Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Spring Cisco (*Coregonus sp.*)

Spring Cisco

2014

Canada

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For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC status reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry.

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PREFACE

The federal, provincial, and territorial government signatories of the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c. 29), the federal competent ministers are responsible for the preparation of recovery strategies for species listed as extirpated, endangered or threatened, and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Fisheries and Oceans is the competent minister for the recovery of the Spring Cisco and has prepared this strategy, as per section 37 of SARA. The strategy was prepared in collaboration with the Ministère des Ressources naturelles and the Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs.

The successful recovery of this species depends on the commitment and cooperation of the many different constituencies that will be involved in implementing the recommendations set out in this strategy. It will not be achieved by Fisheries and Oceans Canada, or any other jurisdiction, alone. All Canadians are encouraged to join in supporting and implementing this strategy for the benefit of the Spring Cisco and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on the recovery measures to be taken by Fisheries and Oceans Canada and the other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to the credits, priorities and budgetary constraints of the participating jurisdictions and organizations.

ACKNOWLEDGMENTS

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Lastly, DFO would like to recognize the invaluable contribution of all the individuals who provided comments on the document.

SUMMARY

The Spring Cisco is the only population of its kind to spawn in the spring; the other cisco populations reproduce in the fall. The relatively high water temperature in deep water in the summer and the slow cooling off in the fall is a possible explanation for the spawning period and the evolution of this population in Lac des Écorces.

The Committee on the Status of Endangered Wildlife in Canada deems that this population, which does not exist anywhere else, is an endangered species. The status and size of the population are unknown, but fish survey catches have fallen drastically over the last 15 years.

Lac des Écorces has undergone many disruptions in recent decades. Human activity began to intensify in the area in the 1970s as new residential areas (primary and secondary residences) were gradually developed along its shores. The water quality, and therefore the quality of the Spring Cisco's habitat, deteriorated. In addition, the lake was stocked with a number of species of fish in an effort to promote recreational fishing. The Rainbow Smelt's recent colonization of the lake, observed in 1999, appears to have become the main threat to the Spring Cisco's recovery because that species is a predator and competes with the cisco.

The recovery strategy priorities proposed in this program are intended to reduce the rainbow smelt population and acquire knowledge on the abundance of the Spring Cisco and its habitat use. The critical habitat identified in this strategy consists of all of Lac des Écorces, which appears to be used in its entirety by this population.

FEASIBILITY OF RECOVERY

The recovery of the Spring Cisco is deemed to be feasible because it meets the four technical and biological feasibility criteria for recovery.

1. **Individuals present in the natural environment are capable of reproduction.**

Yes. Although no inventory of eggs or larvae has been conducted recently, the MRN has reported indications of reproduction.

2. **Habitats are available to allow for the growth and reproduction of the Spring Cisco.**

Yes. Lac des Écorces has good water quality and the pools where spawning occurs are still available. In theory, the entire lake is available to support the growth of the fish.

3. **The threats faced by the species and its habitat can be avoided or mitigated.**

Yes. The threat represented by the introduction of the Rainbow Smelt into the Spring Cisco's habitat can be mitigated. Habitat degradation due to urban and agricultural development can be slowed down, stopped, reversed or avoided.

4. **Techniques exist that can be used to meet the population and distribution objectives**.

Yes. Mass catches of smelt serve to significantly reduce the pressure that this fish exerts on the Spring Cisco. Breeding techniques and fish stocking methods exist that could be applied to the Spring Cisco. There are also a number of techniques to improve water quality and aquatic habitat.

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LIST OF ACRONYMS

COBALI	Comité du bassin versant de la rivière du Lièvre [Lièvre River watershed committee]
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Fisheries and Oceans Canada
MRN	Ministère des Ressources naturelles [Quebec Department of Natural Resources]
RCM	Regional County Municipality
SARA	*Species at Risk Act*
SEA	Strategic Environmental Assessment

1. SPECIES ASSESSMENT BY COSEWIC

This is the summary of the COSEWIC assessment as it appears in the COSEWIC status report (COSEWIC, 2009).

Assessment date: April 2009

Common name (population): Spring Cisco

Scientific name: *Coregonus sp.*

COSEWIC Status: Endangered

Reason for the designation: This species, known from only one small lake in southwestern Quebec, has undergone a drastic decline in abundance over the past 15 years (3 generations). The decline may be related to a combination of factors including habitat degradation and loss resulting from urban and agricultural development, the introduction of non-native species (e.g., Rainbow Smelt and Atlantic Salmon), and climate change.

Canadian Occurrence: Quebec

COSEWIC status history: Designated Special Concern in April 1992. Status re-examined and designated Endangered in April 2009. Last assessment based on an updated status report.

2. SPECIES STATUS INFORMATION

The Spring Cisco is found only in Lac des Écorces, in Quebec. Its entire range is therefore located within Canada. According to NatureServe,[1] the status of the population is S1, or at risk in Canada and vulnerable in Quebec. The Spring Cisco is on the list of species likely to be designated as threatened or vulnerable under Quebec's *Act respecting threatened or vulnerable species*.

3. SPECIES INFORMATION

3.1 Description of the species

The Spring Cisco is a small member of the salmonoid family. It is a silver-sided fish with a back that varies from blue-green to black in colour. Adults are usually 15 to 30 cm long. Closely related to the Lake Cisco, *Coregonus artedi,* which spawns in the fall and has a larger range, the Spring Cisco is shorter, has a smaller head and a

[1] NatureServe is a network of organizations that collates information on species at risk in North America.

narrower and shorter caudal peduncle[2]. The Spring Cisco has 11 rays on its anal fin, while the *C. artedi* has 12.1 to 12.5. The number of gill rakers[3] on the first gill arch is the most distinctive morphological criterion. On average, the Spring Cisco has 42.7 gill rakers, as compared with 50.5 for cisco that spawn in the fall in nearby lakes (Hénault and Fortin, 1989).

