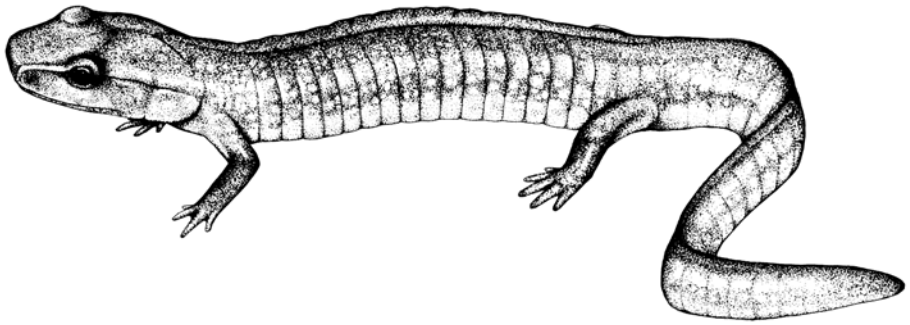
COSEWIC
Assessment and Status Report

on the

Spring Salamander
Gyrinophilus porphyriticus

in Canada



SPECIAL CONCERN
2002

COSEWIC
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CANADA

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COSEWIC 2002. COSEWIC assessment and status report on the spring salamander *Gyrinophilus porphyriticus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 16 pp.

Bonin, J. 1999. COSEWIC status report on the spring salamander *Gyrinophilus porphyriticus* in Canada *in* COSEWIC assessment and status report on the spring salamander *Gyrinophilus porphyriticus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-16 pp.

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Également disponible en français sous le titre Évaluation et Rapport du COSEPAC sur la situation du salamandre pourpre (*Gyrinophilus porphyriticus*) au Canada.

Cover illustration:
Spring salamander — Andrée Jenks, Hamilton, Ontario.

Catalogue No. CW69-14/352-2004E-PDF
ISBN 0-662-35884-8
HTML: CW69-14/352-2004E-HTML
0-662-35885-6


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COSEWIC
Assessment Summary

Assessment Summary – May 2002

Common name
Spring salamander

Scientific name
Gyrinophilus porphyriticus

Status
Special Concern

Reason for designation
This species has a limited, fragmented range and specialized habitat requirements. It is susceptible to habitat degradation leading to population loss. Because of low dispersal rates, as well as late sexual maturity, populations that are lost have little chance of recovery.

Occurrence
Ontario and Quebec

Status history
Designated Special Concern in April 1999. Status re-examined and confirmed Special Concern in May 2002. Last assessment based on an existing status report.

COSEWIC
Executive Summary

Spring Salamander
Gyrinophilus porphyriticus

Species Range

The spring salamander, *Gyrinophilus porphyriticus* (Caudata, Plethodontidae) reaches its northern limit of distribution in Canada. It is represented here by the subspecies called the northern spring salamander, *G. p. porphyriticus*, which is distinct from four other subspecies located in the Appalachian mountains of the United States.

Canadian Populations

There are two distinct populations inhabiting forested mountain streams in southern Quebec. One ranges over 200 km^2 in the foothills of the Adirondacks, Huntingdon county, while the other is discontinuously distributed over 30,000 km^2 of the Appalachian mountains and foothills from the US-Canada border north to Arthabaska county.

Population Size

The spring salamander is rare within its range and usually found in low abundance. Greatest densities are found in headwater streams lacking predatory fish.

Habitat Features

Key habitat features include permanent water flow, cool oxygenated water, an unfrozen winter refuge, and a rocky and gravely stream bed and bank to provide micro-habitat cover for adults and larvae.

Vulnerability

The late sexual maturity (up to 6 years old) and the special habitat requirements of the spring salamander make this species particularly vulnerable to environmental changes.

Limiting Factors

Limiting factors are related to habitat transformation due to agriculture, forest cutting, and the development of housing and intensive recreation in the mountains of southern Quebec.

