COSEWIC
Assessment and Status Report

on the

Pygmy Slug
Kootenaia burkei

in Canada

SPECIAL CONCERN
2016

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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Pygmy Slug — photo credit Kristiina Ovaska.

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COSEWIC
Assessment Summary

Assessment Summary – May 2016

Common name
Pygmy Slug

Scientific name
Kootenaia burkei

Status
Special Concern

Reason for designation
In Canada, this small slug is confined to the moist forests of the northern Columbia basin of British Columbia. It is found in moist mixed-wood and coniferous forests and commonly associated with riparian habitats along small creeks. Key habitat requirements include high substrate moisture with abundant woody debris and leaf litter for shelter. Threats include: existing and new roads resulting in fragmentation, increased edge effects, and barriers to dispersal; predation and competition from invasive species; damage to riparian areas associated with livestock grazing; habitat loss and degradation associated with logging activities; and, projected consequences of climate change, including an increase in drought conditions and an increase in both the number and severity of wildfires.

Occurrence
British Columbia

Status history
Designated Special Concern in April 2016.

COSEWIC
Executive Summary

Pygmy Slug
Kootenaia burkei

Wildlife Species Description and Significance

Pygmy Slug is the sole member of the newly described genus *Kootenaia*. As its common name implies, Pygmy Slug is very small with adults usually 9 – 14 mm long. The colour is from dark grey to tan with dense bluish flecking covering the mantle and tail; dark mottling is often present on the mantle. The tail is rounded (lacking a keel) with a series of parallel and oblique longitudinal grooves, which may resemble thin dark stripes. Pygmy Slug is a regional endemic to moist forests of the northern Columbia Basin, an area that contains many unique plants and animals.

Distribution

The global distribution of Pygmy Slug extends from southeastern British Columbia through the Idaho Panhandle to northwestern Montana. In Canada, Pygmy Slug occurs in the Selkirk and Purcell sub-ranges within the Columbia Mountains in southeastern British Columbia. The species is known from 44 sites in the province; the number of sites may continue to expand with increasing search effort. Approximately 36% of the species' distribution is in Canada.

Habitat

In British Columbia, the slugs occur mostly within the Interior Cedar-Hemlock biogeoclimatic zone, which is among the wettest areas in the interior of the province. The slugs have been found in moist mixed-wood and coniferous forests from low to mid-elevations (580 m – 1585 m), where they are commonly associated with riparian habitats along small tributary creeks. High substrate moisture and abundant shelter, such as provided by coarse woody debris or pockets of deep leaf litter, appear to be key habitat requirements. The slugs have been found from 40 – 50-year-old second growth to old growth (>200 years old) stands. Common trees at occupied sites included Western Redcedar and Black Cottonwood; the understorey often contained moisture-loving plants, such as Thimbleberry, Devil's Club, and Lady Fern.

Biology

The natural history of Pygmy Slug is poorly known. The slugs are hermaphroditic, but the exchange of sperm with other individuals rather than self-fertilization is probably the norm. The slugs lay small clutches of eggs, which are relatively large (10% or more of parent body length). The slugs are known to feed on lichens and fungi and probably also consume decaying organic matter in the duff layer. Most observations in British Columbia and the United States have taken place in autumn, when the slugs are active on the forest floor. Juveniles and an unknown proportion of adults probably overwinter. The generation time is approximately 1 year. The small size of the slugs may enable them to exploit small habitat patches provided that their requirements for moisture and shelter are met. Slugs in general are poor dispersers if not aided by humans or by wind or water; no such passive means of dispersal are known for Pygmy Slug, exacerbating the effects of habitat fragmentation on its distribution within the landscape.

Population Sizes and Trends

Population sizes and trends of Pygmy Slug are unknown. Survey efforts have focused on elucidating the distribution of Pygmy Slug rather than on obtaining abundance estimates. Records for the species from British Columbia are from 2007 – 2015, precluding information on population trends.

Threats and Limiting Factors

The Canadian distribution of Pygmy Slug most likely reflects post-glacial expansion from refugia farther south. Its present distribution is probably limited by a short growing season and/or long and cold winters to the north, and drier forest types to the east and west. Low dispersal ability and requirements for moist habitats limit the speed at which the slugs can colonize new habitats.

Pygmy Slug populations are threatened by extreme events associated with climate change, introduced invasive species, fire and fire suppression, logging, roads, and livestock farming and ranching. The greatest threats to the slugs across their Canadian range are deemed to be from droughts and flood events, the frequency and severity of which are predicted to continue to increase under climate change scenarios. Invasive, non-native species that threaten slug populations include introduced gastropods, which are inadvertently spread by humans and which prey on or compete with native species, and other invertebrate predators such as ground beetles, which can be aggressive predators of slugs. Frequency and severity of wildfires is projected to increase with climate change. Due to their low mobility, gastropods are both unable to escape fire events by moving away and are slow to recolonize burnt areas. Logging is prevalent throughout the Pygmy Slug's range and continues to modify and fragment habitats. The effects of logging on slugs may be mitigated to some degree by riparian buffers, which are required along larger water courses containing fish, or which logging companies may leave voluntarily along small, fishless streams where they are not required. Logging roads and other resource roads also continue to fragment habitats.

Protection, Status, and Ranks

Pygmy Slug has no official protection or status under the federal *Species at Risk Act*, B.C. *Wildlife Act*, or other legislation. Pygmy Slug is ranked by NatureServe as follows: Global status - G2 (imperilled); United States - N2 (imperilled); Canada - N1 (critically imperilled); Idaho: S2 (imperilled); Montana - S1S2 (critically imperilled to imperilled; BC:S1? (possibly critically imperilled). In British Columbia, the species is on the provincial red list of species at risk.

Across the Pygmy Slug's Canadian range, protected lands comprise approximately 20% of the land base and include several provincial parks, provincial Wildlife Habitat Areas established for other species, and other conservation lands. Pygmy Slug has not been recorded from any of the above areas with the exception of one site within a small conservation area. Most of the range and known sites are within provincial forestry lands.

TECHNICAL SUMMARY

Kootenaia burkei

Pygmy Slug

Limace pygmée

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?	NA
Are there extreme fluctuations in number of mature individuals?	Probably not

Extent and Occupancy Information

Estimated extent of occurrence	15,552 km^2
Index of area of occupancy (IAO) (Always report 2x2 grid value).	180 km^2 (discrete; 45 2 x 2 km grid cells); 1160 km^2 (continuous along water courses; 290 2 x 2 km grid cells)
Is the population severely fragmented?	Unknown
Number of locations	>20 based on number of occupied sub-watersheds and threat from climate change and severe weather or invasive species
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	Unknown
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	Unknown

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*?	Unknown
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Yes, observed, inferred, and projected decline habitat quality
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	**N Mature Individuals**
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done

Threats (actual or imminent, to populations or habitats)

Was a threats calculator completed for this species? Yes

i. Livestock farming & ranching (2.3)
ii. Roads & railroads (4.1)
iii. Logging and wood harvesting (5.3)
iv. Fire & fire suppression (7.1)
v. Invasive non-native species (8.1)
vi. Climate change and severe weather: Droughts (11.2), Storms & flooding (11.4)

What additional limiting factors are relevant?
Low dispersal capabilities; dependence on moist micro-habitats

Rescue Effect (immigration from outside Canada)

Status of outside population(s)?	G2 (Global), N2 (US), S2 (Idaho), SIS2 (Montana)
Is immigration known or possible?	Not known but possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada	Yes
Are conditions for the source population deteriorating	Yes
Is the Canadian population considered to be a sink?	No

Is rescue from outside populations likely?	Possible over long term in some areas near the border, but rate would be very low

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: Not previously assessed.

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric code:** Not applicable
Reasons for designation: In Canada this small slug is confined to the moist forests of the northern Columbia basin of British Columbia. It is found in moist mixed-wood and coniferous forests and commonly associated with riparian habitats along small creeks. Key habitat requirements include high substrate moisture with abundant woody debris and leaf litter for shelter. Threats include: existing and new roads resulting in fragmentation, increased edge effects, and barriers to dispersal; predation and competition from invasive species; damage to riparian areas associated with livestock grazing; habitat loss and degradation associated with logging activities; and projected consequences of climate change, including an increase in drought conditions and an increase in both the number and severity of wildfires.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable as no estimates of population size or trends are available.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO (15,552 km^2) meets the threshold for Threatened (< 20,000 km^2) and IAO (180 km^2) meets the threshold for Endangered (< 500 km^2) and Threatened (< 2,000 km^2), the population is not severely fragmented and the number of locations (>20) exceeds the thresholds, and there are no extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No estimates of population size or trends are available.
Criterion D (Very Small or Restricted Population): Not applicable. There are no estimates of population sizes, and D2 for Threatened does not apply as both the IAO and number of locations exceed the thresholds.
Criterion E (Quantitative Analysis): Not applicable. No quantitative analyses have been performed.

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 (2016)

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.

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
Service canadien de la faune
Canada

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Pygmy Slug, *Kootenaia burkei*, was described from specimens from northern Idaho in 2003 (type locality: Little Bumblebee Creek, Panhandle National Forest; Leonard *et al*. 2003). The species is the sole representative of the genus, placed within the large cosmopolitan family Arionidae (Leonard *et al*. 2003). An alternative classification by Bouchet and Rocroi (2005) raises all arionid subfamilies to full family status. Neither of these classifications is satisfactory, because current genetic studies do not support the monophyly of the more inclusive Arionidae or its subfamilies that have been investigated (Backeljau pers. comm. 2011).

Of other North American arionid genera, *Kootenaia* is most closely related to *Prophysaon*, but genetic divergence and comparative anatomy clearly set the two apart (Leonard *et al*. 2003). In addition to *Prophysaon*, Burke (2013) placed *Kootenaia* and two newly discovered monotypic genera, *Carionarion* and *Securicauda* (Leonard *et al*. 2011), in Anadenidae (Anadeninae in other classifications), but without explanation.

The current classification is as follows:

Phylum Mollusca
Class Gastropoda
Subclass Pulmonata
Order Stylommatophora
Suborder Arionoidea
Family Arionidae
(Subfamily Anadeninae)
Genus *Kootenaia*
Species *Kootenaia burkei*

The genus is named after the Kootenay First Nation, who historically occupied the land that encompasses the species' range (Leonard *et al.* 2003). The specific name honours Thomas Burke, a wildlife biologist who has worked extensively on terrestrial gastropods of the Pacific Northwest of the United States.

Morphological Description

As its common name implies, Pygmy Slug is very small with adults usually 9 – 14 mm in extended length (Leonard *et al*. 2003). In British Columbia (BC), the length of slugs when measured live ranged from 3 – 16 mm, including juveniles (Ovaska and Sopuck, unpubl. data 2007 – 2015). The body is slender, and the mantle covers approximately half of the length of the animal (Figure 1). The tail is rounded (lacking a keel) with a series of parallel and oblique longitudinal grooves. The grooves branch at the tip of the tail, forming small polygons, which are characteristic of the species (Burke 2013). The grooves on the tail may resemble thin dark stripes. It lacks an abscission line, such as found in taildroppers (*Prophysaon* species).

Figure 1. Pygmy Slug, *Kootenaia burkei*, from British Columbia. Image by K. Ovaska. The length of the slug is ca. 10 mm.

The colour is from dark grey to tan with dense bluish flecking covering the mantle and tail. Dark mottling is often present on the mantle but is occasionally lacking (Leonard *et al*. 2003). In BC, only unmottled slugs were found at some sites, whereas at most sites only mottled slugs were found (Ovaska and Sopuck, unpubl. data 2007 – 2015).

Internally, Pygmy Slug differs from other arionid slugs by its distal reproductive anatomy, commonly used in the classification and identification of gastropods. Compared to other arionids, it has an unusually reduced male component of the reproductive system and lacks a free epiphallus or vas deferens (Leonard *et al*. 2003).

Population Spatial Structure and Variability

Genetic structure of Pygmy Slug populations is unknown. In BC, the species is known from scattered localities, most of which are south of 49.4°N. These and the more northern localities (up to 50.5°N) are separated by a minimum distance of 58 km (between Sites 4 and 6), and relatively great distances also separate the four northernmost localities from each other (42 km between Sites 5 and 9; 29 km between Sites 9 and 10; 38 km between Sites 10 and 4). Slugs in the northern localities are most likely isolated from each other and from those from farther south. Given the limited dispersal capabilities of the slugs and their affinity for very moist habitats, it is unlikely that there would be much genetic exchange among subpopulations outside single creeks or sub-drainages even within the southern portion of the range, where the species' distribution may be more continuous.

Designatable Units

Pygmy Slug is known from a relatively small area within one COSEWIC National Ecological Area (Southern Mountain). There are no range disjunctions or other information that would suggest the presence of separate discrete and evolutionarily significant units within the Canadian subpopulation, but the genetic, anatomical, or ecological variability within the species has not been studied. The species is treated as one designatable unit.

Special Significance

Pygmy Slug is a regional endemic to moist forests of the northern Columbia Basin, an area that contains many unique plants and animals (Brunsfeld *et al.* 2001). This area extends from southeastern BC and northeastern Washington through the Idaho Panhandle to northwestern Montana. As one of a few genera of slugs endemic to western North America and the only representative of its genus, this species is of scientific interest for the study of glacial history and evolutionary relationships.

DISTRIBUTION

Global Range

The global distribution of Pygmy Slug extends from southeastern BC through the Idaho Panhandle to northwestern Montana (Figure 2). On the Idaho Panhandle, the species has been reported from seven localities (five localities, Leonard *et al*. 2003; Leonard pers. comm. 2013; two localities, Hendricks and Maxwell 2005; Hendricks pers. comm. 2013). There are 25 observations for Pygmy Slug in the Montana Natural Heritage Program database (current up to 11 April 2013; Montana Government 2013). These are from Lincoln, Sanders, and Mineral counties in the northwest of the state. Although there are no records, the species may occur in the extreme northeast of Washington State, based on the proximity of records to the British Columbia border. In Canada, the species has been found only in the Kootenay region of BC. Approximately 36% of the species' range is in Canada.

