

Recovery Strategy for the Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*), Great Lakes/St. Lawrence Population, in Canada

Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence Population



2014



Government
of Canada

Gouvernement
du Canada

Canada

Recommended citation:

Environment Canada. 2014. Recovery Strategy for the Allegheny Mountain Dusty Salamander (*Desmognathus ochrophaeus*), Great Lakes/St. Lawrence Population, in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. iv + 25 pp.

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

Cover illustration: Frédérick Lelièvre, Ministère des Ressources naturelles et de la Faune du Québec

Également disponible en français sous le titre
« Programme de rétablissement de la salamandre sombre des montagnes (*Desmognathus ochrophaeus*), population des Grands Lacs et du Saint-Laurent, au Canada »

© Her Majesty the Queen in Right of Canada, represented by the Minister of the Environment, 2014. All rights reserved.

ISBN 978-1-100-20553-3

Catalogue no. En3-4/148-2015E-PDF

Content (excluding the illustrations) may be used without permission, with appropriate credit to the source.

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 recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

The Minister of the Environment is the competent minister for the recovery of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence Population, and has prepared this strategy, as per section 37 of SARA. It was developed in collaboration with the province of Quebec (Department of Natural Resources and Wildlife).

Success in the recovery 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 strategy and will not be achieved by Environment Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence Population, and Canadian society as a whole.

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

ACKNOWLEDGMENTS

Thanks to the following people for their assistance throughout the preparation of this document: Sylvain Giguère and Alain Branchaud (Environment Canada, Canadian Wildlife Service - Quebec Region), Anaïs Boutin (private consultant), , Jacques Jutras (Ministère des Ressources naturelles et de la Faune du Québec) and Joël Bonin (Nature Conservancy of Canada). Thanks also to the Équipe de rétablissement des salamandres de ruisseaux du Québec (Quebec Stream Salamander Recovery Team) for its participation. The following people also provided assistance during the preparation of the recovery strategy: Karine Picard, Marjorie Mercure, Matthew Wild and Sébastien Rioux (Environment Canada, Canadian Wildlife Service - Quebec Region), Mélanie Frenette (Nature Conservancy of Canada), and Wayne F. Weller (herpetologist).

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

EXECUTIVE SUMMARY

The Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*), Great Lakes/St. Lawrence population was designated threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2007 and added to the Schedule 1 of the *Species at Risk Act* (SARA) in 2009.

The Allegheny Mountain Dusky Salamander is a species endemic to eastern North America. The Great Lakes/St. Lawrence population is found at the northern limit of the species' range. It has a disjunct and very limited distribution, being found only on the northern side of a hill known as Covey Hill, in the southern part of the Montérégie region of Quebec. No genetic exchange is possible between it and the nearest population. The species is generally found in or near forested streams and seeps, which provide high quality fresh water and abundant cover. In summer, the salamanders also use terrestrial habitats bordering the streams and seeps.

The population's isolation and very restricted area of occupancy (2.6 km²) make it highly susceptible to stochastic events and to any alteration, degradation or loss of habitat. Therefore, any actions that change or alter its existing habitat could compromise the survival of the Great Lakes/St. Lawrence population. Groundwater extraction for residential, agricultural or commercial purposes and groundwater extraction for bottling purposes, along with alteration of the Covey Hill peat bog, which supplies water to a large portion of the area of occupancy, currently represent the main threats to the population's survival. Logging and residential and tourism development also represent serious threats.

The recovery of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population is considered technically and biologically feasible. The recovery strategy objectives are based on a five- to ten-year horizon and are aimed at maintaining its presence in each known occurrence. To minimize the effect of threats and make progress toward these objectives, three broad recovery strategies have been established. They are presented in the section on Strategic Direction for Recovery as are eight associated research and management approaches.

The critical habitat of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population has been identified based on the best available knowledge. It includes the eleven occurrences compiled by the Centre de Données sur le Patrimoine Naturel du Québec and the peat bog at the top of Covey Hill.

One or more action plans detailing the measures to be taken to implement this recovery strategy will be posted on the Species at Risk Public Registry within five years after the final posting of the recovery strategy.

RECOVERY FEASIBILITY SUMMARY

Under section 40 of the *Species at Risk Act*, the competent minister must determine whether the recovery of the listed wildlife species is technically and biologically feasible. On the basis of the following criteria established by the Government of Canada (2009), the recovery of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population is considered technically and biologically feasible:

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. The Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population has been able to perpetuate itself up until now due to the presence of breeding individuals. Recent observations have confirmed the presence of breeding adults, juveniles and occupied nests.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. The current habitat, although limited, appears to be sufficient since it has sustained the Great Lakes/St. Lawrence population so far. The salamanders use only a tiny fraction of the area of occupancy, and within this area there is still suitable habitat for the species.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes. The primary threats to the survival of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population and to its habitat can be mitigated through measures proposed in this recovery strategy.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Yes. Effective and appropriate techniques (e.g., stewardship) exist for habitat conservation and maintenance of population size. In addition, landowners have already been notified through awareness efforts and responses to date are favourable. The Laboratoire Naturel de Covey Hill, a natural research area located on private land, has begun to provide support, notably by generating data necessary for identifying effective recovery techniques.

TABLE OF CONTENTS

PREFACE	i
ACKNOWLEDGMENTS	i
EXECUTIVE SUMMARY	ii
RECOVERY FEASIBILITY SUMMARY	iii
1. COSEWIC Species Assessment Information	1
2. Species Status Information	1
3. Species Information	2
3.1 Species Description	2
3.2 Population and Distribution	2
3.3 Needs of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence Population	5
4. Threats	6
4.1 Threat Assessment	6
4.2 Description of Threats	7
5. Population and Distribution Objectives	10
6. Broad Strategies and General Approaches to Meet Objectives	11
6.1 Actions Already Completed or Underway	11
6.2 Strategic Direction for Recovery	12
7. Critical Habitat	14
7.1 Identification of the Species' Critical Habitat	14
7.2 Activities Likely to Result in the Destruction of Critical Habitat	16
8. Measuring Progress	17
9. Statement on Action Plans	17
10. References	18
APPENDIX A : Effects on the Environment and Other Species	24
APPENDIX B: Critical Habitat of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence Population	26

1. COSEWIC SPECIES ASSESSMENT INFORMATION

Date of Assessment: April 2007

Common Name (population): Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence Population

Scientific Name: *Desmognathus ochrophaeus*

COSEWIC Status: Threatened

Reason for Designation: This is a small and secretive salamander, with aquatic larvae, that inhabits forested brooks, cascades, springs, or seeps where there is abundant cover in the form of crevices between stones, leaf litter, or logs. This species has a very small range of less than 100 km² in the Great Lakes/St. Lawrence faunal province in a single locality at the northernmost edge of the Adirondack Mountains. At this locality, the salamanders occupy some 8 to 10 streams and seeps with a total area of occupancy of under 10 km². All of these streams emanate from a single water source. The locality is isolated from any other population of the same species, the nearest other locality is about 90 km away in New York State. Its minute range makes this salamander highly susceptible to stochastic events and the species would easily become endangered if major changes to its habitat were to take place. The major threats to this salamander in Great Lakes/St. Lawrence faunal province are any that could affect the water table and dry out seeps and springs in its habitat, degrade groundwater flow and quality or deplete groundwater reserves. Logging at the single water source could destroy terrestrial habitat by increasing siltation in streams and altering hydrological regimes.

