PROPOSED

Species at Risk Act
Management Plan Series
Adopted under Section 69 of SARA

Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in Canada

Warty Jumping-slug

2015

Government of Canada
Gouvernement du Canada

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For copies of the management plan, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the SAR Public Registry[1].

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

MANAGEMENT PLAN FOR THE WARTY JUMPING-SLUG (*Hemphillia glandulosa*) IN CANADA

2015

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

In the spirit of cooperation of the Accord, the Government of British Columbia has given permission to the Government of Canada to adopt the *Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in British Columbia* (Part 2) under section 69 of the *Species at Risk Act.* Environment Canada has included an addition which completes the SARA requirements for this management plan.

The federal management plan for the Warty Jumping-slug in Canada consists of two parts:

Part 1 - Federal Addition to the *Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in British Columbia*, prepared by Environment Canada.

Part 2 - *Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in British Columbia*, prepared by the Warty Jumping-slug Management Team for the British Columbia Ministry of Environment.

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Part 1 - Federal Addition to the *Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in British Columbia*, prepared by Environment Canada.

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress five years after the publication of the final document on the SAR Public Registry.

The Minister of the Environment and the Minister responsible for the Parks Canada Agency are the competent ministers under SARA for the Warty Jumping-slug and have prepared this management plan as per section 65 of SARA. To the extent possible it has been prepared in cooperation with British Columbia Ministry of Environment. SARA section 69 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for the content. The B.C. Ministry of Environment led the development of the attached management plan for the Warty Jumping-slug (Part 2) in cooperation with Environment Canada and the Parks Canada Agency.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Environment Canada, the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Warty Jumping-slug and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=En&n=6B319869-1%20

ADDITIONS AND MODIFICATIONS TO THE ADOPTED DOCUMENT

The following sections have been included to address specific requirements of SARA that are not addressed in the "Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in British Columbia" (Part 2, henceforth refered to as the provincial management plan) and/or to provide updated or additional information.

Under SARA, there are specific requirements and processes set out regarding the protection of species and their habitats. Therefore, statements in the provincial management plan referring to protection of species and their habitats may not directly correspond to federal requirements, and are not being adopted by Environment Canada or the Parks Canada Agency as part of the federal management plan.

1. COSEWIC* Species Assessment Information

This section replaces the "COSEWIC Species Assessment Information" (section 1) provided in the provincial management plan.

Warty Jumping-slug was re-assessed by COSEWIC in 2013:

Date of Assessment: May 2013

Common Name (population): Warty Jumping-slug

Scientific Name: *Hemphillia glandulosa*

COSEWIC Status: Special Concern

Reason for Designation:
This small slug has a restricted range and patchy distribution on Vancouver Island, where it exists at the northern extremity of its range. Habitat loss and fragmentation, mainly from forestry activities, disturb the shady, moist forest floor conditions and coarse woody debris required by the slugs and may be restricting dispersal movements. Residential and recreational developments are emerging as a new threat on the southwest coast of the island. The low numbers of scattered populations render it vulnerable to both natural and human disturbances.

Canadian Occurrence: British Columbia

COSEWIC Status History: Designated Special Concern in May 2003. Status re-examined and confirmed in May 2013.

*COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

2. Species Status Information

This section replaces the "Species Status Information" (section 2) provided in the provincial management plan.

Legal Designation: SARA Schedule 1 (Special Concern) (2005)

Table 1. Conservation Status of Warty Jumping-slug (from NatureServe 2014, BC Conservation Data Center 2014, and BC Conservation Framework 2012).

Global (G) Rank*	National (N) Rank(s)	Sub-national (S) Rank(s)	COSEWIC Status	BC List	BC Conservation Framework**
G3G4	Canada (N2N3) United States (N3N4)	Canada: BC (S2S3) United States: Oregon (S3), Washington (S3)	Special Concern (2013)	Blue	Highest priority: Priority 2 under Goals 1,3

* Rank 1– critically imperiled; 2– imperiled; 3– vulnerable to extirpation or extinction; 4– apparently secure; 5– secure; H– possibly extirpated; SNR – status not ranked
** The three goals of the B.C. Conservation Framework are: 1. Contribute to global efforts for species and ecosystem conservation; 2. Prevent species and ecosystems from becoming at risk; 3. Maintain the diversity of native species and ecosystems

It is estimated that approximately 10 – 15% of the global range of this species is in Canada (K. Ovaska, Biolinx Environmental Research Ltd, pers. comm., 2013).

3. Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[3]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the Federal Sustainable Development Strategy's[4] (FSDS) goals and targets.

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

The provincial management plan for Warty Jumping-slug contains a section describing the effects of recovery activities on other species (i.e., Section 8). Environment Canada

[3] www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[4] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1

and the Parks Canada Agency adopt this section of the provincial management plan as the statement on effects of recovery activities on the environment and other species. The distribution of Warty Jumping-slug overlaps with that of several other federally-listed species at risk on south-eastern Vancouver Island. Negative impacts to other species at risk are not anticipated. Recovery planning activities for the Warty Jumping-slug will be implemented with consideration of all co-occurring species at risk, such that there are no negative impacts to these species or their habitats.

Some conservation measures for Warty Jumping-slug (e.g., inventory and monitoring, threat mitigation, habitat conservation, education, and research) may promote the conservation of other species at risk that overlap in distribution and rely on similar habitat attributes (i.e., moist forest habitats and riparian areas). The following species at risk are known to, or might, co-occur with the Warty Jumping-slug and are expected to benefit from proposed conservation measures:

- Dromedary Jumping-slug (*Hemphillia dromedarius*) (COSEWIC Threatened 2014): shows some overlap in habitat use with the Warty Jumping-slug; known to co-occur at one site.
- Blue-grey Taildropper (*Prophysaon coeruleum*) (COSEWIC Endangered 2006): known to co-occur with the Warty Jumping-slug at one site.
- Threaded Vertigo (*Nearctula* sp. 1) (COSEWIC Special Concern 2010): known to co-occur with the Warty Jumping-slug at one site.
- Phantom Orchid (*Cephalanthera austiniae*) (COSEWIC Threatened 2000)
- Coastal Wood Fern (*Dryopteris arguta*) (COSEWIC Special Concern 2001)
- Streambank Lupine (*Lupinus rivularis*) (COSEWIC Endangered 2002)

4. References

B.C. Conservation Data Centre. 2014. BC Species and Ecosystems Explorer. B.C. Ministry of Environment Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed July 10, 2014).

B.C. Conservation Framework. 2012. Conservation Framework Summary. B.C. Ministry of Environment. Victoria, B.C. Available: http://www.env.gov.bc.ca/conservationframework/ (accessed July 10, 2014).

COSEWIC. 2013. COSEWIC status appraisal summary on the Warty Jumping-slug *Hemphillia glandulosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 20 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm)

Natureserve. 2014. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, VA. U.S.A. Available http://explorer.natureserve.org. (accessed July 10, 2014).

Part 2 – *Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in British Columbia*, prepared by the Warty Jumping-slug Management Team for the British Columbia Ministry of Environment.

Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in British Columbia

Prepared by the Warty Jumping-slug Management Team

BRITISH COLUMBIA | Ministry of Environment

March 2012

About the British Columbia Management Plan Series

This series presents the management plans that are prepared as advice to the Province of British Columbia. Management plans are prepared in accordance with the priorities and management actions assigned under the British Columbia Conservation Framework. The Province prepares management plans for species that may be at risk of becoming endangered or threatened due to sensitivity to human activities or natural events, or species where management is required to meet population targets for ecosystem management, human uses, or ecological services.

What is a management plan?

A management plan identifies a set of coordinated conservation activities and land use measures needed to ensure, at a minimum, that the target species does not become threatened or endangered or is being managed for use, ecosystem goals, or ecological services. A management plan summarizes the best available science-based information on biology and threats to inform the development of a management framework. Management plans set goals and objectives, and recommend approaches appropriate for species or ecosystem conservation.

What's next?

Direction set in the management plan provides valuable information on threats and direction on conservation measures that may be used by individuals, communities, land users, conservationists, academics, and governments interested in species and ecosystem conservation.