Status Evaluation

Present protection is insufficient to counteract the impact of limiting factors. It is a priority to preserve headwater stream populations in both the Adirondack and Appalachian ranges in Canada. The species must be considered **Special Concern** until sufficient protection can be provided.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as “Vulnerable” from 1990 to 1999, or “Rare” prior to 1990.
** Formerly described as “Not In Any Category”, or “No Designation Required.”
*** Formerly described as “Indeterminate” from 1994 to 1999 or “ISIBD” (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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COSEWIC Status Report

on the

Spring Salamander
Gyrinophilus porphyriticus

in Canada

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1999

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INTRODUCTION

The spring salamander, *Gyrinophilus porphyriticus*, is in the family Plethodontidae, the lungless salamanders. It is thought that these salamanders evolved in association with stream habitats in eastern North America (Wake 1966; Frost 1985; Beachy and Bruce 1992). Members of this family are diversified, with over 225 species distributed throughout North and South America and in a restricted area of southern Europe (Frost 1985). The genus *Gyrinophilus* is considered primitive due to its lengthy aquatic larval period (Beachy and Bruce 1992). The genus contains two species: *G. palleucus* and *G. porphyriticus* (Brandon 1966, 1967a, 1967b, and 1967c) while a third form (*G*. *subterraneus*) previously considered as a distinct species (Beshare and Holsinger, 1977) is now included within *G*. *porphyriticus* (Frost 1985). *Gyrinophilus porphyriticus* itself is diverse, with five recognized subspecies: *G*. *p*. *porphyriticus*, *G*. *p*. *duryi*, *G*. *p*. *dunni*, *G*. *p*. *danielsi*, and *G*. *p*. *subterraneus*. Only the first subspecies is found in Canada.

The current common name of the species is “Spring salamander”, while the subspecies present in Canada is called “Northern spring salamander” (Collins 1990). In French, the species is called “salamandre pourpre” (Cook 1984; Bider and Matte 1994). Brandon (1967c) lists the various names used in the past: *Salamandra porphyritica*, Green 1827; *Salamandra salmonea*, Storer 1838; *Pseudotriton salmoneus*, Baird 1850; *Spelerpes salmonea*, Gray 1850; *Spelerpes porphyritica*, Gray 1850; *Ambystoma salmoneum*, Duméril 1854; *Spelerpes salmoneus*, Cope 1866; *Geotriton porphyritica*, Garman 1884; *Pseudotriton porphyriticus*, Organ 1961. At one time, Bishop (1947) used the name Purple Salamander.

The spring salamander (Fig. 1) is among the largest of plethodontids, reaching up to 20 cm total length. The species is recognized among Canadian salamanders by its reddish color and a light line from the eye to the nostril. Its coloration varies geographically and darkens with age. Nevertheless, a pinkish color is always present between dark markings on the back. The belly of the adult is cream-colored as is the whole body of the larva. Individuals are most colorful (salmon to reddish) at the time of metamorphosis (Brandon 1967c).

Figure 1. *Gyrinophilus porphyriticus*, adult (David M. Green, photo).

Surveys by Canadian herpetologists have produced a fairly good knowledge of this species' distribution in southern Quebec (Bleakney 1958; Weller 1977; Gordon 1979; Shaffer and Bachand 1990; Bonin 1991a; Bider and Matte 1994). However, little attention has been paid to the study of its life history in Canada (Bonin 1991a).

DISTRIBUTION

The distribution of the spring salamander is restricted to the Appalachian mountain system of eastern North America. It is found in Mississippi, Alabama, Georgia, South Carolina, North Carolina, Tennessee, Kentucky, West Virginia, Virginia, Ohio, Maryland, Pennsylvania, New Jersey, Rhode Island, New York, Connecticut, Massachusetts, Vermont, New Hampshire, and Maine (Fig. 2).

