)	0.71 (1.42)	PC	2.86 (5.72)	9.29 (18.58)	12.14 (24.28)
H	Rock Pigeon						1.43 (2.86)	HU			
T	Savannah Sparrow						1.43 (2.86)	PC		2.86 (5.72)	2.86 (5.72)
T	Song Sparrow	1.43 (2.86)	H+S+T	1.43 (2.86)	FO	2.86 (5.72)	1.43 (2.86)	SW	1.43 (2.86)		1.43 (2.86)
T	Sora			1.43 (2.86)	PC	1.43 (2.86)	1.43 (2.86)	PC			
T	Swamp Sparrow	2.86 (5.72)	H+S; H+S+T	2.86 (5.72)	PC	5.71 (11.42)	1.43 (2.86)	SW	2.86 (5.72)	1.43 (2.86)	4.29 (8.58)
H	Tree Swallow	1.43 (2.86)	In flight (over water)			1.43 (2.86)	1.43 (2.86)	PC	0.71 (1.42)		0.71 (1.42)
S	Virginia Rail	1.43 (2.86)	H+S			1.43 (2.86)					
T	Warbling Vireo			1.43 (2.86)	FO: SW	1.43 (2.86)	2.86 (5.72)	SW		1.43 (2.86)	1.43 (2.86)
T	Wilson's Snipe	2.86 (5.72)	H			2.86 (5.72)			2.14 (4.28)	1.43 (2.86)	3.57 (7.14)
S	Yellow Warbler			1.43 (2.86)	FO	1.43 (2.86)	2.86 (5.72)	SW			
	Total 2017: 31 species		**Vegetated riparian strip only**								
	Total	35.71 (71.42)	20.71 pairs	13.57 (27.14)		49.29 (98.58)	30.00 (60.00)		17.14 (34.28)	79.29 (158.58)	96.43 (192.86)
	Number of species	16	8	8		21	18		10	11	16

[1] Code = Category of breeding evidence observed (using the codes from the Québec Breeding Bird Atlas). Descriptions of the categories appear in Appendix E

[2] Watercourse and riparian strip = water + bank + vegetated riparian strip if present.

[3] W = water; B = bank; H = herbaceous cover; S = shrub cover; T = tree cover.

[4] Total riparian zone = water + bank + riparian strip + adjacent habitat (0 m–25 m).

[5] Habitat codes: AC = annual cropland; PC = perennial cropland; OW = open water; OF = old field; FH = farm hedgerow; MA = marsh; SW = swamp; HU = human-modified environment; FO = forested area; WM = wet meadow; UF = uncultivated farmland .

[6] Note: There are some discrepancies between the 2012 values provided here and the data published in the report (Jobin 2015), due to the fact that some adjustments had to be made to the original data.

The birds observed in more distant adjacent habitat provide an indication of the species that frequent the landscape surrounding Blondin Creek. In all, 18 species were observed in these habitats, which consist of perennial cropland and a treed swamp. The Savannah Sparrow and the Marsh Wren were seen on perennial cropland. The Marsh Wren was observed in the flooded portions of the hayfields or near ditches with cattails. A number of species were observed on the National Defence property, including the Pied-billed Grebe, the Baltimore Oriole and the Eastern Kingbird. The Common Raven (nesting confirmed in the region through observation of young) and the Rock Pigeon were seen perching on farm buildings.

Species observed more than 25 m from the watercourse were not recorded during the 2012 surveys; therefore no comparison can be made with the 2017 results for the more distant adjacent habitats.

Five species flew over the site without stopping: the American Black Duck (1 individual), the Double-crested Cormorant (4 individuals), the Bald Eagle (1 individual, species designated Vulnerable in Quebec), the Mourning Dove (1 individual) and the Turkey Vulture (2 individuals).

3.2 Bertco agroforestry plot

The Bertco agroforestry plot was surveyed twice, on June 22 and 29, 2017. The surveys were carried out between sunrise and 10:45 a.m. under good weather conditions. This plot, which is located outside of the flood plain on the first terrace formed by the Champlain Sea (counting from Lake Saint-Pierre), was not affected by the prolonged flooding of the St. Lawrence in 2017.

