

COSEWIC
Assessment and Status Report

on the

Threaded Vertigo
Nearctula sp.

in Canada



SPECIAL CONCERN
2010

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC Assessment Summary

Assessment Summary – April 2010

Common name

Threaded Vertigo

Scientific name

Nearctula sp.

Status

Special Concern

Reason for designation

This minute terrestrial snail species is at the northern extent of its range, and found in lowland areas around the Strait of Georgia and on southern Vancouver Island. Most individuals live on the bark of Bigleaf Maple trees and appear to have poor capacity for dispersal between trees and sites. Removal of trees and habitat degradation due to urban expansion, roads and associated infrastructure, forestry, and agriculture are the main threats.

Occurrence

British Columbia

Status history

Designated Special Concern in April 2010.



COSEWIC
Executive Summary

Threaded Vertigo
Nearctula sp.

Species information

The Threaded Vertigo is a minute land snail with a high, rather cylindrical shell. The shell is about 2.4–3.3 mm high, dull, dark brown, and somewhat coarsely marked with fine, parallel growth lines. Within the opening of the adult shell, there are four white denticles (tooth-like protuberances); the immature shell lacks denticles. The Threaded Vertigo is currently without a formal scientific name due to its convoluted nomenclatural history, but the validity of the species is not in question.

Distribution

The global range of the species extends from southwestern British Columbia through western Washington State and Oregon to west-central California. In Canada, the species occurs on southern Vancouver Island, Saturna Island, and the Sunshine Coast on mainland British Columbia. There are 24 recent (since 1984) distribution records. On Vancouver Island, clusters of sites occur within the Capital Regional District (Victoria area), but the species is known from only scattered sites along the east coast, northward to just south of Courtenay. In the Strait of Georgia, the species is known from one site on Saturna Island. On the Sunshine Coast (B.C. mainland), it occurs at several places between Gibsons and Egmont.

Habitat

In British Columbia, the snails occur in moist deciduous and mixed-wood forests at low elevations, usually below 200 m. They are often associated with Bigleaf Maples and an understory of ferns and shrubs characteristic of moist, rich sites. Older riparian forests containing groves of large maples appear to be particularly suitable. The snails are largely arboreal and encountered most frequently on trunks of maples, where they occur within crevices of grooved bark or moss mats. They are occasionally found on other deciduous trees, on fern fronds, or on the ground within the leaf litter. The snails have a patchy distribution both within and among forest stands, and aggregations occur on some trees while others are devoid of snails.

Biology

Little is known about the biology of the Threaded Vertigo, and hence information has to be extrapolated from similar, related species. Like most land snails, the Threaded Vertigo is hermaphroditic (possesses both male and female reproductive organs), but the extent of cross-fertilization is not known. In similar species, eggs are laid singly. The lifespan is probably short, two years or less. The snails hibernate in winter and probably aestivate during dry periods in summer. Movements and active dispersal are limited, but passive transport on falling leaves during windstorms is plausible. The snails have been found in small groves of trees near roadsides and busy recreational trails, suggesting that they can tolerate some habitat disturbance, provided suitable moist microhabitats remain available.

Population sizes and trends

Few data are available on population sizes or trends. On occupied trees, 1–12 snails were found during searches of the lower 2 m of the trunk during field verification surveys on Vancouver Island and the Sunshine Coast. The snails appear to occur at much lower densities within the litter layer. Surveys in 2008 showed that the species has persisted at many sites over several years, but the size and viability of local populations are unknown.

Limiting factors and threats

The distribution of the species coincides with densely populated and highly modified parts of British Columbia. Much of the land conversion is historical in these lowland coastal areas, but human developments continue to encroach on remaining natural areas concomitant with an expanding population. Housing developments, road building and other associated infrastructure, agriculture, and forestry are shrinking and fragmenting habitats. Most records for this species are from parks or federal lands protected from land conversion, but potential habitats on private lands throughout most of the species' range continue to diminish. Populations in protected areas are not necessarily secure due to habitat degradation from intensive recreational or other uses, and invasion by introduced plants and animals.

Special significance of the species

The species is of no known socio-economic or cultural significance. It contributes to the biodiversity of the rich, extraordinary arboreal communities supported by Bigleaf Maples. At suitable moist sites, epiphytic mosses, liverworts, lichens, ferns, and other vascular plants drape large old maples, in turn providing habitat for a variety of fungi, invertebrates, and other organisms. The ecological roles and services of the different components of these arboreal communities, including the Threaded Vertigo, are yet to be elucidated.

Existing protection

The Threaded Vertigo was designated Special Concern by COSEWIC in April 2010.

TECHNICAL SUMMARY

Nearctula sp.

Threaded Vertigo

vertigo à crêtes fines

Range of Occurrence in Canada: British Columbia

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) | 1 yr |
| Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? | Unknown |
| 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? | N/A |
| Are there extreme fluctuations in number of mature individuals? | Unknown |

Extent and Occupancy Information

| | |
|---|------------------------|
| Estimated extent of occurrence Areas of ocean (unsuitable habitat) in the Strait of Georgia were included. | 9,530 km ² |
| Index of area of occupancy (IAO) Based on a 2 km × 2 km grid. The actual area of occupancy at each site is unknown and the total biologically based AO is much smaller. | 72 km ² |
| Is the total population severely fragmented? | Unknown but not likely |
| Number of locations* There are > 10 locations; 16 recent locations (since 1984) are identified (Table 1), and additional locations likely exist. | 16 |
| Is there an [observed, inferred, or projected] continuing decline in extent of occurrence? | Unknown; likely not |
| Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? | Unknown; likely not |
| Is there an [observed, inferred, or projected] continuing decline in number of populations? | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in number of locations? The number of distribution records has increased in the past 10 years with increased search effort, and new locations continue to be found. The actual trend in number of locations through extirpations or colonization is unknown. | Unknown |

*See definition of location.

| | |
|---|---------------------------------------|
| Is there an observed, inferred, and projected continuing decline in area, extent and quality of habitat? The distribution of the species coincides with lowland coastal areas with dense and expanding human population; deciduous and mixed wood stands inhabited by the snails are shrinking and being degraded as a result of human activities. | Declining in area, extent and quality |
| Are there extreme fluctuations in number of populations? | Unknown; probably not |
| Are there extreme fluctuations in number of locations*? | Unknown; probably not |
| Are there extreme fluctuations in extent of occurrence? | No, as far as known |
| Are there extreme fluctuations in index of area of occupancy? | Unknown |

Number of mature individuals in each population

| Population | N Mature Individuals |
|---------------------------------------|----------------------|
| Vancouver Island | Unknown |
| Saturna Island | Unknown |
| Sunshine Coast, mainland B.C. | Unknown |
| Minimum 3 populations – probably more | |
| Total | Unknown |
| Number of populations | 3 |

Quantitative Analysis

| | |
|--|-----|
| Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years]. | N/A |
|--|-----|

Threats (actual or imminent, to populations or habitats)

| | |
|---|--|
| Main threats: <ul style="list-style-type: none"> Habitat loss and degradation primarily due to urban expansion, roads, and associated infrastructure, forestry, and agriculture | |
| Potential threats: <ul style="list-style-type: none"> Habitat degradation through edge effects, recreational activities and other human uses, and by invasion of introduced plants and animals | |

Rescue Effect (immigration from outside Canada)

| | |
|--|---|
| Status of outside population(s) USA: Apparently secure (N3N5); unranked or with no special status in California, Oregon, and Washington | |
| Is immigration known or possible? | No immigration is known; immigration is very unlikely |
| Would immigrants be adapted to survive in Canada? | Yes |
| Is there sufficient habitat for immigrants in Canada? | Yes |
| Is rescue from outside populations likely? | No |

Current Status

| |
|---|
| COSEWIC: Designated Special Concern in April 2010. British Columbia: S2 (imperilled); red-listed |
|---|

Additional Sources of Information: None

*See definition of location.

Status and Reasons for Designation

| | |
|-----------------------------------|------------------------------------|
| Status: Special Concern | Alpha-numeric code: None |
|-----------------------------------|------------------------------------|

Reasons for designation:

This minute terrestrial snail species is at the northern extent of its range, and found in lowland areas around the Strait of Georgia and on southern Vancouver Island. Most individuals live on the bark of Bigleaf Maple trees and appear to have poor capacity for dispersal between trees and sites. Removal of trees and habitat degradation due to urban expansion, roads, and associated infrastructure, forestry, and agriculture are the main threats.

Applicability of Criteria

| |
|---|
| Criterion A (Decline in Total Number of Mature Individuals): Not applicable. The total number of mature individuals is unknown. |
| Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although EO (9,530 km ²) is <20,000 km ² , IAO (72 km ²) is <500 km ² , and a continuing decline in area and quality of habitat is inferred, the species is not severely fragmented, is found at >10 locations (likely more), and extreme fluctuations (unlikely) in EO, IAO, number of locations or populations, or number of mature individuals are unknown. |
| Criterion C (Small and Declining Number of Mature Individuals): Not applicable. The total number of mature individuals is unknown. |
| Criterion D (Very Small Population or Restricted Distribution): Not applicable. The number of mature individuals is unknown and likely much >1000; IAO >20 km ² and number of locations >5. |
| Criterion E (Quantitative Analysis): No data available. |



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 (2010)

| | |
|------------------------|--|
| 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.

