Amphibian surveys (spring-summer 2018) following habitat restoration work along three watercourses and in an agroforestry plot near Lake Saint-Pierre

Baie-du-Febvre Area

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Table of Contents

List of Figures and Tables

1. Introduction

Lake Saint-Pierre and its floodplain, which is the largest in Québec, is one of the major components of the St. Lawrence ecosystem. With more than 288 resident and migratory bird species and 79 fish species (MDDEFP, 2013), 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. However, beginning in the second half of the 20th century, perennial crops were gradually replaced by annual crops, even in the floodplain area (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 promotes soil erosion during high water periods and results in the destruction of key fish spawning and rearing grounds in the spring. This degradation has played a significant role in the decline of the Yellow Perch population in Lake Saint-Pierre (Magnan et al., 2017). To date, roughly 5,000 ha of potential Yellow Perch spawning habitat has been lost (TCRLSP, 2017).

With the aim of balancing agricultural activities and wildlife protection, an approach for restoring wildlife habitats on the shoreline of Lake Saint-Pierre has been developed (Groupe de travail « Intendance en milieu agricole: culture du littoral au lac Saint-Pierre », 2010). This approach involves stream maintenance (bank reprofiling, planting, etc.) and conversion of annual crops back to perennial crops or natural grasslands. In these regards, three watercourses of the Baie-du-Febvre area were restored in 2012 with the goal of restoring fish habitat while allowing the cultivation of adjacent lands. In parallel with this work, an agroforestry plot was established at Bertco Farm to evaluate the impact on wildlife and agronomy of intercropping traditional cereal crops (or alfalfa) and rows of trees (oaks, maples, poplars, walnuts) spaced 40 m apart in a single field.

Amphibian surveys were conducted for the first time in the summer of 2012 to provide a portrait of the frog and toad species present at these four sites (ie. The three watercourses and the agroforestry plot) before the start of the habitat management and restoration work (Jobin, 2015). New inventories were conducted in the spring and summer of 2018 to measure the evolution of amphibian communities five years after the work was completed.

This approach is part of the project “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 Québec Department of Forests, Wildlife and Parks (MFFP), as part of the 2016–2021 programming of the St. Lawrence Action Plan (SLAP).

2. Method

2.1 Location and description of amphibian survey sites

The three watercourses under study are located in the south-east portion of the floodplain of Lake Saint-Pierre in the Baie-du-Febvre area. It is the Brielle River and the Côte-Lefebvre and Blondin creeks. The agroforestry plot is located outside the 0 to 100 year recurrence zone on the Bertco farm property. The location of these sites is shown in **Figure 1**.