Canadian Occurrence: Quebec

COSEWIC Status History: The species was considered a single unit and designated Special Concern in April 1998. Status re-examined and designated Threatened in November 2001. Split into two populations in April 2007. The Great Lakes / St. Lawrence population was designated Threatened in April 2007.

2. SPECIES STATUS INFORMATION

The Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*), Great Lakes/St. Lawrence population was added to Schedule 1 of SARA as Threatened in 2009. The Quebec government designated the species as threatened under the *Act respecting threatened or vulnerable species* (R.S.Q., Chapter E-12.01) in 2009.

NatureServe (2010) has assigned the species a global status of G5 (secure) because it is abundant across North America. The species is also considered secure (N5) in the United States. However, the species has the rank N2 (imperiled) in Canada and rank S1 (critically imperiled) in Quebec.

3. SPECIES INFORMATION

3.1 Species Description

The Allegheny Mountain Dusky Salamander is slender and small; adults generally measure 7 to 10 cm in length. As its name indicates, the salamander is dark in colour, ranging from brown to black in colour. It has a light stripe down its back which varies in colour but is often yellowish or sometimes reddish. The stripe commonly contains a row of chevron-shaped dark spots down the middle (COSEWIC 2007). For an exhaustive description of the species' morphology and genetics, readers should consult the status report (COSEWIC 2007).

3.2 Population and Distribution

The Allegheny Mountain Dusky Salamander is a species endemic to eastern North America. Its global range is located almost exclusively in the United States and coincides with the Appalachian Mountains. The northern limit of the species' range corresponds to the foothills of the Adirondacks in Quebec. From there, the distribution extends west to Ohio, east to Maryland and south into Georgia (Figure 1) (Orr 1989, Conant and Collins 1998, Petranka 1998).

The Canadian range of the Allegheny Mountain Dusky Salamander is very restricted and represents only a very small portion of its global range (less than 1% of its global range is in Canada) (COSEWIC 2007). The species is found in a small watershed in extreme southern Quebec (Great Lakes/St. Lawrence population), as well as in two streams in the Niagara Gorge of southern Ontario (Carolinian population). The distribution of the Great Lakes/St. Lawrence population is disjunct from the core range, whereas the distribution of the Carolinian population is centred on the northwestern edge of the core range (Figure 1). These remain the only known populations of the species in Canada, despite numerous stream salamander field surveys conducted in Quebec and Ontario (Weller 1977, Gordon 1979, Bonin 1989, Shaffer and Bachand 1989, Denman et al. 1990, Weller and Cebek 1991a, 1991b, 1991c, Bider and Matte 1991, 1994, 1996, Boutin 2004, 2006, Markle 2006, Frenette 2007, Bouthillier 2011, Ministère des Ressources naturelles et de la Faune du Québec and Nature Conservancy of Canada 2012, Nature Conservancy of Canada 2013, Laurendeau in prep.).



Figure 1. North American distribution of the Allegheny Mountain Dusky Salamander.

The numbers identify the Canadian populations: (1) Great Lakes/St. Lawrence, Quebec, (2) Carolinian, Ontario.

Adapted from NatureServe 2010.

The Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population occurs only on the north side of Covey Hill, Quebec (Montérégie region) in the foothills of the Adirondacks (Sharbel and Bonin 1992). The entire distribution is located on private land, in the municipalities of Franklin and Havelock (Frenette 2008). According to COSEWIC (2007), the extent of occurrence of the species is approximately 50 km² but the actual area occupied (area of occupancy) is less than 10 km² (Figure 2). Based on a more precise estimate obtained from the Centre de Données sur le Patrimoine Naturel du Québec (CDPNQ) (2009), the species' area of occupancy is made up of 11 element occurrences³ (hereafter referred to as "occurrences"), totalling an area of 2.6 km² (264.5 hectares). The Great Lakes/St. Lawrence population is located about 90 km away from the nearest population which is in upper New York State (COSEWIC 2007).

³ Element occurrence: an area of land and/or water in which a species is, or was, present (NatureServe 2002).



Figure 2. Extent of occurrence of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population (cross-hatched area)

With regard to the size of the Great Lakes/St. Lawrence population, all that is known, based on the best available information, is that breeding adults, juveniles and occupied nests are present. The data are not sufficient to assess population size, trends or fluctuations (COSEWIC 2007). The data contained in the Atlas des Amphibiens et Reptiles du Québec (AARQ 1988 -), a source databank for the CDPNQ, are sparse and cannot be used to address these questions.

3.3 Needs of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence Population

The COSEWIC report (2007) provides an exhaustive description of the needs of this species. The summary provided here is taken from that report except where a reference is given.

The Allegheny Mountain Dusky Salamander lacks lungs and relies on cutaneous respiration. An important consequence is that its skin must remain moist for gas exchange to occur, and this influences the species' choice of habitat and some of its behaviours (e.g., periods of activity outside of shelters). The salamanders are therefore found mainly in humid shelters near or in cold, slow-flowing streams, cascades, springs or seeps⁴ in forested areas at higher elevations. They are typically absent from fast-flowing streams or streams in which predatory fish occur (Rutheford et al. 2004, Anaïs Boutin unpubl. data).

The Allegheny Mountain Dusky Salamander is the most terrestrial of the stream salamanders found in Quebec.⁵ The larvae of this species can survive in temporary water sources. Furthermore, in summer, Allegheny Mountain Dusky Salamanders disperse to forested areas around the stream or other water source that serves as their home. While the species is known to disperse more than 75 m away from aquatic habitat, there is little information on its movements and migrations. Substrate type is a very important characteristic of the forested habitats in which the salamanders live. An unconsolidated substrate (e.g., organic matter) is essential to enable the salamanders to dig burrows. The presence of certain types of vegetation is also important for maintaining an adequate level of moisture. Nevertheless, the species remains tied to a water source.

