

**COSEWIC**  
**Assessment and Status Report**

on the

**Blue-grey Taildropper slug**  
*Prophysaon coeruleum*

in Canada



**ENDANGERED**  
**2006**

**COSEWIC**  
COMMITTEE ON THE STATUS OF  
ENDANGERED WILDLIFE  
IN CANADA



**COSEPAC**  
COMITÉ SUR LA SITUATION  
DES ESPÈCES EN PÉRIL  
AU CANADA

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## COSEWIC Assessment Summary

### Assessment Summary – April 2006

**Common name**

Blue-grey Taildropper slug

**Scientific name**

*Prophysaon coeruleum*

**Status**

Endangered

**Reason for designation**

This species has a very small extent of occurrence (~ 150 km<sup>2</sup>) and area of occupancy (< 5 km<sup>2</sup>), and a continuing decline is projected in quality of habitat. It is found in remnant patches of older forest with a deciduous component. It is currently known from only 5 locations on southern Vancouver Island. Threats at these locations include heavy recreational use and the impacts of introduced plants and animals, including introduced invasive slugs and snails.

**Occurrence**

British Columbia

**Status history**

Designated Endangered in April 2006. Assessment based on a new status report.



**COSEWIC**  
**Executive Summary**

**Blue-grey Taildropper slug**  
*Prophysaon coeruleum*

**Species information**

The Blue-grey Taildropper is one of nine described species of taildropper slugs (genus *Prophysaon*) endemic to western North America. It is a small- to medium-sized slug (up to 45 mm long when extended) with a slender body. Distinguishing external features include blue-grey colour and parallel grooves and ridges on the back and sides of the tail. Internally, the slugs are distinguished from related species by features of reproductive anatomy.

**Distribution**

The species ranges from southern British Columbia south to Puget Lowlands in Washington State and through the Cascade Range into Oregon and northern California. Much genetic variation exists in the southern portion of the range. An isolated population exists in northern Idaho. In Canada, the species is known only from five sites on southern Vancouver Island, British Columbia.

**Habitat**

The Blue-grey Taildropper inhabits moist, coniferous or mixed-wood forests of varying age classes. All records from British Columbia are from within the Coastal Douglas-fir biogeoclimatic zone. In Washington State, the species is often associated with older forests. Required microhabitat features include abundant coarse woody debris or other cover, a deep forest litter layer, and shaded, moist forest floor conditions.

**Biology**

This species appears to have an annual life cycle, maturing and reproducing within one year. In British Columbia, specimens (all adults) have been found in late autumn only. The Blue-grey Taildropper feeds extensively on fungi, including species that form symbiotic mycorrhizal associations with roots of conifers. Like other taildropper slugs, this species is capable of self-amputation of the tail, an adaptation that is an effective anti-predator mechanism against invertebrate predators, such as ground beetles and carnivorous snails.

## **Population sizes and trends**

The Blue-grey Taildropper slug was first documented from British Columbia in 2002, and due to its recent discovery virtually nothing is known of its population sizes and trends. These slugs tend to be solitary or occur in small groups at scattered locations. Only a few specimens have ever been found, although hundreds of localities on Vancouver Island and in the Lower Fraser Valley on the mainland have been searched for terrestrial gastropods over the past decade. The extent to which the slugs' secretive habits, highly seasonal activity, and scattered distribution pattern contribute to their apparent rarity is presently unknown.

## **Limiting factors and threats**

This species exists at the northern extremity of its geographic range in southwestern British Columbia. Most likely, its present-day distribution reflects the glacial history of the region and resettlement from the south after glacial retreat.

Main immediate threats to populations include habitat loss, fragmentation, and degradation through human activities and land conversions. Additional threats include competition with exotic gastropods and predation by native and introduced animals. Forest habitats outside protected areas are shrinking at an alarming rate on southern and eastern Vancouver Island. Isolation of populations in remnant forest patches increases the probability of local extinctions. Population isolation is likely to be exacerbated by summer droughts, predicted for the region under global climate change scenarios.

## **Special significance of the species**

At the localities where it occurs, the Blue-grey Taildropper might perform an important ecological role by dispersing spores of mycorrhizal fungi that form essential symbiotic associations with tree roots. Although it also feeds on green plant matter, it is unlikely to become a horticultural pest because of its low densities and association with forests rather than with open habitats. With its often-brilliant bluish colouration this species is attractive and could become an emblem of invertebrate conservation in British Columbia.

## **Existing protection**

The Blue-grey Taildropper was placed on the provincial Red List of species at risk in British Columbia in 2005. Species on the Red List are species that are extirpated, endangered, or threatened in British Columbia. While not currently listed as an Identified Wildlife Species in British Columbia, the species could become a candidate for inclusion in a future version of the provincial Identified Wildlife Management Strategy.



## 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<sup>th</sup> 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 (2006)

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

\* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

\*\* Formerly described as "Not In Any Category", or "No Designation Required."

\*\*\* Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



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# **COSEWIC Status Report**

on the

## **Blue-grey Taildropper slug**

*Prophysaon coeruleum*

**in Canada**

2006

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## SPECIES INFORMATION

### Name and classification

*Prophysaon coeruleum* Cockerell, 1890 (Blue-grey Taildropper slug), is a member of the large, cosmopolitan family Arionidae. The genus *Prophysaon* is endemic to western North America and consists of nine described species in two subgenera: *Mimetarion*, which includes *P. vanatta*, *P. obscurum*, *P. fasciatum*, and *P. humile*; and *Prophysaon*, which includes *P. andersoni*, *P. boreale*, *P. coeruleum*, *P. dubium*, and *P. foliolatum*. Characteristics that separate this genus from other North American genera include a greatly reduced penis, specialized epiphallus, and ability to self-amputate the tail (Pilsbry 1948). Further genital characteristics separate subgenera.

*Prophysaon coeruleum* was described based on material from Washington State with the type locality in Olympia. The classification of the species is as follows: Phylum Mollusca, Class Gastropoda, Subclass Orthogastropoda, Order Pulmonata, Suborder Eupulmonata, Infraorder Stylommatophora, Superfamily Arionoidea, Family Arionidae, Genus *Prophysaon*, Subgenus *Prophysaon*, Species *P. coeruleum*.

### Morphological description

*Prophysaon coeruleum* is a small to medium-sized slug with the length of adults up to about 45 mm when extended in movement (Kelley *et al.* 1999). The body is slender and tapering, and the tail lacks a dorsal keel. The mantle is large (almost 1/3 of the total length of the animal), and the pneumostome (or breathing pore) is located slightly to the anterior of the mid-point of the margin of the mantle on the right side. Distinguishing external characteristics include solid blue-grey colour without dorsal or lateral stripes and distinct, parallel grooves and ridges on the back and sides of the foot (Figure 1; Pilsbry 1948, Kelley *et al.* 1999). The margin of the foot is narrow and has a distinct border. Specimens found in British Columbia were mid-tone blue-grey, speckled with scattered, lighter flecking; two specimens found in late autumn lacked speckling. In specimens from the United States, the colour of the back and sides ranges from very pale, occasionally white, to very dark blue or blue-grey. The sole of the foot is light grey or white, and the mucus is clear. A thin, oblique constriction or impressed line is usually visible at the site where tail autotomy (self-amputation) takes place (Figure 1, bottom).