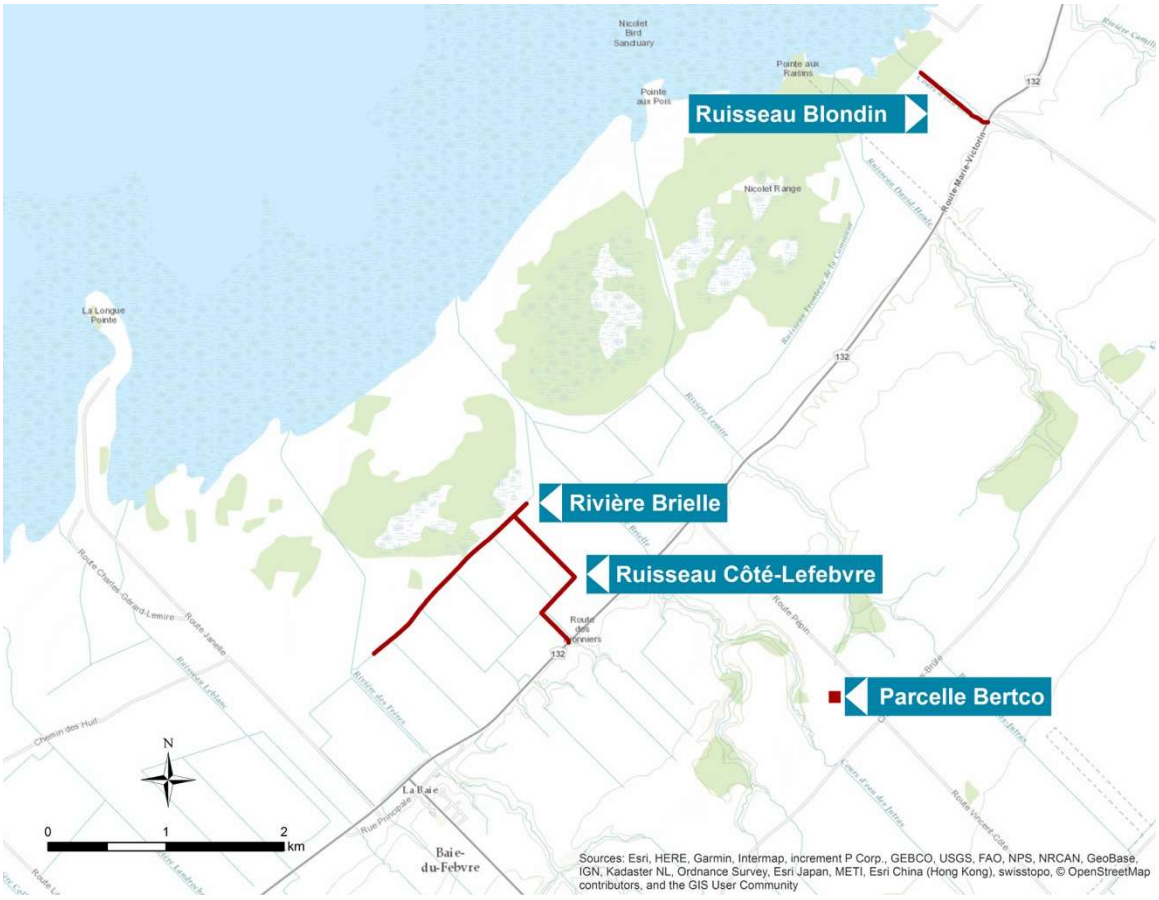

Figure 1. Location of amphibian survey sites (Rivière Brielle: Brielle river; Ruisseau Côte-Lefebvre: Côte-Lefebvre Creek; Ruisseau Blondin: Blondin Creek; Parcelle Bertco : Bertco plot)

2.1.1 Watercourses

The three watercourses restored in 2012 and being monitored are in agricultural landscape (**Figure 2**). The restoration work carried out includes the reprofiling of the banks as well as the planting of trees and shrubs.

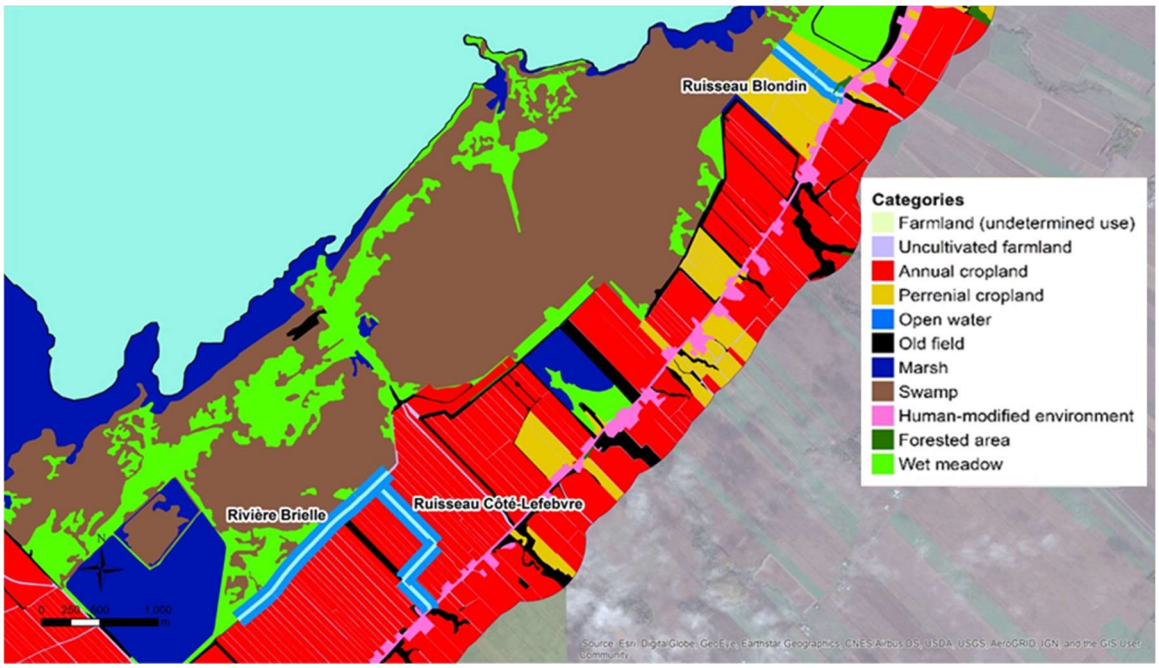

Figure 2. Land use in the area of the three watercourses (0 to 100 year recurrence zone) Source: ECCC and MDDELCC, 2018

Brielle River

The Brielle River, whose restored section is 2 km long, is located in the Baie-du-Febvre municipality (MRC of Nicolet-Yamaska). It is bordered on the north by the Department of National Defence lands and on the south by annual crops. About thirty agricultural ditches flow there. The vegetation planted in the riparian strip in 2012 was largely destroyed.

