

Recovery Strategy for the Northern Dusky Salamander (*Desmognathus fuscus*), Carolinian population, in Canada

Northern Dusky Salamander



2022



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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the [Species at Risk \(SAR\) Public Registry](https://www.sarregistry.gc.ca/)¹.

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¹ www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

RECOVERY STRATEGY FOR THE NORTHERN DUSKY SALAMANDER (*Desmognathus fuscus*), CAROLINIAN POPULATION, IN CANADA

2022

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of Ontario has given permission to the Government of Canada to adopt the *Recovery Strategy for the Allegheny Mountain Dusky Salamander (Desmognathus ochrophaeus) and the Northern Dusky Salamander (Desmognathus fuscus) in Ontario* (Part 2) and the *Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander – Ontario Government Response Statement* (Part 3) under Section 44 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the Northern Dusky Salamander, Carolinian population, in Canada consists of three parts:

Part 1 – Federal Addition to the *Recovery Strategy for the Allegheny Mountain Dusky Salamander (Desmognathus ochrophaeus) and the Northern Dusky Salamander (Desmognathus fuscus) in Ontario*, prepared by Environment and Climate Change Canada.

Part 2 – *Recovery Strategy for the Allegheny Mountain Dusky Salamander (Desmognathus ochrophaeus) and the Northern Dusky Salamander (Desmognathus fuscus) in Ontario*, prepared by Tricia Markle, Anne Yagi and David Green for the Ontario Ministry of Natural Resources².

Part 3 – *Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander – Ontario Government Response Statement*, prepared by the Ontario Ministry of Natural Resources.

² On June 26, 2014, the Ontario Ministry of Natural Resources became the Ontario Ministry of Natural Resources and Forestry.

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Part 3 – *Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander – Ontario Government Response Statement*, prepared by the Ontario Ministry of Natural Resources

Part 1 – Federal Addition to the *Recovery Strategy for the Allegheny Mountain Dusky Salamander (Desmognathus ochrophaeus)* and the *Northern Dusky Salamander (Desmognathus fuscus)* in Ontario, prepared by Environment and Climate Change Canada

Preface

The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#)³ 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 after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Northern Dusky Salamander, Carolinian population, and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Province of Ontario as per section 39(1) of SARA. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Ontario Ministry of Natural Resources (now the Ontario Ministry of Natural Resources and Forestry) led the development of the attached multi-species recovery strategy for the Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander (Part 2) in cooperation with Environment and Climate Change Canada. The Province of Ontario also led the development of the attached Government Response Statement (Part 3), which is the Ontario Government's policy response to its provincial recovery strategy and summarizes the prioritized actions that the Ontario government intends to take and support.

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 and Climate Change, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Northern Dusky Salamander, Carolinian 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 and Climate Change 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.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

³ www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area⁴ be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) of SARA will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federally protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per ss. 58(5.1) and ss. 58(5.2) of SARA.

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

⁴ These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

Acknowledgements

The Federal Addition to the *Recovery Strategy for the Allegheny Mountain Dusky Salamander* (*Desmognathus ochrophaeus*) and the *Northern Dusky Salamander* (*Desmognathus fuscus*) in Ontario (Part 1) was prepared by Christina Rohe and Marie-Claude Archambault (Environment and Climate Change Canada, Canadian Wildlife Service – Ontario).

The Federal Addition benefited from review and input from the following individuals and organizations: Karolyne Pickett, John Brett, Angela Darwin, Krista Holmes, and Elizabeth Rezek (Environment and Climate Change Canada); Joe Crowley, Megan McAndrew, Lucy Ellis, Mark Hulsman, Fiona McGuinness, Glenn Desy (Ontario Ministry of Natural Resources and Forestry) and Don Sutherland (Natural Heritage Information Centre).

Acknowledgement and thanks is given to all other parties that provided advice and input used to help inform the development of this recovery strategy.

Additions and Modifications to the Adopted Document

The following sections (Part 1) have been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Recovery Strategy for the Allegheny Mountain Dusky Salamander* (*Desmognathus ochrophaeus*) and the *Northern Dusky Salamander* (*Desmognathus fuscus*) in Ontario (Part 2 of this document, referred to henceforth as “the provincial recovery strategy”) and to provide updated or additional information.

Environment and Climate Change Canada is adopting the Ontario recovery strategy (Part 2) with the exception of section 2.0, Recovery. In place of section 2.0, Environment and Climate Change Canada has established a population and distribution objective and performance indicators, and is adopting the Government of Ontario’s government-led and government-supported actions of the *Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander – Ontario Government Response Statement* (Part 3) as the broad strategies and general approaches to meet the population and distribution objective.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery strategy referring to protection of the species’ habitat may not directly correspond to federal requirements with respect to critical habitat. Recovery measures dealing with the protection of habitat are adopted; however, whether these measures will result in protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

Only those portions of the Ontario recovery strategy pertaining to the Northern Dusky Salamander are being adopted in this recovery strategy.

The Canadian range of the Northern Dusky Salamander (*Desmognathus fuscus*) is disjunct, representing two designatable units: the Carolinian population in Ontario and the ‘Quebec/New Brunswick’ population in Quebec and New Brunswick (COSEWIC 2012). This recovery strategy is specific to the Carolinian population in Ontario, and the Northern Dusky Salamander, Carolinian population, will hereafter be referred to as the Northern Dusky Salamander unless otherwise referenced.

Recovery Feasibility Summary

The Government of Canada published the proposed “*Species at Risk Act* Policies - Policy on Survival and Recovery⁵” (2016) to guide consistent interpretation of major concepts applicable under the federal *Species at Risk Act* (SARA). Recovery feasibility for the Northern Dusky Salamander, Carolinian population, was assessed following this

⁵ www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/policies-guidelines/survival-recovery-2016.html

guidance. If new information becomes available or if required due to amendments to the Policy on Survival and Recovery, recovery feasibility may be re-assessed in an amendment to this recovery strategy.

Based on the best available information, the Northern Dusky Salamander was probably never particularly widespread or abundant within Canada and is considered to be historically precarious⁶ in Canada (see Appendix A for details). The dusky salamander genus was first reported in Ontario (unspecified location) in 1908 with a subsequent report that mentions its occurrence in 'Ontario opposite Buffalo, New York' (Markle et al. 2013). It wasn't until 1989 when the Northern Dusky Salamander (identified to species level) was confirmed in Ontario, within the Niagara Gorge (Markle et al. 2013). Despite targeted surveys in proximate suitable habitats, it is only known from this one extant location within the Niagara Gorge (COSEWIC 2012). The nearest known population is over 30 km away in New York State and is more than 420 km from the Quebec / New Brunswick population (COSEWIC 2012).

For a species that is determined to be historically precarious, recovery will be considered feasible if the extent of irreversible change⁷ is such that under the best achievable scenario⁸ the condition of the species can be improved to a point that it is approaching the historical condition⁹. The main instance of irreversible change that must be considered for this population is the urbanization of the adjacent up-gradient habitat that supports the species' aquatic habitat through the provision of groundwater flows. The species is also highly susceptible to ecological, demographic and genetic stochasticity (chance events) due to the very small size and isolation of its single known population (See Appendix A for further details).

There are unknowns regarding the feasibility of recovery for the Northern Dusky Salamander. In keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be feasible. This recovery strategy attempts to address the unknowns surrounding the feasibility of recovery. A more thorough discussion of the recovery feasibility assessment for Northern Dusky Salamander can be found in Appendix A.

⁶ A species that, prior to significant effects from human activity, was below the survival threshold or was dependent on demographic connectivity with outside populations for the long-term presence in Canada according to the best available information on the species population in Canada. Such a species may be recovered by achieving a condition that approximates its historical state (GOC 2016).

⁷ A change that results in the establishment of a new set of ecological or biological conditions that constrain the ability of the species to return to its historic condition and which cannot reasonably be changed in a way that improves those conditions for the species within a biologically relevant time frame (e.g., loss of genetic diversity, loss of food/host species, effects of permanent infrastructure) (GOC 2016).

⁸ The biologically and technically achievable scenario with the lowest possible risk of extinction to the species that can be achieved, taking into account irreversible change (GOC 2016).

⁹ An estimate of the historic level of redundancy, resilience, representation, population and distribution, trend, threats, ecological role and any other factors that together determine the risk of extinction or extirpation of the species in Canada prior to significant effects of human activity, based on best available information (GOC 2016).

Assessing Recovery Feasibility

To determine whether recovery is technically and biologically feasible for a historically precarious species, such as the Northern Dusky Salamander, any information that is known or estimated about the historical condition of the species should be used to understand the appropriate context of each fundamental species characteristic in question (Table 1) (GOC 2016; Appendix A).

Table 1. Determination of Recovery Feasibility for Historically Precarious Species

Fundamental Species Characteristic	Recovery Threshold	Technically and Biologically Feasible to Achieve Recovery Threshold Quickly Enough to Help the Species? (Y/N/Unknown)
Population Trend	Approximating historical condition	Unknown
Resilience (Population size)	Approximating historical condition	Unknown
Redundancy (Population # / Distribution)	Approximating historical condition	Unknown
Population Connectivity	Approximating historical condition	Unknown
Mitigation of Human-caused Threats	Significant threats avoided or mitigated to the extent that they no longer threaten the species	Unknown
Species Condition¹⁰	Improved over when first assessed as at risk	Unknown
Representation (Species presence in appropriate ecological communities)	Approximating historical condition at a coarse scale	Yes
Independent of Connectivity with populations outside of Canada	Connectivity okay if necessary	Yes
Independent of Species Interventions	Yes	Yes

¹⁰ The condition of the species refers to the combination of the level of redundancy, resilience, representation, population and distribution, trend, threats, ecological role and any other factors that together determine the risk of extinction or extirpation of the species in Canada. The condition of the species refers to the combination of its population size, distribution, trend, threats, ecological roles and any factors that together determine the risk of extinction or extirpation of the species (GOC 2016).

Summary of Recovery Feasibility

Northern Dusky Salamanders are restricted to a narrow range of habitat conditions and access to cool, highly oxygenated, first-order forested streams or seeps (Markle et al. 2013; COSEWIC 2012). The extant distribution of the population is highly localized and may never have existed well beyond the Niagara Gorge. In addition, with the nearest known U.S. population being over 30km away, it is unlikely that the Ontario population of the Northern Dusky Salamander was historically reliant on populations outside of Canada (COSEWIC 2012). Though it is not known if there was historical connectivity to additional populations in the more immediate vicinity, it is possible that other local populations exist and have not yet been discovered. As such, it is unknown whether unsuccessful search effort is due to the species having more specific requirements than is currently understood (COSEWIC 2012). There is a rough estimate of 7 to 35 mature individuals in the extant Northern Dusky Salamander population (COSEWIC 2012); however, it is unknown if this population size approximates historical condition.

Changes in the supply and quality of water threaten the persistence of this population. The species is dependent on the source water that sustains the streams and seeps where it is found in the Niagara Gorge. Trampling of the streams and seeps by people during recreational activities are also a threat (Markle et al. 2013). It is unknown if significant threats can be avoided or mitigated to the extent that they no longer threaten the species. The Ontario population of Northern Dusky Salamander appears to be self-sustaining but a standardized survey and monitoring program is needed to monitor the genetic health and trends in the population (Markle et al. 2013; Part 3). In addition, periodic habitat management will likely be required to help maintain habitat suitability (e.g., invasive species removal, planting native trees).

The minimum viable population size¹¹ for the Northern Dusky Salamander has not been determined; however, establishing this would provide a better understanding of the number of individuals needed to maintain a self-sustaining population that is resilient against chance random events (e.g., erosion, slope failure, mudslides).

Based on the assessment of recovery feasibility above (i.e., a large number of unknowns, but the absence of any answers to suggest that recovery is not technically or biologically feasible), the recovery feasibility of the Northern Dusky Salamander is considered unknown. It is likely that the species was never widespread in the region, and it will likely always be vulnerable to human-caused stressors and natural, random events. The population will likely continue to be considered rare in Canada despite research to fill knowledge gaps and recovery actions to mitigate threats.

¹¹ An estimate of the number of individuals required for a high probability of survival of a population over a given period of time.

1. COSEWIC* Species Assessment Information

Date of Assessment: May 2012

Common Name (population): Northern Dusky Salamander (Carolinian population)

Scientific Name: *Desmognathus fuscus*

COSEWIC Status: Endangered

Reason for Designation: This species is restricted to one small creek sustained by groundwater seepage on the steep slope of a gorge vulnerable to erosion, atmospheric deposition of pollutants and habitat acidification. The population is small and susceptible to ecological, demographic and genetic stochasticity.

Canadian Occurrence: Ontario

COSEWIC Status History: The species was considered a single unit and designated Not at Risk in April 1999. Split into two populations in May 2012. The Carolinian population was designated Endangered in May 2012.

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

2. Species Status Information

The Northern Dusky Salamander¹² is a lungless salamander that occurs in three Canadian provinces (Ontario, Quebec and New Brunswick) and throughout the north-eastern United States (Appendix B). The species comprises two designatable units (DUs) within Canada: the Carolinian population (occurring in Ontario), and the Quebec/New Brunswick population (occurring in Quebec and New Brunswick). This recovery strategy is specific to the population occurring in Ontario and represents the Northern Dusky Salamander - Carolinian population.

The global conservation status rank for Northern Dusky Salamander¹³, last reviewed on May 10, 2016, is Secure (G5) (NatureServe 2017). In Canada, the species is ranked Vulnerable-Apparently Secure (N3N4), a numeric range rank (i.e., Vulnerable (N3) - Apparently Secure (N4)) is used to indicate uncertainty about the exact status of the taxon (Master et al. 2012). At the subnational scale in Canada, the species is ranked Vulnerable in Quebec and New Brunswick (S3), and Critically Imperiled in Ontario (S1). Definitions of Global (G), National (N) and Subnational (S) ranks, as well as the national and subnational ranks of Northern Dusky Salamander in the United States, are provided in Appendix B.

¹² This reference to the Northern Dusky Salamander is not specific to the Carolinian population.

¹³ This assessment of the species is on a global scale and is not limited to the Carolinian population.