COSEWIC Status Report

on the

Threaded Vertigo

Nearctula sp.

in Canada

2010

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SPECIES INFORMATION

Name and classification

The Threaded Vertigo, *Nearctula* species, is a member of the family Vertiginidae, a group of small land snails with worldwide distribution. Some authorities include this group as a subfamily within the family Pupillidae (Pilsbry 1948; Turgeon *et al.* 1998), while others regard it as sufficiently distinct to warrant a separate family designation (Schileyko 1998; Roth and Sadeghian 2003, 2006; Bouchet and Rocroi 2005). The classification of the Threaded Vertigo, following Forsyth (2004), is as follows:

Phylum Mollusca
Class Gastropoda
Subclass Orthogastropoda
Order Pulmonata
Superfamily Pupilloidea
Family Vertiginidae
Subfamily Vertigininae
Genus *Nearctula*
Nearctula species

The genus *Nearctula* Sterki, 1892, corresponds to the *Vertigo californica* group of Pilsbry (1948). Smith *et al.* (1990), following Coney (1988), separated *Nearctula* from *Vertigo*. This generic designation is used in the American Fisheries Society list of names of molluscs (Turgeon *et al.* 1998). The genus *Nearctula*, as currently known, contains *N. rowellii* with several subspecies (California and Baja California), *N.* species, currently without a formal name (British Columbia to central California) (Turgeon *et al.* 1998), and *N. dalliana* (Oregon and California) (Roth and Sadeghian 2006). Another undescribed and possibly new species, from the Olympic Peninsula and colloquially known as the Hoko Vertigo, may belong to *Nearctula* (Burke *et al.* 1999). The nomenclatural history of the Threaded Vertigo is complicated due to misapplications of names and taxonomic revision, currently leaving this species without a formal name. The validity of the species is not in question (Turgeon *et al.* 1998); rather, the issue is with nomenclature.

The Threaded Vertigo was formerly and erroneously known as *Vertigo rowellii* prior to 1998 (Turgeon *et al.* 1998), but *Nearctula rowellii* (Ribbed Vertigo) is the valid name for another (Californian) species (Smith *et al.* 1990; Roth and Sadeghian 2003, 2006). The Californian species now bearing the name *N. rowellii* was once called *Vertigo californica* (Pilsbry 1948), but these two names are synonyms, with *Pupa rowellii* Newcomb, 1860, the senior synonym (Turgeon *et al.* 1998; Roth pers. comm. 2008). A lectotype designation by Clarke (1960) confirms this change. Hence, the Californian species rightfully claims the name *N. rowellii*, which leaves the Threaded Vertigo without a formal name. Roth and Sadeghian (2003, 2006) referred to this species as *Nearctula* species “p”. Turgeon *et al.* (1998) retained listing for this temporarily unnamed species, for which they had applied the common name Threaded Vertigo in the first edition of the

list in 1988. The formal naming of the Threaded Vertigo is in progress (Turgeon *et al.* 1998; Roth and Sadeghian 2006; Roth pers. comm. 2008).

Morphological description

The Threaded Vertigo is a minute snail with a high, subcylindrical shell. The average shell height of 47 adult specimens from British Columbia measured 2.7 mm (SD = 0.2 mm, range = 2.4–3.3 mm; K. Ovaska, unpublished data). The shell is slightly tapered with a blunt apex. The crest (a ridge behind lip of the aperture on the last whorl), sinulus (an indentation of the lip of the aperture), and palatal callus (the thickened region inside the apertural back from the lip), which are present in some vertiginids, are absent in the Threaded Vertigo. The periostracum (outer layer that covers the shell) is dull and dark brown; somewhat irregularly spaced, raised, minute axial threads give the shell a coarse surface texture (Figure 1). The body of the animal is dark grey dorsally, grading into lighter grey on the sides and sole of the foot.



Figure 1. Threaded Vertigo in groove of furrowed bark of a large Bigleaf Maple, near Sooke River, Vancouver Island (shells 2.5–3.0 mm high; October 2008; photo *in situ* by K. Ovaska).

The lip of the aperture of the adult shell flares outwards and is only slightly thickened. There are four white denticles within the aperture: parietal, columellar, lower palatal, and upper palatal (Figure 2). The broad, slightly twisted parietal denticle is the most prominent. The upper palatal is usually the smallest and lacking in some specimens.

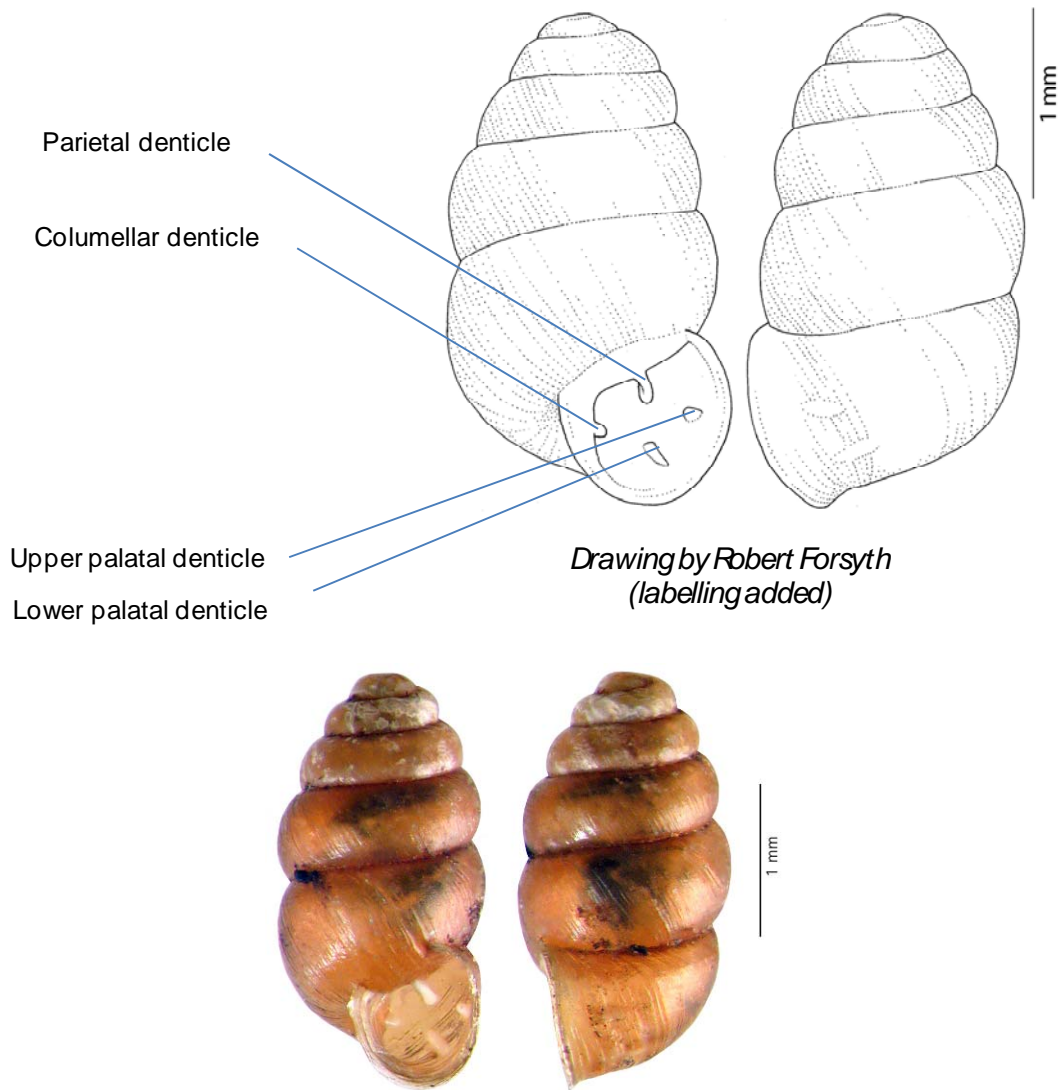


Figure 2. Shell of the Threaded Vertigo, showing the arrangement of apertural denticles. Photo by Robert Forsyth; Vancouver Island (Metchosin), British Columbia.

The Threaded Vertigo can be distinguished from sympatric vertiginids by features of the shell. It can be distinguished from *Vertigo* species by its larger size and arrangement of denticles. The shells of *Columella* species are broader, have a simple lip (not thickened or flared), and lack apertural denticles. Undescribed species of *Nearctula* might occur within the range of the Threaded Vertigo, and it can be difficult to discern whether individuals with unusual features are aberrant or within normal range of variation for this species, or belong to a new species. In these cases, examination of a number of specimens from the same site is required to determine the frequency of individuals with unusual features and the consistency of these features.

Population spatial structure and variability

The population spatial structure of the Threaded Vertigo has not been studied, and no genetic information is available. The geographic range of the species in Canada is disjunct, and stretches of ocean form barriers to movements of snails among Vancouver Island, Saturna Island, and the Sunshine Coast on mainland British Columbia (see **DISTRIBUTION**). These areas are also isolated from populations in the United States by ocean or, in the case of the Sunshine Coast, by Metro Vancouver and surrounding developed areas.

