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Management Plan Series

Management Plan for the Spring Salamander (*Gyrinophilus porphyriticus*) in Canada

Spring Salamander

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[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

PREFACE

The federal, provincial and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] 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) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed special concern species and are required to report on progress within five years.

The Minister of the Environment is the competent minister for the management of the Spring Salamander and has prepared this management plan as per section 65 of SARA. It has been prepared in cooperation with Quebec's Ministère des Ressources naturelles et de la Faune.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this management plan and will not be achieved by Environment Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this management plan for the benefit of the Spring Salamander and Canadian society as a whole.

Implementation of this plan is subject to the appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

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EXECUTIVE SUMMARY

The Spring Salamander is a large stream salamander that occurs in the various mountain ranges that form the Appalachian Mountains of eastern North America. It is at the northern limit of its range in southeastern Quebec. The species is also known to have occurred in the Niagara Peninsula in Ontario, but has not been observed there since 1877. The species was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as special concern in 2002 and was listed in Schedule 1 of the *Species at Risk Act* (SARA) in 2005.

The Spring Salamander occurs in small, clear, cool, well-oxygenated streams with rocky bottoms and the absence of fish. These habitat requirements are a limiting factor for the species, as is its late sexual maturity and its limited dispersal capability. As a result of these factors, the Spring Salamander is particularly sensitive to any habitat alteration, degradation or loss. In Quebec, the most serious threats to the survival of the current population are residential, recreation/tourism and wind power generation and groundwater pumping for residential, commercial and agricultural use. Logging and fish introductions or stocking are also serious threats. In Ontario, the threats to the Spring Salamander have not been documented. The Niagara Peninsula has generally experienced significant agricultural, industrial, commercial and residential growth for many years.

In the long-term, the management objective consists in reducing and, if possible, eliminating the threats to the Spring Salamander in Quebec in order to maintain and, if possible, increase the abundance of the subpopulations identified by COSEWIC and their index of area of occupancy (1412 km^2). To achieve this objective and measure the progress made, it is necessary, in the short term, to better delineate the distribution of the subpopulations identified by COSEWIC and to calculate a corresponding abundance index. The broad strategies and conservation measures identified to achieve these objectives are presented in Chapter 6, and the performance measures are presented in Chapter 7.

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1. COSEWIC* SPECIES ASSESSMENT INFORMATION

Date of Assessment: May 2002

Common Name (population): Spring Salamander

Scientific Name: *Gyrinophilus porphyriticus*

COSEWIC Status: Special concern

Reason for Designation: This species has a limited, disjunct distribution and specialized habitat requirements. It is vulnerable to habitat degradation leading to population loss. Due to its low dispersal rates and delayed sexual maturity, there is little chance of recovery of extirpated populations.

Canadian Occurrence: Quebec and Ontario

COSEWIC Status History: Designated as special concern in April 1999. Status re-examined and confirmed in May 2002.

*COSEWIC: Committee on the Status of Endangered Wildlife in Canada

The Spring Salamander was reassessed by COSEWIC in May 2011 (COSEWIC 2011). The species was split into two distinct designatable units: (1) the Carolinian population, located in Ontario, was designated as extirpated, and (2) the Adirondacks and Appalachian population, located in Quebec, was designated as threatened.

2. SPECIES STATUS INFORMATION

The Spring Salamander (*Gyrinophilus porphyriticus*) was listed as special concern on Schedule 1 of the *Species at Risk Act* (S.C. 2002, c. 29) (SARA) in 2005. In Quebec, it was designated as vulnerable in 2009 under the *Act Respecting Threatened or Vulnerable Species* (R.S.Q., c. E-12.01). In Ontario, the species was designated as extirpated in 2008 under *Ontario Regulation 230/08*, made under the *Endangered Species Act, 2007* (S.O. 2007, c. 6).

The species has a global conservation status rank of G5 (secure) (NatureServe 2011). At the national level, it is ranked secure (N5) in the United States and vulnerable (N3) in Canada. The species is ranked vulnerable (S3) in Quebec and presumed extirpated (SX) in Ontario.

Canada accounts for between 0.7% and 8.6% of the species' global range (COSEWIC 2011).

3. SPECIES INFORMATION

3.1 Species Description

The Spring Salamander, which is a member of the family of lungless salamanders (Plethodontidae), is a large salamander, with adults ranging in total length from 11 to 23 cm. It can be distinguished by its salmon colour, the pale line that runs from eye to snout and its laterally compressed tail. Newly hatched larvae range in colour from yellow-brown to grey and measure 1.8 to 2.6 cm (COSEWIC 2011). For an exhaustive morphological description of the species, the reader is invited to consult the status report (COSEWIC 2011).

3.2 Populations and Distribution

Most of the information presented in this section is taken from the most recent status report on the Spring Salamander in Canada (COSEWIC 2011).

The Spring Salamander is endemic to eastern North America. Most of its range, which coincides with the Appalachian Mountains, is located in the United States. Southeastern Quebec represents the northern limit of its range, which extends south through all eastern seaboard states, except Delaware and Florida, to Mississippi (southern limit) and west through Ohio, Kentucky and Tennessee (Figure 1).