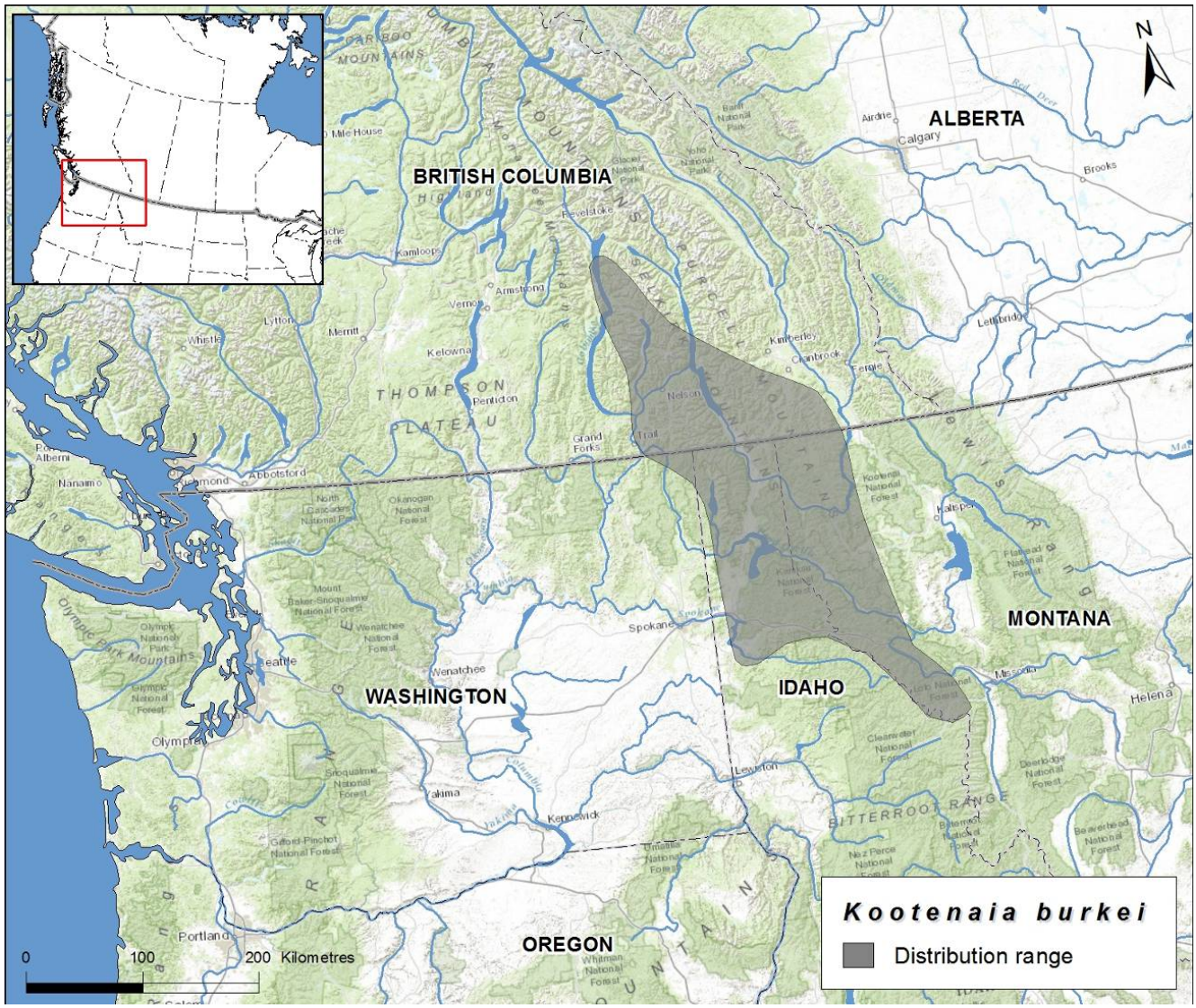

Figure 2. Global distribution of Pygmy Slug, *Kootenaia burkei*. Data sources: Leonard *et al.* (2003); Hendricks and Maxwell (2005); Hendricks pers. comm. (2013); Montana Government (2013); Table 1 (Canadian records). Map prepared by Lennart Sopuck and Jenny Wu.

Table 1. Distribution records for Pygmy Slug, *Kootenaia burkei*, from Canada.

Site #	Site description	Elev. (m)	BEC Zone^	Date	# slugs found	Search time (pers. min.)	Habitat	Appr. stand age (yrs)	Source*
1	Lost Creek (rest area), off HWY3 between Salmo & Creston, BC	664	ICHxw (near border with ICHdw1)	22-Sep-07	1	118	Second-growth mixed-wood forest; riparian forest along river	50	Ovaska and Sopuck 2009a (RBCM uncatalogued)
2	Hawkins Creek, Yahk Meadow FSR, ca. 3 km from Yahk, BC	913	ICHdw1	23-Sep-07	8	132	Second-growth mixed-wood forest; riparian floodplain along creek	80	Ovaska and Sopuck 2009a (RBCM 007-00077-001)
3	Yahk River FSR, along tributary of Sunrise Creek, BC	1260	ICHdm	05-Sep-08	1	70	Second-growth coniferous forest; riparian forest along dried-up creek	50-100	Ovaska and Sopuck 2009a (photos)
4	Lemon Creek, Slocan Valley, BC	705	ICHdw1	03-Sep-08	3	70	Second-growth mixed-wood forest; riparian area along creek	60	Ovaska and Sopuck 2009a (photos)
5	Halfway River FSR, South of Galena (east of Arrow Lake), BC	781	ICHmw2	08-Oct-08	2	124	Older mixed-wood forest; riparian area along creek	100	Ovaska and Sopuck 2009a (photos)
6	Marsh Creek Rd, off Champion Park Rd (off HWY 3), between Fruitvale and Salmo BC	1090	ICHdw1	09-Oct-08	1	120	Older mixed-wood forest; edge of small forest gap in a moist depression		Ovaska and Sopuck 2009a (photos)
7	Sundown Cr. FSR (spur), ca. 5 km SE from Moyie, BC	975	ICHdw1	8-Oct-09	1	60	Second-growth mixed-wood forest; moist riparian area along creek	70	Ovaska and Sopuck 2009b (photos)
8	Sundown Cr, SW of Moyie, BC	1140	ICHdw1	11-Sep-10	16	123	Second-growth mixed-wood forest; seepage area by small creek	50	Ovaska *et al*. 2010 (RBCM uncatalogued)
9	Slewiskin (McDonald) FSR (Site 2), S of Nakusp, BC	640	ICHmw2	22-Sep-13	1	60	Second-growth mixed-wood forest; along fast-flowing tributary creek	60-70	Fieldwork in support of this status report by K. Ovaska and L. Sopuck (RBCM uncatalogued)
10	East Wilson Cr. FSR (Site 2), N of New Denver, BC	581	ICHdw1	22-Sep-13	1	60	Second-growth mixed-wood forest along fast-flowing tributary creek	40-50	Fieldwork in support of this status report by K. Ovaska and L. Sopuck (RBCM uncatalogued)
11	9 Mile Cr. (Site 2B), Pend d'Oreille, BC	608	ICHxw	23-Sep-13	1	60	Older coniferous forest; moist forest along creek	100+	Fieldwork in support of this status report by K. Ovaska and L. Sopuck (RBCM uncatalogued)
12	Sheep Cr. FSR (Site 1), S of Salmo, BC	1179	ICHmw2	24-Sep-13	3	50	Older mixed-wood forest; riparian forest along fast-flowing tributary creek	100+	Fieldwork in support of this status report by K. Ovaska and L. Sopuck (RBCM uncatalogued)
13	Sheep Cr. FSR (Site 2), S of Salmo, BC	969	ICHdw1	24-Sep-13	2	40	Second-growth mixed-wood forest; riparian area along fast-flowing creek	80	Fieldwork in support of this status report by K. Ovaska and L. Sopuck (RBCM uncatalogued)
14	Carroll Cr. Road, W of Yahk, BC	993	ICHdw1	24-Sep-13	1	50	Old-growth coniferous forest; moist area along creek	200+	Fieldwork in support of this status report by K. Ovaska and L. Sopuck (RBCM uncatalogued)

Site #	Site description	Elev. (m)	BEC Zone^	Date	# slugs found	Search time (pers. min.)	Habitat	Appr. stand age (yrs)	Source*
15	Teepee Cr. FSR, SE of Cranbrook, BC	1125	MSdk1 (near border with ICHmk4)	25-Sep-13	9	40	Older coniferous forest; moist creek-side	100	Fieldwork in support of this status report by K. Ovaska and L. Sopuck (RBCM uncatalogued)
16	Meachen Cr. FSR (Site 3 at Fiddler Cr.), ca. 14 km S of Mary's Lake, BC	1284	ESSFwm	18-Sep-14	4	40	North-facing sloping side of ravine with young cottonwoods along fast-flowing tributary creek	60-70	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
17	Hellroaring Cr. FSR (Site 1), S. of St. Mary's Lake, BC	1304	ESSFwm	18-Sep-14	1	60	Cottonwood fringe along road in steep mid-slope mainly coniferous forest	60-70	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
18	Cherry Cr. FSR (Site 3), near Cherry Lake, BC	1229	ICHdm/ MSdk1 border (right on border)	20-Sep-14	2	50	Alluvial flat with alders by stream in coniferous forest, perhaps seasonally flooded	80-90	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
19	Bloom Cr. FSR (Site 3), BC	1269	MSdk1	20-Sep-14	1	60	Riparian area with alders along small stream (trickle of water) in second growth forest	60	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
20	Yahk R FSR (Site 3), BC	1111	MSdk1	21-Sep-14	1	40	Moist, periodically flooded alluvial site along fast-slowing larger stream; canopy gap in coniferous forest with abundant understorey vegetation	100	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
21	Lamb Cr. FSR (Site 1), W of Moyie, BC	1121	ICHdm	22-Sep-14	1	40	Moist riparian floodplain in narrow ravine within landscape of shelter wood logging; several very large cottonwoods	70	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
22	Tate Cr. FSR (Site 1),off Lamb Cr. FSR, BC	1194	ICHdm	22-Sep-14	5	40	Riparian buffer (50-75m wide) with large cottonwoods in rich floodplain along creek	80	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
23	Tate Cr. FSR (Site 2),off Lamb Cr. FSR, BC	1392	ICHdm	22-Sep-14	2	50	Forested ravine along small creek (riparian zone <20 m) surrounded by upland old coniferous forest	150	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
24	Irishman R. FSR, near Moyie, BC	971	ICHdw1	22-Sep-14	1	40	Older moist coniferous forest with little understorey except in canopy gaps	125+	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
25	Cold-Freeman FSR (Site 2), off Hawkins FSR, E of Yahk, BC	1179	ICHdm	23-Sep-14	2	40	Moist riparian area along creek with hummocks and depressions and cottonwoods in second-growth coniferous forest	70-80	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
26	Skelly Cr FSR (Site 1), off Goat Cr. FSR, NE of Creston, BC	944	ICHdw1	24-Sep-14	1	40	Riparian floodplain along creek with cottonwoods in second-growth mainly coniferous forest	60-70	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)

Site #	Site description	Elev. (m)	BEC Zone^	Date	# slugs found	Search time (pers. min.)	Habitat	Appr. stand age (yrs)	Source*
27	Skelly Cr FSR (Site 2), off Goat Cr. FSR, NE of Creston, BC	1095	ICHdm	24-Sep-14	1	56	Narrow (ca 10 m wide) riparian zone along fast-flowing tributary creek, surrounded by dense second-growth coniferous forest with little understorey	40-50	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
28	Goat R FSR (Site 2), NE of Creston, BC	1092	ICHdw1	24-Sep-14	1	40	Moist depression in second-growth (ca. 60-70 year old) forest	60-70	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
29	Mt. Thompson FSR (Site 1), E of Creston, BC	855	ICHxw	24-Sep-14	1	54	Moist riparian area with cottonwoods along fast-flowing creek in otherwise dry coniferous slope with little understorey	90-100	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
30	Sanca Cr FSR (Site 1), N of Creston, BC	1189	ICHdw1	25-Sep-14	5	40	Narrow (ca 10 m wide) riparian zone along fast-flowing tributary creek in otherwise dry, pine-dominated landscape; rare, moist area	40	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
31	Sanca Cr FSR (Site 4; South Fork), N of Creston, BC	1585	ESSFdm	25-Sep-14	1	40	Moist riparian area on floodplain along stream in older coniferous forest; abundant blowdown and big boulders	100+	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
32	Dodge Cr. FSR (Site 2) at Dodge Cr, S of Creston, BC	1325	ICHmw4	26-Sep-14	1	80	Riparian zone with some cottonwoods in young forest; landscape is otherwise dry with clearcutting and only a few creeks	30-40	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
33	Monk Cr FSR (site 1)	1411	ESSFdm	27-Sep-14	2	60	Moist older coniferous forest with productive deep soil and shrubs in swale	100+	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
34	HWY 6 to Nelway (small spur), S of Salmo, BC	668	ICHdw1	27-Sep-14; 24 Sep-15	8; 8	126; 60	Moist riparian area along stream in second-growth coniferous forest	40-60	MoE 2014, 2015 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
35	Champion Lakes (Site 2), N of Trail, BC	1079	ICHdw1	28-Sep-14	1	40	Older coniferous forest with abundant well-decayed moist wood and patches of shrubs in moist depressions	100+	MoE 2014 & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
36	Archibald - Tillicum FSR (Site 2), SW of Salmo, BC	1229	ICHdw1	29-Sep-14; 24 Sep-15	5; 5	50; 120	Moist riparian zone with cottonwoods along small creek within logged landscape in second-growth forest	50-60	MoE 2014, 2015 & fieldwork for COSEWIC report for Sheathed Slug (RBCM uncatalogued)
37	Erie Cr FSR (Site 1), N of Erie, NW of Salmo, BC	991	ICHdw1	29-Sep-14	2	40	Moist ravine with cottonwoods along small creek within landscape of dry, younger (logged) forest	60-70	MoE (Ovaska and Sopuck 2014) & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)

Site #	Site description	Elev. (m)	BEC Zone^	Date	# slugs found	Search time (pers. min.)	Habitat	Appr. stand age (yrs)	Source*
38	Erie Cr FSR (Site 2), N of Erie, NW of Salmo, BC	915	ICHdw1	29-Sep-14	1	40	Moist riparian floodplain with alder in older coniferous forest	100+	MoE (Ovaska and Sopuck 2014) & fieldwork for COSEWIC report for Sheathed Slug** (RBCM uncatalogued)
39	Beaver Lookout Rd (off Archibald - Tillicum FSR), BC	987	ICHdw1	24 Sep-15	2	62	Riparian area by side of fast-flowing creek; small moist, shrubby clearing between road & creek	40-50	MoE (Ovaska and Sopuck 2015); (RBCM uncatalogued)
40	Elmer Creek FSR, SE of Creston, BC	1013	ICHdw1	24 Sept-15	3	90	Riparian area along small fast-flowing tributary stream	40-50	MoE (Ovaska and Sopuck 2015); (RBCM uncatalogued)
41	American Creek FSR, off Hawkin Cr, Meadow Rd, E of Yahk, BC	1135	ICHdm	25 Sept-15	1	60	Canopy gap with abundant herbaceous growth on sloping terrain in moist forest; seepage area on slope	60-70	MoE (Ovaska and Sopuck 2015); (RBCM uncatalogued)
42	Randal Creek FSR, S off Hawkin Cr FSR	1327	ICHdm	25 Sept-15	2	90	Moist grassy slope in forest gap (~30 m upslope from small creek/depression)	50-60	MoE (Ovaska and Sopuck 2015)
43	West Yahk Road, E of Yahk	1189	ICHdm	25 Sept-15	3	90	Moist bench between two streams in older forest	80-90	MoE (Ovaska and Sopuck 2015); (RBCM uncatalogued)
44	West Yahk Road (Site 3), E of Yahk	1223	ICHdm	25 Sept-15	2	60	Riparian habitat along trickling creek in forest patch	50-60	MoE (Ovaska and Sopuck 2015); (RBCM uncatalogued)

^Biogeoclimatic Zone (Meidinger and Pojar 1991); ESSF – Engelmann Spruce/Subalpine Fir; ICH – Interior Cedar/Hemlock; MS – Montane Spruce; subzones: ESSF: dm – Dry Mild; wm – Wet Mild; ICH: dm – Dry Mild; dw1 – West Kootenay Dry Warm; mw2 – Shuswap Moist Warm; mk – Moist Cool; mw4 – Ymir Moist Warm; xw – Very Dry Warm; MS: dk – Dry Cool

*MoE-BC Ministry of Environment; RBCM-Royal British Columbia Museum; RBCM uncatalogued- catalogue number to be assigned

**Surveys conducted by K. Ovaska and L. Sopuck for BC Ministry of Environment (MoE) and in support of the preparation of COSEWIC status report for the Sheathed Slug (*Zacoleus idahoensis*), which occurs in similar habitats as Pygmy Slug.

Canadian Range

In Canada, Pygmy Slug occurs in the Selkirk and Purcell sub-ranges within the Columbia Mountains in southeastern BC (Figure 3). Its range lies between the east arm of the Columbia River (Lake Koocanusa) in the east and the Arrow Lakes in the west. The northernmost record (50.5 N°) is 62 km southeast of Revelstoke on the east side of Upper Arrow Lake.