To escape predation, the Allegheny Mountain Dusky Salamander requires ready access to shelters, such as rocks and fallen tree trunks, in which to hide. The females lay their eggs beneath such shelters, which also play a very important role in protecting individuals from freezing temperatures. To perform their functions, the shelters must be humid and must have a supply of high quality water.

⁴ Areas where groundwater rises to the surface.

⁵ Northern Dusky Salamander (*Desmognathus fuscus*), Northern Two-lined Salamander (*Eurycea bislineata*) and Northern Spring Salamander (*Gyrinophilus porphyriticus*).

4. THREATS

4.1 Threat Assessment

The Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population has a disjunct and very restricted distribution, making it particularly vulnerable to several threats. At present, the most significant threats to its survival and its habitat are the exploitation of water resources and alteration of the Covey Hill peat bog. Other threats to the species include logging, residential and tourism development, all-terrain vehicle use, climate change, crop and livestock production, and the introduction or stocking of fish.

Table 1. Threat Assessment Table

Threat	Level of Concern ¹	Extent	Occurrence	Frequency	Severity ²	Causal Certainty ³
Changes in Ecological Dynamics or Natural Processes						
Groundwater extraction for residential, agricultural or commercial purposes	High	Local	Current	Continuous	Moderate	High
Groundwater extraction for bottling purposes	High	Local	Anticipated	Continuous	High	High
Alteration of the Covey Hill peat bog	High	Local	Current	Continuous	High	High
Logging	Medium	Widespread	Current	Seasonal	Moderate	High
Habitat Loss or Degradation						
Residential and tourism development	Medium	Widespread	Anticipated	Continuous	Moderate	High
Crop and livestock production	Medium	Widespread	Current	Seasonal	Unknown	Medium
All-terrain vehicles	Medium	Local	Current	Continuous	Moderate	Medium
Climate and Natural Disasters						
Climate change	Medium	Widespread	Anticipated	Continuous	Unknown	Medium
Alien, Invasive or Introduced Species/Genomes						
Introduction/stocking of fish	Low	Local	Unknown	Seasonal	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

Nine threats are described below in descending order of concern, with Threat 1 representing the highest level.

Threat 1 – Groundwater extraction for residential, agricultural or commercial purposes

Groundwater reserves feed intermittent streams, springs and seeps that provide essential resting, nesting, feeding and overwintering habitat for the Allegheny Mountain Dusky Salamander. At Covey Hill, the water table is the sole source of water (Frenette 2008). A large peat bog on the hill serves as an important water reservoir and helps to maintain the groundwater reserves (Barrington et al. 1993). In the early 1990s, demand for water for residential, agricultural and commercial uses was not considered problematic (Barrington et al. 1993). The situation has not been re-evaluated, even though the demand has changed. There has been an increase in water requirements in recent years, for instance, for recreation and tourism use and irrigation of orchards. Groundwater extraction is expected to result in a decrease in the amount of water available in the habitat of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population, and in the alteration of natural fluctuations in the hydrologic regime (Jutras 2003, Frenette 2008). This would lead to habitat loss and significant mortality due to the salamanders' limited dispersal abilities. As well, some individuals could become isolated in residual habitat fragments separated by habitat unfavourable to their survival. The decline in water levels would likely affect reproductive success as well as egg, larval and possible adult survival, limit the abundance or accessibility of food resources for the Great Lakes/St. Lawrence population, and considerably reduce or eliminate breeding and overwintering habitat.

Threat 2 – Groundwater extraction for bottling purposes

Groundwater extraction for bottling represents a major threat, although at present it constitutes only a potential threat for the Great Lakes/St. Lawrence population. The groundwater resource at the Covey Hill site is of exceptional quality and has already attracted the attention of promoters of spring water bottling projects (Frenette 2008). Proposals for projects of this type in the Covey Hill area have been turned down so far (Bonin 2001). A hydrogeological study done in 2004 in the municipality of Franklin showed that groundwater extraction for bottling purposes is feasible, but that conflicts might occur among current groundwater users (see Threat 1). While there has been no study of the potential impacts on the ecosystem, it can be posited that an area with a radius of more than one kilometre around the extraction site would be affected. Local or regional overexploitation of groundwater could have irreversible impacts (Côté et al. 2006). The potential effects of groundwater extraction on the size of the Great Lakes/St. Lawrence population and on its habitat are discussed under Threat 1 (Groundwater extraction for residential, agricultural and commercial purposes).

Threat 3 – Alteration of the Covey Hill peat bog

Encompassing an area of 70 hectares, the Covey Hill peat bog is located on three privately owned parcels of land, one of which now belongs to the Nature Conservancy of Canada. It serves as a water reservoir that feeds the water table of the entire Covey Hill area. Since it supplies water to a large proportion of the area of occupancy of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population, any alteration of the peat bog could have disastrous consequences for the species. This is because the peat bog plays a key role in maintaining the most important attribute of the species' critical habitat: a constant supply of high quality cool fresh water (see section 7.1). Under the *Environment Quality Act* (R.S.Q., chapter Q-2), no changes can be made to this habitat without a certificate of authorization. In spite of this, many local residents do not see the peat bog as an important environment deserving protection. For example, one landowner recently transformed a portion of the peat bog into a lake with the intention of stocking it with trout (Mélanie Frenette, personal communication).

Threat 4 – Logging

The area of occupancy of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population consists of private land in municipalities (Franklin and Havelock) that currently have no tree cutting by-laws (Mélanie Frenette, personal communication). This means that landowners can harvest as many trees as they want. Logging remains a particularly critical threat for intermittent streams and seepages, the main habitat of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population (Alvo and Bonin 2003, Jutras 2003, Trottier 2006). The loss of plant cover has an adverse effect on moisture conditions in this species' habitat, and salamander populations generally cannot persist below a forest cover threshold of 50% (Gibbs 1998). Soil compaction, increased erosion and siltation, as well as warming of stream temperatures reduce the availability of suitable shelters for hibernation, resting and nesting (Alvo and Bonin 2003, Trottier 2006). Furthermore, decreases in leaf litter and soil moisture content greatly impede the ability of stream salamanders to dig burrows and find food, in addition to affecting prey density. Timber harvesting also has an adverse effect on the physical condition and reproductive success of the Allegheny Mountain Dusky Salamander (Knapp et al. 2003).