Designatable units

There is one designatable unit. More than one designatable unit is not applicable because no subspecies are recognized and all sites are found in similar habitat within one ecozone. While natural disjunction appears to exist among populations on islands and the mainland, there are no data available on the genetic distinctiveness or evolutionary significance (such as local adaptations) of these populations.

DISTRIBUTION

Global range

The geographic range of the Threaded Vertigo extends from southwestern British Columbia southward through western Washington State and Oregon to west-central California (Frest and Johannes 2000; Roth and Sadeghian 2006; Duncan pers. comm. 2008; Burke pers. comm. 2008; Figure 3). The species' distribution appears to be relatively continuous from west-central Oregon to California, where records exist from all coastal and several sub-coastal counties from Lane County, Oregon, to Monterey County, California at the southernmost limits of the species' range (Frest and Johannes 2000; Roth and Sadeghian 2006). In northern Oregon and Washington, it is known from scattered records only, including several sites away from the coast in the northern Oregon Cascades (Duncan pers. comm. 2008). The eastern limits of the distribution throughout the United States are poorly known.



Figure 3. Global distribution of the Threaded Vertigo in western North America. Distribution in USA compiled from information from Roth and Sadeghian (2006), Frest and Johannes (2000), Burke pers. comm. 2009, Duncan pers. comm. 2008, Roth 2009 pers. comm. Eastern limits of the distribution are approximate. Map prepared by L. Sopuck.

Canadian range

In Canada, the Threaded Vertigo is known from Vancouver Island and from the Sunshine Coast on the southwestern mainland of British Columbia (Appendix 1; Figure 4). It was recently (March 2009) found on Saturna Island in the Strait of Georgia, and it is likely that it occurs on other Gulf Islands as well. On Vancouver Island, records exist from near Sooke in the southwest to Union Bay on the east-central coast and from several places in between along the south and east coast of the island. There are clusters of records from the Metchosin–Sooke area and from the Saanich Peninsula within the Capital Regional District around Victoria, and scattered records from coastal forests farther north along the east coast of Vancouver Island. On the Sunshine Coast, records exist from a 100 km-long stretch of coast from Roberts Creek to near Egmont on the Sechelt Peninsula. The northern extent of the species' distribution on Vancouver Island and along the mainland coast north of Sunshine Coast remains unknown, but it is unlikely that the species occurs much farther north from where it is presently known (see **Habitat requirements**).

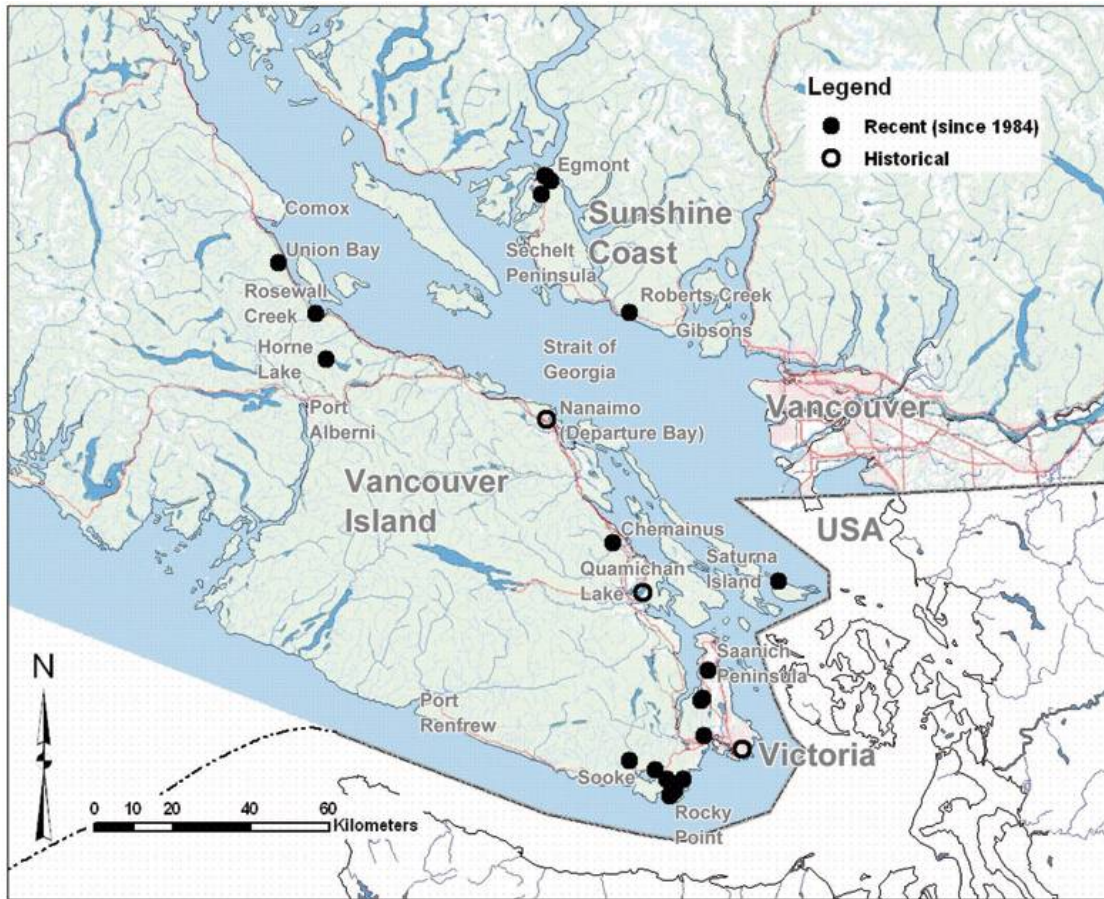


Figure 4. Canadian distribution of the Threaded Vertigo in southwestern British Columbia. Map prepared by Alain Filion from data in Appendix 1 (place names added to original map).

As of March 2009, there are 24 recent (since 1984) and three historic (from the mid-1890s to early 1920s) records of the species from British Columbia (Appendix 1). It is likely that additional sites exist, as suggested by seven new distribution records documented during field verification surveys targeting this species and its microhabitats in 2008 (Appendix 1).

Based on the premise that open expanses of water form barriers for dispersal (see **Dispersal/migration**), there is a minimum of three populations (Saturna Island, the Sunshine Coast, and Vancouver Island), but more than three populations are probable. In particular, the distribution records for the species on the east coast of Vancouver Island are scattered and may represent several populations. The ability of this species to disperse over long distances is unknown and survey effort is incomplete, making delineation of these possible populations unfeasible at this time.

The extent of occurrence (EO) is about 9,530 km², using the minimum polygon method and including areas of ocean in the Strait of Georgia. Ocean, which is unsuitable habitat, covers about a third of this area. The index of area of occupancy (IAO) is 72 km², calculated by superimposing a grid with 2 km × 2 km cells on the range and counting the number of cells that encompass records of the species. The actual area of occupancy is unknown. The EO represents about 7% of the global range of the species, but this value is uncertain because all areas with potential habitat have not been adequately surveyed for the species. There is no information on the historic range of the species in Canada, but it was probably larger in the past because riparian zones and other suitable moist forest habitats have shrunk due to human activities over the past century.

HABITAT

Habitat requirements

In British Columbia, the Threaded Vertigo occurs in moist low-elevation deciduous and mixed-wood forests (Forsyth 2004). The species occurs in restricted habitats within the Coastal Douglas-fir and Coastal Western Hemlock biogeoclimatic zones (Meidinger and Pojar 1991). All records from the province are from below 200 m above sea level (Appendix 1). Farther south, however, the species has been found at elevations up to about 1650 m in the Oregon Cascades (Duncan pers. comm. 2008), but it appears to prefer low- to mid-elevation areas (Frest and Johannes 2000). In British Columbia, the snails most often occur in forest stands containing Bigleaf Maple (*Acer macrophyllum*) and with an understory of Sword Fern (*Polystichum munitum*), Salmonberry (*Rubus spectabilis*), and other shrubs and herbs characteristic of moist, rich sites and riparian areas (Figure 5). Bigleaf Maples are restricted to middle and low elevations (usually below 300 m) in the southwestern part of the province, including Vancouver Island and the adjacent mainland coast, and occur mainly at latitudes below 51°N (Peterson *et al.* 1999; B.C. Forests and Range, undated). Maples decrease in occurrence with increasing elevation and latitude and inland from the coast. Stands with the highest proportion of Bigleaf Maples occur at scattered places on southern and southeastern Vancouver Island and along the extreme southwestern portion of the mainland. Older riparian forests containing groves of large Bigleaf Maples appear to be particularly important for the snails, as they provide a high level of humidity, an abundance of moss and epiphytes, and a deeply furrowed bark for shelter.



Figure 5. Habitat of the Threaded Vertigo in mainly deciduous riparian forest with Bigleaf Maple and Sword Fern (Rocky Point, Vancouver Island; photo by K. Ovaska).