Figure 1. Global range of the Spring Salamander. Taken from COSEWIC (2011)

In Canada, the Spring Salamander currently occurs only in southeastern Quebec, exclusively in the Appalachian ecoregion. In Ontario, a single record of the species is considered valid and consists of three larvae captured in 1877 in Welland County (today part of the Niagara Regional Municipality) (Figure 1). Following a major inventory project in the Niagara Peninsula between 2006 and 2008, in which information on close to 15 000 amphibian and reptile observations were collected, no Spring Salamanders were located (Yagi et al. 2009). The species has been considered extirpated by the Government of Ontario since 2008, and the Ontario population (Carolinian population) was designated extirpated by COSEWIC in April 2011.

In Quebec, the extent of occurrence[3] of the Spring Salamander is south of the St. Lawrence River and west of the Chaudière River. Twenty-four subpopulations were defined by COSEWIC (2011), including the Portneuf subpopulation in the St. Lawrence Lowlands ecoregion. However, COSEWIC (2011) expressed doubts about the validity of the Portneuf subpopulation. Following verification with the person who made the observation, it was concluded that this subpopulation was not valid because it was based on erroneous geographical coordinates. As a result, the Portneuf subpopulation is not considered in this management plan. The 23 subpopulations are isolated from one another, and are located primarily at altitudes of between 214 m and 444 m. They have an index of area of occupancy[4] of 1412 km²,[5] and over 95% of that area is on private lands. The subpopulations are distributed among six mountain complexes of the Appalachian system: the Monteregian Hills (3 subpopulations), the Green Mountain Foothills (9 subpopulations), the White Mountain Foothills (3 subpopulations), the Estrie Hills (5 subpopulations), the Bécancour Hills (2 subpopulations) and the Adirondack Foothills (1 subpopulation). Some of the foothills subpopulations (Adirondack, Green Mountains, White Mountains) are likely shared with the United States.

[3] The area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a wildlife species.
[4] The index calculated the area within the "extent of occurrence" that is potentially occupied by the species. This index is a function of the altitude and possible movements of the species. See COSEWIC (2011) for further details.
[5] This total excludes the index of area of occupancy calculated for the Portneuf subpopulation (4 km²).

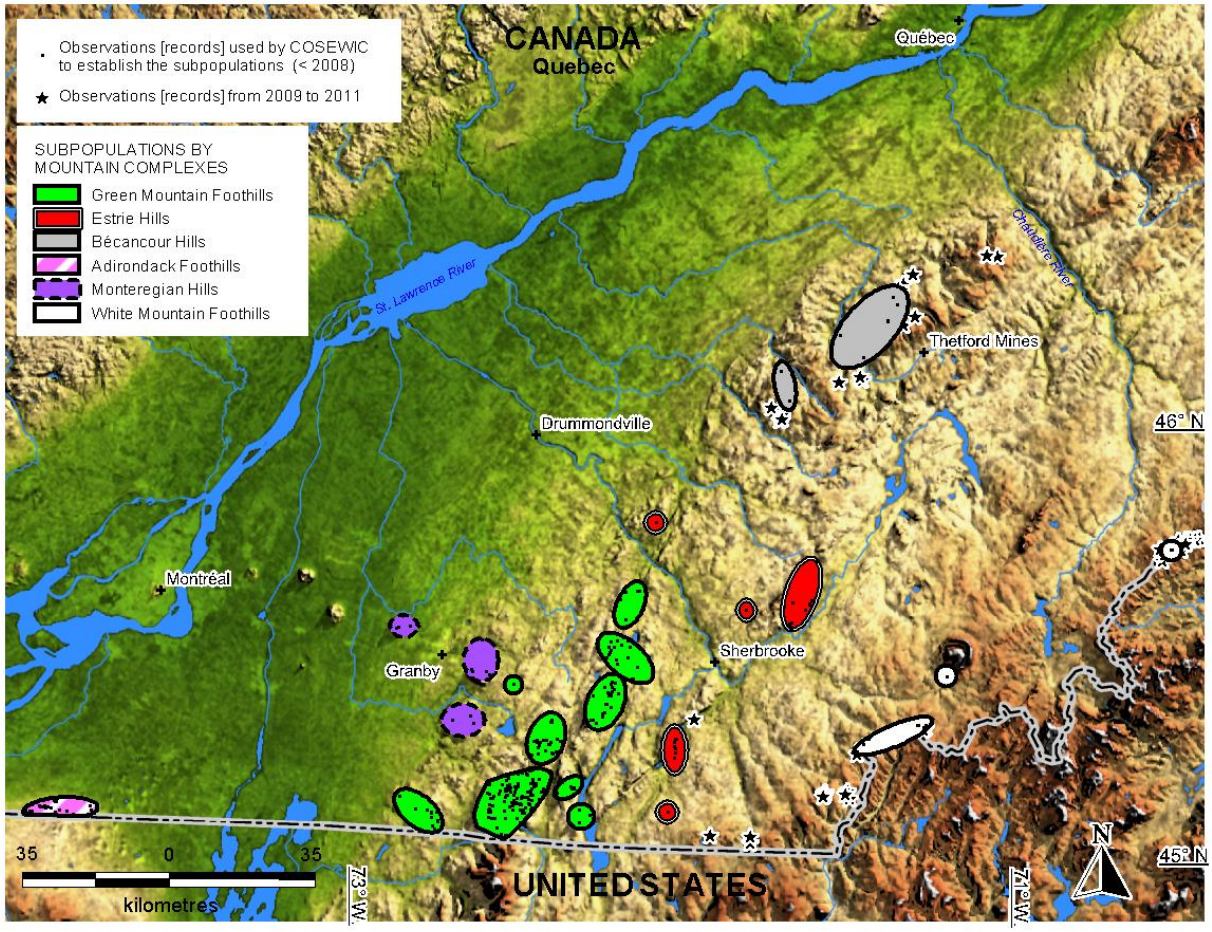

Figure 2. Current distribution of Spring Salamander subpopulations identified by COSEWIC (2011) and observations of the species from 2009 to 2012. The Portneuf subpopulation is not shown on the map. **Adapted from COSEWIC (2011).**