Threat 5 – Residential and tourism development

Residential and tourism development in the Covey Hill area may result in the destruction (e.g., deforestation), degradation (e.g., changes in the hydrological regime, reduced water quality) and fragmentation (e.g., roads) of the habitat of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population. Furthermore, new developments often necessitate the construction of wells to supply drinking water, a situation that can adversely affect the amount of water available in the species' habitat (see Threat 1). Residential and tourism development also increases the risk of salamander mortality (e.g., in-filling, road mortality) (Frenette 2008). The entire area of occupancy is currently subject to the *Act Respecting the Preservation of Agricultural Land and Agricultural Activities* (R.S.Q., c. P-41.1; 2006), the purpose of which is “to secure a lasting territorial basis for the practice of agriculture” and to ensure that the conversion of land for other uses is limited (e.g., residential and tourism development).

Threat 6 – All-terrain vehicle use

The recreational activity that poses the greatest threat to the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population involves the use of all-terrain vehicles in or near the area of occupancy. The use of these vehicles in riparian areas can have serious consequences: destruction of shelters, alteration of the species' habitat, interference with natural patterns of behaviour and direct mortality. Another potential threat associated with this type of activity is the contamination of surrounding habitat or groundwater through fuel leaks. Repeated ford crossings can also have a major impact on Allegheny Mountain Dusky Salamander habitat by reducing water quality (e.g., sedimentation, contamination), altering surface flows, or drying up the natural streambed.

Threat 7 – Climate change

Climate change projections for North America include a rise in the mean temperature and a change in precipitation patterns, with less frequent but more intense precipitation events and longer inter-event droughts (Brooks 2009). These changes are expected to result in higher evapotranspiration rates, with attendant drying of surface water sources and lowering of the water table. Some streams and seeps, such as those used by the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population could disappear. These kinds of changes could affect the diversity and abundance of species that use such streams, particularly species with poor dispersal ability like the Allegheny Mountain Dusky Salamander. The increased frequency of torrential rainfall can alter the species' habitat, as occurred in the Covey Hill area in 2011 with the passage of Tropical Storm Irene (Anaïs Boutin, pers. comm.). This type of inrush of water can also cause mortalities by carrying away individuals or by washing out or plugging nests. Another concern is that stream salamander recruitment could be severely compromised by these phenomena. Hibernation sites and shelters could also be destroyed, or access to them could be limited. Hydrogeologic modelling of Covey Hill seeps, combined with ecological modelling based on the Allegheny Mountain Dusky Salamander, shows that future climate scenarios could favour the species owing to increased water flows (Larocque et al. 2013). However, following an increase in annual precipitation over a 12-year period, Lowe (2012) observed a significant decline in the abundance of adult Spring Salamander in the streams in which it occurs. According to Lowe (2012), there is a risk that the adverse impacts associated with increased precipitation will intensify under climate change. The impacts of this threat would be amplified for the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population given that its very restricted and disjunct distribution makes it more vulnerable to stochastic environmental events (COSEWIC 2007).

Threat 8 – Crop and livestock production

Crop and livestock production represents a threat to the species because it entails:

1) deforestation and the conversion and fragmentation of forest habitat; 2) increased demand for water and the use of groundwater reserves; 3) a decrease in water quality (e.g., pollution, turbidity, sedimentation); and 4) disturbances to or direct mortality of individuals. With the exception of maple syrup production, agricultural activities in the Covey Hill area currently take place primarily on the periphery of the salamanders' habitat, at lower elevations. However, much of the Covey Hill area is currently zoned as farmland. Therefore, an expansion of agricultural activities to areas higher up on the hill would pose a real threat to the remaining forest and the species' habitat. There are many orchards in the region (more than 220 000 apple trees in the

municipality of Franklin) and the demand for water to irrigate the orchards has increased considerably (Frenette 2008). Maple syrup production poses a potential threat to the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population. Certain practices associated with maple syrup production (e.g., creation and maintenance of access roads, fording sites, forest drainage) can potentially affect the hydrological environment of forests and have an impact on the species (L. Bouthillier, pers. comm.). The municipalities of Franklin and Havelock are among those with the highest maple syrup production potential in the regional county municipality, each having the potential for an additional 129,000 taps (Horizon multiressource 2001). No additional quotas have been available since 2005 (CRÉ Vallée-du-Haut-Saint-Laurent 2006).

Threat 9 - Introduction or stocking of fish

The introduction or stocking of fish in permanent streams could adversely affect the Great Lakes/St. Lawrence population by increasing predation. These streams are important in ensuring connectivity between occupied areas, and the presence of fish could reduce the quality of the habitat for the Allegheny Mountain Dusky Salamander (Jacques Jutras, pers. comm.). In addition, stocked or introduced fish can vector diseases or parasites that could affect the salamanders or other species in the ecosystem (Bonin 2001, Jutras 2003). At Covey Hill, some episodes of Brook Trout (*Salvelinus fontinalis*) migration from the United States have been observed (Alain Branchaud, pers. comm.). However, since the Allegheny Mountain Dusky Salamander typically uses intermittent streams, contact with such predators is likely to be limited.

5. POPULATION AND DISTRIBUTION OBJECTIVES

The population and distribution objectives have been set using a horizon of five to ten years. They consist of maintaining the presence of Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population, in each known occurrence.

There is currently no data on population size, fluctuations or trends for the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population (COSEWIC 2007). This lack of data explains the qualitative nature of the population objective and the short time frame.

Implementation of the broad strategies outlined in section 6 should make it possible to specify this objective within five to ten years.

Despite the positive effects expected from the implementation of the recovery strategy, the population's disjunct and very restricted distribution may make it unlikely that the species will be removed from Schedule 1 of SARA at some future point in time.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Underway

A stream salamander recovery team was established in Quebec in 2001 (Bonin 2001). They prepared an initial intervention plan for the period 2004 to 2008 (Jutras 2003), and they are currently preparing a second five-year plan. Among the measures implemented since 2004, the following are especially noteworthy:

- The Nature Conservancy of Canada now owns 124 hectares of land at Covey Hill and it has entered into several conservation easements with private landowners;
- Forest protection measures have been adopted to protect stream salamanders in Quebec. They provide a legal framework for forestry operations on public land, whereas private landowners' adherence is voluntary (Ministère des Ressources Naturelles et de la Faune du Québec 2008);
- Studies undertaken to document the habitat of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population have played an instrumental role in identification of the species' critical habitat (Boutin 2006, Larocque et al. 2006);
- The Laboratoire Naturel de Covey Hill, a natural research area on private land, was established in 2006 thanks to the co-operation of property owners who agreed to provide access to their land. The participating research organizations⁶ conduct studies in the following areas: plant and animal biology, hydrology and geomorphology. One of its primary contributions is the creation of a network of permanent hydrological sampling stations;
- A population monitoring protocol has been developed and tested since 2008 at ten sites located in two occurrences;
- Annual surveys have been carried out within the species' range since 2011 by the Quebec Department of Natural Resources and Wildlife and Nature Conservancy Canada in order to determine the population's extent of occurrence and area of occupancy;
- Molecular methods have been developed to confirm the identification of the Allegheny Mountain Dusky Salamander, the Northern Dusky Salamander, and their first-generation hybrids (Boutin 2006). A project is currently underway to develop reliable criteria for distinguishing between the Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander (Anaïs Boutin, pers. comm.). It is being carried out jointly with the stream salamander recovery team, the Quebec Department of Natural Resources and Wildlife, and the Université de Montréal;
- A conservation plan has been developed for the stream salamanders at Covey Hill (Frenette 2008). Among other things, it identifies priority conservation areas and strategic conservation measures;
- In terms of awareness efforts, the Nature Conservancy of Canada and the Société de Conservation et d'Aménagement du Bassin de la Rivière Châteauguay are very active in raising awareness among local and regional stakeholders. Nature Conservancy Canada

⁶ Université du Québec à Montréal, Université de Montréal, Institut de Recherche en Biologie Végétale, McGill University's Brace Centre for Water Resources Management, and the Nature Conservancy of Canada.

has developed a best practices guide for Covey Hill property owners. The Ontario Ministry of Natural Resources has also produced a stewardship guide on the salamanders of Ontario and Quebec (Yagi et al. 2010). In 2012, the organization Éco-Nature, in collaboration with the stream salamander recovery team, produced outreach postcards for distribution to the general public.

6.2 Strategic Direction for Recovery

The broad strategies and the research and management approaches discussed in this section stem largely from the discussions launched by the Quebec stream salamander recovery team in developing its second intervention plan (2009–2014). To work toward achieving the population and distribution objectives, three broad strategies for recovery have been established. Research and management approaches have been recommended for these different strategies (Table 2).

Table 2. Recovery Planning Table

Threat or Limitation	Priority	Broad Strategy to Recovery	General Description of Research and Management Approaches
Groundwater extraction for residential, agricultural or commercial purposes Groundwater extraction for bottling purposes Alteration of the Covey Hill peat bog Logging Residential and tourism development	Urgent	Minimize the main threats to the species and to its habitat	<ul style="list-style-type: none"> • Safeguard the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population and its habitat through stewardship and other appropriate methods. • Monitor the effectiveness of the measures taken to safeguard habitats and individuals. • Develop communications strategies aimed at reducing threats, and implement them with targeted stakeholders. • Determine the level of concern for specific threats.
Knowledge gaps related to the species' abundance and occupancy	Necessary	Supplement knowledge regarding distribution and monitor the population	<ul style="list-style-type: none"> • Continue developing the population monitoring protocol. • Determine and monitor distribution.
Knowledge gaps related to the species' demographic characteristics and movements	Beneficial	Identify the biological and ecological knowledge required for recovery	<ul style="list-style-type: none"> • Continue and support development of the Laboratoire naturel de Covey Hill. • Design and implement the studies required to identify certain characteristics of the ecology of the species.

7. CRITICAL HABITAT

7.1 Identification of the Species' Critical Habitat

The critical habitat of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population has been identified based on the best available knowledge and is thought to be sufficient to meet the population and distribution objectives. The biophysical⁷ attributes of the critical habitat are as follows:

Attribute 1: Constant supply of high quality cold water

The Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population lives near generally intermittent streams, cascades, wet rock faces or high-quality cold water seeps in forested environments. These water sources provide the moisture required for its cutaneous respiration (COSEWIC 2007) and they represent the most important component of the species' critical habitat. In summer, provided that soil moisture conditions are suitable, the salamanders can disperse into adjacent terrestrial habitats. With the return of cooler weather, the salamanders move back to their water source and burrow into water-saturated soil (Bishop 1941, Organ 1961). The larvae have the ability to survive in temporary streams and seepages.

Attribute 2: Loose soil

The soil layer between the soil surface and the water table is an important component of critical habitat, particularly in the summer. The salamanders require unconsolidated substrates into which they can burrow. The presence of leaf litter and plant cover (e.g., mosses, herbaceous plants) helps to maintain these conditions.

Attribute 3: Abundant cover

The Allegheny Mountain Dusky Salamander is a species that is vulnerable to predation and its survival depends greatly on the availability of abundant cover. Rocks, crevices, fallen tree trunks and other woody debris are examples of shelter that protect the salamanders throughout their life cycle (feeding, resting, nesting, hibernation) (COSEWIC 2007).

Critical habitat is identified in this recovery strategy as the suitable habitat (as defined above) present in the eleven occurrences of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population, as well as the entire area of the peat bog at the top of Covey Hill (Appendix B). The eleven occurrences are located on the north side of Covey Hill (Map 31H04, Natural Resources Canada, scale: 1:50 000). Occurrence data are maintained by the Centre de Données sur le Patrimoine Naturel du Québec (CDPNQ) (2009). Although the Covey Hill peat bog does not harbour Allegheny Mountain Dusky Salamanders, it is identified as critical habitat because it plays a crucial role in ensuring the species' survival. The peat bog supplies water to a large proportion of the area of occupancy (eight of the eleven occurrences compiled by the

⁷ These attributes are considered critical habitat features.

CDPNQ). It therefore supports the most important attribute of the species' critical habitat: a constant supply of high-quality cold water.

Occurrences recorded by the CDPNQ

The methodology used to delineate the eleven occurrences is summarized in the paragraphs below. While the method comes from the CDPNQ (2008), the basis for the methodology came out of discussions on the protection of threatened stream salamanders in public forests managed by the Quebec government (Ministère des Ressources Naturelles et de la Faune du Québec 2008).

An occurrence is an area of land and/or water in which a species is present (NatureServe 2002). Each of the eleven occurrences was circumscribed based on observations of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population compiled in the Atlas des Amphibiens et Reptiles du Québec (AARQ 1988-), a source databank for the CDPNQ. These observations are located either along streams or in seep areas (Table 3). The existence of these two habitat types, together with the fact that the seep areas are not identified on base maps (scale: 1:20 000), led to the delineation of two types of occurrence:

Type 1: For observations in seeps, each occurrence is defined by a 150-m radius centred at each available observation. When the observations are close together, the occurrences will look like several overlapping circles. The conservative value of 150 m was established using input from experts who deal with this species in Quebec and based on the fact that the seeps are not inventoried and there may be other seeps near where observations were made.

