COSEWIC
Assessment and Status Report

on the

Broad-banded Forestsnail
Allogona profunda

in Canada

ENDANGERED
2014

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Broad-banded Forestsnail — Photo by Allan Harris.

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COSEWIC
Assessment Summary

Assessment Summary – November 2014

Common name
Broad-banded Forestsnail

Scientific name
Allogona profunda

Status
Endangered

Reason for designation
In Canada, this large terrestrial snail is known to exist only in Point Pelee National Park and on Pelee Island. An overabundance of nesting Double-crested Cormorants has most likely led to the loss of subpopulations on some small Lake Erie islands since the early 1980s; historical losses of woodlands and forests also occurred on the mainland and Pelee Island. Major continuing threats are from recreational activities and shoreline erosion. A possible threat is predation by introduced Wild Turkeys, which are rapidly increasing in numbers.

Occurrence
Ontario

Status history
Designated Endangered in November 2014.

COSEWIC
Executive Summary

Broad-banded Forestsnail
Allogona profunda

Wildlife Species Description and Significance

Broad-banded Forestsnail is a large (about 30 mm in diameter) terrestrial snail. Shells usually have a distinctive low tooth inside the lower lip of the aperture (shell opening) and a large open umbilicus (hole at the central part of the underside of the shell). The lip of the aperture is white and flares outward. The shell is pale yellow, often with pale brown bands, and the surface is sculptured with fine grooves. Canadian populations of Broad-banded Forestsnail may be genetically isolated from other populations and have significance for conservation.

Distribution

Broad-banded Forestsnail is distributed from southern Ontario and the Upper Peninsula of Michigan south to northern Alabama and east to Pennsylvania and North Carolina. Fossil shells along the Mississippi River as far south as Louisiana represented its southern range limit during the Pleistocene. In Canada, Broad-banded Forestsnail is restricted to the Carolinian Forest region of Ontario on the north shore and islands of Lake Erie. Known subpopulations are presently restricted to Point Pelee and Pelee Island, but there are historical records from the smaller Lake Erie islands and several mainland sites.

Habitat

Broad-banded Forestsnail habitat consists of deciduous forest. In Ontario, extant subpopulations are found primarily in forest and woodland on sandy soil. Empty snail shells were found at some sites extending into wooded alvars (shallow soils over limestone) and shrubby vegetation on sandy soil adjacent to deciduous forest.

Biology

Little information is available about Broad-banded Forestsnail biology. It is an air-breathing, terrestrial snail. Individuals have both male and female reproductive parts (hermaphroditic) and both members of a mating pair exchange sperm and produce eggs. Broad-banded Forestsnail may reach maturity as early as one year, and can live for at least four years. Hibernation occurs buried 5 – 10 cm under the soil or in shallow depressions in the forest floor where leaf litter provides insulation. Broad-banded Forestsnails are active both day and night, but often retire to shelter under leaf litter from mid-morning until late afternoon. Foraging usually takes place on the ground. Green plants and fungus growing on decaying logs are apparently important food sources. Terrestrial snails require damp habitat to feed, move, and reproduce and most species are restricted to forested or wooded habitats that provide shade and retain moisture in the soil and leaf litter. Individuals probably move only a few metres over the course of their lives. Eggs and immature stages are not known to be dispersed by the wind or water.

Population Sizes and Trends

The Canadian population probably declined in the early 1800s, when most of the historical Canadian range was cleared for agriculture. More recently, the number of extant sites has decreased with the apparent loss of subpopulations on Middle Sister, East Sister and Middle islands. The population size is unknown.

Threats and Limiting Factors

Historical and recent threats included forest clearing and Double-crested Cormorants. Most of the forest cover within the mainland range of Broad-banded Forestsnail was cleared decades ago and extant populations are within protected areas where further forest clearing is a negligible threat. Double-crested Cormorant nesting colonies have increased dramatically on the smaller Lake Erie islands since the early 1980s. Associated habitat changes from vegetation dieback and altered soil chemistry probably contributed to the extirpation of snails on these islands. Cormorants prefer to nest on uninhabited islands and are unlikely to colonize Point Pelee and Pelee Island.

Present threats are less well understood. Trampling from recreational use of trails probably kills snails at Point Pelee and Pelee Island. Snails also may be killed in prescribed burns. Altered shoreline processes caused by climate change and shoreline development are causing substantial erosion at Point Pelee and Fish Point. Invasive plants and earthworms occur throughout southern Ontario and may have altered forest ecosystems and snail habitat. Introduced Wild Turkeys and Ring-necked Pheasants may be additional sources of predation.

Protection, Status, and Ranks

Broad-banded Forestsnail is not protected by any Canadian legislation, regulations, customs or conditions except as indicated below. It is not listed under the US *Endangered Species Act* or under any state or provincial acts. It is not listed under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES). The species and its habitat are protected in Point Pelee National Park and Fish Point Provincial Nature Reserve by federal and provincial park regulations, but threats from invasive species, accidental trampling from recreational use, and similar activities can still occur.

The Global Rank is G5 (Secure) and Subnational Rank in Ontario is S1 (Critically Imperilled). It is not ranked in most states where it occurs.

TECHNICAL SUMMARY

Allogona profunda

Broad-banded Forestsnail — Escargot-forestier écharge

Range of occurrence in Canada: Ontario

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2008) is being used) Assuming most individuals mature at one year and live four or more years, generation time is estimated at 3-4 years.	3-4 years
Is there an [observed, **inferred**, or projected] continuing decline in number of mature individuals? Extirpation of small island subpopulations is recent but began more than 3 generations ago. Continuing declines in quality of habitat could cause corresponding declines in numbers of mature snails.	Possibly
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [**reduction** or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	Unknown
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence Historical: 1770 km^2	116 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value). Historical: 72 km^2	32 km²
Is the population severely fragmented?	No
Number of locations At least two locations are identified: Point Pelee and Pelee Island with potentially up to 4 locations on Pelee Island (see **Threats** below).	2-5

Is there an [observed, **inferred**, or projected] continuing decline in extent of occurrence? Loss of small island subpopulations is recent decline not continuing decline; however, decline could be continuing on islands that could not be surveyed.	Unknown
Is there an [observed, **inferred**, or projected] continuing decline in index of area of occupancy? Loss of small island subpopulations is recent decline not continuing decline; however, decline could be continuing on islands that could not be surveyed.	Unknown
Is there an [observed, **inferred**, or projected] continuing decline in number of populations? Loss of small island subpopulations is recent decline not continuing decline; however, decline could be continuing on islands that could not be surveyed.	Unknown
Is there an [observed, **inferred**, or projected] continuing decline in number of locations*? Loss of small island subpopulations is recent decline not continuing decline; however, decline could be continuing on islands that could not be surveyed.	Unknown
Is there an [observed, **inferred**, or projected] continuing decline in [**area, extent** and/or **quality**] of habitat? Invasive plants and animals, recreational activities, and prescribed burning are probably causing habitat quality to decline; shoreline erosion also will reduce area and extent of habitat	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	**N Mature Individuals**
Point Pelee	Unknown
Pelee Island	Unknown
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Unknown

Threats (actual or imminent, to populations or habitats)

Based on the threats calculator, the overall threat impact is low but the impacts of several threats are unknown. The most imminent threats at Point Pelee are probably a combination of prescribed burns, invasive species, habitat fragmentation by roads, recreational activities, and shoreline erosion. The Pelee Island location(s) (including extant populations at Fish Point and possible/ historical populations elsewhere on the island) faces similar threats. The two (to five) locations are separated by 15 km of Lake Erie. Loss of forest cover on the mainland and habitat changes caused by Double-crested Cormorant on the Lake Erie islands caused the apparent extirpation of several subpopulations but do not threaten extant subpopulations.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Status in states adjoining Ontario is unknown (NatureServe 2014)	Unknown
Is immigration known or possible?	Possible, but unlikely
Would immigrants be adapted to survive in Canada?	Possible
Is there sufficient habitat for immigrants in Canada?	Possible
Is rescue from outside populations likely?	No

Data-Sensitive Species

Is this a data-sensitive species? Potential for snail poaching is unknown.	Possibly

Status History

Not previously assessed

Additional Sources of Information:

Status and Reasons for Designation:

Status:	**Alpha-numeric code:**
Endangered	B1ab(iii,v)+2ab(iii,v)
Reasons for designation: In Canada, this large terrestrial snail is known to exist only in Point Pelee National Park and on Pelee Island. An overabundance of nesting Double-crested Cormorants has most likely led to the loss of subpopulations on some small Lake Erie islands since the early 1980s; historical losses of woodlands and forests also occurred on the mainland and Pelee Island. Major continuing threats are from recreational activities and shoreline erosion. A possible threat is predation by introduced Wild Turkeys, which are rapidly increasing in numbers.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. The number of mature individuals is unknown.

Criterion B (Small Distribution Range and Decline or Fluctuation): Meets EN B1ab(iii,v)+2ab(iii,v) because both the EO (116 km^2) and IAO (32 km^2) are well below the thresholds for EN (<5,000 km^2 and <500 km^2, respectively), the species is found in fewer than 5 locations, and there is a projected continuing decline in area, extent, and quality of habitat (iii), which will also result in an inferred decline in number of mature individuals (v).
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Number of mature individuals is unknown.
Criterion D (Very Small or Restricted Population): D1 is not applicable as the number of mature individuals is unknown. D2 TH also is not applicable because while the IAO (32 km^2) is slightly above the typical < 20 km^2 threshold and the number of locations is below the typical threshold (= 5), the impact of the major threats from Recreation and Habitat Alteration are not expected to act within a short time frame (1-2 generations).
Criterion E (Quantitative Analysis): Not applicable as analyses have not been done.

COSEWIC HISTORY

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. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2014)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* 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. Definition of the (DD) category revised in 2006.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Kingdom: Animalia - Animal, animals, animaux

Phylum: Mollusca - mollusks

Class: Gastropoda - gastropods

Order: Pulmonata

Suborder: Stylommatophora

Family: Polygyridae

Subfamily: Polygyrinae

Genus: *Allogona* Pilsbry, 1939

Species: *Allogona profunda* (Say, 1821)
Broad-banded Forestsnail, escargot-forestier écharge

There are four species in the genus *Allogona*, three of which occur in Canada (Pilsbry 1940; COSEWIC 2013a). Oregon Forestsnail (*A. townsendiana* – Endangered, COSEWIC 2013a) and Idaho Forestsnail (*A. ptychophora*) are found in British Columbia. The fourth species, Selway Forestsnail (*A. lombardii*) is endemic to Idaho. Broad-banded Forestsnail is the only member of the subgenus *Allogona* and the only species in eastern North America (Pilsbry 1940; Hubricht 1985). The three western species belong to the anatomically distinct subgenus *Dysmedoma* (Pilsbry 1940).

Pilsbry (1940) recognized *Allogona profunda strontiana* (Clapp, 1916) as a subspecies endemic to North Harbour and Middle Sister islands in Ontario and Green (formerly Strontian) and West Sister islands in Ohio. The subspecies was described by Clapp (1916) based on shell height to width ratio. Subsequent authors (e.g., Hubricht 1985) considered this to be an invalid taxon because these shell characteristics are within the range of variation of individuals found elsewhere. No other subspecies were recognized by Pilsbry (1940).