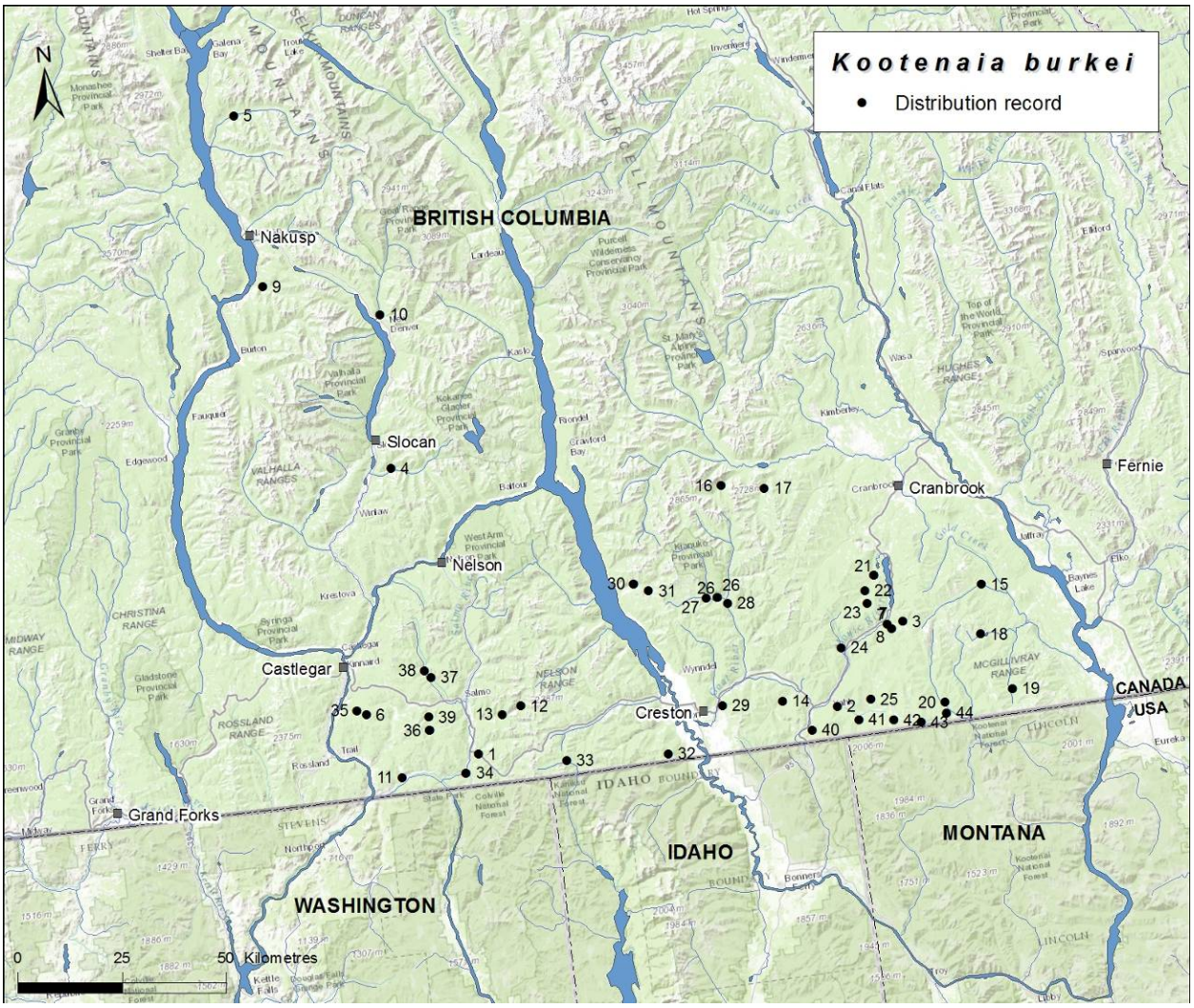

Figure 3. Canadian distribution of Pygmy Slug. Source of records from Table 1 (map prepared by Jenny Wu, COSEWIC Secretariat).

Pygmy Slug was first discovered in BC in 2007, and subsequent targeted surveys from 2008 – 2015 have documented additional localities. There are now records from 44 sites in BC (sites are defined as localities >1 km from each other; Table 1). All but four sites are from below 49.58°N and within 64 km north of the international border. New sites continue to be found with increasing search effort; seven new sites were found in September 2013, 23 in 2014 as part of targeted surveys associated with the preparation of this status report and that for the Sheathed Slug, *Zacoleus idahoensis*, respectively, and six were found in 2015 during additional surveys for the BC Ministry of Environment, but the boundaries of the known range did not increase significantly. Additional sites are likely to exist, especially within the southern portion of the species' range.

Extent of Occurrence and Area of Occupancy

Using the minimum convex polygon method based on known occurrence records, the extent of occurrence (EOO) is 15,552 km^2 with the international border with the United States as the southern boundary of the polygon.

The index of area of occupancy (IAO) based on a discrete grid for each observation record or group of records, is 180 km^2 (45 2 x 2 km grid cells). A more realistic IAO may be obtained by considering the entire creek with records of the species. Using this method, the continuous IAO is 1160 km^2 (290 2 x 2 grid cells) (EOO and IAO calculations by Jenny Wu, COSEWIC Secretariat). Additional, undocumented sites may exist that could further expand the IAO.

Search Effort

Little information exists on survey effort from the Kootenay region in BC before the 1990s. In his review of terrestrial gastropods of the Columbia Basin, Forsyth (1999) reported only four brief accounts that included terrestrial molluscs (from 1905 – 1945). Since the early 1990s, extensive surveys have been carried out in the Kootenay region, and over 700 sites have been surveyed (Table 2; Figure 4). Most of these surveys specifically targeted terrestrial gastropods, with the exception of those by Copley and Copley, which were general arthropod surveys in which all gastropods encountered were collected and subsequently identified. Surveys have been carried out mostly in autumn, which generally is the best time for locating terrestrial gastropods, especially slugs; at this time, conditions are favourable for gastropod activity (wet and mild) and most slugs are mature, facilitating their detection.

Pygmy Slug was first found by Biolinx Environmental Research Ltd. in 2007; their surveys in subsequent years (2008, 2009, 2010, 2013, 2014, and 2015) resulted in further records for the species. Surveys in September 2013 and 2014 were in support of the preparation of this status report and that of the Sheathed Slug, respectively, and focused on habitats of Pygmy Slug; the Sheathed Slug occurs in similar habitats (see Appendix 1 for survey sites and species found). In an attempt to better delineate the Pygmy Slugs' distribution in BC in 2013, areas outside its known range to the west, north, and east were surveyed, progressing inward towards the presumed core range in the West Kootenays. The surveys in 2013 resulted in seven and those in 2014 in 23 new records for Pygmy Slug (Sites 9 – 38 in Table 1 and Figure 3) but only marginally increased the EOO. Additional surveys supported by the BC Ministry of Environment in 2015 (Ovaska and Sopuck 2015) resulted in six new sites but did not expand the EOO.

Table 2. Summary of survey effort for terrestrial gastropods in southeastern British Columbia. Number of non-overlapping survey sites were calculated from GIS maps within the area of interest delineated in Figure 4.

Year	Months	# sites	Search time	Surveys conducted by:	Source or project*
1998-1999	September (1 in July)	40		RBCM (Kelly Sendall, Phil Lambert)	Living Landscape project; RBCM files
1990-2013	Various	135		Robert Forsyth	R. Forsyth personal main database (current up to 2013) and other unique sites; includes Flathead Bioblitz 2012
2007	July, September	63	66.1 person-hours	Biolinx Environmental Research Ltd (Kristiina Ovaska, Lennart Sopuck)	Ovaska and Sopuck 2009a
2008	September, October	45	48 person-hours	Biolinx Environmental Research Ltd (Kristiina Ovaska, Lennart Sopuck)	Ovaska and Sopuck 2009a
2009	October	17	20.9 person-hours	Biolinx Environmental Research Ltd (Kristiina Ovaska, Lennart Sopuck)	Ovaska and Sopuck 2009b
2009-2013	July - September	96		Claudia and Darren Copley	C. Copley data files
2008-2011	Various	85		Dwayne Lepitzki	Surveys in Alberta and BC; Lepitzki personal database
2010	September	56	67.9 person-hours	Biolinx Environmental Research Ltd (Kristiina Ovaska, Lennart Sopuck)	Ovaska *et al.* 2010
2011	August, September	29		Jeff Nekola, Brian Coles, Michael Horsek	Surveys for Valhalla Wilderness Society; Nekola *et al.* 2011
2012	August	6		Melissa Frey	Flathead Bioblitz; RBCM database; Note: additional sites that overlap with those of Forsyth are excluded.
2013	September	36	31.7 person-hours	Biolinx Environmental Research Ltd (Kristiina Ovaska, Lennart Sopuck)	Fieldwork associated with the preparation of COSEWIC status report for Pygmy Slug
2013	June	14		Dwayne & Brenda Lepitzki	Flathead Bioblitz; Lepitzki data files
2014	September	72	72.2 person-hours	Kristiina Ovaska & Lennart Sopuck	Gastropod surveys for BC Ministry of Environment and fieldwork associated with the preparation of COSEWIC status report for the Sheathed Slug
2015	September	36**	38.5 person-hours	Biolinx Environmental Research Ltd (Kristiina Ovaska, Lennart Sopuck)	Gastropod surveys for BC Ministry of Environment (Ovaska and Sopuck 2015)

*MoE-BC Ministry of Environment; RBCM-Royal British Columbia Museum

**6 sites were revisits to sites where Pygmy Slug or Sheathed Slug had been found previously.

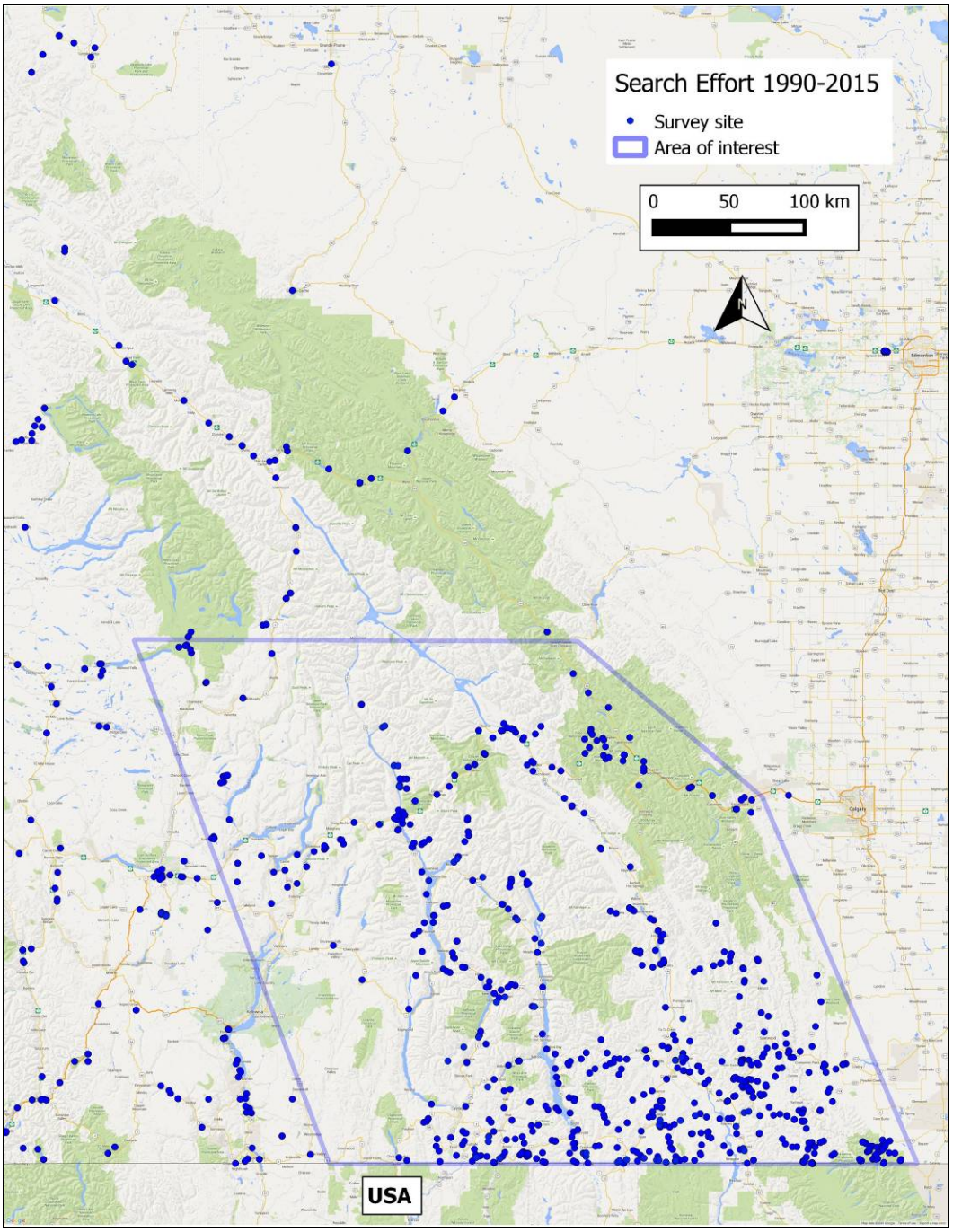

Figure 4. Overview of sites surveyed for gastropods in and around the range of Pygmy Slug in southeastern British Columbia (see Table 2 for data sources within the area of interest; map prepared by Lennart Sopuck).

HABITAT

Habitat Requirements

Across its global range, Pygmy Slug occurs in moist mixed-wood and coniferous forests, particularly in riparian habitats (Leonard *et al*. 2003; Hendricks and Maxwell 2005; Ovaska and Sopuck 2009a,b). Leonard *et al*. (2003) mentioned the close proximity of occupied sites to perennial water bodies, presumably because they contain suitable moist substrates. A predicted distribution model for Montana, based on the analysis of biophysical features at 20 known points and 60,000 random background points, showed that high suitability habitat was largely restricted to strips of riparian habitat along watercourses (Montana Government 2013). Observations in BC are also mostly from riparian habitats, frequently along fast-flowing creeks (Table 1). The riparian zone along these creeks was often confined to narrow strips in gullies, but in some cases the slugs were found in more expansive seepage areas with flatter terrain. Common understorey plants at occupied sites included Thimbleberry (*Rubus parviflorus*), Devil's Club (*Oplopanax horridum*), Lady Fern (*Athyrium filix-femina*), Wild Sarsaparilla (*Aralia nudicaulis*), Twinflower (*Linnea borealis*), and Foamflower (*Tiarella trifoliata*). The slugs are not inhabitants of open shorelines or wetlands, such as Cattail (*Typha latifolia*) marshes.

Pygmy Slug occurs from low to mid-elevations in Idaho (640 m – 700 m asl (above sea level); Leonard *et al.* 2003), Montana (762 m – 1372 m asl for most records; reported as 2500' – 4500'; Montana Government 2013), and BC (571 m – 1585 m asl; Table 1). Thirty six of the 44 (81.8%) Canadian records are from the Interior Cedar – Hemlock (ICH) Biogeoclimatic Zone (see Meidinger and Pojar 1991 for the classification of zones). Two sites are from the Montane Spruce (MS), two from the border of ICH and MS, and four from the Engelmann Spruce – Sub-alpine Fir (ESSF) zone (Table 1). The ICH zone occurs from low to mid-elevations in the lower slopes of the Columbia Mountains in southeastern BC, extending south to eastern Washington, Idaho Panhandle, and western Montana (Ketcheson *et al*. 1991). It is flanked from above along an elevational gradient by the ESSF zone. The ICH zone is characterized by cool, wet winters and warm, dry summers with much of the soil moisture derived from snowmelt. The growing season (with above 0°C temperatures) extends from two to five months, depending on the latitude and elevation. It is among the wettest interior BC zones, sharing features with moist coniferous forests along the Pacific Coast; it is sometimes referred to as the Interior Wet Belt. Productive upland coniferous forests are prevalent throughout the landscape, but topography and soil conditions have resulted in a mosaic of wetter and drier forest types with relatively high over- and understorey diversity.