[2] The caudal peduncle is the portion of the body from behind the anal fin to the caudal fin.

[3] Gill rakers are cartilagenous protuberances of which there are two rows on the gill arches; they serve to protect the gill rakes from food in the mouth cavity.

3.2 Population and distribution

The only spring cisco population in Canada is found in Lac des Écorces (Figure 1), in the Laurentian region of Quebec. Recently discovered, the presence of this spring-spawning cisco population was first reported by Pariseau et al. (1983). The range of the species corresponds to the surface area of the lake, which is 6.58 km^2.

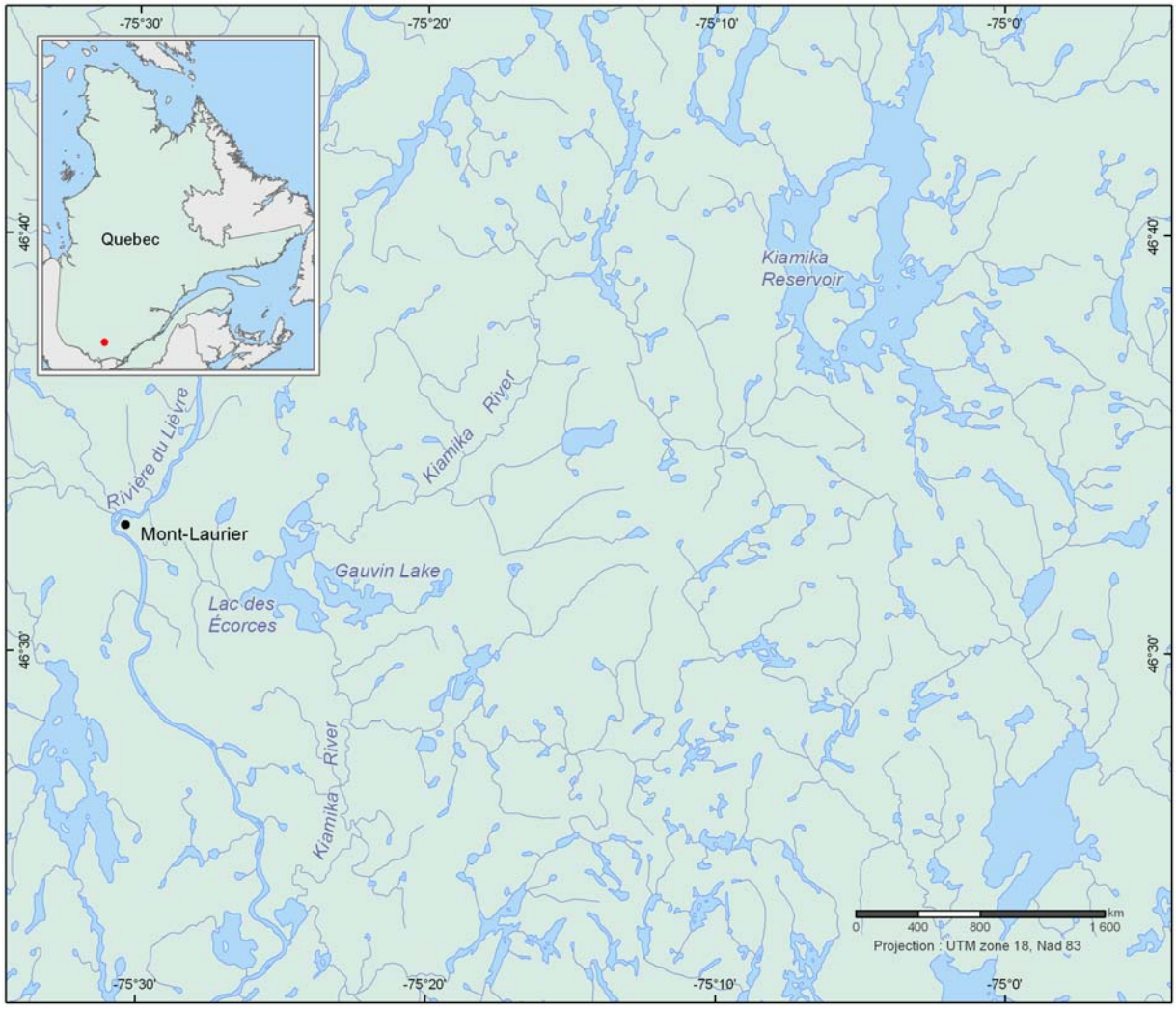

Figure 1. Map of the area around Lac des Écorces.