For more information

To learn more about species at risk recovery planning in British Columbia, please visit the Ministry of Environment Recovery Planning webpage at:
<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

Management Plan for the Warty Jumping-slug (*Hemphillia glandulosa*) in British Columbia

Prepared by the Warty Jumping-slug Management Team

March 2012

Recommended citation

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Kristiina Ovaska, Biolinx Environmental Research Ltd., Sidney, BC

Additional copies

Additional copies can be downloaded from the B.C. Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

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Disclaimer

This management plan has been prepared by the Warty Jumping-slug Recovery Team, as advice to the responsible jurisdictions and organizations that may be involved in managing the species.

This document identifies the management actions that are deemed necessary, based on the best available scientific and traditional information, to prevent Warty Jumping-slug populations in British Columbia from becoming endangered or threatened. Management actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and management approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions and all members of the management team have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals on the management team.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this management plan. The B.C. Ministry of Environment encourages all British Columbians to participate in the conservation of Warty Jumping-slug.

MANAGEMENT TEAM MEMBERS

Trudy Chatwin, B.C. Ministry of Forests, Lands and Natural Resource Management
John Deal, Western Forest Products, Campbell River, BC
Jennifer Heron (Chair), B.C. Ministry of Environment, Vancouver, BC
Suzie Lavallee, University of British Columbia, Vancouver, BC
Steve Pratt, BC Parks, Black Creek, BC
Tory Stevens, BC Parks, Victoria, BC
Ross Vennesland, Parks Canada Agency, Vancouver, BC

RESPONSIBLE JURISDICTIONS

The British Columbia Ministry of Environment is responsible for producing a management plan for Warty Jumping-slug under the *Accord for the Protection of Species at Risk in Canada*. This document was prepared in cooperation with Environment Canada's Canadian Wildlife Service and Parks Canada Agency.

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Jennifer Heron wrote the draft management plan and completed subsequent edits based on recovery team input. Additional information and review were provided by Ross Vennesland (Parks Canada, Vancouver), Arthur Robinson (Canadian Forest Service, Victoria), Geoff Scudder (University of British Columbia, Vancouver), Jessica Hellmann (University of Notre Dame, Indiana), Bill Woodhouse (BC Parks, Black Creek), Mike Rody (BC Parks, Black Creek), Kristiina Ovaska (Biolinx Environmental Research Ltd.), Lennart Sopuck (Biolinx Environmental Research Ltd.) and Marilyn Fuchs (Capital Regional District, Victoria) and Jeff Brown (B.C. Ministry of Environment). Thank you to Kristina Ovaska for photographs. Leah Westereng (B.C. Ministry of Environment) completed the editorial and technical review and was instrumental in moving the document forward. This document follows the B.C. guidance for recovery planning (Ministry of Environment 2010a).

EXECUTIVE SUMMARY

Warty Jumping-slug (*Hemphillia glandulosa*) is a small (adults approximately 2 cm long), forest-dwelling slug ranging in North America from southern British Columbia (B.C.) through western Washington to Oregon. In Canada, the species occurs at the northern limits of its range on southern Vancouver Island, with a range extent estimated at 4700 km^2. Historical and recent distribution records exist from 18 locations, all on southern Vancouver Island, south of Alberni Inlet.

Warty Jumping-slug is designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) due to its small range, scattered populations, and habitat loss and fragmentation primarily due to forestry activities. It is listed as Special Concern in Canada on Schedule 1 of the *Species at Risk Act* (SARA). In B.C., Warty Jumping-slug is ranked S2S3 (imperiled to vulnerable) by the Conservation Data Centre and is on the provincial Blue list. The B.C. Conservation Framework ranks the Warty Jumping-slug as a priority 2 under goals 1 (contribute to global efforts for species and ecosystem conservation) and 3 (maintain the diversity of native species and ecosystems).

Warty Jumping-slug inhabits a wide range of moist forest types, inhabiting old-growth western redcedar and western hemlock stands to second-growth mixedwood stands. The species is often associated with riparian vegetation. Key microhabitat features include moist forest floor conditions, abundant coarse woody debris, a deep litter or moss layer that holds moisture, and shade provided by the forest canopy. The predominant threat to Warty Jumping-slug is logging (IUCN-CMP #5 Biological resource use).

The population and distribution goal is to ensure the persistence of Warty Jumping-slug at all known (and newly recorded) locations throughout the species' range in Canada. The management objectives for Warty Jumping-slug are to (1) to ensure protection[1] for the known locations (and new locations) and habitats of Warty Jumping-slug; (2) to assess and mitigate the extent of current threats (IUCN-CMP Threats 1, 4, 5, 6, 7, 8, 9) at all locations in B.C.; and (3) to address knowledge gaps (e.g., habitat requirements, range extent within Vancouver Island) for Warty Jumping-slug.

[1] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

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1 COSEWIC* Species Assessment Information

Date of Assessment: April 2003
Common Name (population): Warty Jumping-slug
Scientific Name: *Hemphillia glandulosa*
COSEWIC Status: Special Concern
Reason for Designation: Habitat loss and fragmentation through clear cut logging forest practices are altering quantity and quality of coarse woody debris that provides refuges for the slugs and may be restricting dispersal movements. The species exists at the northern extremity of its range on southern Vancouver Island and the low numbers of scattered populations render it vulnerable to both natural and human disturbances.
Canadian Occurrence: British Columbia
COSEWIC Status History: Designated Special Concern in April 2003. Assessment based on a new status report.

* Committee on the Status of Endangered Wildlife in Canada.

** Common and scientific names reported in this recovery strategy follow the naming conventions of the B.C. Conservation Data Centre, which may be different from names reported by COSEWIC.

2 Species Status Information

Warty Jumping-slug[a]		
Legal Designation:		
Identified Wildlife:[b] No	B.C. *Wildlife Act:*[c] No	SARA Schedule: 1– Special Concern (2005)
Conservation Status[d]		
B.C. List: Yellow	B.C. Rank: S2S3 (2008)	National Rank: N2N3 (2005) Global Rank: G3G4 (2005)
Other Subnational Ranks:[e] Oregon : S2; Washington : S3		
B.C. Conservation Framework (CF)[f]		
Goal 1: Contribute to global efforts for species and ecosystem conservation.		Priority:[g] 2 (2009)
Goal 2: Prevent species and ecosystems from becoming at risk.		Priority: 6(2009)
Goal 3: Maintain the diversity of native species and ecosystems.		Priority: 2 (2009)
CF Action Groups:	Compile Status Report; Monitor Trends; Planning; Send to COSEWIC; Habitat Protection; Habitat Restoration; Private Land Stewardship	

[a] Data source: B.C. Conservation Data Centre (2011) unless otherwise noted.
[b] Identified Wildlife under the *Forest and Range Practices Act*, which includes the categories of species at risk, ungulates, and regionally important wildlife (Province of British Columbia 2002).
[c] Designated as wildlife under the B.C. *Wildlife Act* ,which offers it protection from direct persecution and mortality (Province of British Columbia 1982).
[d] S = subnational; N = national; G = global; B = breeding; X = presumed extirpated; H = possibly extirpated; 1 = critically imperiled; 2 = imperiled; 3 = special concern, vulnerable to extirpation or extinction; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure; NA = not applicable; NR = unranked; U = unrankable. U.S. data from NatureServe (2010).
[e] Data source: NatureServe (2010).
[f] Data source: Ministry of Environment (2010b).
[g] Six-level scale: Priority 1 (highest priority) through to Priority 6 (lowest priority).

3 species Information

3.1 Species Description

Warty Jumping-slug (*Hemphillia glandulosa* Bland & W.G. Binney 1875) is a small slug, reaching approximately 20 mm in length as an adult. Characteristic features of jumping-slugs include a prominent, elevated dorsal hump covered by the mantle and a slit in the mantle, exposing a portion of a yellowish or horn-coloured shell plate (COSEWIC 2003). Features that distinguish Warty Jumping-slug from the sympatric Dromedary Jumping-slug include its smaller size, shorter tail, and mantle covered with distinct conical papillae (Figures 1 and 2). Refer to the British Columbia (B.C.) gastropod field guide (Forsyth 2004) and the COSEWIC (2003) status report for further morphological descriptions.

Warty Jumping-slug is one of seven described species of jumping-slugs endemic to western North America (family Arionidae: genus *Hemphillia*) (Turgeon *et al.* 1998). No subspecies of Warty Jumping-slug have been recognized, but recent molecular studies have revealed much genetic fragmentation among populations from different geographic areas, suggesting the nominal species *H. glandulosa* may represent a complex of sister species (Wilke 2004).