In BC, Pygmy Slug has been found in mixed-wood and coniferous forest stands of varying ages, ranging from 40 – 50-year-old second growth to old growth (>200 years old) stands (Table 1). Western Redcedar (*Thuja plicata*) was present in 74%, Black Cottonwood (*Populus trichocarpa*) in 61%, Engelmann Spruce (*Picea engelmannii*) in 58%, and Western Hemlock (*Tsuga heterophylla*) in 42% of the 38 occupied sites. Other tree species included Grand Fir (*Abies grandis*), Amabilis Fir (*Abies amabilis*), Subalpine Fir (*Abies lasiocarpa*), Paper Birch (*Betula papyrifera*), Western Larch (*Larix occidentalis*), and rarely Lodgepole Pine (*Pinus contorta*). A moderate understorey of diverse shrubs was usually present and often included moisture-loving species, such as Thimbleberry and Devil's Club. Pockets of deeper leaf litter or relatively large amounts of coarse woody debris (mean = 14% coverage within 10 m from slug observations) were usually present (Ovaska and Sopuck, unpubl. data 2007 – 2014). Slugs were found in leaf litter, frequently within wet Cottonwood leaves, or under woody debris on the forest floor in moist situations. Common features among the sites included very moist substrates and abundant cover for the slugs to seek refuge. The availability of these microhabitat features may exert an overriding influence on the forest type or other coarse-scale habitat features.

Habitat Trends

Within the Pygmy Slug's Canadian range, most suitable habitats are on provincial and private forestry lands subjected to ongoing logging. The removal of tree cover, building of forestry roads, and silvicultural activities associated with forestry have had the greatest impact on the availability of habitat within the species' range, and logging continues to fragment and alter habitats. Ninety five percent of the known Pygmy Slug sites are within landscapes with ongoing logging (see **Threats**).

The Annual Allowable Cut (AAC) established for Crown lands on the three Timber Supply Areas encompassing the species' range (Arrow, Kootenay Lake, and Cranbrook) has been relatively constant over the past four decades (MFLNRO 2014a). The latest AAC for these Timber Supply Areas, covering the next 5 – 10 years, suggests that a slightly lower level of harvest will be maintained. Most of the timber harvested in the past was from old-growth and from maturing forests on naturally disturbed areas. In the future, a greater proportion of the harvest will be obtained from regenerating second growth stands. In areas where the forest was logged 50 – 60 years ago (mainly lower to mid-elevations), conditions in maturing forests may allow the slugs to re-colonize some previously logged areas. Such increases in habitat availability will only partially compensate for the continuing degradation of habitat from logging. It is important to note, however, that logging does not occur, or is restricted, in parks, conservation lands, near fish-bearing streams, community watersheds, old-growth management areas, and special resource management zones that are scattered throughout the slugs' range. The available land base for harvest for the Kootenay Lake Timber Supply Area, which encompasses over half of the slugs' range, is estimated at 42% of productive forest land, after accounting for these conservation areas and other constraints to logging (MFLNRO 2014b). Additional timber is harvested each year on private lands and by woodlot licensees on Crown land (quantitative information could not be found).

Livestock grazing on Crown forest lands is confined mainly to the drier southern and eastern portions of the species' range (iMapBC 2014). Range tenures on Crown lands are managed to avoid excessive grazing, potentially reducing impacts on riparian areas.

Land conversions for residential and industrial developments and for agriculture have resulted in the permanent loss of slug habitat mainly on private land at lower elevations, especially along river valleys, lake shores, and highways. However, the population density of the West Kootenay region is relatively low compared to other areas of southern BC, such as the Okanagan Valley and eastern Columbia Basin. Since 2001, the human population in the West Kootenay region has increased at a rate of only 1.3% per decade, reaching 64,379 people in 2011 (Columbia Basin Rural Development Institute 2012). Large population centres within the species' range occur at Nelson and Creston, and a few much smaller communities occur at Fruitvale, Kaslo, Nakusp, Slocan Valley, Moyie Lake and Yahk. The relatively large cities of Castlegar, Trail, and Cranbrook lie just outside the species' range.

Mining and quarrying activities are also present but involve a small percentage of the Pygmy Slug's range. Mining and placer claims are common throughout the species' range, especially in the south (Trail, Nelson, Salmo, Moyie Lake), and central (New Denver/Silverton) areas, and several mineral exploration projects are underway (Grieve 2010). Although new mines could be developed in the future, no mining projects are currently being assessed in the slugs' range (iMapBC 2014). However, immediately to the northeast near Trout Lake, the reopening and expansion of a mine for the mineral molybdenum is under review. Extensive habitat degradation from air pollution has occurred over the last 100 years in the vicinity of the smelter in Trail, on the periphery of the species' range.

Reservoirs associated with hydroelectric development have flooded large areas of potential slug habitat over the past century (Kootenay Lake and Pend D'Oreille within the range; Arrow Lakes, Duncan Lake, and Lake Koocanusa on the periphery). Several projects are underway to upgrade hydro power stations, but no large-scale creation or expansion of reservoirs are planned in the near future (iMapBC 2014). Power transmission line corridors are relatively common in the species' range and several more will likely be built to serve expanded hydro operations. Over 20 smaller-scale run-of river hydroelectric projects are also proposed or approved (1 is operational, 8 are approved and the remainder are under review) within the species' range (Wildsight 2014).

Recreational developments such as ski areas, tourist resorts and campgrounds are scattered over the Pygmy Slug's range, but infrastructure is limited at present. No large tourist developments are currently being assessed for the area (iMapBC 2014). The proposed Jumbo Glacier Resort development is located northeast of the species' range. Widespread recreational activities in the area include use of all-terrain vehicles, snowmobiles, and mountain bikes.

Previous and ongoing habitat fragmentation due to all human activities combined, especially at lower elevations, is a concern for Pygmy Slug. Fragmentation has occurred as a result of extensive logging, increased frequency of catastrophic wildfires (due to buildup of fuels to unnatural levels), the creation of large hydroelectric reservoirs, highway construction, urbanization, and land conversions for agriculture. The ICH biogeoclimatic zone is prone to periodic fire disturbance but to a lesser degree than drier biogeoclimatic zones in the southern interior of BC (Biodiversity Guidebook 1995). Logging on the other hand selectively removes high-value timber in moist, productive sites, resulting in fewer refuges being available to slugs after logging.

Climate Change

The West Kootenay Resilience Program (undated) has produced a series of documents addressing climate change and its implications in the West Kootenay region of British Columbia. Pygmy Slug occurs mainly in the south and middle subzones of the West Kootenays, and along the southern fringe of the north subzone. All models and scenarios examined project higher mean seasonal temperatures that increase progressively by 2020s, 2050s and 2080s (Utzig 2012a). By 2080, winters are predicted to be 2 – 5 C° warmer and 10 – 25% wetter and summers 3 – 7°C warmer and up to 30% drier than during the baseline period (poorest performance models excluded). Associated changes that have implications for Pygmy Slug include increase in summer moisture stress, potential increase in wildfires and insect and disease outbreaks that would reduce forest cover, and changes in seasonal stream flow patterns as a result of reduced snow-packs and summer droughts, which would alter the riparian areas inhabited by the slugs. Increase in the magnitude and frequency of extreme events, such as high intensity rain events, severe droughts, and wind storms, are also predicted (Utzig 2012a).

Wang *et al.* (2012) examined climate change effects on BC's 16 biogeoclimatic zones, which are based on large-scale climate gradients and widely used to classify ecosystems in the province (Meidinger and Pojar 1991). Models showed that climate envelopes supporting this zonation have already shifted since the 1970s (Wang *et al.* 2012). Projected into the future (2020s, 2050s, and 2080s) and across the entire province, the models predict a substantial expansion of moist continental cedar-hemlock forests, typical of the ICH zone where Pygmy Slug is found, potentially expanding this zone up to three-fold by 2080, with the ICH zone becoming the most common forest type in the province over the long term (Wang *et al*. 2012). At a regional scale, the projections are more complex and influenced by topography and local factors (Utzig 2012b). Climate models for the West Kootenays indicate that the ICH zone will expand over the long term under one of three climate change scenarios examined ("Warm/Moist" scenario), while it is predicted to be largely displaced by the Coastal Western Hemlock and Coast Transition-type ecozones, which also consist of moist forests, under the "Hot/Wet" scenario, and by the drier Grassland-steppe and Ponderosa Pine woodlands under the "Very Hot/Dry" scenario (Table 3.1 and Figure 3.5 in Utzig 2012b). The expansion of moist and wet forest types favourable to Pygmy Slug are mostly in the northern portion of the species' range and/or at higher elevations (>1000 m asl). Correspondingly, suitable habitat would shrink in the southern portion of the range and at lower elevations. Whether Pygmy Slug would be able to spread northwards and upwards in

pace with the ecosystem shifts to take advantage of the newly available habitats is questionable. The changes may be driven largely by extreme climatic events such as summer droughts or storms and mediated through pest outbreaks, fires or other disturbances rather than occurring through gradual transition (Pojar 2010; Utzig 2012b); also, novel bioclimatic zones may emerge with new combinations of seasonal climatic variables (Utzig 2012b), increasing the unpredictability of the projections.

Table 3. Summary of IUCN threats calculator assessment for Pygmy Slug. Those threat categories that were not applicable to the species are omitted (hence the numbering of threats has gaps).

Assessment date: 5 Feb-2014		Level 1 Threat Impact Counts	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	2	0
D	Low	4	6
Calculated Overall Threat Impact:		High	Medium

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)
2	Agriculture & aquaculture	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Serious (31-70%)	High (Continuing)
2.3	Livestock farming & ranching	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)
3	Energy production & mining		Negligible	Negligible (<1%)	Extreme - Serious (31-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Extreme - Serious (31-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing
4	Transportation & service corridors	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)
4.1	Roads & railroads	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)
4.2	Utility & service lines		Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)
5	Biological resource use	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)
5.2	Gathering terrestrial plants		Negligible	Restricted - Small (1-30%)	Negligible (<1%)	High (Continuing)
5.3	Logging & wood harvesting	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)
6	Human intrusions & disturbance		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)
6.1	Recreational activities		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)
7	Natural system modifications	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)
7.2	Dams & water management/use		Negligible	Negligible (<1%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)
8	Invasive & other problematic species & genes	CD	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)
8.1	Invasive non-native/alien species	CD	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)
10	Geological events		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
10.3	Avalanches/ landslides		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
11	Climate change & severe weather	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)
11.4	Storms & flooding	D	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)

Historical fire regimes and projections for the future under climate change have been examined in detail for the West Kootenays (Utzig *et al*. 2011). Over the first half of the 20th century, fires occurred almost annually and burned large areas, especially in the southern part of region, with annual burn exceeding 30,000 ha in some years (Figures 2 and 3 in Utzig *et al*. 2011). A threshold appeared to have been reached around 1940 with greatly diminished annual fire frequency until the 1980s, with slight increases thereafter. The decrease was associated with a cooling trend in spring and summer and fire suppression efforts in the latter half of the century. Projected into the future, all models showed increases in the area burned with the greatest increases in the north sub-region. Reflecting uncertainty, there is much variability in the outputs from the different models about the magnitude of the increase in fire frequency, but by 2050 the mean projected increase could be up to 300-fold in the north, 30-fold in the middle, and 15-fold in the south subzone. The projected increases are more modest by 2020, and only in the north exceed historical values recorded since the beginning of the 20th century (Figure 9 in Utzig *et al*. 2011).

BIOLOGY

Little information is available on the biology of Pygmy Slug, apart from natural history notes in the description of the species (Leonard *et al*. 2003) and information associated with subsequent distribution records from Montana and BC (Montana Government 2013; Ovaska and Sopuck, unpubl. data 2007 – 2014). Some general information can be gleaned from the biology of other arionid slugs.

Life Cycle and Reproduction

Pygmy Slug is hermaphroditic, possessing both female and male reproductive organs (Leonard *et al*. 2003). However, like most pulmonate gastropods, individuals probably exchange sperm (Tompa 1984); there is no evidence of self-fertilization in this species.

There is only one observation of egg-laying; a slug from Idaho laid a clutch of three eggs in captivity in July (Leonard *et al*. 2003). The oval eggs were large (1 x 1.8 mm versus 9 mm body length of the parent) and hatched seven weeks later in September. In Idaho, adults have been found both in spring and autumn (Leonard *et al*. 2003). The Montana Natural Heritage Program database contains 25 records of Pygmy Slug from September to November, with most records from October (Montana Government 2013). In BC, adults (based on body length $\geq$ 9 mm) and juveniles have been found from September to October (Table 1), but only a few targeted surveys have been conducted at other months. The smallest juveniles were 2 – 3 mm in length and were probably newly hatched.

Juveniles presumably overwinter, but the proportion of adults that do so is unknown. The generation time is probably 1 year or slightly more, based on the small body size of the adults and relatively short life spans of arionid slugs in general.

Physiology and Adaptability

Pygmy Slug is often associated with riparian habitats and appears to require a high level of environmental moisture. The degree to which it tolerates habitat disturbance is largely unknown, but it is most likely adversely affected by human activities that alter the hydrology of occupied sites and result in drying or flooding of the forest floor. Due to its small size and resulting ability to exploit moist microhabitats, subpopulations may persist in small remnant habitat patches, provided that moisture requirements are met. However, isolated habitat patches from where the species becomes extirpated are unlikely to be repopulated through immigration, at least over the short term.

Movements and Dispersal

Movements and dispersal of Pygmy Slug are unknown. Land snails in general have poor dispersal abilities if not aided by humans or transported by other passive means, such as wind or water (review in Cordeiro 2004). No passive means of transport are known for Pygmy Slug, but it is conceivable that the slugs may inadvertently attach to the fur of mammals such as bears, as speculated for other slugs (COSEWIC 2012).

Interspecific Interactions

Leonard *et al*. (2003) reported observations of Pygmy Slugs feeding on lichen growing on coarse woody debris on the forest floor. The slugs may also feed extensively on fungi, as reported for other slugs (*Prophysaon coeruleum*: McGraw *et al.* 2002), potentially aiding dispersal of their spores. In BC, Pygmy Slugs have been found on fungi growing on downed wood (Ovaska and Sopuck, unpubl. data 2013; Figure 1). Pygmy Slugs probably act as prey for a variety of forest floor invertebrates, such as ground beetles (Coleoptera: Carabidae) and centipedes (Chilopoda). Due to their small size, they are probably not actively hunted by small mammals but may be consumed by birds that forage on the forest floor.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

In BC, survey efforts have focused on elucidating the distribution of Pygmy Slug rather than on obtaining abundance estimates (see **Search Effort)**. Methods have consisted mainly of one or more observers walking through the area of interest and searching the forest floor, concentrating on microhabitats deemed important for gastropods, such as decaying logs, sloughed-off bark, stumps, rocks, or other cover-objects or moist refuges, and accumulations of moist leaf litter. Some of the surveys, including all of those during which Pygmy Slug have been found, included the amount of time spent in intensively searching suitable microhabitat as an index of search effort (Table 1 and references therein).

Abundance

Population sizes and densities are unknown, but the slugs appear to be patchily distributed in the landscape, even within apparently suitable habitats. Most observations in BC have consisted of 1 – 3 slugs per site, but concentrations of 8 – 16 slugs, including juveniles, were found on four occasions (at Sites 2, 8 15, and 34 in Table 1) within an area of approximately 10 – 15 m in diameter. At all sites, the species was usually detected within the first 10-15 minutes of search time or not found at all.

Comparisons of Pygmy Slug records with those of other native forest slugs in the Kootenay region of BC provide some information on their relative rarity. During surveys by Biolinx Environmental Research Ltd in 2007 – 2014, Pale Jumping-slug (*Hemphillia camelus*) was widespread and abundant when compared to Pygmy Slug; Magnum Mantleslug (*Magnipelta mycophaga*; COSEWIC status: Special Concern) was more widespread but found only at a few scattered sites; Reticulate Taildropper (*Prophysaon andersonii*) was found less frequently but has a wide distribution in BC, extending well beyond the Kootenays; Sheathed Slug (*Zacoleus idahoensis*; COSEWIC 2016) was found only infrequently and in the southern portion of Pygmy Slug's range.

Fluctuations and Trends

Pygmy Slug was discovered only recently (2007), and no information exists of fluctuations or population trends in Canada or the United States.