Figure 1. The Blue-grey Taildropper slug, *Prophysaon coeruleum*, from Vancouver Island. Specimen at top is from Colwood; specimen at bottom is from Rocky Point peninsula. Both slugs measured about 25 mm fully extended. Photographs by K. Ovaska.

As for most slugs, characteristics of the reproductive anatomy of *P. coeruleum* are useful for identification. In this species, the epiphallus consists of a distal bulbous, muscular portion and a proximal long, slender portion, which is in a tangled coil immediately anterior to the muscular structure. The ovotestis is large, with numerous lobules. The size of the penis appears to be variable and can be almost as large as the muscular portion of the epiphallus in some specimens (Ovaska *et al.* 2004). The vagina and the entire common duct are slender and long. This species differs from all species of the subgenus *Mimetarion* by having the distal portion of the epiphallus highly muscularized and abruptly enlarged (Pilsbry 1948). It differs from the larger *P. andersoni* and *P. foliolatum* by having a shorter, almost spherical distal portion of the epiphallus and a longer penis (Pilsbry 1948). Diagrams of the reproductive anatomy of *P. coeruleum* can be found in Pilsbry (1948) and Ovaska *et al.* (2004).

### **Genetic description**

Wilke and Duncan (2004) examined genetic structure of *P. coeruleum* throughout the species' range using markers from two mitochondrial genes. The study included two specimens from Rocky Point, Vancouver Island, British Columbia. Within the overall range, the analysis showed a complex genetic structure and revealed three major

clades, presumed to be about 2.6 – 5.9 million years old. Superimposed on this deep phylogenetic structure is a shallow structure with a total of eight minor clades. This shallow structure is less than 2 million years old and probably reflects perturbations associated with Pleistocene glaciations. The genetic distances among the three major clades are similar to or greater than those between other species of *Prophyaon*, and it is possible that the form currently known as “*Prophyaon coeruleum*” represents a complex of cryptic species (Wilke and Duncan 2004).

Most of the genetic fragmentation is found within the southern portion of the species’ range, especially in the Klamath region in southern Oregon (Wilke and Duncan 2004). The geographic distribution of the large major clade that includes British Columbia extends from southern Vancouver Island south through the Cascade Mountains in Washington State to south-central Oregon; a disjunct population in Idaho is also included within this major clade. This major clade, in turn, consists of three minor clades – a northern contingent, a small clade in south-central Oregon, and a curious clade with representatives in both southern Oregon and northern Idaho. The British Columbia specimens are a part of the large northern minor clade, with representatives also in Washington State and Oregon. Therefore, the Vancouver Island population does not represent a genetically distinct population.

## DISTRIBUTION

### Global range

The geographic distribution of *P. coeruleum* extends from southern Vancouver Island, British Columbia, south to the Puget Lowlands in Washington State and through the Cascade Range into Oregon and northern California (Figure 2). A disjunct population exists in northern Idaho (Ovaska *et al.* 2004). Populations in southern Oregon and northern California may represent separate species (see Genetic description). The distribution of the species throughout the northern portion of its range appears to be highly fragmented and consists of geographically isolated populations. For example, there are only a few recent locality records from western Washington, although extensive surveys have been conducted in this area (Ovaska *et al.* 2004). The reasons for the fragmentation are unclear and may reflect a combination of past climatic changes and habitat modification through human activities.

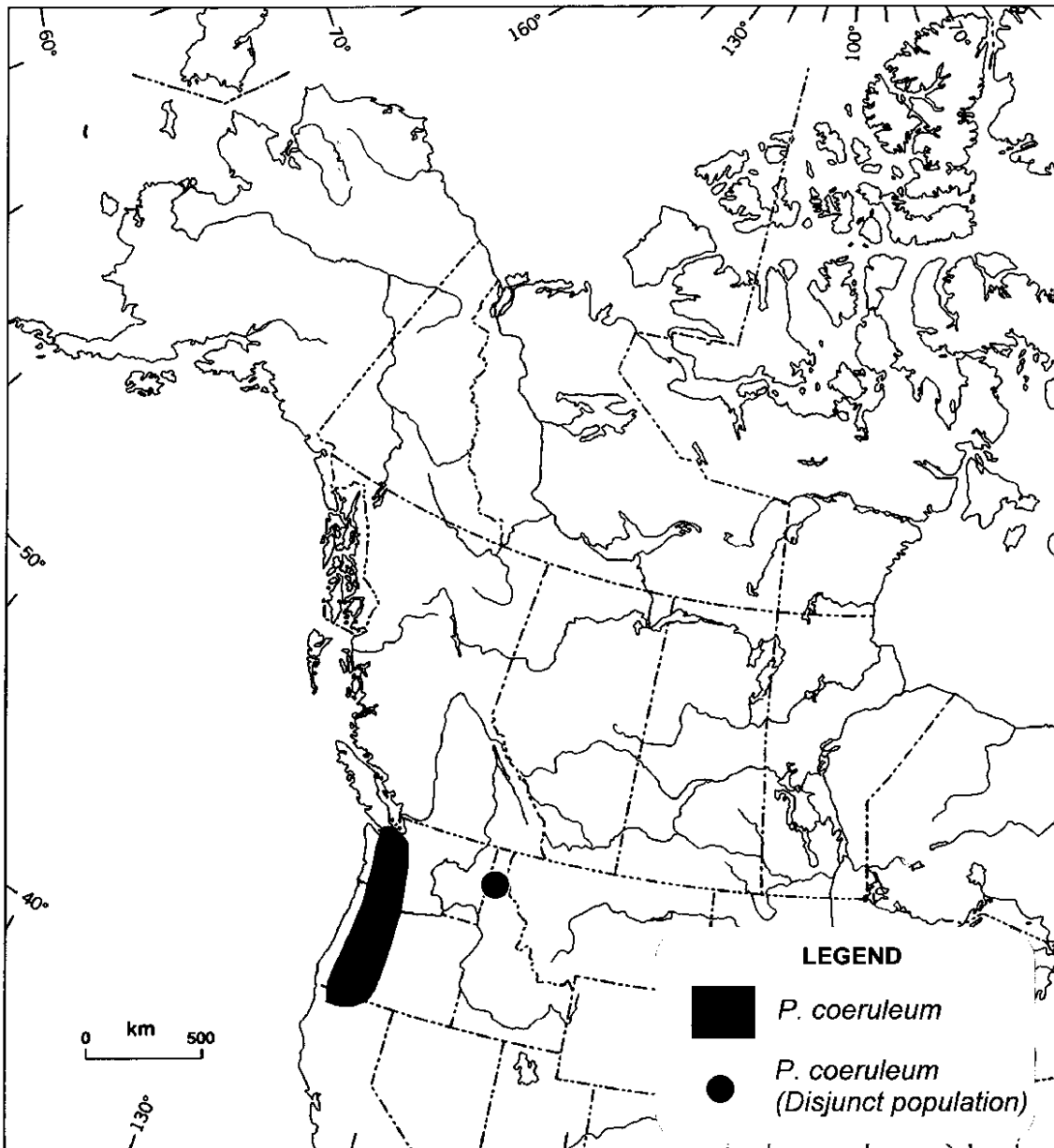


Figure 2. North American distribution of *Prophyaon coeruleum*, based on Wilke and Duncan (2004) and Ovaska *et al.* (2004).