Morphological Description

Broad-banded Forestsnail is a large terrestrial snail. Adult shells are up to 15 mm high and about 30 mm in diameter (Pilsbry 1940). The spire (conical point at top of the shell) is low. Shells usually have a distinctive denticle (a tooth-like structure) inside the lower lip of the aperture (shell opening) and a large open umbilicus (hole at the central part of the underside of the shell) (Figure 1). The lip of the aperture is white and flares outward. The

shell is pale yellow, often with pale brown bands, and the surface is sculptured with fine grooves oriented across the whorls.

Other large land snails sympatric with Broad-banded Forestsnail in Canada lack the combination of the large open umbilicus, denticle on the lower lip, and banded shell.

Figure 1. Broad-banded Forestsnail shell collected at Point Pelee on April 28, 2013 (Allan Harris). The shell is 26 mm in diameter. Note the tooth on the lower lip of the aperture in the lower photo.

Population Spatial Structure and Variability

Canada's population of Broad-banded Forestsnail consists of extant subpopulations on Point Pelee and Pelee Island. Other historical subpopulations, including on five other Lake Erie islands and several mainland sites, were not confirmed as being extant during fieldwork in 2013. No genetic or population structure data are available. *Allogona profunda strontiana* of the Lake Erie islands was formerly recognized as a subspecies (therefore suggesting genetic isolation), but its validity has been rejected by more recent authors (Hubricht 1985) although the rejection was not based on genetic or any other empirical method.

The Lake Erie islands were formed about 4,000 years ago when rising lake levels isolated the islands from the mainland (Forsyth 1988). Broad-banded Forestsnails presumably colonized the islands while they were still connected to the mainland during the 8,000 years between the retreat of the Laurentide ice sheet and inundation of the land bridge. Since the islands were formed, dispersal between islands and between the islands and mainland is probably very rare. Point Pelee is about 15 km from Pelee Island and there is a minimum of about 1.5 km between any other islands historically occupied by the species. NatureServe (2014) considers permanent water bodies greater than 30 m wide to constitute a dispersal barrier for terrestrial gastropods. While aerial dispersal of land snails by birds can occur (Kew 1893; Kawakami *et al.* 2008; Wada *et al* 2012), it is very unlikely for this species.

On Pelee Island, Broad-banded Forestsnail occurs at Fish Point in a continuous patch of about 100 ha of forest habitat, probably constituting a single subpopulation. Historical subpopulations elsewhere on Pelee Island were probably connected by continuous forest and woodland, but now about 80% of the native vegetation has been converted to agricultural land (ERCA 2002) and extant subpopulations are presumably isolated from each other.

Within Point Pelee National Park a continuous band of suitable habitat extends along the west side of the park and connects the sites where Broad-banded Forestsnail was observed in 2013. The presence of continuous habitat suggests that genetic exchange among individuals within the habitat at Point Pelee is possible and that this constitutes a single subpopulation. Dispersal between mainland sites (if any are extant outside Point Pelee) has probably been greatly reduced with anthropogenic changes to the landscape. Less than 5% of the Canadian range of Broad-banded Forestsnail is forested with the majority of the remainder having been converted to agricultural and urban uses (ERCA 2002). About half of the remaining forest is swamp and therefore unsuitable habitat for Broad-banded Forestsnail. Most forest occurs as scattered patches of less than 10 ha (ERCA 2002).

The role of human-aided dispersal of Broad-banded Forestsnail in Canada is unknown, but possible. Passive dispersal of invasive gastropods on vehicles and garden material occurs frequently (Grimm *et al.* 2009). Broad-banded Forestsnail has apparently been established outside its natural range in New York as a result of transportation by humans (Hotopp and Pearce 2007).

Designatable Units

All Canadian subpopulations are within the Great Lakes Plains ecological area (COSEWIC 2013b). Subpopulations on Pelee Island and Point Pelee are naturally disjunct from each other and have apparently been separated for at least 4,000 years due to water level rise (Forsyth 1988). However, genetic data and evidence of local adaptations are unavailable and the “discreteness” and “significance” of the two subpopulations is unknown. The species occurs near the northern limit of its range in Canada and is widespread in the US. The loss of the Canadian subpopulations would not result in an extensive gap in Broad-banded Forestsnail range. All Canadian occurrences are considered to be a single designatable unit.

Special Significance

The Canadian population of Broad-banded Forestsnail occurs in the Carolinian Forest Region. They may be genetically isolated from other populations and have significance for conservation. The species’ ecological significance is unknown but in general, large terrestrial molluscs play an important role in forest ecosystem functioning, specifically (i) aiding in decomposition, nutrient cycling and soil building processes (Mason 1970a,b; Jennings and Barkham 1979), (ii) providing food and essential nutrients to wildlife (South 1980; Churchfield 1984; Frest and Johannes 1995; Martin 2000; Nyffeler and Symondson 2001), and (iii) serving as host for parasitic worms (Rowley *et al.* 1987). Broad-banded Forestsnail is little known to most Canadians. It has no commercial value and is not an agricultural or garden pest. Aboriginal traditional knowledge was not available for this species at this time.

DISTRIBUTION

Global Range

Broad-banded Forestsnail is distributed from the Upper Peninsula of Michigan south to northern Alabama and from Iowa and Kansas east to Pennsylvania and North Carolina (Hubricht 1985; Figure 2). All the records from Wisconsin, Minnesota, northern Iowa, and the Upper Peninsula of Michigan are further north than those from southern Ontario. A record from central New York State is probably a local introduction (Hotopp and Pearce 2007). No recent records are known south of northern Alabama, but fossil shells along the Mississippi River as far south as Louisiana represented its southern range limit during the Pleistocene (Baker 1934; Hubricht 1985).

The global range covers over 1.4 million km^2 (calculated by the report writers) as measured by minimum convex polygon (excluding the fossil records and the presumably introduced New York record).

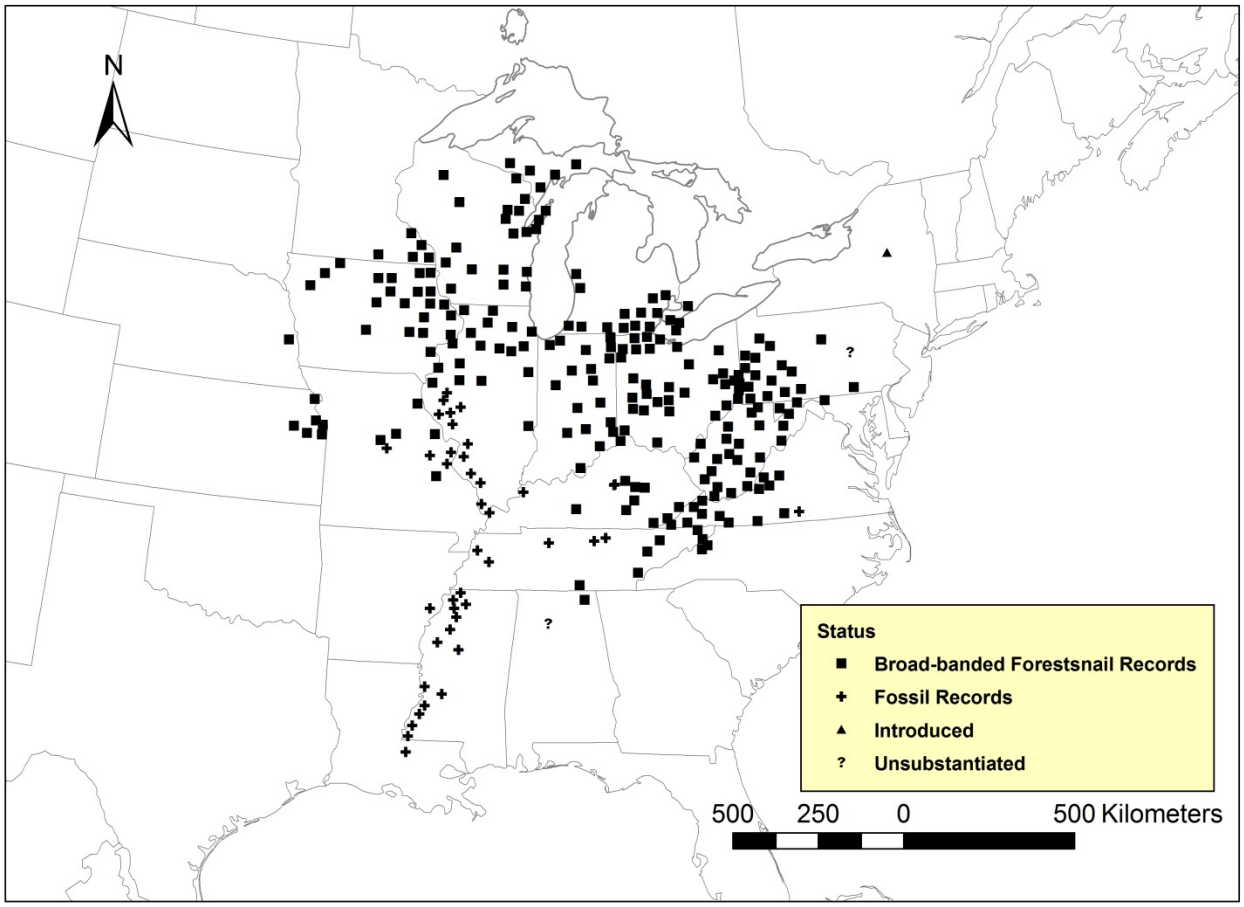

Figure 2. Global range of Broad-banded Forestsnail. Based on Hubricht (1985) and updated with Hotopp and Pearce (2007), van Devender pers. comm. (2013), COSEWIC 2014a.

Canadian Range

In Canada, Broad-banded Forestsnail is restricted to the Carolinian Forest region of Ontario on the north shore and islands of Lake Erie (Pilsbry 1940; Oughton 1948; Grimm 1996) (Figures 3 and 4, Table 1). There are historical records of the species from Point Pelee, Pelee Island, Middle Island, Middle Sister Island, East Sister Island, North Harbour Island, Hen Island, Leamington, Oxley, and Chatham (Clapp 1916; Goodrich 1916; Oldham 1996; COSEWIC 2014a). Broad-banded Forestsnail is apparently no longer extant at some of these sites.