The Threaded Vertigo is largely arboreal, similar to some other vertiginid snails, such as *Vertigo bollesiana*, which in Nova Scotia was found exclusively on trunks of deciduous trees (Davis 1995). Other species of vertiginids that occur in British Columbia, however, are usually found within the leaf litter or climbing on ferns or low bushes (Forsyth 2004). During field verification for this status report in 2008, the Threaded Vertigo was most often found on trunks of large Bigleaf Maples, where they occupied microhabitats within crevices of grooved bark or within or under moss growing on the bark (Figures 1 and 6). They were found infrequently on the bark of other deciduous trees (Cottonwood, *Populus balsamifera*, Red Alder, *Alnus rubra*) and on Sword Fern fronds. Other records from the province indicate that the snails are also found within the leaf litter, but whether they regularly occur in the litter layer is unknown. These records might represent snails that have dropped from trees or ferns. In Oregon, the snails occur primarily on perennial bushes and small trees with smooth bark, including California Hazel (*Corylus cornuta californica*), Red Alder, Cascara (*Rhamnus purshiana*), and Vine Maple (*Acer glabrum*), where they are often found on the underside of small branches (Frest and Johannes 2000). In British Columbia, however, searches of smaller trees and bushes were unproductive during the field verification surveys. It is possible that the snails use these microhabitats seasonally; it is also possible that habitat use at the northern limits of the species' distribution here is different from that farther south in the United States.

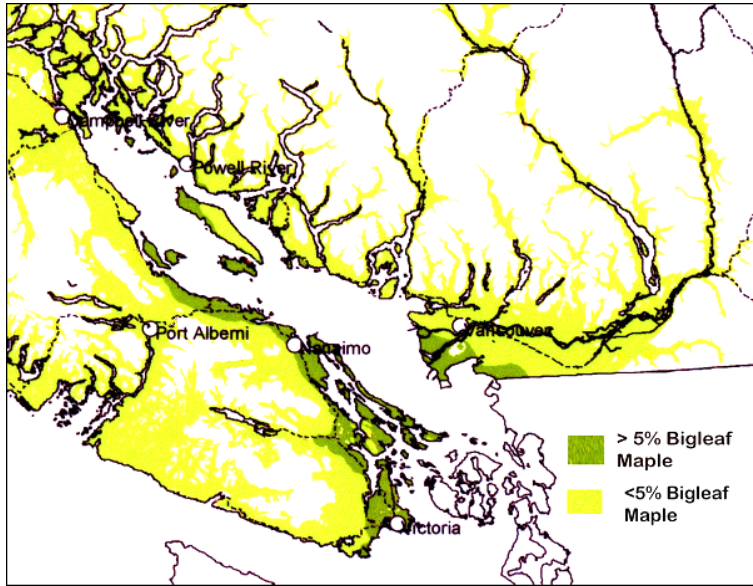


Figure 6. Large, moss-covered Bigleaf Maple, which provided arboreal microhabitats for the Threaded Vertigo (Rosewall Creek, Vancouver Island; photo by K. Ovaska).

Some degree of habitat connectivity both within and among stands is likely required, but no data are available. Fragmented forest stands and stands with only scattered maples or other suitable deciduous trees may not support viable populations, as subpopulations of snails on individual trees or small groups of trees may become isolated and prone to extirpation.

Habitat trends

The distribution of the Threaded Vertigo coincides with the highly modified landscape and dense human population in southwestern British Columbia, where the species is associated with forest stands containing Bigleaf Maples. Although Bigleaf Maples are not rare in this region, forest stands containing old (> 121 years), large trees comprise only a small proportion of maples on both Vancouver Island (2.4% of age classes) and the southwestern mainland (1.5% of age classes; values based on the volume of maples in areas that allow harvesting; Peterson *et al.* 1999). Furthermore, stands that include more than scattered maples (at least 5%) are restricted to narrow, low-elevation coastal strips in the extreme southwest of the province (Figure 7, top). Unfortunately, these areas are also where people prefer to live (Figure 7, bottom), and hence have been fragmented.



Source: Generated from digital map provided by Dr. Andreas Hamann, Department of Renewable Resources, University of Alberta, Edmonton (Hamann pers. comm. 2009).



Yellow areas: Human population density in 2001 (1 dot = 50 people)
 Source: B.C. Ministry of Environment. State of the Environment Reporting – Environmental Trends 2007.
 Web site: http://www.env.gov.bc.ca/soe/et07/01_population_economic/overview.html [accessed February 2009]

Figure 7. Distribution of Bigleaf Maple (top) in relation to human population density (bottom) in southwestern British Columbia.

On Vancouver Island, most of the human population is concentrated in low elevation areas on the south and east coast. Much of the conversion of the habitat into residential areas, agriculture, and other human uses is historical, but human developments continue to encroach on remaining natural areas. For example, the human population within the Capital Regional District (CRD, encompassing 13 municipalities on southern Vancouver Island), where concentrations of records of the Threaded Vertigo occur, grew by an average of 6% annually within the five-year period from 2001 to 2006, to a total of 345,164 people in 2006 (CRD 2007). Within CRD, West Shore communities exhibited the fastest growth (11%) during this period. They include Metchosin and Sooke areas, where much of remaining forests are located and where the snail has been found. Population growth within CRD is projected to continue over the next decades, increasing from 151.09 people/km² in 2006 to 176.94 people/km² by 2031 (B.C. Ministry of Environment 2007). Smaller but steady increases are also projected for the east-central coast with records of the Threaded Vertigo (Comox-Strathcona Regional District: from 5.36 people/km² in 2006 to 7.13 people/km² by 2031).

The portion of the Sunshine Coast where the Threaded Vertigo occurs is subject to similar trends of habitat loss and fragmentation. The Sunshine Coast Regional District covers an area of 3,778 km² and is relatively sparsely populated (27,759 persons in 2006; SCORE 2006). However, most of the human population is concentrated in the relatively narrow coastal strip of lowlands that support mixed-wood forest with abundant Bigleaf Maples and provide habitat for the Threaded Vertigo, rather than in the mainly coniferous, mountainous areas away from the coast. This area is within commuting distance from metropolitan Vancouver, the fastest growing area in the province, and is experiencing population expansion. The total population of the district had grown by 8.4% in the five-year period from 2001 to 2006 (SCORE 2006). Population growth was more rapid in some of the coastal communities, including Roberts Creek (16.2% increase), where the Threaded Vertigo has been found. Population growth is projected to continue into the future, increasing from 7.75 people/km² in 2006 to 11.18 people/km² by 2031 (B.C. Ministry of Environment 2007).

Habitat protection/ownership

Lands over most of the geographic range of the species are privately owned, both on Vancouver Island, the Gulf Islands, and the Sunshine Coast, and are primarily used for residential and forestry purposes. Moist mixed-wood and deciduous stands containing suitable habitat for the Threaded Vertigo are scattered in riparian areas and other low elevation sites amid rural, agricultural, and forestry lands, and it is impossible to estimate the extent of suitable habitat that is on private versus public lands. Most known sites of the Threaded Vertigo are on public lands, including regional and provincial parks, largely reflecting the distribution of survey effort that has focused on these relatively undisturbed areas. However, many additional sites probably exist on private lands. The species and its habitats have no protection on private lands.

On Vancouver Island, the Threaded Vertigo is known from two federal properties used by the Department of National Defence for military training activities (Rocky Point Ammunition Depot and Heals Rifle Range). At present, the habitat at both sites is relatively intact and under no immediate pressure from development; however, their long-term future is not secure. The species is also known from two regional parks and from a narrow right-of-way of a regional trail within the Capital Regional District Parks and Trails System. Records exist from three provincial parks on Vancouver Island (John Dean, Horne Lake, and Rosewall Creek Provincial Parks) and two on the Sunshine Coast (Skookumchuck Narrows and Roberts Creek Provincial Parks). On Saturna Island, the species occurs within the Gulf Islands National Park. Habitats within parks are protected from development but are not necessarily safe from habitat degradation, resulting from invasive species, intensive recreational activities, or other disturbances.

BIOLOGY

Virtually no information is available on the life history and other aspects of the biology of the Threaded Vertigo in British Columbia or within its range in the United States. Therefore, information provided below is extrapolated from relevant aspects of the biology of other land snails, especially vertiginids or other species of *Nearctula*, when available.

Life cycle and reproduction

Like most pulmonate gastropods, the Threaded Vertigo is hermaphroditic (possesses both male and female reproductive organs) but probably exchanges gametes with other individuals through copulation. Cross-fertilization appears to be the norm in most terrestrial gastropods (Tompa 1984), but self-fertilization and aphally (loss of male genitalia) is widespread in European species of Vertiginidae (Pokryszko 1987). It is unknown whether self-fertilization occurs in the Threaded Vertigo. In European vertiginids, eggs are laid singly (Pokryszko 1987), but it is unknown if the Threaded Vertigo does the same.

Little is known of the life cycle and patterns of survival of the Threaded Vertigo. In British Columbia, most records are from the autumn, but adult snails have also been found in March and June, suggesting that the lifespan is more than one year. Applegarth and Duncan (2005) speculated that the related Hoko Vertigo is probably short-lived with a lifespan of two years or less. Timing of reproduction is unknown. Some pupilloids in temperate areas overwinter while gravid, giving birth in early spring (Tompa 1984). Generation time for the Threaded Vertigo might be about one year, but no definite information is available. The snails probably hibernate in the winter and aestivate during dry periods in the summer. Threaded Vertigo individuals appeared to be inactive and likely aestivating during a dry period in June 2008 (Forsyth pers. comm. 2009).

Herbivory/predation

The Threaded Vertigo probably gleans microorganisms from the bark of trees and shrubs, as suggested for *Nearctula* species in the United States based on their arboreal habits (Applegarth and Duncan 2005). The snails may also feed on decaying vegetable matter and fungi while within the leaf litter, but no information is available.