Figure 1. Warty Jumping-slug (Carmanah Valley, Vancouver Island, 2000). Photo K. Ovaska.

Figure 2. Warty Jumping-slug (Mount Brenton, Vancouver Island, 2001). Photo K.Ovaska.

3.2 Populations and Distribution

The global distribution of Warty Jumping-slug extends from central Vancouver Island, B.C., southward west of the Cascade Mountains through Washington to west-central Oregon (Figure 3). About 10% of the global distribution is within Canada.

Figure 3. North American distribution of Warty Jumping-slug (COSEWIC 2003).

In Canada, Warty Jumping-slug is known from the southern third of Vancouver Island (Figure 4). The estimated extent of occurrence in B.C. is approximately 4700 km^2, but the area of occupancy is a small fraction of this range (about 20–100 km^2) although it cannot accurately be estimated at this time. As of September 2011, there are 16 extant locations[2], most of which are on the west coast of Vancouver Island, from Barclay Sound south to Sooke Inlet (Table 1). Two locations on the east coast of Vancouver Island (Cowichan River and Nanaimo Lakes) are considered historic locations and because of lack of specific information pertaining to the exact spatial location, continued presence at these two locations is difficult to determine. No records exist from mainland B.C. (B.C. Conservation Data Centre 2011).

[2] Distribution records more than 5 km apart, in different habitats (such as along an elevational gradient and more than 1 km apart), or separated by insurmountable barriers were considered distinct locations.

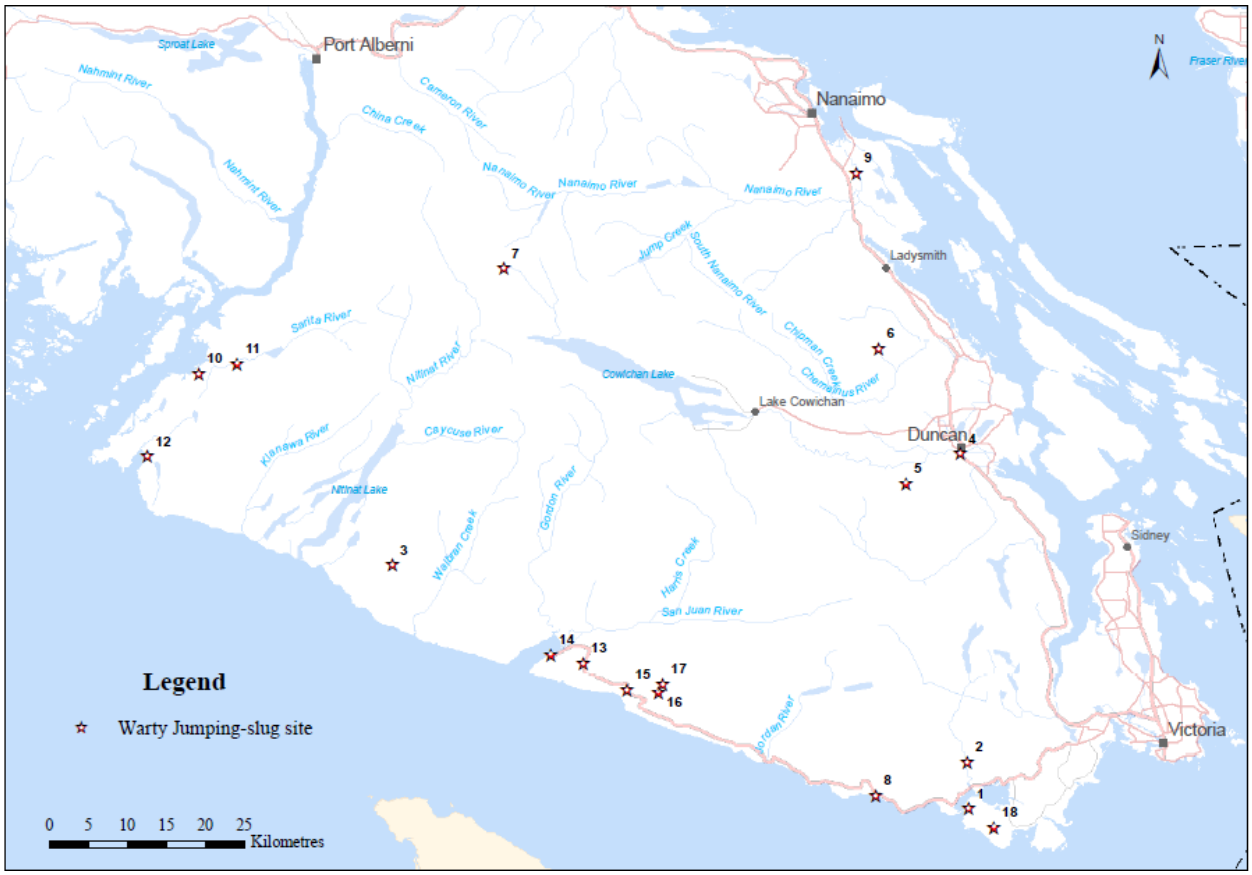

Figure 4. Warty Jumping-slug locations in British Columbia (broken line: Canada-U.S. border) (B.C. Ministry of Environment 2011).

Warty Jumping-slug has a scattered distribution pattern both on Vancouver Island (B.C. Conservation Data Centre 2011) and in the United States (Kelley *et al.* 1999). In the interior and east coast of Vancouver Island, the species is known from only a few isolated locations. However, in the very moist forests of the west coast, its distribution appears to be more continuous, but logging has fragmented habitats in many areas (Table 1). Much of the potential habitat within the range of the Warty Jumping-slug has not been surveyed, and other locations probably exist on the island. The area of occupancy or available habitat cannot be estimated accurately for any of the locations at present.

Table 1. Status and description of Warty Jumping-slug locations in B.C. (B.C. Conservation Data Centre 2011)

Location Number (Figure 4)	Location Name	Locality or Latitude (N) Longitude (W)	Most Recent Observation Date	Land Status
1	Anderson Cove, East Sooke Regional Park	48°21.68' 123°39.64' 48°21.50' 123°39.73'	2003	Private (CRD) [a]
2	Galloping Goose Regional Trail (Sooke)	48°24.91' 123°42.33'	2006	Private (CRD)
3	Carmanah Walbran Provincial Park	48°39.6´ 124°41.6´ 48°39.4´ 124°42.2´	2000	B.C. Crown (Carmanah Walbran Provincial Park)
4	Cowichan River	48°46.3´ 123°42´	Historic Before 1913?	Private?
5	Keating Lake (SW of Duncan)	48°44.4´ 123°47.8´	2001	Private forestry
6	Mount Brenton, Holyoak Lake	48°53.78´ 123°50.21´	2001	Private forestry
7	Mount Hooper (Unnamed lake, Mt. Hooper, ca. 20 km NW of Youbou)	48°59.99´ 124°29.32´	2001	Private forestry
8	Muir Creek (Hwy. 14, ca. 5 km E Shirley)	48°22.81´ 123°51.94´ 48°22.90 123°52.08'	2001 2003	Private Private forestry
9	Nanaimo River	Unknown (~ 4.8 km from mouth of Nanaimo River)[b]	Historic Oct. 1900	Private
10	North of Sarita	48°53.05´ 125°01.5´	2001	B.C. Crown
11	Sarita (S of Mt. Blenheim)	48°53.75´ 124°57.47´	1984	Crown
12	Pachena Bay	48°47.4´ 125°07.0´ 48°45.7´ 125°07.4´	1984[c]	Federal (Pacific Rim National Park Reserve)
13	Parkinson Creek (Parkinson Creek Rd. at Hwy. 14)	48°32.53´ 124°21.94´	2000	B.C. Crown
14	Port Renfrew, Snuggery Cove	48°33.17´ 124°25.29´ 48°33.17´ 124°25.29´	1998 2001	Private

	(Cerantes Rd.)			
15	Sombrio River, Sombria Creek (Branch of Sombrio River Hwy. 14, ca. 11 km SE of Port Renfrew)	48°30.6´ 124°17.44´ 48°30.89' 124°17.22'	2001 2006	B.C. Crown
16	North Noyse Creek (tributary of Loss Creek, east of Hwy 14)	48°30.39' 124°14.19'	2006	B.C. Crown
17	South Noyse Creek (tributary of Loss Creek, east of Hwy. 14)	48°30.90' 124°13.71'	2006	B.C. Crown
18	East Sooke Regional Park, Park Heights	48° 28' 42.037" 123° 27' 55.851"	2011	Private (CRD)

[a]CRD = Capital Regional District.
[b] Based on maps and descriptions of sites from R. Cameron (based on pers. comm. by R. Forsyth 2001). Approximate location.
[b] Warty Jumping-slug was recorded from Pachena Bay in1984, however no Warty Jumping-slugs have been recorded during recent slug surveys within Pacific Rim National Park Reserve (see Appendix 1).