In Ontario, the Northern Dusky Salamander is known from only one location in the Niagara Gorge and was listed as Endangered¹⁴ on Schedule 1 of the federal *Species at Risk Act* (SARA) in June 2017. The Northern Dusky Salamander is listed as Endangered¹⁵ under the provincial *Endangered Species Act, 2007* (ESA).

The Canadian distribution (i.e., both DUs) accounts for about 5% of the global range and of this, Ontario only represents a small proportion of this percentage in the Niagara Gorge (Carolinian population), with the remaining larger proportion being in Quebec and scattered areas in southern New Brunswick (Quebec / New Brunswick population) (COSEWIC 2012).

3. Threats

The provincial *Recovery Strategy for the Allegheny Mountain Dusky Salamander* (*Desmognathus ochrophaeus*) and the *Northern Dusky Salamander* (*Desmognathus fuscus*) in Ontario (Part 2) describes the threats to survival and recovery of the Northern Dusky Salamander in Ontario. Environment and Climate Change Canada is adding a recently discovered threat, which is described below.

Disease from alien pathogens

The Northern Dusky Salamander could be highly vulnerable in the face of pathogen introduction due to its small population size and geographic isolation. Pathogens like ranaviruses and chytrid fungi *Batrachochytrium dendrobatidis* and *Batrachochytrium salamandrivorans* are introduced through regional and international trade of animals, and have caused important declines in amphibians and other ectotherms around the world (Duffus et al. 2015; Yap et al. 2015). Mortalities caused by Ranaviruses and *B. dendrobatidis* have been documented in various amphibian species of Canada (Hughey et al. 2014; Duffus et al. 2015). *B. salamandrivorans*, a pathogen specific to salamanders, has not yet been recorded in North America, but introduction is considered likely given considerable salamander imports from Asia where the disease originates (Yap et al. 2015). A number of mitigation measures have been proposed for at-risk species, including treatments of infected populations and application of prevention protocols in animal trade (Scheele et al. 2014; Yap et al. 2015). Considering the limited and evolving understanding of these diseases, as well as the enforcement challenges associated with identifying different salamander species at Canada's numerous ports of entry, the Government of Canada implemented a precautionary, one-year import restriction prohibiting the import of all species of the order Caudata (living or dead) (such as salamanders, newts and mudpuppies) into Canada (unless authorized by a permit issued by Environment and Climate Change Canada) while additional scientific data was collected and analyzed, and longer-term options were explored. This import restriction, implemented through an amendment to the federal Wild Animal and Plant Trade Regulations (WAPTR) came into effect on May 31, 2017.

¹⁴ Under SARA, an endangered species means a wildlife species that is facing imminent extirpation or extinction.

¹⁵ Under the ESA, a species shall be classified as an endangered species if it lives in the wild in Ontario but is facing imminent extinction or extirpation.

After this one-year restriction, the best available scientific information indicated that these pathogens continue to pose a significant conservation threat to Canadian salamanders, so a longer-term approach prohibiting the import of all species of the order Caudata unless accompanied by a permit came into effect on May 12, 2018 through an amendment to the WAPTR in order to replace the one-year temporary import restriction on salamanders.

4. Population and Distribution Objectives

Under subsection 41 (1) (d) of SARA, a population and distribution objective must be established for listed endangered, threatened and extirpated species when recovery is deemed feasible. The population and distribution objective established by Environment and Climate Change Canada for the Northern Dusky Salamander is to:

- Maintain the one known local population in Ontario and promote natural population expansion in the general area occupied by the species.

Based on the provincial record, only a single population of the Northern Dusky Salamander has ever been confirmed in Ontario. Due to the small, isolated range the species inhabits, it is highly susceptible to habitat change (e.g., in quality or availability) and continued degradation could compromise the long-term survival of the Carolinian population. The Northern Dusky Salamander is primarily found in seepages, small streams and surrounding forested areas with an abundance of refuges (e.g. woody debris, rocks) to carry out its life processes (breeding, egg-laying, overwintering, larval development, foraging, daytime retreats and dispersal) (Markle et al. 2013). The suitable habitat required by the Northern Dusky Salamander is considered highly specific and naturally rare in southwestern Ontario (Markle et al. 2013). Maintaining the current distribution in Ontario will in part, depend on maintaining the suitable habitat conditions, particularly groundwater quantity and quality. Recovery actions that protect and manage the surface water and groundwater system that sustains the seep and stream habitat of the Northern Dusky Salamander will be a key priority. Improving knowledge of the population demographics and specific habitat requirements in Ontario, encouraging the implementation of beneficial management practices that minimize impacts on groundwater recharge areas and seeps, and supporting education and awareness that inspire collaboration in the protection and recovery of the species (Part 3) will promote the feasibility of natural population expansion and likely contribute to the success of the population and distribution objective overall.

The objective focuses on the continued persistence of the one extant population rather than a quantitative target (e.g., effective population size), based on the best available information at the time of posting this recovery strategy. The current population abundance is estimated to be between 7-35 mature individuals (COSEWIC 2012). All life stages have been observed, and based on information to date, it appears that the local population is reproducing and is considered to be self-sustaining¹⁶ (Markle et al.

¹⁶ A population that on average demonstrates stable or positive population growth and is large enough to withstand random events and persist in the long term without the need for permanent active management intervention.

2013). However, stochastic events (e.g. mudslides) pose a threat to this population as it is small in size and restricted to a single known general location in Ontario. Supporting the development and implementation of a standardized survey and monitoring program will benefit the extant known population and enable the possibility of discovering new ones (Part 3). Although a larger population size does not protect against all threats, it is a strong predictor of resilience against rates of decline due to inbreeding or chance events. Because the species is a poor overland disperser, opportunity for the population to naturally increase will in part be dependent on stream network connectivity (COSEWIC 2012). As such, due to limitations of site accessibility, temporary waterways formed during heavy rainfall may provide dispersal access between otherwise terrestrially isolated streams/seeps (COSEWIC 2012). For these reasons, the support of a natural increase in its extant distribution is warranted and where possible, promoting natural increases should be supported (Part 3).

This objective is consistent with the province of Ontario's Government Response Statement developed under the provincial *Endangered Species Act*, which outlines the provincial government's goal for the recovery of the species and summarizes the prioritized actions the government intends to take and support (see Part 3 for more information). The Government Response Statement for the province of Ontario lists the following recovery goal for the recovery of the Northern Dusky Salamander in Ontario:

- The government's goal for the recovery of the Northern Dusky Salamander is to maintain suitable habitat conditions in the Niagara Gorge in order to retain existing known populations in a self-sustaining state and promote natural increases.

5. Broad Strategies and General Approaches to Meet Objectives

The government-led and government-supported actions identified in the *Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander – Ontario Government Response Statement* (Part 3) as they pertain to the Northern Dusky Salamander, are adopted as the broad strategies and general approaches to meet the population and distribution objectives. In addition to the actions identified in Ontario's Government Response Statement, Environment and Climate Change Canada is modifying the Government-led Actions, for the purpose of this recovery strategy, to read as follows:

- Support actions that continue to address the limited and evolving understanding of disease from alien pathogens and Northern Dusky Salamander recovery.

6. Critical Habitat

6.1 Identification of the Species' Critical Habitat

Section 41(1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. Under section 2(1) of SARA, critical habitat is "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

Identification of critical habitat is not a component of provincial recovery strategies developed under the Province of Ontario's ESA. Under the ESA, when a species becomes listed as endangered or threatened on the Species at Risk in Ontario List, it automatically receives general habitat protection. The Northern Dusky Salamander currently receives general habitat protection under the ESA. In some cases, a habitat regulation may be developed that replaces the general habitat protection. A habitat regulation is a legal instrument that prescribes an area that will be protected¹⁷ as the habitat of the species by the Province of Ontario. A habitat regulation has not been developed for the Northern Dusky Salamander; however, the provincial recovery strategy includes a recommendation on the area that should be considered in developing a habitat regulation for the species (see Part 2, section 2.5).

Critical habitat for the Northern Dusky Salamander in Canada occurs within the 1 km x 1 km standardized UTM grid squares where the critical habitat criteria and extent of biophysical attributes described in this section are met (Figure 1). Detailed critical habitat mapping is not presented in the document owing to identified threat of trampling of the streams and seeps by hikers and curiosity-seekers (such as naturalists) searching for the species and disturbing the habitat the Northern Dusky Salamander depends upon.

Critical habitat for the Northern Dusky Salamander in Canada is identified in this federal recovery strategy for the one extant population. The identified area containing critical habitat is considered insufficient to achieve the population and distribution objectives, as there is a need to better understand the groundwater hydrology that maintains suitable habitat for the species. Therefore a Schedule of Studies has been included (Table 3). If new or additional information becomes available, refinements to, or additional critical habitat may be identified in an amendment to this recovery strategy. For more information on critical habitat identification, contact Environment and Climate Change Canada – Canadian Wildlife Service at ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

¹⁷ Under the federal Species at Risk Act (SARA), there are specific requirements and processes set out regarding the protection of critical habitat. Protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

6.1.1 Areas Containing Critical Habitat

In Canada, the presence and persistence of the Northern Dusky Salamander depends on an area greater than that occupied by individuals of the species. It requires landscape features that promote and maintain suitable habitat¹⁸ for the salamanders and allow for natural processes related to healthy population dynamics and reproduction to occur. The area containing critical habitat for the Northern Dusky Salamander is the landscape feature (i.e., the deciduous forest embankment of the Niagara Gorge) where the Northern Dusky Salamander is known to occur¹⁹.

6.1.2 Biophysical Attributes of Critical Habitat

Northern Dusky Salamanders depend upon the groundwater discharge that feeds the streams and seeps in which they dwell, and are typically found along the edges of small high quality woodland streams, and in damp seepage areas where there is an abundance of logs, stones and leaf litter. Terrestrial habitat provides necessary protection against high temperatures and maintains humidity, as well as cover objects for shelter and protection from predators. Adult salamanders will forage along seepage areas and streams and the forest floor. The biophysical attributes of the critical habitat for the Northern Dusky Salamander include:

Aquatic habitat

- Seepages, portions of streams or wet cavities from intermittent (permanent and semi-permanent) seeps or streams that are of sufficient quality²⁰ to support Northern Dusky Salamander (from groundwater discharge to Niagara River edge); AND

Terrestrial habitat

Shaded and moist forested habitat with available leaf litter, woody debris, rocks and naturally vegetated habitat within 75 metres²¹ on either side of intermittent (permanent and semi-permanent) seeps or streams.

¹⁸ Suitable habitat is composed of the biophysical attributes (e.g. soil and moisture conditions, light penetration, species composition and species interactions) that provide individuals of the species the necessary conditions to carry out essential life processes.

¹⁹ Based on data available to Environment and Climate Change Canada as of July 2017; the landscape feature is included up to 75 m from the seeps and streams where the Northern Dusky Salamander is known to occur.

²⁰ Salamanders are important indicators of ecosystem health, requiring relatively high water quality (e.g. clear and low turbidity) and are highly sensitive to stream pollution and siltation (COSEWIC 2012). Physiochemical and biological changes to habitat caused by urbanization (e.g., impacts from runoff, salting, or pollution) can vary, but the detrimental impacts of these changes on salamander populations are consistent (Barrett and Price 2014). However, should the aquatic habitat become impacted (e.g., by a severe rain or pollution event), thus compromising its quality, it is still considered as meeting the biophysical attributes until it is determined to no longer support the salamander.

²¹ Home ranges for Northern Dusky Salamanders are estimated to be within 15 m of a stream or seep (Hom 1987). Maximum dispersal limit within suitable habitat has been estimated as 30 m on either side of a stream (COSSARO 2012), but it is possible that travelled distances may increase during cool and wet

Table 2: Grid squares that contain critical habitat for the Northern Dusky Salamander, Carolinian population, in Canada. Critical habitat for the Northern Dusky Salamander may occur within these 1 x 1 km standardized UTM grid squares where the description of critical habitat is met.

1 x 1 km Standardized UTM grid square ID ^a	Province/Territory	UTM Grid Square Coordinates ^b		Land Tenure ^c
		Easting	Northing	
17TPH5766	Ontario	656000	4776000	Non-federal Land
17TPH5776		657000	4776000	

^a Based on the standard UTM Military Grid Reference System (see <http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9789>), where the first 2 digits represent the UTM Zone, followed by a letter representing the UTM Band, the following 2 letters indicate the 100 x 100 km standardized UTM grid, followed by 2 digits to represent the 10 x 10 km standardized UTM, and the last 2 digits indicate the 1 x 1 km standardized UTM grid containing the geographic location of the area containing critical habitat. This unique alphanumeric code is based on the methodology produced from the Breeding Bird Atlases of Canada (See <http://www.bsc-eoc.org> for more information on breeding bird atlases).

^b The listed coordinates are a cartographic representation of where the geographic location of the area containing critical habitat can be found, presented as the southwest corner of the 1 x 1 km standardized UTM grid square. The coordinates are provided as a general location only.

^c Land tenure is provided as an approximation of the types of land ownership that exist at the geographic location of the area containing critical habitat and should be used for guidance purposes only. Accurate land tenure will require cross referencing geographic location boundaries with surveyed land parcel information.

periods (Markle et al. 2013). Due to the dynamic nature of the seeps within the area containing critical habitat, a 75 m distance extending from either side of all permanent and semi-permanent seeps or streams where the Northern Dusky Salamander is known to occur defines the terrestrial portion of critical habitat to ensure that all suitable habitat for Northern Dusky Salamander is included.