In all, 40 species were observed during the surveys. Ten species representing 14.5 pairs were found in the agroforestry plot, and 37 species representing 67 pairs used the adjacent habitats (Table 3). Within the plot, the Song Sparrow, the Savannah Sparrow and the Vesper Sparrow were the most abundant species, making up 55% of the pairs observed.

These three species that nest on the ground (or also near the ground, in the case of the Song Sparrow) used crops for foraging and croplands as breeding sites. They also used the planted trees as perches for singing and as lookout sites. Of the three species, breeding was confirmed in the plot only for the Savannah Sparrow, through observation of an adult carrying food. The bird returned to the same place several times (beneath the corn plants, between two rows of trees) with food in its bill.

Of the seven other species observed in the plot, three were in flight: the American Goldfinch, the Cedar Waxwing and the Great Crested Flycatcher. The American Robin was observed foraging on the ground. The Baltimore Oriole, the Northern Flicker and the Brown-headed Cowbird were seen perching on hybrid poplars. The male and the female of the Baltimore Oriole both frequented the agroforestry plot and were observed carrying food.

Table 3. Results of bird surveys conducted in Bertco agroforestry plot and adjacent habitats, 2017 and 2012

Code[1]	Species	Agroforestry plot		Adjacent habitats		
		2017	2012[3]	2017		2012[3]
		Pairs (individuals)	Pairs (individuals)	Pairs (individuals)	Habitat[2]	Pairs (individuals)
S	Alder Flycatcher		1 (2)	1 (2)	FH	
H	American Crow			1 (2)	FO	
H	American Goldfinch	1 (2)	1 (2)			
T	American Robin	1 (2)	1,5 (3)	2 (4)	OF; FO	1 (2)
AT, P	Baltimore Oriole	1 (2)				
AT	Belted Kingfisher			1 (2)	OF	
S	Black-and-white Warbler			1 (2)	FO	
S	Black-billed Cuckoo			1 (2)	FO	
S	Black-capped Chickadee			1 (2)	FO	
S	Black-throated Green Warbler			1 (2)	FO	
S	Blue Jay			1 (2)	In flight	
P	Brown-headed Cowbird	1 (2)	3 (6)	4 (8)	OF; FH	0,5 (1)
H	Cedar Waxwing	1 (2)				
H	Common Grackle			1,5 (3)	FH	
S	Common Yellowthroat			2 (4)	OF; FO	2 (4)
S	Downy Woodpecker			2 (4)	FO	
H	Eastern Kingbird		0,5 (1)	0,5 (1)	OF	
T	Eastern Wood-Pewee			3 (6)	FO	
H	European Starling		0,5 (1)			2 (4)
S	Gray Catbird			0,5 (1)	OF	
P	Great Crested Flycatcher	0,5 (1)		3 (6)	FH; FO	1 (2)
S	Hermit Thrush			1 (2)	FO	
JE	House Wren			2 (4)	FO	
H	Killdeer		2 (4)	1 (2)	AC	1 (2)
S	Least Flycatcher			1 (2)	FO	
T	Northern Flicker	1 (2)		1 (2)	OF	
T	Ovenbird			3 (6)	FO	
S	Pine Warbler			1 (2)	FO	
T	Red-eyed Vireo			7 (14)	FO	1 (2)
H	Red-tailed Hawk			1 (2)	AC	
P	Rose-breasted Grosbeak			1 (2)	FO	
AT	Savannah Sparrow	2 (4)		1 (2)	AC	
S	Scarlet Tanager			2 (4)	FO	
P	Song Sparrow	4 (8)	5 (10)	8 (16)	OF; FH; FO	0,5 (1)
T	Veery			2 (4)	FO	
T	Vesper Sparrow	2 (4)	3 (6)	1 (2)	FH	
T	Warbling Vireo			2 (4)	FO	
T	White-breasted Nuthatch			1 (2)	FO	
T	Wood Thrush			2 (4)	FO	
T	Yellow Warbler			2 (4)	OF	1 (2)
S	Yellow-bellied Sapsucker			0,5 (1)	FO	0,5 (1)
	Total 2017 : 40 species					
	Total	14,5 (29)	17,5 (35)	67 (134)		10,5 (21)
	Number of species	10	9	37		10