Rescue Effect

The closest Canadian records of Pygmy Slug to the international border with the United States are only 4 km north from eastern Washington State (Site 11 in Table 1 and Figure 3) and 7.6 km north from western Montana (Site 2 in Table 1 and Figure 3). The species has not been documented from Washington, but the habitat south from the BC border appears to be relatively continuous. In western Montana, there are records of the species from within approximately 5 km of the international border (Montana Government 2013). The examination of imagery from Google Earth® shows large clearcuts in the intervening area on the Canadian side, which would impede movements of slugs. However, some interchange of individuals with the United States could occur both through the east and west portions of the Pygmy Slugs' Canadian range over longer time frames within the constraints of poor dispersal abilities of the slugs and impediments posed by human land uses, such as roads, clearcuts, and settlements.

THREATS AND LIMITING FACTORS

Limiting Factors

Pygmy Slug exists at the northern limits of its global distribution in southeastern BC, where its distribution most likely reflects post-glacial expansion from refugia farther south. Its northward expansion is probably limited by a short growing season and/or long and cold winters. Drier forest types to the east probably limit its eastward expansion and explain the absence of the species from most of the East Kootenays. Complex topography and the resulting mosaic of drier and wetter habitats probably constrain its distribution both within and among watersheds. Logging has further fragmented habitats and reduced permeability of the landscape to movements and gene flow. Low dispersal ability and requirements for moist habitats limit the speed at which the slugs can colonize new habitats.

Threats

The IUCN threats calculator (Master *et al.* 2009) was used to assess threats to the Pygmy Slug (Table 3; Appendix 2). Threats were considered across the entire Canadian distribution of the species to account for possible undocumented sites, but using threats and land uses at known sites as guidance. The threats calculator method consists of scoring the scope, severity, and timing for each standard threat category; the overall threat impact is then computed from these ratings.

The overall threat impact for Pygmy Slug was scored as “high – medium”, where the range reflects uncertainty. Under the “high” impact scenario, there were two medium and four low impact threats, whereas under the “medium” impact scenario, there were six low impact threats. The two highest ranking threats, “climate change and severe weather” and “invasive, non-native species”, have much uncertainty associated with both the scope within the next ten years and the severity of the impacts on slug populations. Headings in the following narrative correspond to categories (or subcategories) of the threats calculator, in the approximate order of their perceived importance.

<u>Climate change and severe weather (threat impact medium – low; scope: pervasive; severity: moderate – slight):</u>

Severe weather and increased frequency of extreme events associated with climate change were considered pervasive in scope for Pygmy Slug (71 – 100% populations affected), because the entire Canadian range of the species is likely to be influenced by the same broad weather patterns. However, terrain and habitat features could modulate impacts on the slugs among watersheds and sites. The main impacts on the slugs will probably accrue from droughts and flood events, both of which are predicted to increase in frequency and severity under climate change scenarios (Utzig 2012a). Because of its reliance on habitats with high moisture, prolonged and severe summer droughts may be particularly devastating to local subpopulations of Pygmy Slugs both directly by increasing mortality and indirectly by reducing the length of time available for growth and reproduction. Series of years with droughts that extend well into the autumn are expected to be particularly detrimental. The Kootenay region of British Columbia experienced Stage 2 drought

conditions (dry) during May, June and July 2015, followed by Stage 3 conditions (very dry) from August to mid-September (BC Ministry of Forests, Lands and Natural Resource Operations 2015). Four sites where the species had been found in previous years were revisited in late September 2015; Pygmy Slug was found at two of these sites (Ovaska and Sopuck 2015). The drought may have reduced the abundance or detectability of the slugs, but the sample size is too small to draw reliable conclusions. The reduction in detectability was particularly evident at a site on the eastern periphery of the species' range, where nine Pygmy Slugs were found in 2013 but none in 2015. Whether the slugs were deeper in the substrate or had suffered declines is unknown.

Increased frequency of flooding events could result in mortality or displacement of slugs living close to water courses and could scour riparian areas of the duff layer and refuges. While flooding might be of short duration along mountain streams, its effects are potentially more devastating where the slugs inhabit flatter terrain that may remain inundated for longer periods.

Much uncertainty exists about the severity of the impacts of climate change and severe weather on Pygmy Slug, as reflected by the wide range of assigned threats calculator ratings. However, a precautionary approach is warranted because of the potentially widespread and serious nature of this threat. With a few exceptions, impacts associated with climate change are unstudied for terrestrial gastropods. The studies that do exist have focused on habitat shifts along altitudinal gradients in Europe and have projected range shrinkages and subpopulation declines for high elevation species (Müller *et al.* 2009) and upward altitudinal shifts for lower elevation species (Baur and Baur 2013). For Pygmy Slug, it is likely that proximate factors such as droughts that drive ecosystem shifts are more important than the shifts themselves; with its low dispersal capability and reliance on moist habitats, the slugs may not be able to track ecosystem shifts that may occur.

Invasive non-native species (threat impact medium – low; scope: restricted; severity: moderate to slight):

Non-native gastropods and other invertebrates pose a threat to native gastropods through competition for food and shelter, predation, and/or alteration of ecosystem processes and habitats. Over 20 species of non-native gastropods have been recorded from BC (Forsyth 2004). Although mostly found in disturbed areas, many are spreading into forested habitats. Humans continue to facilitate the spread of introduced gastropods across the province, where they can be found in most areas frequented by humans, including picnic sites, campsites, and rest stops along highways. Other widely introduced invertebrates in BC include carabid beetles (Coleptera: Carabidae), which can prey on gastropods (Symondson 2004), and earthworms, which can reduce or remove the duff layer through their actions with potentially detrimental effects on native forest floor invertebrates (Addison 2009). In the West Kootenays, introduced gastropods were found at only two of 38 known sites occupied by Pygmy Slug (Sites 1, 10), and were probably also present at at least two additional sites, readily accessed by recreational users (Sites 6, 11). Increased human access to the backcountry associated with resource extraction activities and an expanding road network will facilitate the spread of these and other introduced invertebrates to new areas.

Much uncertainty exists with the severity of impacts of introduced species on Pygmy Slug, as reflected by the wide range of threats calculator ratings. Introduced gastropods pose a threat to native gastropod faunas around the world (Mahtfeld 2000), but their effects in terrestrial habitats are generally poorly documented. An exception is island faunas, where alien invertebrate predators and competitors, including other gastropods, have been largely responsible for the demise of native land snail faunas (e.g., Hawaii: Hadfield *et al*. 1993; South Pacific: Cowie 2001). In BC, introduced gastropods include scavengers/predators, such as *Boettgerilla pallens* and *Oxychilus* species, and herbivores/detrivores, such as species of *Arion* that can become exceedingly abundant in suitable habitats and could have a demographic advantage over native species in competition for resources. Carabid beetles are known predators of terrestrial gastropods in both natural and disturbed habitats, and slugs form a large portion of the diet of many generalist carabids (Symondson 2004). While snail predators tend to be specialized, predation on slugs does not appear to require specific adaptations by the beetles. In the United Kingdom, carabid beetles with a large proportion of slugs in their diet were relatively large with strong mouth parts and had the ability to forage widely (Tod 1970, *cited in* Symondson 2004). Defences of slugs against carabid attacks include the production of copious amounts or highly viscous mucus, repellants or toxic chemicals in the mucus or tissues, and tail autotomy (Symondson 2004). Pygmy Slug is not known to possess any of these mechanisms and may rely on crypsis and small size to avoid predation. However, it may be defenceless against aggressive introduced predators, such as the carabid beetle *Carabus granulatus*, which was observed preying on native slugs (*Hemphillia camelus* and *Prophysaon andersonii*) in the West Kootenays during fieldwork for this report; the ability to autotomize the tail appeared to provide no advantage to *P. andersonii* (Ovaska and Sopuck, unpubl. data 2013). The site where *C. granulatus* was observed (Site 2013-13 in Appendix 1) is only 2.5 km from a known Pygmy Slug site.

Logging and wood harvesting (threat impact: low; scope: restricted; severity: moderate):

Most of the Canadian distribution of Pygmy Slug is within lands used for forestry. Large areas of the landscape have already been subjected to clear-cut and selective logging, and new logging continues to degrade habitat and fragment the species' range, but quantitative data on the amount of habitat affected over the next ten years are lacking. Harvesting of maturing second growth has started in the region, also at largely unknown rates. Effects of logging on the slugs would result from changes in moisture and temperature regimes on the forest floor due to canopy removal and from disturbance to the understorey vegetation and forest floor structure.

Based on visual estimation from forestry layers in iMapBC (2014) and Google Earth (2014; imagery from 2003-2013), 95% of the known Pygmy Slug sites are within landscapes with ongoing logging, but it is unknown how many new sites will actually be logged over the next ten years. Only one site (Site 35 in Table 1) is secure from logging. Pygmy Slugs may be able to persist in small forest patches or riparian buffers within logged sites, at least over the short term, as evidenced by their presence in such habitats within recently logged landscapes. However, it is conceivable that there is a time lag before the full effects of recent logging are manifested, and the long-term viability of subpopulations in these habitats is unknown.

Within logged landscapes, Pygmy Slug could receive protection from forested riparian buffers. Riparian buffers are required along larger, fish-bearing streams under the BC *Forest and Range Practices Act*, but there are no such requirements for small, fishless streams (S6 streams), along which Pygmy Slugs are usually found; nor are there required buffers for other non-classified drainage features, such as seepages. However, some forestry companies operating in the Kootenay region voluntarily leave buffers along all streams, regardless of their size or status (Stuart-Smith pers. comm. 2014). Even with voluntary efforts, many small streams are likely to be impacted, increasing the scope. In addition to riparian buffers, there is usually a 7 m wide no-machinery zone along creeks, although trees may be taken from this zone. Pygmy Slug habitat along creeks in steep-sided gullies would be buffered, because the terrain is usually too steep for timber harvesting (Stuart-Smith pers. comm. 2014).

Fire and fire suppression (threat impact low; scope: small; severity: moderate):

Fires are harmful to terrestrial gastropods by causing direct mortality and, perhaps more importantly, by altering habitat through reduction in shelter and food sources over the short and longer term (Jordan and Hoffman Black 2012). Due to their generally low mobility, gastropods are both unable to escape fire events by moving away and are slow to recolonize burnt areas. In the West Kootenay region, more frequent and severe fires are predicted as climate change proceeds (see **Habitat Trends**). The size and intensity of the burn are expected to greatly influence the outcome for gastropod populations; greatest effects are likely when the burn covers a large continuous area and extends deep into the ground, while smaller, discontinuous, and less severe burns would be less devastating. In the latter situation, gastropods could survive in underground refugia or unburned habitat patches, which could serve as sources for recolonization once the habitat regenerates. Riparian areas along small creeks inhabited by the slugs may be somewhat protected from fires that sweep the landscape, especially in steep gullies and on north-facing slopes; unburned streamsides within large recent burns were observed at such sites during fieldwork for this report (Ovaska and Sopuck, unpubl. data 2007-2013).

Several studies have reported negative effects of fire on species richness and/or abundance of terrestrial gastropods (review in Jordan and Hoffman Black 2012). Snails seem to be particularly vulnerable (Anderson 2004; Duncan 2005), but effects on slugs have also been reported (Duncan 2005). In southwestern Oregon, both the distribution and abundance of four species of terrestrial gastropods studied were reduced after low-intensity prescribed fires (Duncan 2005). The effects were more severe on snails than on slugs (e.g., Blue-grey Taildropper, *Prophysaon coeruleum*), but slugs were not found at over a quarter of the sites that supported them during pre-fire surveys. The author suggested that at sites with continued persistence, slugs survived in deep fissures in coarse rock substrate or other underground refuges and suggested that the distribution of microhabitats that allow for vertical movements is important for the long-term viability of slug populations within the landscape.

Roads and railroads (threat impact: low; scope: small; severity: moderate – slight):

Logging roads are prevalent throughout the Pygmy Slug's range, and a major highway is within 1 km of four known sites (Sites 1, 7, 10 and 34). Visual examination of the landscape within 1 km radius from each known site, based on iMapBC (2014), estimated road density as "high" at six sites (Sites 10, 11, 14, 18, 22, and 32) and low at seven sites (Sites 6, 12, 13, 26, 27, 34 and 35); the remaining 25 sites were rated as "medium" with respect to road density.

New roads associated with forestry and other types of resource extraction are likely to increase over the next ten years with the expansion of these activities to new areas. Adverse effects on slugs from new roads result from habitat loss on the road corridor and through edge effects that can extend far into the forest, from possible changes to drainage patterns, desiccation from increased wind and solar radiation and from habitat fragmentation through barriers to movements. Adverse effects on slugs may also accrue from traffic on existing roads, such as dust that extends into the surrounding forest, or reactivation of roads in previously logged areas. Road corridors may exacerbate effects of droughts through edge effects. However, because resource roads are usually not placed along water courses, their effects on Pygmy Slugs in riparian habitats are limited to stream crossings. Therefore, the scope for this threat was rated as "small" (1 – 10% of slugs affected) and would hover around the lower end of the spectrum (around 1%).

Livestock farming and ranching (threat impact low; scope: small; severity: moderate – slight):

Livestock are usually not free-ranged in dense, steep forested areas characteristic of the West Kootenays, and grazing tenures within the Pygmy Slug's range occur mostly in drier more open forests in the south and east (iMapBC 2014). However, where free-ranging does occur, cattle and other livestock tend to concentrate in riparian areas, where they can affect slug habitat by compacting soils and removing understorey vegetation. Signs of cattle use were observed at or in the vicinity of 5 (13%) of known sites occupied by Pygmy Slug (Appendix 2).

Cumulative Effects

Cumulative impacts result from additive or synergistic interactions among two or more threats, which would elevate the level of the overall threats. For Pygmy Slug, cumulative effects are likely to accrue from interactions among climate change and severe weather, fire and fire suppression, and forestry. Increased frequency and severity of prolonged summer droughts is likely to exacerbate the effects of logging (both recent and planned) and wildfires on the slug's habitat. For example, narrow forested riparian buffer zones that would otherwise support viable Pygmy Slug subpopulations may no longer do so under prolonged and more frequent droughts. Severe droughts will probably increase the frequency, areal extent, and intensity of wildfires, potentially resulting in the loss of subpopulations from local areas. Both interactions would increase habitat fragmentation and isolation of subpopulations of Pygmy Slugs. Any activities that increase human access, such as resource roads, increase the

potential for the introduction or spread of invasive, non-native gastropods and other invertebrates. Climate change and forest disturbance are also expected to facilitate their spread with largely unknown and untracked but potentially serious impacts on native gastropod faunas.

Number of Locations

The greatest plausible threats to Pygmy Slug, as per the threats calculator analysis, are from climate change and severe weather and from invasive and introduced species. Considering each occupied watershed as a separate location, where all slugs could be affected by a single threatening event (severe drought), then there are at least 28 locations; the exact number depends on how sub-drainages are delineated and which sites are combined; additional occupied watersheds may exist. Although droughts are likely to be broad-scale across the entire region, impacts on the slugs may be better assessed at watershed scale, depending on amount of logging in the landscape, width of riparian buffers, availability of coarse woody debris, and other site-specific conditions that affect refuges for slugs and moisture regimes on the forest floor. Similarly, effects of introduced invasive species could be considered at the watershed scale, as they may spread through a watershed after an initial introduction.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Currently, Pygmy Slug has no official protection or status under the federal *Species at Risk Act*, B.C. *Wildlife Act*, or other legislation.

Non-Legal Status and Ranks

NatureServe (2013) provides the following global, national, and sub-national rankings for Pygmy Slug: Global status - G2 (imperilled); United States - N2 (imperilled); Canada - N1 (critically imperilled); Idaho: S2 (imperilled); Montana - S1S2 (critically imperilled to imperilled; BC - S1? (possibly critically imperilled). In BC, the species is on the provincial red list of species at risk. In Montana, Pygmy Slug is designated as a Species of Concern (Montana Government 2013).