No population information is available for the Warty Jumping-slug. At locations where the species is recorded on Vancouver Island the average was 2.6 slugs found per 1 person-hour of searching (B.C. Conservation Data Centre 2011; see Appendix 1). Relatively high apparent densities occurred at the Muir Creek location (up to 15 slugs per 30 minutes of searching) when compared to the other locations where 1–7 slugs were found during searches of up to 3 person-hours. At occupied locations, the distribution of the slugs is often clustered within small areas, possibly reflecting availability of suitable microhabitats.

3.3 Needs of the Warty Jumping-slug

3.3.1 Habitat and Biological Needs

Warty Jumping-slug is an inhabitant of moist coniferous and mixedwood forests ranging in elevation from near sea level to about 1060 m on Vancouver Island. Most of the low-elevation locations are on the wet, west coast of the island. Forest age ranges from old growth (> 200 years) to naturally regenerated second-growth stands. The species has been found in remnant patches of old growth on the west coast and on mountaintops in the interior of the island (Ovaska *et al.* 2001; Ovaska and Sopuck 2004, 2006b). The species is often associated with riparian areas or other moist locations (COSEWIC 2003). Where suitable moist conditions are present, the slug can occupy young seral stages but is more often found in stands at least 60 years old. At one location, the species was found in a recently logged area, buried deep within

decaying wood substrate in a moist depression (Keating Lake location [Table 1]; Ovaska and Sopuck 2001) but whether Warty Jumping-slug can persist in newly logged areas is unknown.

Forest stands occupied by Warty Jumping-slug are often dominated by western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*), with a minor component of amabilis fir (*Abies amabilis*) or deciduous trees, such as red alder (*Alnus rubus*) or bigleaf maple (*Acer macrophyllum*) at lower elevations (Ovaska *et al.* 2001; COSEWIC 2003; Ovaska and Sopuck 2004, 2006b). The higher density Muir Creek location is a moist riparian forest dominated by red alder. Understory vegetation includes sword fern (*Polystichum munitum*), deer fern (*Blechnum spicant*), huckleberry species (*Vaccinium* spp.), and salmonberry (*Rubus spectabilis*). Moisture-favouring plants, such as devil's club (*Oplopanax horridus*), Indian hellebore (*Veratrum viride*), and skunk cabbage (*Lysichitum americanum*), are present at some locations. The soils are typically moist and productive, and abundant coarse woody debris is present. Warty Jumping-slug often recorded sheltering under decayed logs and sloughed-off bark but can also be found within moist leaf litter (K. Ovaska pers. comm. 2008; L. Sopuck pers. comm. 2008). Figures 5 and 6 show examples of the range of habitats where the species has been found. Detailed ecosystem descriptions need to be completed for all occupied locations.

Both suitable forest structure and microhabitat conditions are essential for population persistence of Warty Jumping-slug over the long term. Key habitat features include moist forest floor conditions, abundant coarse woody debris, deep litter or moss layer that holds moisture, and shade provided by the forest canopy. Coarse woody debris at variable states of decay provides shelter, egg-laying sites, and a source of moisture for slugs. Across the landscape, suitable habitats must be connected to facilitate colonization of new habitats, repopulation of habitat patches from which the species might have disappeared, and genetic exchange that maintains variability and ability of populations to adapt to changing conditions. The dispersal ability of the Warty Jumping-slug is thought to be poor and is probably hindered by open habitats that do not maintain high humidity and moisture. Such habitats include recently logged areas and other disturbed habitats, especially at drier locations and within the heavily fragmented low-elevation coniferous forests of southern Vancouver Island.

Figure 5. A remnant patch of western redcedar and western hemlock old-growth forest at Noyse Creek North, outside of Port Renfrew. Photo credit K. Ovaska.
This remnant patch was surrounded by recently harvested cutblocks. Five Warty Jumping-slugs were found within 2-person hours of intensive search. Several small creeks and pools of water were present in the patch. The forest floor was moist and contained abundant, layered coarse woody debris including large-diameter decaying logs.

Figure 6. Moist second-growth habitat with red alder and bigleaf maple near East Sooke; Anderson Cove location. Note dense understory of sword fern. Photo credit K. Ovaska.

3.3.2 Ecological Role

Warty Jumping-slug plays an ecological role[3] as a decomposer, soil builder, consumer of live and decaying plant matter; and as prey for various vertebrate and invertebrate predators. Gastropods in general contribute to the turnover of organic matter and decomposition processes on the forest floor (Mason 1970; Richter 1979). Some species also disperse seeds of forest plants and fungal spores, including fungi that form important symbiotic associations with tree roots (Richter 1980; Gervais *et al.* 1998; McGraw *et al.* 2002). Ecological interactions of Warty Jumping-slug have not been studied but it is likely the species plays similar roles. The slug has been observed feeding on fungi and may be important dispersal agents for their spores (Ovaska and Sopuck 2006b). Slugs form important prey for various predators including ground beetles, amphibians, reptiles, birds, and small mammals. Populations at the northern extremity of a species' distribution may possess unique ecological adaptations and provide a reservoir of genetic variability that allows the species to respond to changing environmental conditions. The Warty Jumping-slug is an important contributor to the forest floor biodiversity in temperate rainforests of the west coast.

3.3.3 Limiting Factors

Dispersal ability: The dispersal ability of Warty Jumping-slug is likely poor, and it is unclear how much spatial area (habitat) is required to sustain a population within a location. The heavily fragmented coniferous forests of southern Vancouver Island may limit natural dispersal. By their very nature, slugs are sedentary and cryptic animals, and their natural ability to colonize new areas is likely poor.

Low density and low reproductive potential: Warty Jumping-slug may be nocturnal. By evidence of low detection during surveys (see Ovaska *et al.* 2001; Ovaska and Sopuck 2002b, 2004b, 2006c; Ovaska and Sopuck 2009a; Ovaska and Sopuck 2011) the slug appears secretive, occurs at low densities, and thus presumably has low reproductive potential even within optimal habitats.

Northernmost extent of global range: Warty Jumping-slug is at the northernmost extent of its global range, which likely increases the species' susceptibility to climatic and stochastic population fluctuations.

Requirement for high air moisture environments: Warty Jumping-slug is an associate of coniferous and mixedwood forests, with well-developed and thick understory vegetation that provides the moist microhabitat necessary to maintain high humidity. The slug has a scattered distribution pattern throughout its range, likely due to the isolation of suitable habitat patches and poor dispersal capabilities.

Susceptibility to dehydration: Slugs are known to initiate "water seeking" responses to dehydration after a short-term reduction in locomotor activity (Prior 1985). The physiology and activity patterns of Warty Jumping-slug inherently make them susceptible to continuous water

[3] E.g., Warty Jumping-slug contributes to the natural capital, or ecosystem goods and services.

loss through dehydration. All slugs deposit a dilute mucous trail, and experience constant evaporative water loss through the lung surface and integument. Numerous ecological and physiological studies show a relationship between varying body temperature hydration on locomotor activity (Machin 1975; Peake 1978; Burton 1983; Riddle 1983; Martin 1983 as cited in Prior 1985). Within two hours, active slugs can lose 30–40% of their initial body weight and habitat selection by slugs is correlated with water availability (Prior 1985). Although this information pertains to other slug species, it is likely similar for Warty Jumping-slug.

4 THREATS

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community or ecosystem) in the area of interest (globe, nation, or subnation). For purposes of threat assessment, only present and future threats are considered[4]. Threats presented here do not include biological features of the species or population such as inbreeding depression, small population size, and genetic isolation; or likelihood of regeneration or recolonization for ecosystems, which are considered limiting factors[5].