[1] Code: Category of breeding evidence observed (using the codes from the Québec Breeding Bird Atlas). Descriptions of the categories appear in Appendix E.
[2] Habitat codes: **AC** = annual cropland; **OF** = old field (ravine); **FH** = farm hedgerow; **FO** = forested area.

[3] Note: There are some discrepancies between the 2012 values provided here and the data published in the report (Jobin 2015), due to the fact that some adjustments had to be made to the original data.

The Song Sparrow and the Vesper Sparrow were among the most abundant species in the plot in 2012, and the number of pairs was similar. However, the Savannah Sparrow was not observed during the 2012 survey period, whereas the nesting of Killdeer was confirmed. That species had been the third-most abundant species in the plot in 2012, was not seen there in 2017. The growth of the trees between the two survey periods might explain why the Killdeer abandoned the plot as a breeding habitat: the species prefers open areas with little or no herbaceous vegetation and is even more likely to avoid woody plants. The trees might also explain the presence in 2017 of some species that had been absent in 2012, such as the Cedar Waxwing, the Baltimore Oriole, the Northern Flicker, and the Great Crested Flycatcher.

Bertco agroforestry plot, June 22, 2017. (Photo: Alexandre Nicole)

The results obtained in the adjacent habitats provide an indication of the bird species that frequent the landscape surrounding the agroforestry plot. In all, 37 species were counted in these habitats, which are made up of woods, old fields (wide ravine), a windbreak (tamarack hedgerow) and annual cropland. The number of species observed in each type of habitat is shown in Table 4. Wooded areas top the list with 24 species reported; the most abundant were the Red-eyed Vireo, the Ovenbird and the Eastern Wood-Pewee (designated Special Concern in Canada). Five warbler species were also found there, as were the Black-billed Cuckoo and the Scarlet Tanager. Nine species were observed in old fields, including the Song Sparrow, the Yellow Warbler and the Common Yellowthroat. Six were found in the tamarack hedgerow, including two pairs of Great Crested Flycatchers observed simultaneously. Three of the species seen in the agroforestry plot also appeared in the tamarack hedgerow: the Song Sparrow, the Vesper Sparrow and the Brown-headed Cowbird. The Savannah Sparrow, the Red-tailed Hawk and the Killdeer were seen on the adjacent annual cropland, which was the habitat where the fewest species were recorded.

Table 4. Number of bird species observed in habitats adjacent to Bertco agroforestry plot

Habitat	Number of species
Annual cropland	3
Old fields (wide ravine)	9
Windbreak (tamarack hedgerow)	6
Forested areas	24
In flight	1

In the 2012 surveys, ten species were observed in the adjacent habitats. All of them, except for the European Starling, were seen again in 2017. The much higher number of species (37) found in the adjacent habitats in 2017 is undoubtedly due to the fact that, in 2012, only birds observed in the first 25 metres of adjacent habitat were reported.

One species, the Turkey Vulture (1 individual), flew over the site without stopping.

Conclusion

Watercourses
The watercourse surveys were carried out under ideal weather conditions, but the water was high and overflowed the banks of the watercourses in multiple locations. Owing to the flooding, water birds were more abundant than usual at Blondin and Côté-Lefebvre creeks, and the Brielle River survey had to be abandoned.

The Blondin Creek survey transect was half the length of the transect along Côté-Lefebvre Creek, yet the riparian zone of Blondin Creek was used by twice as many species (21 versus 10). In addition, the average pair density at Blondin Creek was almost six times higher (49.3 versus 8.7 pairs/km). The presence of woody plants in the riparian strip, perennial cropland in the adjacent habitat, and more diversified habitat in the general area are factors contributing to this difference. Not only was Côté-Lefebvre Creek flooded, but there was little or no vegetation on its banks.