Type 2: For observations made along permanent and intermittent streams, each occurrence takes the form of elongated polygons following the shoreline of streams used by the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population. Each occurrence includes the streambed and shoreline. For each available observation, the occurrence includes the first 60 m on either side of the stream, from the high water mark—two-year flood recurrence (riparian protected area). Each occurrence extends over a distance of 500 m upstream and downstream from the observation. If additional observations are located within 500 m, the occurrences are merged so that they form a single occurrence. The distance for the riparian protected area (60 m) and the distance for the upstream and downstream area (500 m) for each occurrence were initially established with a view to minimizing the impact of logging in habitats used by the species. The inclusion of these areas thus ensures that the key attributes of the species' habitat, as described earlier, are preserved. Moreover, the distances used correspond to the majority of large movements recorded among species of the same family as the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population (NatureServe 2010).

Table 3. Critical habitat: the eleven occurrences compiled by the CDPNQ

Table of critical habitat the eleven oceanic seeps compiled by the GBR NGA						
Reference Number ¹	Stream / Seep	Area (ha)	Most Recent Observation	Longitude	Latitude	Location
				Central coordinates (NAD 83)		
20799	Stream and seeps	81.2	2012	-73.8101 W	45.03785 N	Municipality of Havelock, Lavallée area
14974	Stream	53.9	2007	-73.7669°W	45.0355°N	Municipality of Havelock, Allen Stream
160	Streams	61.0	2013	-73.9614°W	45.0036°N	Municipality of Franklin, Canada-U.S. border, Jasper Stream
14970	Stream	19.7	2004	-73.7710°W	45.0091°N	Municipality of Havelock, du Gouffre Stream
14964	Seep	3.3	2003	-73.8150°W	45.0078°N	Municipality of Havelock, du Gouffre area
14963	Stream and seep	16.5	2004	-73.8749°W	45.0315°N	Municipality of Franklin, Cecyre area
18456	Seeps	76.7	2013	-73.7949°W	45.0360°N	Municipality of Havelock, Lavallée area
14962	Stream	15.2	2002	-73.8948°W	45.0185°N	Municipality of Franklin, Ulchen area, upstream of Outardes-Est River
162	Stream	13.3	1998	-73.9451°W	45.0013°N	Municipality of Franklin, Canada-U.S. border, Mitchell Stream
163	Stream	13.1	1992 ²	-73.8203°W	45.0207°N	Municipality of Havelock, Covey Hill road
14966	Stream	7.0	1990	-73.8250°W	45.0414°N	Municipality of Havelock, Brook Stream

¹ Refers to the EO_ID of CDPNQ.

² A 1997 observation is associated with this occurrence. However, it is located more than 1 km from occurrence 163. It is likely associated with another intermittent stream located closer to the observation (Lucie Veilleux, pers. comm.). For these reasons, the 1997 observation was deleted from this table.

Adapted from the Centre de Données sur le Patrimoine Naturel du Québec 2009.

Covey Hill peat bog

The peat bog on Covey Hill occupies an area of 70 hectares. It is located south of Covey Hill road, opposite the intersection with Montée Stevenson. The central position of the peat bog is as follows: -73.82648°W/45.00793°N (NAD 83).

7.2 Activities Likely to Result in the Destruction of Critical Habitat

Activities likely to cause the destruction of critical habitat are determined on a case-by-case basis. Destruction may occur if part of the critical habitat is subjected to temporary or permanent degradation and therefore no longer meets the needs of the species. Destruction may result from one or more activities carried out at a given time or from the cumulative effects of one or more activities carried out over a period of time (Government of Canada 2009).

Anthropogenic activities likely to result in the destruction of the critical habitat of Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population include the following:

- *Alteration of the hydrological regime (e.g., prolonged drying) and water quality.* The Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population currently inhabits slow-flowing streams and seeps. Its critical habitat is likely to be destroyed by any activity that affects the hydrological regime or water quality. One example is groundwater extraction, which could cause some streams and seeps to dry up, become altered, and become unavailable or unclear. Drainage activities affecting the Covey Hill peat bog or the forest environment are other practices that could destroy the critical habitat.
- *Conversion of habitat (direct loss).* Housing and cottage development, along with the associated road infrastructure and channelling, may cause direct habitat loss and destruction.
- *Soil disturbance.* Activities that result in soil compaction, such as the operation of forest machinery and all-terrain vehicles, are likely to destroy critical habitat since these activities can destroy shelters and make it difficult for the salamanders to dig burrows.

The examples provided do not constitute an exhaustive list of activities likely to result in the destruction of critical habitat.

8. MEASURING PROGRESS

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives. The success of this recovery program will be assessed every five years on the basis of the following indicators:

- the area of occupancy is maintained;
- individuals are present in each of the known occurrences.

9. STATEMENT ON ACTION PLANS

One or more action plans on the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population will be posted on the Species at Risk Public Registry within five years of the final recovery strategy document being posted.

10. REFERENCES

- AARQ. 1988 - . Atlas des amphibiens et des reptiles du Québec : banque de données active depuis 1988 alimentée par des bénévoles et professionnels de la faune. Société d'histoire naturelle de la vallée du Saint-Laurent et ministère des Ressources naturelles et de la Faune du Québec.
- Alvo, R., J. Bonin. 2003. Rapport sur la situation de la salamandre sombre des montagnes (*Desmognathus ochrophaeus*) au Québec (traduction française). Société de la faune et des parcs du Québec. 32 pp.
- Barrington, S., H. Pillion, J. Bonin. 1993. An evaluation of the water reserve potentials: the ecological region of the Covey Hill "Gulf". Report for The Nature Conservancy of Canada. 44 pp.
- Bider, J.R., S. Matte. 1991. Atlas des amphibiens et des reptiles du Québec. Société d'Histoire Naturelle de la Vallée du St-Laurent et ministère du Loisir, de la Chasse et de la Pêche, Québec. 429 pp.
- Bider, J.R., S. Matte. 1994. Atlas des amphibiens et des reptiles du Québec. Société d'histoire naturelle de la vallée du Saint-Laurent et ministère de l'Environnement et de la Faune du Québec. 106 pp.
- Bider, J.R., S. Matte. 1996. The Atlas of Amphibians and Reptiles of Quebec. St. Lawrence Valley Natural History Society and the ministère de l'Environnement et de la Faune, direction de la faune et des habitats: Québec, QC. 106 pp.
- Bishop, S.C. 1941. The salamanders of New York. New York State Museum Bulletin 324:329-359.
- Bonin, J. 1989. Statut des espèces de salamandres des ruisseaux dans le comté de Huntingdon, Québec. Rapport final présenté à la Direction générale de la ressource faunique, ministère du Loisir, de la Chasse et de la Pêche. 39p p.
- Bonin, J. 2001. Update on the status of *Desmognathus ochrophaeus* extrait du document original: Stratégie de rétablissement des salamandres des ruisseaux du complexe appalachien: *Gyrinophilus porphyriticus*, *Desmognathus ochrophaeus* et. *Desmognathus fuscus*. Direction du développement de la faune, Société de la faune et des parcs du Québec. 13 pp.
- Bouthillier, L. 2011. Inventaire d'acquisition de connaissance Salamandres sombres des Montagnes Covey Hill. 2010 field report. Ministère des Ressources Naturelles et Faune, Longueuil, Quebec.