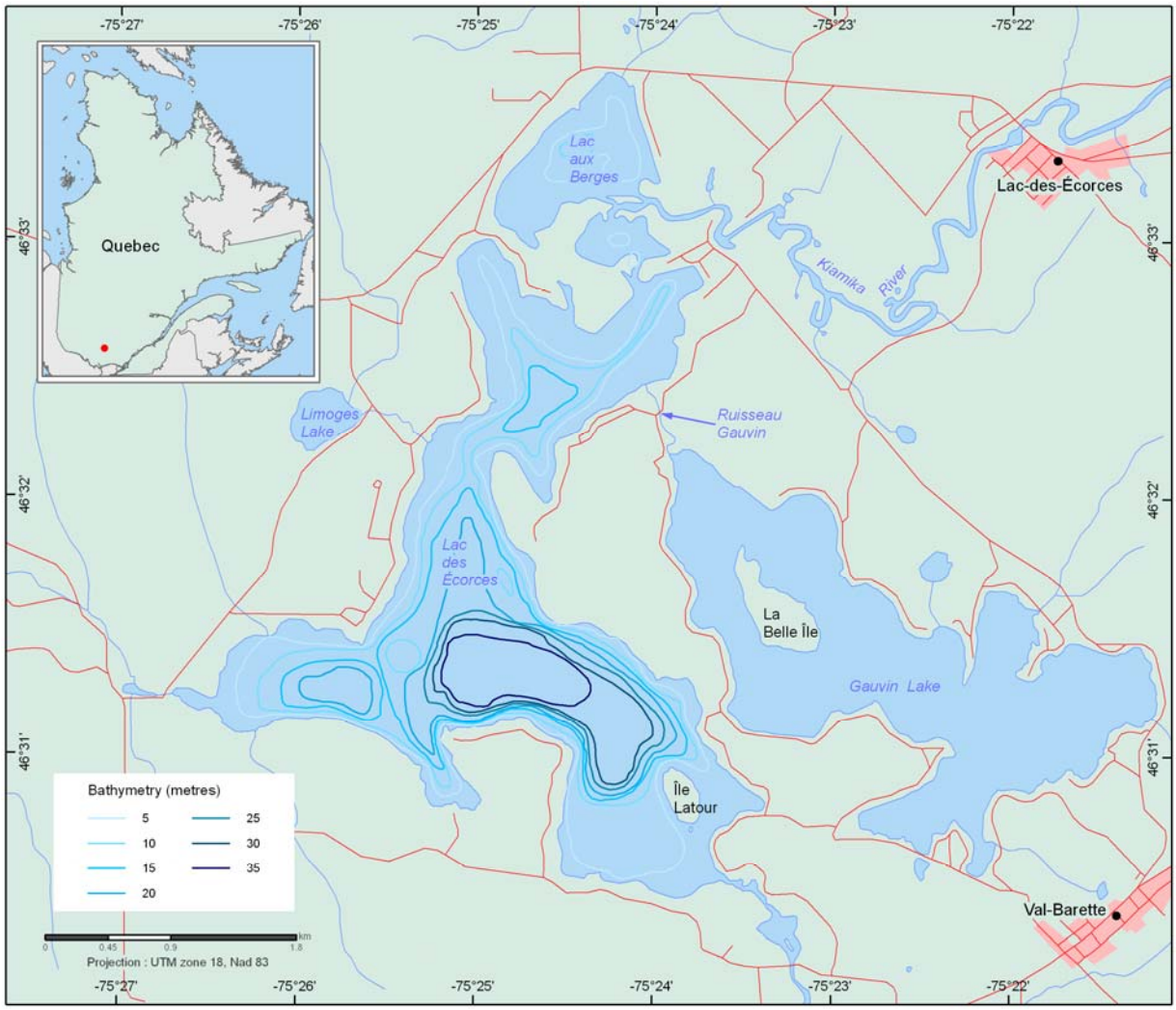

Figure 2. Map of Lac des Écorces, including its bathymetry.

The data available on the Spring Cisco is still limited. However, the trend observed between 1994 and 2008 indicates a significant decline in the population. According to the experimental fishing that has been conducted since 1981, the number of spring ciscoes caught per unit of effort has been trending downward since the 1990s (DFO, 2010). The number of fish caught diminished over the course of that period, even though the effort increased. There was also a slight reduction in the average size of the fish caught (DFO, 2010).

3.3 Needs of the Spring Cisco

The Spring Cisco reaches sexual maturity at 3 years of age and very few individuals survive beyond 8 years of age. The average age is 5 years old (Hénault and Fortin, 1991). Gonad development is delayed in the fall by the high temperature of the hypolimnion[4] in Lac des Écorces (Hénault and Fortin, 1991). Maturation of the

[4] The hypolimnion is the layer of deep water in a lake where the temperature stays colder.

ovocytes[5] happens slowly during the winter and culminates in spawning, which occurs from mid-May to early June. The eggs begin to hatch at the end of July and this continues during the month of August. As soon as they hatch, it seems that the cisco larvae come to the surface to fill their air bladders with oxygen so that they can adjust their buoyancy, after which they can start to feed (Hénault and Fortin, 1991).

Information on the Spring Cisco's diet is inferred from the literature on the lake cisco. The pelagic larvae of the cisco are plankton eaters and feed almost exclusively on copepods and cladocerans (Anderson and Smith, 1971). Adults looking for food tend to stay at the hypolimnion level during the summer. They feed on plankton, but have a varied diet consisting of insects, eggs, small fish and crustaceans (Bernatchez, 2000). The Spring Cisco is preyed upon by a number of species that are present, such as the Northern Pike, the Walleye, the Smallmouth Bass, the Yellow Perch and the Rainbow Smelt (Bernatchez, 2000).

The Spring Cisco seems to prefer cold water (12ºC or less) that is well oxygenated. The waters of Lac des Écorces are well oxygenated at all depths all year long. With an average depth of 13 m, the lake can be divided into two basins, one that is 23 m deep and another that is 38 m deep (Figure 2). Due to its high turnover rate of 7 times per year, the thermal regime of Lac des Écorces is similar to that of a river (Pariseau et al., 1983). The waters of the hypolimnion heat up quickly in the summer (7.8ºC), and stay warm until the end of the fall, whereas in neighbouring lakes the water temperature of the deep layer stays at 4ºC. During the summer warming period, adults look for food in the hypolimnion layer, where the temperature stays below 12°C (Hénault and Fortin, 1991). In the fall, spring ciscoes are found at depths of 12 m or more (Hénault and Fortin, 1993).

To spawn, the Spring Cisco requires well-oxygenated water below 5º–6ºC (Hénault and Fortin, 1991). In the spring, spawners gather in the deep part of the lake, between 20 and 30 m deep, where the temperature is low enough to ensure normal development of the eggs during the summer period. The eggs are deposited on a soft, muddy substrate.

Little is known about the ecology of the first life stages of the Spring Cisco. The temperature of the water in Lac des Écorces is already high when hatching occurs in August. The larvae could therefore already be better able to tolerate temperature variation in this environment because they have to come to the surface to feed and fill their air bladders. (Hénault and Fortin, 1991; DFO, 2010). It is possible that the larvae migrate vertically in the lake once a day in order to take advantage of the cooler night-time temperatures (Hénault and Fortin, 1991; DFO, 2010).

[5] Ovocytes are the developing female germ cells.