The Green Mountain Foothills form the core of the index of area of occupancy (61.3%) (Table 1). This range is also the mountain complex with the largest number of observations. Although it has not been recently quantified, the index of area of occupancy in the White Mountain Foothills and Bécancour Hills has increased considerably since 2009, with several new localities being added through professional surveys (Figure 2) (Laurendeau, in prep.). These complexes could be even more significant due to the fact that several sectors of suitable habitat have never been inventoried. The Monteregian Hills and the Estrie Hills contain isolated subpopulations, which typically have small indices of area of occupancy. Lastly, the subpopulation of the Adirondack Foothills, which is located more than 75 km from the nearest subpopulation, marks the western limit of the species' range as currently reported in Canada (Figure 2).

Table 1. Details on the range and last observation period of the valid subpopulations of Spring Salamanders identified by COSEWIC in Canada based on the data available in 2008.

Mountain Complex	Subpopulation (mountain/locality)	Last Observation Period	IAO* (km^2)	Protected IAO** (km^2)
Green Mountain Foothills	Sutton Mountains	1999–2008	320	128
	Mount Orford	1999–2008	116	72
	Brompton Lake	1989–1998	104	16
	Bolton	1999–2008	96	20
	Montagne du Cinq	1999–2008	88	0
	Lake Memphremagog	1999–2008	52	3
	Mont Le Pinacle	1999–2008	48	3
	Owl's Head and Elephant Mountains	1999–2008	44	0
	Mount Foster	Before 1989***	n.a.	n.a.
Estrie Hills	Westbury	1999–2008	108	0
	Stoke Mountain	1989–1998	32	0
	Lake Massawippi	1999–2008	24	0
	Mont des Smith	Before 1989***	n.a.	n.a.
	Cassville	Before 1989	n.a.	n.a.
Bécancour Hills	Kinnear's Mills	1989–1998	116	0
	Arthabaska	1989–1998	32	0
Adirondack Foothills	Covey Hill	1999–2008	116	16
Monteregian Hills	Mount Shefford	1999–2008	48	12
	Mount Yamaska	1999–2008****	16	0
	Mount Brome	1999–2008****	n.d.	n.d.
White Mountain Foothills	White Mountains	1989–1998	28	0
	Sixtynine Mountain	1999–2008	16	0
	Mount Mégantic	1999–2008	8	0

* Index of area of occupancy Adapted from COSEWIC (2011).

** Located in a protected area (pursuant to R.S.Q., c. R-26 and R.S.Q., c. P-9) or on private land managed for conservation purposes (e.g. stewardship measures)

*** Surveys conducted in 2012 confirmed the presence of the species (Laurendeau, in prep.)

**** Unpublished validated data were obtained following the COSEWIC report (2011) and confirm the presence of the species between 1999 and 2008.

The size of the subpopulations identified by COSEWIC is unknown. The species is rare and the densities found are generally low, i.e., fewer than 8 individuals per 100 metres of stream. It is not possible to assess the population trend on the basis of currently available data. Despite the suspected loss of one subpopulation which has not been seen for over 25 years (Cassville - Table), there has been an upward trend in the species' extent of occurrence since the early 2000s. However, this trend is associated with the fact that the species distribution was poorly known prior to the 2000s and that the state of knowledge has increased considerably since then (COSEWIC 2011).

3.3 Needs of the Spring Salamander

The habitat and biological needs of the Spring Salamander, as well as limiting factors, are described in detail in the COSEWIC status report (2011).

3.3.1 Habitat and Biological Needs

The Spring Salamander lacks lungs and breathes through its skin, which it must keep moist to allow gaseous exchange to take place. The species is primarily associated with cool, clear, well-oxygenated upper reaches of small mountain streams with rocky bottoms. To ensure larval development and to maximize survival, these small tributaries must also be bordered by forest and devoid of fish. In a study conducted by Lowe (2003) over a three-year period in New England, 97 out of 118 Spring Salamanders were found to move less than one metre. For the 21 individuals that moved more than one metre, the mean distance was 9.1 m (± 2.8 m). The maximum distance moved in an upstream direction was 484 m, compared with maximum downstream movement of 85 m. Unlike the larvae, which are confined to aquatic habitats, the adults can use riparian forest environments over distances of up to 9 m (although typically less than 2 m). The species' movements on land are more frequent in June and July, as the distance they move away from the aquatic environment appears to depend on the plant succession stage of the riparian environment.

To avoid predation, the Spring Salamander requires shelters in its habitat in which it can seek refuge at all times. These shelters are usually rocks or old trunks of fallen trees (terrestrial habitat). Given the species' large size, the shelters must contain sufficient interstitial spaces. Shelters appear to be particularly important for protecting the species from frost in winter. The eggs are also deposited in these shelters.

Very little is known of the species' oviposition or hibernation habitats. They are found in aquatic environments and, according to the data available in the United States, no migration occurs between the various life cycle stages.