The extent of the species' range in the United States has been estimated to be about 1,000 – 5,000 km<sup>2</sup> (Cordeiro 2002a, b, c). Populations in British Columbia and Idaho have since been documented, and the larger value might be a more accurate estimate of the global range.

## Canadian range

In Canada, the species is known from only a small number of localities on southern Vancouver Island, British Columbia (Figure 3). Currently, there are six locality records from five sites, all from the Capital Regional District: Sooke, District of Metchosin (two nearby localities on Rocky Point Peninsula and an additional site), Colwood, and Saanich (Figure 3). The two farthest localities (Rocky Point and Saanich) are about 25 km apart.

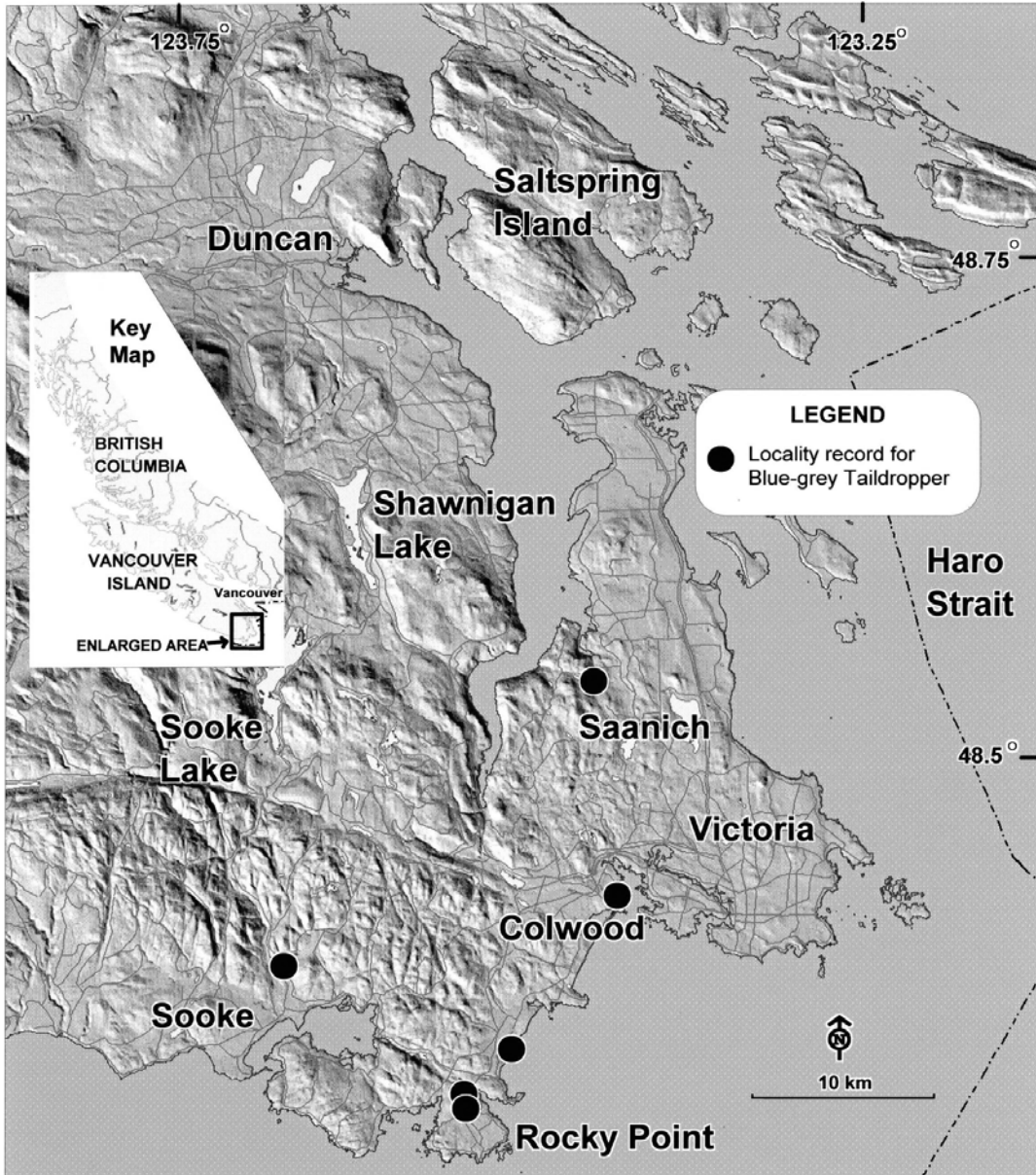


Figure 3. Canadian distribution of *Prophyaon coeruleum*.