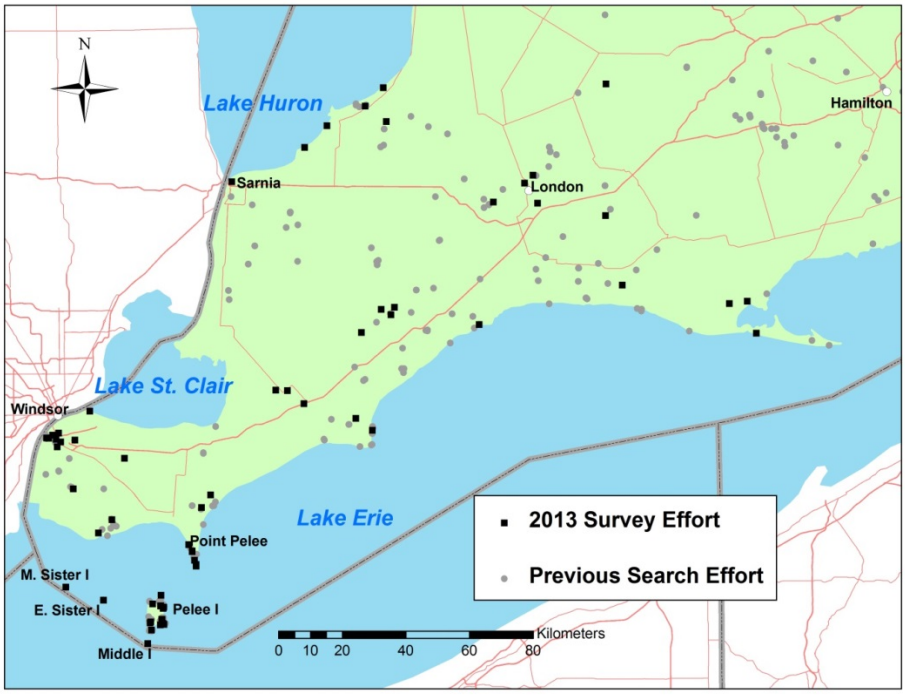

Figure 3. Broad-banded Forestsnail survey effort. Previous search effort survey points are personal records from Oldham and Nicolai 1992-2012.

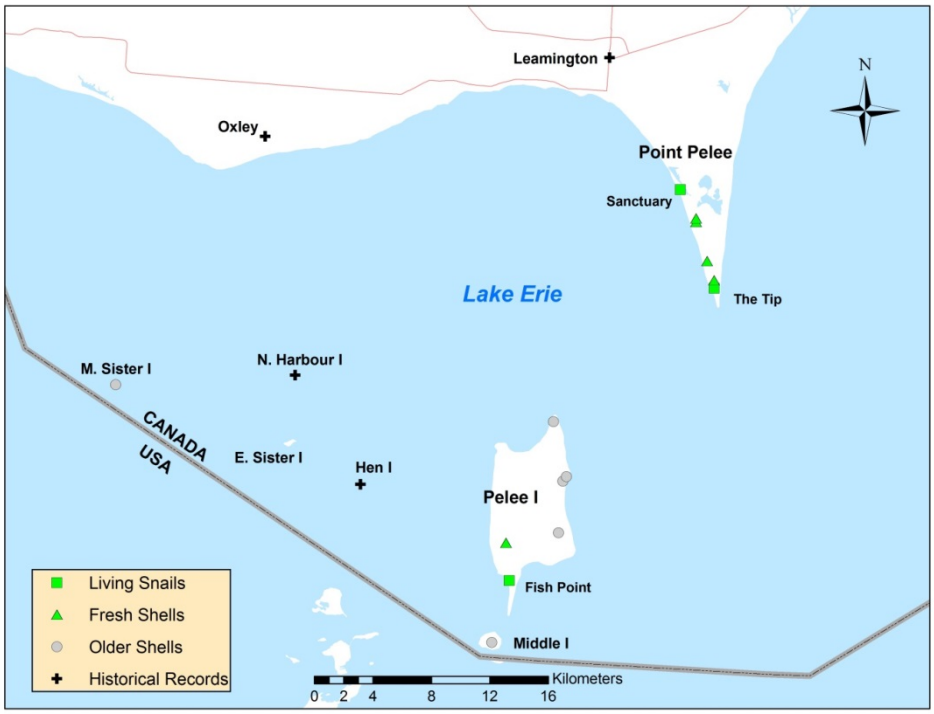

Figure 4. 2013 Broad-banded Forestsnail records at Point Pelee and the Lake Erie islands. The historical sites at Leamington and Oxley are approximate. An additional historical site at Chatham (about 50 km northeast of Leamington) is not mapped.

Table 1. Status of Broad-banded Forestsnail sites in Canada.

Site	Year of Most Recent Record	Status	Basis of Most Recent Record	Notes
Point Pelee	2013[1]	Extant	Living snails	Living snails and/or fresh shells found at all six sites searched in 2013 (11.5 person-hours) extending from the tip to the north end of the park.
Pelee I. – Fish Point	2013[1]	Extant	Living snails	Living snails found in 2013 fieldwork (5 person-hours)
Pelee I. – R. and B. Ivey	2013[1]	Probably extant	Fresh shells	Fresh shells found in 2013 fieldwork (1.5 person-hours)
Pelee I. – Lighthouse Point	2013[1]	Possibly extirpated	Old shells	Old shells found in 2013 fieldwork (3.5 person-hours)
Pelee I. – Middle Pt Woods	2013[1]	Possibly extirpated	Old shells	Old shells found in 2013 fieldwork (5.5 person-hours)
Pelee I. – Stone Rd Alvar	2013[1]	Possibly extirpated	Old shells	Old shells found in 2013 fieldwork (3 person-hours)
Pelee I. – Shaughnessy Cohen	2013[1]	Possibly extirpated	Old shells	Old shells found in 2013 fieldwork (3 person-hours)
Middle Island	2013[1]	Probably extirpated	Old shells	Old shells found in 18 person-hours of fieldwork in 2013. Habitat severely degraded by cormorants
East Sister Island	1915[1,2]	Probably extirpated	Unknown	No shells found in 4.5 person-hours of fieldwork in 2013. Habitat severely degraded by cormorants
North Harbour Island	1915[2]	Probably extirpated	Unknown	No known surveys since 1915, but very small island degraded by a seasonal residence; little if any habitat remaining.
Middle Sister Island	1996[1,3]	Probably extirpated	Old shells	Fresh shells were collected in 1996. In 2013 several dead shells were found buried in the soil but none on the surface (3.5 person-hours). Habitat severely degraded by cormorants.
Hen Island	1916[4]	Unknown	Unknown	Private island, not accessible
Chatham	?[4]	Probably extirpated	Unknown	Coordinates of historical sites unknown but there is very little

Site	Year of Most Recent Record	Status	Basis of Most Recent Record	Notes
Leamington	?[4]	Probably extirpated	Unknown	natural forest cover remaining near any of these towns. Accessible sites in the vicinity of all three towns were searched, although they may not have been in the exact sites of the historical collections.
Oxley	1905[4]	Probably extirpated	Unknown	

References: [1] Foster *et al.* (2013), [2] Clapp (1916) and Goodrich (1916); [3] Oldham (1996); [4] COSEWIC (2014a).There are 3 records from Hen Island, one with no date and the others from 1916. One record among 10 from Oxley was dated 1905; the others had no dates. Similarly, no dates were given for records from Chatham and Leamington but collections probably occurred around 1900.

Fieldwork in 2013 found living Broad-banded Forestsnails at Point Pelee and Fish Point on Pelee Island. Fresh shells (unweathered and unbleached) were collected at the Richard and Beryl Ivey Nature Reserve on Pelee Island in 2013, and older shells were found at four other properties on Pelee Island, suggesting that the species is possibly extant there (Table 1).

The status of Broad-banded Forestsnails on the smaller Lake Erie islands is uncertain. East Sister, Middle Sister and Middle islands were surveyed in 2013, but no living or fresh shells were found; however, old shells were found on the latter two islands (Table 1). As described under **THREATS AND LIMITING FACTORS**, the habitat on these islands has been severely degraded by Double-crested Cormorants (*Phalacrocorax auritus*). North Harbour Island was not surveyed in 2013, but is a very small island degraded by a seasonal residence with little if any habitat remaining. Hen Island, owned by the Quinnebog Fishing Club (2014), also was not surveyed, but intact forest habitat persists and it should be considered potential habitat.

The exact coordinates of the historical sites at Chatham, Leamington, and Oxley are unknown, but there is very little natural forest cover remaining near any of these towns. Surveys of suitable wooded habitat near these towns in 2013 found no Broad-banded Forestsnails.

In summary, Broad-banded Forestsnail is extant at Point Pelee and Fish Point on Pelee Island; its status on Hen Island is unknown. The species may be extant at four other sites on Pelee Island. Habitat changes and absence of fresh shells suggest that the species is extirpated on the smaller Lake Erie islands and the mainland sites at Chatham, Oxley, and Leamington.

Canada has less than 0.1% of the global range of the species.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EO) of Broad-banded Forestsnail in Canada is 116 km^2 as measured by minimum convex polygon (excluding those sites where habitat has been lost). Much of this area is Lake Erie. If all historical records are included, the EO is 1770 km^2.

The index of area of occupancy (IAO) is 32 km^2 (i.e., occurs in eight 2 km x 2 km squares) (assuming only those sites where living snails or fresh shells were observed are extant). If all historical records are included, the IAO is 72 km^2 (using one square for each of Chatham, Leamington, and Oxley).

Extent of occurrence and IAO were calculated by the status report writers.

Search Effort

COSEWIC (2014a) summarized all known Canadian occurrences of Broad-banded Forestsnail from a literature review (based largely on the *Bibliography of the Terrestrial Molluscs of Canada* compiled by Forsyth 2013) and a search of collections at the Royal Ontario Museum, Canadian Museum of Nature, Bishops Mills Natural History Centre (containing many of the collections of F.W. Grimm), University of Michigan Museum of Zoology (containing many of the pre-1950s holdings of the Royal Ontario Museum), Carnegie Museum, Academy of Natural Science of Philadelphia, Museum of Comparative Zoology at Harvard University, and the personal collections of Jeff Nekola, Mike Oldham, and Robert Forsyth.

Most of the land snail data compiled by COSEWIC (2014a) consists of collection sites and dates but lacks information on survey effort or negative search results. Notable surveys include those conducted on the Lake Erie islands by Clapp (1916) and Goodrich (1916) and the efforts of John Oughton between about 1930 and 1948 (see Oughton 1948). F.W. Grimm collected extensively in southern and eastern Ontario between 1970 and the mid-1990s, but much of his collection data are unavailable. Michael Oldham collected snails across the province beginning in 1992 and continuing to the present. More recently, Annegret Nicolai has collected land snails across southwestern Ontario and these data were reviewed.

Distribution of survey effort between 1992 and 2012 by Nicolai and Oldham is shown in Figure 3. These include about 150 sites in the Great Lakes Plains Ecological Region (south of a line connecting Toronto to Grand Bend). Many of these surveys were general land snail searches rather than targeted searches for Broad-banded Forestsnail. Surveys were mostly or entirely visual searches for living snails and empty shells on the surface of the ground and under logs, rocks and similar objects. Survey effort was generally unrecorded and no efforts were made to estimate population size. Because Broad-banded Forestsnail is a relatively large species leaving conspicuous empty shells, it is less likely to have been overlooked during these surveys than most Canadian terrestrial snail species, which are considerably smaller.