Côté-Lefebvre Creek

The Côté-Lefebvre creek, whose restored section is 1.4 km long, is located in Baie-du-Febvre municipality (MRC of Nicolet-Yamaska). It drains farmland on both sides of the route 132 and empties into the Brielle River. In the restored section, the creek is bordered by annual crops only. The vegetation planted in the riparian strip in 2012 was largely destroyed.

Blondin Creek

The Blondin Creek, whose restored section is 0.7 km long, is located between the route 132 and Department of National Defence lands in the municipality of Nicolet (MRC of Nicolet-Yamaska). The runoff water from agricultural land located south of the route 132 are the main source of this creek, and this one pours directly into Lake Saint-Pierre. Perennial crops and a small woodlot border Blondin Creek. The vegetation planted as part of the restoration work in 2012 is still present.

2.1.2 Bertco agroforestry plot

The Bertco plot is located in the municipality of Baie-du-Febvre (MRC of Nicolet-Yamaska), between the route 132 and the Pays Brûlé road. It consists of a 10 ha development where an intercropping agroforestry system (IAS), alternating rows of trees and stripes of cultivated land, have been set up (**Figure 3**; Rivest et al. 2018). The implanted IAS at Bertco farm is one of the second generation, characterized by a 40 m spacing between the rows (this distance varies from 8 m to 15 m for the IAS of the first generation and 25 m to 40 m for those of the second generation). In total, the IAS, count four rows of trees formed of noble hardwoods with moderate growth (oaks, maples, walnuts) which separate one of the others by fast-growing hybrid poplars, a provision that allows to divide the harvest of wood over time (Rivest et al., 2018). On the stripes of land between rows of trees, the owners rotate crops of cereals and legumes (in 2018, the crop was soybean). The parcel is bordered by a woodlot to the north, by other annual crops and agricultural gullies to the east and south, and by a windbreak hedge of tamaracks to the west.

Figure 3. Limits of the Bertco agroforestry plot (Source: Google Earth, 2017)

2.2 Amphibian survey method

The amphibian survey protocol, focusing on anuran species (frogs and toad), is based on the protocol used in the Quebec Amphibian Population Monitoring Program (Société d'histoire naturelle de la vallée du Saint-Laurent, 2009), as was also done in the surveys in 2012, which preceded the restoration efforts.

Quebec's anuran species can be divided into two categories, based on the reproductive strategy they use: early breeders and late breeders. Visits were planned to coincide with the vocalization periods of all species.

Three visits were planned to the sites: the first in April, the second in May and the third in June. The actual evening of the visit was chosen based on the weather conditions and the air temperature. Evenings with rain or heavy winds were avoided and the temperature had to be within the target species' preferred temperature range for each visit. The periods and temperature ranges favouring species detection are shown in Appendix A. Preferably, before the first visit, a control site, where species were known to be present, was visited to confirm that species were active, since the onset of breeding season varies from year to year and is strongly influenced by the weather. Surveys began 30 minutes after sunset and were completed before midnight, when the intensity of anuran activity decreases.

Survey stations were positioned at 500-m intervals along several watercourses and in a plot under agroforestry management (**Figures 4, 5 and 6**). Blondin Creek had two survey stations, Côté-Lefebvre Creek, three; Brielle River, five, and the Bertco agroforestry plot, two, for a total of 12 survey stations. The coordinates of the survey stations are shown in Appendix B. At each survey station, a point count was conducted, which involved listening for anuran vocalizations for three minutes; a relative abundance score was then assigned to each species heard (**Table 1**).

Table 1. Description of relative abundance scores based on anuran calls (source: MFFP 2015)

Score	Description
0	No calls heard.
1	Each call can be distinguished and the number of calling males can be counted.
2	Calls blend together somewhat (partially overlapping calls) and not all calling males can be counted.
3	Continuous chorus; individual calling males are impossible to count.