The benefits of planting trees and shrubs in riparian strips have been demonstrated by a number of authors (Goupil, 1995; Maisonneuve and Rioux, 1998; Ministère de l'Environnement du Québec, 1998; Nourry, 2006), and they were confirmed by the results of this study. More species (8) and a higher density (20.7 pairs/km) were recorded in the riparian strip of Blondin Creek, where herbaceous plants, shrubs and trees were present, than in that of Côté-Lefebvre Creek (4 species and 3.1 pairs/km), which was devoid of woody plants.

The higher water levels of 2017, compared to 2012, made it difficult to accurately compare the results from the two years. That explains why the main differences between the 2012 and 2017 surveys involved ground nesters and species attracted to water. Ground-nesting species were more abundant in 2012 than in 2017 along both watercourses, whereas more species that are attracted to water were detected in the Blondin Creek area in 2017. The situation was quite different at Côté-Lefebvre Creek, where more duck species were present in 2012. The flooding of the herbaceous riparian strips may have deprived these species of their nesting sites in 2017.

At Côté-Lefebvre Creek, only one species at risk was seen in 2017: the Bald Eagle (designated Vulnerable in Quebec). At Blondin Creek, there were two: the Barn Swallow (designated Threatened in Canada) and the Eastern Wood-Pewee (designated Special Concern in Canada).

Agroforestry plot
The survey of the Bertco agroforestry plot was conducted under good weather conditions. Two of the most abundant species were the same in both the 2012 and the 2017 surveys: the Song Sparrow and the Vesper Sparrow. The Killdeer, whose breeding habitat had been altered by the growth of trees planted amidst the crops, was not seen on the site in 2017. On the other hand, breeding of the Savannah Sparrow, another species associated with open areas, was confirmed in the agroforestry plot in 2017, although it was not observed there in 2012. The presence of the trees might explain why a number of species absent in 2012 were observed in 2017, such as the Cedar Waxwing, the Baltimore Oriole, the Northern Flicker and the Great Crested Flycatcher.

The adjacent habitats, especially the wooded areas, supported a broad diversity of species, and those habitats are unquestionably important for wildlife in an intensive-agriculture area. Fewer species were observed in the adjacent habitats planted with annual crops than in the agroforestry plot (3 versus 10), which suggests that the trees enabled the plot to support a larger number of species.

In 2017, two species at risk were observed during the surveys of the Bertco plot: the Wood Thrush (designated Threatened in Canada) and the Eastern Wood-Pewee (designated Special Concern in Canada). Both were found in the adjacent forested areas.

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Appendix A
Watercourse transect field sheet

SONGBIRD SURVEY: WATERCOURSES, SUMMER 2017

STATION No:	OBSERVER:	TEMPERATURE:
Visit No (1 or 2):	No of PAGES FOR THIS STATION:	WIND:
DATE: JUNE 2017		PRECIPITATIONS:
TIME (START - END):		CLOUD COVER:

SPECIES	No OF INDIVIDUALS	TYPE OF CONTACT	SEX	LOCATION (O, B, V, A)	IF RIPARIAN STRIP - HABITAT (H, S, T)	ADJACENT HABITAT – I or O (1st 25 m)	ADJACENT HABITAT – HABITAT TYPE	COMMENTS

- WIND:
- **0**: NO WIND
- **1**: LIGHT WIND (LEAVES MOVE)
- **2**: MODERATE WIND (BRANCHES MOVE)
- **3**: STRONG WIND (BRANCHES BEND)
- **4**: HIGH WIND (BRANCHES BREAK)

- PRECIPITATIONS:
- **0**: NO PRECIPITATION
- **1**: DRIZZLE
- **2**: LIGHT RAIN
- **3**: HEAVY RAIN
- **4**: THUNDERSTORM

- CLOUD COVER:
- **0**: CLEAR
- **1**: PARTLY CLOUDY
- **2**: OVERCAST

COMMENTS:

- TYPE OF CONTACT:
- **T**: **T**ERRITORIAL BEHAVIOR (SONG)
- **C**: **C**ALL
- **H**: VISUAL OBSERVATION IN THE **H**ABITAT
- **F**: **F**LYING
- **A**: FLYING OVER THE HABITAT (HIGH IN THE **A**IR)
- **N**: **NEST**
- **F**: **F**AMILY

- SEX: ♂: MALE ♀: FEMALE

- LOCATION OF BIRD:
- **O**: **O**PEN WATER
- **B**: **B**ANK
- **V** : **V**EGETATED RIPARIAN STRIP
- **A**: **A**DJACENT HABITAT

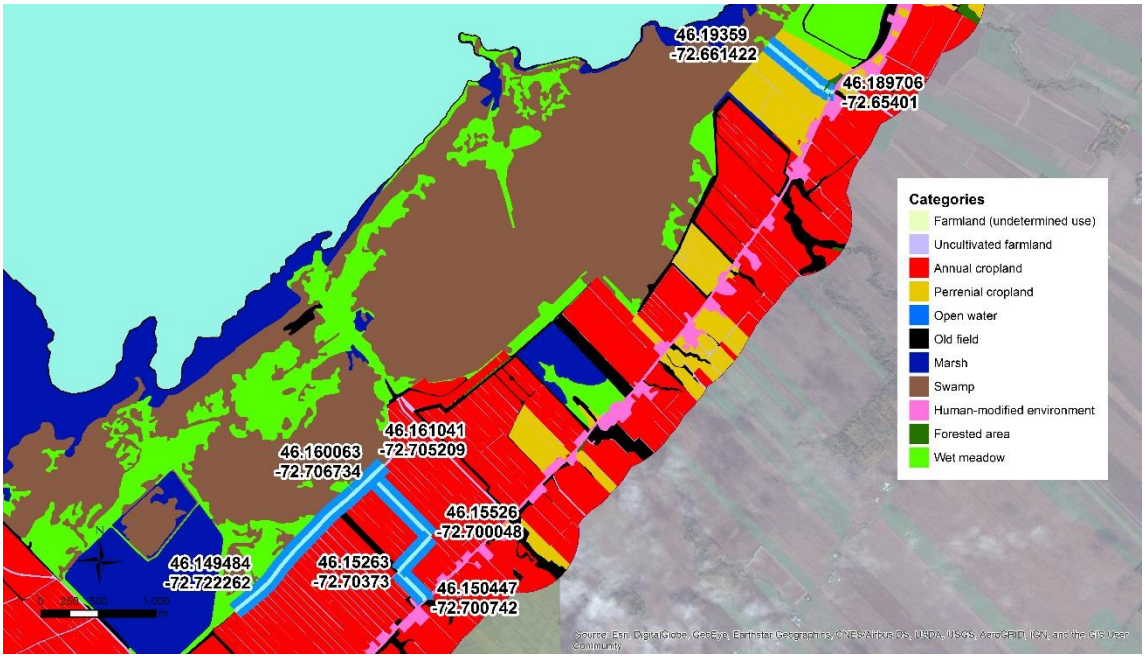
- VEGETATED RIPARIAN STRIP – HABITAT USED:
- **H**: **H**ERBACEOUS
- **U**: **S**HRUBS
- **T**: **T**REES

- ADJACENT HABITAT – POSITION OF BIRD: INSIDE OR OUTSIDE THE 1st 25 m:
I: INSIDE **O**: **O**UTSIDE

- ADJACENT HABITAT – HABITAT TYPE USED BY BIRD:
- **AC**: **A**NNUAL **C**ROPLAND
- **PC**: **P**ERENNIAL **C**ROPLAND
- **UF**: **U**NCULTIVATED **F**ARMLAND
- **FH**: **F**ARM **H**EDGEROW
- **OW**: **O**PEN **W**ATER
- **OF**: **O**LD **F**IELD
- **MA**: **MA**RSH
- **SW**: **SW**AMP
- **HU**: **HU**MAN-MODIFIED ENVIRONMENT
- **FO**: **FO**RESTED **A**REA
- **WM**: **W**ET **M**EADOW