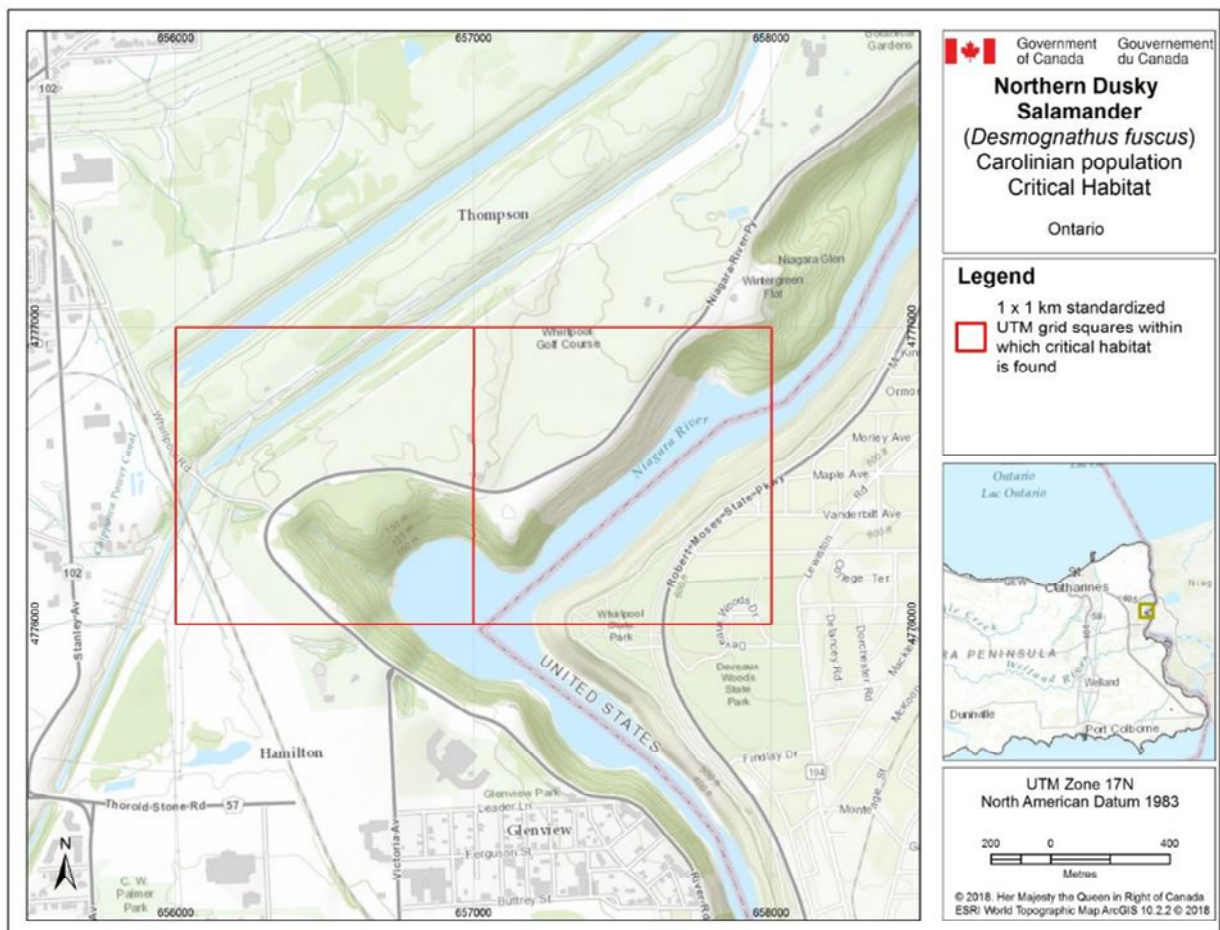


Figure 1. Critical habitat for the Northern Dusky Salamander, Carolinian population, occurs within the 1 x 1 km standardized UTM grid squares indicated (red outline) where the criteria and biophysical attributes set out in section 6.1 are met. This standardized national grid system indicates the general geographic area within which critical habitat is found; detailed critical habitat mapping is not shown.

6.2 Schedule of Studies to Identify Critical Habitat

Table 3. Schedule of Studies to Identify Critical Habitat

Description of Activity	Rationale	Timeline
Identify the extent of the groundwater recharge area necessary to sustain the seep and stream habitat supporting the species.	As the local population is associated to intermittent groundwater discharge stream(s), there is a need to better understand the groundwater hydrology that maintains suitable habitat for the species in order to determine the specific biophysical attributes and how much habitat is required to meet the population and distribution objective.	2027

6.3 Activities Likely to Result in Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part or all of the critical habitat was degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single activity or multiple activities at one point in time or from the cumulative effects of one or more activities over time. It should be noted that not all activities that occur in or near critical habitat are likely to cause its destruction. Activities described in Table 4 are examples of those likely to cause destruction of critical habitat for the species; however, destructive activities are not necessarily limited to those listed.

Currently, the greatest threat to Northern Dusky Salamander habitat is any activity that changes the hydrology (quantity or quality) of its habitat. Detrimental changes may include increased or decreased peak flows and discharge volumes, increased turbidity or sedimentation, increased water temperature, and altered water chemistry through contaminated surface water. The groundwater recharge area outside the Niagara Gorge is heavily developed for urban and industrial uses. Development activities that reduce, redirect, or stop the groundwater flow that feeds the inhabited seeps and streams would threaten this population. Further research is required to accurately measure, forecast, and detect changes in the quantity and quality of water supporting the species' habitat (Part 3). This information is required to identify the type of activities likely to cause harm, their geographic extent, and the level of each activity likely to cause harm (i.e. thresholds).

Table 4. Activities Likely to Result in the Destruction of Critical Habitat

Description of Activity	Description of effect in relation to function loss	Details of effect
Activities that result in the removal, redirection or reduction of groundwater and surface water levels (e.g., water extraction for urban development, water management, golf courses).	Hydrological changes may destroy or degrade suitable habitat by modifying or disrupting water flow, water balance or soil moisture. The Northern Dusky Salamander is lungless and relies on its moist skin for respiration, and as a result, any deterioration or interruption of the groundwater and surface water that supports the species could potentially have catastrophic effects.	When conducted within or outside the boundaries of critical habitat, such activities may result in the destruction of this habitat if the water level and flow that contribute to the maintenance of critical habitat are altered.
Activities that increase the quantity of surface water runoff (e.g. storm water runoff from residential development and roads).	Storm water management and increases in impervious surface area may result in landslides or mudslides (which have the potential to re-direct or even completely remove the stream that is inhabited by the species). This could alter water quality in seeps and streams by increasing turbidity and sedimentation and result in the net removal, disturbance or destruction of cover objects (e.g., rocks, logs or woody debris) and/or canopy cover (e.g., displacement of trees).	If this activity occurs within or adjacent to critical habitat, at any time of year, the effects will be direct and cumulative and are likely to destroy or impair critical habitat.
Activities that release pollutants in the groundwater recharge area or directly into surface water where the species occurs (e.g. pesticides, atmospheric deposition, industrial chemicals, road salt).	Pollutants entering the groundwater recharge area and/or directly to the surface water that supports the species could potentially reduce water quality, degrade habitat and expose the Northern Dusky Salamander to environmental toxicity.	If this activity occurs within or outside of the critical habitat (groundwater recharge largely occurs outside of critical habitat bounds), at any time of year, the effects may be direct and cumulative and could destroy or impair critical habitat.
Development activities that result in the net removal of habitat (e.g., tree harvesting, site clearing)	Tree harvesting, site clearing (e.g., infrastructure for tourism) and other activities that result in the net removal of habitat would result in the direct loss of habitat which the species relies on (e.g., foraging, loss of canopy, overwintering).	If this activity occurs within critical habitat at any time of year, the effects will be direct and will destroy or impair critical habitat.
Introduction of exotic and invasive plant species such as European Common Reed (<i>Phragmites australis</i>)	<p>European Common Reed may be eliminating shoreline habitat where it is able to form thick stands, thus reducing the access and availability of shoreline habitat for the species (e.g., foraging habitat, daytime retreat along the banks, dispersal corridor).</p> <p>Once introduced, any activities that result in the loss of native vegetation (e.g., off-trail hiking) favours the spread of exotic and invasive plant species.</p> <p>Exotic and invasive plant species have strong dispersal capabilities, thus may spread to critical habitat over time and cause destruction.</p>	If this activity occurs within critical habitat, at any time of year, the effects will be direct and most likely result in the destruction or damage of critical habitat.

Off-trail hiking and other recreational activities (e.g., bouldering ²²)	Off-trail hiking and bouldering activities can displace objects used for cover by the species, increase water turbidity, and erode the stream bed and its banks through direct trampling, trampling of vegetation.	If this activity occurs within critical habitat at any time of year, the effects will be direct and most likely result in the destruction or damage of critical habitat.
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7. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives. Every five years, success of recovery strategy implementation will be measured against the following performance indicators:

1. Number of mature individuals in Canada is between 7 to 35 or more.
2. Natural population expansion has been promoted through actions to maintain suitable habitat in the general area occupied by the species.

8. Statement on Action Plans

One or more action plans will be completed for Northern Dusky Salamander, Carolinian population, and posted on the Species at Risk Public Registry by 2027.

²² Bouldering is the activity (sport) of climbing on large boulders.

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Appendix A: Historical Context for Northern Dusky Salamander

Historical Context

The first step in determining the recovery feasibility of the Northern Dusky Salamander is to establish the historical context (whether the species' existence in Canada was historically precarious or not precarious). To make this determination, Environment and Climate Change Canada uses the four criteria outlined below. A species is considered to have been historically precarious if any of the following are known or likely to have been true in Canada, prior to significant effects from human activity:

1. The species was undergoing a long-term natural decline;
 - Unknown. The number of mature individuals observed in the Niagara Gorge location is very low, but there is no available long-term data on trends (COSEWIC 2012).
2. The species consisted of fewer than 1,000 mature individuals;
 - Unknown. Presumed Yes. The exact number of mature individuals is unknown. Since 2005, a total of 79 individuals have been observed at the one known location in the Niagara Gorge (Markle et al. 2013). It is unknown if the species historically existed in much higher numbers.
3. The species existed at five or fewer locations or less than 20 km² index of area of occupancy (IAO);
 - Unknown. Presumed Yes. The Northern Dusky Salamander, Carolinian population, is known from only one location despite targeted survey effort in nearby areas of suitable sites. The species has an index of area of occupancy (IAO)²³ of 4 km² (COSEWIC 2012).
4. The species was dependent on connectivity with populations outside Canada for its long term presence in Canada.
 - No. Due to the species' limited dispersal ability, specific habitat needs, and the vast geographic separation of >30 km between the nearest extant population in New York State, as well as the barrier created by the large and fast flowing Niagara River, there is no evidence to suggest that historic (or current) Northern Dusky Salamanders were connected to populations in the United States (COSEWIC 2012).

Based on this assessment, the Northern Dusky Salamander was never particularly widespread or abundant and is therefore presumed to have been historically precarious.

²³ A biologically defensible estimate of the occupied habitat within a wildlife species' range. Measured by an estimate of the number of grid squares occupied by extant populations (<https://cosewic.ca/index.php/en-ca/reports/preparing-status-reports/guidelines-index-area-occupancy.html>).

Extent of Irreversible Change

The Northern Dusky Salamander is confirmed from only a single location on a steep forested talus slope within the Niagara Gorge (in the area of the 'Whirlpool' of the Niagara River) (COSEWIC 2012; Markle et al. 2013). At this location, the entire population is confined between the urbanized up-gradient tableland at the top of the Niagara Gorge and the fast flowing Niagara River along the bottom. The population is further limited within the Niagara Gorge by suitable habitat availability, dispersal opportunity and the unlikely chance of a rescue effect²⁴ (COSEWIC 2012; Markle et al. 2013).

The primary threats to the survival and recovery of this population include changes in water flow or water quality that degrade or destroy suitable habitat. The Niagara region of Ontario has undergone significant urban and agricultural development since European settlement, resulting in a loss of high quality groundwater habitat. The Northern Dusky Salamander was first documented in Ontario in 1989, well after much of this change had already taken place. However, the species requires cool, highly oxygenated, first-order streams and nearby forested habitat but a continued decline in quality of habitat, specifically through run-off and erosion on hillsides in the species habitat is a concern. The effect of trampling by humans has also accelerated erosion and siltation.

Due to the isolation and small population size, continued persistence of this population is highly dependent upon a naturally functioning deciduous forest ecosystem that supports the species needs within the Niagara Gorge and requires reducing threats within the adjacent urbanized landscape (COSEWIC 2012; Markle et al. 2013).

Narrative to Support Recovery Feasibility

Population Trend

For the purposes of determining recovery feasibility, the population trend refers to whether a species' population can become stable or increase over a biologically relevant timeline.

The minimum recovery threshold for historically precarious species allows for a population trend to be evaluated over a period of ten years or three generations, whichever is longer (up to 100 years). The generation time of the Northern Dusky Salamander is approximately six years (COSEWIC 2012) therefore, a period of eighteen years is the appropriate timeframe to provide information on the species' population trends.

In 1989, two local populations of dusky salamanders were recorded within the Niagara Gorge and until recently, both populations were presumed to be Northern Dusky Salamanders. It wasn't until 2004 when genetic tests confirmed one of the

²⁴ Genetic or demographic immigration into a population to reduce extinction pressures.

two populations to be Allegheny Mountain Dusky Salamanders (*Desmognathus ochrophaeus*) (Markle et al. 2013).

Rough estimates suggest the abundance of Northern Dusky Salamanders in the Niagara Gorge to be between 7 to 35 mature individuals (COSEWIC 2012). Adults, juveniles, larvae and eggs belonging to the species have been found at this location and the population appears to be self-sustaining, but may be few in number and have low levels of genetic variation (Markle et al. 2013).

Although Northern Dusky Salamanders were confirmed inhabiting the Niagara Gorge in 1989, there isn't sufficient information to determine with confidence whether this population is stable or increasing.

Resilience (Population size)

Resilience is the species' ability to recover after a disturbance and is critical to the survival of a species that is considered historically precarious. Although a larger population size does not protect against all threats, it is a strong predictor of resilience against increasing rates of decline due to inbreeding or chance events (Elphick et al. 2001; McGowan et al. 2014).

There is a rough estimate of 7 to 35 mature individuals in this extant Northern Dusky Salamander population (COSEWIC 2012); however, it is unknown if this population size approximates historical condition. The minimum viable population size for the Northern Dusky Salamander has not been determined; however, establishing this would provide a better understanding of the number of individuals needed to maintain a self-sustaining population that is resilient against chance stochastic events (e.g., erosion, slope failure, mudslides).

Redundancy (Population size and distribution)

Redundancy refers to the number of local populations and their distribution. If one local population is damaged or destroyed, others can act as a source to restore this missing local population. Despite survey effort, the Northern Dusky Salamander is only known to occur at one isolated location in the Niagara Gorge, making it particularly susceptible to chance events and extirpation in Canada.