In 2013, 73 sites in southwestern Ontario were surveyed in support of this status report (Foster *et al.* 2013) (Table 1; Appendix 1; Figure 3). Surveys in 2013 included historical sites at Point Pelee, Pelee Island, Middle Island, Middle Sister Island, and East Sister Island. The historical site at North Harbour Island and the potentially suitable Hen Island are privately owned and permission to conduct surveys was not obtained. Precise coordinates for historical records at Oxley, Leamington, and Chatham were unavailable but nearby remnants of forested habitat were searched. Other potential habitat within the range of Broad-banded Forestsnail was also searched in 2013 in the Windsor, London, and lower Lake Huron areas, particularly where there is remaining forest cover and sandy soils. Survey sites were mainly small remnants of forest in parks and conservation areas.

The Point Pelee, Pelee Island, and other Lake Erie island surveys were conducted on April 28 to May 2, 2013. Surveys of sites near Windsor and on the north shore of Lake Erie were conducted in early May 2013. Other sites were surveyed opportunistically between January (during a snow-free period) and September 2013 (Appendix 1). The timing of the early spring fieldwork was planned to coincide with cool, moist conditions when snails are most likely to be active but before vegetation growth obscures the forest floor. A total of 184 person-hours of survey effort was spent in the field in 2013 (Appendix 1).

The survey methods consisted of searching for shells and living snails on the surface of the leaf litter and on vegetation. Logs, rocks, and other objects on the forest floor were turned over and the underside and ground beneath searched for snails before being replaced. Drift at the edges of streams and rivers was searched for empty shells. At each site, live snails and empty shells of terrestrial gastropod species encountered were collected for later identification. Voucher specimens (shells) were collected to confirm identification and for eventual curation and deposition at the New Brunswick Museum.

HABITAT

Habitat Requirements

Broad-banded Forestsnail habitat consists of rich deciduous forest (Pilsbry 1940). In Kentucky, the species inhabits woodlands on steep rocky slopes and cliff lines (Dourson 2010). In Pennsylvania, Broad-banded Forestsnail is often, but not exclusively associated with limestone bedrock (Pearce pers. comm. 2013).

In Ontario, extant subpopulations are found primarily in forest and woodland on sandy soil. Extant subpopulations of Broad-banded Forestsnail at Point Pelee occur in hardwood forest and woodland on fine sandy soils (especially Dry - Fresh Hackberry (*Celtis occidentalis*) Deciduous Forest Type FODM4-3; Dougan and Associates 2007). Fish Point on Pelee Island is a sandspit peninsula with similar Hackberry-dominated forest (Figure 5) (OMNR 2005). Middle Island is dominated by Hackberry forest (FOD 4-3, FOD 7-5) and cultural thicket originating from clearing in the early 1930s. Empty snail shells were found in wooded alvars on Pelee Island, where tree canopy cover varies from 0 to 60% and soils are generally less than about 80 cm deep over limestone (McFarlane pers. comm. 2013a). Broad-banded Forestsnail may have occurred on deeper and richer soils in southern Ontario, but these sites were the first to be converted to agriculture and may have been lost before the historical distribution was fully known. No subpopulations are known to occur in wet forest in Ontario.

Figure 5. Fish Point, Pelee Island supports an extant population of Broad-banded Forestsnails, May 1, 2013 (R.F. Foster).

Double-crested Cormorant nesting has altered the forest composition on Middle Island (see **THREATS AND LIMITING FACTORS**) (North-South Environmental Inc. 2004; Boutin *et al.* 2011). The other smaller Lake Erie islands had deciduous forest cover, but some also have been recently invaded by cormorants.

Fungi associated with decomposing logs on the forest floor are apparently an important food source. Blinn (1963) found that Broad-banded Forestsnails appeared to move towards areas with well-rotted logs after emerging from hibernation, possibly seeking feeding opportunities or moist refugia.

The historical presence of Broad-banded Forestsnail on small islands including North Harbour (0.7 ha), Hen (2.8 ha) (size for both from Moore pers. comm. 2014), East Sister (15 ha), Middle Sister (4 ha), and Middle (18 ha) (sizes from Hebert *et al.* 2014) suggests that subpopulations can be sustained in relatively small areas.

Habitat Trends

Much of the potential habitat within the historical Canadian range of Broad-banded Forestsnail has been lost since the 1800s. About 95% of the forest cover north of Lake Erie was cleared during the 1800s (ERCA 2002). Most of this area has clay soil and may not have been suitable habitat for Broad-banded Forestsnail even with forest cover. Much of the remaining forest is in Point Pelee National Park, with smaller areas in other parks and conservation areas, and privately owned fragments less than 10 ha in size. The amount of forest cover on sandy soils has remained relatively constant since 1997 (COSEWIC 2010). On Pelee Island, about 15 to 20% of the natural vegetation cover is still intact (ERCA 2002), most of which is under management by the Nature Conservancy of Canada or the Ontario Ministry of Natural Resources.

Middle Island, East Sister Island and Middle Sister Island have been colonized by nesting Double-crested Cormorants in recent decades, causing loss and degradation of forest cover and acidification of soils (Figures 6, 7) (see **THREATS AND LIMITING FACTORS**). Over 40% of the forest cover on Middle Island was lost between 1995 and 2006 as a result of cormorant damage to vegetation and soils (Dobbie 2008). Based on observations in 2013, East Sister Island and Middle Sister Island have suffered similar or greater losses. These photographs (Figures 6, 7) show typical island habitats with only a few remnant green patches remaining on East Sister Island. Hebert *et al.* (2014) documented a decline in forest cover from 73% and 54% on Middle Sister and East Sister islands, respectively, in 2001 to only 11% and 17% in 2010. Vegetation on Middle Island has begun to recover since cormorant controls were implemented (Dobbie pers. comm. 2014; Hebert *et al.* 2014).

In the US range of Broad-banded Forestsnail, much forest cover was lost with clearing by European settlers, but increased between the 1920s and the 1970s as marginal farmland was abandoned and allowed to revert to forest (U.S. Department of Agriculture 2001). Some regional declines in Broad-banded Forestsnail habitat have been reported in Pennsylvania associated with loss of forest habitat in the past decade (Pearce pers. comm. 2013).

Figure 6. East Sister Island. April 30, 2013. Contrast the lack of herbaceous vegetation with Figure 5 (A.G. Harris).

Figure 7. Middle Sister Island formerly supported Broad-banded Forestsnails, April 30, 2013. Note the Double-crested Cormorant nests in the trees and absence of living herbaceous layer.

BIOLOGY

Little information is available about most aspects of Broad-banded Forestsnail biology. Blinn (1963) describes some aspects of seasonal and diurnal activity based on a two-year field study in Illinois. Additional information in this section was derived from descriptions of other terrestrial snails, especially Oregon Forestsnail, the only other member of the genus for which there is any appreciable information (e.g., Steensma *et al.* 2009; COSEWIC 2013a), supplemented with general information on terrestrial snail behaviour and ecology from Barker (2001).

Life Cycle and Reproduction

Broad-banded Forestsnail is an air-breathing, terrestrial snail. It is a simultaneous hermaphrodite. Both members of a mating pair exchange sperm and produce eggs (Pilsbry 1940). A description of the mating process is provided by Webb (1948). Few other details are known about reproduction, but in Oregon Forestsnail, mating occurs in early spring and oviposition in late spring. Mean clutch size of Oregon Forestsnail is about 30 eggs, which are laid in a depression into soft, moist soil. The eggs hatch after about 60 days (Steensma *et al.* 2009; COSEWIC 2013a). In most snail species, larger individuals lay more eggs than smaller ones (Heller 2001). Blinn (1963) reported that most Broad-banded Forestsnails in Illinois reach maturity at one year, but some did not mature until age two. However, other large land snails, such as Grand Globe (*Mesodon normalis*) (Stiven and Foster 1996) and Oregon Forestsnail (COSEWIC 2013a), require two to three years to mature. The average annual growth rate of Broad-banded Forestsnails ranged from 0.6 to 5.2 mm/month in Illinois (Blinn 1963). Although longevity is unknown, one individual studied by Blinn (1963) was at least four years old. The weathered appearance of several living Broad-banded Forestsnails observed at Point Pelee in 2013 suggests that it is long-lived (> 5 years) (Nicolai pers. obs.). If most Broad-banded Forestsnails mature at one year and they can live four or more years, generation time could be estimated at 3-4 years. Other large land snails are long-lived, sometimes reaching maturity at 5 years or older (Heller 2001; COSEWIC 2013a).

In early autumn, Broad-banded Forestsnails move to suitable hibernation sites consisting of shallow depressions in the forest floor. These microhabitats may be selected because leaf litter is deeper and provides increased insulation. Individuals apparently home to hibernation sites used in previous years. On Pelee Island, Broad-banded Forestsnails were observed hibernating under 5 to 10 cm of soil (Nicolai pers. obs.) as is typical of other land snails (Pearce and Orstan 2006). In Illinois, however, Broad-banded Forestsnails hibernate on the surface of the leaf litter (Blinn 1963). The shell opening is oriented upwards in hibernating snails and sealed with a white, calcareous epiphragm (Blinn 1963). Idaho Forestsnail also orients itself with the aperture upwards during hibernation, possibly to reduce contact with microbes, nematodes, or mites on the forest floor (Carney 1966). Hibernation extends from early October until mid-April (Blinn 1963).

Broad-banded Forestsnails can be active both day and night, but often retire to shelter under leaf litter from mid-morning until late-afternoon (Blinn 1963). Foraging usually takes place on the ground, but snails sometimes climb onto low vegetation (Blinn 1963). Plant material is the primary food of most terrestrial gastropods, and Broad-banded Forestsnail were seen feeding on forbs at Point Pelee (Nicolai pers. obs.). Fungus growing on decaying logs is apparently another important food source for Broad-banded Forestsnails (Blinn 1963). Blinn (1963) suggested that Broad-banded Forestsnails are able to metabolize polysaccharides ingested from rotten wood.

Physiology and Adaptability

Terrestrial gastropods require damp habitat to feed, move, and reproduce. Although found in a wide range of ecosystems, most species are restricted to forested or wooded habitats that provide shade and retain moisture in the soil and leaf litter (Pearce and Orstan 2006). Broad-banded Forestsnails survive cold conditions by hibernating. During dry conditions, many land snails aestivate by drawing into their shells and becoming dormant (Pearce and Orstan 2006), but aestivation has apparently not been demonstrated in Broad-banded Forestsnails.

Snails require calcium for shell formation and soil and bedrock calcium availability influence the snail species' richness of an area (Hotopp 2002; Nekola 2005).

Many terrestrial gastropods can be reared in captivity with relative ease (COSEWIC 2002), but captive breeding has apparently not been recorded in Broad-banded Forestsnails.

Dispersal and Migration

Broad-banded Forestsnails presumably colonized the Lake Erie islands while they were connected to the mainland between 4,500 and 12,500 years ago. The Lake Erie islands were formed about 4,500 years ago when rising lake levels isolated the islands from the mainland (Forsyth 1988; Duncan *et al.* 2011). The islands had been connected to the mainland for about 8,000 years after Lake Erie was formed at the front of the retreating Laurentide ice sheet.