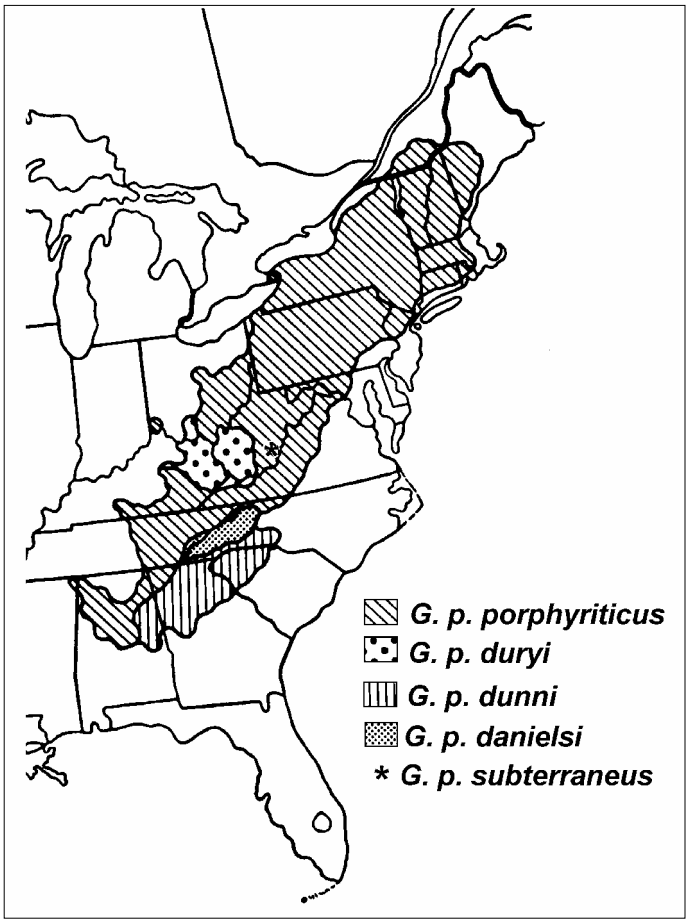

Figure 2. North American distribution of *Gyrinophilus porphyriticus* (after Conant and Collins, 1991).

In Canada, the present distribution of the species is restricted to the Appalachian mountains of southern Quebec (Fig. 3). There are two early records for Ontario which have not been confirmed by any subsequent surveys (Cook 1970 and 1977; OHS 1996). For a 1934 record, a larva was collected at Britannia near Ottawa. If *G. porphyriticus*, it resulted apparently from an introduction (Bleakney 1958; F. R. Cook, pers. comm.). Another record, from 1877, is of three larvae collected from “opposite to Buffalo, New York”, which may correspond to the Niagara region in Welland county. If true, the spring salamander is evidently extirpated from that area and is therefore extirpated from Ontario (Oldham 1996). However, both these Ontario records are of larvae only and their identification as *G. porphyriticus* may be suspect. Thus, its presence in Ontario has never been proven.

In Quebec (Fig. 3), *Gyrinophilus porphyriticus* occurs in the Adirondacks at Covey Hill, Huntingdon County), the Appalachians at Pinnacle, Sutton, Foster, Orford, Elephant and Stokes mountains, in several isolated localities at the margin of the Appalachians including the Monteregion Hills of Brome, Shefford and Yamaska, Lake Massawipi, the Smith mountains at Richmond, and Arthabaska County (Weller 1977; Gordon 1979; Shaffer et Bachand 1989; Bonin 1991a; Bider et Matte 1994). The species has not been found further east in the Notre-Dame Mountains and in most of the White Mountains, although further searches may be required. The St. Lawrence lowlands represent the northwestern limit of the species' range in Canada (Bleakney 1958; Bonin 1991a). The Atlas of Amphibians and Reptiles of Quebec databank contains an updated list of records, although some records may need to be verified because they originate from a variety of sources including non-professional herpetologists.

PROTECTION

The species is not listed in the current Quebec Endangered Species Act, “Loi sur les espèces menacées ou vulnérables” (L.R.Q., chap. E-12-01), but is on the list of species to be evaluated for designation (Beaulieu and Huot 1992). A status report was prepared for that purpose (Bonin 1991b).

The Quebec wildlife conservation act, “Loi sur la conservation et la mise en valeur de la faune” (L.R.Q., chap. C-61.1), regulates the harvesting, sale and collection of native species in Quebec. The spring salamander cannot be collected in the wild, sold, or kept in captivity. A licence is required for purposes of scientific and educational collection.