3.3.2 Limiting Factors

Because of its dependence on cutaneous respiration and its vulnerability to predation, the Spring Salamander is restricted to specific habitats (i.e. mountain summits), which results in the isolation of the various subpopulations. The species also has limited dispersal capacity. Average daily dispersal is estimated at less than 15 cm (W. H. Lowe, pers. comm.). In contrast to most stream organisms, dispersal of the Spring Salamander is mainly from downstream to upstream sections.

Sexual maturity in the Spring Salamander is normally reached at five years, making it the member of the family Plethodontidae with the latest age at first reproduction. It is a territorial species and has a low recruitment rate, which results in a low population density. Because the species' life expectancy is likely over 10 years, the maintenance of the Spring Salamander population likely depends largely on adult survival, as is the case of other long-lived species having a late age at first reproduction.

4. THREATS

4.1 Threat Assessment

The threat assessment (Table 2) is conducted at the scale of the species' current range. It is therefore a general assessment, and cannot be representative of certain local situations.

The most critical threats to the survival of the current Quebec Spring Salamander population are residential, recreation/tourism and wind power generation and groundwater pumping for residential, agricultural and commercial use. Other threats to the species include logging, fish introductions and/or stocking, climate change, agricultural production and alteration of surface water quality by acid rain and de-icing salts. Table 2 presents the assessment of these threats.

The threats that may have affected the Ontario population of Spring Salamander are not known, particularly because the only valid record of the species dates from 1877 and is geographically imprecise. Generally speaking, the Niagara Peninsula has experienced significant agricultural, industrial, commercial and residential growth for many years. Table 2 does not include the threats that likely contributed to the extirpation of the species in Ontario since they are largely unknown.

Table 2. Assessment of threats within the range of the current population, Quebec

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Changes in ecological dynamics or natural processes						
Groundwater pumping for residential, agricultural and commercial use	High	Widespread	Current	Continuous	High	High
Logging	Medium	Widespread	Current	Seasonal	Moderate	High
Habitat loss or degradation						
Residential, recreational/tourism and wind power generation	High	Widespread	Current	Continuous	High	High
Agricultural production	Low	Widespread	Current	Seasonal	Unknown	Medium
Alteration of surface water quality by acid rain and de-icing salts	Low	*Widespread **Unknown	Unknown	Unknown	Moderate	Medium
Alien, invasive or introduced species or genome						
Fish introductions/ stocking	Medium	Localized	Unknown	Unknown	Moderate	High
Climate and natural disasters						
Climate change	Medium	Widespread	Anticipated	Continuous	Unknown	Medium

[1] *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table.*

[2] *Severity: reflects the population-level effect (High: very large population-level effect; Moderate; Low; Unknown).*

[3] *Causal Certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; medium: there is a correlation between the threat and population viability e.g., expert opinion; Low: the threat is assumed or plausible).*

4.2 Description of Threats

The threats are presented in decreasing order of concern for the current Quebec population, the threats to the Ontario population being largely undocumented.

Threat 1. Residential, recreational/tourism and wind power generation
Residential, recreational/tourism and wind power generation could result in Spring Salamander habitat destruction (e.g. forest clearing), degradation (e.g. alteration of the hydrologic regime) or fragmentation (e.g. roads). It very often involves the addition of new water supply wells, which can affect water availability in this species' habitat (see threat 2). These types of development can also increase the risk of direct mortality (e.g. road mortality) (Frenette 2008, COSEWIC 2011).

Since the early 1990s, residential, recreational/tourism and wind power generation has increased significantly within the range of the current Spring Salamander population (Quebec) (COSEWIC 2011). Residential development, in particular, is on the rise in the Green Mountain Foothills, and increased recreation and tourism development (e.g. ski hills, ATV trails, campgrounds) has become more widespread and is affecting a growing number of subpopulations (several examples are reported in COSEWIC (2011)). In addition, wind power generation is increasing in Quebec and the province has large wind resources within the species' range, particularly in the Monteregian Hills, the Bécancour Hills and the White Mountain Foothills (Benoît and Wu 2004). Wind farm projects covering several hundred square kilometres are affecting certain subpopulations as well as many sectors that contain suitable Spring Salamander habitat (Anaïs Boutin, pers. comm.). The development and maintenance of road networks within the wind farms pose specific threats associated with wind energy generation.

Ontario's Niagara Peninsula has experienced significant industrial, commercial and residential growth for many years (Environment Canada 2010). Major changes in land use, such as those mentioned above, together with other factors, including the lack of success in detecting the species despite significant search efforts (e.g. Yagi et al. 2009), led the Committee on the Status of Species at Risk in Ontario (COSSARO) to consider the Spring Salamander extirpated from Ontario (Committee on the Status of Species at Risk in Ontario 2010).

Threat 2. Groundwater pumping for residential, agricultural and commercial use
The recharge of most headwaters is largely controlled by water table inflow, which is critical to the maintenance of minimum annual flows[6] (Larocque and Pellerin 2006) and is a key factor in

[6]The lowest level of flow occurring in a stream during the driest period of the year.

the quality of stream salamander habitat (Fournier 2008). Groundwater pumping for residential, agricultural and commercial purposes may affect the Spring Salamander by reducing water availability in its habitat and by modifying the natural water regime (Jutras 2003, Frenette 2008), which could cause habitat loss or degradation and significant mortality due to the species' limited dispersal capacity. Individuals could also become isolated in remaining habitat fragments separated by habitat that is unsuitable to their survival. The reduction in water levels could also affect the species' reproductive success and food resources.