Predators likely include songbirds that forage on trees and shrubs, such as chickadees, bushtits, and wrens. The Winter Wren (*Troglodytes troglodytes*) has been observed feeding in bushes with aggregations of *Nearctula* sp. (cited as *Pupa rowellii*), apparently feeding on these snails (Andrews 1897 cited in Pilsbry 1948). Various arthropod predators may prey on the Threaded Vertigo in both arboreal and terrestrial habitats. For example, carabid beetles, such as *Scaphinotus* species, are known snail-predators (Digweed 1993) and commonly climb tree trunks at night (Ovaska and Sopuck, unpublished data).

Physiology

Applegarth and Duncan (2005) noted that pupilloid snails, including *Nearctula* species, presumably possess some degree of freeze-tolerance, as they overwinter exposed on tree limbs in the Pacific Northwest of the United States where ambient temperatures frequently drop below freezing during winter months. However, the physiological mechanisms for doing this are unknown. Little is also known about summer dormancy or aestivation of the Threaded Vertigo or other *Nearctula* species. Like most land snails, the Threaded Vertigo produces an epiphragm of dried mucus that temporarily seals off the aperture, so reducing water loss, during periods of dormancy. Studies of another pupilloid snail (*Lauria cylindracea*) demonstrate specialized physiological mechanisms that enable the snails to withstand water loss during prolonged dry periods (Zeev *et al.* 1998). This species inhabits open, often rocky, areas and forest edges and is probably able to withstand drier conditions than the Threaded Vertigo. Nevertheless, the Threaded Vertigo may possess similar physiological adaptations that enable it to survive summer droughts in a dormant stage.

Dispersal/migration

Individual snails of this species are likely to be sedentary, perhaps confining their movements to individual trees. Active dispersal of land snails in general is extremely limited (reviewed in Cordeiro 2004), and long-distance dispersal usually occurs through passive means with wind, water, or animal vectors, or aided by human activities. Small snails such as the Threaded Vertigo could be transported by wind while adhering to falling leaves, but no data are available, and on trees the snails have been found on bark, not leaves. Extrapolating from movements of sediment particles, Kirchner *et al.* (1997) calculated that a small vertiginid snail (*Truncatellina rothi*), comparable in size to the Threaded Vertigo, could be transported up to several kilometres during severe storms, contributing to the colonization of oceanic islands and genetic interchange among populations from different islands. The Threaded Vertigo may similarly be

transported from stand to stand by storms with high winds. Passive transport with human activities could also occur, for example, with firewood removal.

It is likely that the Vancouver Island, Saturna Island, and mainland B.C. populations are isolated from each other (and populations in the U.S.) due to stretches of ocean. Within each of the above geographic areas, low-elevation deciduous and mixed-wood forest stands containing Bigleaf Maple are highly fragmented by urban development and other human activities. However, uncertainties exist about the implications of this fragmentation for the snails because (a) their long-distance dispersal capabilities through passive means are unknown; (b) scattered small groves of Bigleaf Maples could potentially provide stepping-stones for dispersal; and (c) Bigleaf Maples are able to regenerate relatively rapidly, within decades, after disturbance (Peterson *et al.* 1999), although older stands that may be more suitable continue to be lost. For the above reasons, habitats of the snails within each of the three larger areas are not considered severely fragmented, although some sites on southern Vancouver Island, in particular, are isolated amid developed areas.

Interspecific interactions

Surveys conducted in 2008 indicate a close association of the Threaded Vertigo with the Bigleaf Maple (see **Habitat requirements**). The furrowed bark apparently provides preferred habitat for these snails. The snails may obtain minerals directly from the bark, as the bark is rich in calcium (Peterson *et al.* 1999), which is important for shell development in snails. All forest stands where the Threaded Vertigo has been found in British Columbia contain Bigleaf Maples (Appendix 1), but the snails have occasionally been found on trunks of other deciduous trees and within leaf litter on the forest floor. Whether populations would be able to persist in mixed-wood or deciduous forest stands devoid of Bigleaf Maples is unknown and requires more extensive, comparative surveys throughout the species' potential range in British Columbia.

Adaptability

Due to its minute size, resource requirements of the Threaded Vertigo are also small. It may be able to persist in small forest patches or groves of trees that contain suitable microhabitats. It can probably coexist with a variety of human activities as long as moist habitat with deciduous trees is retained; it has been found alongside busy recreational trails and near roadsides (Appendix 1). However, the snails occupy specialized arboreal microhabitats, increasing their vulnerability to changes in conditions that change the structure or microclimate of these habitats.

POPULATION SIZES AND TRENDS

Sampling effort

Terrestrial gastropod faunas of British Columbia are relatively poorly known, and undocumented native species continue to be discovered. Vancouver Island is better surveyed than most other areas of the province, beginning with efforts of early malacologists, such as G.W. Taylor and A.W. Hanham, in the late 1800s (see Drake 1963 and Forsyth 2004 for an overview of the history of malacology in British Columbia). Survey effort has been sporadic and negligible over much of the 20th century.

Recent surveys in the province include those by R.A.D. Cameron, Robert Forsyth, and Biolinx Environmental Research Ltd. (Kristiina Ovaska and Lennart Sopuck). Surveys until 2008, outlined below, did not target tree trunk microhabitats preferred by the Threaded Vertigo, and the species might have been missed. Therefore, these surveys do not adequately reflect efforts expended to locate these snails in British Columbia.

Cameron (1986) surveyed 38 lowland forest sites on Vancouver Island, Lower Fraser Valley, and Chilliwack Valley in 1984. He found the Threaded Vertigo at two sites, both on Vancouver Island. Robert Forsyth has surveyed numerous places throughout British Columbia since 1990, including hundreds of sites on Vancouver Island and the southwestern mainland (Forsyth pers. comm. 2008). He found the species at five sites, on Vancouver Island and the Sechelt Peninsula. From 1999 to 2008, Biolinx Environmental Research Ltd. conducted numerous surveys for terrestrial gastropods in British Columbia, including the following areas: 152 sites in the Queen Charlotte Islands (Haida Gwaii), 108 sites in the Kootenay region, about 300 sites on Vancouver Island and the Gulf Islands, and about 200 sites on the coastal mainland. These surveys included the following areas: Pacific Rim, Gulf Islands, and Gwaii Haanas National Park Reserves (for Parks Canada); Department of National Defence (DND) properties on southern Vancouver Island, Lower Mainland, and Graham Island (for DND/CFS Natural Resources Management Program); selected forestry lands managed by Western Forest Products (formerly Weyerhaeuser Company) on Vancouver Island, Graham Island, and southwestern mainland near Powell River; numerous other sites on Vancouver Island, southwestern mainland, and interior of the province (for the B.C. Ministry of Environment); numerous sites on Vancouver Island, Lower Mainland, and the Queen Charlotte Islands as part of projects supported by the Endangered Species Recovery Fund and Wildlife Habitat Canada; selected regional parks on southern Vancouver Island (for Capital Regional District Parks). While some of the above surveys consisted of one-time visits, several others included intensive, repeated surveys over several years using artificial cover-objects and/or extraction of small snails from litter samples. The Threaded Vertigo was found at three sites surveyed by Biolinx Environmental Research Ltd. before the field verification surveys conducted for this status report.

Field verification associated with the preparation of this status report included surveys of 17 sites (13 on Vancouver Island and four on the Sunshine Coast) for a total of 20.3 person-hours in 2008, targeting habitats of the Threaded Vertigo in low elevation mixed-wood or deciduous forest (Appendix 1, 2). The species was found at nine sites, including all four sites on the Sunshine Coast (Appendix 1). These surveys were intended to provide presence/absence level information to confirm the presence of the species at historical sites and to fill in distribution gaps; more intensive methods, such as quadrat searches, needed to provide density estimates were not deployed. During searches of trees, only the lower portion of tree trunks below 2 m were available for examination without specialized climbing equipment; when covered by moss, moss was not stripped but the trunk was selectively sampled to avoid excessive disturbance.

Abundance

Little information is available on densities or relative abundance of the Threaded Vertigo, and no attempts have been made to estimate population sizes. In general, arboreal vertiginids tend to have patchy distribution patterns within suitable forest stands, with relatively large numbers of snails found in some trees and none in other seemingly similar trees (Applegarth and Duncan 2005 and references therein). During field verification surveys for this report, an average of 2.9 snails/occupied tree were found on the portion of trunk below 2 m that was searched (range: 1–12 snails per tree, n = 27 occupied trees). The snail populations on entire trees could have been much larger.

In contrast to arboreal habitats, the snails appear to exist at low densities in the litter layer on the forest floor. Cameron (1986) found one and four snails, respectively, at two sites where the species was detected. At both sites, the snails were within a 30 m x 30 m sampling area that was intensively searched both visually and by extracting small snails from litter samples (see Cameron [1986] for details of methods). At three sites on southern Vancouver Island in the autumn of 2008, Ovaska and Sopuck (2008, 2009) found only one individual snail per site using artificial cover-objects placed on the forest floor (100–650 cover-object checks per site). Additional cover-objects in other parts of the same sites resulted in no records of this species. Cardboard cover-objects effectively sample a variety of forest floor gastropods (Boag 1990; Hawkins *et al.* 1998; Ovaska and Sopuck 2001), but may underestimate abundance of the Threaded Vertigo because of their mainly arboreal habits.