Though the Northern Dusky Salamander is presumed to be historically precarious in Canada and may never have existed well beyond its current extant location, it is possible that other local populations may be occurring in the immediate vicinity and have not yet been discovered. There are eight to nine seeps (each ranging in approximate length between 65 and 200 metres) within the vicinity of the extant population where the habitat is theoretically large enough to support 970 individuals, assuming 1-metre wide seeps (based on a density of 1.42 metamorphosed²⁵ individuals/m² (documented in streams of the Piedmont region in North Carolina, USA; Spight 1967 in Price et al. 2012)). It is not known whether unsuccessful search effort is due to the species having more specific requirements than is currently understood

²⁵ Metamorphosis: (in an insect or amphibian) the process of transformation from an immature form to an adult form in two or more distinct stages.

(e.g., stream chemistry, temperature or some other factor) or whether the species' absence is due to historical extirpations and/or lack of successful colonization attempts, or if there are detection issues due to limitations of site accessibility (i.e., surveyor access to areas of suitable habitat within the Niagara Gorge are somewhat limited by steep, dangerous topography (COSEWIC 2012).

Population Connectivity

Connectivity among local populations can be important in naturally restoring depleted populations. If connectivity between habitat patches is decreased (e.g. through habitat loss or population declines), remaining local populations may be too small to be viable on their own, or may become inbred due to a lack of gene dispersal. In determining the appropriate level of population connectivity required to ensure the survival or recovery of the species in Canada, it is important to consider the historical level of connectivity to which the species is adapted.

Though it is not known if there was historical connectivity to additional populations of the Northern Dusky Salamander in this region (only record is of the one extant population in the Niagara Gorge), the population is currently isolated by the large, fast flowing Niagara River and the nearest U.S. population is over 30 km away across the gorge and extensive urban areas (COSEWIC 2010). The population will likely continue to occur as a highly isolated population.

Mitigation of Human-caused Threats

This criterion refers specifically to those threats, as a result of human activity, that significantly increase risk to the species. Due to the limited range within the Niagara Gorge, the Northern Dusky Salamander is highly susceptible to habitat change. Changes in water supply and quality due to human activities are the main threat to the Northern Dusky Salamander. Decreased groundwater supply could be catastrophic to this population as this is the source water that sustains the streams and seeps the species depends upon. Runoff water from urban, industrial and agricultural areas can contaminate groundwater and surface water but can also cause slope instabilities leaving salamanders vulnerable to mudslides and rock falls. Although levels of pollutants from atmospheric deposition are unknown, it should be regarded as a serious threat to the species throughout its global range (COSEWIC 2012). For example, atmospheric deposition is the primary source of mercury in surface waters in the Northern U.S. and the toxic exposure is considered to be a significant factor in the dramatic decline of the species in Acadia National Park, Maine (COSEWIC 2012). Trampling of the streams and seeps by hikers venturing off trails, individuals involved in bouldering and curiosity-seekers (such as naturalists) also threaten the species (Markle et al. 2013).

Threat mitigation could help reduce the risks associated with these threats, however, given its small population size and isolated location the species will likely remain highly susceptible to chance events especially those resulting in habitat change and any

degradation could compromise the long-term survival of the species in Ontario (Markle et al. 2013). It is unknown if significant threats can be avoided or mitigated to the extent that they no longer threaten the species. A standardized survey and monitoring program is needed to monitor the genetic health and trends in the population and habitat threats. A better understanding of the quantity and quality of water supporting the species' habitat (e.g., through water budget modeling) could help to forecast and identify potential impacts caused by changing land and water uses (Markle et al. 2013; Part 3). Management and stewardship actions exist and may be sufficient to conserve the terrestrial habitat upon which the species depends. For example, stewardship activities such as planting native trees reduce slope erosion, maintaining a natural vegetation buffer on the tableland at the top-of-slope could help reduce runoff and harmful pollutants from entering the site and outreach activities to raise awareness of the species may reduce habitat degradation (Part 3). And if necessary, additional habitat could be made available through alternate habitat management, as the species can colonize artificial seeps (Grover and Wilbur 2002 in COSEWIC 2012).

Representation in Appropriate Ecological Communities

Northern Dusky Salamanders are restricted to a narrow range of habitat conditions (i.e., semiaquatic forested habitat with available cover objects (e.g., logs, leaf litter, moss and rocks). Access to cool, highly oxygenated, first-order forested streams or seeps is essential for the persistence of the species (Markle et al. 2013; COSEWIC 2012). Though the extant distribution of the population is highly localized, it likely approximates the historic condition.

Independent of Connectivity with Populations Outside of Canada

It is unlikely that the Ontario population of the Northern Dusky Salamander was historically reliant on populations outside of Canada for survival, as the Niagara Gorge, Niagara River, and expanses of land without suitable habitat present large barriers between Canadian and American populations of this species.

Independent of Species Interventions

The Ontario population of Northern Dusky Salamander appears to be self-sustaining and it is expected that the persistence of the species would be independent of continuous human interventions following mitigation of human-caused threats, which are likely threatening the viability of this population. However, habitat management will likely be required periodically to help maintain habitat suitability (e.g., invasive species removal, planting native trees).

Appendix B: Conservation Status Ranks of the Northern Dusky Salamander (*Desmognathus fuscus*) in Canada and the United States

Country (N Rank)	State or Province (S Rank)
Canada (N3N4)	New Brunswick (S3), Ontario (S1), Quebec (S3)
United States (N5)	Connecticut (S4), Delaware (S5), District of Columbia (S5), Georgia (S5), Indiana (S4), Kentucky (S5), Maine (S5), Maryland (S5), Massachusetts (S4S5), New Hampshire (S5), New Jersey (SNR), New York (S5), North Carolina (S5), Ohio (SNR), Pennsylvania (S5), Rhode Island (S4), South Carolina (SNR), Tennessee (S5), Vermont (S5), Virginia (S5), West Virginia (S5)

Source: NatureServe 2017

Definitions of Global (G), National (N) and Subnational (S) Conservation Status Ranks (Master et al. 2012)

Rank	Definition
G1 N1 S1	Critically Imperiled—At very high risk of extinction or elimination (G1), or at very high risk of extirpation in the jurisdiction (N1, S1), due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
G2 N2 S2	Imperiled—At high risk of extinction or elimination (G2), or at high risk of extirpation in the jurisdiction (N2, S2), due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3 N3 S3	Vulnerable—At moderate risk of extinction or elimination (G3), or extirpation in the jurisdiction (N3, S3), due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4 N4 S4	Apparently Secure—At a fairly low risk of extinction or elimination (G4), or extirpation in the jurisdiction (N4, S4), due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5 N5 S5	Secure—At very low risk of extinction or elimination (G5), or at very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.
N#N# S#S#	Range Rank—A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).
SNR	Unranked—State/province conservation status not yet assessed.

Appendix C: 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*](#)²⁶. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the [*Federal Sustainable Development Strategy*](#)'s²⁷ (FSDS) goals and targets.

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

Protecting the habitat of this species will benefit other native plant and animal species within the Niagara Gorge, including species at risk such as the Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*), Deerberry (*Vaccinium stamineum*), and Red Mulberry (*Morus rubra*). Measures recommended in the Government Response Statement for the Northern Dusky Salamander in Ontario and adopted by Environment and Climate Change Canada will benefit species in the Niagara Gorge and those that depend on the water of the Niagara River through the development of programs focused on water quality and quantity and best management practices for activities impacting water in the area, habitat management, and education of visitors to the area.

The potential for the strategy to inadvertently lead to adverse effects on other species was considered. None of the management activities proposed includes activities that would negatively affect other species. The SEA concluded that this strategy will clearly benefit the environment and will not entail significant adverse effects.

²⁶ www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html

²⁷ www.fsds-sfdd.ca/index.html#/en/goals/

**Part 2 – *Recovery Strategy for the Allegheny Mountain Dusky Salamander (Desmognathus ochrophaeus) and the Northern Dusky Salamander (Desmognathus fuscus) in Ontario*,
prepared by Tricia Markle, Anne Yagi and David Green for the
Ontario Ministry of Natural Resources**

Allegheny Mountain Dusky Salamander
Photo: Rob Tervo



Northern Dusky Salamander
Photo: Rob Tervo



Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*)

and Northern Dusky
Salamander
(*Desmognathus fuscus*) in Ontario

Ontario Recovery Strategy Series

Recovery strategy prepared under the *Endangered Species Act*, 2007

Natural. Valued. Protected.

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the Endangered Species Act (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

Under the ESA a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. There is a transition period of five years (until June 30, 2013) to develop recovery strategies for those species listed as endangered or threatened in the schedules of the ESA. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Natural Resources Species at Risk webpage at: www.ontario.ca/speciesatrisk

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Cover illustration: Allegheny Mountain Dusky Salamander (top), Northern Dusky Salamander (bottom). Photo credit: Rob Tervo

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DECLARATION

The recovery strategy for the Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander was developed in accordance with the requirements of the *Endangered Species Act, 2007* (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all of the individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

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.

RESPONSIBLE JURISDICTIONS

Ontario Ministry of Natural Resources
Environment Canada – Canadian Wildlife Service, Ontario

EXECUTIVE SUMMARY

Both the Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*) and the Northern Dusky Salamander (*Desmognathus fuscus*) are listed as endangered in Ontario under the *Endangered Species Act, 2007*. The Allegheny Mountain Dusky Salamander is a federally endangered species listed on Schedule 1 of the *Species at Risk Act*. The Northern Dusky Salamander in Ontario is yet to be assessed at the federal level.

Like all plethodontid salamanders, these species are lungless and rely on their moist skin for respiration. They are thus restricted to moist environments and avoid conditions that risk their dehydration. Both species are typically found along the edges of small woodland streams and in damp seepage areas where there is an abundance of logs, stones and leaf litter.

Dusky salamanders have a characteristic light line that runs from the corner of the mouth to the eye. The two species can best be distinguished from each other by the cross-sectional shape of the tail, the colour of the dorsal stripe and the colour of the underside. The Allegheny Mountain Dusky Salamander has a tail that is rounded in cross-section, an evident yellow- to red-coloured dorsal stripe with chevron shaped darker patches running along it, and a typically dark brown or black underside. The Northern Dusky Salamander has a keeled tail that is laterally compressed and triangular in cross-section, a uniformly tan or brown dorsal stripe, and a cream-coloured underside.

The principle limiting factor for the Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander in Ontario is their extremely restricted range. In Ontario, Allegheny Mountain Dusky Salamanders have now been identified from two localities in the Niagara Gorge, while Northern Dusky Salamanders are known only from a single site. As both species occupy very similar habitats, and share many characteristics, the threats to their survival and recovery are virtually identical. The current habitat is so limited that any degradation is likely to compromise the long-term survival of these salamanders in Ontario.

The Allegheny Mountain Dusky Salamander and Northern Dusky Salamander in Ontario utterly depend upon the groundwater discharge that feeds the streams and seeps in which they dwell. Any decrease, curtailment or interruption of the groundwater is considered a serious threat to the continuing existence of these salamanders. Landslides or mudslides in the Niagara Gorge that in any way affect the salamanders' streams and stream-side habitats pose severe threats. Further, degradation of habitat may occur when hikers venture off the maintained trail and inadvertently stir up the stream bed, trample vegetation and increase erosion. Clearing of the habitats used by these salamanders would also constitute a serious threat.

The recovery goal is to safeguard the existing known populations of Allegheny Mountain Dusky and Northern Dusky Salamander species, and if feasible, introduce each species

to unoccupied habitat within the Niagara Gorge that is either created or found to be suitable, with the aim of increasing known population sizes by 50 percent. The four recovery objectives are to:

- protect and enhance existing significant habitat for Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario;
- conduct a thorough population study, and if necessary maintain the genetic health of Allegheny Mountain Dusky Salamander and Northern Dusky Salamander populations in Ontario;
- locate additional populations, and expand the current ranges of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders through introductions where appropriate; and
- elicit public support and collaboration in the protection and recovery of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario.

The areas to be considered for habitat regulation include the streams and seeps inhabited by the salamanders, plus the surrounding forested habitat up to 75 m away from the edges of seeps and streams. In addition, the area between the two Allegheny Mountain Dusky Salamander populations should be protected as a dispersal corridor. Also to be considered are the catchment basins supplying the groundwater that feeds the springs from which the streams and seeps originate.

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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

COMMON NAME: Allegheny Mountain Dusky Salamander

SCIENTIFIC NAME: *Desmognathus ochrophaeus*

SARO List Classification: Endangered

SARO List History: Endangered (2008)

COSEWIC Assessment History:

Allegheny Mountain Dusky Salamander (Carolinian population) – Endangered (2007)

Allegheny Mountain Dusky Salamander – Threatened (2001), Special Concern (1998)

SARA Schedule 1: Endangered (March 5, 2009)

RANKINGS: GRANK: G5 NRANK: N2 SRANK: S1

COMMON NAME: Northern Dusky Salamander

SCIENTIFIC NAME: *Desmognathus fuscus*

SARO List Classification: Endangered

SARO List History: Endangered (2004)

COSEWIC Assessment History: Endangered (2012), Not at Risk (1999)

SARA Schedule 1: No Schedule, No Status

RANKINGS: GRANK: G5 NRANK: N3N4 SRANK: S1

The glossary provides definitions for technical terms, including the abbreviations above.

1.2 Species Description and Biology

Species Descriptions

Dusky salamanders have a characteristic light line that runs from the corner of the mouth to the eye. The hind legs are substantially larger than the front legs (Petranka 1998). These features serve to distinguish both species from any other salamanders that may be present in the Niagara Gorge.

The Allegheny Mountain Dusky Salamander ranges in size from 70 to 110 mm total length, with males roughly six to twenty percent longer than females (Bruce 1993, Orr 1989, Pauly and Watson 2005). Northern Dusky Salamanders range from 60 to 140 mm total length, with males about seven percent larger than females (Means 2005). Colour and pattern are variable in each species, although the Allegheny Mountain Dusky Salamander is typically more brightly coloured, and the Northern Dusky Salamander usually has black specks or spots present along the sides. Allegheny Mountain Dusky Salamander larvae are 13 to 18 mm long and have dark dorsolateral stripes, often with spots (Petranka 1998). Northern Dusky Salamander larvae are 12 to 20 mm total length with paired blotches or spots along the back. Both species have 14 costal grooves.