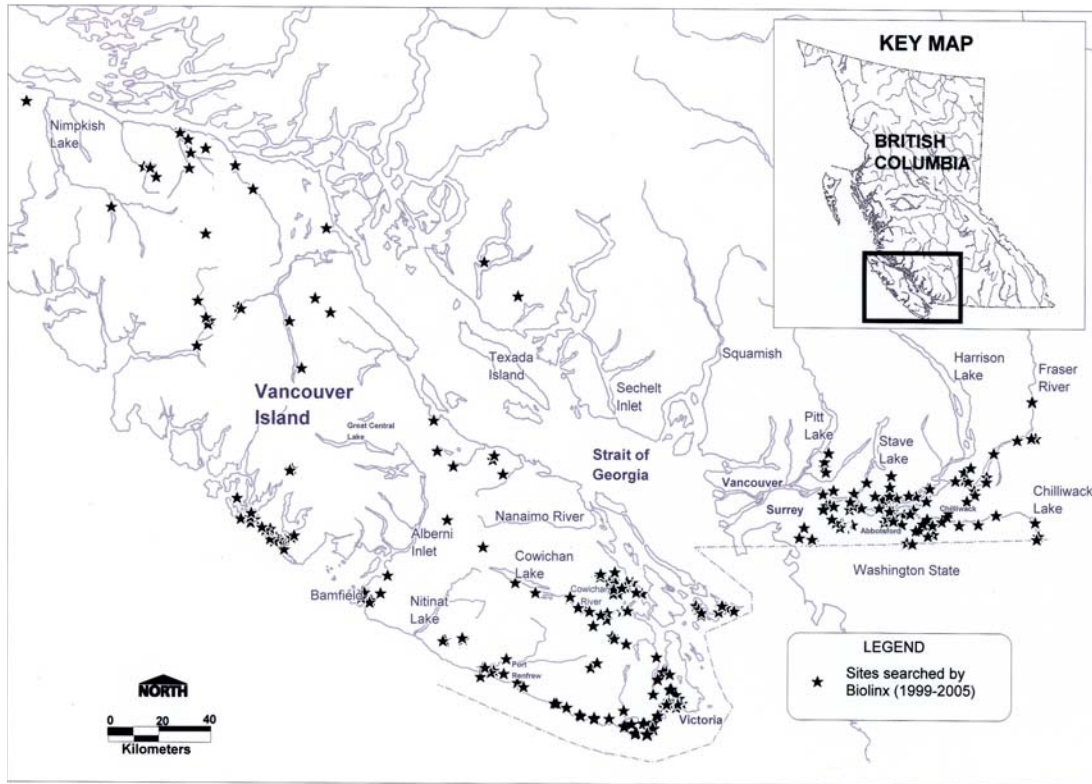


Figure 4. Localities searched for terrestrial gastropods on Vancouver Island and the coastal mainland of British Columbia by Biolinx Environmental Research Ltd. (1999-2005).

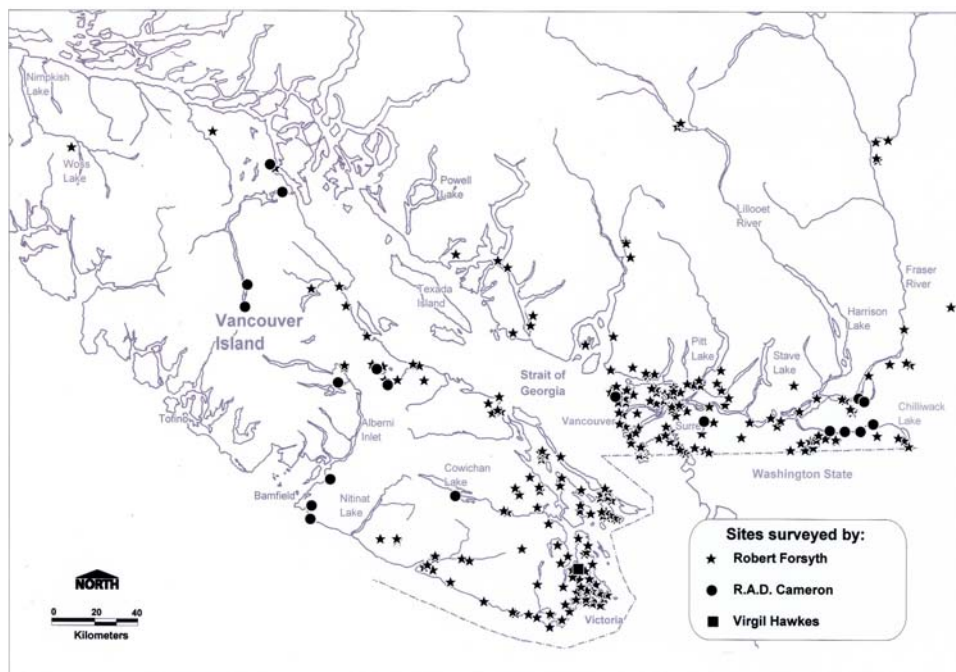


Figure 5. Localities searched for terrestrial gastropods on Vancouver Island and the coastal mainland of British Columbia by Cameron (1984), Forsyth (1990-2003) and Hawkes (2004).

Three of the known sites (Rocky Point, Colwood, and Saanich) are on federal lands managed by the Department of National Defence. The remaining two sites are within Capital Regional District Parks (see Habitat protection and ownership)

This species was documented from Canada only recently with the first record from Rocky Point Peninsula in 2002 (Ovaska and Sopuck 2002, Ovaska *et al.* 2004). In 2003 and 2004, the species was found at four additional localities (Ovaska and Sopuck 2004a, b; Hawkes 2004). Surveys by Ovaska and Sopuck (2004a,b and field verification associated with this status report) specifically targeted this species. The lack of previous records probably reflects a combination of factors: relatively low search effort during the optimal seasonal period, low detectability (seasonal activity peaking in late autumn; secretive habits), and population and distribution characteristics of the species (apparent rarity; patchy distribution; low densities). However, sufficient search effort is available to indicate that the species is relatively rare and has a small geographic range when compared to most other forest slugs in southwestern British Columbia (see Search effort).

The extent of the species' range in British Columbia is poorly known. As of December 2004, the known extent of occurrence was about 150 km<sup>2</sup>, representing about 3% of the estimated global range of the species. The known area of occupancy is unknown but represents a small fraction of this value, which includes highly modified and developed areas on southern Vancouver Island.

## HABITAT

### Habitat requirements

Because only a few sites for *P. coeruleum* are known from British Columbia, a review of the species' habitat requirements based on studies in the United States is useful. However, inferences to British Columbia populations should be made with caution, as populations at the northern limits of the species' range in Canada may differ in their ecology and habitat requirements from populations farther south.

Records of *P. coeruleum* exist from near sea level (in British Columbia) to 1,650 m above sea level (in Oregon) (Wilke and Duncan 2004). All records from British Columbia are from low elevations (< 100 m). In the United States, *P. coeruleum* occurs in a wide range of coniferous and mixed-wood forests, where it is usually associated with moist plant communities such as those containing bigleaf maple (*Acer macrophyllum*) and sword fern (*Polystichum munitum*) (Kelley *et al.* 1999, Burke *et al.* 2000). The species is frequently encountered in mature and old growth forests but also occurs in younger stands, especially where attributes of older forest are present (Miller *et al.* 1999, Burke *et al.* 2000). Burke *et al.* (2000) stated that in Washington the species appears to be largely confined to old-growth forests. In one study in Oregon, a negative association was found with bracken fern (*Pteridium aquilinum*), an indicator of disturbed habitats, suggesting that the slugs might prefer more natural habitats to disturbed sites (Miller

*et al.* 1999). Required microhabitat features include abundant coarse woody debris or other cover, deep forest litter layer, and shaded, moist forest floor conditions (Burke *et al.* 2000). The availability of mycorrhizal fungi for food and the plants that support them is also thought to be important (see Diet and predation).