Fluctuations and trends

Few data are available on population fluctuations or trends. Loss of habitat over the past century due to human activities may have resulted in a population decline of the Threaded Vertigo, but no historic baseline data are available. The increase in the number of distribution records over the past 10 years is due to the increased search effort. Field verification surveys carried out in 2008 indicate that the species has persisted at many of the sites surveyed over several years. The species' continued presence was confirmed near the site of a previous record on the Sunshine Coast,

where it was first found near Egmont in 1996, and within the Capital Regional District on southern Vancouver Island, where it was first found at Rocky Point in 2002. In contrast, it was not found near three historic sites on the east coast of Vancouver Island north of Victoria (Union Bay in 1996; Departure Bay and Quamichan Lake, undated, from the mid-1890s to early 1920s). The latter two records are inexact, but little original habitat remains in the vicinity of these populated areas.

Rescue effect

Dispersal of the snails from western Washington State to the mainland of British Columbia is conceivable but unlikely. On the Canadian side, the nearest known populations of the Threaded Vertigo are on the Sunshine Coast north of the metropolitan area of Vancouver, which is likely to act as a barrier to movement if the snails were to cross the border. The distribution of the species appears to be scattered in Washington. There are several records from the San Juan Islands, from Lopez and Patos islands (Burke pers. comm. 2008); Patos Island is only 6 km from Saturna Island on the Gulf Islands in British Columbia. If long-distance transport occurs by severe windstorms, a low frequency of natural dispersal between Washington and Vancouver Island via the San Juan Islands and Gulf Islands cannot be ruled out.

LIMITING FACTORS AND THREATS

The Threaded Vertigo reaches the northern extremity of its geographic range in southwestern British Columbia. Its expansion to the north and higher elevations in the province are probably limited by the distribution and abundance of Bigleaf Maple and associated ecosystems, and possibly by physiological tolerances of the snails to low temperatures, but these are presently unknown.

Main known threats to the Threaded Vertigo are from habitat loss, fragmentation, and degradation associated with an expanding human population in the lowland, coastal areas where the snails occur (Figure 7; see **Habitat trends** for details). Human activities that threaten habitats within the range of the Threaded Vertigo include housing developments, road building and other associated infrastructure, agriculture, and forestry. Although Bigleaf Maples are not usually commercially harvested, many trees are felled or damaged as a result of clear-cut logging operations, and harvesting of conifers around small maple stands or individual trees exposes them to the drying effects of wind and sun, so deteriorating habitat conditions for snails. Any human activity that alters natural patterns of hydrology can result in conditions that are either too dry or too wet for maples or the epiphytic communities they support. Bigleaf Maples are intolerant of flooding for prolonged periods (Peterson *et al.* 1999). Conversion of riparian hardwood stands to conifers as part of forestry activities or aquatic habitat restoration is also a potential threat to *Nearctula* species, as suggested for the Hoko Vertigo in Washington State (Applegarth and Duncan 2005).

Fragmentation of forest habitats is a potential threat for terrestrial gastropods with poor dispersal capabilities. On one hand, their ability to persist in small habitat patches for long periods is likely to ameliorate requirements for habitat connectivity at landscape and larger scales (Roth 1993). On the other hand, snail populations in small habitat patches are vulnerable to extirpation from catastrophic events, such as fires, or from stochastic environmental or population fluctuations. Hence, both the number of occupied habitat patches and their distribution within the landscape are an important consideration for assessing threats and probability of persistence of the species over larger geographic areas. For the Threaded Vertigo, many more occupied habitat patches than are currently known probably exist, and the species occurs at widespread places, suggesting that the total population might be somewhat resilient to habitat fragmentation. However, there is incomplete information both on the number of forest stands that are occupied and on the number that are necessary for the species to persist and be viable over the long term within a given area. There is insufficient evidence to determine whether the distribution can be considered severely fragmented, as the size of occupied areas and habitat patches and viability of subpopulations are unknown. During field verification surveys in 2008, the smallest stand where the Threaded Vertigo was found was a small isolated grove of about 10 maples in a moist depression amid unsuitable habitat (a clear-cut on one side and a highway and lake on the other) on the Sechelt Peninsula. Unless the snails are passively transported by wind or other means, small populations such as this one might not be viable over the long term. Similarly, populations of the Threaded Vertigo in small, protected areas, such as several CRD Parks and narrow trail right-of-ways surrounded by residential developments, may be isolated and vulnerable to extinction.

Potential threats include habitat degradation from edge effects that reduce moisture, increased disturbance from recreational and other uses, and introduced plants and animals. Invasive introduced plants (such as English Ivy [*Hedera helix*], Scotch Broom [*Cytisus scoparius*], Gorse [*Ulex europaeus*], and Laurel-leaved Daphne [*Daphne laureola*]) are extensively modifying natural ecosystems within the range of the Threaded Vertigo and are common at many sites where the snails occur. English Ivy is extremely abundant at some sites both on the forest floor and in trees and directly modifies arboreal communities; its effects on snail populations are unknown but potentially detrimental. Habitat degradation is expected to be particularly prevalent in small forest stands that are subject to invasion by introduced species and changes in microclimate, including drying of the forest floor and arboreal habitats.

Introduced carabid beetles, which are known predators of land snails, may be a threat. There has been a widespread change in the carabid beetle fauna with 22 introduced species now in B.C. (C. Copley pers. comm. 2010). Just how many of these non-native carabids are in the area of the Threaded Vertigo and whether they predate the Threaded Vertigo, or what the effects might be, are unknown.

Detrimental effects of climate change on the snail populations are plausible, particularly in degraded and fragmented habitats. Prolonged summer droughts and increased frequency of extreme climatic events are predicted to occur in

British Columbia under climate change scenarios (B.C. Ministry of Environment 2007). Drier conditions during the activity period of the snails from spring to autumn could adversely affect snail populations, especially here at the northern extremity of the species' range where the growing season is already relatively short. Increased frequency and severity of flooding and fires would also be detrimental to snails and their habitats.

Based on an analysis of main threats at each occupied site, there are 16 recent locations for the Threaded Vertigo, applying the COSEWIC definition based on threats to define location (Table 1). Historical distribution records were excluded from the analysis. The number of locations is somewhat arbitrary, because landownership, zoning, habitat fragmentation, and a myriad of other factors affect the geographic scope and immediacy of threats to this species including development, land clearing, edge effects, and fire. The following locations were identified: one location on Saturna Island; four locations on the Sunshine Coast; and 11 locations on Vancouver Island within the Capital Regional District and on the east coast north of this area. The records for the species are mostly widely spaced point records from areas that are usually under different land ownership and different immediacy of threats. Supported by the patchy distribution and apparently low dispersal capability of the species, most of these points are considered a separate location. A notable exception is the cluster of records from southwest of Victoria, which was divided into three locations, based on land ownership, habitat fragmentation, habitat type, and potential threats.

SPECIAL SIGNIFICANCE OF THE SPECIES

The Threaded Vertigo is of no known socio-economic or cultural significance, and no Aboriginal traditional knowledge is available. In fact, few people apart from malacologists and dedicated naturalists are even aware of the existence of these minute snails. These snails contribute to the biodiversity of the rich, extraordinary arboreal communities supported by large Bigleaf Maples. These communities include abundant epiphytic mosses, liverworts, lichens, ferns, and other vascular plants that grow on the branches and boles of old maples (Peterson *et al.* 1999). These communities are particularly well developed in moist riparian areas, inhabited by the snails. Some epiphytic bryophyte communities associated with Bigleaf Maples are unique and contribute significantly to British Columbia's biodiversity (Peterson *et al.* 1999). Epiphytes, in turn, enhance conditions for other organisms, ranging from fungi and minute invertebrates to birds and mammals. These communities are poorly understood, and the ecological roles and services of the different components, including the Threaded Vertigo, are yet to be elucidated.