4. THREATS

A variety of factors could explain the decline in catches and the average size. The main threat is the recent introduction of the Rainbow Smelt which is harmful to the quality of spring cisco recruitment and growth. In addition, Lac des Écorces has undergone a number of changes in recent decades, in part owing to residential development.

4.1 Threat assessment

The table below provides a summary of the main threats to the recovery of the Spring Cisco. Climate change could exacerbate the impact of some of the threats. Between 1960 and 2003, the central and western parts of southern Quebec experienced average annual temperature increases of between 0.5°C and 2.0°C (Yagouti et al., 2006). The climate forecasting models are predicting warmer summers in southern Quebec, which will result in increased evaporation; however, there is no agreement on a reduction or an increase in precipitation (Bourque and Simonet, 2008). An increase in the frequency and severity of extreme weather events is also being predicted, which will have a direct impact on shoreline and shore erosion.

Table 1. Summary of threats to the recovery of the Spring Cisco

Threat		Range	Occurrence	Frequency	Causal certainty	Severity	Level of concern
Introduction of competing or predatory species		General	Current	Ongoing	High	High	**High**
Habitat degradation	**Erosion of agricultural land**	Localized	Current	Ongoing	High	Moderate	**Moderate**
	Degradation of banks	Localized	Current	Ongoing	High	Moderate	**Moderate**
	Discharge of wastewater	Localized	Current	Recurrent	High	Moderate	**Moderate**

Legend: **Range**: indicates whether the threat is general throughout the distribution range or just present locally. **Occurrence**: indicates whether the threat is historical, current, imminent or anticipated. **Frequency**: indicates whether the threat is one-time, seasonal, ongoing or recurrent (not annual or seasonal). **Causal certainty**: indicates whether available knowledge about the threat and its impact on the viability of the population is of high, moderate or low quality. **Severity**: indicates whether the severity of the threat is high, moderate or low. **Level of concern**: indicates whether threat management is, on the whole, of high, moderate or low concern. This may take into account the capacity to mitigate or eliminate the threat.

4.2 Description of threats

4.2.1 Introduction of invasive species

In order to enhance recreational fishing, over the years a number of fish species including the Brook Trout and the Walleye were introduced in Lac des Écorces and upstream in the Kiamika Reservoir. The introduction of competing and predatory species, notably the Rainbow Smelt, a species that was illegally introduced in the

Kiamika Reservoir at the end of the 1990s and has now colonized Lac des Écorces, has led to changes in predator-prey relations within the fish community. Given that the Rainbow Smelt's preferred habitat overlaps with that of the cisco, in the larval and adult stages, competitive and predatory interaction is likely. The fact that rainbow smelt prey on spring cisco larvae in the deeper waters of Lac des Écorces seems to be having a severe impact on the population (DFO, 2010). The negative impact on cisco populations brought about by the introduction of the Rainbow Smelt into small bodies of water has been well documented worldwide (reviewed in Rooney and Paterson, 2009). The establishment in Lac des Écorces of a competing and predatory population, such as the Rainbow Smelt, is therefore the most significant threat to the recovery of the Spring Cisco.

The Eurasian Watermilfoil (*Myriophillum spicatum*), an exotic aquatic plant, has been quite abundant in Lac des Écorces and many other lakes in the Outaouais since 2001 (Labelle et al., 2010), and at least five lakes in the Lièvre watershed (COBALI, 2011). The plant is very invasive and colonizes vast stretches of the littoral zone. A Eurasian Watermilfoil invasion could profoundly change the ecology of a lake by having an impact on most of its biophysical characteristics. Among the known impacts, reduction of the dissolved oxygen in the hypolimnion, increased populations of species that prey on cisco larvae and juveniles, and the degradation of littoral habitats (Auger, 2006; Labelle et al., 2010) are likely to constitute threats to the recovery of the Spring Cisco.

4.2.2 Habitat degradation

The main causes of habitat degradation are associated with the intensive agriculture and urban development that has taken place in the Kiamika River basin and in the vicinity of Lac des Écorces. It is difficult to assess and quantify the impact of this threat to the Spring Cisco’s habitat. However, it does seem clear that the degradation of the lake shores and the discharge of wastewater and agricultural runoffs are contributing to the observed euthrophication and deteriorating the quality and range of the Spring Cisco’s habitat. This enrichment is translating into heavy aquatic plant growth in the bays of Lac des Écorces. Cyanobacteria blooms have also been reported. A diagnosis conducted in 2010 (Envireau, 2010) concluded that Lac des Écorces is still oligotrophic[6] and that the overall water quality is quite good. However, low concentrations of dissolved oxygen (less than 5 mg/l) have been observed in the hypolimnion at the end of the summer, which could be harmful to the survival of the Spring Cisco. Because the general water quality of Lac des Écorces currently seems to be quite good, this threat is deemed to be of moderate concern.

[6] Describes an environment with very low levels of nutrients.

Erosion of agricultural land

The Comité du bassin versant de la rivière du Lièvre has developed a profile of the watershed with information on the different economic activities, including agriculture (COBALI, 2011). The agriculture zone in the RCM of Antoine-Labelle is located mainly along the Lièvre River and the Kiamika River, which is the main tributary of Lac des Écorces. In the Lièvre watershed, which covers 9544 km², crops cover a surface area of about 195 km² or 2% of the land, the majority of which is used for fodder crops. In the municipalities of Lac-des-Écorces and Mont-Laurier, located on the shores of Lac des Écorces, the total cultivation area is about 40 km² or about 5% of the land. Over 75% of the farms in the Lièvre watershed report that they produce or use manure and it is used in solid form on about half of the land. However, the average phosphorous levels at the mouth of the Lièvre River are above the threshold level for eutrophication prevention and excess phosphorus was also noted in the Kiamika River (Gangbazo et al., 2005; Banque de données sur la qualité du milieu aquatique du MDDEFP, 2012). Water quality monitoring conducted in 2010 at a number of stations in Lac des Écorces showed an average of 7.6 µg/l for total phosphorous (Envireau, 2010). This value places the lake in the oligotrophic category. However, the phosphorous values obtained at some stations place it in the oligo-mesotrophic[7] category.