Habitat Protection and Ownership

Roughly 10% of the Canadian range of Pygmy Slug is within provincial parks, including Valhalla, Kokanee Glacier, West Arm, Lockhart Creek, Kianuko, Stagleap, Champion Lakes, and Kootenay Lake provincial parks (visual estimation from iMapBC protected areas layer). In March 2014, Bill 4, an amendment to the *Parks Act* was passed by the BC government. The bill allows for exploratory drilling, ore sampling and road building within BC Parks. Approximately 5% of the range is within provincial Wildlife Habitat Areas established for other species, or in other conservation lands (information from iMapBC). Additionally, the

Darkwoods Conservation Area, a large (55,000 ha) private property purchased by Nature Conservancy Canada in 2008 located between Nelson and Kootenay lakes and adjacent to West Arm Provincial Park and Midge Creek Wildlife Management Area, is within the core range of Pygmy Slug. This area encompasses 4% of the species' range, bringing the total percentage of protected lands to 19%. An additional 25% of the range is within community watersheds that receive some degree of protection. Pygmy Slug has not been recorded from any of the above areas with the exception of Site 11, which is within a small conservation area associated with a BC Hydro development. Additionally, Site 35 is within and Site 6 is immediately adjacent to Champion Lakes Provincial Park. Limited surveys within the Darkwoods Conservation Area (Copley, unpubl. data 2010 - 2012) have failed to locate Pygmy Slug.

Much of the range and most records of Pygmy Slug are from provincial forestry lands. As a provincially red-listed species impacted by forest and range practices, Pygmy Slug is potentially eligible for management under the Identified Wildlife Management Strategy of the B.C. *Forest and Range Practices Act*. However, it is not listed as identified wildlife at present, and hence no specific management measures are available or required. Riparian reserves around fish-bearing streams required under the act may help protect Pygmy Slugs persist in logged areas, but no such protection is required around smaller, non-fish-bearing (S6) streams. Some forest companies voluntarily leave reserve areas around all water courses, including S6 streams (Stuart-Smith pers. comm. 2014).

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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, after which she completed two post-doctoral studies in animal behaviour and population biology with McGill University and University of British Columbia, respectively. Presently, she is a partner in Biolinx Environmental Research Ltd., biologist with Habitat Acquisition Trust, and research associate at the Royal British Columbia Museum. 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, including the Kootenays. She has prepared status reports, recovery documents, 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 30 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

Collections at Royal British Columbia Museum were queried, but no specimens were examined.

Appendix 1. Summary of sites surveyed and gastropods found by Biolinx Environmental Research Ltd. (K. Ovaska and L. Sopuck) during fieldwork for this status report in September 2013 and for the Sheathed Slug (*Zacoleus idahoensis*) in September 2014 in the Kootenay region of British Columbia. Additional support for surveys in 2014 came from BC Ministry of Environment. [Editorial note: This table has been modified to remove geographic coordinates. The complete table can be obtained by contacting the COSEWIC Secretariat.]

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2013-1	Echo Lake Recr. Site, Akolkolex R. FSR, BC	859	Second-growth coniferous forest	80	20-Sep-13	50	*Arion rufus* (1), *Euconulus fulvus* (1), *Hemphillia camelus* (1), *Vertigo* sp (1)
2013-2	Akolkolex-Dumont FSR, BC	600	Coniferous old growth forest; moist & rich site	200	20-Sep-13	60	*Arion* sp. *(7), Cryptomastix mullani (2), Discus sp. (1), Discus whitneyi (1), Euconulus fulvus (1) Microphysula ingersollii (2), Nesovitrea sp. (1), Vitrina pellucida (3), Zonitoides sp. (1)*
2013-3	Akolkolex FSR (Site 1), BC	646	Second-growth mixed-wood forest; along small creek	50	20-Sep-13	60	*Discus whitneyi (12), Euconulus fulvus (1), Hemphillia camelus (1), Microphysula ingersollii (3), Nesovitrea sp.(2), Punctum randolphii (1), Vertigo sp (1), Vitrina pellucida (4)*
2013-4	Akolkolex FSR (Site 2), BC	635	Second-growth mixed-wood forest; along small creek	60-70	20-Sep-13	60	*Deroceras laeve* (1), *Discus* sp (1), *Hemphillia camelus* (8), *Microphysula ingersollii* (1)
2013-5	Little Fish Creek (near), off HWY 23, S of Revelstoke, BC	560	Second-growth mixed-wood forest; moist depression	30-40	20-Sep-13	40	*Allogona ptygophora (1), Discus whitneyi (6), Nesovitrea sp. (3), Zonitoides arboreus (1)*
2013-6	Eagle Bay Recr. Site, off Shelter Bay FSR, on Arrow Lake, BC	451	Second-growth coniferous forest; narrow strip of riparian habitat along small creek	70	20-Sep-13	90	*Prophysaon andersoni* (3), *Zonitoides arboreus* (2)
2013-7	Catherine Lake, W side of Upper Arrow Lake, BC	833	Second-growth mixed-wood forest; along lakeshore	40-50	21-Sep-13	60	*Allogona ptygophora* (9), *Euconulus fulvus* (3), *Hemphillia camelus* (6), *Zonitoides* sp (3)
2013-8	Fosthall/Mosquito Lake FSR, W of Upper Arrow Lake, BC	700	Older coniferous forest; moist depression	100	21-Sep-13	60	None
2013-9	Mosquito Lake Recr. Site, W of Upper Arrow Lake, BC	682	Older mixed-wood forest; narrow remnant strip of forest along lake shore	100	21-Sep-13	40	*Euconulus pratica*, *Vertigo* sp, *Zonitoides* sp
2013-10	Mosquito Cr. FSR, W of Upper Arrow Lake, BC	612	Young second-growth mixed-wood forest; along small creek	30	21-Sep-13	60	*Cryptomastix mullani (2), Hemphillia camelus (9), Microphysula ingersollii (1), Nesovitrea sp.(1), Vertigo sp (1), Vitrina pellucida (3)*
2013-11	Steven's Cr. Recr. Site, W of Upper Arrow Lake, BC	842	Second-growth mixed-wood forest, along fast-flowing creek	40-50	21-Sep-13	60	*Cryptomastix mullani (4), Euconulus fulvus (1), Hemphillia camelus (1), Nesovitrea sp.(1), Punctum randolphii (5), Vertigo sp. (1)*

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2013-12	Whatshan R. FSR (near east end of Whatshan Lake), BC	693	Second-growth mixed-wood forest; moist site	60	21-Sep-13	40	*Cryptomastix mullani (3), Discus whitneyi (4), Euconulus fulvus (2), Hemphillia camelus (1), Nesovitrea* sp. *(2), Zonitoides* sp. *(1)*
2013-13	McDonald Cr. Prov. Park, E side of Arrow Lake, BC	456	Second-growth mixed-wood forest; Disturbed camping area	70	21-Sep-13	120	*Allogona ptygophora* (1), *Arion rufus* (2), *Cepaea nemoralis* (20), *Hemphillia camelus* (1), *Prophysaon andersoni* (22)
2013-14	Slewiskin (McDonald) FSR (Site 1), S of Nakusp, BC	745	Older mostly coniferous forest; along fast-flowing tributary stream	100	22-Sep-13	40	*Discus whitneyi* (5), *Euconulus fulvus* (3), *Vertigo* sp (1), *Zonitoides* sp (2), *Zonitoides arboreus* (1)
2013-15	Slewiskin (McDonald) FSR (Site 2), S of Nakusp, BC	640	Second-growth mixed-wood forest; along fast-flowing tributary creek	60-70	22-Sep-13	60	*Allogona ptygophora (1), Cryptomastix mullani (3), Discus whitneyi (1), Kootenaia burkei (1), Microphysula ingersollii (2), Nesovitrea* sp. *(1), Planigyra clappi (6), Punctum randolphii (1), Vertigo* sp. *(8), Vitrina pellucida (3), Zonitoides arboreus (3)*
2013-16	East Wilson Cr. FSR (Site 1), N of New Denver, BC	673	Young second-growth mixed-wood forest; along fast-flowing tributary creek	40	22-Sep-13	50	*Discus whitneyi (20; may include Radiodiscus), Euconulus fulvus (2), Microphysula ingersollii (1), Nesovitrea* sp. *(3), Punctum randolphii (1), Radiodiscus abietum (1), Vertigo* sp. *(10), Zonitoides arboreus (1)*
2013-17	East Wilson Cr. FSR (Site 2), N of New Denver, BC	581	Second-growth mixed-wood forest; along fast-flowing tributary creek	40-50	22-Sep-13	60	*Arion* sp. *(2), Cryptomastix mullani (3), Discus whitneyi (2), Euconulus fulvus (2), Kootenaia burkei (1), Punctum randolphii (5), Vertigo* sp. *(10), Zoogenetes harpa (10)*
2013-18	Kane Cr. FSR, E of New Denver, BC	829	Second-growth mixed-wood forest; along fast-flowing tributary creek	70-80	22-Sep-13	60	*Arion* sp. *(3), Euconulus fulvus (1), Hemphillia camelus (2), Nesovitrea* sp. *(1), Oreohelix* sp. *(1), Radiodiscus abietum (1),Vertigo* sp. *(1), Zonitoides arboreus (1)*
2013-19	Keen Cr. FSR, W of Kaslo, BC	758	Old-growth coniferous forest; moist area along creek	200+	22-Sep-13	50	*Discus* sp. (1), *Euconulus fulvus* (3), *Pristiloma* sp (1), *Vertigo* sp. (3), *Zonitoides* sp (1)
2013-20	Kokanee Cr. Prov. Park, BC	558	Second-growth mixed-wood forest; Disturbed forest at campsite	80	22-Sep-13	80	*Arion rufus* (3), *Cepaea nemoralis* (50), *Cryptomastix mullani* (1), *Limax maximus* (1)
2013-21	Sentinel Mtn FSR, E of Castlegar, BC	526	Second-growth mixed-wood forest; forest edge at roadside	50	23-Sep-13	50	*Arion* sp. *(6), Arion intermedius (10), Cryptomastix mullani (9), Deroceras reticulatum (8), Discus whitneyi (25), Euconulus fulvus (4), Nesovitrea* sp.*ovitrea sp (2), Vertigo* sp. *(1), Vitrina pellucida (7), Zonitoides* sp. *(1)*
2013-22	Murphy Cr., S of Castlegar, BC	437	Young second-growth mixed-wood forest; Disturbed site along creek-side	30	23-Sep-13	40	*Cryptomastix mullani (4), Nesovitrea* sp. *(7), Punctum randolphii (1), Zonitoides arboreus (2)*
2013-23	Casino Cr., SE of Trail, BC	1070	Second-growth mixed-wood forest; seepage area within dry forest	70	23-Sep-13	60	*Anguispira kochi (3), Cryptomastix mullani (4), Euconulus fulvus (2), Punctum randolphii (2), Vertigo* sp. *(5), Zonitoides arboreus (2)*

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2013-24	Seven Mile Road, Pend d'Oreille, BC	521	Second-growth coniferous forest; Disturbed stream-side forest	60	23-Sep-13	40	*Allogona ptygophora (4), Deroceras reticulatum (4), Euconulus fulvus (1), Haplotrema vancouverense (2), Microphysula ingersollii (1), Prophysaon andersoni (1), Punctum randolphii (2), Vertigo* sp. *(2)*
2013-25	9 Mile Cr. (Site 1), Pend d'Oreille, BC	703	Young second-growth mixed-wood stand; Disturbed stream-side forest	30	23-Sep-13	40	*Cryptomastix mullani* (1), *Deroceras laeve* (2), *Discus whitneyi* (2), *Euconulus fulvus* (1), *Oreohelix* sp. (1)
2013-26	9 Mile Cr. (Site 2A), Pend d'Oreille, BC	618	Older coniferous forest; moist forest along creek	100	23-Sep-13	60	*Allogona ptygophora* (5), *Cryptomastix mullani* (4), *Euconulus fulvus* (1), *Kootenaia burkei* (1), *Oreohelix* sp (2), *Zacoleus idahoensis* (2)
2013-27	Sheep Cr. FSR (Site 1), S of Salmo, BC	1179	Older mixed-wood forest; riparian forest along fast-flowing tributary creek	100+	24-Sep-13	50	*Discus whitneyi* (1), *Euconulus fulvus* (15), *Kootenaia burkei* (3)
2013-28	Sheep Cr. FSR (Site 2), S of Salmo, BC	969	Second-growth mixed-wood forest; riparian area along fast-flowing creek	80	24-Sep-13	40	*Discus whitneyi* (1), *Euconulus fulvus* (20), *Hemphillia camelus* (3), *Kootenaia burkei* (2), *Prophysaon andersoni* (2), *Vertigo* sp. (1), *Zonitoides arboreus* (3)
2013-29	Ezekiel - Corn Cr. FSR, SW of Creston, BC	841	Second-growth coniferous forest; along fast-flowing creek	70-80	24-Sep-13	40	*Allogona ptygophora* (1), *Anguispira kochi* (1), *Cryptomastix mullani* (1), *Discus whitneyi* (1), *Euconulus fulvus* (5), *Microphysula ingersollii* (1)
2013-30	Spider-Kid Cr. FSR, E of Creston, BC	961	Older mixed-wood forest; along fast-flowing creek	100+	24-Sep-13	70	*Cryptomastix mullani* (3), *Discus* sp. (2), *Euconulus fulvus* (2), *Hemphillia camelus* (2), *Vertigo* sp. (5), *Zonitoides* sp (1)
2013-31	Carroll Cr. Road, W of Yahk, BC	993	Old-growth coniferous forest; moist area along creek	200+	24-Sep-13	50	*Kootenaia burkei* (1), *Zacoleus idahoensis* (1)
2013-32	Gold Cr. FSR, E of Cranbrook, BC	1199	Second-growth coniferous forest; moist stream-side in dry landscape	80	25-Sep-13	40	*Deroceras laeve* (1), *Discus* sp. (1), *Euconulus fulvus* (2), *Vertigo* sp. (3), *Zonitoides arboreus* (1)
2013-33	Teepee Cr. FSR, SE of Cranbrook, BC	1125	Older coniferous forest; moist creek-side	100	25-Sep-13	40	*Discus whitneyi* (1), *Euconulus fulvus* (1), *Kootenaia burkei* (9), *Vertigo* sp. (1)
2013-34	Plumbob Cr. FSR, SE of Cranbrook, BC	1059	Second-growth mixed-wood forest; moist depression and riparian area along slow-moving creek	80	25-Sep-13	40	*Discus whitneyi* (1), *Euconulus fulvus* (4), *Oreohelix* sp. (2)
2013-35	Caven Cr. FSR, ca. 4 km W of Koocanusa Lake, BC	810	Second-growth coniferous forest; moist depression in dry landscape	80	25-Sep-13	40	*Euconulus fulvus* (3), *Zonitoides arboreus* (2)
2014-1A	Wait Cr/Lost Dog Cr junction ca. 20 km NE from Kimberley, BC	867	Bottom of ravine in drier forest	20	16-Sep-14	170	*Euconulus fulvus* (10), *Microphysula ingersollii* (5), *Zonitoides arboreus* (1)