Table 1. Threats for sites with records of the Threaded Vertigo and the assignment of the sites to COSEWIC locations.

| Geographic area | Site ¹ ID # (land status) | Threat (in order of priority) | Location # |
|---|--|---|------------|
| Vancouver Island: east-central coast | 1 (private) | <ul style="list-style-type: none"> • Logging • Development • Intensive wildfire | 1 |
| Vancouver Island: east-central coast | 1 (private) | <ul style="list-style-type: none"> • Logging • Development • Intensive wildfire | 1 |
| Vancouver Island: east-central coast | 2 (provincial park) | <ul style="list-style-type: none"> • Recreational activities • Conversion to conifers through succession | 2 |
| Vancouver Island: east-central coast | 3 (provincial park) | <ul style="list-style-type: none"> • Recreational activities • Conversion to conifers through succession | 3 |
| Vancouver Island: southeast coast | 1 (private) | <ul style="list-style-type: none"> • Logging • Development • Recreational activities | 4 |
| Vancouver Island: CRD ² (North Saanich) | 1 (provincial park) | <ul style="list-style-type: none"> • Conversion to conifers through succession • Recreational activities • Intensive wildfire | 5 |
| Vancouver Island: CRD (Saanich) | 2 (federal) | <ul style="list-style-type: none"> • Military training activities • Conversion to conifers through succession | 6 |
| Vancouver Island: CRD (Highlands) | 3 (regional park) | <ul style="list-style-type: none"> • Recreational activities • Conversion to conifers through succession | 7 |
| Vancouver Island: CRD (Metchosin) | 4 (regional park) | <ul style="list-style-type: none"> • Intensive wildfire • Recreational activities • Invasive species • Severe weather or stochastic events (small, isolated population) • Intensive wildfire | 8 |
| Vancouver Island: CRD (Metchosin) | 5 (federal) | <ul style="list-style-type: none"> • Military training activities • Conversion to conifers through succession | 9 |
| Vancouver Island: CRD (Metchosin) | 6 (right-of-way of regional trail surrounded by private lands) | <ul style="list-style-type: none"> • Recreational activities • Development • Invasive species • Edge effects • Intensive wildfire | 10 |
| Vancouver Island: CRD (Sooke) | 7 right-of-way of regional trail surrounded by private lands) | <ul style="list-style-type: none"> • Development • Recreational activities • Invasive species • Intensive wildfire | 11 |
| Saturna Island | 1 (national park) | <ul style="list-style-type: none"> • Recreational activities • Conversion to conifers through succession • Intensive wildfire | 12 |
| Sunshine Coast: SE of Sechelt | 1 (provincial Park) | <ul style="list-style-type: none"> • Recreational activities • Conversion to conifers through succession • Invasive species • Intensive wildfire | 13 |

¹ Site – single distribution record or cluster of records

² CRD – Capital Regional District (Victoria).

| Geographic area | Site ¹ ID # (land status) | Threat (in order of priority) | Location # |
|-----------------------------------|---|--|------------|
| Sunshine Coast: Sechelt Peninsula | 2 (private) | <ul style="list-style-type: none"> • Development • Logging • Recreational activities • Conversion to conifers through succession • Invasive species • Edge effects • Severe weather or stochastic events (small, isolated population) • Intensive wildfire | 14 |
| Sunshine Coast: Sechelt Peninsula | 3 (private) | <ul style="list-style-type: none"> • Development • Intensive wildfire | 15 |
| Sunshine Coast: Sechelt Peninsula | 4 (private at edge of B.C. crown land) | <ul style="list-style-type: none"> • Recreational activities • Development • Edge effects • Intensive wildfire | 16 |

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The Threaded Vertigo was designated Special Concern by COSEWIC in April 2010. The species is on the provincial red list of species at risk. NatureServe (2009) lists the species as “apparently secure” globally (G3G5; rounded status G4) with national status in the United States also “apparently secure” (N3N5) but “imperilled” in Canada (N2) and British Columbia (S2). No other sub-national rankings for the United States are available from NatureServe, which last assessed the species on 30 January 2006.

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The following required contacts were consulted:

David Cunnington (Canadian Wildlife Service)
Brian Reader and Todd Columbia (Parks Canada)
Jennifer Heron (B.C. Ministry of Environment)
Lea Gelling (B.C. Conservation Data Centre)
Erin Prescott (B.C. Conservation Data Centre)
Gloria Goulet (COSEWIC Secretariat – ATK Coordinator)
Alain Filion (COSEWIC Secretariat – mapping support)

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Kristiina Ovaska, Ph.D., M.Sc., received her doctoral degree in biology from the University of Victoria in 1987, after which she completed two post-doctoral studies in animal behaviour and population biology. Presently, she is a partner in Biolinx Environmental Research Ltd. and a research associate at the Department of Forest

Sciences, University of British Columbia. Her experience with terrestrial gastropods includes research into effects of forestry practices, studies on patterns of abundance and distribution of species at risk, and numerous surveys in different parts of British Columbia. She has prepared status reports, recovery strategies, a multi-species action plan, and best management practices guidelines for terrestrial gastropods. Her photographs of gastropods appeared in the Royal B.C. Museum Handbook "Land Snails of British Columbia" by R. Forsyth. She is the author of more than 40 publications in the refereed scientific literature, including several papers on terrestrial gastropods.

Lennart Sopuck, M.Sc., RPBio, has studied a wide variety of wildlife species over the past 25 years. His expertise includes assessing and mitigating effects of various human activities on wildlife, including species at risk. Together with Dr. Ovaska, he is a partner of Biolinx Environmental Research Ltd. and has conducted numerous survey and research projects on terrestrial gastropods of British Columbia. He is co-author of several status reports, recovery strategies, a multi-species action plan, and management documents for terrestrial gastropod species.

COLLECTIONS EXAMINED

The following institutional collections were consulted. Only the Royal British Columbia Museum (one record) and the Field Museum of Natural History (three records) had specimens from British Columbia.

Canadian Museum of Nature, PO Box 3443, Stn. D, Ottawa, ON K1P 6P4

Carnegie Museum of Natural History, 4400 Forbes Ave, Pittsburgh, PA 15213-4080

Delaware Museum of Natural History, 4840 Kennett Pike, P.O. Box 3937, Wilmington, DE 19807-0937

The Field Museum of Natural History, 1400 S. Lake Shore Drive, Chicago, IL 60605-2496. Identifications verified by R. Forsyth.

Royal British Columbia Museum, 675 Belleville Street, Victoria, BC V8V 1X4. Identifications verified by R. Forsyth.

Royal Ontario Museum, 100 Queen's Park, Toronto, Ottawa, ON M5S 2G6

Appendix 1. Distribution records of the Threaded Vertigo, *Nearctula* species, from Canada. CDC EO# - B.C. Conservation Data Centre Element of Occurrence number; FMNH – Field Museum of Natural History; RBCM – Royal British Columbia Museum.

| Coll. date | No. of snails | Collector | Location description | Elev. (m) | Habitat (microhabitat) | Database, collection, or source |
|----------------|---------------|---|--|-----------|---|---|
| Undated | 6 | Unknown | Vancouver Island, BC: "Quamichan Lake, Duncan" | | | FMNH (52665) "Ex ROM Zoology" |
| Undated | 11 | Unknown | Vancouver Island, BC: "Victoria" | | | FMNH (132500) "Ex Alan Solem Collection" |
| Undated | 17 | Unknown | Vancouver Island, BC: "Wellington (Departure Bay)" | | | FMNH (132267) "Ex Alan Solem Collection" |
| 14-17 Aug-1984 | 5 | R.A.D. Cameron | Vancouver Island, BC: Lake Horne | | Second-growth mixed-wood forest with Bigleaf Maple; damp mull type litter; Sword Fern & Thimbleberry in understory (presumably within litter) | Cameron (1986) |
| 10-Nov-96 | 1 | R. Forsyth, T. Forsyth | Sechelt Peninsula, BC: near Egmont | | At side of the road on flattened shoulder; grass, Sword Ferns; a few Maiden-hair Ferns (on maple leaves on ground) | Robert Forsyth personal collection (96.159.4271); CDC EO #4 |
| 13-Nov-96 | 3 | T. Forsyth, R. Forsyth | Vancouver Island, BC: Union Bay | 80–100 | Alder, Fir and Salmonberry (on leaf litter on ground) | Robert Forsyth personal collection (96.167.4330); CDC EO #5 |
| 08-Nov-99 | 2 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck, S. Beauchesne) | Vancouver Island, BC: Chemainus Lake | 90 | Mature mixed-wood stand with Red Alder, Douglas-fir, Western Hemlock, and Western Redcedar; 80% canopy cover; sparse understory; moderately deep leaf/needle litter layer (within litter) | RBCM (000-00046-005; verified by R. Forsyth in 2000); Ovaska and Sopuck 2000; CDC EO #6 |

| Coll. date | No. of snails | Collector | Location description | Elev. (m) | Habitat (microhabitat) | Database, collection, or source |
|-------------------|----------------------|---|--|------------------|---|--|
| 30-Mar-02 | 4 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Vancouver Island, BC: Saanich (Maple transect 3) | 80–100 | Mixed-wood stand with large Bigleaf Maples (>60% canopy coverage) and Douglas-fir, Grand Fir, and Western Redcedar; understory with dense Sword Ferns (within maple leaf litter) | K. Ovaska personal collection (#S1); Ovaska & Sopuck 2002; CDC EO #3 |
| 25-Oct-02 | 1 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Vancouver Island, BC: Metchosin (Alder transect 1) | 30–35 | Mature Red Alder with a minor component of Bigleaf Maple, Douglas-fir, Grand Fir, and Cottonwood; understory of Sword Fern, Salmonberry, and Salal; sedges and Skunk Cabbage in wet areas (within litter) | K. Ovaska personal collection (#234); Ovaska & Sopuck 2002; CDC EO #1 |
| 25-Oct-02 | 1 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Vancouver Island, BC: Metchosin | 30–35 | Mature Red Alder with a minor component of Bigleaf Maple, Douglas-fir, Grand Fir, and Cottonwood; understory of Sword Fern, Salmonberry, and Salal; sedges and Skunk Cabbage in wet areas (on fern frond) | K. Ovaska personal collection (#119); Ovaska & Sopuck 2002; CDC EO #1 |
| 13-Nov-02 | 7 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck, L. Matthias) | Vancouver Island, BC: Metchosin (Maple transect 2) | 30–40 | Mixed-wood stand dominated by mature Bigleaf Maple, interspersed with Douglas-fir, Red Alder, Grand Fir, and Cottonwood; understory of Sword Fern, Salal, and Salmonberry (within litter (6 snails); on fern frond (1 snail)) | K. Ovaska personal collection (#2, #31, #122; 1 per sample); Ovaska & Sopuck 2002; CDC EO #2 |