Active dispersal distances are unknown but snail species of similar size typically move only a few metres over their lives (Baur and Baur 2006; Grimm *et al.* 2009). Blinn (1963) found marked Broad-banded Forestsnails at distances of 1 to 4 m from hibernation sites, these movements being within their home ranges. Oregon Forestsnails dispersed a maximum of 32.2 m over a 3-year study (Edworthy *et al.* 2012). Eggs and immature stages are not known to be dispersed by the wind, water, or other vectors. Passive transportation on birds or other animals or by rafting on floating objects may occur, but is probably rare.

The Broad-banded Forestsnail population in Canada is not severely fragmented according to IUCN (2010) standards. Although confined to small habitat patches on islands or separated by agricultural land, the species was apparently able to sustain itself on small Lake Erie Islands (0.7 to 18 ha) for several thousand years until human disturbance or habitat degradation caused by Double-crested Cormorants resulted in rapid habitat changes. The remaining habitat patches at Point Pelee and Pelee Island are larger than those islands and therefore apparently large enough to support viable subpopulations.

Interspecific Interactions

Interspecific interactions of Broad-banded Forestsnail have not been documented. Predation is often a significant source of mortality for land snails (COSEWIC 2002). Shrews and rodents are important predators on terrestrial gastropods (Blinn 1963; Nekola 2004). Birds, amphibians, and reptiles are other potential predators. The snail-eating ground beetles of the tribe Cychrini (Coleoptera: Carabidae) have narrow heads and mouthparts allowing them to feed on snails through the aperture of the shell. One snail specialist, *Scaphinotus bilobus*, occurs in Ontario (Goulet and Bousquet 2004) but has not been documented at Point Pelee or Pelee Island (Marshall *et al.* 2009). Parasitic mites frequently infect land snails and at high levels of infestation can adversely affect growth and reproduction (Schupbach and Baur 2008).

Competition with other terrestrial molluscs including exotic species has not been documented but is a potential threat (Whitson 2005; Grimm *et al.* 2009).

The impacts of Double-crested Cormorants on Broad-banded Forestsnail are discussed in **THREATS AND LIMITING FACTORS**.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

The methodology as outlined in **SEARCH EFFORT** was aimed at determining presence / not detected rather than estimating population size and trends.

Abundance

Abundance data are unavailable. Small numbers of living snails were observed at Fish Point (about 5 living snails in 5 person-hours of effort) and Point Pelee (19 living snails in 11.5 person-hours of effort). However, no efforts were made to estimate subpopulation size at any sites. Dead shells were common at Point Pelee and Fish Point, but difficult to translate into a subpopulation estimate due to the persistence of shells for several years (Pearce 2008).

Fluctuations and Trends

Population trends of Broad-banded Forestsnail are not known with certainty, but based on the apparent loss of subpopulations on East Sister, Middle Sister, and Middle islands and other historical mainland sites, the Canadian population has probably declined from historical levels. More recent trends are difficult to track due to the lack of survey effort, the persistence of empty shells even after populations have been extirpated (dead snail shells were identifiable after 4 to 7 years in Delaware and Michigan forests but decomposition rates varied among species (Pearce 2008)), and difficulty in finding living snails. However, as described in **Habitat Trends**, most of the historical Canadian range has been deforested

since the early 1800s. More recently, the number of extant sites appears to have decreased with the apparent loss of subpopulations on Middle Sister, East Sister and Middle islands when cormorant numbers increased.

Given its large size and well-calcified shell, Broad-banded Forestsnail is probably a relatively long-lived species (Heller 2001; COSEWIC 2013a) and the adult population size probably does not undergo extreme fluctuations.

Rescue Effect

Rescue is unlikely. Broad-banded Forestsnail occurs in Michigan and Ohio within about 50 km (mainly Lake Erie) of the present and historical range in Ontario, but the fragmented habitat in mainland Ontario, the isolated nature of the islands, and the limited dispersal capability of the species make immigration unlikely.

THREATS AND LIMITING FACTORS

Threats

The International Union for Conservation of Nature-Conservation Measures Partnership (2006) (IUCN-CMP) threats calculator was used to classify and list threats to Broad-banded Forestsnail. This exercise was completed by a group of experts (Appendix 2). The Molluscs SSC then reviewed the results. The threats calculations were based on the extant subpopulations at Point Pelee and Pelee Island, including all sites where habitat is relatively intact and living snails or empty shells were observed in 2013. The mainland subpopulations and those of the smaller Lake Erie islands were considered to be extirpated and not included in the threats calculator assessment.

The overall Threat Impact for Broad-banded Forestsnail is Low, but the impacts of several possible threats are unknown (Appendix 2). Most of the damage to the species and its habitat occurred historically through loss of forests and habitat fragmentation, and more recently through habitat degradation caused by Double-crested Cormorants. The threats calculation was based on the extant occurrences at Point Pelee and Pelee Island (both in protected areas) where the historical threats of loss of forest cover and cormorants are now negligible. Low-impact threats include Recreational Activities (Threat 6.1) and Climate Change and Severe Weather (Threat 11). Threats of unknown impacts include Natural System Modifications (Threat 7) and Invasive and Other Problematic Species and Genes (Threat 8). Threats that are applicable to Broad-banded Forestsnail are further discussed below under the IUCN-CMP level 1 headings.

Human intrusions and disturbance (IUCN-CMP Threat 6)

Calculated Impact – Low; Scope – Large; Severity – Slight; Timing – High

Recreational Activities (Threat 6.1):

Point Pelee has several hundred thousand visitors per year within Broad-banded Forestsnail habitat. The park is open year-round and receives tens of thousands of visitors in May for birding and in summer using trails and beaches. Visitor numbers increased by about 20% from 202,424 in 2008 - 2009 to 245,780 in 2012 - 2013 (Parks Canada 2013). In 2011, an estimated 103,000 to 180,000 visitors used the walking trails in the park. Most visitors use the main park trails, which total over 10 km within Broad-banded Forestsnail habitat (Dobbie pers. comm. 2014). Snail trampling by pedestrians has not been studied at Point Pelee, but during damp conditions in spring and early summer, snails disperse across trails and are vulnerable to being crushed (M. Oldham pers. obs.). Snails may be attracted to trails to feed on previously crushed snails (Lepitzki pers. comm. 2014), which could increase the likelihood of crushing additional individuals on trails.

Climate change and severe weather (IUCN/CMP Threat 11)

Calculated Impact – Low; Scope – Small; Severity – Extreme; Timing – High

Habitat Shifting and Alteration (Threat 11.1):

The Point Pelee peninsula (i.e., the tip) is subject to a natural process of sand erosion on the east side and deposition on the west side. However, lower lake levels and reduced winter ice coverage on the west side of the point are expected to reduce sand deposition causing the tip to become thinner and recede (BaMasoud and Byrne 2011). The creation of armoured shorelines and harbours east of Point Pelee has further disrupted movement of sand that was formerly deposited on the west side of the point (Baird and Associates Coastal Engineers Ltd. 2009). At the present rates, the tip is expected to retreat by 50 m over the next 50 years (BaMasoud and Byrne 2011). Beaches have receded along the west side, particularly within about 1 km of the tip (Baird and Associates Coastal Engineers Ltd. 2009). Most of the Broad-banded Forestsnail habitat at Point Pelee is within about 200 m of the west side of the point, suggesting that a loss of 1 to 10% of snail habitat may occur within 10 years. One of the objectives of the Parks Canada Management Plan for the park (Parks Canada 2010) is to collaborate and participate in the development of an erosion management strategy to mitigate and manage erosion along the western shoreline.

A similar process is apparently occurring at Fish Point on Pelee Island (Kamstra *et al* 1995; Oldham pers. obs.), but quantitative data are unavailable.

Droughts (Threat 11.2) and Temperature Extremes (Threat 11.3):

Southwestern Ontario is projected to have less summer precipitation, increased evaporation, and more extreme climate events including droughts, floods, and temperature extremes under climate change models (Varrin *et al.* 2007; Expert Panel on Climate Change Adaptation 2009). Snails may be vulnerable to increasing temperatures and increased incidence of drought (Pearce and Paustian 2013), but responses to the projected temperature changes and droughts within the Canadian range of Broad-banded Forestsnail are unknown. The calculated impact for both these level 2 threats is unknown.

Transportation and service corridors (IUCN/CMP Threat 4)

Calculated Impact – Negligible; Scope – Negligible; Severity – Unknown; Timing – High

Roads and Railroads (Threat 4.1) and Utility and Service Lines (Threat 4.2):

Point Pelee has about 10 km of paved roads within Broad-banded Forestsnail habitat. No road expansions are planned in the next 10 years (Dobbie pers. comm. 2014). Snail subpopulations separated by paved roads with high traffic densities may be isolated from each other because snails tend not to cross the roads (Baur and Baur 1990). Road mortality has been recognized as a threat for wildlife in the park (Parks Canada 2007) but no data on road kill of invertebrates are available (Dobbie pers. comm. 2014). Point Pelee National Park plans to replace an above-ground hydropower line with a buried line within the next 20 years. Heavy machinery would likely be used to remove the poles and line (Dobbie pers. comm. 2014). Broad-banded Forestsnails and their habitat could be damaged by these activities, but the area constitutes less than 1% of the Canadian range. Parks Canada will implement this activity only after an environmental assessment, which would include any impacts on Five-lined Skink (*Plestiodon fasciatus*) and other species at risk.

Natural system modifications (IUCN/CMP Threat 7)

Calculated Impact – Unknown; Scope – Large; Severity – Unknown; Timing – High

Fire and Fire Suppression (Threat 7.1):

Prescribed burning has been implemented on a small scale at Point Pelee and Pelee Island to maintain savannah and alvar habitats (NCC 2008; Parks Canada 2010). Point Pelee burned 2.8 ha in 2012 and 2013 (Dobbie pers comm. 2013). Prescribed burns may occur in Broad-banded Forestsnail habitat but burn areas will be small and typically occur in non-forested habitat. A prescribed burn plan will be prepared in advance of any burns and include consultation with snail experts (Dobbie pers. comm. 2014).

Portions of the Stone Road Alvar on Pelee Island were subjected to prescribed burns by Ontario Nature and the Essex Region Conservation Authority in 1993, 1997, 1999, and 2005 (NCC 2008). There are no immediate plans to burn alvar or forest habitat on NCC lands on Pelee Island. Any prescribed burns would be restricted to small areas under conditions conducive to light surface fires (MacFarlane pers. comm. 2013b). Although the impacts on Broad-banded Forestsnail are unknown, burning has the potential to reduce land snail abundance and richness by removing leaf litter and humus (Nekola 2002) and through direct mortality. The impact of fire on snail subpopulations may have been smaller in the pre-settlement landscape where habitat was more widespread and recolonization from unburned areas was more frequent.