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2014-1B	Wait Cr/Lost Dog Cr junction ca. 20 km NE from Kimberley, BC	849	Tributary creek bed on floodplain (dry)	15	16-Sep-14	60	*Deroceras reticulatum* (25), *Euconulus fulvus* (1), *Nesovitrea* sp. (3), *Zonitoides arboreus* (1)
2014-1C	Wait Cr/Lost Dog Cr junction ca. 20 km NE from Kimberley, BC	856	Riparian area along creek in ranchland meadow	NA	15-Sep-14	40	*Deroceras reticulatum* (12), *Vitrina pellucida* (1), *Zonitoides nitidus* (3)
2014-2A	Kimberley Nature Park (Site 1), Kimberley, BC	1117	Riparian area along small, fast-flowing creek in shaded forest	70	16-Sep-14	50	I (2), *Discus* sp. (1), *Euconulus fulvus* (2), *Hemphillia camelus* (2), *Zonitoides arboreus* (2)
2014-2B	Kimberley Nature Park (Site 2), Kimberley, BC	1114	Riparian area along small, fast-flowing creek under cottonwoods in shaded forest	70	16-Sep-14	30	*Arion circumscriptus* (1), *Discus whitneyi* (3), *Euconulus fulvus* (3), *Nesovitrea* sp. (6), *Vitrina pellucida* (1), *Zonitoides arboreus* (2)
2014-2C	Kimberley Nature Park (Site C, Elmer Lake), Kimberley, BC	1144	Riparian area along small creek flowing into Elmer Lake in shaded forest	60	16-Sep-14	30	*Discus whitneyi* (5), *Euconulus fulvus* (12), *Zonitoides arboreus* (2)
2014-3	Norbury Provincial Park, NE of Cranbrook, BC	849	Moist pocket of habitat in woodlot in lowland depression	50	17-Sep-14	70	*Deroceras laeve* (3), *Discus whitneyi* (8), *Euconulus fulvus* (2), *Punctum randolphii* (1), *Vitrina pellucida* (15), *Zonitoides nitidus* (38)
2014-4	Bummers Flats (Site 1), NE of Cranbrook, BC	767	Forest edge on floodplain of Kootenay R.; patch of aspens (some large) and thicket of shrubs	60	17-Sep-14	50	*Deroceras laeve* (4), *Discus whitneyi* (2), *Euconulus fulvus* (1), *Euconulus pratica* (4), *Nesovitrea* sp. (1), *Zonitoides nitidus* (1)
2014-5	Rest area on HWY 95A (Lost Dog Creek area), ca. 10 km E of Kimberley, BC	892	Floodplain of river; dense spruce stands along river; periodic flooding	100	17-Sep-14	60	*Deroceras laeve* (1), *Deroceras reticulatum* (2), *Discus whitneyi* (5), *Euconulus fulvus* (2)
2014-6	Meachen Cr. Falls (Site 1), S of St. Mary's Lake, BC	1100	Ravine along river; lots of windthrow	100	18-Sep-14	60	*Hemphillia camelus* (1), *Vertigo* sp. (6)
2014-7	Meachen Cr. FSR (Site 2), ca 11 km S of St. Mary's Lake, BC	1208	Steep mossy ravine of fast-flowing tributary creek of Meach Cr.; rocky, substrate along creek	100+	18-Sep-14	50	*Hemphillia camelus* (5), *Vertigo* sp. (5)
2014-8	Meachen Cr. FSR (Site 3 at Fiddler Cr.), ca. 14 S of Mary's Lake, BC	1284	North-facing sloping side of ravine with young cottonwoods along fast-flowing tributary creek; pockets of deep leaf litter under cottonwoods	60-70	18-Sep-14	40	*Euconulus fulvus* (1), *Kootenaia burkei* (4), *Microphysula ingersollii* (1), *Vertigo* sp. (7)
2014-9	Meachen Cr. FSR (Site 4), S of St. Mary's Lake, BC	1457	Seepage on north slope		18-Sep-14	50	*Hemphillia camelus* (8)

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2014-10	Meachen Cr. FSR (Site 5) S of St. Mary's Lake, BC	1567	Mid-slope of forest sloping towards river; moist site but not riparian	150+	18-Sep-14	52	*Hemphillia camelus* (2)
2014-11	Hellroaring Cr. FSR (Site 1), S. of St. Mary's Lake, BC	1304	Cottonwood fringe along road in steep mid-slope forest	60-70	18-Sep-14	60	*Discus whitneyi* (3), *Kootenaia burkei* (1), *Microphysula ingersollii* (3), *Punctum randolphii* (1), *Vertigo* sp. (1), *Vitrina pellucida* (1)
2014-12	Hellroaring Cr. FSR (Site 2), S. of St. Mary's Lake, BC	1372	Narrow riparian zone along fast-flowing tributary creek through old clearcut; patch of old forest across road along stream (opposite side of road from search area)	20	18-Sep-14	68	*Euconulus fulvus* (2), *Hemphillia camelus* (9), *Magnipelta mycophaga* (1), M*icrophysula ingersollii* (2), *Punctum randolphii* (2), *Vertigo* sp. (1), *Zonitoides* sp. (1)
2014-13	Gold Cr. FSR (Site 1), ca. 35 km S of Cranbrook, BC	1113	Flat area along creek-side floodplain with some large spruce	100+	19-Sep-14	40	*Deroceras laeve* (8), *Deroceras reticulatum* (5), *Discus whitneyi* (12), *Euconulus fulvus* (4), *Microphysula ingersollii* (1), *Zonitoides arboreus* (2)
2014-14	Gold Cr. FSR (Site 2), W of Koocanusa Lake, BC	972	Well-drained flat area along creek-side	70	19-Sep-14	40	*Discus whitneyi* (1)
2014-15	Wickman Cr. FSR (Site 1), off Yahk R. FSR, W of Koocanusa Lake, BC	1159	Riparian floodplain along creek and upland forest edge (alder fringe)	40	19-Sep-14	50	*Deroceras laeve* (3), *Discus whitneyi* (8), *Euconulus fulvus* (1), *Microphysula ingersollii* (1), *Vitrina pellucida* (1)
2014-16	Wickman Cr. FSR (Site 2), off Yahk R. FSR, W of Koocanusa Lake, BC	1184	Cottonwood stand along creek in moist depression	40	19-Sep-14	50	*Discus whitneyi* (2), *Euconulus fulvus* (2), *Hemphillia camelus* (3), *Microphysula ingersollii* (3), *Vertigo* sp. (2), *Zonitoides* sp. (1)
2014-17A	Cherry Cr. FSR (Site 1), near Cherry Lake, BC	1231	Stunted forest on south-facing slope at south end of lake	40-50	19-Sep-14	70	*Discus whitneyi* (2), *Zacoleus idahoensis* (2), *Zonitoides* sp. (1)
2014-17B	Cherry Cr. FSR (Site 2), SW end of Cherry Lake, BC	1221	Rich alluvial site by stream (inlet/outlet of lake); selectively logged	80-90	20-Sep-14	44	*Hemphillia camelus* (3)
2014-17C	Cherry Cr. FSR (Site 3), near Cherry Lake, BC	1229	Alluvial flat by stream, perhaps seasonally flooded; moist site	80-90	20-Sep-14	50	*Discus whitneyi* (3), *Euconulus fulvus* (2), *Kootenaia burkei* (2), *Nesovitrea* sp. (1), *Zonitoides arboreus* (2)
2014-19	Bloom Cr. FSR (Site 1), BC	1213	Ravine in coniferous forest	100+	20-Sep-14	50	*Discus whitneyi* (4), *Euconulus fulvus* (1), *Hemphillia camelus* (1), *Zonitoides arboreus* (3)
2014-20	Bloom Cr. FSR (Site 2), BC	1246	Riparian zone along fast-flowing tributary creek in otherwise dry forest; north-facing, shaded site	50-60	20-Sep-14	80	*Euconulus fulvus* (1), *Hemphillia camelus* (11), *Microphysula ingersollii* (1), *Vertigo* sp. (2)

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2014-21	Bloom Cr. FSR (Site 3), BC	1269	Riparian area along small stream (trickle of water) in second growth forest	60	20-Sep-14	60	*Discus whitneyi* (2), *Euconulus fulvus* (1), *Hemphillia camelus* (5), *Kootenaia burkei* (1), *Punctum randolphii* (1), *Vertigo* sp. (1)
2014-22	Yahk R FSR (Site 1; near Blacktail Cr.), BC	1595	Seepage along small creek in spruce forest on north-facing slope	120+	20-Sep-14	70	*Hemphillia camelus* (2), *Microphysula ingersollii* (3), *Punctum randolphii* (1), *Zacoleus idahoensis* (1)
2014-23	Gilnockie Cr. (Rec site), off Yahk R FSR, BC	1051	Riparian floodplain forest by creek	80	21-Sep-14	40	*Deroceras reticulatum* (1), *Euconulus fulvus* (1), *Hemphillia camelus* (1), *Zonitoides arboreus* (1)
2014-24	Yahk R FSR (Site 2), BC	1105	Riparian area by slow-moving tributary creek; mostly clearcut, some selective cutting (with some older trees ca. 70 years old)	20	21-Sep-14	40	*Allogona ptygophora* (2), *Oreohelix strigosa* (1)
2014-25	Yahk R FSR (Site 3), BC	1111	Moist, periodically flooded alluvial site along fast-slowing larger stream (Yahk River); forest gap with abundant understorey vegetation	100	21-Sep-14	40	*Allogona ptygophora* (4), *Euconulus fulvus* (2), *Kootenaia burkei* (1), *Magnipelta mycophaga* (1), *Microphysula ingersollii* (1), *Oreohelix* sp. (1), *Zonitoides arboreus* (1)
2014-26	Yahk R FSR (Site 4), BC	1216	Riparian forest along small tributary stream	60-70	21-Sep-14	50	*Discus whitneyi* (1)
2014-27	Yahk R FSR (Site 5), BC	1147	Riparian forest along stream; clearcut on other side of stream	80-100	21-Sep-14	110	None
2014-28	Yahk R FSR (Site 6) at Malpas Cr. FSR, BC	1323	Older moist coniferous stand with small canopy gaps and depressions with herbaceous vegetation	100+	21-Sep-14	50	*Euconulus fulvus* (1), *Hemphillia camelus* (2), *Microphysula ingersollii* (1), *Vertigo* sp. (1)
2014-29	Yahk R FSR (Site 7), BC	1627	Riparian forest along tributary creek in otherwise dry, pine-dominated forest	80	21-Sep-14	40	None
2014-30	Yahk R FSR (Site 8), BC	1612	Patch of trees in ravine	60-70	21-Sep-14	60	*Zacoleus idahoensis* (1)
2014-32	Lamb Cr. FSR (Site 1), W of Moyie, BC	1121	Moist riparian floodplain in narrow ravine (1-sided) within landscape of shelter wood logging; several very large cottonwoods	70	22-Sep-14	40	*Deroceras laeve* (1), *Discus whitneyi* (12), *Euconulus fulvus* (1), *Kootenaia burkei* (1), *Microphysula ingersollii* (1), *Punctum randolphii* (1), *Vertigo* sp. (4)

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2014-33	Tate Cr. FSR (Site 1),off Lamb Cr. FSR, BC	1194	Riparian buffer (50-75m wide) in rich floodplain along creek	80	22-Sep-14	40	*Discus whitneyi* (1), *Hemphillia camelus* (1), *Kootenaia burkei* (5), *Vertigo* sp. (1), *Vitrina pellucida* (1)
2014-34	Tate Cr. FSR (Site 2),off Lamb Cr. FSR, BC	1392	Forested ravine along small creek (riparian zone <20 m) and surrounding upland coniferous forest	150	22-Sep-14	50	*Euconulus fulvus* (2), *Hemphillia camelus* (2), *Kootenaia burkei* (2), *Microphysula ingersollii* (1), *Vertigo* sp. (3)
2014-35	Tate Cr. FSR (Site 3),off Lamb Cr. FSR, BC	1384	Moist coniferous forest with little understorey except in canopy gaps and old road/trail that traverses site; transitional forest between ICH and ESSF	125+	22-Sep-14	40	*Euconulus fulvus* (1), *Hemphillia camelus* (1), *Microphysula ingersollii* (2), *Vertigo* sp. (1), *Zonitoides arboreus* (2)
2014-36	Irishman R. FSR, near Moyie, BC	971	Floodplain of creek in pocket of cedars, continuous with older forest along creek	60-70	22-Sep-14	40	*Discus whitneyi* (1), *Hemphillia camelus* (1), *Kootenaia burkei* (1)
2014-37	Hawkins-Canuck Cr FSR (Site 1), E of Yahk, BC	1041	Shallow ravine with an intermittent, small creek; moist, north-facing site with abundant hebaceous vegetation	70	23-Sep-14	70	*Allogona ptygophora* (7), *Anguispira kochi* (6), *Discus whitneyi* (12), *Hemphillia camelus* (2), *Magnipelta mycophaga* (2), *Prophysaon andersoni* (45), *Punctum randolphii* (1)
2014-38	Hawkins-Canuck Cr FSR (Site 2), E of Yahk, BC	1222	Shallow ravine with flowing creek and narrow riparian zone	50-60	23-Sep-14	40	*Discus whitneyi* (15), *Euconulus fulvus* (3), *Hemphillia camelus* (4), *Punctum randolphii* (1), *Vertigo* sp. (4)
2014-39	American Cr. FSR, off Hawkins Cr, Meadow Rd, E of Yahk, BC	1135	Canopy gap with abundant herbaceous growth on sloping terrain in moist forest; seepage area (mostly dry) on site	60-70	23-Sep-14	60	*Anguispira kochi* (60), *Discus* sp. (20), *Oreohelix strigosa* (4), *Prophysaon andersoni* (1), *Zacoleus idahoensis* (1)
2014-40	West Yahk Rd, West of Yahk, BC	1150	Bottom of gully of small tributary creek (to Hawkins Cr) and surrounding forest	100+	23-Sep-14	80	*Allogona ptygophora* (1), *Discus whitneyi* (10), *Euconulus fulvus* (3), *Vitrina pellucida* (1), *Zacoleus idahoensis* (4)
2014-41	Cold-Freeman FSR (Site 1), off Hawkins FSR, E of Yahk, BC	1277	Forest edge and ravine along small creek, parallel to road	70-80	23-Sep-14	40	*Deroceras laeve* (3), *Hemphillia camelus* (2), *Microphysula ingersollii* (1)
2014-42	Cold-Freeman FSR (Site 2), off Hawkins FSR, E of Yahk, BC	1179	Moist riparian area with hummocks and depressions along creek	70-80	23-Sep-14	40	*Discus whitneyi* (3), *Euconulus fulvus* (2), *Kootenaia burkei* (2)
2014-43	Goat R FSR (Site 1), NE of Creston, BC	849	Narrow riparian zone by fast-flowing tributary creek	70	24-Sep-14	40	*Discus whitneyi* (3), *Euconulus fulvus* (2), *Microphysula ingersollii* (3), *Punctum randolphii* (2)