| Coll. date | No. of snails | Collector | Location description | Elev. (m) | Habitat (microhabitat) | Database, collection, or source |
|-------------------|----------------------|---|---|------------------|--|--|
| 20-Nov-02 | 1 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | BC: Vancouver Island: Metchosin Maple transect 3) | 30–40 | Mixed-wood stand dominated by mature Bigleaf Maple; some Douglas-fir, Red Alder, Grand Fir, and Cottonwood present; understory of Sword Fern, Salal, and Salmonberry (within litter) | K. Ovaska personal collection (#1055); Ovaska & Sopuck 2002; CDC EO #1 |
| 13-Jun-08 | 3 | Robert Forsyth | Vancouver Island, BC: Metchosin | 37 | On Bigleaf Maple trunks, to 2 m above ground. Exposed, on bark, or in crevices; no moss or a thin network of moss | R. Forsyth, personal collection (08.052.1795) |
| 13-Jun-08 | 11 | Robert Forsyth | Vancouver Island, BC: Sooke | 20 | On Bigleaf Maple trunk, to 2 m above ground. Sunny side, no moss; snails exposed | R. Forsyth, personal collection (08.053.1798) |
| 13-Jun-08 | 5 | R. Forsyth, L. Ramsay, L. Gelling | Vancouver Island, BC: Metchosin | 27 | On Bigleaf Maple tree trunks; in crevices of bark and in moss, 1–2 m above the ground; in leaf litter | R. Forsyth, personal collection (08.048.1803) |
| 13-Oct-08 | 1 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Vancouver Island, BC: Thetis Lake Regional Park (Plot 2) | 80 | Woodland with Douglas-fir, Garry Oak, and Bigleaf Maple; dense shrub understory with Oregon Grape and Snowberry (under cardboard cover-object) | K. Ovaska, personal collection; Ovaska & Sopuck 2008 |
| 14-Oct-08 | 1 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Vancouver Island, BC Metchosin | < 50 | Moist depression with abundant Sword Fern and some Salal, surrounded by Douglas-fir (about 80 years old) and some alder/willow (under cardboard cover-object) | K. Ovaska, personal collection; Ovaska & Sopuck 2009 |

| Coll. date | No. of snails | Collector | Location description | Elev. (m) | Habitat (microhabitat) | Database, collection, or source |
|-------------------|----------------------|---|--|------------------|--|---|
| 15-Oct-08 | 9 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Vancouver Island, BC: Sooke | 82 | Forested trail right-of-way with Bigleaf Maple, Western Redcedar, Western Hemlock, and Douglas-fir; understory of ferns and some shrubs; very moist site (maple trunk, in grooves of bark (most snails) or on smooth bark (1 snail)) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |
| 19-Oct-08 | 6 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Sechelt Peninsula, BC: near Egmont | 87 | Second-growth stand with Western Redcedar, Western Hemlock, and large Bigleaf Maples; understory of Sword Fern and some shrubs (maple trunk, in crevices & under moss) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |
| 19-Oct-08 | 5 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Sunshine Coast, BC: SE of Sechelt | 123 | Old stand of mixed-wood forest with Western Redcedar, Western Hemlock, Douglas-fir, and scattered Bigleaf Maple; understory of Sword Fern and some shrubs (trunk of large maple with grooved bark) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |
| 19-Oct-08 | 7 | Biolinx Environmental Ovaska, L. Sopuck) | Sunshine Coast, BC: Skookumchuck Narrows | 110 | Riparian forest along small creek with Bigleaf Maple, Western Hemlock, and Western Redcedar; understory of ferns and some shrubs (maple trunk (2 snails); alder trunk (1 snail); fern (1 snail)) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |

| Coll. date | No. of snails | Collector | Location description | Elev. (m) | Habitat (microhabitat) | Database, collection, or source |
|-------------------|----------------------|---|--|------------------|---|---|
| 19-Oct-08 | 8 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Sunshine Coast, BC near Ruby Lake | 100 | Grove of large Bigleaf Maples in a depression within disturbed landscape (maple trunk, on bare bark or under moss) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |
| 25-Oct-08 | 13 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | BC: Vancouver Island: North Saanich | 160 | Mature forest with Douglas-fir, Bigleaf Maple, Western Redcedar, Red Alder, and Grand Fir; moist site with large maples (maple trunk, large tree with grooved bark) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |
| 26-Oct-08 | 10 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | BC: Vancouver Island: Metchosin | <50 | Riparian forest with large Bigleaf Maples, Douglas-fir, and Red Alder; dense understory of shrubs (maple trunk, in grooves of bark in one large tree) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |
| 28-Oct-08 | 12 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | BC: Vancouver Island: Metchosin | <50 | Riparian forest with large Bigleaf Maples, Cottonwoods, and Red Alders; dense understory of mostly Sword Fern; very moist site (maple trunk (7 snails); cottonwood trunk (3 snails); alder trunk (1 snail)) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |
| 03-Nov-08 | 15 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | BC, Vancouver Island: south of Courtenay | 36 | Riparian forest with Douglas-fir, abundant Bigleaf Maple, Western Hemlock, Western Redcedar, and Red Alder; moist, rich site (maple trunk; most snails in crevices or furrowed bark or under moss of large trees) | K. Ovaska, personal collection; Fieldwork associated with COSEWIC status report |

| Coll. date | No. of snails | Collector | Location description | Elev. (m) | Habitat (microhabitat) | Database, collection, or source |
|------------|---------------|---|--|-----------|---|---|
| 22-Nov-08 | 1 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Vancouver Island: Saanich | 80–100 | Older, mainly coniferous forest with Western Redcedar and Grand Fir; few scattered Bigleaf Maples; understory of Sword Fern (under cardboard cover-object) | K. Ovaska, personal collection; Ovaska & Sopuck 2009 |
| 20-Mar-09 | 12 | Biolinx Environmental Research Ltd. (K. Ovaska, L. Sopuck) | Saturna Island: Gulf Islands National Park Reserve | 10 | Trunks of large Bigleaf Maples in second-growth stand with Western Redcedar, Western Hemlock, and large Bigleaf Maples; understory of Sword Ferns, nettles and some shrubs (maple trunks) | Risk assessment for gastropods on the Winter Cove property of Gulf Islands National Park Reserve, March 2009 (Sopuck and Ovaska 2009) |

* Approximate location; no coordinates given; identification confirmed by R. Forsyth in 2002; collected from mid-1890s to early 1920s

^ Sites 27–28 for *Vertigo rowellii* in Cameron (1986). No coordinates given, but map indicates that both sites are at the western tip of Lake Horne.

Appendix 2. Sites where the Threaded Vertigo was not detected during field verification surveys associated with the preparation of this status report by Biolinx Environmental Research Ltd. Nine sites where the species was found are shown in Appendix 1.

| Date | Site description | Elev. (m) | Latitude North | Longitude West | Macrohabitat |
|-------------|--|------------------|-----------------------|-----------------------|---|
| 19-Jun-08 | BC, Vancouver Island: South end of Quamichan Lake (Kinsmen Park) | 30 | 48° 47.264' | 123° 40.279' | Riparian area with scattered Cottonwood and Bigleaf Maple; dense patches of shrub |
| 19-Jun-08 | BC, Vancouver Island: NE end of Quamichan Lake at Elkington Creek (at Osprey Place) | 90 | 48° 48.547' | 123° 37.455' | Strip of mixed-wood forest with Red Alder, Bigleaf Maple, and Douglas-fir amid residential development; dense understory of shrubs and herbs |
| 19-Jun-08 | BC, Vancouver Island: Departure Bay, Beach Estate Park (Nature Trail along Northfield Creek) | 40 | 49° 11.466' | 123° 57.960' | Remnant strip of forest along creek surrounded by residential areas; Western Redcedar and Bigleaf Maple dominant trees with variable understory |
| 19-Jun-08 | BC, Vancouver Island: Union Bay (woodlot off Green Road) | 100 | 49° 34.458' | 124° 53.949' | Selectively logged second-growth stand with Douglas-fir, Red Alder, and scattered Bigleaf Maple; dense shrub understory |
| 23-Oct-08 | BC, Vancouver Island: Fort Rodd National Heritage Site, Metchosin (CRD) | <50 | 48° 25.965' | 123° 27.264' | Mixed-wood forest with Douglas-fir, Grand Fir, Bigleaf Maple, and Arbutus; dense shrub understory |
| 03-Nov-08 | BC, Vancouver Island: Somenos Road, north of Duncan | 47 | 48° 50.930' | 123° 43.3841' | Moist riparian forest with Bigleaf Maple, Red Alder, Western Redcedar, and Grand Fir on steep slope; dense Sword Fern understory |
| 03-Nov-08 | BC, Vancouver Island: Englishman River Falls Provincial Park | 211 | 49° 14.864' | 124° 21.140' | Mostly coniferous forest with scattered Bigleaf Maples |
| 03-Nov-08 | BC, Vancouver Island: Fuller Lake | 65 | 48° 54.279' | 123° 43.300' | Mostly coniferous stand with scattered maples |