The first visit took place on April 24 (Blondin Creek, Côté-Lefebvre Creek, Bertco agroforestry plot) and April 30 (Brielle River); the second, on May 20 (all sites); and the third, on June 27 (all sites). The field datasheet used is shown in Appendix C.

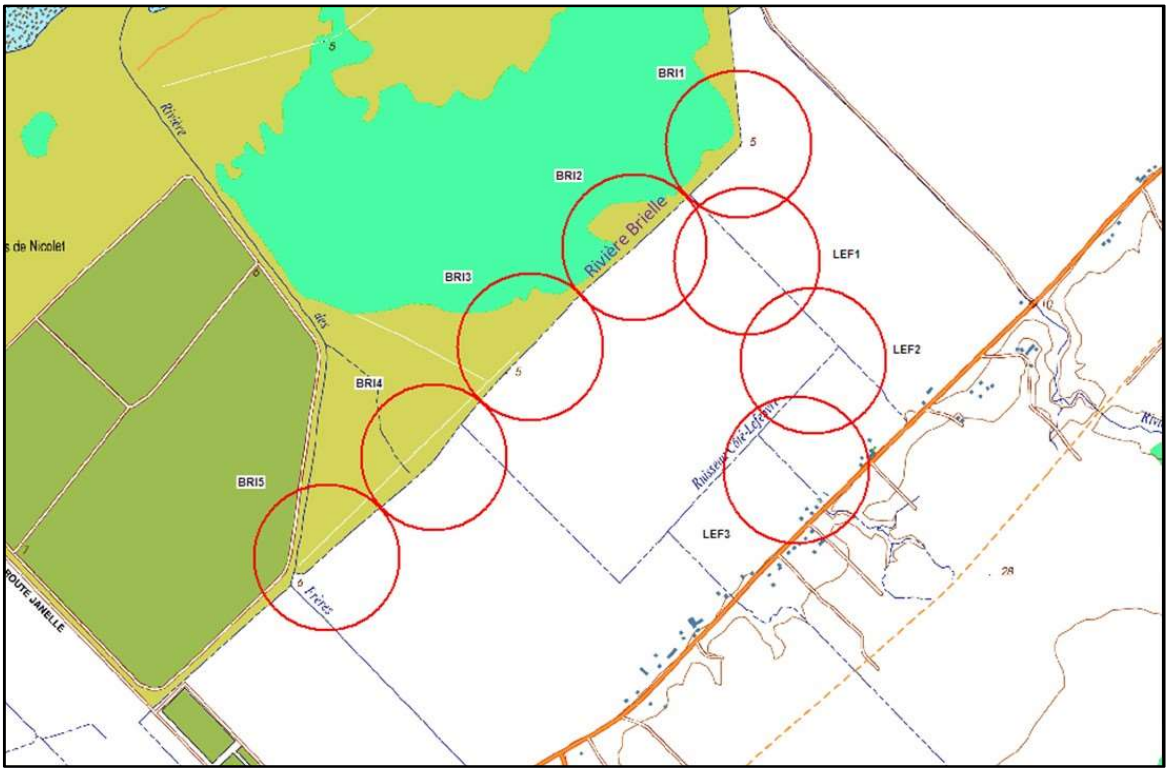

Figure 4. Location of the amphibian survey sites along the Brielle River and the Côté-Lefebvre Creek