Demand for groundwater within the range of the current population (Quebec) is growing, particularly in the southwest portion of its range (Adirondack Foothills, Green Mountain Foothills and Monteregian Hills). Groundwater pumping for agriculture (e.g. irrigation of orchards), recreation-tourism (e.g. campgrounds, golf courses) and drinking water supplies (e.g. bottling) are the main activities identified that could have an adverse effect on the species.

In the species' historical range (Ontario), it is not known whether groundwater pumping for residential, agricultural and commercial use contributed to the extirpation of the species.

Threat 3. Logging

The effects of logging on the Spring Salamander could be significant (COSEWIC 2011). Erosion, which may be caused by certain forestry activities (e.g. construction and maintenance of the transportation network), could increase stream turbidity and sedimentation, which are known to adversely affect the survival of adult Spring Salamanders (Lowe et al. 2004) by reducing the availability of shelter and food resources (Waters 1995, Shannon 2000). Erosion can also lead to increased organic matter in the aquatic environment, which can reduce dissolved oxygen concentrations, creating conditions to which larvae would be particularly vulnerable (Bider and Matte 1994). Recruitment in stream salamanders, which include the Spring Salamander, could also be impaired if sediments are deposited on eggs (Bruce 1978). Logging can also lead to habitat fragmentation, and salamander populations that are isolated in small habitat fragments would be at a higher risk of disappearance (Ford et al. 2002).

In Quebec, the area calculated by the index of area of occupancy for the Spring Salamander is primarily on lands where logging is permitted. The extent of this threat, however, has not been precisely determined. Within the species' historical range (Ontario), it is not known whether logging contributed to the extirpation of the species.

Threat 4. Fish introductions/stocking

Predation by fish is the most serious threat to Spring Salamander larvae (COSEWIC 2011). Brook Trout is a particularly serious predator because its habitat requirements are similar to those of the Spring Salamander. The introduction of this species into habitat used by Spring Salamander reduces the growth rate and survival of individuals (Resetarits 1991, 1995, Lowe et al. 2004), resulting in a decline in population size (Lowe and Bolger 2002). Stocked fish can also transmit diseases or parasites to salamanders and to other organisms in the ecosystem (Bonin 2001, Jutras 2003).

Annual salmon stocking is carried out in several streams located within the species' current range (Quebec), specifically downstream from certain streams used by the Spring Salamander (Ministère des Ressources naturelles et de la Faune 2008a). However, there is insufficient information to determine whether the stocked fish actually reach the areas in which the salamanders occur, and whether such areas were formerly free from predatory fish species (i.e. salmonids).

Within the species' historical range (Ontario), it is not known whether fish introductions or stocking contributed to the extirpation of the species.

Threat 5. Climate change

This threat was not identified by COSEWIC (2011). Climate projections for North America show an increase in annual average temperature and changes in precipitation patterns, with more frequent intense events separated by longer drought periods. These projected changes will result in an increase in evaporation rates (losses of surface water and lowering of the water table) (Brooks 2009). Some streams, including those used by the Spring Salamander, could disappear or be altered (i.e. too little or too much water). Such changes would affect the diversity and abundance of the species that use these streams, particularly species that have limited dispersal capability, such as the Spring Salamander. It is also anticipated that the reproductive success of stream salamanders will be severely compromised (Brooks 2009). Moreover, Lowe (2012) observed an increase in precipitation in New Hampshire, where the Spring Salamander is known to occur, between 1999 and 2010. His results suggest that increasing precipitation is causing a decline in adult recruitment and could lead to the extirpation of certain local populations. According to Lowe, the increased volume and frequency of spring and fall floods due to the increase in precipitation contributes to higher mortality of metamorphosing individuals.

The streams used by the current population of Spring Salamander (Quebec) are likely to be affected by climate change.

Threat 6. Agricultural production

Certain types of agricultural production could pose a threat to the Spring Salamander because they may involve 1) clearing, conversion and fragmentation of forest habitat; 2) increased demand for water; 3) a decline in water quality (e.g. pollution, turbidity, sedimentation); and 4) disturbance or direct mortality of individuals.

In Quebec, over 40% of the area calculated by the index of area of occupancy of the Spring Salamander is located on land subject to the *Act Respecting the Preservation of Agricultural Land and Agricultural Activities* (R.S.Q., c. P-41.1). The types of crops most likely to adversely affect the Spring Salamander are believed to be berries (particularly blueberries), Christmas trees, grapes and apples. These crops can be grown at higher elevations than row crops. The Covey Hill (Adirondack Foothills) subpopulation of Spring Salamanders is believed to be particularly vulnerable to agricultural activities due to the presence of orchards and vineyards near habitats used by the species (Frenette 2008). Elsewhere in the Appalachians, agricultural activities are carried out on the periphery of the subpopulations and are not believed to pose an imminent

threat[7]. However, agricultural development at high elevations is a possibility in the medium term and could compromise the persistence of some subpopulations.

In Ontario, agricultural production in Welland County and throughout the Niagara Peninsula has been increasing significantly for many years. A total of 64% of the area of the Niagara Peninsula is devoted to agriculture (Niagara Peninsula Source Protection Area 2011). Due to major changes in land use, such as those observed for agricultural purposes, together with other factors, such as the lack of success in detecting the species despite not-insignificant search efforts (e.g. Yagi et al. 2009), COSSRO now considers the Spring Salamander to be extirpated from Ontario (Committee on the Status of Species at Risk in Ontario 2010).