The two species can best be told apart by the colour of the dorsal stripe, the cross-sectional shape of the tail and the colour of the underside (Tilley 1969, Petranka 1998). The Allegheny Mountain Dusky Salamander has a tail that is rounded in cross-section, an obvious yellow to red-coloured dorsal stripe with chevron shaped darker patches running along it and a typically dark brown or black underside. In contrast the Northern Dusky Salamander has a keeled tail that is laterally compressed and triangular in cross-section, a uniformly tan or brown dorsal stripe and a cream-coloured underside.

Species Biology

Like all plethodontid salamanders, these species are lungless and rely on their moist skin for respiration. They are thus restricted to moist environments and avoid conditions that risk their dehydration (Spotila 1972, Alvo and Bonin 2003). Dry conditions restrict activity and the animals' low metabolic rates, large energy stores, and resistance to starvation enable them to survive extended periods of time without food (Feder 1983, Feder and Londos 1984).

Both species are typically found along the edge of small woodland streams and in damp seepage areas where there is an abundance of logs, stones and leaf litter (Means 2005, Pauly and Watson 2005). They are nocturnal and remain under cover objects at the edges of streams and seeps during the day. Peak surface activity occurs an hour after sunset on warm, wet nights (Keen 1979, Holomuzki 1980). Adults and juveniles likely move short distances along stream channels where there is continual moisture. However, the Mountain Dusky Salamander is more terrestrial than the Northern Dusky Salamander and is known to venture 75 m away from streams (Organ 1961).

In the northern part of their ranges including New York (and likely Ontario), Allegheny Mountain Dusky and Northern Dusky Salamanders mate during both autumn and spring (Bishop 1941, Petranka 1998). Courtship is lengthy and intricate, involving a spermatophore laid by the male that the female picks up for internal fertilization of the eggs. Grape-like egg clusters are attached to the undersides of logs or rocks, or deposited amid moss, clumps of leaf litter or organic debris, usually within a meter of a stream or seep (Bishop 1941, Krzysik 1980, Hom 1987). The Allegheny Mountain Dusky Salamander lays clutches of one to two dozen eggs; the Northern Dusky Salamander lays clutches of two to three dozen eggs (Hall 1977, Petranka 1998, Means 2005, Pauly and Watson 2005). Females guard their eggs for the duration of the incubation period (Houck et al. 1985, Forester 1979). Eggs hatch in 6 to 10 weeks (Bishop 1941). Eggs laid in early spring hatch in early fall; eggs laid in the fall hatch the following spring (Bishop 1941, Keen and Orr 1980, Orr 1989).

Larvae inhabit slow moving streams and seeps, and shelter underneath rocks or other debris. Allegheny Mountain Dusky Salamander larvae may metamorphose into adult form in as little as a few weeks or may take up to eight months (Keen and Orr 1980). Northern Dusky Salamanders will remain larvae for eight months to a year (Means 2005). Sexual maturity in Allegheny Mountain Dusky Salamanders is attained when they are about three years old (Hall 1977) and in Northern Dusky Salamanders at two years (Bishop 1941).

Adults and larvae of both species feed upon aquatic and terrestrial insects such as spiders, beetles, earthworms, snails, mites, aphids and insect larvae (Fitzpatrick 1973, Keen 1979, Petranka 1998). All life stages of dusky salamanders are preyed upon, principally by snakes, crayfish, aquatic insects, small mammals and birds (Bishop 1941, Hom 1988, Orr 1989, Whiteman and Wissinger 1991, Petranka 1998). Northern Dusky Salamanders are also known to prey upon smaller salamanders (Means 2005).

1.3 Distribution, Abundance and Population Trends

Allegheny Mountain Dusky Salamanders extend from eastern Tennessee through the Appalachian Mountains and along the southern shores of Lake Erie and Lake Ontario to extreme southern Quebec. Northern Dusky Salamanders follow a similar, yet wider, distribution and range from South Carolina through much of the Northeast United States into southern Quebec. In Ontario, Allegheny Mountain Dusky Salamanders are now known to occur at two localities in the Niagara Gorge, while Northern Dusky Salamanders are known only from a single population. All sites are located along the Niagara River, downstream from Niagara Falls, near Queenston (Figure 1). The closest Allegheny Mountain Dusky Salamander and Northern Dusky Salamander populations are separated by approximately four kilometres of Niagara River shoreline.

Dusky salamanders were first reported from Ontario in 1908 (Nash 1908), although a general area was not mentioned until Bishop (1941, 1943) reported dusky salamanders occurring in "Ontario opposite Buffalo, New York". In 1989, dusky salamanders were

discovered in two localities in the Niagara Gorge: the first locality was a stream in the Whirlpool area and the second was a stream just south of Queenston (Kamstra 1991). These sites were the first specific localities identified for dusky salamanders in Ontario and one specimen from each locality was collected for museum records (Kamstra 1991). Originally specimens from both localities were identified as Northern Dusky Salamanders. However, in 2004, local MNR staff suspected that the Queenston dusky salamanders were actually Allegheny Mountain Dusky Salamanders based on physical appearance. Genetic analysis confirmed the salamander population to be Allegheny Mountain Dusky (Markle and Green 2005, 2006, Markle et al. 2006).

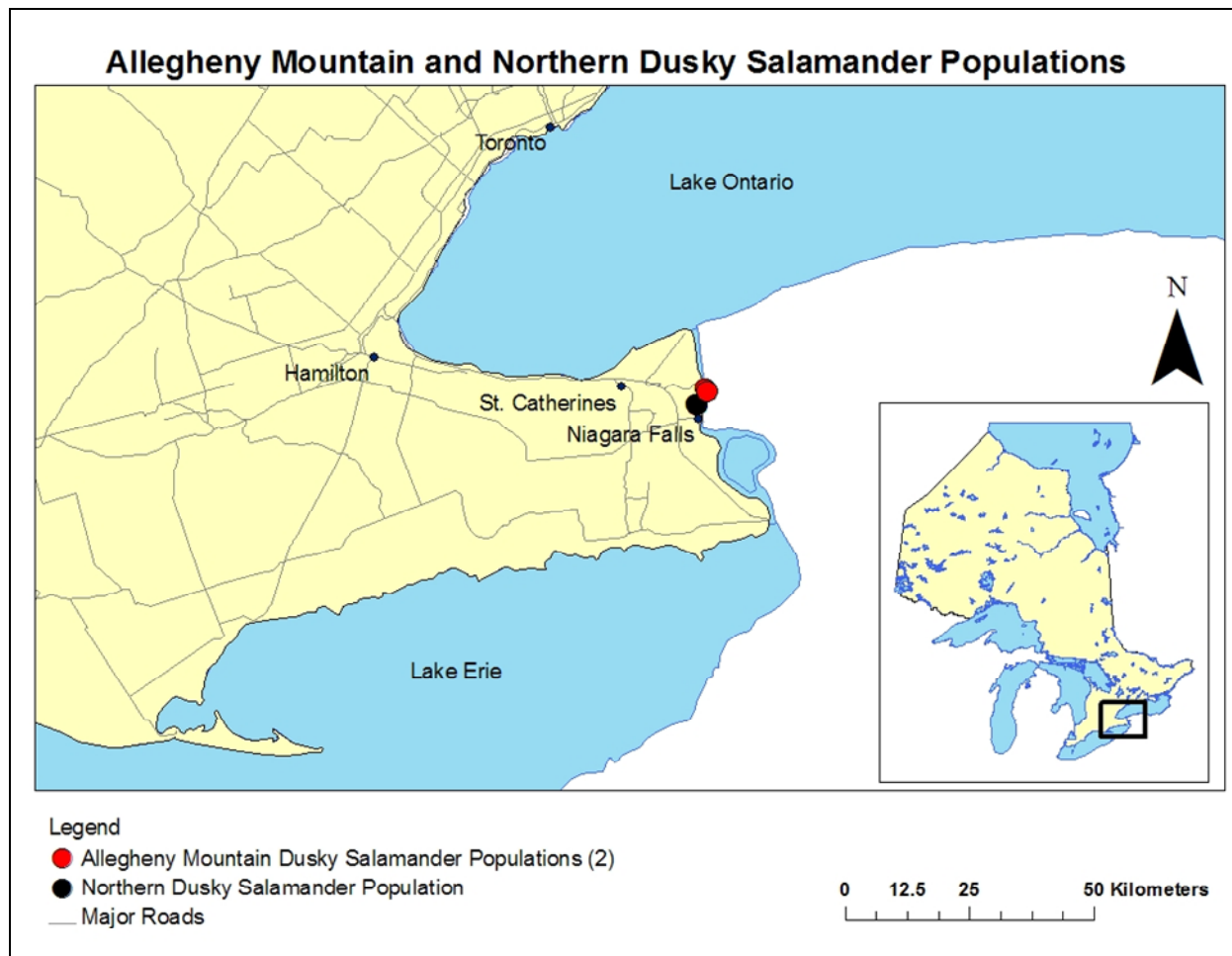


Figure 1. Distributions of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario. (Note that the Allegheny Mountain Dusky Salamander populations are represented by two closely overlapping circles on the map.)

In the fall of 2010, partnership between staff of Ontario Power Generation (OPG), along with the Ontario Ministry of Natural Resources' Niagara Area office, led to the discovery of a second site for Allegheny Mountain Dusky Salamanders in the Niagara Gorge (Weller 2010, 2011) bringing the total to two known populations of Allegheny Mountain

Dusky Salamanders in Ontario. The two populations are found half a kilometre apart southeast of the town of Queenston.

The single population of Northern Dusky Salamanders inhabits a steep bank in the vicinity of the Whirlpool, and is watered by eight or nine seeps that flow into the Niagara River. Surveys along the escarpment have failed to uncover any additional populations of Northern Dusky Salamanders, and the nearest known population is over 30 km away in New York State (Bonin 1999, Markle and Green 2005).

While there are no precise data on abundance or trends for either species in Ontario, as of 2012, 38 Allegheny Mountain Dusky Salamanders have been observed in the Queenston population (COSEWIC 2007, A. R. Yagi, pers. comm. 2012, W. F. Weller, pers. comm. 2012) and a total of 17 individuals have been observed from the Smeaton Creek population (Weller 2010, 2011, W. F. Weller, pers. comm. 2012). For Northern Dusky Salamanders, a total of 79 individuals have been observed in the Whirlpool site since 2005 (A. R. Yagi, pers. comm. 2012). For both species, and in each population, three age-classes (including larvae, juveniles, and adults) have been found, along with eggs. Based on the information to date, it appears that all three populations are viable and self-sustaining.

1.4 Habitat Needs

Terrestrial Habitat

Throughout their ranges, Allegheny Mountain Dusky and Northern Dusky Salamanders occur in a variety of aquatic or semiaquatic forested habitat, and are often found to be abundant in or about seeps, as well as along the margins of small streams (Petranka 1998, Means 2005, Pauly and Watson 2005). The forest canopy is critical in maintaining shady conditions, which protects against high temperatures and maintains humidity. Leaf litter, woody debris, rocks and naturally vegetated habitat between and adjacent to individual seeps and small streams are important for dispersal for both species. Cover objects such as logs, leaf litter, moss and rocks in these areas provide shelter and protection from predators and inclement weather. Adults of both species will actively defend space under cover objects from other salamanders (Petranka 1998). Dusky salamanders are nocturnal and remain under cover objects during the day, coming out at night to forage along seepage areas and streams, and across the forest floor. Adult salamanders of both species feed predominantly on terrestrial or semi-terrestrial invertebrates (Petranka 1998).

Moist retreats also offer the ideal habitat to lay eggs, and nests are often found under rocks in seepage banks, or in mud crevices beneath logs or moss (Jones 1986, Petranka 1998). Females of both species are known to remain with their eggs to defend them and will greatly reduce foraging during this time (Fitzpatrick 1973, Montague and Poiniski 1978).

The average home range for an Allegheny Mountain Dusky Salamander is likely less than one square metre (Petranka 1998). Some individuals in the United States, however, are known to venture up to 75 m from water (Organ 1961), and during optimal conditions may venture much further. Allegheny Mountain Dusky Salamanders in general are found to be more terrestrial than Northern Dusky Salamanders and are often found some distance from permanent seeps or streams (Organ 1961). For Northern Dusky Salamanders, home ranges are estimated to remain within 15 m of a stream, with a maximum home range recorded at 114 m² (Hom 1987, Petranka 1998). However, during cool and wet periods dusky salamanders can likely travel large distances between seepage areas.

Aquatic Habitat

Once larvae emerge from eggs they live in seepages, sluggish portions of streams, or in wet cavities along the stream edge until they transform into adults (Petranka 1998). During this time they feed on small invertebrates. Seasonal factors such as moisture, levels of seeps and time of year that the eggs are laid may influence the length of the larval period and whether or not they overwinter as larvae.

Winter Retreats

These salamanders are active on the ground surface at all times of year except during the coldest winter months. During the colder months, salamanders overwinter in subsurface cavities, burrows, fissures and seepages, to depths of 90 cm or more, where they can avoid freezing temperatures and remain moist (Bishop 1941, Organ 1961). Often adults and juveniles are found to congregate together in these retreats (Petranka 1998). Northern Dusky salamanders are found to move 12 to 25 cm below ground when temperatures drop below 7°C (Ashton 1975).

Indirect Habitat

As both species require access to cool, highly oxygenated, first-order forested streams or seeps, they are thus highly dependent upon specific hydrological conditions that ensure a constant supply of groundwater to the source springs. As a result, indirect habitat includes the source water of streams and seeps that is so critical to their survival.

1.5 Limiting Factors

The principle limiting factor for Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario is their extremely limited range. Each species is known only from one or two localities of very limited extent. They are constrained to these sites by highly specific requirements for a stream habitat that is rare within southern Ontario. The limited distribution of suitable sites in the Niagara region restricts the salamanders to the Niagara Gorge and curtails their capability for dispersal (Oldham 2006). There is no possibility for a rescue effect via immigration from populations in New York because none are nearby and the Niagara River is an effective barrier to dispersal.