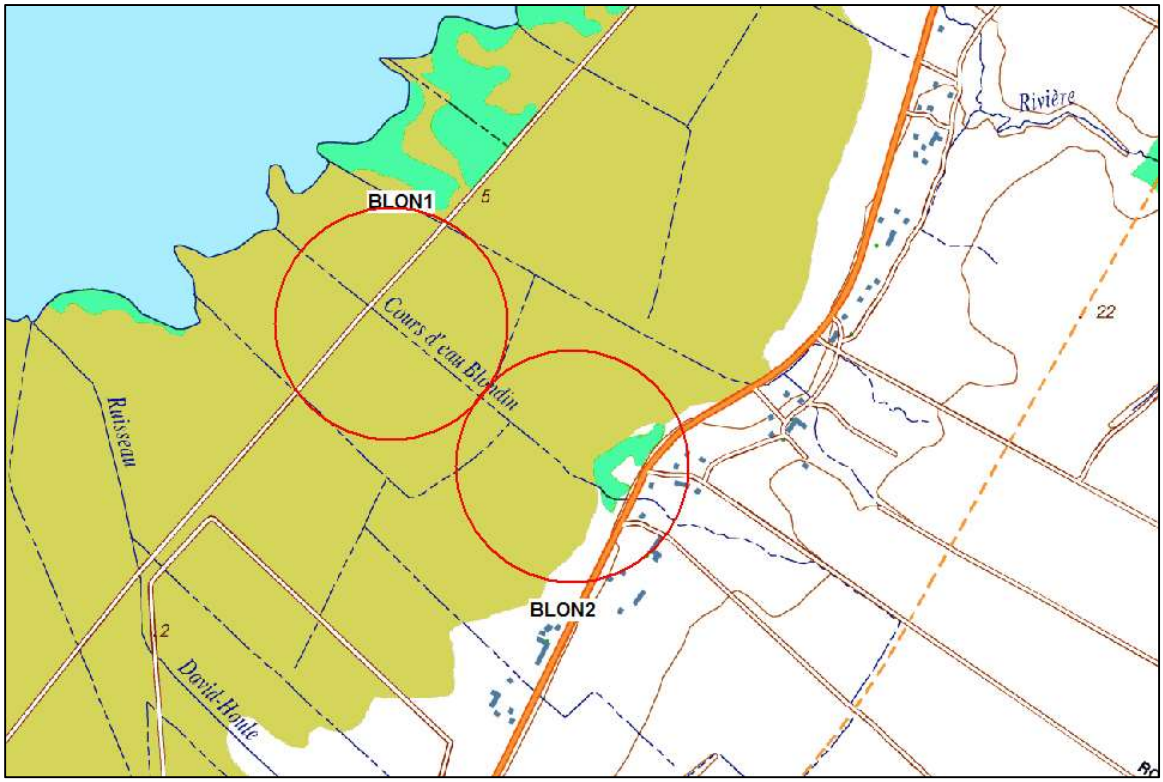

Figure 5. Location of the amphibian survey sites along the Blondin Creek

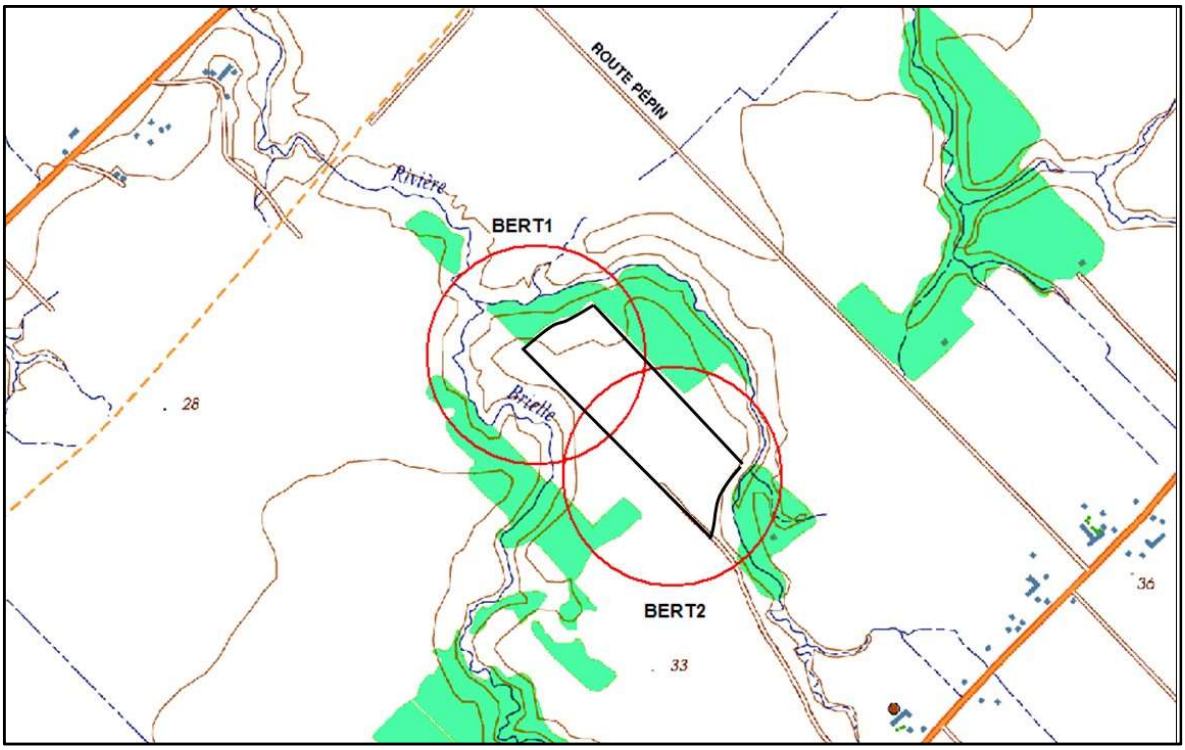

Figure 6. Location of the amphibian survey sites at the Bertco agroforestry plot

3. Results and discussion

3.1 Watercourses

3.1.1 Brielle River

Brielle River was visited three times (April 30, May 20 and June 27, 2018). On the first two visits, surveyors used a kayak to travel between stations, but went on foot for the third. Weather conditions were acceptable to good (temperature near or above the lower limit for the target species, no wind to moderate winds, light or no precipitation). Listening conditions were moderate to good with some background noise from traffic (Highway 132), the wind and the honking of large flocks of Snow Geese and Canada Geese present in the nearby flooded fields.

In all, we detected five anuran species during the surveys of Brielle River in 2018: American Toad (five stations), Wood Frog (three stations), Northern Leopard Frog (one station), Green Frog (three stations) and Northern Spring Peeper (five stations, **Table 2**). Four of the five species had also been detected in 2012, with the exception being Northern Spring Peeper. Except for the Green Frog, most anurans heard seemed to be calling from the swamps located on Department of National Defence (DND) land.

American Toads were heard at a greater number of survey stations in 2018 than in 2012, while the opposite was true for the Northern Leopard Frog and Green Frog. The Northern Leopard Frog, heard at four out of five stations in 2012 (with an abundance score as high as 3), was only heard at a single station in 2018, although favourable survey conditions for its detection were present on all three visits. The Wood Frog was heard at an equal number of survey stations in 2018 and 2012. As we mentioned earlier, the first observation of the Northern Spring Peeper in these surveys was in 2018; the species was found at four out of five stations during the first visit and at all stations during the second visit. Most calls seemed to come from DND land.

It should also be noted that as many as eight Green Frogs were heard or seen during the daytime visits carried out for bird surveys.