Increased drainage capacity, stream straightening, intensive agricultural practices and the loss of riparian vegetation areas can lead to a significant quantity of sediment and nutrients being deposited in streams. Increased nutrient loads contribute to the proliferation of algae and aquatic plants and accelerate the invasion process of the aquatic environment. Reduced concentrations of oxygen, notably at the hypolimnion level, which is an important habitat, could threaten the survival of the Spring Cisco. Sediment input into the lake could irritate the fish, especially its gills. Increased turbidity may also have a negative impact on cisco feeding by reducing the visibility of their prey.

Shoreline degradation

Shoreline degradation has been observed at Lac des Écorces, leading to the gradual sedimentation of the lake bottom. Filling, deforestation, lawn maintenance, riprap and the construction of walls and other infrastructure contribute to shoreline hardening. The presence of trees, shrubs and vegetation along the shores of the lake provide a screen to prevent excessive water heating and helps to control erosion. In residential areas, the riparian band of vegetation also reduces the amount of fertilizer and runoff from septic systems that would otherwise enter the lake.

[7] An oligo-mesotrophic body of water is one that is between a lake with low levels of nutrients and one that is moderately rich in nutrients.

During a 2010 inspection of riparian residences near Lac des Écorces, the City of Mont-Laurier measured the amount of vegetation in the riparian strip. Of the residences that were inspected, 53% of them had shoreline areas that were completely covered with vegetation (Séguin, 2010). This is an improvement in terms of compliance with municipal regulations, the purpose of which is to create riparian strips from 3 to 15 metres wide, depending on the type of property, on 100% of the properties bordering the lake.

Discharge of wastewater

In 2010, the City of Mont-Laurier conducted an inspection of the septic tanks at the 153 residences located within the city limits, along the shoreline of Lac des Écorces. All these properties have a private sewage treatment system. The septic tanks and septic fields can be a source of pollution when some of the wastewater flows into the lake. This type of pollution occurs when the treatment system is inadequate or the volume of wastewater is too high for the septic system. In 2010, the City of Mont-Laurier noted that 11% of the properties inspected along the shores of Lac des Écorces had a high risk of pollution (Séguin, 2010). This portrait does not include properties located in the Lac-des-Écorces municipality.

5. POPULATION AND DISTRIBUTION OBJECTIVES

This recovery strategy is designed to improve the status of the Spring Cisco in order to arrest the process of extinction and increase species abundance. There are no estimates of the current and historical numbers of spring ciscoes, only abundance indicators with a high degree of uncertainty. In this context, a recovery target of 40% of the average abundance index prior to the decline in the 1990s has been set (DFO, 2010). Based on this approach, which involves a precautionary approach and the surplus production model, the recovery target will be in the order of 5 individuals/hour/net, as the average abundance index prior to 1990 was 12 individuals/hour/net. A viability analysis applied to the Atlantic Whitefish (DFO, 2009) was used to establish the recovery target of 1275 individuals. This value corresponds to the minimum census population size required to maintain the genetic diversity of the species; the actual size[8] of the population is assessed at 500 individuals. The population and distribution objectives proposed in this strategy may be updated as new information on the Spring Cisco and its habitat becomes available. In addition, the methods used to measure population abundance will likely be changed because fishing with a net, which had been used until quite recently to measure the abundance index, could cause too many mortalities. An abundance estimate using acoustic methods (calibrated using Lake Cisco, which is much more abundant) seems to be a promising solution.

[8] The actual size of a population corresponds to all of the individuals able to reproduce.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

To attain the population objectives, three **general approaches** were recommended:

1) **Conservation**: legislative or administrative measures and recommended actions, other than outreach and research, to foster the recovery of the Spring Cisco;
2) **Outreach**: outreach and education for groups concerned on the at-risk status of the spring cisco population and the threats to its recovery;
3) **Research and monitoring**: study and monitor the Spring Cisco and the threats to its recovery.

6.1 Actions already completed or currently underway

A number of measures, presented below, have already been taken to prevent the decline of the spring cisco population. Though these measures do not always target the Spring Cisco specifically, they have been beneficial for that population.

6.1.1 Conservation measures

Legal protection
The Spring Cisco has been listed in Schedule 1 of SARA since 2013 and is covered by the prohibition on killing, harming, harassing, capturing or taking an individual of a designated wildlife species.

Rainbow Smelt catches
Since the spring of 2010, Quebec's Ministère des Ressources naturelles has been undertaking a mass removal of rainbow smelt from Gauvin Creek, a tributary of Lac des Écorces, during the spawning season. Just over 900 kg of rainbow smelt were removed from the creek in 2010, 1500 kg in 2011, 400 kg in 2012, and 1723 kg in 2013 (L. Nadon, MDDEFP, 2013). This mass removal of rainbow smelt undertaken each spring for a number of years should help to considerably reduce the population in Lac des Écorces, as Gauvin Creek seems to be the only spawning ground in the area. Visual monitoring of spawning at the end of the mass removal program will determine its efficacy and whether there is a need to continue the program. Research to locate other rainbow smelt reproduction sites has also been done since 2010.

Controlling Eurasian Watermilfoil
In 2012, the Agence de bassin versant des Sept [the seven watersheds agency], which covers the Gatineau River watershed, began a pilot project to control the Eurasian Watermilfoil; the project involved laying burlap on the bottom of some parts of Lac Pemichangan to prevent regrowth. The project, funded by the MRN, will be monitored for efficacy over the course of the coming years. If the technique proves to be effective, it could be used in Lac des Écorces. Another biological method for controlling Eurasian watermilfoil makes use of an insect, a species of weevil

(*Euhrychiopsis lecontei*) that feeds on Eurasian watermilfoil. This method is also in the research/pilot project phase.