POPULATION SIZE AND TREND

The spring salamander is considered to be rare in Canada (Cook 1970 and 1977; Leclair 1985; Vial and Saylor 1993; Bider and Matte 1994). Usually few individuals are found in a suitable habitat, out-numbered by two-lined salamanders, *Eurycea bislineata* (Bonin 1991; Resetarits 1995). Very occasionally, larger numbers can be found, from five to twenty individuals per 25 m of stream (pers. obs.). This situation is similar in the

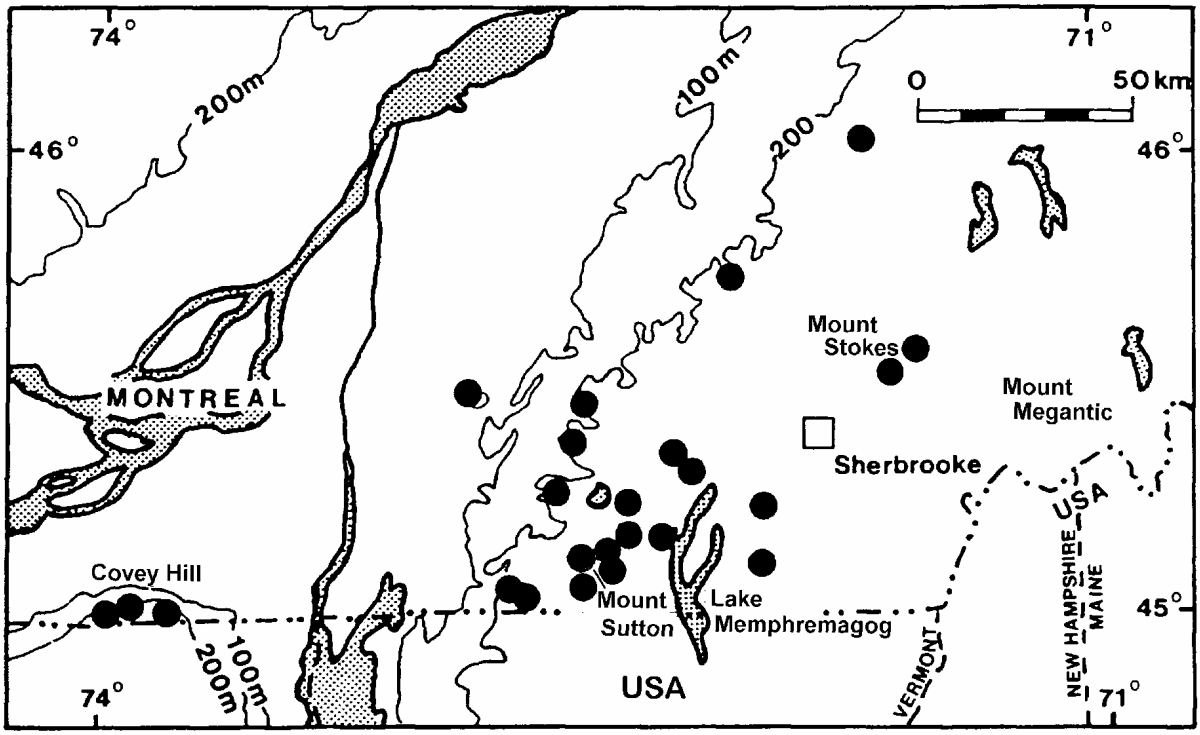

Figure 3. Canadian distribution of *Gyrinophilus porphyriticus*.

northern part of the United States (Brandon 1967c; Burton and Likens 1975). In New York state, Bishop (1941) found it to be abundant locally. The species is uncommon to rare in New England, except in Vermont and in the northwestern part of Berkshire county in Massachusetts, where it is common (DeGraaf and Rudis 1983). Nevertheless, R. Wyman (in: Vial and Saylor 1993) considered the species sensitive only in Massachusetts.

We can distinguish two populations in Canada, one located in the Appalachians and the other in the Adirondacks. These two populations are separated by the Richelieu River - Lake Champlain - Hudson River system. Brandon (1966) distinguished morphologically the Adirondack and Appalachian populations in New England based on number of vertebrae and ventral coloration. The ranges of the Adirondack and the Appalachian populations in Canada are, respectively, 200 km^2 and 30,000 km^2. Globally, this represents about 5% of the total species range in North America (Ovaska 1995).