For the most part, threats are related to human activities, but they can be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., invasive species introduction). Effects of natural phenomena (e.g., fire, hurricane, flooding) may be especially important when the species or ecosystem is concentrated in one location or has few occurrences, which may be a result of human activity (Master *et al.* 2009). As such, natural phenomena are included in the definition of a threat, though should be applied cautiously. These stochastic events should only be considered a threat if a species or habitat is damaged from other threats and has lost its resilience, and is thus vulnerable to the disturbance (Salafsky *et al.* 2008) so that this type of event would have a disproportionately large effect on the population/ecosystem compared to the effect they would have had historically.

[4] Past threats may be recorded but are not used in the calculation of Threat Impact. Effects of past threats (if not continuing) are taken into consideration when determining long-term and/or short-term trend factors (Master *et al.* 2009).

[5] It is important to distinguish between limiting factors and threats. Limiting factors are generally not human induced and include characteristics that make the species or ecosystem less likely to respond to recovery/conservation efforts.

4.1 Threat Assessment

The threat classification below is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system and is consistent with methods used by the B.C. Conservation Data Centre and the B.C. Conservation Framework. For a detailed description of the threat classification system, see the CMP web location (CMP 2010). For information on how the values are assigned, see Master *et al.* (2009) and table footnotes for details. Threats for the Warty Jumping-slug were assessed for the entire province (Table 2).

Table 2. Threat classification table for Warty Jumping-slug

Threat		Impact	Scope	Severity	Timing	Locations
1	Residential & commercial development	Low	Small	Extreme	Moderate	
1.1	Housing & urban areas	Low	Small	Extreme	Moderate	• Unsurveyed habitat in the Nanaimo area south on Vancouver Island, and potentially parts of Sooke
1.2	Commercial & industrial areas	Low	Small	Extreme	Moderate	• Unsurveyed habitat in the Nanaimo area south on Vancouver Island, and potentially parts of Sooke
1.3	Tourism & recreation areas	Low	Small	Serious	Moderate	• East Sooke Regional Park (Anderson Cove) • Galloping Goose Trail (Sooke) • Pachena Bay • East Sooke Regional Park (Park Heights) • Carmanah Walbran Park • Unsurveyed habitat in the Nanaimo area south on Vancouver Island, and potentially parts of Sooke
2	Agriculture & aquaculture	Not Calculated	Small	Extreme	Low	
2.1	Annual & perennial non-timber crops	Not Calculated	Small	Extreme	Low	• Unsurveyed habitat
4	Transportation & service corridors	Low	Small	Serious	Moderate	
4.1	Roads & railroads	Low	Small	Serious	Moderate	• 13 locations (not considered a threat at the 2 locations in national and provincial parks). • Unsurveyed habitat

5	Biological resource use	High	Large	Serious	High	
5.3	Logging & wood harvesting	High	Large	Serious	High	• 11 locations (not considered a threat at the locations in national and provincial parks or at CRD locations) • Unsurveyed habitat
6	Human intrusions & disturbance	Low	Restricted	Moderate	High	
6.1	Recreational activities	Low	Restricted	Moderate	High	• East Sooke Regional Park (Anderson Cove) • Galloping Goose Trail (Sooke) • Pachena Bay • Carmanah Walbran Park • East Sooke Regional Park(Park Heights) • Unsurveyed habitat
7	Natural system modifications	Low	Small	Extreme	High	
7.1	Fire & fire suppression	Low	Small	Extreme	High	• All locations (although not widespread across all habitats at any one time) Unsurveyed habitat
8	Invasive & other problematic species & genes	Unknown	Large	Unknown	High	
8.1	Invasive non-native/alien species	Unknown	Large	Unknown	High	• Likely all locations
9	Pollution	Unknown	Small	Unknown	High	
9.3	Agricultural & forestry effluents	Unknown	Small	Unknown	High	• All locations. • Unsurveyed habitat
10	Geological Events	Not Calculated	Small	Extreme	Low	
10.2	Earthquakes/tsunamis	Not Calculated	Small	Extreme	Low	• 4 locations: Galloping Goose Trail (Sooke); Pachena Bay; East Sooke (Anderson Cove); East Sooke Regional Park (Park Heights)
11	Climate change & severe weather	Not Calculated	Pervasive	Unknown	Low	
11.2	Droughts	Not Calculated	Pervasive	Unknown	Low	• Impacts to 16 locations

[a] **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 stress 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 as it is only considered to be in the past (e.g., timing is insignificant/negligible or low); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **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%).

[c] **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 $\geq$ 0%).

[d] **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.

4.2 Description of Threats

The overall province-wide Threat Impact for this species is High.[6] The predominant threat to Warty Jumping-slug is logging (IUCN-CMP #5 Biological resource use). Threats are further discussed below under the Threat level 1 headings.

4.2.1 High Impact Threat

IUCN-CMP Threat 5.0 Biological Resource Use (5.3 Logging and wood harvesting)
The range of Warty Jumping-slug coincides with an area of B.C. that has an extensive logging history. Within the Canadian range of Warty Jumping-slug, less than 6% of the landbase remains in old-growth forests and remaining habitats are highly fragmented (MacKinnon and Eng 1995). This forest landbase continues to be intensively managed due to the high demand for forest products. Forest management practices, including pre-commercial thinning, pruning, removal of select tree species, fertilization practices, patch-size harvesting, and clearcut harvesting, likely have detrimental effects on populations of Warty Jumping-slug through changes to coarse woody debris and ground substrate availability, as well as changes to microhumidity and the moisture retention of such habitat.

Pre-commercial thinning and pruning practices reduce the quantity and/or alter the timing of leaf and branch litter that would otherwise fall to the forest floor and provide shelter for Warty Jumping-slug. Pruning activities that remove lateral branches reduce the overall forest canopy, which results in lower relative humidity and subsequent desiccation of the forest floor.

Survival of Warty Jumping-slug within a harvested and/or second-growth forest landscape may depend on the availability of old rotten logs within which the species can take cover and lay eggs. Present day intensive forest management practices may target large dead coarse woody debris for removal during the second rotation of forest harvesting. For example, a century ago Douglas-fir trees were a priority harvest species. Western redcedar trees were still cut, but often only Douglas-fir logs were removed and the large western redcedar logs remained behind. Some second-growth forests are now at harvest age, and consequently some large western redcedar logs, which were left on the forest floor after the first harvest rotation, can still be of merchantable value in present-day markets (e.g., for cedar shakes). Where such logs are still merchantable and are accessible, it is common practice (dependent on market conditions at the time) to remove these logs during or subsequent to the second harvest. Thus, large coarse woody debris may be in short supply in intensively managed forests; these logs are likely important for maintaining stable microclimates for developing eggs, and thus suitable microhabitat for Warty Jumping-slug.

The threat from logging practices is applicable to habitat surrounding the 11 locations: Noyse Creek North, Noyse Creek South, Parkinson Creek, Sarita, Sombrio River (Sombria Creek),

[6] The overall threat impact was calculated following Master *et al.* (2009) using the number of Level 1 Threats assigned to this species where Timing = High or Moderate. This includes 1 High, 5 Low, and 2 Unknown (Table 2).The overall threat considers the cumulative impacts of multiple threats.

Muir Creek (Shirley), Port Renfrew (Snuggery Cove), Keating Lake, Mount Brenton (Holyoak Lake), Mount Hooper, and Cowichan. The potential habitat surrounding each of these locations has not been surveyed and there are likely additional occurrences within these contiguous patches of habitat. Logging is not considered a threat in the national and provincial parks or at the two locations within the CRD.

4.2.1 Low or Unknown Impact Threats

IUCN-CMP Threat 1.0 Residential & commercial development
Loss of mature and old-growth forest habitats as a result of urbanization and other developments was identified as a main threat to Warty Jumping-slug (COSEWIC 2003). However, this threat was more predominant historically than it is at present. This threat is not applicable to known locations of Warty Jumping-slug, but there is likely some incremental and cumulative habitat loss from land conversion of low elevation private forestland within unsurveyed habitats (particularly from Nanaimo southwards towards Sooke), including areas for recreational opportunity, such as golf courses.

Construction of new recreational infrastructure may potentially impact five locations within parks and protected areas: East Sooke Regional Park (Anderson Cove); Galloping Goose Trail (Sooke); Pachena Bay; East Sooke Regional Park (Park Heights) and Carmanah Walbran. All four of these parks are popular and well-liked recreational areas, especially in summer, and increased demand for parking facilities, washroom facilities, and trails is concurrent with urban/commercial development.