Shoreline protection measures
The Quebec government's Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains recommends that municipalities prohibit the mowing of grass or the cutting of any vegetation along a protection zone of about 10 to 15 m wide, depending on the slope. Since 2007, a number of municipalities, including Mont-Laurier and Lac-des-Écorces, have adopted regulations governing the vegetation on the first three metres of the shoreline when it is already used for recreational or residential purposes. Inspections were conducted by the City of Mont-Laurier in 2010 to verify the condition of the shorelines and the septic systems. Most residents had complied with the regulations governing the three-metre protection zone; a variety of ground cover was present, from full to sparse (Séguin, 2010).

Reducing wastewater pollution
Municipal regulations are in effect in the municipalities of Mont-Laurier and Lac-des-Écorces governing the periodic emptying of septic tanks within the municipality. The regulations specify that such tanks must be emptied once every two years for permanent residences and once every four years for secondary residences. As with shoreline protection, inspections of septic systems were conducted in 2010 in the City of Mont-Laurier. In addition to checking the systems, the inspections provided an opportunity to educate the public on a number of issues relating to the protection of Lac des Écorces, as the exclusive habitat of the Spring Cisco (Séguin, 2010).

6.1.2 Outreach measures

The Spring Cisco's presence in Lac des Écorces is raised in the development plan for the RCM of Antoine-Labelle (2006), and in the Lièvre watershed profile (COBALI, 2011). Changes in the status of the cisco will be mentioned in the RCM's development plan, as will any protection measures. The presence of this specific species may even be mentioned in all future outreach documents.

Many outreach activities surrounding the protection of aquatic environments in general and Lac des Écorces in particular have been carried out chiefly as a reaction to the appearance of blue-green algae (cyanobacteria) blooms in Lac de Écorces and other lakes in the region. Any actions that lead to improvements in Lac des Écorces's water quality indirectly benefit the recovery of the Spring Cisco.

6.1.3 Research activities

Aside from the work done by Pariseau (Pariseau et al., 1983) and Hénault and Fortin (Hénault and Fortin, 1989, 1991, 1992, 1993), no other study has been conducted that specifically targets the Spring Cisco. However, inventories with an experimental net and physico-chemical data collected between 1968 and 2008 could be used to establish the baseline conditions for the spring cisco population and Lac des Écorces's water quality. Hénault conducted surveys in August of 1984 and 1989

(Hénault and Fortin, 1993), using an echo sounder, that could also provide the baseline conditions for establishing an acoustic monitoring of the population.

6.2 Strategic direction for recovery

The table below presents the recovery strategies that could be implemented by DFO and any partners involved in the recovery of the Spring Cisco.

Table 2. Recovery plan

The recovery strategies (second column) provide details on the proposed measures and are grouped together based on the overall approaches. The strategies are intended to mitigate the threats listed in the "Threats" column. The measures are categorized based on level of priority.

Priority	Recovery strategies	Measures	Threats
Conservation			
High	1. Reduce Rainbow smelt predation and competition.	1.1. Conduct mass removals of rainbow smelt during the spawning season (in the spring). 1.2. Monitor the size of the smelt population. 1.3. Monitor the known and potential spawning grounds of the smelt.	Introduction of invasive species
High	2. Stock Lac des Écorces with spring ciscoes.	2.1. Develop a reproductive and growth plan for the population. 2.2. Develop a reproduction method for fish farming. 2.3. Stock the lake with spring ciscoes. 2.4. Monitor spring ciscoes produced through artificial reproduction.	All
Medium	3. Restore or revegetate the Lac des Écorces shoreline.	3.1. Monitor the prohibition on grass mowing along the first three metres of shoreline (municipal regulation). 3.2. Reduce shoreline encroachments such as wharves and boat launches. 3.3. Enforce Quebec's Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains which requires that 10–15 metres of the shoreline be protected, depending on the slope.	Shoreline degradation
Medium	4. Reduce or prevent the introduction of organic matter and contaminants from septic systems.	4.1. Update the database of septic systems in the vicinity of Lac des Écorces. 4.2. Monitor septic systems and follow up on compliance with the emptying regulations.	Discharge of wastewater

Priority	Recovery strategies	Measures	Threats
Low	5. Reduce or prevent the introduction of nutrients and organic matter from agricultural activities.	5.1. Conduct inspections and monitor compliance.	Erosion of agricultural land
Low	6. Create a sanctuary population by introducing the Spring Cisco in another body of water, once the Lac des Écorces population has recovered.	6.1. Develop a reproduction plan. 6.2. Identify the best body of water to receive the new spring cisco population (summertime thermal refuge, absence of rainbow smelt and impact on the species present). 6.3. Develop and implement a genetic reproduction plan. 6.4. Monitor the new population.	All
Outreach			
High	8. Educate fishers on the introduction of invasive species.	8.1. Target the clientele. 8.2. Develop outreach tools. 8.3. Develop a targeted outreach plan.	Introduction of invasive species
Medium	7. Educate citizens about the impact that wastewater has on water quality and the necessity of complying with the regulations governing septic systems.	7.1. Develop a communications plan. 7.2. Design information leaflets and publish them in local newspapers. 7.3. Design information capsules and publish them on the Internet. 7.4. Promote existing and available information tools.	Discharge of wastewater
Medium	9. Educate all users about the necessity of protecting the shoreline.	9.1. Develop a communications plan for municipalities, shoreline residents, farmers, contractors and stakeholders in the real estate field. 9.2. Design information leaflets and publish them in local newspapers. 9.3. Design information messages and publish them on the Internet. 9.4. Create and promote a list of available information tools. 9.5. Design and distribute an information kit for contractors.	Shoreline degradation