The size of the Canadian population is not known. From an ecological study conducted in the Québec portion of the Adirondacks, Bonin (1991a) estimated that 14 km of suitable stream habitats would be inhabited by the species. Although salamander densities were unknown, it was estimated that a diurnal search over that area would yield about 846 adults. Some portions of these habitats may support higher densities but their extent is unknown. In Virginia, larval density of ca. 5 to 10 / m^2 are reported for headwater streams where predatory fish are absent (Resetarits 1995).

Population trends are not documented in Canada. In 1993, fifteen old localities were surveyed to verify the persistence of populations (Bonin 1994). The species was found in only five sites because of the imprecision of initial localities (4 sites), the presumed low abundance of the species (5 sites) and the destruction of the habitat (1 site in a ski center).

Gyrinophilus porphyriticus populations have declined in New Jersey (Cromartie 1982) and Mississippi, probably due to habitat modification (Ashton 1976). The species is also threatened in Massachusetts and Connecticut (DeGraaf and Rudis 1983).

HABITAT

Habitat definition

Gyrinophilus porphyriticus is mainly associated with cool and clear water streams of forested, mountainous regions (Weller 1977). The species has been also found in various other situations: streams in open areas, ponds, lake edges, peat habitats and caves (Brandon 1967c; DeGraaf and Rudis 1983).

Permanent streams are required for the development of the aquatic larvae, which need well-oxygenated water for aquatic respiration (Hairston 1987). Foraging activity of terrestrial adults requires moist, cool environments, because skin respiration limits the tolerance of lungless salamanders for desiccation (Spotila 1972; Feder 1983). Cover objects are thus important microhabitat features for adults (Bonin 1991a). During summer, adults are usually found at the edges of streams, underneath large flat rocks in the vicinity of water (Barbour 1971; pers. obs.).

Wintering habitats are probably underground wet cavities (Bishop 1941) or unfrozen springs (pers. obs. of larvae). At our latitude, streams can freeze deeply if not fed with underground spring water. Freezing tolerance has not been documented for this species (K. Storey pers. comm.)

Forest cover is a key habitat feature (Bonin 1991a), providing suitable cover and humidity for adults to forage around the stream. It would also shade the stream, preventing the warming of the water. It also plays a role in filtering runoff, avoiding siltation of the stream bed used for foraging by salamander larvae (Bury 1980; Bonin 1991a).

Gyrinophilus porphyriticus is usually found in uphill areas (Bonin 1991a) with greatest numbers in headwater springs and portions of streams bedded with flat rock, particularly limestone (pers. obs.; Bishop 1941). Small headwater streams free of predatory fish support larger populations of spring salamanders (Resetarits 1995). Springs in rock outcrop areas may also provide suitable wintering conditions. Furthermore, limestone crevices would offer shelter for young larvae, avoiding predation from fish and from cannibalism by larger larvae (Resetarits 1995).

Habitat trends

The forest has been eliminated over large parts of the southern Quebec lowlands and water drainage has been modified to favor agriculture. This may have affected populations located in the foothill areas at the margin of the species' range. In mountainous regions where most of the actual localities are, forest cutting has been the major habitat modification. Although this may not result in the loss of habitats, it may have altered habitat quality and affected population survival. Over the last few decades, development of housing (cottages, condominiums) and recreation centers (ski slopes, golf course) has increased in the Appalachian region of Quebec. This has probably affected the quality of the habitat in several regions, especially around Mounts Shefford, Brome, Orford, and Sutton.

Habitat protection

The provincial regulation on forestry practices includes the protection of a 20 m wide buffer zone along water courses (Anonymous 1986). However, high quality stream habitats represented by the smaller headwater springs are often overlooked by foresters.

The Mount Orford Provincial Park (5,840 ha) secures habitats of the species within the Appalachian range. There is a record from Yamaska Provincial Park (1290 ha) but there are few suitable habitats within the park's limits. A record from the lake on Mount Shefford is within the protected area of a water reservoir used by the municipality of Granby. *Gyrinophilus porphyriticus* was also found in the vicinity of the Ruiter Valley Land Trust, a 170 ha private conservation area protecting suitable habitats in the Sutton Mountains.

GENERAL BIOLOGY

Reproduction

Sexual dimorphism of the cloacal gland is described by Sever (1986) while sperm morphology is illustrated in Wortham et al. (1982). Males are relatively longer than females and, through the clear belly skin, the black testes can be distinguished from white eggs (Bishop 1941).