Threat 7. Alteration of surface water quality caused by acid rain and de-icing salts
The permeable skin and aquatic nature of the Spring Salamander make it vulnerable to changes in water quality caused by acid rain and de-icing salts.

The acidification of streams (as a result of acid rain) adversely affects the survival and abundance of most amphibians (Petranka 1998). In Spring Salamanders, the negative effect of acid rain may be exacerbated by the very poor buffer capacity of headwater streams, which could pose a problem during heavy rain episodes (Green and Peloquin 2008). In addition, runoff of de-icing salts applied to roads in winter into Spring Salamander habitat could result in habitat degradation. Increased salinity of streams is known to affect the survival of the Yellow-spotted Salamander (*Ambystoma maculatum*) (Karraker et al. 2008), and all indications are that the effect is the same for the Spring Salamander, although the extent of the problem is unknown. The alteration of surface water quality caused by de-icing salts was not identified as a threat by COSEWIC (2011) and it has not been documented in the species' range (current or historical).

5. MANAGEMENT OBJECTIVES

In the long term, the management objective is to reduce and, if possible, eliminate the threats to the Spring Salamander in Quebec in order to maintain and, if possible, increase the abundance of the subpopulations identified by COSEWIC[8] and the species' index of area of occupancy (currently 1412 km²). To achieve this objective and measure the progress made, it is necessary, in the short term, to better delineate the distribution of the subpopulations identified by COSEWIC and to calculate a corresponding abundance index.

Rationale: It is critical to maintain the abundance of the various subpopulations and the index of area of occupancy in order to prevent the species from becoming threatened or endangered in Canada. Due to the specific habitat needs of the Spring Salamander (i.e. upstream reaches of small mountain streams devoid of fish), which tend to result in isolation of the various subpopulations, as well as to other limiting factors (e.g. low mobility, low recruitment rate, low

[7] Note that maple syrup production is considered an agricultural activity under the *Act Respecting the Preservation of Agricultural Land and Agricultural Activities*. The extent of occurrence of the Spring Salamander is found within maple-syrup-producing regions where legal protection afforded to Sugar Maple stands may contribute to mitigating threats to the species' habitat.
[8] The Portneuf subpopulation is excluded from this objective; see section 3.2 for further details.

density of individuals), this species has very little resilience to changes in its habitat. Given these same factors, it may be difficult to increase the abundance of the subpopulations or their index of area of occupancy. The management of this species is based on the current Quebec population since, despite search efforts in Ontario, the species has not been observed there since 1877. In the event of the rediscovery of the species in that province, the management objective will be reviewed.

6. BROAD STRATEGIES AND CONSERVATION MEASURES

6.1 Measures Already Completed or Currently Underway

A stream salamander recovery team was established in Quebec in 2001 (Bonin 2001). The team developed an initial recovery plan for the period 2004–2008 (Jutras 2003) and is currently completing a 10-year plan. To date, the team has been particularly active at Covey Hill (Adirondack Foothills), primarily because it is the only location in the province where the Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*), a species threatened in Quebec and Canada, occurs. A number of important measures have, however, been taken elsewhere within the range of the Spring Salamander, specifically by non-governmental organizations involved in the conservation of this species. The measures already completed or currently underway are grouped into three main areas: (1) management, conservation and stewardship of the species and its habitat; (2) search and monitoring efforts; and (3) outreach and communication. Unless otherwise indicated, the information presented comes from COSEWIC (2011).

Management, conservation and stewardship of the species and its habitat
In Quebec, the Spring Salamander population has benefited from the adoption of conservation measures—focused essentially on forest development activities—adopted to conserve stream salamander habitat. These measures are designed to provide a legal framework for forestry operations (e.g basal area removal, hauling, construction of bridges and culverts, protection of the riparian zone) on Crown land (Ministère des Ressources naturelles et de la Faune du Québec, 2008b). Information on these measures will also be disseminated to private landowners (see "Outreach and communication") for implementation on a voluntary basis. Thanks to the growing popularity of FSC (Forest Stewardship Council) certification, more and more managers of private forests are taking the needs of species at risk into account in their operations. These conservation measures are also used, in whole or in part, to provide a framework for other areas of activity such as wind farm projects (Nathalie Tessier, pers. comm.).

In the Adirondack Foothills, the conservation plan for stream salamanders at Covey Hill (Montérégie) has been developed (Frenette 2008). The plan identifies priority conservation areas and strategic elements to be implemented to conserve the assemblage of stream salamanders that occurs there. In this mountain complex, the Nature Conservancy of Canada currently owns 1.2 km² at Covey Hill, and a number of conservation easements have been signed with private landowners. In the Green Mountain Foothills, several non-governmental initiatives have resulted in the acquisition of over 68 km² of habitat in the centre of the species' range. The Nature Conservancy of Canada, in collaboration with Domtar Inc. and the organization Appalachian Corridor, has created the largest private protected area in Quebec in the Sutton Mountains

(~ 67 km²), doubling the area of protected land within the Spring Salamander's Canadian range. The largest area of land protected by the Quebec government is also found in this mountain complex (Parc national du Mont Orford ~ 55 km², Réserve écologique de la Vallée-du-Ruiter ~ 1.2 km²). In the Monteregian Hills, a number of initiatives have been undertaken to conserve several subpopulations or adjacent areas, such as the Mount Shefford subpopulation, which is located in part on land used by the municipality of Granby for drinking water supplies.