In British Columbia, most locality records are from the Coastal Douglas-fir biogeoclimatic zone, a narrow strip of land that encompasses the southeast coast of Vancouver Island, Gulf Islands in the Strait of Georgia, and a tiny fringe of the southern mainland coast (Meidinger and Pojar 1991). One record (from Sooke) is from a transitional forest between the Coastal Douglas-fir and Coastal Western Hemlock biogeoclimatic zones. All records are from second-growth, mixed-wood stands, but the details of habitat features at these sites are variable (Table 1). For example, on the Rocky Point Peninsula, one locality is in a fringe of Bigleaf Maple in an otherwise largely coniferous forest, whereas the other locality is along the edge of a small wetland in a small stand of trembling aspen (*Populus tremuloides*) (Ovaska and Sopuck 2002, Ovaska *et al.* 2004). All sites are moist and productive, as indicated by varied and abundant understory vegetation, which often includes sword fern. Abundant cover (coarse woody debris, talus, and/or leaf litter) is present at these sites.

### **Habitat trends**

The Coastal Douglas-fir (CDF) biogeoclimatic zone encompasses about 200,000 ha of land, most of which is below 150 m in elevation (Meidinger and Pojar 1991). It is one of the most disturbed ecosystems of British Columbia, and little of the original forest remains (MacKinnon and Eng 1995, MSRM 2004). According to the Sensitive Ecosystems Inventory, older forests (with average age of trees 100 years or more) comprise only 2.6% of eastern Vancouver Island, from Campbell River in the north to Sooke in the south, and on the Gulf Islands (MSRM 2004). This value includes old-growth and mature second-growth forest within the CDF and the Coastal Western Hemlock (CWH) biogeoclimatic zones. The CWH zone occurs at higher elevations and/or moister sites, particularly in the northern and western portions of the Sensitive Ecosystems Inventory area. Maturing second-growth forest (with average age of trees 60 – 100 years) are relatively common on forested lands on southeastern Vancouver Island and consist of coniferous or mixed-wood stands, often with a deciduous component of red alder (*Alnus rubra*) or bigleaf maple, or more rarely trembling aspen. Due to continued pressures on the land-base, however, it is unlikely that much of the regenerating forest outside protected areas will be allowed to reach maturity. Efforts are under way to protect the larger of these stands in key areas (MSRM 2004).



**Table 1. Habitat features at localities where *Prophysaon coeruleum* has been found on Vancouver Island, British Columbia.**

Locality (reference)	Stand age (years)	Context and land ownership	Dominant tree species	Dominant understory shrubs & ferns	Dominant herbaceous plants	Microhabitat features	Disturbance
Metchosin: Rocky Point, Site 1 (Ovaska and Sopuck 2002)	70 – 80	Maple fringe of largely coniferous stand; federal land (DND property)	Douglas Fir, Bigleaf maple, Grand Fir, Western Redcedar	Sword Fern, Salal, Huckleberry, Ocean Spray, Indian Plum, Oregon Grape		Deep layer of leaf litter; abundant coarse woody debris	Within 50 m from a paved road; introduced plants and gastropods present
Metchosin: Rocky Point, Site 2 (Ovaska and Sopuck 2002)	70 – 80	Edge of small wetland adjacent to an older coniferous stand; federal land (DND <sup>1</sup> property)	Trembling aspen	Sword Fern, Salal, Nootka Rose, Trailing Blackberry	Western Trumpet Honeysuckle, grass	Deep layer of leaf litter; some coarse woody debris	Gravel road and clearing within 50 m; introduced plants (Scotch Broom); introduced gastropods
Colwood (Ovaska and Sopuck 2004a)	70 – 80	Edge of mostly coniferous stand at the base of a rocky outcrop with Garry Oak/ Arbutus; federal land (DND property)	Douglas Fir, Western Hemlock, Grand Fir, Bigleaf Maple	Sword Fern, Oregon Grape, Ocean Spray, Trailing Blackberry, Nootka Rose	Fringecup, Sweet Cicily, Bedstraw, Pathfinder	Abundant coarse woody debris; compact, mostly needle litter	Adjacent to access road within military training area; recent firewood cutting; introduced plants and gastropods present
Saanich (Hawkes 2004)	Young second-growth	Douglas Fir – Salal plant community; base of hill with Garry Oak/ Arbutus; federal land (DND property)	Douglas Fir, Arbutus, Western Redcedar	Oregon Grape, Salal (well-developed understory)		Abundant coarse woody debris; rock and talus piles; closed canopy	Gravel access road within 50 m; adjacent to a popular recreational area; introduced plants and gastropods present
Metchosin: Devonian Regional Park	60	Remnant patch of forest within agricultural area; CRD <sup>2</sup> regional park	Douglas Fir, Arbutus, Bigleaf Maple	Ocean Spray, Oregon Grape, Indian Plum, Rose, Holly, Snowberry, Bracken Fern, Sword Fern	Pathfinder, Bedstraw, grass	Little coarse woody debris; needle/leaf litter	Forest edge by agricultural/residential area; recreational trails; many introduced plants and gastropods present
Sooke: Galloping Goose Trail	50 – 60	Moist, productive mixed-wood, second-growth forest; CRD regional park	Bigleaf Maple, Red Alder, Western Hemlock, Western Redcedar, Douglas Fir, Grand Fir, Arbutus	Salal, Oregon Grape, Salmonberry, Sword Fern			Adjacent to recreational trail near parking lot

<sup>1</sup>DND = Department of National Defence

<sup>2</sup>CRD = Capital Regional District

All distribution records for *P. coeruleum* from British Columbia are from within the Capital Region, which covers the extreme southern portion of Vancouver Island and the southern Gulf Islands in the Strait of Georgia. The Capital Region encompasses 245,103 hectares of land within 13 regional municipalities. Only about 6,200 ha of older forest (with trees over 100 years) remain within this area (CRD 2003). Most of the older forest is located within the Western Communities, a region immediately west of Victoria, extending from Esquimalt Harbour to Rocky Point peninsula along the shoreline of the Juan de Fuca Strait (about 4,500 ha). Western Communities include two of four municipalities with records of *P. coeruleum* (City of Colwood and District of Metchosin). Very little older forest (< 100 ha) remains on Saanich Peninsula, which includes one locality of the species (in the District of Saanich). The remaining record is from near Sooke, in the southwestern part of Vancouver Island. The west coast of Vancouver Island, north of Sooke, is very moist and consists mainly of coniferous forest, dominated by western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and Sitka spruce (*Picea sitchensis*). This type of wet, coastal forest may be unsuitable for *P. coeruleum*.

The Capital Region is densely populated (325,754 people in 2001; CRD 2004a). The population grew at a relatively rapid rate of 8.7% from 1991 – 2001. The areas experiencing highest rates of growth during this period were the Western Communities (16.6%) and the Gulf Islands (18.1%), but most of the growth occurred within the first half of the period. By 2026 the population within the Capital Region is predicted to continue to grow by about 30% from population size in 1996. The population increase is forecast to be greatest for Western Communities (92.1% increase), where relatively large areas of natural habitats still exist. As the human population within the Capital Region continues to grow, the remaining natural areas are under increasing pressures from development.