IUCN-CMP Threat 2.0 Agriculture and aquaculture (2.1 Annual and perennial non-timber crops)
Loss of mature and old-growth forest habitats as a result of agricultural land conversion was identified as a threat to Warty Jumping-slug (COSEWIC 2003). However, this threat was more predominant historically than it is at present. This threat is not applicable to known locations of Warty Jumping-slug, but there is likely some incremental and cumulative habitat loss from agricultural land conversion in private low elevation forestland within unsurveyed habitats where Warty Jumping-slug could still be present.

IUCN-CMP Threat 4.0 Transportation and service corridors (4.1 Roads and railroads)
Within unsurveyed habitats, there is potential for road and highway expansion projects that include plans to divert, infill, and alter watercourses and clear riparian habitats where Warty Jumping-slug could occur. Transportation infrastructure projects that isolate habitat patches increase population isolation, decrease available habitat, and increase drought from edge effects and stand/wind penetration, which eventually leads to increased mortality and ecosystem changes through introduced species. This threat is potentially applicable to 13 locations, particularly where safety and access are important (e.g., regional parks) and logging roads (e.g., on both Crown and private forestland), as well as highways expansion projects (e.g., diverting watercourses and culverts that would prevent road flooding).

IUCN-CMP Threat 6.0 Human intrusions and disturbance (6.1 Recreational activities)
Intensive recreational activities such as hiking, foot and bicycle traffic, and use of all-terrain vehicles and trail bikes, especially off-trail (e.g., when coarse woody debris is used to build bike ramps and jumps) can result in soil compaction and alteration of plant cover. Even within protected areas, what would appear as low impact activities, such as hiking, and bicycle traffic can result in degradation of habitat quality through soil compaction and can also cause accidental mortality. Such effects can be pronounced in areas where the species is restricted to small habitat patches. Inadvertent trampling of the location could result in significant mortality, especially during the fall breeding period when the slugs are active on the forest floor. Further, popular hiking trails may eventually require additional management (e.g., for safety and access) and thus require the eventual use of herbicides or creation of infrastructure such as the addition of bark mulch or construction of wider trails.

This threat is applicable to at least five Warty Jumping-slug locations: Carmanah Walbran Provincial Park, Pachena Bay, East Sooke CRD Park (Anderson Cove), East Sooke Regional Park (Park Heights) and Galloping Goose Regional Trail (Sooke). However, at Carmanah Walbran Provincial Park the impact of this threat is likely minimal because of decreasing access and limited use within the park.

IUCN-CMP Threat 7.0 Natural system modifications (7.1 Fire and fire suppression)
Burke *et al*. (1999) cited fire as a threat to gastropod populations in Washington State. Coniferous forests on the eastern side of southern Vancouver Island are typically dry and much more susceptible to fire, particularly in July through September. Human activities that increase the threat of fire, including careless attendance to campfires, discarded cigarettes, and improperly wired camping equipment and machinery used within wilderness areas, contribute to the possibility of wildfires. Forests fires occur yearly at present, although efforts are made to control the frequency, size, and spread of fire through fire suppression programs. All Warty Jumping-slug locations are subject to fire suppression activities, although the type of activity varies depending on the region. Natural fires throughout the ecosystems of southern Vancouver Island would have occurred in higher frequency and severity historically. This is not considered a high threat at present, partially due to fire suppression programs.

IUCN-CMP Threat 8.0 Invasive and other problematic species and genes (8.1 Invasive non-native/alien species)
Introduced gastropods compose approximately one-third of gastropod species of B.C. (Forsyth 2004). Introduced gastropods likely compete with Warty Jumping-slug as consumers of similar food sources or prey upon the species. Many introduced gastropods occur in habitats throughout Vancouver Island (Forsyth 2004), are widespread within urban and agricultural landscapes in southwestern B.C., and can be locally abundant (Forsyth 1999). Although most introduced species are primarily in areas of high human use and alteration, some have spread into intact coniferous forest habitats and increased their range extent (K. Ovaska pers. comm. 2008).

Invasive gastropods found at Warty Jumping-slug locations include the Chocolate Arion (also called European Black Slug) (*Arion rufus*), Giant Gardenslug (*Limax maximus*), Grey Gardenslug (*Deroceras reticulatum*), and Garlic Snail (*Oxychilus alliarius*) (Ovaska *et al.* 2001; Ovaska and Sopuck 2004, 2006a, 2006b). Chocolate Arion and Giant Gardenslug may compete

with native forest-dwelling species for shelter and egg-laying locations. Giant Gardenslug is known to be an aggressive competitor (Rollo and Wellington 1979) with other gastropod species. Carnivorous gastropods, such as Longneck Fieldslug (*Deroceras panormitanum*) and Wormslug (*Boettgerilla vermiformis*), may also be of concern, although at present neither appears widely distributed within Vancouver Island forests (K. Ovaska pers. comm. 2007; L. Sopuck pers. comm. 2007). Within forests in Washington State, Chocolate Arion is documented from within old growth forests, and may be displacing native Banana Slug (*Ariolimax columbianus*) (Burke *et al*. 1999). The impact of this threat is unknown and needs additional research.

Invasive plant species are known to change the forest floor vegetation and soil structure and increase the light penetrating the understory vegetation to the forest floor. Increases in light levels lead to drier microclimate and understory conditions and result in desiccation of the forest floor and increase dehydration stress to Warty Jumping-slug and other species that depend upon high water and humidity levels. Introduced plant species, such as English ivy (*Hedera helix*), have the potential to spread and displace the native vegetation on forest floors. Native gastropods are not known to live within vegetation patches of English Ivy (Burke *et al*). English holly (*Ilex aquifolium*) and Himalayan blackberry (*Rubus discolor*) are also widely spread introduced plants within native ecosystems in coastal B.C., and are known to displace native vegetation. This threat needs additional research.

Roadsides act as corridors into natural habitats and are known to facilitate the rapid spread of introduced species (e.g., plant seeds attach to car tires, and become dislodged at new locations) (Trombulak and Frissell 2000).

The threat of invasive plants and invertebrates exist at all Warty Jumping-slug locations, although the level of impact is unknown.

IUCN-CMP Threat 9.0 Pollution (9.3 Agricultural and forestry effluents)

Herbicides are used in some locations to control roadside vegetation, both within private forestlands and on Crown lands. Both at present day and in the past, herbicides have been used along hiking trails, throughout recreational picnic areas within parks, and along road and railway corridors. For example, various herbicides have been tested to control two highly invasive plants, Scotch broom (*Cytisus scoparius*) and gorse (*Ulex europaeus*), along roadsides in the Duncan area on Vancouver Island (Zielke *et al.* 1992). Herbicides are used less today; however, it is unclear how extensive this practice was (or is currently), within the mature forest habitats where Warty Jumping-Slug is known to occur on southern Vancouver Island.

Baur and Baur (1990) have documented the use of roadsides by gastropods and concluded the Land Snail *Arianta arbustorum* prefers moving along road verges and avoids crossing roads, including unpaved roads of only 3 m wide (as cited in Trombulak and Frissell 2000). The related species, Dromedary Jumping-slug, has been observed along roadside verges (K. Ovaska pers. comm. 2007), as well as crossing a trail within Pacific Rim National Park Reserve (Ovaska and Sopuck 2003a; K. Ovaska pers. comm. 2007). It is possible Warty Jumping-slug also has similar dispersal behaviour, and may also inhabit trail and forest edges. Spraying herbicides to control roadside vegetation likely would harm gastropods within these roadside verges, and the

cumulative and lasting effects of herbicides within these environments may lead to long-term declines in gastropod numbers (although this has not been substantiated).

This threat is potentially applicable to all Warty Jumping-slug locations although further research and monitoring is needed to determine the effects of herbicides on Warty Jumping-slug and the overall impact of this threat.

IUCN-CMP Threat 10.0 Geological events (10.2 Earthquakes/tsunamis)
The low-elevation areas of greater Victoria are within the tsunami zone; should a natural disaster happen, extensive flooding would occur throughout much of this area and at least four known locations of Warty Jumping-slug would be wiped out: Galloping Goose Trail (Sooke), Pachena Bay, East Sooke Regional Park (Park Heights) and East Sooke (Anderson Cove).