Table 2. Relative abundance scores of anuran species detected during surveys conducted along the Brielle River in 2018 and 2012

	Relative abundance score					
	2018			2012		
	Visit 1 (30 April)	**Visit 2** (20 May)	**Visit 3** (27 June)	**Visit 1** (19 April)	**Visit 2** (15 May)	**Visit 3** (26 June)
American toad						
Bri-1		1	1		1	1
Bri-2		1	1			
Bri-3		1				
Bri-4		1		3		
Bri-5		2				
Maximum score	0	2	1	3	1	1
Wood frog						
Bri-1				1		
Bri-2				1		
Bri-3	1			1		
Bri-4	1					
Bri-5	1					
Maximum score	1	0	0	1	0	0
Northern Leopard frog						
Bri-1				3	2	1
Bri-2				3	1	
Bri-3						
Bri-4				1		
Bri-5		1		2		1
Maximum score	0	1	0	3	2	1
Green frog						
Bri-1			1		2	2
Bri-2			1		1	1
Bri-3			1		1	
Bri-4						
Bri-5					1	
Maximum score	0	0	1	0	2	2
Northern Spring peeper						
Bri-1		1				
Bri-2	1	1				
Bri-3		2				
Bri-4	2	3				
Bri-5	3	3				
Maximum score	3	3	0	0	0	0

The south bank of the Brielle River has no woody vegetation, and the width of the riparian strip still does not comply with regulations. A mound of soil deposited at the interface between the watercourse and some of the farm plots serves as a dike. (Photo by Alexandre Nicole, June 16, 2018.)

3.1.2 Côté-Lefebvre Creek

Côté-Lefebvre Creek was visited three times (April 24, May 20 and June 27, 2018). Surveyors travelled between stations on foot. Weather conditions were acceptable to good (temperature above the lower limit required for the target species, no wind to moderate winds, no precipitation). Listening conditions were moderate to good, with background noise from the traffic on Highway 132, the wind, and the honking of large flocks of Snow Geese and Canada Geese in the nearby flooded fields.

In all, three anuran species were detected during the surveys of Côté-Lefebvre Creek in 2018: American Toad (three stations), Green Frog (two stations) and Northern Spring Peeper (two stations, **Table 3**). Among the three, only American Toad was heard in 2012 (at two out of three stations). In 2018, this species was detected at all survey stations, receiving a higher abundance score than in 2012.

Green Frog and Northern Spring Peeper were detected at two survey stations. The Spring Peeper calls seemed to come from DND land.