Gyrinophilus porphyriticus reproduces annually in North Carolina (Bruce 1969). Mating occurs in fall with egg deposition the following spring or summer (Bruce 1969 and 1972). Courtship success varies, possibly in relation to the body size of adults (Beachy 1996). Eggs are attached underneath large rocks or logs, in flowing water. The number of eggs varies from 44 to 132 in New York (Bishop 1941). Smaller clutch sizes are reported for southern regions: 9 to 63 in South and North Carolina (Bruce 1972), 87 for a female from North Carolina (Calisaya and Marks 1994), and 44 to 66 in Virginia (Organ 1961). Hatching occurs at the end of the summer (DeGraaf and Rudis 1983) or in the fall (Organ 1961). Development from fertilization to hatching is described by Calisaya and Marks (1994).

Growth and longevity

The larval period is longer than that of any other plethodontid (Hairston 1987; Beachy and Bruce 1992), ranging from 3 to 5 years (Bruce 1980) and even up to 6 years (Resetarits 1995). Larval growth is affected by aquatic habitat condition and predation pressure (Bruce 1978 and 1980; Resetarits 1991 and 1995). Metamorphosed juveniles emerge in spring or summer while sexual maturity is reached a year later (Bishop 1941). In New York, individuals mature sexually at 4 to 5 years old, at a total length of 14 cm (Bishop 1947). Bruce (1969) estimates that females mature sexually at 5 years old. Resetarits (1995) reported sexually immature individuals over 6 years old. This suggests that the spring salamander has one of the most delayed ages at sexual maturity and probably one of the lowest recruitment rates of the Plethodontidae. Longevity is probably over ten years (Tilley 1977; Castenet et al. 1996).

Movements

As for other stream salamanders, movements of larvae and adults probably occur along stream habitats, although this has not been reported specifically for *G. porphyriticus* (Bruce 1986). Headwater populations may represent a source of colonists for downstream populations following the drift of larvae (Resetarits 1995).

Terrestrial movements should be rare compared to other salamander species (Bruce 1978), although distances traveled have not been reported. Bishop (1941) mentions movements between streams. Barbour (1971) indicates that movements away from a stream usually occur along wet habitats like road ditches. Huheey and Stupka (1967) report many individuals crossing roads during rainy nights in the Great Smoky Mountains. Restricted movements between streams may favor the isolation of populations (Tilley and Scherdtfeger 1981). This may explain the geographical variations and the tendency of sexual isolation among populations and subspecies of *G. porphyriticus* (Bruce 1978; Beachy 1996) (see Figure 2).

Ecology

The spring salamander is a predator of other salamanders, of terrestrial and aquatic invertebrates, and of conspecifics (Burton 1976; Resetarits 1995). Larvae forage on the substrate and under cover objects (Resetarits 1991) while adults forage mostly at the stream edges. Intense predation by *G. porphyriticus* may reduce the availability of food (Culver 1973, 1975) and food shortage would slow larval growth (Resetarits 1991; 1995). In a portion of stream having a high density of spring salamanders, other stream salamanders may be less abundant or be absent (Bonin 1991a, pers. obs.).

The larvae are subjected to predation by trout (*Salvelinus fontinalis*), which strongly affect distribution and population dynamics (Resetarits 1991 and 1995). Adults avoid predation from trout by using terrestrial habitat. Toxic cutaneous secretions and the red coloration which mimics that of even more toxic species are thought to protect

adults from terrestrial predators (Brodie et al. 1979; Brandon and Huheey 1981). The spring salamander is the host of more than a dozen species of helminth parasites (Catalano et al. 1982).

Behavior, physiology and vulnerability

Gyrinophilus porphyriticus is nocturnal, foraging only during rainy nights (Burton and Likens 1975; Burton 1976). It therefore rarely interacts directly with humans. However, it might be intolerant to changes in habitat conditions because of the physiological limits related to lunglessness (Spotila 1972; Feder 1983) and the prolonged larval period (Resetarits 1995). Under natural conditions, the longevity of adults and their relatively large clutch sizes balance larval mortality related to variation in aquatic habitat conditions and predation pressure (Resetarits 1995). The species should have a limited adaptability when changes in the habitat affect adult survival or preclude the aquatic larval development. The vulnerability of the species is illustrated by the specificity of its habitat described above and by the numerous limiting factors listed below.