### **Habitat protection/ownership**

About 13% of the land-base on Vancouver Island is designated as parks or other protected areas. About 24% of the island is privately owned; of this proportion about 75% consists of privately owned forestry lands (Sierra Club 2003, van Kooten 1995). Most of the private lands are on the southeastern portion of the island and include extensively logged forestry lands and those converted to agriculture, industrial uses, and housing. Crown lands prevail in the northern and western portions of the island, where more old-growth forest remains. However, to date *P. coeruleum* has been recorded only from the extreme southeastern portion of Vancouver Island from the Coastal Douglas-fir Biogeoclimatic Zone. Only about 5% of forested land-base within this zone is within protected areas (MWLAP 2002).

As of December 2004, three of five known localities for *P. coeruleum* are from federal lands managed by the Department of National Defence (DND). Canadian Forces Ammunition Depot Rocky Point (1,100 ha) in the District of Metchosin consists largely of coniferous and mixed-wood forest and includes relatively large, continuous stands of old-growth and mature forest. Colwood Supply/Fuel Oil Depot (98 ha) is

bounded by housing and commercial developments within the City of Colwood. About 46 ha of the property are forested, mostly by mature (>80 years old) second-growth stands. The Heals Rifle Range (230 ha) in the District of Saanich includes large areas of mature coniferous and mixed-wood forests and in the west abuts Mount Work Regional Park, which in turn is contiguous with Gowland-Tod Provincial Park in the District of Highlands. Together these areas form an important ecosystem of continuous forest cover amidst residential and agricultural lands on the Saanich Peninsula.

DND properties contain relatively large tracts of older forest within otherwise highly modified landscapes on the southern tip of Vancouver Island and might form refuges for *P. coeruleum* and other inhabitants of the vanishing coastal Douglas-fir ecosystems. These areas are presently protected from development but are not secure, however, as DND retains the option of disposing of lands that are not used for training or other military purposes. It should be noted, however, that it would be impossible for a federal department to dispose of lands without first ensuring that the habitat needs of Species at Risk occupying those lands are met.

The remaining two records for *P. coeruleum* are from Capital Regional District parks (Devonian Regional Park; Galloping Goose Trail). Devonian Regional Park protects a small stand of forest (14.4 ha) amidst residential and agricultural lands. The Galloping Goose Trail is used mainly for recreational purposes and consists of a 30 m-wide right-of-way that the Capital Regional District Parks department manages as a linear park corridor. The lands adjacent to the corridor are extensively forested along portions of the trail, especially in the south in Sooke and Metchosin, but are mostly privately owned.

Protected areas within the Capital Regional District consist of a network of 27 regional parks and park reserves, and two regional trails with a total area of 10,583 hectares (CRD 2004b). The largest regional parks and regional park reserves include Sooke Hills Wilderness (4,100 ha), East Sooke (1,436 ha), Thetis Lake (778 ha), Sea to Sea Green Blue Belt (609 ha), Mt. Work (536 ha), and Elk/Beaver Lake (442 ha). Several regional parks are small (<10 ha), and some are highly modified and subject to intense recreational use. Of the larger parks, Thetis Lake and Elk/Beaver Lake in particular, receive heavy recreational use, and numerous introduced plants and animals are present, further modifying the ecosystems.

Provincial parks within the Capital Region include Gowland Tod (1,219 ha), John Dean (174 ha), and Goldstream (388 ha). Other larger provincial parks on southern Vancouver Island are Koksilah River (210 ha), Cowichan River (873 ha), and Chemainus River (128 ha) on the southeast coast and Juan de Fuca (1,277 hectares) on the southwest coast. These parks have not been systematically surveyed for terrestrial gastropods. The Gulf Islands National Park Reserve, established in 2003, covers about 33 km<sup>2</sup>, in total, on 16 islands in the Strait of Georgia (Parks Canada 2004). Most lands incorporated into the new park were already protected as provincial or regional parks, but some new properties were acquired. Surveys for terrestrial gastropods, including *P. coeruleum*, were carried out on two of the larger islands

(Pender and Saturna) within the Gulf Islands National Park Reserve in 2004 (Ovaska and Sopuck 2005). There are no records of *P. coeruleum* from the Gulf Islands or from the southwest coast Vancouver Island.

Three of the known sites (Rocky Point, Colwood, and Saanich) are in the immediate vicinity of the following Indian Reserves: South Saanich 1 (Tsarlip Nation); Esquimalt (Esquimalt Nation); New Songhees 1A (Songhees Nations); Beecher Bay 1 and 2 (Beecher Bay Nation). The species' range also overlaps other aboriginal lands that may contain suitable habitat: T'Sou-ke 1 and 2 (T'Sou-ke Nation); East Saanich 2 (Tsawout Nation); Cole Bay 3 (Pauquachin Nation); Union Bay 4 (Tseycum Nation) (CRD 2001).

## BIOLOGY

Most aspects of the ecology and life history of *P. coeruleum* are poorly known. Information on British Columbia populations in particular is virtually non-existent and based on unpublished observations by the authors. Burke *et al.* (2000) provided a summary of the species' biology in the United States as a part of management recommendations. McGraw *et al.* (2002) studied the diet of the species in Oregon.

### Life cycle and reproduction

This species appears to have an annual life cycle, maturing and reproducing within one year (Burke *et al.* 2000). An absence of observations of adults in the early spring, both in British Columbia and the United States, suggest that few or no individuals survive to their second year. The slugs probably over-winter as eggs, which then hatch in the spring. All records from British Columbia are from late autumn, from October to December; all individuals found were adults.

Like other pulmonate gastropods, *P. coeruleum* is oviparous and simultaneously hermaphroditic, each individual possessing both male and female reproductive organs. There is no evidence of self-fertilization in this species, however, and cross-fertilization may be the norm as in most other pulmonate species. Clutch size and details of the reproduction are unknown.

### Diet and predation

In Oregon, fungi form a large part of the diet of *P. coeruleum*, based on the presence of fungal spores and hyphae in the feces (McGraw *et al.* 2002). Fungal hyphae and spores were the most common items found and were present in 90% of the samples examined (spring and autumn samples combined). Although fungi were a major item in the samples during both seasons, the frequency of fungal spores was much greater in the autumn (62%) than in the spring (24%). The spores recovered from the samples represented 10 different families of fungi. Most of the fungi were mycorrhizal associates of vascular plants, including beneficial fungi associated with

roots of conifers. Other food items found in fecal samples consisted of plant tissues (frequency of occurrence = 59%; spring and autumn data combined) and lichens (25%). In British Columbia slugs kept in captivity consumed fresh vegetable matter (lettuce and carrots) and survived for several months (K. Ovaska, unpublished data).

A variety of predators, both vertebrate and invertebrate, feed on slugs and probably also on *P. coeruleum* (Burke *et al.* 2000). Lancetooth snails (*Haplotrema* and *Ancotrema* species) and carabid beetles (Coleoptera: Carabidae) are common in habitats where the species is found and feed extensively on gastropods. Like other species in the genus *Prophysaon*, this species is capable of self-amputation of the tail, an adaptation that is an effective anti-predation mechanism (Hand and Ingram 1950).