Lastly, four Northern Leopard Frogs were observed during the bird surveys. This species was not detected during the nocturnal anuran surveys.

The banks of Côté-Lefebvre Creek contain no woody vegetation (except for along a short stretch near its mouth). The heavy floods in 2017 and 2018 hindered the establishment of herbaceous vegetation. (Photo by Alexandre Nicole, June 8, 2018.)

Table 3. Relative abundance scores of anuran species detected during surveys conducted along the Côté-Lefebvre Creek in 2018 and 2012

	Relative abundance score					
	2018			2012		
	Visit 1 (24 April)	**Visit 2** (20 May)	**Visit 3** (27 June)	**Visit 1** (19 April)	**Visit 2** (15 May)	**Visit 3** (26 June)
American toad						
Lef-1			1			
Lef-2		2	1	1		
Lef-3		2		1		
Maximum score	0	2	1	1	0	0
Green frog						
Lef-1			1			
Lef-2			1			
Lef-3						
Maximum score	0	0	1	0	0	0
Northern Spring peeper						
Lef-1		1				
Lef-2						
Lef-3		1				
Maximum score	0	1	0	0	0	0

3.1.3 Blondin Creek

Blondin Creek was visited three times (April 24, May 20 and June 27, 2018). Surveyors travelled between the stations on foot. Weather conditions were good (temperature above the lower limit for the target species, no wind to light winds, no precipitation) and listening conditions were moderate to good, with background noise from traffic (Highway 132), the wind and the honking of Canada Geese in the nearby flooded fields.

In all, two anuran species were detected during the surveys of Blondin Creek in 2018, the American Toad (two stations) and the Northern Spring Peeper (two stations, **Table 4**). American Toad was also found in 2012 (two stations), along with Northern Leopard Frog (one station) and Green Frog (one station). Northern Spring Peepers were only detected in 2018. The abundance scores for the American Toad were higher in 2018 than in 2012.

Lastly, two Northern Leopard Frogs were observed during the bird surveys, but the species was not detected during the nocturnal anuran surveys.

Blondin Creek (Photo by Alexandre Nicole, June 15, 2018.)

Table 4. Relative abundance scores of anuran species detected during surveys conducted along the Blondin Creek in 2018 and 2012

	Relative abundance score					
	2018			2012		
	Visit 1 (24 April)	**Visit 2** (20 May)	**Visit 3** (27 June)	**Visit 1** (19 April)	**Visit 2** (15 May)	**Visit 3** (26 June)
American toad						
Blond-1		2			1	
Blond-2		3			1	1
Maximum score	0	3	0	0	1	1
Northern Leopard frog						
Blond-1					1	1
Blond-2						
Maximum score	0	0	0	0	1	1
Green frog						
Blond-1						1
Blond-2						0
Maximum score	0	0	0	0	0	1
Northern Spring peeper						
Blond-1		2				
Blond-2		2				
Maximum score	0	2	0	0	0	0

3.2 Bertco agroforestry plot

The Bertco agroforestry plot was visited three times (April 24, May 20 and June 27, 2018). Surveyors travelled between stations on foot. Weather conditions were good (temperature near or above minimum threshold for target species, no wind to light winds, no precipitation), as were listening conditions.

In 2018, as in 2012, no anurans could be detected during the three visits, either in the agroforestry plot itself or in the adjacent habitats, which consist of cultivated fields, agricultural ditches, woodlots and ravines. The call of an American Toad was heard on the evening of May 20, 2018, but from very far away.

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

Conclusion

Watercourses
The surveys of the three watercourses were carried out under acceptable weather conditions. Listening was sometimes hindered by traffic noise, wind and the presence of several thousand waterfowl (Anatidae) in nearby flooded fields. In general, caution should be used in interpreting the results, owing to the difficulty of distinguishing individuals located along the watercourses from those on DND land.

We detected a total of five species of anurans during the surveys of the watercourses. The American Toad, considered to be a generalist species (Maisonneuve and Rioux 1998), and the Northern Spring Peeper, which was not detected in 2012, were heard at 100% and 90% of the survey stations respectively. The Northern Leopard Frog, which was very abundant along the Brielle River in 2012 (4 stations, abundance score of 3), was only detected at a single station in 2018 (abundance score of 1), with its calls seeming to come from DND land. However, during the bird surveys, the species was observed along the other two watercourses, although it had not been reported in 2012. The Wood Frog was only present on DND land. Green Frog vocalizations, which were the easiest to pinpoint in terms of location, were heard along the banks of the Brielle River and Côté-Lefebvre Creek.