- Bouthillier, L. Pers. comm. 2012. Email correspondence. November 2012. Chair of the Quebec stream salamander recovery team, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, Secteur de la faune, Direction des Opérations régionales de l'Estrie-Montréal-Montérégie, Longueuil, Quebec.
- Boutin, A. 2004. Rapport sur l'inventaire des salamandres sombres des montagnes (*Desmognathus ochrophaeus*) et sombres du nord (*Desmognathus fuscus*) réalisé dans la région de Covey Hill (Québec), de mai à septembre 2004. Presented to the Quebec stream salamander recovery team. 11 pp.
- Boutin, A. 2006. Caractérisation de l'habitat d'une communauté de salamandres de ruisseaux comportant des hybrides. Master of Science thesis submitted to the Faculty of Graduate Studies, Department of Biological Sciences, Université de Montréal. April 2006. 91 pp.
- Boutin, A. Pers. comm. 2012. Telephone conversation. December 2012. Biologist, Coordinator, Équipe de rétablissement des salamandres de ruisseaux du Québec, Montreal, Quebec.
- Branchaud, A. Pers. comm. 2009. Telephone conversation. October 2009. Biologist, Species at Risk Recovery, Environment Canada, Canadian Wildlife Service – Quebec Region, Montréal (Québec).
- Brooks, R.T. 2009. Potential impacts of global climate change on the hydrology and ecology of ephemeral freshwater systems of the forests of the northeastern United States. *Climate Change* 95:469-483.
- Centre de données sur le patrimoine naturel du Québec. 2009. Extraction des occurrences de la salamandre sombre des montagnes pour le territoire du Québec. Ministère des Ressources naturelles et de la Faune et ministère du Développement durable, de l'Environnement et des Parcs, Québec. Data retrieved in November 2009.
- Centre de données sur le patrimoine naturel du Québec. 2008. Spécifications d'occurrences (Eospecs) pour *Desmognathus ochrophaeus*. Ministère des Ressources naturelles et de la Faune et ministère du Développement durable, de l'Environnement et des Parcs, Québec. February 11, 2008 version. 4 pp.
- CRÉ Vallée du Haut-Saint-Laurent. 2006. Étude visant à proposer un ou des concepts de gestion et d'aménagement des ressources naturelles, Volet 1 – État de la situation relié à la forêt et aux ressources naturelles. Prepared by Groupe Desfor, in collaboration with the Agence forestière de la Montérégie and the ministère des Ressources naturelles et de la faune du Québec. 84 pp. + annexes.
- Conant, R., J.T. Collins. 1998. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston. 616 pp.

- COSEWIC. 2002. COSEWIC assessment and status report on the spring salamander *Gyrinophilus porphyriticus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 16 pp.
- COSEWIC. 2007. COSEWIC assessment and status report on the spring salamander *Gyrinophilus porphyriticus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 16 pp.
- Côté, M.-J., Y. Lachance, C. Lamontagne, M. Nastev, R. Plamondon, N. Roy. 2006. Atlas du bassin versant de la rivière Châteauguay. Ministère du Développement durable, de l'Environnement et des Parcs, en collaboration étroite avec la Commission géologique du Canada et l'Institut national de la recherche scientifique – Eau, Terre et Environnement. Quebec. 64 pp.
- Denman, N.S., F.W. Schueler and W.F. Weller. 1990. Geographic Distribution: *Eurycea bislineata bislineata*. Herpetological Review 21(2): 36.
- Frenette, M. Pers. comm. 2006. Telephone conversation. April 2006. Biologist, former coordinator, Équipe de rétablissement des salamandres de ruisseaux du Québec, Montreal, Quebec.
- Frenette, M. 2007. Bilan des actions de l'Équipe de rétablissement des salamandres de ruisseaux du Québec. Report drafted for the Équipe de rétablissement des salamandres de ruisseaux. Ministère des Ressources naturelles et de la Faune. 59 pp.
- Frenette, M. 2008. Plan de conservation des salamandres de ruisseaux au mont Covey Hill, Montérégie. Conservation de la nature Canada and Équipe de rétablissement des salamandres de ruisseaux. Montréal. 57 pp.
- Gibbs, J.P. 1998. Distribution of woodland amphibians along a forest fragmentation gradient. Landscape Ecology 13:263-268.
- Gordon, D.M. 1979. New localities for the Northern Spring Salamander and the Fourtoed Salamander in southwestern Quebec. Canadian Field-Naturalist 93:193-195.
- Government du Canada. 2009. *Species at Risk Act Policies, Overarching Policy Framework* [Draft]. *Species at Risk Act, Policies and Guidelines Series*. Environment Canada, Ottawa. 38 pp.
- Horizon multiressource Inc. 2001. Potentiel acéricoles des forêts privées des MRC de Vaudreuil-Soulanges, le Haut-Saint-Laurent et les Jardins-de-Napierville. Horizon multiressources Inc, Lachute. iv + 44 p.
- Jutras, J. (ed.). 2003. Plan d'intervention sur les salamandres de ruisseaux du Québec, Direction du développement de la faune, Société de la faune et des parcs du Québec, Québec. 26 pp.