Appendix B

Geographic coordinates of the watercourses transects surveyed (Source: ECCC and MDDELCC, 2017)



Appendix C

Point count field sheet for Bertco agroforestry plot

SONGBIRD SURVEYS, BERTCO AGROFORESTRY PLOT, SUMMER 2017

SITE: Parcelle Bertco	OBSERVER:	TEMPERATURE:
VISIT No (1 or 2):	No OF PAGES FOR THIS SITE:	WIND:
DATE:		PRECIPITATIONS:
TIME (START- END):		CLOUD COVER:

SPECIES	No OF INDIVIDUALS	TYPE OF CONTACT	SEX	I or O PLOT	HABITAT	COMMENTS

- **WIND:**
  - **0**: NO WIND
  - **1**: LIGHT WIND (LEAVES MOVE)
  - **2**: MODERATE WIND (BRANCHES MOVE)
  - **3**: STRONG WIND (BRANCHES BEND)
  - **4**: HIGH WIND (BRANCHES BREAK)

- **PRECIPITATIONS:**
  - **0**: NO PRECIPITATION
  - **1**: DRIZZLE
  - **2**: LIGHT RAIN
  - **3**: HEAVY RAIN
  - **4**: THUNDERSTORM

- **CLOUD COVER:**
  - **0**: CLEAR
  - **1**: PARTLY CLOUDY
  - **2**: OVERCAST

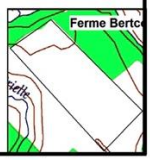
COMMENTS:

- **TYPE OF CONTACT:**
  - **T**: TERRITORIAL BEHAVIOR (SONG)
  - **C**: CALL
  - **H**: VISUAL OBSERVATION IN THE HABITAT
  - **F**: FLYING
  - **A**: FLYING OVER THE HABITAT (HIGH IN THE AIR)
  - **N**: NEST
  - **F**: FAMILY

- **SEX:** ♂: MALE, ♀: FEMALE

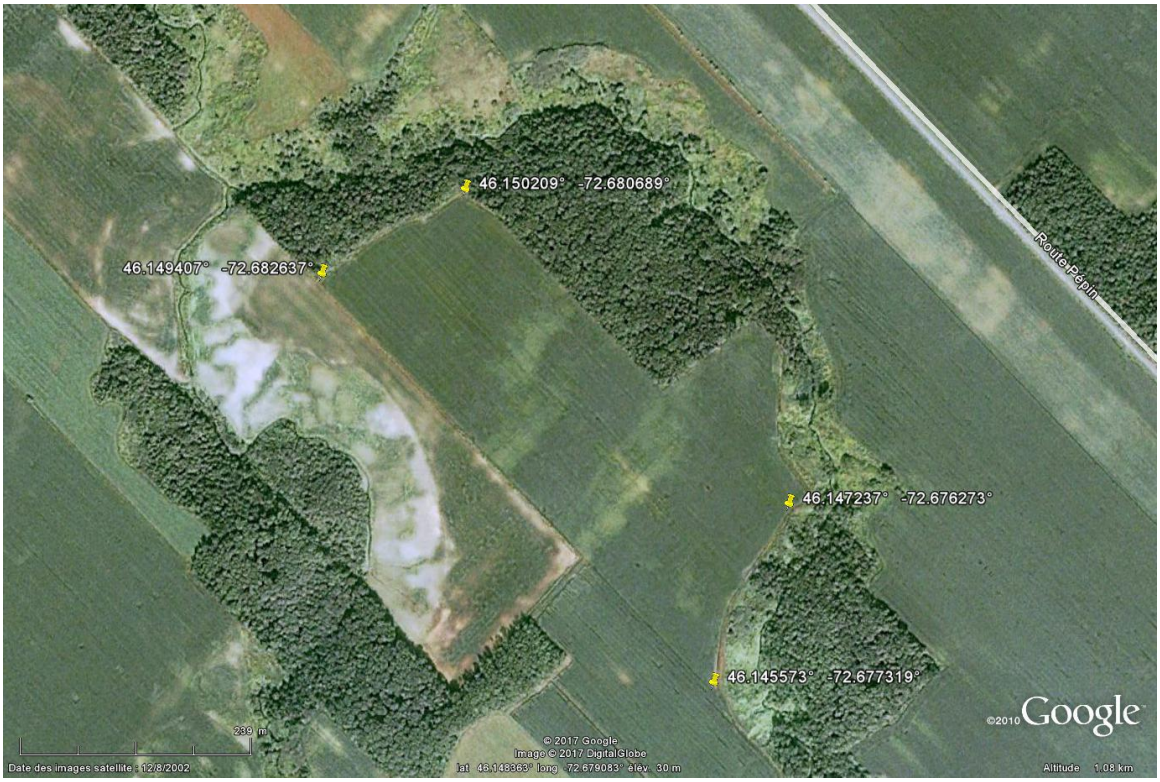
- **LOCATION OF BIRD:**
  - **I**: INSIDE OF THE AGROFORESTRY PLOT
  - **O**: OUTSIDE OF THE AGROFORESTRY PLOT