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2014-44	Skelly Cr FSR (Site 1), off Goat Cr. FSR, NE of Creston, BC	944	Riparian floodplain along creek	60-70	24-Sep-14	40	*Discus whitneyi* (1), *Kootenaia burkei* (1), *Microphysula ingersollii* (2), *Punctum randolphii* (1), *Vertigo* sp. (1)
2014-45	Skelly Cr FSR (Site 2), off Goat Cr. FSR, NE of Creston, BC	1095	Narrow (ca 10 m wide) riparian zone along fast-flowing tributary creek, surrounded by dense coniferous forest with little understorey	40-50	24-Sep-14	56	*Discus* sp. (2), *Kootenaia burkei* (1), *Microphysula ingersollii* (1), *Vertigo* sp. (1)
2014-46	Goat R FSR (Site 2), NE of Creston, BC	1092	Moist depression within ca. 50 m from river	60-70	24-Sep-14	40	*Deroceras laeve* (1), *Euconulus fulvus* (2), *Kootenaia burkei* (1), *Microphysula ingersollii* (3), *Vertigo* sp. (1), *Zonitoides arboreus* (2)
2014-47	Mt. Thompson FSR (Site 1), E of Creston, BC	855	Moist riparian area along fast-flowing creek in otherwise dry coniferous slope with little understory	90-100	24-Sep-14	54	*Anguispira kochi* (1), *Discus whitneyi* (5), *Euconulus fulvus* (1), *Kootenaia burkei* (1), *Punctum randolphii* (1)
2014-48	Mt. Thompson FSR (Site 2), E of Creston, BC	1538	Seepage area in ravine/canopy gap	150+	24-Sep-14	40	*Discus whitneyi* (1), *Euconulus fulvus* (1), *Vitrina pellucida* (1)
2014-49	Sanca Cr FSR (Site 1), N of Creston, BC	1189	Narrow (ca 10 m wide) riparian zone along fast-flowing tributary creek in otherwise dry, pine-dominated landscape; rare, moist area	40	25-Sep-14	40	*Hemphillia camelus* (1), *Kootenaia burkei* (5), *Microphysula ingersollii* (1), *Nesovitrea* sp. (1), *Punctum randolphii* (2)
2014-50	Sanca Cr FSR (Site 2), N of Creston, BC	1339	Coniferous slope in older forest; small seepage at site	100+	25-Sep-14	40	*Discus whitneyi* (4), *Euconulus fulvus* (4), *Hemphillia camelus* (1), *Punctum randolphii* (1), *Vertigo* sp. (1), *Zonitoides arboreus* (2)
2014-51	Sanca Cr FSR (Site 3; South Fork), N of Creston, BC	1360	Riparian area along small tributary creek in older coniferous forest at valley bottom	150+	25-Sep-14	44	*Hemphillia camelus* (2), *Vertigo* sp. (1)
2014-52	Sanca Cr FSR (Site 4; South Fork), N of Creston, BC	1585	Moist riparian area on floodplain along stream in older forest; abundant blowdown and big boulders	100+	25-Sep-14	40	*Euconulus fulvus* (2), *Kootenaia burkei* (1)
2014-53	Duck Lake (Site 1), Creston Valley, BC	544	Cottonwood stand on floodplain along Kootenay River	50-60	25-Sep-14	30	*Allogona ptygophora* (100+), COCLU (1), *Deroceras reticulatum* (1), *Oreohelix strigosa* (100+)
2014-55	Dodge Cr. FSR (Site 1), S of Creston, BC	1052	Narrow riparian zone along small, dry tributary creek and surrounding upland forest	30-40	26-Sep-14	46	*Anguispira kochi* (13), *Discus whitneyi* (1), *Hemphillia camelus* (2), *Oreohelix strigosa* (1), *Vitrina pellucida* (1)

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2014-56	Dodge Cr. FSR (Site 2) at Dodge Cr, S of Creston, BC	1325	Riparian zone in young forest at headwaters of Dodge Cr; landscape is otherwise dry with clearcutting and only a few creeks	30-40	26-Sep-14	80	*Anguispira kochi* (4), *Discus* sp. (3), *Euconulus fulvus* (3), *Hemphillia camelus* (7), *Kootenaia burkei* (1), *Microphysula ingersollii* (1), *Punctum randolphii* (1), *Vertigo* sp. (50), *Vitrina pellucida* (1)
2014-57	Blazed Cr/Jersy Cr FSR off HWY 3, W of Creston, BC	1102	Older coniferous forest along fast-flowing creek	100+	26-Sep-14	44	*Anguispira kochi* (3), *Cryptomastix mullani* (1), *Discus whitneyi* (2), *Hemphillia camelus* (1), *Nesovitrea* sp. (1), *Oreohelix* sp. (1), *Zonitoides arboreus* (1)
2014-58	Maryland FSR (Site 1) off HWY 3, W of Creston, BC	1508	Subalpine open forest; very moist	100+	26-Sep-14	54	*Hemphillia camelus* (2), *Pristiloma chersinella* (1)
2014-59B	Boundary Lake off Boundary L. FSR, W of Creston, BC	1288	Moist old growth forest with seepages close to lakeshore	150+	26-Sep-14	50	*Deroceras laeve* (1), *Discus whitneyi* (1), *Hemphillia camelus* (1), *Pristiloma chersinella* (1)
2014-59C	Boundary Lake, W of Creston, BC	1288	Moist old growth forest with seepages close to lakeshore	150+	26-Sep-14	130	*Hemphillia camelus* (2)
2014-60	Maryland Cr FSR, W of Boundary L, BC	1300	Moist coniferous old growth stand by stream	125+	27-Sep-14	40	*Discus whitneyi* (1), *Hemphillia camelus* (2), *Vertigo* sp. (1)
2014-61	Monk Cr FSR, W of Creston, BC	1411	Moist old coniferous forest with productive deep soil in swale	100+	27-Sep-14	60	*Discus whitneyi* (5), *Kootenaia burkei* (2), *Magnipelta mycophaga* (1), *Pristiloma chersinella* (5), *Punctum randolphii* (2)
2014-62	Stagleap Provincial Park (from Monk Cr FSR Entrance), Kootenay Pass, BC	1960	High elevation old growth forest, very moist	150+	27-Sep-14	58	*Hemphillia camelus* (1), *Vitrina pellucida* (1)
2014-64	Rosebud Lake Rd. S of Salmo, BC	810	Shrubby riparian zone along small creek in ravine within mostly young, logged landscape	20	27-Sep-14	48	*Allogona ptygophora* (1), *Arion circumscriptus* (1), *Arion rufus* (2) *Cochlicopa lubrica* (1), *Deroceras laeve* (2), *Discus whitneyi* (8), *Euconulus fulvus* (1), *Vertigo* sp. (1), *Zonitoides* sp. (3)
2014-65	HWY 6 to Nelway (small spur), S of Salmo, BC	668	Moist riparian area along stream	40-60	27-Sep-14	126	*Discus whitneyi* (1), *Haplotrema vancouverense* (1), *Kootenaia burkei* (8), *Nesovitrea* sp. (2)
2014-66A	Champion Lakes (Site 1), N of Trail, BC	1072	Moist old forest with small creek	120+	28-Sep-14	140	*Anguispira kochi* (3), *Cryptomastix mullani* (5), *Discus whitneyi* (10), *Euconulus fulvus* (4), *Nesovitrea* sp. (1), *Punctum randolphii* (2), *Zonitoides arboreus* (1)
2014-66B	Champion Lakes (Site 2), N of Trail, BC	1079	Old forest with abundant well-decayed moist wood	100+	28-Sep-14	40	*Discus whitneyi* (1), *Kootenaia burkei* (1)
2014-67	Nine Mile Rd, S of Fruitvale, BC	850	Disturbed forest in moist depression	40-50	28-Sep-14	50	*Cryptomastix mullani* (2), *Discus whitneyi* (10), *Euconulus fulvus* (6), *Hemphillia camelus* (2), *Nesovitrea* sp. (1), *Oreohelix strigosa* (18), *Prophysaon andersoni* (12), *Zonitoides arboreus* (1)

Site ID	Site description	Elev. (m)	Habitat type	Stand age (yrs)	Date	Search effort (person-min)	Species found (# of animals)
2014-68	Bear Cr FSR, N of Fruitvale, BC	724	Moist disturbed site in ravine with small creek within landscape of drier forest	40-50	28-Sep-14	40	*Anguispira kochi* (16), *Cryptomastix mullani* (3), *Discus whitneyi* (16), *Hemphillia camelus* (1), *Nesovitrea* sp. (1), *Zonitoides arboreus* (1)
2014-69	Bear Cr FSR (Site 2), N of Fruitvale, BC	821	Ravine with small creek at bottom in patch of second-growth coniferous forest	50-60	28-Sep-14	40	*Deroceras laeve* (1), *Discus whitneyi* (2), *Euconulus fulvus* (4), *Zonitoides arboreus* (1)
2014-70	King George VI Prov Park, off HWY 22, S of Rossland, BC	693	Moist forest edge by dried up creek	80	28-Sep-14	40	*Allogona ptygophora* (3), *Arion circumscriptus* (30), *Cryptomastix mullani* (2), *Euconulus fulvus* (10), *Oreohelix strigosa* (1), *Prophysaon andersoni* (23), *Zonitoides arboreus* (1)
2014-71	Archibald - Tillicum FSR (Site 1), SW of Salmo, BC	879	Moist shady forest with big old stumps in depression along creek	70	29-Sep-14	70	*Discus whitneyi* (3), *Haplotrema vancouverense* (1), *Hemphillia camelus* (1)
2014-72	Archibald - Tillicum FSR (Site 2), SW of Salmo, BC	1229	Moist riparian zone along small creek within logged landscape	50-60	29-Sep-14	50	*Euconulus fulvus* (3), *Hemphillia camelus* (2), *Kootenaia burkei* (5), *Microphysula ingersollii* (2), *Vertigo* sp. (10)
2014-73	Erie Cr FSR (Site 1), N of Erie, NW of Salmo, BC	991	Moist ravine along small creek within landscape of dry, younger (logged) forest	60-70	29-Sep-14	40	*Discus whitneyi* (2), *Euconulus fulvus* (2), *Kootenaia burkei* (2), *Nesovitrea* sp. (3), *Punctum randolphii* (2), *Zonitoides arboreus* (1)
2014-74	Erie Cr FSR (Site 2), N of Erie, NW of Salmo, BC	915	Moist riparian floodplain forest	100+	29-Sep-14	40	*Hemphillia camelus* (3), *Kootenaia burkei* (1)

Appendix 2. Threats calculator results, with notes, for Pygmy Slug based on conference call in May 2014.

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	*Kootenaia burkei*
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	2/5/2014
Assessor(s):	Ian Adams, Joe Carney, Dave Fraser, Andrew Hebda, Gerry Mackie, Rob McQuarry, Dwayne Lepitzki, Julie Perrault, Kristiina Ovaska, Lennart Sopuck, Kari Stuart-Smith, (revision of initial assessment by Ovaska and Sopuck based on comments)
References:	Draft COSEWIC status report

Overall Threat Impact Calculation Help:

	Threat Impact	Level 1 Threat Impact Counts: high range	low range
A	Very High	0	0
B	High	0	0
C	Medium	2	0
D	Low	4	6
	Calculated Overall Threat Impact:	High	Medium

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	1 site (7% of 15) near town that might expand; over the entire range, residential development probably minimal in slug habitats, although river valleys may be targeted.
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	2 sites (13%) affected; may be expansion in Roseberry area or infrastructure associated with Pend d'Oreille dam
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	No plans for new developments known
2	Agriculture & aquaculture	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Serious (31-70%)	High (Continuing)	No specific examples known in slug habitat, but expansion of hay fields could occur; slug habitat in areas of productive soils
2.2	Wood & pulp plantations						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	Ranching mostly in drier areas of West Kootenays; cattle tend to concentrate in riparian areas; affect understory plants and riparian areas by compacting soils and removing vegetation; some cattle in Hawkins Creek area, but no free-range cattle in most areas within the species' range. Few tenures for grazing within the slug's range, mostly in SE part of range.
2.4	Marine & freshwater aquaculture						
3	Energy production & mining		Negligible	Negligible (<1%)	Extreme - Serious (31-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
3.1	Oil & gas drilling						No oil and gas drilling or extraction within the slug's range at present
3.2	Mining & quarrying		Negligible	Negligible (<1%)	Extreme - Serious (31-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Sub-surface mining grants in the immediate vicinity of 3 sites (20% of 15 sites), but their developed probability within next 10 years is low; lots of exploration but likelihood of new operating mines is low. Historically, lots of mining exploration, but looking into the future, scope is probably <1%
3.3	Renewable energy						Possible on some of some ridges, but no examples known.
4	Transportation & service corridors	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	
4.1	Roads & railroads	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High (Continuing)	All sites are near (within 1 km) roads, and roads are expanding to new areas with resource extraction. Effects on slugs are from habitat loss (corridor & through edge effects), possible changes to drainage patterns, and habitat fragmentation (barriers to movements) associated with new roads, and habitat degradation from traffic on existing roads (e.g., dust). New resource roads are seldom (if ever) built along creeks but will cross them - therefore amount of slug habitat that is lost is small. Scope hovers around the low end (around 1%) and could be negligible.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.2	Utility & service lines		Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)	Power transmission lines present at 4 sites (27% of 15 sites). Effects are from land clearing associated with the expansion of existing lines or construction of new lines; likelihood of new lines (apart from minor ones to individual houses) is small. Maintenance activities such as brushing are not a threat because habitat has already been lost. Severity higher than for roads because of larger footprint & edge effects.
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants		Negligible	Restricted - Small (1-30%)	Negligible (<1%)	High (Continuing)	Mushroom picking; mostly in recent burns but also in forest; some sites are near known mushroom picking areas.
5.3	Logging & wood harvesting	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	Logging (clearcut, selective cut) is present within 1 km of records at all sites; some is old (from 1960s - 1980s), but second growth harvesting occurring at least at some sites; difficult to get information on trends for next 10 years. Riparian leave strips mitigate effects to some degree, if left on small creeks that slugs occupy. Forestry buffers are not required in small creeks with no fish (S6 streams), but some forestry companies voluntarily leave buffers along them (Kari Stuart Smith pers. comm. 2013). Despite of voluntary efforts, many small streams are likely to be impacted, increasing the scope. There is usually also a 7 m wide no-machinery zone along creeks, but trees may be taken from this zone. Non-classified drainages (such as seepages) don't need to be buffered. Gullies would be buffered because the terrain is usually too steep for harvesting. Scope elevated from Small - Restricted to Restricted in response to review comments (on 24 Jun-14), reflecting lack of requirements for buffers for small streams and seepages.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	Recreation affects 6 known sites (40% of 15 sites), based on proximity to trailheads & other recreational opportunities; scope lowered much of overall is away from well travelled areas (e.g., big mountaneous parks). Impacts are from ATV use & snowmobiling (soil compaction & damage to vegetation); hiking on trails has little or no impact.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	ICH is relatively wet zone, and stand-replacing events are rare. Fires may occur in drier areas of the zone. Fires tend to be more severe when they do happen, due to fire suppression and climate change. Fires seem to be getting hotter and more severe in the area. Fire retardants using in fighting fires can also be detrimental to slugs, but no data are available.
7.2	Dams & water management/use		Negligible	Negligible (<1%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	One known site is by a hydro-electric dam, which could potentially be expanded or changing water levels could affect this site. Run-of-river projects could affect the slugs, but no plans found in iMap within the slug's range (note: iMap data not complete; several are approved or proposed within the slugs' range, as per revised draft report)
7.3	Other ecosystem modifications		Unknown	Unknown			Silviculture systems modifying forest compositions, e.g., predominant planting Douglas-fir
8	Invasive & other problematic species & genes	CD	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species	CD	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)	Introduced gastropods are present or potentially present at 4 occupied sites (27% of 15 sites); other introduced macro-invertebrates, including predators, such as ground beetles, may also be present at these sites. The introduced carabid bettle *Carabus granulatus* has been observed preying on native slugs in the West Kootenays only a couple km away from known Pygmy Slug site (Ovaska and Sopuck, unpubl. data 2013). Much uncertainty exists with impacts of introduced species.
8.2	Problematic native species						
8.3	Introduced genetic material						
9	Pollution						
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents		Unknown	Unknown	Unknown		Fuel spill associated with fighting a forest fire 2 km downstream of the Lemon Creek site (Site 4) on 26 July 2013. Pesticides & herbicides generally not used in forestry in the area. Fertilizers: occasionally applied to planted areas but not a common practice.
9.4	Garbage & solid waste						
9.5	Air-borne pollutants		Unknown				
9.6	Excess energy						
10	Geological events		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Example: large landslide at Johnsons Landing by Kootenay Lake, just northeast of the known range of the species in 2012
11	Climate change & severe weather	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
11.1	Habitat shifting & alteration						ICH will expand with climate warming but the slugs may not be able to take advantage of new areas due to pace of change.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Probably main issue for slugs. More prolonged and severe summer droughts are predicted. Much uncertainty with both scope and severity. Although climate patterns and droughts would be region-wide, slugs in different parts of the range may be affected differently because of differences in moisture regimes due to hydrology and terrain and availability of refuges. Consider effects at watershed scale.
11.3	Temperature extremes						At the northern limits of distribution in BC; probably not an issue
11.4	Storms & flooding	D	Low	Restricted - Small (1-30%)	Moderate - Slight (1-30%)	High (Continuing)	Flooding is an issue because of the affinity of the slugs to riparian habitats. However, slugs may have some capability of surviving floods, which are a natural seasonal event. Spring freshets may be more intense in the future, although probably of short duration, and may displace slugs. At sites on flatter terrain, flooding could result in extirpation of local populations.