In the eastern part of the species' range (White Mountain Foothills, Estrie Hills, Bécancour Hills), very few initiatives have been undertaken, although the Parc national du mont Mégantic (~ 55 km²) includes the headwaters of a stream used by one subpopulation. Spring salamanders are observed approximately 1 km downstream from the park boundaries.

Search and monitoring efforts
Since the late 1990s, a number of stream salamander surveys conducted in Quebec have resulted in close to 400 Spring Salamander observations, primarily in the Adirondack Foothills, Green Mountain Foothills and, more recently, the White Mountain Foothills and Bécancour Hills. Studies have been conducted to document the important characteristics of Spring Salamander habitat and have made it possible to begin identifying suitable habitat for the species (Boutin 2006, Ploss 2010). A protocol for monitoring the Allegheny Mountain Dusky Salamander population that has been developed and tested since 2008 in the Adirondack Foothills could also provide information on the Spring Salamander.

Outreach and communication
The main outreach and communication efforts have been conducted in the Adirondack Foothills and Green Mountain Foothills by non-governmental organizations working in the area of conservation (Nature Conservancy of Canada, Appalachian Corridor, Société de conservation du corridor naturel de la rivière au Saumon, Société de conservation et d'aménagement du bassin de la rivière Châteauguay). These organizations are primarily involved with landowners, but also with local and regional stakeholders. They have also designed and distributed best practices guides for private lands.

6.2 Broad Strategies

Like the management objective, the following broad strategies are focused on the current Quebec population.

1. *Eliminate or reduce the main threats to the species and its habitat in Quebec*

   The long-term viability of the Spring Salamander population depends on the integrity of its habitat and the size of the population. Habitat integrity can be impaired by threats, particularly those of anthropogenic origin, which must therefore be reduced and, if possible, eliminated to ensure sustainable management of the species. Four approaches have been identified to guide the implementation of this broad strategy: (1) determine the level of concern related to certain threats; (2) safeguard the Spring Salamander and its habitat through stewardship, legal measures and other appropriate management measures; (3) develop communication strategies to reduce threats, and implement these strategies with targeted stakeholders; (4) monitor the effectiveness of the measures put in place to safeguard the species and its habitat.

2. *Obtain complete information on the distribution of Quebec subpopulations and initiate monitoring*

   The various Quebec subpopulations are isolated from one another. As a result, management at the subpopulation scale appears to be appropriate (see strategy 3). Monitoring of distribution, together with monitoring of the species within the area of occupancy, is a management tool for reporting on the progress achieved or difficulties encountered. The implementation of monitoring to identify trends in subpopulations first requires obtaining basic demographic data for each subpopulation (or for subpopulations representative of a subset). A large part of the range of the Spring Salamander has never been surveyed in Quebec (Figure 1). To ensure consistent management of the species, complete information must be obtained on its distribution in order to determine the exact extent of its range.

3. *Identify the ecological knowledge that is required to ensure recovery*

   Although the Quebec subpopulations are isolated from one another, the actual degree of divergence between the various subpopulations and between occurrences within the subpopulations is unknown. This information is required for the management of the Spring Salamander, particularly for confirming the scale used (i.e. subpopulation). It would also be appropriate to delineate suitable habitat as it has never been surveyed.

6.3 Conservation Measures

Table 3 presents the conservation measures to be implemented for each of the broad strategies identified. The conservation measures are limited to Quebec's current population and are based on the planning carried out by the Quebec stream salamander recovery team.

Table 3. Implementation schedule*

Conservation Measures	Priority	Threats** or Concerns Addressed	Timeline
Strategy 1. Eliminate or reduce the main threats to the species and its habitat in Quebec			
Approach 1A. Determine the level of concern related to certain threats			
For each subpopulation, document the measures put in place to conserve habitat	High	Knowledge gaps	2014–2016
Characterize the threats to each subpopulation	High	All threats	2014–2019
Characterize and monitor the impact of sedimentation on Spring Salamander habitat	High	1, 3, 5 and 6	2014–2019
Characterize and monitor fish introductions/stocking that could have an impact on the area of occupancy	Medium	4	2014–2019
Develop and implement indicators to monitor the impacts of climate change	Medium	5	2014–2019
Characterize and monitor activities that could affect the hydrological regime and water quality in the area of occupancy	Medium	1, 2, 3, 6, 7	2014–2019
Approach 1B. Safeguard the Spring Salamander and its habitat through stewardship, legal measures and other appropriate management measures			
Prioritize sites to be conserved and implement measures to conserve priority sites	High	1, 2, 3, 4, 6, 7	2014–2019
Define and map the habitat under the Quebec *Act Respecting Threatened or Vulnerable Species*	High	1, 2	2014–2019
Establish regional zoning for streams in which no fish stocking would be allowed	High	4	2014–2019
Ensure conservation of the habitat needed to enable the mobility of individuals in subpopulations	Medium	1, 2, 3, 4, 6	2017–2019
Amend, where necessary, regulations (federal, provincial and municipal) respecting the water environment, as well as prescriptive guides and technical factsheets regarding work in the water environment, to take into account the needs of the Spring Salamander	Medium	1, 2, 3, 6, 7	2019
Approach 1C. Develop communication strategies to reduce threats, and implement them with targeted stakeholders			
Promote the application of sound forestry practices in private forests for stream salamanders	High	3	Ongoing
Develop and implement a communication strategy in order to reduce specific threats and protect habitat	High	1, 2, 4, 6, 7	2014–2019
Define sound agricultural practices and promote their application on privately owned land	Medium	2, 6	2015–2019
Promote and maintain cooperative management of transboundary Spring Salamander subpopulations with stakeholders in the United States (New York, Vermont, Maine)	Low	All threats	Ongoing