A number of authors (Goupil 1995, Maisonneuve and Rioux 1998, Ministère de l'Environnement du Québec 1998, Nourry 2006) have demonstrated the positive effect of the presence of trees and shrubs in riparian strips. In particular, herpetofauna abundance increases progressively with the extent of vegetation stratification (Maisonneuve and Rioux 1998). At Blondin Creek, where the trees and shrubs are doing well, the abundance score for American Toad was higher in 2018 than in 2012. However, the destruction of the vegetation planted in 2012 along the edge of Brielle River and Côté-Lefebvre Creek limited the scope of the survey carried out at these sites. The banks of these watercourses would benefit from revegetation.

Bertco agroforestry plot
The survey of the Bertco plot was conducted under favourable conditions. However, no anuran species were detected there in either 2018 or 2012. This is not surprising, given the fact that the site is located in an area of intensive agriculture where the fields are commonly tiled (drained) and leveled. Consequently, all meltwater and runoff quickly drain into the watercourses. However, the absence of anurans in the adjacent habitats, which consist of woodland and fallow fields, is a little surprising, since certain species, like the American Toad, could occur there. We hypothesize that these habitats, which are located on slopes (ravines), have good natural drainage hence limiting the presence of habitats favorable to anurans.

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Appendix A

Periods and temperature ranges favouring the detection of anuran species found in Quebec

Species	Date	Air temperature (°C)
Western Chorus frog	End of March to mid-May	5 to 20
Northern Spring peeper	End of March to mid-May	5 to 20
Wood frog	End of March to May	5 to 12
Northern Leopard frog	April to end of May	8 to 20
Pickerel Frog	May and June	8 to 20
American toad	April and May	13 to 20
Gray treefrog	May to June	13 to 28
Boreal Chorus frog	May to June	13 to 28
Green frog	June to August	20 to 28
Mink frog	June to August	20 to 28
Bullfrog	June to August	20 to 28

Source : Desroches and Rodrigue, 2004; Garant, 2004 (Extracted from : MFFP, 2015)

Appendix B

Geographic coordinates of amphibian survey sites

Site	Latitude	Longitude
BERT01	46,14924531	-72,68229074
BERT02	46,14670448	-72,67826636
BLON01	46,19319000	-72,66091881
BLON02	46,19037327	-72,65586912
BRI01	46,16172813	-72,70443010
BRI02	46,15858530	-72,70916272
BRI03	46,15554105	-72,71385420
BRI04	46,15216704	-72,71823545
BRI05	46,14911324	-72,72308607
LEF01	46,15811453	-72,70409719
LEF02	46,15500163	-72,70119050
LEF03	46,15164268	-72,70200548

Appendix C

Field datasheet used during amphibian surveys (available in French only)

INVENTAIRE DES ANOURES - SECTEUR BAIE-DU-FEBVRE

Date : _____

Période : 1 ☐ 2 ☐ 3 ☐

Qualité d'écoute : _____

Dérangements : _____
(chien, séchoir, circulation, autre)

T °C : _____

Vent (0 à 3) : _____

Précipitations : Nulles ☐ Légères ☐ Abondantes ☐

Ciel dégagé ☐
Partiellement couvert ☐
Couvert ☐

Observateur(s) : _____
_____

Heure	Point GPS	Longitude (dd,dddd)	Latitude (dd,dddd)	Cote d'abondance									
				CRAP	VERS	CRUC	GRIL	BOIS	LÉOP	MARA	VERT	NORD	OUAO
h													
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h													

Cote d'abondance : 0 = aucun cri; **1** = individus peuvent être comptés; **2** = individus peuvent être comptés, d'autres se chevauchent; **3 =** chorale, coassements continus et se chevauchent, individus impossibles à dénombrer.

Espèces : CRAP = Crapaud d'Amérique.; **VERS** = Rainette versicolore; **CRUC** = Rainette crucifère; **GRIL** = Rainette faux-grillon de l'Ouest; **BOIS** = Grenouille des bois; **LÉOP** = Grenouille léopard; **MARA** = Grenouille des marais; **VERT** = Grenouille verte; **NORD** = Grenouille du Nord; **OUAO** = Ouaouaron.

Vent : 0 = fumée droite; **1 =** fumée donne direction du vent; **2 =** sensation de vent au visage, feuilles frémissent, girouettes tournent; **3 =** feuilles agitées, drapeaux légers déployés; **4 =** poussière soulevée, petites branches agitées.

Remarques: _____
_____