- Knapp, S.M., C.A. Haas, D.N. Harpole, R.I. Kirkpatrick. 2003. Initial effects of clearcutting and alternative silvicultural practices on terrestrial salamander abundance. *Conservation Biology* 17(3):752-762.
- Larocque, M., G. Leroux, C. Maramoo Too, F.J. Lapointe, S. Pellerin, J. Bonin. 2006. Mise en place d'un Laboratoire naturel sur le mont Covey Hill (Québec, Canada). *VertigO – La revue en sciences de l'environnement* 7(1):11 pp.
- Larocque, M., L. Parrott, D. Green, M. Lavoie, S. Pellerin, J. Levison, P. Girard, M.-A. Ouellet. 2013. Modélisation hydrogéologique et modélisation des populations de salamandres sur le mont Covey Hill: Perspectives pour la conservation des habitats en présence de changements climatiques. Final report. May 2013. xii + 87 pp.
- Laurendeau, C. *in preparation*. Rapport d'inventaire de salamandres pourpres dans la région de l'Estrie en 2010 et dans les régions du Centre-du-Québec et de Chaudières-Appalaches en 2011. Québec. Ministère du Développement durable, Environnement, Faune et Parcs, Secteur Faune Québec.
- Laurendeau, C. *in preparation*. Rapport d'inventaire de salamandres pourpres à Saint-Robert-Bellarmin (Estrie) et aux Monts Foster, Glen et Bromont (Montérégie/Estrie) en 2012 au Québec. Ministère du Développement durable, Environnement, Faune et Parcs, Secteur Faune Québec.
- Lowe, W. H. 2012. Climate change is linked to long-term decline in a stream salamander. *Biological Conservation* 145: 48-53.
- Markle, T. M. 2006. Range limitations and phylogeography of stream salamanders in Quebec and Labrador. A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Master of Science. Department of Biology, McGill University, Montreal, Quebec, August 2006. 107pp.
- Ministère des Ressources naturelles et de la Faune du Québec. 2008. Protection des espèces menacées ou vulnérables en forêt publique — Les salamandres de ruisseaux : la salamandre pourpre (*Gyrinophilus porphyriticus*), la salamandre sombre des montagnes (*Desmognathus ochrophaeus*) et la salamandre sombre du Nord (*Desmognathus fuscus*). Faune Québec, Direction de l'expertise sur la faune et ses habitats. 38 pp.
- Nature Conservancy Canada. 2013. Inventaire et désignation de l'habitat légal de la salamandre sombre des montagnes. Update of the technical report produced in March 2012. March 2013. 2 pp.
- NatureServe. 2002. Element Occurrence Data Standard. NatureServe, Arlington, Virginia. URL: <http://www.natureserve.org/prodServices/eodata.jsp>. [Accessed February 11, 2011].

- NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application]. Version 5.0. NatureServe, Arlington, Virginia.
URL: <http://www.natureserve.org/explorer>. [Accessed September 10, 2010].
- Organ, J.A. 1961. Studies of the local distribution, life history, and population dynamics of the salamander genus *Desmognathus* in Virginia. *Ecological Monographs* 31:189-220.
- Orr, L.P. 1989. *Desmognathus ochrophaeus* (Cope), Mountain dusky salamander. pp. 181-189, in R.A. Pfungsten and F.L. Downs. *Salamanders of Ohio*. Bulletin of the Ohio Biological Survey 7(2). College of Biological Sciences, The Ohio State University. Columbus, Ohio.
- Petranka, J.W. 1998. *Salamanders of the United States and Canada*. Smithsonian Inst. Press, Washington. 576 pp.
- Rutherford, A., G. Leroux, C. Senecal, A. Boutin and C. Madramootoo. 2004. Using quantitative methods to gather small stream flow data for habitat characterization. Société de conservation et d'aménagement du bassin de la rivière Châteauguay (SCABRIC). 20 pp.
- Shaffer, F., Y. Bachand. 1989. Nouvelles localités pour la salamandre pourpre au Québec. *Naturaliste canadien* 116:279-281.
- Sharbel, T.F., J. Bonin. 1992. Northernmost record of *Desmognathus ochrophaeus*: Biochemical identification in the Châteauguay River drainage Basin, Quebec. *Journal of Herpetology* 26:505-508.
- Trottier, J. 2006. Impact de l'exploitation forestière sur la richesse et l'abondance des amphibiens de la forêt boréale méridionale du Bas-Saint-Laurent. Master's thesis. Université du Québec à Rimouski. 97 pp.
- Veilleux, L. Pers. comm. 2014. Email correspondence. February 2014. Wildlife technician, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, Direction régionale de l'Estrie, de Montréal et de la Montérégie, Longueuil (Québec).
- Weller, W. 1977. Distribution of stream salamanders in southwestern Quebec. *Canadian Field-Naturalist* 91:299-303.
- Weller, W.F. and J.E. Cebek. 1991a. Geographic Distribution: *Desmognathus fuscus fuscus*. *Herpetological Review* 22(1):23.
- Weller, W.F. and J.E. Cebek. 1991b. Geographic Distribution: *Eurycea bislineata*. *Herpetological Review* 22(1):23-24.
- Weller, W.F. and J.E. Cebek. 1991c. Geographic Distribution: *Gyrinophilus porphyriticus porphyriticus*. *Herpetological Review* 22(1):24.

Yagi, A.R., T. Markle, A. Brant and R. Tervo. 2010. Quebec & Ontario Stream Salamander Stewardship Guide, prepared for Environment Canada Habitat Stewardship Program. iii + 37 pp.

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*](#)⁸. 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.

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.

The most important broad strategy for recovery that is set out herein—that is, reducing the main threats to the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population and its habitat will have many positive effects on the surrounding biotic communities and the physical environment of Covey Hill.

In the Covey Hill area, the Allegheny Mountain Dusky Salamander is commonly found with the Northern Two-lined Salamander, the Redback Salamander, the Northern Dusky Salamander, and the Spring Salamander (Boutin 2006). It should be noted that the Northern Dusky Salamander is included on the list of species likely to be designated threatened or vulnerable in Quebec. The Spring Salamander is listed as vulnerable by the Quebec government. It is listed as a species of special concern in Canada (COSEWIC 2002) and included on Schedule 1 of SARA. Conservation of the habitat of the Allegheny Mountain Dusky Salamander, Great Lakes/St. Lawrence population will have an important beneficial effect on all the salamanders that share its habitat.

Overall, benefits are expected to accrue to all the plants and animals present in the species' habitat, whether they are associated with wetlands or forests. This includes other amphibian species, insect communities of the forest floor and streambanks, crayfish and stream-dwelling fish species as well as predators of amphibians (birds, mammals, rodents, reptiles).

In addition, habitat conservation will make it possible to limit the magnitude of most of the threats to the species. Conservation of the Covey Hill peat bog will also help to maintain the hydrological regime and the water quality in the Chateaugay River watershed.

⁸ <http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1>

The possibility that this recovery strategy will inadvertently have adverse effects on the environment and on other species has been considered. Since the recommended activities consist solely of non-intrusive actions, such as population surveys and monitoring, it can be concluded that the strategy will not have any significant negative effects.

APPENDIX B: CRITICAL HABITAT OF THE ALLEGHENY MOUNTAIN DUSKY SALAMANDER, GREAT LAKES/ST. LAWRENCE POPULATION