Priority	Recovery strategies	Measures	Threats
		9.6. Distribute information on shoreline vegetation stabilization techniques (with a view to increasing the number of protected shoreline areas).	
Research and follow-up			
High	10. Monitor the Lac des Écorces spring cisco and rainbow smelt populations.	10.1. Develop an acoustic inventory method. 10.2. Evaluate the size and make-up of the populations. 10.3. Study the ecology of the spring cisco population (reproduction rate, mortality rate, habitat and food supply).	All
High	11. Monitor the quality of the water in Lac des Écorces.	11.1. Conduct general water quality monitoring. 11.2. Monitor the dissolved oxygen in the hypolimnion (4 seasons).	Habitat degradation
Medium	12. Conduct a study of the watershed.	12.1. Conduct an inventory of land use. 12.2. Create a profile of the quality of Lac des Écorces tributaries.	Habitat degradation
Low	13. Verify the species range.	13.1. Check for the presence of spring ciscoes in lakes within the same watershed.	All

7. CRITICAL HABITAT

7.1 Identification of the species' critical habitat

The *Species at Risk Act* stipulates that when a recovery strategy is drafted, it should identify "*the species' critical habitat, to the extent possible, based on the best available information,* […]*, and examples of activities that are likely to result in its destruction*" (paragraph 41(1)(*c*)). The purpose of such identification is to facilitate protecting the Spring Cisco's critical habitat from the human activities that could destroy it, thereby compromising the survival and recovery of the species.

Under the *Species at Risk Act*, the critical habitat of a species is defined as:

"*the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species."* (subsection 2(1))

In addition, SARA defines the habitat for species at risk as:

"the spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced." (subsection 2(1))

The critical habitat for the Spring Cisco has been identified, to the extent possible, by relying on the best information available. It consists of Lac des Écorces in its entirety. The Spring Cisco spends its entire life in this habitat, which therefore supports all of its vital functions: feeding, rearing, spawning and growth. There is little scientific information available to determine the features and attributes of the critical habitat. However, the temperature of the water in the hypolimnion and its oxygen concentration seem to be key features of Lac des Écorces for the Spring Cisco. The schedule for the studies presented in Section 7.2 provides an overview of the research required for more in-depth knowledge of the habitat's features, which would help complete the critical habitat identification.

7.1.1 Information and methods used to identify critical habitat

As a result of the 2009 updated COSEWIC report on the status of the Spring Cisco, a process to assess the recovery potential was established by DFO Science, in collaboration with the MNR, to provide information and scientific advice on the species, particularly its critical habitat (DFO, 2010). Critical habitat identification in this recovery strategy is based on the assessment of the recovery potential.

The type of thermal variation that occurs in Lac des Écorces is unique to that lake. The phenotypic and ecological differences and reproductive isolation among coregonids flow directly from a process of natural selection induced by the

environment. In this context, and given the endemic nature of spring ciscoes, all of the Lac des Écorces habitat is essential to the survival and recovery of the species (DFO, 2010). Knowledge of habitat use at the different life stages is still incomplete, but there is no indication that some parts of the lake are not used.

7.1.2 Description of the critical habitat

The entire range of the Spring Cisco, namely Lac des Écorces (Figure 3), has been identified as critical habitat.