Nevertheless, because the Ontario populations of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders are isolated from each other by inhospitable terrain, it is unlikely that hybridization or competition between the species will occur, such as has been documented where they co-occur on Covey Hill in Quebec (Sharbel et al. 1995, Boutin 2006). However, hybridization and competition between the species is likely to occur if the species are transplanted to, or invade, each other's habitats. The larger, more aggressive Northern Dusky Salamander is an important competitor of Allegheny Mountain Dusky Salamanders where the species are found to occur together. Northern Dusky Salamanders are found to be capable of driving Allegheny Mountain Dusky Salamanders away from preferred habitat closer to the streamside (Krzysik 1979, Grover and Wilbur 2002, Boutin 2006). Thus, in the presence of Northern Dusky Salamanders, Allegheny Mountain Dusky Salamanders preferentially occupy drier microhabitats on finer substrates farther from the water's edge (Tilley 1997, Petranka and Smith 2005, Boutin 2006). At the same time, because Allegheny Mountain Dusky Salamanders have higher tolerances for a wider range of ecological conditions than do Northern Dusky Salamanders (Tilley 1970, Grover 2000), they are able to survive well in such habitats.

1.6 Threats to Survival and Recovery

As both the Allegheny Mountain Dusky and Northern Dusky Salamanders have very similar biology, and because they occupy similar habitats and are separated by roughly four kilometres of river bank, the threats to their survival and recovery are virtually identical. Due to their extremely small range sizes in Ontario, both species are highly susceptible to habitat change. The current habitat is so limited that any degradation is likely to compromise the long-term survival of these salamanders in Ontario.

Disruption or Contamination of Groundwater

Allegheny Mountain Dusky and Northern Dusky Salamanders in Ontario utterly depend upon the groundwater discharge that feeds the streams and seeps in which they dwell. Any diminution, curtailment or interruption of the groundwater is a serious threat to the continuing existence of these salamanders. Lowering of groundwater and decreased dissolved oxygen concentrations have been linked to declines in other species of stream salamanders (Bowles and Arsuffi 1993, Turner 2004). Contamination of the surface water that maintains this hydrological system would likewise have potentially catastrophic effect upon the animals. Northern Dusky Salamander larvae have been shown to be sensitive to stream pollution and siltation, and densities are found to be inversely proportional to the degree of stream disturbance associated with urbanization (Petranka 1998). Population declines are generally attributed to siltation or loss of ground cover, although potential contaminants could include storm runoff from industrial and urban areas or herbicides and pesticides applied in the catchment areas of these streams. In addition, there is potential for groundwater feeding the seeps and streams to be redirected, decreased, or cut off as a result of large developments in the area and water flow should be monitored accordingly.

Erosion

Landslides or mudslides in the Niagara Gorge that in any way affect the salamanders' seep and stream-side habitats would be considered severe threats. At the top of the slope, uncontrolled stormwater flows from roadways, parking lots or other cleared areas have been discharged over the bank and have been known to trigger mudslides within the Gorge and erode trails (MNR staff D. Mills and A. R. Yagi, pers. comm. 2012).

Deforestation

Clearing of the forested canopy above the streams or seeps used by the salamanders would be a serious threat to these species by causing changes to the thermal regime and quality of subterranean refugia. Fortunately, the entire extent of significant habitat for these species is owned and managed by the Niagara Parks Commission (NPC), an important stakeholder in the overall recovery of these species. For that reason tree removal is unlikely, but remains a potential threat if it were to occur accidentally or through a natural event such as a mudslide. The newly discovered population of Allegheny Mountain Dusky Salamanders at Smeaton Creek occur on NPC land that is currently being leased to OPG. Communication between stakeholders regarding land use and potential impacts on salamanders and their habitat is therefore critical.

Habitat Degradation

Although salamanders are located in steep and normally inaccessible areas within the Niagara Gorge, the streams and seeps where these salamanders live are often explored by hikers who venture off the maintained trail (A. R. Yagi, pers. comm. 2012). This can stir up the stream bed, trample vegetation and increase erosion. Litter originating from the maintained trail may also contaminate the area.

Further, the invasive strain of the European Common Reed (*Phragmites australis*) has moved into the more gently sloping sections of the stream beds and is eliminating some potential habitat used by the salamanders wherever it is able to grow into thick stands. Research needs to be done to examine the potential impact of this plant on dusky salamanders and habitat, and what the most effective methods of removal may be.

Inbreeding

The genetic health of all three known populations of dusky salamanders in Ontario should be determined and monitored. As the Niagara River is considered a major barrier to dispersal for these salamanders, the Ontario populations are considered to be small population isolates that have no way of receiving gene flow from the nearest populations in New York State. Ontario Dusky Salamander populations are anticipated to be relatively small based on numbers detected to date and on the areas known to be occupied. Further, genetic studies across the northern range of Allegheny Mountain Dusky Salamanders have found that genetic variability is already very low, likely as a result of rapid population expansion since the last glacial cycle (Tilley and Mahoney 1996). As very small populations may be vulnerable to detrimental effects of inbreeding such as genetic defects and lower reproductive success (Hedrick and Kalinowski 2000), it would be prudent to determine whether inbreeding appears to be a problem, and if so

to consider introductions of individuals from New York to maintain the long-term health of the populations.

Population Loss

As the entire range of each species in Ontario is extremely limited, there is much concern that a single stochastic event (such as a landslide) could wipe out a whole population of either species at any given time. Further, groundwater levels and seepage outputs are susceptible to change as the result of human activity, especially near urban and industrial areas where these salamanders are found. A major spill of contaminants, which gets into the seepage surface water, would also likely be detrimental to these populations. For Northern Dusky Salamanders in particular, there may be little opportunity for dispersal to other suitable habitats. To safeguard against major losses to either of these species, measures should be taken to expand the known ranges of each species by locating new populations (if they exist) and creating or finding additional suitable habitat for introductions where appropriate.

Collection by People for the Pet Trade

While unlikely, there is some concern that salamanders could be taken from the Niagara Gorge and used in the pet trade. As populations are believed to be very low in numbers, removal of any numbers and of any age classes could have large impacts. Public education materials may help to convince park visitors of the special circumstances, and regulations, surrounding these populations, and the importance of leaving the habitat and populations intact.

1.7 Knowledge Gaps

The hydrology of the groundwater springs that feed the streams in which these salamanders live needs to be better understood. The extent of the groundwater recharge area is not fully known, and the results of a study investigating groundwater flows to the seeps and their relationship with surface water would be helpful. The salamanders are utterly dependent upon these sources of water, and the hydrology of the area needs to be thoroughly examined to ensure continued water quantity and quality. Aspects of water quality such as mineral content, pH, dissolved oxygen and contaminant load need to be ascertained so that changes that could affect the salamanders may be detected. While the extent of the groundwater recharge area, which contributes to the dusky streams, is not fully known, it likely includes the tableland area immediately west of the Niagara River Gorge and extending from the Niagara Escarpment south to the Whirlpool.

There is almost no demographic information on the populations of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario. Population sizes are not known, nor how much they fluctuate in size over time. Demographic characteristics such as mortality rates, growth rates and reproductive success are likewise unknown, as is information on dispersal potential and genetic diversity. This lack of information is in part because they have only recently been discovered and identified, and is also due

to the difficulty in safely accessing much of the habitat. However, considering the extremely limited extent of habitats they occupy, these salamanders are undoubtedly few in numbers and genetically impoverished. Since the significant threats to the welfare and recovery of these species are all related to habitat, gaps in the understanding of these species' population ecologies should not limit the ability to adequately define recovery goals, objectives, or approaches for these species, nor to recommend the habitats that should be considered for regulation.

1.8 Recovery Actions Completed or Underway

Following the discovery of populations of Allegheny Mountain Dusky and Northern Dusky Salamanders in Ontario, a provincial recovery team was established and identified the recovery goals detailed in this recovery strategy. The recovery team has produced educational and promotional materials on the salamanders, including stickers, magnets, shopping bags and a stewardship guide (Yagi et al. 2010). The Ontario Ministry of Natural Resources has completed some on-the-ground habitat enhancement work, particularly for the Allegheny Mountain Dusky Salamander population, including cedar planting, removal of European Common Reed and corridor planting.

Areas of significant habitat have been mapped and described in detail for the Queenston site (Yagi and Tervo 2008a) and for the Whirlpool site (Yagi and Tervo 2008b). However, the Smeaton Creek site has not yet been mapped to reflect areas of significant habitat. Work is underway in conjunction with OPG to trace the origins of the groundwater springs (W. F. Weller, pers. comm. 2012). Some protection is afforded to the salamander populations because the Niagara Parks Commission manages all of the territory occupied at these sites. Further, both the Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander are provincially listed in Ontario as endangered under the *Endangered Species Act, 2007* (Ontario Regulation 230/08). In addition, the Allegheny Mountain Dusky Salamander is a federally endangered species listed on Schedule 1 of the Species at Risk Act (SARA). The Northern Dusky Salamander is not listed under SARA, although a COSEWIC status report update is in preparation.

2.0 RECOVERY

2.1 Recovery Goal

The recovery goal is to safeguard the existing known populations of Allegheny Mountain Dusky and Northern Dusky Salamander species, and if feasible, introduce each species to unoccupied habitat within the Niagara Gorge that is either created or found to be suitable with the aim of increasing known population sizes by 50 percent.

2.2 Protection and Recovery Objectives

Table 1. Protection and recovery objectives

No.	Protection or Recovery Objective
1	Protect and enhance existing significant habitat for Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario.
2	Conduct a thorough population study, and if necessary maintain the genetic health of Allegheny Mountain Dusky Salamander and Northern Dusky Salamander populations in Ontario.
3	Locate additional populations, and expand the current ranges of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders through introductions where appropriate.
4	Elicit public support and collaboration in the protection and recovery of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario.

2.3 Approaches to Recovery

Table 2. Approaches to recovery of the Allegheny Mountain Dusky and Northern Dusky Salamanders in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
1. Protect and enhance existing significant habitat for Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario.				
Critical	Short-Term	Research – Potential Threats	1.1 Identify extent of groundwater recharge area.	<ul style="list-style-type: none"> • Disruption of groundwater • Poor understanding of hydrology and groundwater recharge area
Critical	Short-Term	Research – Potential Threats	1.2 Measure flows of seeps and streams occupied by dusky salamanders to determine seasonal and yearly averages.	<ul style="list-style-type: none"> • Disruption of groundwater • Poor understanding of hydrology and groundwater recharge area
Critical	Long-Term	Protection	1.3 Have source water protection (both surface and ground water) for land in the upgradient tableland areas.	<ul style="list-style-type: none"> • Disruption of groundwater • Poor understanding of hydrology and groundwater recharge area
Necessary	Long-term	Management	1.4 Ensure that all development activities on adjacent land that may involve contaminating or lowering of the groundwater table are monitored for groundwater impacts.	<ul style="list-style-type: none"> • Disruption or contamination of groundwater

Recovery Strategy for the Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Long-Term	Management and Monitoring	1.5 Control quantity and quality of stormwater discharge from adjacent land including industrial, recreational and urban areas: <ul style="list-style-type: none"> eliminate the application of herbicides and pesticides in the vicinity of seeps; monitor stormwater quality for pollutants; develop an emergency spills action plan for the area; create wetland areas to capture and slow down stormwater run-off; plant native trees to stabilize the slope. 	<ul style="list-style-type: none"> Disruption or contamination of groundwater Erosion
Beneficial	Ongoing	Management and Monitoring	1.6 Monitor erosion rates on the hillsides where salamanders are found for indications of slope instability.	<ul style="list-style-type: none"> Erosion
Beneficial	Ongoing	Management and Monitoring	1.7 Ensure that forest canopy remains intact.	<ul style="list-style-type: none"> Deforestation
Beneficial	Ongoing	Research and Stewardship	1.8 Discourage park visitors from off-trail hiking.	<ul style="list-style-type: none"> Habitat degradation
Beneficial	Ongoing	Research and Stewardship	1.9 Investigate and implement best management practices for removal of European Common Reed.	<ul style="list-style-type: none"> Habitat degradation
2. Conduct a thorough population study, and if necessary maintain the genetic health of Allegheny Mountain Dusky Salamander and Northern Dusky Salamander populations in Ontario.				
Critical	Short-term	Research – Populations	2.1 Conduct a thorough population study to determine more accurate population size and trends for each species in Ontario: <ul style="list-style-type: none"> may involve mark-recapture fieldwork and/or genetic analysis. 	<ul style="list-style-type: none"> Inbreeding Lack of demographic information
Necessary	Long-term	Monitoring and Assessment	2.2 Monitor genetic health of populations: <ul style="list-style-type: none"> check for inbreeding with genetic analysis every 25 years. 	<ul style="list-style-type: none"> Inbreeding

Recovery Strategy for the Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Short-term	Research and Management	2.3 If inbreeding appears to be a concern, look into the feasibility of salamander introductions from New York State, which is the nearest population source.	<ul style="list-style-type: none"> • Inbreeding
3. Locate additional populations, and expand the current ranges of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders through introductions where appropriate.				
Critical	Short-term	Research and Management	3.1 Search suitable/accessible habitat in Niagara Gorge for any additional populations of dusky salamanders.	<ul style="list-style-type: none"> • Population Loss • Lack of demographic information
Necessary	Short-term	Research and Management	3.2 Research the probability of success if individuals are translocated from sites outside of Ontario to suitable unoccupied habitats: <ul style="list-style-type: none"> • determine likelihood of survival; • establish what numbers would be needed for a successful introduction and if they can be moved; • research other potential barriers to introductions; • identify areas with no obvious impediments to re-establishment; • investigate potential habitat along the Niagara Escarpment and Fonthill Kame Moraine. 	<ul style="list-style-type: none"> • Population Loss
Beneficial	Long-term	Management	3.3 If potential habitat is found (and successful introduction seems likely), pilot an introduction project.	<ul style="list-style-type: none"> • Population Loss

Recovery Strategy for the Allegheny Mountain Dusky Salamander and the Northern Dusky Salamander in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
4. Elicit public support and collaboration in the protection and recovery of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario.				
Beneficial	Ongoing	Education and Outreach	4.1 Prepare educational materials such as pamphlets to inform park visitors about the endangered status of these salamanders and the need to not disturb them or their habitat.	<ul style="list-style-type: none"> • Habitat degradation and salamander loss • Collection by people for pet trade

Narrative to Support Recovery Objectives and Approaches

The first objective for recovery is to protect, conserve and enhance the current habitats where Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders are found. Although habitat protection is already afforded through the Niagara Parks Commission, this does not guarantee that water feeding the streams and seeps inhabited by the salamanders will remain of high quality and quantity. For that reason the most critical approach to the recovery includes management of the supporting groundwater recharge and discharge areas to ensure that water quality and quantity are maintained. Monitoring and regulation of surface water is also needed to control potentially toxic discharges from industrial, recreational and urban areas in adjacent lands, as well as to mitigate high stormwater discharge that can lead to mudslides.