### **Dispersal/migration**

These slugs are thought to have very limited dispersal capabilities, in the order of tens to hundreds of metres per generation, but few data are available (Wilke and Duncan 2004; N. Duncan, pers. comm.). Slugs from Oregon kept in enclosures moved very little (N. Duncan, pers. comm.). Whether there is a dispersal period at some stage of the life cycle is unknown, but it is unlikely that the slugs would be able to move far within a generation without assistance from other animals or physical forces. There are no known or suspected animal vectors or other means of dispersal (such as wind or water) for this species.

Transport by humans is possible but unlikely to be important. Unlike exotic slugs that are common in disturbed areas throughout most of North America, this species is not known to be invasive, is an inhabitant of forests rather than open, disturbed areas, and has an extremely patchy distribution throughout the northern portion of its range in Canada and the United States. Therefore, inadvertent introduction of slugs or eggs by humans, such as with nursery stock or in soil adhering to footwear, is unlikely for this species.

Although discovered only recently, *P. coeruleum* has most likely been present on Vancouver Island for long periods. The following lines of evidence support this conclusion (R. Forsyth, pers. comm.). First of all, very few of B.C.'s native terrestrial molluscs show any propensity towards being introduced. Introduced species are almost always synanthropic. Non-native species that occur in "natural" forests, for example, are just a subset of the non-native species that occur in city gardens. There are no introduced species that only inhabit natural forests. Secondly, the known range of *P. coeruleum* on Vancouver Island does not present an anomaly; rather, it fits well with the non-Canadian range for this species and there are parallels with other terrestrial mollusc species as well.

### **Interspecific interactions**

Many species of exotic gastropods occur within the range of *P. coeruleum* in British Columbia (Forsyth 2004). Exotic species found at sites with records of this

species include the Chocolate Arion (*Arion rufus*), Giant Garden Slug (*Limax maximus*), and Worm Slug (*Boettgerilla pallens*) (K. Ovaska and L. Sopuck, unpublished data). It is unknown whether competition for food or shelters with exotic species or predation is a problem for *P. coeruleum* populations, but adverse effects are possible.

### **Adaptability**

This species can tolerate some degree of disturbance to the habitat as evidenced by its occurrence in second-growth forests and in forest edge habitats in British Columbia. The availability of shelter (provided by decaying logs and other cover) and shady, moist conditions might be more important than forest age. However, it remains unknown whether the slugs prefer second-growth habitats or persist in available marginal habitats in the absence of older forest stands.

## **POPULATION SIZES AND TRENDS**

### **Search effort**

In comparison with vertebrates, terrestrial gastropod faunas of British Columbia forests are relatively poorly known, and undocumented native species continue to be discovered. Vancouver Island is better surveyed than most other areas of the province, beginning with efforts of early malacologists, such as G.W. Taylor and A.W. Hanham, in the late 1800s (see Drake 1963 and Forsyth 2004 for an overview of the history of malacology in British Columbia). Surveys were sporadic over much of the 20<sup>th</sup> century, and many areas even on Vancouver Island have received scant attention.

Rollo and Wellington (1975) carried out surveys in the vicinity of Vancouver in the early 1970s. A decade later Cameron (1986) surveyed numerous sites on Vancouver Island and the Lower Fraser Valley. More recently (1990 – 2003) Forsyth surveyed hundreds of localities in these two areas (R. Forsyth, pers. comm.). Since 1999, Biolinx Environmental Research Ltd. has conducted numerous surveys for terrestrial gastropods in southwestern and coastal British Columbia, including attempts to locate species deemed rare and potentially at risk such as *P. coeruleum*. As of April 2005, the number of sites surveyed by Biolinx Environmental Research Ltd. as part of various projects was 152 localities in Haida Gwaii (Queen Charlotte Islands), 234 on Vancouver Island, and 98 on the Lower Mainland of British Columbia. These surveys included the following: Pacific Rim, Gulf Islands, and Gwaii Haanas National Park Reserves for Parks Canada; Department of National Defence (DND) properties on southern Vancouver Island, Lower Mainland, and Graham Island for DND/CFS Natural Resources Management Program; selected forestry lands managed by Weyerhaeuser Company Limited in 1999 – 2004 on Vancouver Island, Lower Mainland, and Graham Island; numerous localities on Vancouver Island and Lower Mainland for the BC Ministry of Water, Land and Air Protection; numerous localities on Vancouver Island, Lower Mainland, and Haida Gwaii as part of projects supported by the Endangered Species Recovery Fund and Wildlife Habitat Canada.

In the autumn of 2004, the authors surveyed remnant forest habitats within Capital Regional District Parks as part of field verification associated with the preparation of this status report to better delineate the distribution of this species. Of the 21 localities surveyed intensively and repeatedly using artificial cover-objects, *P. coeruleum* was detected at one locality (Devonian Regional Park). They also found the species at both previously known sites on the Rocky Point Peninsula using cover-objects, and at an additional site (Sooke) during searches of natural cover on the forest floor.

To date hundreds of localities have been searched for terrestrial gastropods on Vancouver Island and the coastal mainland of British Columbia (Figures 4 and 5). Numerous localities have been surveyed throughout much of Vancouver Island, Lower Fraser Valley, and Haida Gwaii in different habitat types. *Prophysaon coeruleum* has been located only in the extreme southern portion of Vancouver Island in low-elevation mixed-wood forests within the Coastal Douglas-fir Biogeoclimatic Zone. However, some areas that are difficult to access remain virtually unsurveyed. These areas include the northwest coast of Vancouver Island (from Tofino to Brooks Peninsula) and coastal forests north of Powell River on the mainland of British Columbia.

## Abundance

Population sizes and densities for *P. coeruleum* are unknown both in British Columbia and the United States. Pilsbry (1948) noted that the species often occurs solitarily on the forest floor. However, at Vancouver Island sites with multiple captures, the individuals were found within a few metres from each other, suggesting either affinity to specific microhabitat features at these sites or social reasons, such as mating.

At the Vancouver Island sites, the number of individuals found ranged from one to five per locality during a survey period, and only limited information on patterns of abundance can be gleaned from these observations, summarized below. At the Rocky Point site, Ovaska and Sopuck (2002) searched a total of 35 transects (1 m wide, 100 m long) in the spring and autumn and located *P. coeruleum* along two transects (5.6% frequency of occurrence; a total of 6 individuals found, 5 along one transect and 1 along another transect 1 km away). Minimum densities along the two transects were 0.05 and 0.01 slugs per square metre. In contrast, *Ariolimax columbianus* (Pacific Banana Slug), a common species in forests of coastal British Columbia, was found along all but three transects (91.4% frequency of occurrence; in total, 117 individuals found; minimum densities up to 0.12/m<sup>2</sup>). Twenty artificial cover-objects set in each of the two localities where *P. coeruleum* was found along about 100 m stretches of forest floor resulted in the finding of a total of three individuals during two inspections in the autumn of 2003.