IUCN-CMP Threat 11.0 Climate change and severe weather
Climate change is considered a potential, but poorly understood, threat to Warty Jumping-slug habitat. Climate change may increase possible drought and cause a shift in understory vegetation composition. Should climate become drier, forest floor conditions are likely to deteriorate microhabitat quality and have detrimental effects on survivorship of Warty Jumping-slug adults and their eggs. The loss of a suitable moisture regime would then increase the susceptibility of adults and eggs to desiccation. Indirect impacts could include the concentration of predators and competitors, including introduced species, into remaining moist areas.

5 MANAGEMENT GOAL AND OBJECTIVES

5.1 Population and Distribution Goal

The population and distribution goal is to ensure the persistence of Warty Jumping-slug at all known (and newly recorded) locations throughout the species' range in Canada.

5.2 Rationale for the Population and Distribution Goal

Warty Jumping-slug has a restricted range in Canada and apparently low densities at all known locations. The overall population and distribution goal aims to ensure no populations become extirpated in Canada. The species will likely always be considered "special concern" unless a significant number of new locations are found. Historical abundance and distribution information for this species is not available and limited to two historic museum records. Both of these records are from within the known range of the species, and both records are within a highly modified and impacted area (e.g., forestry, urban and other threats). As there is no information to indicate that the species was previously more widespread (e.g., with a larger range extent), an objective to actively increase the number of populations, which may allow the species to be downlisted, is not appropriate.

The population and distribution goal for Warty Jumping-slug cannot be quantified due to knowledge gaps, as population size is unknown at each of the 16 Warty Jumping-slug locations.

Warty Jumping-slug is not commonly found and surveys within known locations usually result in only one or two individuals being recorded (see Appendix 1). The difficulty with estimating populations at low densities, coupled with the difficulty of tagging and monitoring small soft-bodied gastropods, makes population estimates labour intensive and logistically difficult. The possibility of causing undue stress to Warty Jumping-slug populations and unintended mortality from handling must also be considered. The above population and distribution goal sets a minimum population objective (> 1 slug) for each location. This allows the survival/recovery habitat to be aimed at identifying and protecting the habitat needed to ensure the species persists at any given location.

5.3 Management Objectives

1. To ensure protection[7] for the known locations (and new locations) and habitats of Warty Jumping-slug.
2. To assess and mitigate the extent of current threats (IUCN-CMP Threats 1, 4, 5, 6, 7, 8, 9) at all locations in B.C.
3. To address knowledge gaps (e.g., habitat requirements, range extent within Vancouver Island) for Warty Jumping-slug.

6 APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Underway

The following actions have been categorized by the action groups of the B.C. Conservation Framework (Ministry of Environment 2010b). Status of the action group for this species is given in brackets.

Compile Status Report (complete)

- COSEWIC report completed (COSEWIC 2003).

Send to COSEWIC (complete)

- Warty Jumping-slug assessed as Special Concern (COSEWIC 2003).

Planning (complete)

- B.C. management plan completed (this document, 2012).

Habitat Protection and Private Land Stewardship (in progress)

- Numerous surveys for terrestrial gastropods have been conduc ted on Vancouver Island, Sunshine Coast, Gulf Islands, Haida Gwaii, and the southwestern mainland of B.C., primarily in the Lower Fraser Valley (Appendix 1). Most of these surveys have taken place within the past 10 years. Inventory has been completed to inform landowners of the species presence and thus enable landowners to make informed land use decisions.

[7] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

- Research on effects of forestry practices on terrestrial gastropods (1999–present) (Ovaska and Sopuck 2005). Warty Jumping-slug was found at two of the operational, variable-retention locations surveyed, in 2000 and 2001. Research has been completed to enable landowners to make informed land use decisions.
- Locations of Warty Jumping-slug within the Carmanah Walbran Provincial Park and Pacific Rim National Park Reserve are afforded protection through the legal provisions of the B.C. *Park Act* and the *Canada National Parks Act*, respectively.

6.2 Recovery Planning Table

Table 3. Recommended management actions for Warty Jumping-slug

Conservation Framework action group	Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
Objective 1. To secure protection[c] for the known locations (and new locations) and habitats of Warty Jumping-slug.			
Habitat Protection; Private Land Stewardship	1. Ensure protection[c] measures are in place for the 16 locations (and future locations as they are recorded).	1, 2, 4, 5, 6, 7, 9	Essential
	2. Recommend Warty Jumping-slug to be listed as Identified Wildlife under B.C. *Forest and Range Practices Act*.	5.3, 9.3	Necessary
	3. Work with local government to use environmental protection tools under current legislation and bylaws (e.g., Development Permit Areas, Riparian Areas Regulation, pesticide use restrictions) and prepare best management practices guidelines (may require more than one type of BMP depending on the landowner or local government), local conservancy groups and other landowners that may contain undocumented location. Include options for managing habitat for forest-floor invertebrates under different land-use practices.	1, 2, 4, 5, 6, 7, 8, 9	Essential
	4. Determine the area of occupancy of known locations and spatially define the habitat polygon at each location.	Knowledge gap	Essential
	5. Create standard protocol for gathering habitat information at each location (locations spatially mapped from Action 4 above). This will assist with habitat suitability rating (e.g., as prioritized sites for protection), identifying survival/recovery habitat and comparing site attributes to determine if Warty Jumping-slug presence is correlated to a certain suite of habitat attributes.	Knowledge gap	Essential

Conservation Framework action group		Actions to meet objectives	Threat[a] or concern addressed	Priority[b]
Objective 2. To assess and mitigate the extent of the current threats (IUCN-CMP Threat 1, 4, 5, 6, 7, 8, 9) at all locations in B.C.				
Habitat Protection; Private Land Stewardship; Habitat Restoration	1.	When completing inventory, attempt to list, quantify, and rate threats to habitat through standard protocol thereby assessing reasons slugs may or may not be present within certain habitats.	All	Essential
	2.	Investigate distribution and habitat use patterns of the slugs in relation to those of introduced predators and competitors.	8.1	Essential
	3.	Work with land developers to ensure that Warty Jumping-slug habitats in urban and rural areas include the needs of the species into land use plans, and habitat is not degraded by developments near occupied habitat.	1.1, 1.2, 1.3	Essential
	4.	In parks and recreational areas, identify site-specific threats related to recreational activities within each location to minimize damage to Warty Jumping-slug habitat caused by erosion and destruction of vegetation within occupied habitats; fire management, prevention, or suppression activities; intensive recreational activities use within known occupied habitats; or invasive species removal/management programs.	6.1, 7.1, 8.1, 9.3	Essential
Objective 3. To address knowledge gaps (e.g., habitat requirements, range extent within Vancouver Island) for Warty Jumping-slug.				
Habitat Protection; Private Land Stewardship; Habitat Restoration	1.	Complete spatial mapping of all suitable (potential) Warty Jumping-slug habitats within the Canadian range on southern Vancouver Island using information in habitat description. Delineate and label these spatial areas into sites.	Knowledge gap	Essential
	2.	From spatial mapping, prioritize sites for Warty Jumping-slug inventory based habitat suitability rating (e.g., high, medium, low) and previous/ongoing inventory or known records.	Knowledge gap	Essential
	3.	Inventory potential unsurveyed priority habitats (as determined from #2 above) within the range of Warty Jumping-slug.	1, 2, 4, 5, 6, 7, 8, 9	Necessary
Monitor Trends	4.	Based on information gained through inventory, develop monitoring program to investigate the vegetative habitat components and microhabitat components (e.g., coarse woody debris, micro-humidity) of each known location. Monitoring program would allow understanding of changes over time from potential threats, including climate change.	All	Necessary
Monitor Trends	5.	As part of a long-term monitoring program, assess changes in habitat use and distribution due to the effects of climate change (e.g., more frequent drought).	11.2	Beneficial

[a] Threat numbers according to the IUCN-CMP classification (see Table 2 for details).

[b] Essential (urgent and important, needs to start immediately); Necessary (important but not urgent, action can start in 2–5 years); or Beneficial (action is beneficial and could start at any time that was feasible).
[c] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

6.3 Narrative to Support Recovery Planning Table

Warty Jumping-slug is recommended for inclusion in the category of "species at risk" under the provincial *Forest and Range Practices Act* (FRPA), which enables habitat management tools as per the Identified Wildlife Management Strategy. Protection measures under this Act include the establishment of Wildlife Habitat Areas to help protect the species' habitat from forestry threats on provincial Crown land.

Locations of Warty Jumping-slug within the Carmanah Walbran Provincial Park and Pacific Rim National Park Reserve are afforded protection through the legal provisions of the BC *Park Act* and the *Canada National Parks Act*, respectively. However, within protected areas, further work may be needed to address habitat needs and threats at the specific locations where Warty Jumping-slugs occur.