- **HABITAT TYPE USED BY BIRD:**
  - **AC**: ANNUAL CROPLAND
  - **PC**: PERENNIAL CROPLAND
  - **UF**: UNCULTIVATED FARMLAND
  - **FH**: FARM HEDGEROW
  - **OW**: OPEN WATER
  - **OF**: OLD FIELD
  - **MA**: MARSH
  - **SW**: SWAMP
  - **HU**: HUMAN-MODIFIED ENVIRONMENT
  - **FO**: FORESTED AREA
  - **WM**: WET MEADOW



Appendix D

Geographic coordinates of the Bertco agroforestry plot perimeter (Source: ECCC and MDDELCC, 2017)



Appendix E

Breeding evidence codes from the *Québec Breeding Bird Atlas* (AONQ, 2017)

SPECIES OBSERVED

X	Species observed during its breeding season, but in habitat unsuitable for nesting (no evidence of breeding).

POSSIBLE BREEDING

H	Species observed in suitable nesting habitat during its breeding season.
S	Individual singing, or sounds associated with reproduction (e.g., calls, drumming) heard in suitable nesting habitat during the species' breeding season.

PROBABLE BREEDING

M	At least 7 individuals singing or producing sounds associated with reproduction (e.g., calls, drumming) heard during a single visit in suitable nesting habitat during the species' breeding season.
P	Pair observed in suitable nesting habitat during the species' breeding season.
T	Presumed territory based on the presence of an adult bird, whether producing sounds associated with breeding (e.g., song, other calls or drumming) or not, at the same place, in suitable nesting habitat, on at least two visits, one week or more apart, during the species' breeding season.
C	Breeding behaviour involving a male and female (e.g., display, courtship feeding and copulation) or antagonistic behaviour between two or more individuals (e.g., territorial disputes or chases), in suitable nesting habitat during the species' breeding season.
V	Bird visiting a probable nest site in suitable habitat during the species' breeding season.
A	Agitated behaviour or alarm calls of an adult in suitable habitat during the species' breeding season.
B	Brood patch or cloacal protuberance on an adult individual caught in suitable nesting habitat during the species' breeding season.
N	Nest building by wrens or nest hole excavation by woodpeckers..

CONFIRMED BREEDING

CN	Nest building, including the carrying of nesting material, by all species except wrens and woodpeckers.
DD	Individual attempting to draw attention away from a nest or young by feigning injury or by using any other distraction display.
NU	Empty nest used during the atlas survey period, or the shells of eggs laid during the same period.
JE	Recently fledged (nidicolous species) or downy (nidifugous species) young incapable of sustained flight.
NO	Adult leaving, occupying or entering a probable nest site (visible or not) whose behaviour is suggestive of an occupied nest.
FE	Adult carrying a fecal sac.
AT	Adult carrying food for one or more young.
NF	Nest containing one or more eggs.
NJ	Nest containing one or more young (seen or heard).

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