A second major objective for recovery is research to determine the actual size of each population in the Niagara Gorge and to better understand population trends for improved management. Maintaining the genetic health of the existing populations is also critical, as inbreeding depression can lead to reduced reproductive success.

The third objective is to locate new, potentially suitable habitat for the salamanders and determine the feasibility of expanding existing Ontario populations. Habitat along the Niagara Escarpment and the Fonthill Kame Moraine would have been connected to the Niagara Gorge in the past, and may offer potential habitat suitable for introductions. There is also some potential that additional populations of dusky salamanders may naturally occur at these locations. Suitable habitat may also be created in adjacent sites by adding cover objects, removing invasive plants and increasing moist areas where feasible. Because the known populations are so highly localized, a single catastrophic erosion event could wipe out an entire seepage area inhabited by these salamanders and thus extirpate the species in Ontario.

The fourth objective is public education and the engendering of good stewardship, which will be imperative for the long-term survival of these populations. The public needs to be aware that the Niagara Gorge is important habitat for these two species, and that activities such as off-trail hiking or collection of salamanders as pets may be detrimental to their continued survival. Consideration should be given to joining public education efforts toward dusky salamander conservation and protection with that of other wildlife species in the Niagara Gorge that share similar habitats and needs.

Supporting Narrative for Recovery Approaches 1.1 to 1.9:

One of the major priorities for the long-term recovery of these species is to ensure that groundwater quantity and quality is maintained. Current groundwater levels are adequate for the survival of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in the Niagara Gorge. However, any development on adjacent land that could change the hydrology, either increasing or decreasing peak flows and discharge volumes, increasing turbidity or sedimentation, or increasing water temperature, could spell disaster for dusky salamander populations and should be subject to assessment and monitoring. The extent of the groundwater recharge area is not fully known and needs to be thoroughly examined to ensure water quantity and

quality. Contaminated surface water could potentially infiltrate into the groundwater table within the Lockport formation. Alteration of water chemistry by the application of fertilizers or herbicides, increasing turbidity or dissolved solids and changing the temperature or pH could disrupt levels of dissolved oxygen and nutrients critical to the maintenance of salamander habitat. While the full extent of source waters remain unknown, it likely includes the tableland area immediately west of the Niagara River Gorge and from the Niagara Escarpment south to the Whirlpool.

Stormwater discharges from adjacent lands can also have catastrophic impacts on the salamander populations, both in the quality and quantity of water. Increases in erosion rates along the slope due to stormwater discharges may increase the instability of the slope. Resulting mudslides have the potential to decimate entire populations. While habitat stewardship activities have focused on replanting the mudslide areas in the short-term, wetland creation to capture and slow down the storm run-off discharges in the tablelands would be a long-term solution. Furthermore, contaminants such as herbicides, pesticides, oil, dangerous goods, and other pollutants can kill salamanders directly or make them more susceptible to disease by weakening their immune systems. As these salamanders are restricted to moist environments, and their larvae live within the seepages, groundwater pollution can have a catastrophic impact. Finally, an emergency spills action plan for this area would be valuable.

Deforestation is a threat to all forest-dwelling salamanders. However, it is not likely a serious threat for the Ontario populations of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders which reside in lands that are owned and managed by the Niagara Parks Commission (Yagi and Tervo 2008a,b).

The invasive strain of the European Common Reed now grows in thick stands at the base of the slope in the Niagara Gorge. It acts to further stabilize the slope but also eliminates habitat use by dusky salamanders (Yagi and Tervo 2008a). Mechanical removal is necessary to control its spread; however, the long-term benefit of this approach has not yet been assessed. The removal of trees and shrubs in an area can lead to soil erosion, increased sedimentation in streams, changes in light intensity and temperature, changes in prey availability and modification or loss of habitat. This being the case, it is important to investigate and implement the best management practices for removal of European Common Reed.

Supporting Narrative for Recovery Approaches 2.1 to 2.3:

To better understand the management needs of these salamander populations, it is critical to determine current population sizes and trends for both species. Appropriate recovery actions may differ depending upon whether populations are increasing, decreasing or remaining constant.

Small populations are prone to inbreeding. This may become a concern with these populations over time, as natural migration across the Niagara River is virtually impossible, and dusky salamanders are not known to inhabit the opposite shore at this time. As inbreeding may result in decreased breeding success and other genetic

defects, it is recommended to check on the genetic health of Ontario dusky salamander populations at regular intervals. If found to be necessary, and introductions are deemed feasible, genetic rescue could be arranged. As genetically similar salamanders are known to inhabit adjacent New York State (Markle and Green 2005), there is potential that introduction of small numbers from New York into the Niagara Gorge populations could alleviate inbreeding effects.

Supporting Narrative for Recovery Approaches 3.1 to 3.3:

Stochastic events, such as major mudslides, could wipe out entire salamander populations within the Niagara Gorge. Therefore, it is critical to determine whether there is suitable habitat available for dusky salamander on adjacent land that will support introductions. Dispersal by salamanders out of the Niagara Gorge is presently unlikely as they are hemmed in by the Niagara Parkway at the top and the Niagara River on the bottom, yet it is possible that there were migration corridors between the Niagara Gorge and the Niagara Escarpment in the past. Suitable habitat may still exist along the Niagara Escarpment or the Fonthill Kame Moraine. If potential habitat is found, the feasibility of introductions should be considered.

If feasible and realistic within the habitat available, the recovery goal is to increase known populations of each species by 50%. As a new population was recently discovered, and potentially suitable (yet very difficult to access) salamander habitat remains to be surveyed, there is a good possibility that additional populations of both species may occur in the Niagara Gorge. Within the gorge there is plenty of suitable forest habitat; however, the limiting factor appears to be an abundance of quality seeps. Some habitat might be modified slightly to be more appealing to dusky salamanders, thereby encouraging additional populations where suitable. For instance, niche quality can be improved through adding cover objects (a potential limiting factor for abundance), along with the removal of invasive plant species where they are affecting natural groundcover or forest canopy. In addition, there may be some potential to increase available seep habitat and moist areas in the talus slope by re-routing the portion of groundwater not currently being used by salamanders to suitable but unoccupied areas. This goal is ambitious, and while work would need to be done to examine the feasibility of creating/modifying habitat and introducing species, it could be an important step in safeguarding the populations of these species in Ontario. Finally, improving the habitat between the two Allegheny Mountain Dusky Salamander populations could aid in dispersal and gene flow between the two sites.

Supporting Narrative for Recovery Approaches 4.1 and 4.2:

Although located in a steep and normally inaccessible area, streams and seeps in the Niagara Gorge are often explored by hikers who venture off the maintained trail. Litter from trail users is spread throughout the area. In addition, there may be potential for some salamanders to be collected by people for the pet trade. The human impact on these populations and how to mitigate this impact needs to be better understood, however, controlling human access to the habitats supporting dusky salamanders and educating trail users and visitors to the Niagara Gorge would likely help limit potential

damage. Discouraging human access off trail would not only be directly beneficial to the salamanders but could help to reduce erosion on the slopes as well.

2.4 Performance Measures

As dusky salamanders are nocturnal, elusive and liable to occupy habitat that is very difficult to access, obtaining reasonable estimates of population size for Ontario is difficult. It is likely that population estimates will require long-term and consistent monitoring including consecutive years of monthly surveys. Salamanders are expected to recover fairly quickly where optimal habitat is made available. Successful recovery will require both an increase in suitable habitat and an increase in abundance for both Allegheny Mountain Dusky and Northern Dusky Salamanders. As information is added through research and monitoring, it is recommended that recovery approaches be adjusted to ensure effectiveness.

Performance measures for each objective include:

Protect and enhance existing significant habitat for Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario.

- Extent of the groundwater recharge area identified.
- Flows of seeps and streams occupied by salamanders measured to determine seasonal and yearly averages.
- Major projects or developments on the tablelands that could impact groundwater quantity or quality at salamander sites monitored.
- Emergency spills action plan developed.
- Program in place to annually monitor water quality and detect pollutants at salamander sites.
- Program in place to monitor erosion rates at base of Niagara River Shoreline.
- Invasive plants within/near salamander habitat removed as appropriate.

Conduct a thorough population study, and if necessary maintain the genetic health of Allegheny Mountain Dusky Salamander and Northern Dusky Salamander populations in Ontario.

- Population sizes, trends and demographics assessed for both species.
- Genetic health of each population quantified.
- Nearest source populations of each species identified in New York for potential introduction if inbreeding appears to be of concern.

Locate additional populations and expand the current ranges of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders through introductions where appropriate.

- All other accessible suitable habitat within the Niagara Gorge and Niagara Escarpment surveyed for additional populations of dusky salamanders.
- Potential habitat for introductions within Niagara Gorge or Niagara Escarpment identified.

- Increased quality of adjacent suitable habitat so that populations of each species in Ontario have the potential to increase by a minimum of 50%.

Elicit public support and collaboration in the protection and recovery of Allegheny Mountain Dusky Salamanders and Northern Dusky Salamanders in Ontario.

- Education tools (pamphlets, magnets, etc.) developed and distributed to Niagara Gorge visitors to provide awareness of the impact of off-trail actions on salamander habitat.
- Outreach projects to encourage stewardship and involve stakeholders on adjacent lands above the Gorge initiated.

2.5 Area for Consideration in Developing a Habitat Regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of Natural Resources on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the author will be one of many sources considered by the Minister when developing the habitat regulation for this species.

All populations of Allegheny Mountain Dusky and Northern Dusky Salamanders in the Niagara Gorge occupy forested areas with groundwater discharges. While their habitat requirements are virtually the same, Allegheny Mountain Dusky Salamanders are slightly more terrestrial and may inhabit semi-permanent streams or seeps, whereas Northern Dusky Salamanders are nearly always located in permanent streams or seeps. Preservation of these moist areas within a forested habitat is essential.

All three known populations of dusky salamanders in Ontario are completely dependent on the continuing existence of the seeps and streams emanating from rock layers on the sides of the Niagara Gorge. Any regulation concerning the areas presently occupied by the salamanders would become irrelevant if the springs and the ground water flow that feeds them were to become contaminated or disrupted. Thus the adjacent land above the Gorge that serves as the catchment basin for these springs should also be considered if the long-term survival of these salamander populations is to be ensured.

Allegheny Mountain Dusky Salamander *Direct Habitat*

The two localities inhabited by Allegheny Mountain Dusky Salamanders are found on the west bank of the Niagara Gorge near Queenston. Each consists of a single, permanent groundwater discharge stream running down a very steep gradient through mixed deciduous forest (Yagi and Tervo 2008a, Weller 2010, 2011). The origin of both cascades is groundwater, which seeps out from rock layers at an elevation below the tableland. As all life stages of the Allegheny Mountain Dusky Salamander depend to

some extent on permanent streams or seeps and on rocky habitat, it is recommended that these stream areas be included in a habitat regulation.

Forested areas include the subterranean frost-free environment, soil, wet cavities along stream edges, vegetation, canopy cover, rocks, leaf litter and logs surrounding seep areas. This habitat provides shelter and food resources, and is critical to the survival and recovery of the species. Although the movements of Allegheny Mountain Dusky Salamanders in these populations are not well known, in other parts of its range individuals have been found up to 75 m from water (Organ 1961). For this reason, dispersal habitat for Ontario populations should include the forest floor extending to 75 m from the edges of a stream or associated seep occupied by these salamanders. Consequently, it is recommended that the entire extent of the two groundwater discharge streams and a 75 metre zone of forested land on both sides of each stream be included in the habitat regulation. Therefore, total direct habitat recommended for regulation of Allegheny Mountain Dusky Salamanders at the Queenston site is 1.98 ha, and for the Smeaton Creek population, 2.54 ha.

Finally, as two populations of Allegheny Mountain Dusky Salamanders (roughly half a kilometre apart) are now known in the Niagara Gorge, it is recommended that the area between the two localities be included in the habitat regulation as a dispersal corridor. While direct dispersal is not expected to occur frequently, it may be possible for salamanders to cross such distances over time in ideal cool/moist conditions. Gene flow between the sites would help to mitigate potential impacts of inbreeding that could occur in small isolated populations. The corridor habitat makes up an additional 4.2 ha of direct habitat, providing a total of 8.72 ha (the two sites plus the corridor) recommended for direct habitat regulation for the species.

Indirect Habitat

Populations of Allegheny Mountain Dusky Salamanders in the Niagara Gorge rely on the groundwater seepage streams during all life stages. Any decrease, curtailment or interruption of the ground water is likely to be detrimental to salamander recovery. Further, studies have demonstrated that siltation and urban impacts can decrease water quality and reduce dusky salamander populations. As a result, protection of groundwater quantity and quality needs to be considered in a habitat regulation for the long-term survival of this species in Ontario.

A study is in progress to determine the relationship between the water level in the Sir Adam Beck complex reservoir and stream flow at the Smeaton Creek site, Queenston site and Whirlpool site. The results of this study should be incorporated into follow-up documentation related to this recovery strategy. Although the full extent of the groundwater recharge area has yet to be determined with the appropriate hydrological studies, the Sir Adam Beck reservoir operates within the elevation of groundwater discharge areas and may play a role in maintaining a hydraulic gradient toward the seepage area of Allegheny Mountain Dusky Salamander populations. In late 2011, OPG lowered water in the reservoir to zero as part of an initiative to investigate future re-lining the reservoir to prevent leakage. During this time, it was observed that flow to

Smeaton Creek was dramatically reduced (A. R. Yagi, pers. comm. 2012). While a detailed analysis is needed to explicitly make the connection between the reservoir and stream or seepage flow, there is potential for the reservoir to be contributing a large amount of the flow to Smeaton Creek, and perhaps some to the Queenston Allegheny Mountain Dusky Salamander population as well.