Other Ecosystem Modifications (Threat 7.3):

Invasive species occur throughout the Canadian range of Broad-banded Forestsnail. Highly invasive plants within Broad-banded Forestsnail habitat at Point Pelee include Garlic Mustard (*Alliaria petiolata*) and Spotted Knapweed (*Centaurea stoebe*) (Dougan and Associates 2007; Parks Canada 2007). Both of these species are considered to be a very high invasive threat in Point Pelee, the former becoming abundant in parts of the park (Dougan and Associates 2007). Although the impacts of these species on land snails have not been documented, invasive plants can alter soil nutrient cycles (Stoll *et al.* 2012) and displace native plants.

Non-native earthworms have invaded parts of Canada relatively recently (native earthworms did not survive the Pleistocene) and have altered forest floor habitats by reducing or eliminating the natural leaf litter layer and digging up and mixing of mineral soil with the organic surface layer (CABI 2013). This change in forest floor structure is expected to profoundly affect plant and invertebrate communities (Addison 2009; CABI 2013). Norden (2010) suggested that invasive earthworms could alter terrestrial snail communities, although direct evidence is lacking. Although invasive earthworms are present on the north shore of Lake Erie (Evers *et al.* 2012) and on Pelee Island (Reynolds 2011), changes in leaf litter or forest soils have apparently not been documented in Broad-banded Forestsnail habitat.

Competition with exotic terrestrial molluscs such as Grovesnail (*Cepaea nemoralis*) and slugs (*Arion* spp.) has not been documented but is a potential threat (Whitson 2005; Grimm *et al.* 2009). Grovesnail and several invasive slug species are present at Fish Point and Point Pelee as well as many other mainland sites within the historical range of Broad-banded Forestsnail. However, Grovesnail occurs mainly in disturbed habitat or along forest edges (Nicolai pers. obs.) where Broad-banded Forestsnail is typically absent, and its impact is probably minimal.

Pollution (IUCN/CMP Threat 9)

Calculated Impact – Unknown; Scope – Unknown; Severity – Unknown; Timing – High

Agriculture and Forestry Effluents (Threat 9.3):

The impacts of pesticides on terrestrial gastropods are poorly known. Population level impacts of herbicides on terrestrial snails and slugs were not detected in agricultural (Roy *et al.* 2003) or forested (Hawkins *et al.* 1997) landscapes, but laboratory studies have shown that exposure to some herbicides increases mortality of some snail species (e.g., Koprivnikar and Walker 2011). Glyphosate is used at both Point Pelee (Dobbie pers. comm. 2014) and Nature Conservancy of Canada lands on Pelee Island (McFarlane pers. comm. 2014). At both localities, the herbicide is used infrequently and in carefully controlled conditions to control invasive plants. Druart *et al.* (2011) found no effect on mortality or growth in laboratory exposures of the terrestrial snail *Helix aspera* to glyphosate or glufosinate but did report a non-significant decrease in albumen gland mass; glyphosate also accumulated in the exposed snails. Whether similar effects would be found in Broad-banded Forestsnail is unknown. The close proximity of agricultural land to Broad-banded Forestsnail habitat on Pelee Island may also expose snails to pesticide drift.

Invasive and other problematic species and genes (IUCN/CMP Threat 8)

Calculated Impact – Unknown; Scope – Pervasive; Severity – Unknown; Timing – High

Invasive Non-native/aliens Species (Threat 8.1) and Problematic Native Species (Threat 8.2)

Wild Turkeys (*Meleagris gallopavo*) were reintroduced to southwestern Ontario in the mid-1980s, after being extirpated in the early 1900s. By the early 2000s, there were an estimated 40,000 birds in Ontario (Sandilands 2005). Turkeys colonized Point Pelee National Park in 2006 and increased to over 100 by 2008, before stabilizing at about 40 to 60 birds between 2010 and 2013 (Dobbie pers comm. 2013). Wild Turkeys were introduced to Pelee Island in 2002 (approximately 25 breeding turkeys, Municipality of Pelee Island 2014) and now number in the hundreds. There are no historical records indicating that the species occurred naturally on the island (Jones 1912a,b,c,d). A flock of 250 individuals was observed by Pelee Island Bird Observatory staff in a field adjacent to Fish Point in November 2010 (Gibson pers. comm. 2013). Hunting of these birds is currently prohibited (Municipality of Pelee Island 2014) so numbers are expected to continue to increase. Meanwhile, numbers of Wild Turkeys observed during the Christmas Bird Count in the Point Pelee circle also have risen over the last 10 years (CBC 2014). Wild Turkeys are omnivorous and include snails in their diet (Sandilands 2005). While only very small quantities of minute unidentifiable shell fragments were found in 1 of 28 crops of turkeys examined from Pelee Island from 2003-2006 (Sadowski and Bowman 2008), a crushed shell of *Cepaea nemoralis* (Forsyth pers. comm. 2014), a snail of similar size to Broad-banded Forestsnail, was found in a turkey from Bruce Peninsula (not Pelee Island) in 2012 (Sadoski pers. comm. 2014). Due to the rapid passage of food through the digestive

system and other limitations of diet studies, the impacts on snail subpopulations are unknown, but turkeys are a potential additional source of predation on Broad-banded Forestsnail and were recently listed as an ongoing threat to the endemic (only on Pelee Island), Endangered (COSEWIC 2014b) Small-mouthed Salamander (*Ambystoma texanum*).

Ring-necked Pheasants (*Phasianus colchicus*) were introduced to Pelee Island in the late 1920s and increased to 50,000 to 100,000 birds by 1934 (Sandilands 2005). Populations are supplemented by annual releases of up to 25,000 birds to support hunting. As with Wild Turkeys, pheasants feed on snails (Sandilands 2005) but impacts on Broad-banded Forestsnail subpopulations are unknown.

White-tailed Deer (*Odocoileus virginianus*), Striped Skunk (*Mephitis mephitis*), Virginia Opossum (*Diadelphis virginiana*), and Northern Raccoon (*Procyon lotor*) are native to southern Ontario, but populations are higher than historical levels due to decreased predation and subsidized feeding (Phillips and Murray 2005; Dobbie pers. comm. 2014). Impacts on snails or snail habitat have not been documented.

Recent and Historical Threats

Double-crested Cormorant nesting colonies have increased dramatically on Lake Erie islands since the early 1980s. On Middle Island, cormorants increased from 3 nests in 1987 to a peak of approximately 6,600 nests in 2002 and 2004 (Boutin *et al.* 2011). Nest densities have been as high as 418 nests/ha (Dobbie and Thorndyke 2011). Nests on East Sister Island increased from 6 in 1981 to over 5,000 in 2008 (OMNR 2009). Cormorant numbers on Middle Sister Island have risen from 15 nests recorded in the year 2000 to an estimated 2,453 nests in 2014 (Moore pers. comm. 2014). Nesting cormorants break branches from trees and cause accumulation of guano leading to tree dieback, reduced plant species richness, and an increased proportion of non-native species (Figures 6 and 7) (Boutin *et al.* 2011). Guano accumulation also affects snails directly by lowering soil pH and reducing calcium availability (Breuning-Madsen *et al.* 2010). Calcium is needed in forming shells, but also serves other basic physiological functions, including reproduction (Dallinger 2001; Hotopp and Pearce 2006), which is suppressed by the lack of available calcium (Wäreborn 1979). Cormorant culls have taken place on Middle Island since 2008 (Dobbie and Thorndyke 2011). Cormorants are unlikely to establish nesting colonies at Point Pelee or Pelee Island given their preference for small islands (typically less than 1.2 ha; Sandilands 2005). Cormorants apparently do not nest on Hen Island or North Harbour Island (snail surveys were not conducted on these islands in 2013), possibly due to human presence on those islands. The vegetation of North Harbour Island has been degraded by a seasonal residence with little if any habitat remaining. Hen Island is occupied by a fishing camp and could not be surveyed for snails, but potential habitat is present.

Cormorants increased from a few nests on each of the islands to thousands of nests over about 25 years, or six to eight generations of Broad-banded Forestsnail. Because this threat began before the 3 generation COSEWIC time line, cormorants are considered a recent threat.

As discussed under **Habitat Trends**, most of the forest cover within the historical range of Broad-banded Forestsnail was cleared during the 1800s (ERCA 2002). Most of the remaining forest cover is within parks and further forest clearing is probably a minor threat.

Limiting Factors

Natural limiting factors for Broad-banded Forestsnail probably include its poor dispersal capability and therefore limited ability to colonize new habitat. Climate change may also limit its Canadian distribution. The warm climate on the north shore of Lake Erie is the northern limit of the species' Canadian range and cold conditions may limit its northern distribution. In addition, many terrestrial snails are limited by calcium availability. Soils with low calcium support fewer species (Hotopp and Pearce 2006). As described in **Interspecific Interactions**, predation may limit snail populations.

Number of Locations

Broad-banded Forestsnail occurs at a minimum of two locations in Canada: Point Pelee and Pelee Island; the status of the snail on Hen Island is unknown. The two locations are separated by about 15 km of Lake Erie. The species is considered to be extant at Point Pelee and Fish Point on Pelee Island. The other Pelee Island sites are considered to be probably extant (Ivey property where fresh shells were seen) or possibly extirpated (other properties where only old shells were seen), yielding a maximum of four potential locations on Pelee Island based on the various threats and land ownership (Appendix 1). However, if predation by introduced Wild Turkeys is the major threat on Pelee Island, then there would only be one location on this island. The historical mainland subpopulations and the East Sister Island, Middle Sister Island, North Harbour Island, and Middle Island subpopulations are considered to be probably extirpated, because the habitat has been destroyed or severely degraded by cormorants (Table 1).

The most imminent threats at Point Pelee are probably a combination of recreational trail use and habitat loss caused by altered shoreline processes. The Pelee Island location(s) (including extant subpopulations at Fish Point and possible/historical subpopulations elsewhere on the island) face(s) similar threats.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Broad-banded Forestsnail is not protected by any Canadian legislation, regulations, customs or conditions except as indicated below. It is not listed under the US *Endangered Species Act* or under any state or provincial acts. It is not listed under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES).

Non-Legal Status and Ranks

Nature Serve (2014) provides the following ranks:

- Global Rank: G5 (last reviewed 22 Oct 2009)
- National Rank (Canada): N2N3 (last reviewed 25 Jan 2013; should be changed to N1, Oldham pers. comm. 2014)
- National Rank (US): N5 (last reviewed 8 Oct 2002)

Subnational Ranks (S-ranks[1]) as provided by NatureServe (2014) are as follows:

- SNR: AL, IL, IN, IA, KS, MI, MN, MO, NE, NY, OH, WV
- SU: MD
- SX: AR, LA, MS
- S1: ON (rank changed from S2S3 to S1 on 13 November 2013, Oldham pers. comm. 2014; NatureServe has yet to change its Internet database).
- S2S3: NC, PA, WI
- S4: KY, TN, VA

The "SX" status in AR, LA, and MS apparently refers to Pleistocene fossil records rather than recent occurrences (Hubricht 1985). The species is apparently non-native in NY (Hotopp and Pearce 2007), and a status of "SE" is appropriate.