Within regional parks, collaborative work is needed with parks planning to ensure Warty Jumping-slug locations and associated habitat are incorporated into management plans, future recreational development within the park, and vegetation management. Habitat management for Warty Jumping-slug at each location may require location-specific plans, or may be able to be incorporated with existing management plans (such as park plans, land use plans, forest stewardship plans, development plans, and other similar planning documents). Location-specific management plans would incorporate threat mitigation (such as impacts from recreational activities, vegetation management, and habitat modification).

On private lands and in regional parks, protection of occupied locations is to be accomplished through stewardship actions. To successfully protect many species at risk in B.C., voluntary initiatives by all Canadians will be important to help maintain areas of natural ecosystems that support these species. This stewardship approach will cover many different kinds of activities, including: following guidelines or best management practices to support species at risk; voluntarily protecting important areas of habitat; conservation covenants on property titles; and eco-gifting or sale of property (in whole or in part) to protect certain ecosystems or species at risk. Both government and non-governmental organizations have successfully conserved lands in the province.

Several known locations and much potential habitat for Warty Jumping-slug are on private lands (Table 1) used for forestry or other purposes. Stewardship is an essential part of this management plan and will involve engaging landowners and managers in voluntarily protection measures.

Specific research on habitat requirements, clarification of threats, and better information on distribution is needed to address more effective protection measures for Warty Jumping-slug. This information will allow the development of improved best management practices guidelines.

Inventory for Warty Jumping-slug within unchecked suitable habitats on southern Vancouver Island is needed. The first step is to map all potential habitats within the historic range of the species and assess habitat suitability using orthophotos, satellite imagery, forest cover maps, and biophysical mapping. The second step is to generate a prioritized list of locations for inventory based on habitat suitability. The third step is to conduct field surveys at an appropriate time of the year (spring/early summer and fall) and under suitable moist conditions. Field visits are also required to locate key microhabitat features, such as patches of moist older forest, riparian areas, and locations with deep forest litter, and to confirm habitat suitability. Multiple surveys per year are recommended to increase chances of detecting rare species. Initially, the surveys are to target federal and provincial Crown lands. If new locations are found, contact with the respective landowners should be initiated and best management practices applied.

Inventory, monitoring, and habitat assessment can be completed through a multi-species approach that includes all gastropods. Inventory for Warty Jumping-slug can incorporate searches for other gastropods at risk including the Oregon Forestsnail (*Allogona townsendiana*), Puget Oregonian Snail (*Cryptomastix devia*), Blue-gray Taildropper slug (*Prophysaon coeruleum*), and Dromedary Jumping-slug (*Hemophilia dromedarius*) as well as introduced gastropods.

Selected habitat features and populations of Warty Jumping-slug within protected locations (e.g., within parks) need to be monitored to assess effectiveness of management actions.

7 Measuring progress

The following performance indicators provide a way to define and measure progress toward achieving the population and distribution goal and recovery objectives. Performance measures are listed below for each objective.

The successful implementation of recovery actions for Warty Jumping-slug will be indicated through monitoring of locations and habitat trends through time. Warty Jumping-slug may have an annual life cycle and therefore population sizes may vary from year to year and overall population (on a scale of decades) may vary within areas of suitable habitat. Population monitoring will allow for an indication of possible extirpation at a given location, changes in area of extent at a given location, and whether the number of extant locations is stable or increasing. The management plan will be reviewed in 5 years to assess progress and to identify additional approaches.

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution goal and management objectives. Performance measures are listed below for each objective.

Objective 1: To secure protection[8] for the known locations (and new locations) and habitats of Warty Jumping-slug.

[8] Protection can be achieved through various mechanisms including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, and protected areas.

- Recommend Warty Jumping-slug be a priority for listing as Identified Wildlife under the provincial *Forest and Range Practices Act.*
- Stewardship agreements and/or covenants have been established for known (and any new) Warty Jumping-slug locations on regional district and municipal lands by 2016.
- Where appropriate, protection measures and threat mitigation has been initiated for all locations through existing legislative protection (e.g., Protected Areas, Wildlife Habitat Areas, landscape management plans) and local government bylaws and planning (e.g., official community plans, development permit areas) by 2016.
- Attempt contact with private landowners with occupied or potential habitat by 2016.

Objective 2: To assess and mitigate the extent of the current threats (IUCN-CMP Threats 1, 4, 5, 6, 7, 8, 9) at all locations in B.C.

- Best management practices guidelines for Warty Jumping-slug have been drafted for each landowner or land manager, outlining the threats applicable to each location by 2016.
- Assist landowners with identifying actions that minimize primary threats to Warty Jumping-slug, link with other species at risk (if possible) and identify management actions that allow for multi-species approaches, by 2016.

Objective 3: To address knowledge gaps (e.g., habitat requirements, range extent within Vancouver Island) for Warty Jumping-slug.

- An inventory schedule has been determined for surveying Warty Jumping-slug in potential habitats in B.C. by 2014.
- A standardized inventory protocol for monitoring presence and habitat assessment of Warty Jumping-slug is developed by 2014.
- Inventory of Warty Jumping-slug potential habitat in B.C. has been initiated by 2015.

8 Effects on Other Species

Approximately 24 species are known to inhabit forest similar to Warty Jumping-slug. Integrating Warty Jumping-slug habitat protection into measures that protect these additional species will allow for habitat connectivity and potential future habitat.

Coordinated, ecosystem-based approaches are needed to ensure Warty Jumping-slug recovery actions are compatible with activities for other species and ecosystems of southern Vancouver Island.

Survey and habitat assessments for Warty Jumping-slug may increase knowledge about other gastropods at risk:[9]

- Dromedary Jumping-slug (*Hemphillia dromedarius*) (Endangered 2003), which is known from similar habitat types on southern Vancouver Island.
- Evening Fieldslug (*Deroceras hesperium*) (Data Deficient 2003)
- Threaded Vertigo (*Nearctula* sp. 1) (Special Concern 2010)

[9] COSEWIC status is in brackets following species' name.

- Oregon Forestsnail (*Allogona townsendiana*) (Endangered 2002)

Plant species that may benefit as a result of recovery efforts for Warty Jumping-slug:[8]

- Scouler's corydalis (*Corydalis scouleri*) (Threatened 2001)
- phantom orchid (*Cephalanthera austiniae*) (Threatened 2000)
- coastal wood fern (*Dryopteris arguta*) (Special Concern 2001)
- streambank lupine (*Lupinus rivularis*) (Endangered 2002)

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Personal Communications

Ovaska, Kristiina. 2003–2011. Senior researcher. Biolinx Environmental Research Ltd., Victoria, BC.

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APPENDIX 1. WARTY JUMPING-SLUG GASTROPOD SURVEYS

Table A1. Multi-species gastropod surveys that included Warty Jumping-slug as a target species.

Survey year	Report citation	Number of Vancouver island sites surveyed	Number of Gulf Islands sites surveyed
1984	Cameron 1986	N/A	N/A
1999–2003	Ovaska and Sopuck 2000, 2002a, 2003a; Ovaska *et al.* 2001	24	0
2000–2001	Ovaska *et al.* 2001	104	0
2002	Ovaska and Sopuck 2002b	3	0
2003	Ovaska and Sopuck 2003b	22	0
2003	Ovaska and Sopuck 2003c	30	13
2003–2004	Ovaska and Sopuck 2004	39	0
2006	Ovaska and Sopuck 2006a	26	0
2006	Ovaska and Sopuck 2006b	21	0
2007	Ovaska and Sopuck 2007a	6	0
2007	Ovaska and Sopuck 2007b	6	0
2006	Ovaska and Sopuck 2007c	21	0
2008	COSEWIC 2010	13	0
2008	Ovaska and Sopuck 2008	22	0
2008	Ovaska and Sopuck 2009a	22	0
2008	Ovaska and Sopuck 2009b	6	0
2007–2009	Ovaska and Sopuck 2009c	22	0
2009	DND 2010	6	0
2010	Ovaska and Sopuck 2010	10	0
2011	Ovaska and Sopuck 2011	10	0
2009	Sopuck and Ovaska 2010	0	5
1990–2011	R. Forsyth personal data 2011	unknown	unknown
Total: 1984–2011		**413**	**18**