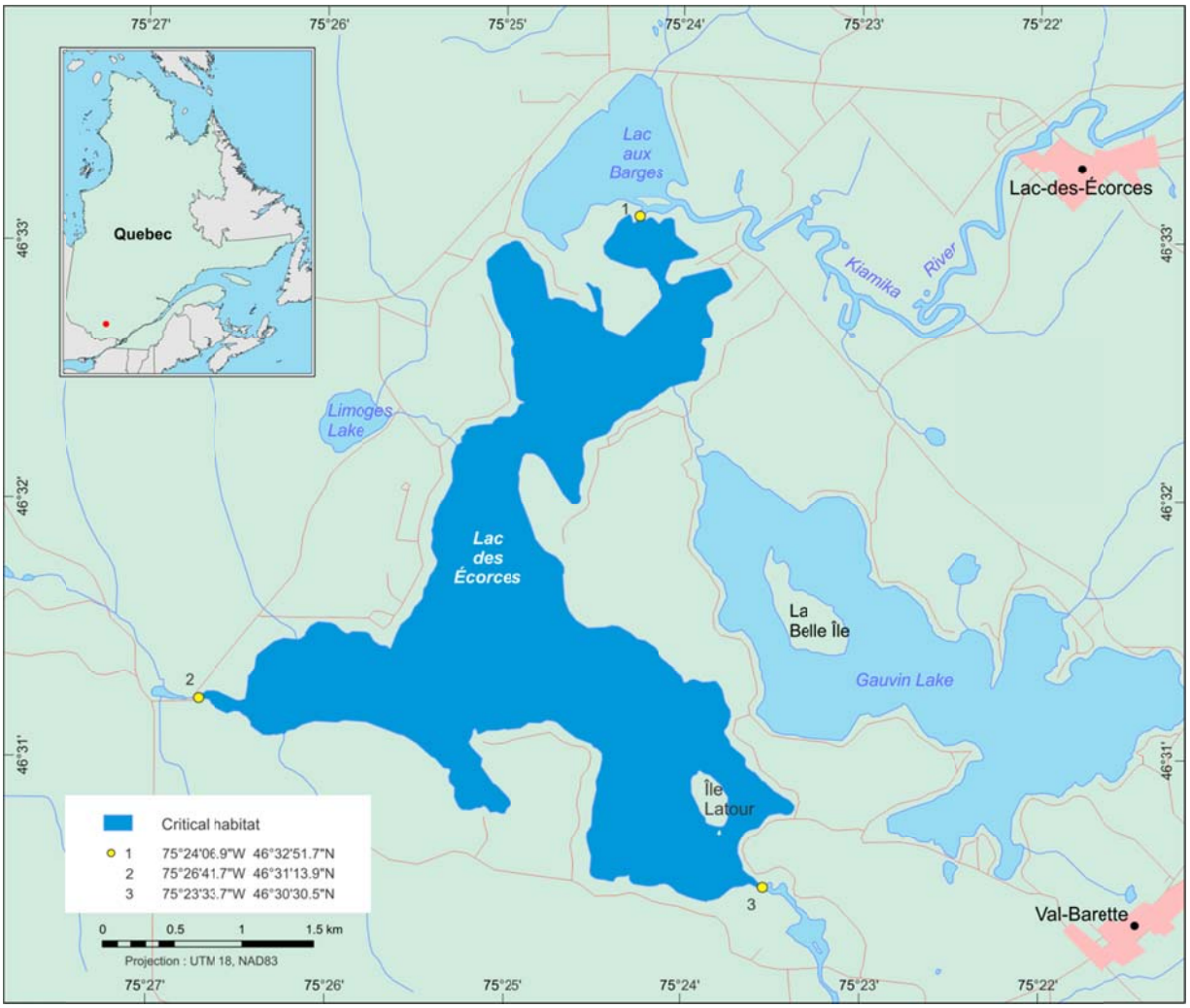

Figure 3. Spring cisco critical habitat – Lac des Écorces.

Adult habitat

The Spring Cisco seems to prefer cold and well-oxygenated waters. During the summer warming, adults in search of food are found throughout the lake in the hypolimnion. In the fall, spring ciscoes are found throughout the lake at depths of 12 m or more. This deep layer seems to correspond to the adult cisco's growth and feeding grounds.

Spawning habitat
In spring, spawners gather in the deep zone of the lake where the temperature is below 6ºC. Spring ciscoes have been caught at depths ranging between 20 and 30 meters, over a soft muddy substrate on which eggs are deposited. This adaptation allows the normal hatching of eggs during the summer period when temperatures are higher. Preserving habitat quality in the deep part of the lake is crucial to the survival of spring ciscoes.

The temperature of the water in the hypolimnion and its oxygen concentration are features of the Spring Cisco's critical habitat (Table 3).

Table 3. Summary of critical habitat features and functions

Function	Features	Attributes
Feeding and growth (adults)	Water temperature	< 12°C
	Concentration of dissolved oxygen	> 8 mg/l
Spawning	Water temperature	< 6°C
	Concentration of dissolved oxygen	Unknown
	Substrate	Soft and muddy

7.2 Schedule of studies to identify critical habitat

Knowledge of the features of the Spring Cisco's habitat is still limited. The objectives for the population and the critical habitat identification in this recovery strategy are based on the abundance indexes that have some uncertainty. In addition, the Spring Cisco's use of the habitat in Lac des Écorces is not well known. Consequently, research must be done to improve knowledge about the size of the population, as well as the features of the critical habitat and the functions it supports (Table 4).

Table 4. Schedule of studies

Description of Activities	Results/Rationale	Deadline
Determine the population abundance and its use of the habitat	Confirm that the entirety of Lac des Écorces is critical to the recovery	5 years
Identify the needs of the species in terms of habitat for each phase in its biological cycle	Knowledge of the critical habitat features and their attributes	5 years

7.3 Examples of activities likely to destroy critical habitat

Any activity that modifies the attributes (presented in Table 3) of the different features of the identified critical habitat may lead to its destruction. In light of the fact that habitat use varies over time, each human activity must be assessed separately and specific mitigation measures must be implemented when they are effective and available. The list of activities presented in the table below (Table 5) is not

exhaustive. The absence of a given human activity from the list must not prevent or impede the Department's ability to regulate it under SARA. In addition, the inclusion of an activity on the list does not automatically entail its prohibition, as it is the destruction of the critical habitat that is prohibited rather than the activity.

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a recovery strategy or action plan. For the Spring Cisco critical habitat, it is anticipated that this will be accomplished through a SARA Critical Habitat Order made under subsections 58(4) and (5), which will invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat.

Any activity that could alter the specific hydraulic conditions of Lac des Écorces, and therefore the seasonal variations in temperature that led to the evolution of the cisco's springtime spawning, could result in the destruction of this species' critical habitat.

Table 5. Examples of activities likely to destroy critical habitat

Activity	Pathway of Effects	Disrupted function	Disrupted feature	Disrupted attribute
Building and operating dams	Changes to the hydraulic conditions	Feeding Growth	Temperature	< 12°C
			Dissolved oxygen	> 8 mg/l
		Spawning	Temperature	< 6°C
			Dissolved oxygen	Unknown

8. MEASURING PROGRESS

The performance indicator presented below proposes a method for defining and measuring progress toward attaining the population objectives. Specific progress made toward the implementation of the recovery strategy will be measured in relation to the indicators defined in future action plans.

1. Increase the size of the Spring Cisco population (abundance index). The type of abundance index to be used has yet to be determined, as use of the fishing net method could cause too many mortalities to be used again.

9. ACTIVITIES PERMITTED BY THE RECOVERY STRATEGY

No activities have been authorized as part of the recovery strategy. Any activity that could have an impact on the Spring Cisco or its critical habitat requires a permit issued under SARA, if the activity meets the requirements set out in section 73 of the Act.

10. STATEMENT ON ACTION PLANS

One or more action plans will be completed within five years of the final posting of the recovery strategy.

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APPENDIX A. EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted for all SARA recovery planning documents, in accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[9] goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

Protection of the Spring Cisco's habitat should have benefits for the other species that frequent Lac des Écorces. Measures that are implemented to improve the water quality should also be of benefit to the aquatic species that are present in the lake. The Rainbow Smelt will be negatively affected by the measures proposed in this strategy. However, that species was introduced into the lake and is disrupting its ecosystem.

[9] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

APPENDIX B. RECORD OF COLLABORATION AND CONSULTATION

The first draft of the recovery strategy was distributed to a number of organizations and the Aboriginal community of Kitigan Zibi for feedback. The following people participated in this review: Pierre Dumont and Michel Hénault from Quebec's Ministère des Ressources naturelles, Janie Larivière of the Comité du bassin versant de la rivière du Lièvre, and Jocelyn Campeau of the RCM of Antoine-Labelle.