1

SNR	Unranked
SU	Unrankable.
SX	Presumed Extirpated
S1	Critically Imperilled
S2	Imperilled
S3	Vulnerable.
S4	Apparently Secure
S2S3	Status is between S2 and S3

Habitat Protection and Ownership

Both known extant occurrences of Broad-banded Forestsnail occur in parks and receive protection from some human threats such as logging, grazing, and urbanization. However, as described under **THREATS AND LIMITING FACTORS**, invasive species and habitat fragmentation by roads and loss by erosion are ongoing threats independent of habitat ownership. Point Pelee has a management strategy to maintain and enhance native vegetation, but invasive species continue to spread. The park is also heavily used by the public with several hundred thousand visitors annually (Parks Canada 2010). Fish Point Provincial Nature Reserve is managed to "protect provincially significant, special and representative life science, earth science and cultural heritage features" (OMNR 2005). The degree of use by visitors and the status of invasive species are apparently not monitored.

Most of the potential and historical Broad-banded Forestsnail habitat on Pelee Island is on lands owned or managed by the Nature Conservancy of Canada (NCC 2008). Some of these properties are managed to maintain alvar vegetation although they also include large areas of forest and wetland.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS (ALPHABETICAL ORDER)

Robert Foster is co-founder and principal of Northern Bioscience, an ecological consulting firm offering professional consulting services supporting ecosystem management, planning, and research. Dr. Foster has a B.Sc. in Biology from Lakehead University and a D. Phil. in Zoology from the University of Oxford. Rob has worked as an ecologist in Ontario for over 20 years, and has authored or co-authored COSEWIC status reports on the Weidemeyer's Admiral, Bogbean Buckmoth, Hop-tree Borer, Laura's Clubtail, Rapids Clubtail, Riverine Clubtail, Northern Barrens Tiger Beetle, Gibson's Big Sand Tiger Beetle, Crooked-stem Aster, Bluehearts, Georgia Basin Bog Spider, and Drooping Trillium, as well as recovery plans for rare plants, lichens, and odonates.

Allan Harris is a biologist with over 20 years' experience in northern Ontario. He has a B.Sc. in Wildlife Biology from the University of Guelph and an M.Sc. in Biology from Lakehead University. After spending seven years as a biologist with Ontario Ministry of Natural Resources, he co-founded Northern Bioscience, an ecological consulting company based in Thunder Bay, Ontario. Al has authored or coauthored dozens of scientific papers, technical reports, and popular articles, including COSEWIC status reports for Gibson's Big Sand Tiger Beetle, Bogbean Buckmoth, Rapids Clubtail, Laura's Clubtail, Riverine Clubtail, Georgia Basin Bog Spider, Hoptree Borer, Northern Barrens Tiger Beetle, Bluehearts, Small-flowered Lipocarpha, and Drooping Trillium. Al also authored the Ontario provincial status report for Woodland Caribou, and has authored or co-authored national and provincial recovery strategies for vascular plants and birds. He is a member of the Committee on the Status of Species at Risk in Ontario (2008 – 2013).

Annegret Nicolai is a biologist and currently in a postdoc position at the University of Western Ontario in the B.J. Sinclair Lab. She has a Ph.D. from the University of Bremen in Germany and from the University Rennes 1 in France. Since her master's, she has been investigating eco-physiological questions in terrestrial snails, specifically about the impact of climate change and resource availability on the physiology and reproduction in endangered and invasive species. She also co-supervises a Ph.D. thesis analyzing the pathways of invasion of terrestrial gastropods. She has very specific knowledge about biology, anatomy, physiology and ecology of terrestrial gastropods. In Germany she developed captive breeding of the protected *Helix pomatia* and in France she was co-author of the Species Report and the Recovery Strategy in *Tyrrhenaria ceratina* in Corsica. In the Sinclair lab, Annegret investigates the overwintering strategy of *Cepaea nemoralis*. Since 2012 Annegret has been committed to the survey of terrestrial gastropods in Ontario, participating in the project "barcoding of life" at Guelph University.

Michael J. Oldham has been a biologist with the Natural Heritage Information Centre, Ontario Ministry of Natural Resources (OMNR), for the past 20 years. Previously he worked for the OMNR and conservation authorities in Aylmer, Chatham, Essex, London, Richmond Hill, and Toronto. Mike has a B.Sc. in Biology from the University of Guelph. Mike is a former member of COSEWIC and the COSEWIC Amphibians and Reptiles SSC and a current member of the Vascular Plants SSC. He also served for more than a decade on the provincial Committee on the Status of Species at Risk in Ontario (COSSARO). Mike has authored or co-authored more than a dozen COSEWIC status reports. He has been interested in terrestrial gastropods for more than 20 years and has studied and collected them throughout Ontario.

COLLECTIONS EXAMINED

Collections at the Canadian Museum of Nature and the Royal Ontario Museum were searched for Canadian specimens of Broad-banded Forestsnail by Jean-Marc Gagnon and Maureen Zubowski, respectively.

Appendix 1. Summary of 2013 Broad-banded Forestsnail survey sites. Refer to Figure 3 for map. Observers are Jane Bowles (JMB), Tammie Dobbie (TD), Robert Foster (RFF), Allan Harris (AGH), Mykola Merkulov (MM), Annegret Nicolai (AN), Mike Oldham (MJO), Hiroko Udaka (HU), Litza Coello (LC).

Site	Site Name	Effort (person-hours)	Observers	2013 Survey Dates	Broad-banded Forestsnail?	Weather
1	Middle Island, Point Pelee National Park, Lake Erie	6; 12	RFF, AN, MJO; AN, TD, MM	May 1; Aug 29	Empty shells	18°C, sunny; 23°C, sunny, humid
2	East Sister Island, Lake Erie	4.5	TD, RFF, AGH, AN, MJO	Apr 30	No	18°C, sunny
3	Middle Sister Island, Lake Erie	3.5	TD, RFF, AGH, AN, MJO	Apr 30	Empty shells	18°C, sunny
4	Lighthouse Point Provincial Nature Reserve, Pelee Island	1.5; 2	RFF, AN, MJO; AN, MM	May 1; Aug 25	Empty shells	20°C, sunny, dry, windy; 25°C, sunny, humid
5	Erie Sand and Gravel NCC parcel, Pelee Island	3.5	AN, MJO, AGH	May 2	No	24°C, sunny, dry
6	Middle Point Woods – north part (NCC), Pelee Island	2; 1	AGH, RFF, MJO, AN; AN	May 2; Aug 25	Empty shells	24°C, sunny, dry; 24°C, sunny, humid
7	Gibwood Property (NCC), Pelee Island	2	AN, MJO	May 2	No	22°C, sunny, dry
8	Richard and Beryl Ivey Nature Reserve (NCC), Pelee Island	1.5	RFF, AGH, AN	May 1	Empty shells	24°C, sunny
9	Winery property, Pelee Island	4	RFF, AGH, AN, MJO	May 2	No	24°C, sunny
10	Porchuk Property (NCC), Pelee Island	2	AN, MJO	May 2	No	22°C, sunny
11	Fish Point Provincial Nature Reserve, Pelee Island	5	RFF, AGH, AN	May 1	**Live snails**	18°C, sunny
12	Fleck Property, Pelee Island	1	RFF	May 2	No	22°C, sunny
13	Essex Conservation Authority lands at Stone Road Alvar, Pelee Island	1	AGH	May 2	No	22°C, sunny
14	Ontario Nature Stone Road Alvar, Pelee Island	1; 2	AGH; AN, MM	May 2; Aug 27	Empty shells	22°C, sunny; 25°C, sunny,
15	Cohen Shaughnessy Property, NCC, Pelee Island	1; 2	AGH; AN,MM	May 2; Aug 27	Empty shells	23°C, sunny; 25°C, sunny, humid
16	Krestel Parcel (NCC), Pelee Island	1	AGH	May 1	No	20°C, sunny

Site	Site Name	Effort (person-hours)	Observers	2013 Survey Dates	Broad-banded Forestsnail?	Weather
17	Middle Point Woods – south part (NCC), Pelee Island	1.5; 1	RFF, AGH, AN; AN, MM	May 1, 2; Aug 26	Empty shells	22°C, sunny; 25°C, sunny, humid
18	Florian Diamante Nature Reserve (NCC), Pelee Island	4.5	AGH, RFF, AN	May 2	No	22°C, sunny
19	Point Pelee Nat. Park, tip	3	AGH, AN, MJO	Apr 28	**Live snails**	15°C, rain, stopped later
20	Point Pelee Nat. Park, tip to Visitor Centre	2	AGH, AN, MJO	Apr 28	**Live snails**	15°C, rain, stopped later
21	Point Pelee Nat. Park, West Beach Trail	3	AGH, AN, MJO	Apr 28	**Live snails**	15°C, rain, stopped later
22	Point Pelee Nat. Park, Dunes Picnic area	1	RFF	April 29	Empty shells	18°C, overcast
23	Point Pelee Nat. Park, east of Dunes Picnic area	1	AGH	April 29	Empty shells	18°C, overcast
24	Point Pelee Nat. Park, Sanctuary Picnic area	1.5	AGH, MJO, AN	Apr 28	**Live snails**	17°C, overcast
25	Oxley Swamp (NCC)	2	AN, HU	May 20	No	26°C, sunny, humid
26	Cedar Creek Conservation Area	3	RFF, AGH	April 29	No	12°C, overcast
27	Kopegaron Woods Conservation Area	4	RFF, AGH; AN, MJO	Apr 29; 30	No	14°C, overcast
28	Two Creeks Conservation Area, Wheatley	2	MJO	May 18	No	-
29	Canard River Conservation Area	2	AN, MJO	April 29	No	18°C, overcast
30	Maidstone Conservation Area	2	RFF, AGH	April 29	No	14°C, overcast
31	Devonwood Conservation Area, Windsor	2	AN, MJO	April 29	No	18°C, overcast
32	Springgarden Road Park, Windsor	2	AN, MJO	April 29	No	18°C, overcast
33	Ojibway Park, Windsor	5	AN, MJO, JMB	Apr 29; May 3	No	18°C, overcast; 20°C, sunny
34	Black Oak Heritage Forest, Windsor	4; 2	AN, MJO, JMB; MJO	Apr 29; May 3; Sep 5	No	18°C, overcast; 20°C, sunny
35	Malden Park, Windsor	2	AN, JMB	May 3	No	20°C, sunny
36	Rondeau Provincial Park	3; 3.5	MJO, JMB; AGH	May 17; Sep 4	No	22°C, sunny
37	Sinclair's Bush	2	MJO, JMB	May 17	No	-