Conservation Measures	Priority	Threats** or Concerns Addressed	Timeline
Approach 1D. Monitor the effectiveness of the measures put in place to safeguard the Spring Salamander and its habitat			
Monitor the effectiveness of the sound practices (agricultural, forestry or measures related to fish stocking) that are implemented	Medium	3, 4, 6	2014–2019
Assess whether legal and regulatory measures, land use plans, prescriptive guides and factsheets related to the protection of the water environment or the riparian zone adequately protect the species and its habitat	Medium	1, 2, 3, 6, 7	2014–2018
Strategy 2: Obtain complete information on the distribution of Quebec subpopulations and initiate monitoring			
Approach 2A. Document and monitor distribution			
Inventory suitable habitat within the species' range that has never been visited	High	Knowledge gaps	2014–2019
Monitor the species' area of occupancy	Medium	Knowledge gaps	2014–2019 (annual)
Approach 2B. Monitor the species within its area of occupancy			
Document the catch per unit effort at sites where such a calculation is possible	High	Knowledge gaps	2014–2019
Develop and implement a program to monitor trends in subpopulations	High	Knowledge gaps	2014–2019
Confirm the presence of subpopulations that have not been seen for over 25 years	High	Knowledge gaps	2014–2019
Monitor the quality of occurrences in the CDPNQ	Medium	Knowledge gaps	2019
Strategy 3: Identify the ecological knowledge that is required to ensure recovery			
Approach 3A. Design and conduct the necessary studies.			
Locate suitable habitat using a landscape analysis approach (watershed scale)	High	Knowledge gaps	2014–2019
Assess genetic connectivity within the various subpopulations as a function of landscape characteristics	Medium	Knowledge gaps	2014–2019

* Responsibility for the implementation of the activities listed in Table 3 will be established by a process of consultation involving the responsible jurisdictions and organizations concerned.

** 1: Residential, recreational/tourism and wind power generation; 2: Groundwater pumping for residential, agricultural and commercial use; 3: Logging; 4: Fish introductions/stocking; 5: Climate change; 6: Agricultural production; 7: Alteration of surface water quality by acid rain and de-icing salts.

7. MEASURING PROGRESS

The performance indicators presented below provide a basis for defining and measuring progress toward achieving the management objectives established for the Spring Salamander in Canada. Success in implementing this management plan will be evaluated every five years using the following performance indicators:

- The index of area of occupancy of the subpopulations identified by COSEWIC[7] is maintained at a minimum of 1412 km².
- The threats to the subpopulations identified by COSEWIC[7] are reduced or eliminated.
- The abundance of the subpopulations identified by COSEWIC[7] is maintained or increased.

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APPENDIX A. EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[9]. 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.

The planning of the management of a species of special concern is intended to benefit species at risk and biodiversity in general. However, it is recognized that management plans 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 management plan itself, but are also summarized below in this statement.

This management plan contributes directly to the achievement of the goals and targets of the Federal Sustainable Development Strategy for Canada. More specifically, it will contribute to restoring populations of wildlife to healthy levels and to maintaining productive and resilient ecosystems with the capacity to recover and adapt (goals 5 and 6 of the Strategy).

The potential for this plan to inadvertently lead to adverse effects on the environment and on other species was considered. Since the recommended activities are limited to non-intrusive measures such as population monitoring and habitat stewardship activities, it is possible to conclude that this management plan will not result in significant adverse effects.

The activities proposed to reduce the main anthropogenic threats to the Spring Salamander and its habitat will very likely have an overall positive effect on all plant and wildlife species present in the habitats of the target species, which is associated with aquatic areas but also with riparian forest areas. Such species include other amphibian species, aquatic and forest litter insect communities, crayfish and predators of amphibians (birds, mammals, rodents, reptiles).

Obtaining the information needed to determine the distribution and abundance of the Spring Salamander subpopulations will likely facilitate the monitoring of other amphibian species. For instance, the Spring Salamander often occurs in association with the Northern Two-line Salamander (*Eurycea bislineata*), the Eastern Red-backed Salamander (*Plethodon cinereus*), the Northern Dusky Salamander (*Desmognathus fuscus*) and the Allegheny Mountain Dusky Salamander (Adirondack Foothills) (Boutin 2006). It should be noted that the Northern Dusky Salamander is on the list of species likely to be designated as threatened or vulnerable in Quebec, and the Allegheny Mountain Dusky Salamander is designated as threatened by the Quebec government. The Allegheny Mountain Dusky Salamander (Great Lakes and St. Lawrence population) was also assessed as threatened in Canada by COSEWIC (2007) and is listed on the List of Wildlife Species at Risk (Schedule 1) of SARA. Other species at risk are also found in the Appalachians, such as Bicknell's Thrush (*Catharus bicknelli*), the Olive-sided Flycatcher (*Contopus cooperi*), the Milksnake (*Lampropeltis triangulum*), and American Ginseng (*Panax quinquefolius*). Although these species occupy a different habitat than that of the Spring Salamander, the efforts made to ensure the conservation and long-term viability of this species could facilitate the recovery and management of these other species at risk.

[9] http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1