LIMITING FACTORS

Habitat modification is the major threat to the species. Sedimentation related to stream bed and shore bank alteration during road construction and canalization work affects survival of salamander larvae (Bury 1980). The transformation of hydrographic systems has affected the survival of *G. porphyriticus* in New Jersey and Mississippi (Ashton 1976). Pumping of aquifers near springs also affects the survival of stream salamanders. In fact, water pumping in residential areas can modify a water regime from permanent to temporary (Medina 1990).

Changes in stream conditions following the elimination of forest at the stream edge also affects the survival of salamanders (Bury 1980; Corn and Bury 1989). Though the effect of forest cutting on aquatic habitats may be temporary (Martin et al. 1984; Likens 1985) it may have long term effects on genetic diversity and survival of salamander populations (Stiven and Bruce 1988).

The impact of atmospheric pollutants or pesticides used in forestry and agriculture (especially in orchards) is not documented (Harfenist et al. 1989). However, *G. porphyriticus* may be vulnerable to contamination due to its high trophic level and its longevity. Bury (1980) mentions that pollution of underground water and runoff of contaminants into streams can affect the survival of stream salamanders.

Predatory fish limit the survival of spring salamander larvae (Resetarits 1991 and 1995). The introduction of trout into headwater streams and ponds might therefore affect salamander populations.

Beavers modify stream conditions by the construction of dams, causing the warming of the water and eutrophication of the aquatic habitat. This affects mainly

streams in lowland and foothill regions since beavers usually avoid mountain streams because spring floods affect water level variation (Banfield 1975). Although the impact of beaver activities may be restricted to marginal downstream populations, it could become significant if the beaver populations increase following reduction of beaver trapping, reduction of the beaver's natural predators, and increase in the beaver's food resources due to forestry practices favoring second growth tree species.

SPECIAL SIGNIFICANCE OF THE SPECIES

The spring salamander is the largest and the most primitive plethodontid found in Canada. Geographically distinct populations are present in the country. These populations, located at the northern limit of the species' range, present unique traits compared to other American populations (Brandon 1966). The species is among the largest predators in headwater stream communities (Resetarits 1995). However, the species is poorly known to the public because of its rarity and its secretive, nocturnal behavior.

EVALUATION

The spring salamander should be considered **Special Concern** in Canada because of its limited range in Canada; its normally low abundance in suitable habitats in northeastern America; its delayed sexual maturity; which suggests a low recruitment rate and the need for a stable environment; its specialized habitat requirement for clear, cool, forested, mountain streams; its vulnerability to changes in its ecosystem due to human activities including elimination of forest cover at the stream edge, modification to the water regime, increased sedimentation, pollution, introduction of predatory fish, etc.; the impact on its survival due to extended logging activities within its distribution range in Canada; the impact of habitat transformation resulting from the recent increase in development for housing and recreation within its distribution range in Canada; and the limited protection afforded to the species and its habitat, which cannot counteract these negative habitat trends.

The two distinct Appalachian and Adirondack populations should be considered in conservation initiatives. The Adirondack population has a very restricted range and presently has no habitat protection. This population is therefore at greater risk and its conservation should receive priority. The Appalachian population occurs in several mountains and few of these subpopulations benefit from habitat protection. Headwater stream habitat protection is required in Mts Brome, Elephant, Shefford, Stokes and Sutton especially. Protection initiatives should focus on headwater stream populations and other high density populations, as these probably supply colonists for other populations downstream.

Our knowledge of populations at the margin of the species' distribution range is limited, especially in mountainous areas along the northeastern edge. The persistence of populations in old localities is also poorly known. A more accurate status evaluation

would require more precise knowledge of the species range boundaries and population trends.

ACKNOWLEDGEMENTS

The production of this Canadian status report was supported by the Canadian Wildlife Federation. A preliminary French version was produced for the province of Quebec with the support of the “Ministère du loisir, de la chasse et de la pêche” in 1991. I thank the following persons for their support in previous surveys or in providing me with accurate distribution data: R. Alvo, Y. Bachand, J. R. Bider, F. R. Cook, and W. Weller.

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