Site	Site Name	Effort (person-hours)	Observers	2013 Survey Dates	Broad-banded Forestsnail?	Weather
38	Peche Island Provincial Park, Windsor	2	AN, HU	May 19	No	22°C, sunny
39	Thames Grove Conservation Area (Chatham)	1	AN, JMB	May 3	No	20°C, sunny
40	Moraviantown First Nation	6	AN, JMB	June 7	No	15°C, overcast, humid
41	John E. Pearce Provincial Park	2	MJO	May 15	No	-
42	Newport Forest, TTLT	1; 2	AN; AN, HU	April 21; Sep 01	No	18°C, sunny, humid; 23°C after rain
43	Wardsville Woods TTLT	1	JMB	May 17	No	-
44	Backus Woods	1; 3	MJO; AGH	May 15; Sep 2	No	18°C, sunny
45	St. Williams Conservation Reserve	2	MJO	May 15	No	-
46	Calton Swamp	1	MJO	May 15	No	-
47	Lake Whittaker Conservation Area	2	AN,HU	June 8	No	18°C, overcast
48	Westminster Ponds, London	1	AN	April 7	No	15°C, overcast
49	Komoka Provincial Park	1	AN, HU	Jan 13	No	12°C, humid, no snow
50	UWO, London	0.5	AN	April 15	No	18°C, sunny
51	Canatara Park, Sarnia	3	JMB, MJO; AGH	May 16, August 3	No	22°C, sunny (Aug 3)
52	Killary Meadows, London	1	AN	May 4	No	20°C, sunny
53	Lambton United Church Camp	2	AGH	August 3	No	25°C, sunny
54	Highland Glen Conservation Area	1	AGH	August 3	No	25°C, sunny
55	Joany's Woods TTLT	1	AN, JMB	April 1	No	12°C, overcast
56	Port Franks	2; 4	AGH; MJO	Aug 4; Sep 4	No	24°C, sunny
57	Pinery Provincial Park	1;1	AN	May 5; July 07	No	20°C, sunny; 25°C, sunny
58	C.M. Wilson Conservation Area, Chatham	2	MJO, JMB	May 16	No	-
59	Paxton Wood, Chatham	2	MJO, JMB	May 16	No	-

Site	Site Name	Effort (person-hours)	Observers	2013 Survey Dates	Broad-banded Forestsnail?	Weather
60	Skunk's Misery	2	MJO, JMB	May 16	No	-
61	Oakwood, Windsor	2	AN, MM	Aug 27	No	22°C, sunny, humid
62	Brunet Park, La Salle	1	AN	Aug 28	No	22°C, sunny, humid
63	South Cameron Woodlot, Windsor	1	AN, MM	Aug 28	No	22°C, sunny, humid
64	Avon trail near St. Mary's	1	AN	Jul 27	No	20°C, rain
65	Long Point Provincial Park	2	AGH	Sep 2	No	24°C, sunny
66	Bickford Oak CA	2	AN, LC	Sep 22	No	18°C, cloudy, wet
67	Brigden Crown Game Reserve	2	AN, LC	Sep 22	No	18°C, cloudy, wet
68	Moore Wildlife Refuge CA	2	AN, LC	Sep 22	No	18°C, cloudy, wet
69	Perch Creek CA	2	AN, LC	Sep 21	No	20°C, cloudy, wet
70	Floodway CA	2	AN, LC	Sep 21	No	20°C, cloudy, wet
71	Petrolia CA	1	AN, LC	Sep 22	No	18°C, cloudy, wet
72	Rouge Park, Scarborough	4	AN	Sep 14,15	No	22°C, sunny, humid
73	High Park, Grenadier Pond, Toronto	1	MM	Sep 22	No	18°C, cloudy, wet

Appendix 2. Threat classification table for Broad-banded Forestsnail in Canada based on IUCN-CMP (2006). For information on how the values are assigned, see Master *et al.* (2012) and table footnotes for details.

Species or Ecosystem Scientific Name	Broad-banded Forestsnail (*Allogona profunda*)
Date :	26 February 2014 (reviewed by SSC 10 August 2014)
Assessor(s):	Mhairi McFarlane (SW Ontario Nature Conservatory of Canada); Valerie Minelga (Parks Canada); Vivian Brownell (COSEWIC member for ON); Dwayne Lepitzki (responsible Molluscs co-chair); Gerry Mackie (Mollusc co-chair); Dave Fraser (COSEWIC member for BC + Chair Criteria WG); Tammy Dobbie (Point Pelee National Park ecologist); Ruben Boles (COSEWIC member for CWS); Robert Foster, Allan Harris, Annegret Nicolai, Michael Oldham (report co-writers).
References:	draft COSEWIC Status Report + draft new Table 1 (review by SSC based on 6-month)

Overall Threat Impact Calculation:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	2	2
Calculated Overall Threat Impact:		Low	Low

Assigned Overall Threat Impact:	**D = Low**
Impact Adjustment Reasons:	
Overall Threat Comments	Most of the damage to the species and its habitat occurred in the past i.e., loss of forests, habitat fragmentation, and cormorants. Species currently confined to two small areas in Canada.

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						n/a
1.1	Housing & urban areas						Snail currently lives only in Protected Areas. Hen Island is private property and could have suitable habitat but permission to search was not obtained.
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						Rejuvenation of NorthWest Beach (PPNP) planned but activities would be within existing footprint
2	Agriculture & aquaculture						n/a
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						n/a
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors		Negligible	Negligible (<1%)	Unknown	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Unknown	High (Continuing)	No road expansions slated for next 10 years; possible roadkill as there are roads through PPNP. Recent Ph.D. study on road kill in PPNP did not include invertebrates (Dobbie pers. comm. 2014).
4.2	Utility & service lines		Negligible	Negligible (<1%)	Unknown	Low (Possibly in the long term, >10 yrs)	Point Pelee National Park plans to replace an above-ground hydropower line with a buried line within the next 20 years. Heavy machinery would likely be used to remove poles and line (Dobbie pers. comm. 2014). Broad-banded Forestsnails and their habitat could be damaged by these activities, but the area constitutes less than 1% of the Canadian range. Parks Canada will implement this activity only after an environmental assessment of the impacts on Five-lined Skink (*Plestiodon fasciatus*) and other species at risk.
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						n/a
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						Impacts from forest removal discussed in the status report; historical threat only.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Point Pelee has several hundred thousand visitors per year within Broad-banded Forestsnail habitat. The park is open year-round and receives tens of thousands of visitors in May for birding and in summer using trails and beaches. Visitor numbers increased by about 20% from 202,424 in 2008 - 2009 to 245,780 in 2012 - 2013 (Parks Canada 2013). In 2011, an estimated 103,000 to 180,000 visitors used the walking trails in the park. Most visitors use the main park trails, which total over 10 km within Broad-banded Forestsnail habitat (Dobbie pers. comm. 2014). Snail trampling by pedestrians has not been studied at Point Pelee, but during damp conditions in spring and early summer, snails disperse across trails and are vulnerable to being crushed (M. Oldham pers. obs.). Snails may be attracted to trails to feed on previously crushed snails (Lepitzki pers. comm. 2014), which could increase the likelihood of crushing additional individuals on trails. However, the effects on populations over 10 years or 3 generations is slight.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Probably more work activity at PPNP but less severe impact than recreational activities due to fewer workers in comparison to visitors.
7	Natural system modifications		Unknown	Large (31-70%	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.1	Fire & fire suppression		Unknown	Small (1-10%)	Unknown	High (Continuing)	PPNP will have annual prescribed burns including btwn the road & beach (prime snail habitat) but burn areas will be small, are usually in thickets and meadows (not forested), and burned areas could be recolonized. Any prescribed burn plan would first do an environmental assessment including consultation with snail experts. The policy is not to suppress natural wild fires unless they potentially affect people or infrastructure in PPNP as well as on Pelee Island; most snails live in heavily wooded habitat that is less likely to naturally burn. No prescribed burns planned on NCC property on Pelee Island, habitat moist and no history of natural burns (small scale grass fire occurred a long time ago only - no impact on vegetation). Snails prefer forests which are less likely to burn. Summary: small burns would affect small number of snails; effect on population within next 10 years or 3 generations is uncertain.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications		Unknown	Large (31-70%)	Unknown	High (Continuing)	Trails are gravel (not mowed), not maintained near beaches in PPNP unless a log falls. Invasive plants (e.g., Garlic Mustard *Alliaria petiolata*) and invertebrates (worms and molluscs) are directly affecting habitat but no data on effects of plants or invertebrates in specific habitats occupied by BBFS. Cormorants are a past threat. Loss of all species of ash trees on Pelee Island with habitat then being invaded by poison ivy has unknown ecological effect.
8	Invasive & other problematic species & genes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species		Unknown	Large (31-70%)	Unknown	High (Continuing)	Introduced Wild Turkeys on Pelee Island (turkeys are native to PNPP but are presently found in low numbers) probably eat snails. Ring-necked Pheasants are also introduced on Pelee Island (up to 50,000 individuals present in the 1930s) and are known to eat snails. No introduced carnivorous gastropods are currently known in BBFS habitat.
8.2	Problematic native species		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	White-tailed Deer (*Odocoileus virginianus*), Striped Skunk (*Mephitis mephitis*), Virginia Opossum (*Diadelphis virginiana*), and Northern Raccoon (*Procyon lotor*) are native to southern Ontario, but populations are higher than historical levels due to decreased predation and subsidized feeding (Phillips and Murray 2005; Dobbie pers. comm. 2014). Impacts on snails or snail habitat have not been documented. Fox Squirrel (*Sciurus niger*) is introduced to Pelee Island, but impacts on snails are unknown. Some invasive carabid beetles (*Scaphinotus* spp.) are snail-feeding specialists, but none are known to occur on Point Pelee or Pelee Island (Marshall *et al.* 2009). Scope is pervasive because this threat is an issue on the island and mainland but severity uncertain.
8.3	Introduced genetic material						
9	Pollution		Unknown	Unknown	Unknown	High (Continuing)	
9.1	Household sewage & urban waste water						Little road salt use in PPNP.
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents		Unknown	Unknown	Unknown	High (Continuing)	Glyphosate is used in spot applications at PPNP and Pelee Island. Bioaccumulation of glyphosate and other pesticides reduces growth and causes reproductive problems in gastropods in lab studies, but studies showing population declines in terrestrial gastropods were not found.
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10	Geological events						n/a
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	
11.1	Habitat shifting & alteration	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	Reduced sand accretion on the west side of Point Pelee caused by lower lake levels and reduced ice cover are expected to cause the tip to recede by 50 m over the next 50 years (BaMasoud and Byrne 2011), resulting in a loss of snail habitat. Most snail habitat is within about 200 m of the west side of the point, suggesting that a loss of 1 to 10% of snail habitat may occur within 10 years. Similar changes are probably occurring at Fish Point on Pelee Island.
11.2	Droughts		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Southwestern Ontario is projected to have less summer precipitation, increased evaporation, and more extreme climate events including droughts, floods, and temperature extremes as a result of climate change (Varrin *et al.* 2007; Expert Panel on Climate Change Adaptation 2009). Snails may be vulnerable to increasing temperatures and increased incidence of drought (Pearce and Paustian 2013), but responses to the projected temperature changes and droughts within the Canadian range of Broad-banded Forestsnail are unknown.
11.3	Temperature extremes		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Frequency of periods of extreme temperatures (highs and lows) are likely to increase (see comments for threat 11.2 above).
11.4	Storms & flooding						

Impact – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

Scope – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

Severity – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

Timing – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.