It is therefore recommended that indirect habitat regulation include the groundwater recharge area and surface water catchment that feeds the source springs of both Allegheny Mountain Dusky Salamander populations. While detailed hydrological studies will provide a better sense of the extent of this area, a rough estimate includes some 700 ha of tableland and adjacent lands (Yagi and Tervo 2008a).

Northern Dusky Salamander

Direct Habitat

Although movements of Northern Dusky Salamanders in this population are not well understood, the average home range of individuals in USA populations is estimated to extend not further than 15 m from a stream or seep (Petranka 1998). Streams and seeps are critical habitat for larvae to develop and provide year-round essential moisture for adults. For this reason, it is recommended that all of the permanent or semi-permanent groundwater seeps within the currently occupied range of Northern Dusky Salamanders at the Whirlpool site be included in a habitat regulation.

Terrestrial forested habitat is important as a foraging area for adult salamanders. While under most conditions Northern Dusky Salamanders will remain near a permanent source of water, under ideal conditions (wet/cool nights) it is likely that they will disperse much further into the forest habitat to search for food or mates. Seepage areas occupied by Northern Dusky Salamanders at the Whirlpool site are quite dynamic in terms of flow, and can vary greatly from year to year depending on amounts of rainfall. Seasonality is also likely to influence seepage flow, although seasonal aspects of the Whirlpool seepage flows have not been determined. During periods of heavy rainfall seepage flow increases, saturating forest floor and increasing seepage areas. Such events can dramatically increase the available terrestrial habitat accessible to these salamanders. Because of the dynamic nature of the seeps at this site, a 75 m area extending from all permanent and semi-permanent seeps is proposed as a precautionary minimum for direct habitat protection. This will help to ensure that we capture all of the hydrologic function of this site and enable dispersal between the many seepage areas. Further, it provides enough habitat protection to allow for some changes to seepage flow over time. The total direct habitat recommended for regulation for the Northern Dusky Salamander is 3.36 ha.

Indirect Habitat

While we still do not fully understand the extent of the groundwater recharge area, it is evident that shallow groundwater seeping into the gorge is the predominant source of essential moisture for these salamander populations. Therefore it is highly recommended that some level of source water protection (both surface and groundwater) be provided for land in the up-gradient tableland areas. The groundwater

source is believed to originate in the Lockport rock formation. While the full extent of this area has not yet been determined (Yagi and Tervo 2008b), approximately 550 ha of tableland and adjacent lands are likely involved. This includes lands immediately west of the Niagara River Gorge and extending from the Niagara Escarpment to the Whirlpool. The maintenance of the groundwater discharge is essential to the long-term survival of all dusky salamander populations in Ontario. As a result, major projects on the tableland that have the potential to affect groundwater quality and quantity need to be thoroughly assessed and monitored once initiated.

Other considerations

The populations of both dusky salamander species in the Niagara Gorge are recent discoveries made as the result of intensive off-trail surveys in steep and treacherous terrain. It is quite possible that additional populations of both dusky salamanders may exist in the province. Areas of potential salamander habitat need to be searched extensively wherever possible and any new areas where dusky salamanders are found need to be quickly added to an area of habitat regulation. Further, where suitable habitats are available (or where available habitats can be made suitable), introductions should be considered and habitat regulation extended to include habitat at introduction sites.

GLOSSARY

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act, 2007* that is responsible for assessing and classifying species at risk in Ontario.

Conservation status rank: A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

- 1 = critically imperilled
- 2 = imperilled
- 3 = vulnerable
- 4 = apparently secure
- 5 = secure

Costal grooves: A set of parallel, vertical grooves between the ribs on the sides of some salamanders, newts and their larvae.

Cross-section: A surface or shape that is or would be exposed by making a straight cut through something, especially at right angles to an axis.

Dorsal: Relating to the upper side or back of an animal.

Endangered Species Act, 2007 (ESA): The provincial legislation that provides protection to species at risk in Ontario.

First-order stream: A stream that has no permanent or semi-permanent tributaries feeding into it.

Hybridization: the act of mixing different species or varieties of animals or plants, thus producing hybrids.

Keeled: A flattened, ridge-like part.

Plethodontid: Lungless salamanders from the family Plethodontidae.

Refugia: An area in which organisms can survive through a period of unfavourable conditions.

Seep: Flow or leak slowly through porous material or small holes.

Species at Risk Act (SARA): The federal legislation that provides protection to species at risk in Canada. This act establishes Schedule 1 as the legal list of wildlife species at risk to which the SARA provisions apply. Schedules 2 and 3 contain lists of species that at the time the Act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

Spermatophore: A cone-shaped jellylike mass topped with a sperm cap, deposited by male salamanders during courtship.

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**Part 3 – *Allegheny Mountain Dusky Salamander and the
Northern Dusky Salamander* –Ontario Government
Response Statement, prepared by the Ontario Ministry
of Natural Resources**

Allegheny Mountain Dusky Salamander and Northern Dusky Salamander

Ontario Government Response Statement



PROTECTING AND RECOVERING SPECIES AT RISK IN ONTARIO

Species at risk recovery is a key part of protecting Ontario's biodiversity. Biodiversity – the variety of living organisms on Earth – provides us with clean air and water, food, fibre, medicine and other resources that we need to survive.

The *Endangered Species Act, 2007* (ESA) is the Government of Ontario's legislative commitment to protecting and recovering species at risk and their habitats. As soon as a species is listed as extirpated, endangered or threatened under the ESA, it is automatically protected from harm or harassment. Also, immediately upon listing, the habitats of endangered and threatened species are protected from damage or destruction.

Under the ESA, the Ministry of Natural Resources (the Ministry) must ensure that a recovery strategy is prepared for each species that is listed as endangered or threatened. A recovery strategy provides science-based advice to government on what is required to achieve recovery of a species.

GOVERNMENT RESPONSE STATEMENTS

Within nine months after a recovery strategy is prepared, the ESA requires the Ministry to publish a statement summarizing the government's intended actions and priorities in response to the recovery strategy. The recovery strategy for Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*) and Northern Dusky Salamander (*Desmognathus fuscus*) was completed on January 11, 2013 (http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@species/documents/document/stdprod_099152.pdf).

The response statement is the government's policy response to the scientific advice provided in the recovery strategy. All recommendations provided in the recovery strategy were considered and this response statement identifies those that are considered to be appropriate and necessary for the protection and recovery of the species. In addition to the

Dusky salamanders are greyish-brown in colour and slender in shape with long tails and hind legs that are larger than their front legs. The Allegheny Mountain Dusky Salamander ranges from 70 to 110 mm in length with a bright yellow to red-coloured dorsal stripe running along it, and a dark brown or black underside. The Northern Dusky Salamander ranges from 60 to 140 mm in length with a uniformly tan or brown dorsal stripe, and a cream-coloured underside.

strategy, the response statement is based on input from stakeholders, other jurisdictions, Aboriginal communities and members of the public. It reflects the best available traditional, local and scientific knowledge at this time and may be adapted if new information becomes available. In implementing the actions in the response statement, the ESA allows the Ministry to determine what is feasible, taking into account social and economic factors.

MOVING FORWARD TO PROTECT AND RECOVER ALLEGHENY MOUNTAIN DUSKY SALAMANDER AND NORTHERN DUSKY SALAMANDER

The Allegheny Mountain Dusky Salamander and Northern Dusky Salamander are listed as endangered species under the ESA, which protects both the animals and their habitat. The ESA prohibits harm or harassment of both species and damage or destruction of their habitat without authorization. Authorization would require that conditions established by the Ministry be met.

The Allegheny Mountain Dusky Salamander is known to occur at two locations in Ontario's Niagara Gorge, southeast of the town of Queenston. Its range extends from eastern Tennessee through the Appalachian Mountains and along the shores of Lake Erie and Lake Ontario to southern Quebec. Located approximately four kilometres away, the Northern Dusky Salamander's single known population in Ontario is found among seeps that flow into the Niagara River. The Northern Dusky Salamander's range is similar to that of the Allegheny Mountain Dusky Salamander, extending from South Carolina through the Northeast United States into southern Quebec. Both species are considered globally secure.

The Allegheny Mountain Dusky Salamander and Northern Dusky Salamander are lungless and rely on their moist skin for respiration. These species inhabit moist and shaded streams supported by groundwater discharge, which are rare within southern Ontario. As a result, any deterioration, interruption or contamination of the groundwater and surface water that supports the species could potentially have catastrophic effects. As well, loss of ground cover – such as leaf litter, woody debris, rocks and moss that provide shelter and protection from predators and harsh weather – may lead to population declines. Other threats include landslides causing erosion and siltation, the clearing of the forested canopy above the species' habitat, disruption by hikers venturing off trail, the invasive European Common Reed (*Phragmites australis* ssp. *australis*), and inbreeding. Based on the information to date, all populations in Ontario are believed to be viable and self-sustaining.

The government's goal for the recovery of the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander is to maintain suitable habitat conditions in the Niagara Gorge in order to retain existing known populations in a self-sustaining state and promote natural increases.

Protecting and recovering species at risk is a shared responsibility. No single agency or organization has the knowledge, authority or financial resources to protect and recover all of Ontario's species at risk. Successful recovery requires inter-governmental co-operation and the involvement of many individuals, organizations and communities.

In developing the government response statement, the Ministry considered what actions are feasible for the government to lead directly and what actions are feasible for the government to support its conservation partners to undertake.

GOVERNMENT-LED ACTIONS

To help protect and recover the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander the government will directly undertake the following actions:

- Protect and manage the surface water and groundwater system that sustains the seep and stream habitat of the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander through continued water budget assessments that determine the quantity and quality of the water moving within the local area of the Niagara Gorge and any natural or human activities that influence the system.
- Educate other agencies and authorities involved in planning and environmental assessment processes on the protection requirements under the ESA.
- Encourage the submission of Allegheny Mountain Dusky Salamander and Northern Dusky Salamander data to the Ministry's central repository at the Natural Heritage Information Centre or the Ontario Reptile and Amphibian Atlas.
- Undertake communications and outreach to increase public awareness of species at risk in Ontario.
- Protect the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander and their habitat through the ESA.
- Support conservation, agency, municipal and industry partners, and Aboriginal communities and organizations to undertake activities to protect and recover the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander. Support will be provided through funding, agreements, permits (including conditions) and/or advisory services.
- Establish and communicate annual priority actions for government support in order to encourage collaboration and reduce duplication of efforts.

GOVERNMENT-SUPPORTED ACTIONS

The government endorses the following actions as being necessary for the protection and recovery of the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander. Actions identified as "high" will be given priority consideration for funding or for authorizations under the ESA. The government will focus its support on these high-priority actions over the next five years.

Focus Area:	Research and Monitoring
Objective:	Assess and improve knowledge of the species' demographics and physical environment in Ontario.
	Actions:
	1. (HIGH) Develop and implement a standardized survey and monitoring program for the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander and their habitat to:

- conduct searches of suitable unoccupied habitat along the Niagara Escarpment and Fonthill Kame Moraine for undiscovered populations;
 - monitor changes in slope stability and erosion rates on hillsides in the species' habitat;
 - monitor population levels and trends; and
 - monitor genetic health of the populations to detect potential inbreeding.
2. **(HIGH)** Develop an integrated program to measure, forecast, and detect changes in the quantity and quality of water supporting the species' habitat. This includes:
- developing a water budget model;
 - characterizing and simulating the surface water and groundwater system and contaminant transport;
 - assessing water use and land use scenarios;
 - measuring seasonal and yearly averages of the flows of seeps and streams; and
 - integrating the monitoring of climate, surface and groundwater within the local area of the Niagara Gorge.

Focus Area:
Objective:

Protection and Management

Maintain suitable habitat, particularly groundwater quantity and quality, and minimize threats from adjacent land uses.

Actions:

3. **(HIGH)** Work with stakeholders, engineers, and contractors to implement beneficial management practices that minimize impacts on groundwater recharge areas and seeps. Water budget modelling can help to forecast and identify potential impacts caused by changing land and water uses.
4. Plant native trees to reduce hillside erosion and deforestation and create stormwater management ponds to capture and slow down run-off of herbicides, pesticides and other pollutants.
5. Investigate whether the removal of European Common Reed will improve or negatively impact the quality of the habitat. The European Common Reed eliminates habitat use by the salamanders, but also helps to stabilize the slope and prevent soil erosion. If appropriate, implement the Ministry's protocol for the control of European Common Reed.

Focus Area:
Objective:

Awareness

Raise awareness and promote collaboration in the protection and recovery of the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander in Ontario.

Actions:

6. Prepare educational materials such as pamphlets to inform park visitors about the endangered status of these salamanders and the need to not disturb them or their habitat, and to discourage off-trail hiking.

IMPLEMENTING ACTIONS

Financial support for the implementation of actions may be available through the Species at Risk Stewardship Fund, Species at Risk Research Fund for Ontario, or the Species at Risk Farm Incentive Program. Conservation partners are encouraged to discuss project proposals related to the actions in this response statement with the Ministry. The Ministry can also advise if any authorizations under the ESA or other legislation may be required to undertake the project.

Implementation of the actions may be subject to changing priorities across the multitude of species at risk, available resources and the capacity of partners to undertake recovery activities. Where appropriate, the implementation of actions for multiple species will be co-ordinated across government response statements.

REVIEWING PROGRESS

The ESA requires the Ministry to conduct a review of progress towards protecting and recovering a species not later than five years from the publication of this response statement. The review will help identify if adjustments are needed to achieve the protection and recovery of the Allegheny Mountain Dusky Salamander and Northern Dusky Salamander.

ACKNOWLEDGEMENT

We would like to thank all those who participated in the development of the "Recovery Strategy for the Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*) and Northern Dusky Salamander (*Desmognathus fuscus*) in Ontario" for their dedication to protecting and recovering species at risk.

For additional information:

Visit the species at risk website at ontario.ca/speciesatrisk

Contact your MNR district office

Contact the Natural Resources Information Centre

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