At the Colwood site, Ovaska and Sopuck (2004a) spent 21.4 h searching for gastropods along 10 meandering survey routes. They found two individuals of *P. coeruleum* along one of the routes. At Heals Rifle Range in Saanich, Hawkes (2004) found one *P. coeruleum* within an area of about 230 ha that was searched for a total of about 24 h in the autumn. In Devonian Regional Park, Ovaska and Sopuck (2004b) inspected 20 artificial cover-objects three times (60 cover-object flips) and found one

individual *P. coeruleum*. At the Sooke site, Ovaska and Sopuck (2004b) spent 54 person-minutes searching the forest floor and found one individual *P. coeruleum*.

### **Fluctuations and trends**

Nothing is known of population fluctuations and trends of *P. coeruleum* in British Columbia. In the United States, the species appears to be relatively common in southwestern Oregon but rare and declining in other parts of Oregon and in Washington State (Cordeiro 2002a, b, c). Habitat at most of the historical sites in Washington State has been heavily modified for urban developments. The species appears to be extirpated from these sites, including the type locality in Olympia (Wilke and Duncan 2004).

### **Rescue effect**

Immigration of slugs from Washington State to the Lower Mainland of British Columbia is conceivable but unlikely. No populations of *P. coeruleum* are known from mainland British Columbia, and forest habitats in the vicinity of the border and throughout the Lower Fraser Valley are fragmented amidst agricultural lands and urban developments. Vancouver Island is isolated from mainland British Columbia by the Strait of Georgia and from the Olympic Peninsula, Washington State, by the Strait of Juan de Fuca, precluding rescue effects through natural dispersal.

## **LIMITING FACTORS AND THREATS**

This species exists at the northern extremity of its geographic range in southwestern British Columbia. It is unknown whether areas farther north are outside physiological tolerances of the species, or whether the present distribution in British Columbia reflects Pleistocene extinctions and glacial history of the area and subsequent barriers to dispersal.

Main threats to populations include habitat loss, fragmentation and degradation. Additional threats include competition with exotic gastropods and predation by native and introduced species.

*Habitat loss* – Forest habitats outside protected areas are shrinking at an alarming rate on southern and eastern Vancouver Island due to urban developments and associated infrastructure (see Habitat trends). Habitats at localities within Capital Regional District regional parks are protected from land conversions but are often degraded by heavy recreational use and introduced plants and animals. Habitats at known sites within Department of National Defence properties also receive some degree of protection.

*Habitat fragmentation* – Fragmentation of habitats concomitant with habitat loss is a major threat for this species with presumably poor dispersal capabilities. Isolation of



populations in remnant forest patches increases the probability of local extinctions, as recruitment and recolonization through immigration is curtailed. Fragmentation of forest habitats within the Capital Regional District is extensive.

*Habitat degradation* – All human activities that result in reduced moisture and cover on the forest floor have the potential to degrade habitats of this species. Logging, thinning, grazing, and firewood cutting decrease canopy closure and potentially result in drier forest floor conditions, reducing habitat suitability. Off-road recreational activities, such as all-terrain-vehicles or mountain biking, compact the substrate. Trampling of the forest floor through other intensive recreational activities is similarly detrimental. Forest harvesting practices that prevent the accumulation of coarse woody debris, including large logs in all stages of decay, deplete essential cover for this species on the forest floor. Intense fires that modify the forest floor are thought to be detrimental for *P. coeruleum* (Burke *et al.* 2000). Invasive introduced plants (such as Scotch broom, gorse, and laurel-leaved daphne) are extensively modifying natural ecosystems within the range of *P. coeruleum*. Habitat degradation is prevalent in small forest stands that are subject to invasion by introduced species and changes in microclimate, including drying of the forest floor.

*Competition with exotic gastropods* – Competition from exotic gastropods for shelter or food is considered a threat to populations of *P. coeruleum* in the United States (Burke *et al.* 2000). There are at least 25 exotic gastropods, most of them of European origin, in British Columbia (Forsyth 2004). Exotic gastropods are prevalent within populated areas of Vancouver Island, and several are present at sites where *P. coeruleum* occurs (see Interspecific interactions). Some invasive exotic species, including the giant garden slug, are aggressive competitors (Rollo and Wellington 1979), whereas the wormslug includes eggs of other slugs in its diet (Forsyth 2004). Both species have been found at localities where *P. coeruleum* occurs (Ovaska and Sopuck, unpublished data).

*Predation by native and exotic animals* – As habitats become more fragmented, the risk from predation is likely to increase. Predation may be a problem for *P. coeruleum* in small habitat patches that have a relatively large amount of edge and are subject to invasion by predators that use disturbed habitats, such as crows, some ground beetles, and exotic gastropods. Autonomy of the tail in the genus *Prophysaon* is believed to be an evolutionary adaptation to predation from beetles, among other organisms. In a related species, *P. foliolatum*, there is strong evidence that tail autonomy is an effective escape response from carabid beetles (Deyrup-Olsen *et al.* 1986). Native predatory beetles are unlikely to be a threat to *P. coeruleum* unless the size of the population declines to such an extent that it can no longer cope with natural predation. The carnivorous snail *Oxychilus draparnaudi* has been identified as a potential threat to native gastropods in areas where it has been introduced (Frest and Rhodes 1982). The diet of the exotic slug *Boettgerilla pallens* includes eggs of other gastropods (Reise *et al.* 2000). The availability of suitable shelter, including large decaying logs, is expected to be particularly important in small habitat patches to provide refuges from predation.

*Global climate change* – Prolonged summer droughts and increased frequency of extreme events are predicted to occur under global climate change scenarios (Gates 1993, Environment Canada 2002). Drier conditions on the forest floor during the activity period of the slugs from spring to autumn are likely to adversely affect populations. The effects of prolonged summer droughts can be expected to be particularly severe in marginal, degraded habitat patches that may lack microhabitats suitable for refuges.

## **SPECIAL SIGNIFICANCE OF THE SPECIES**

This species appears to feed extensively on mycorrhizal fungi, including fungal species that form obligatory, symbiotic associations with tree roots (see Diet and predation). It might act as an important dispersal agent for these fungi, which often have fruiting bodies underneath the surface within the duff or decaying wood and that rely on animal vectors to excavate and disperse their spores. However, because of the rarity of the species in British Columbia, its role in this process is probably restricted and confined to local areas.

Apart from a possible role in improving forest health through dispersal of spores of mycorrhizal fungi, *P. coeruleum* has no economic significance. It is unlikely to become a horticultural pest because of its association with moist forests rather than with open, disturbed sites and because of its apparently low densities and scattered distribution pattern.

Land snails and slugs in general have cultural significance for Aboriginal Peoples on Vancouver Island (N. Turner, pers. comm.). However, to our knowledge, there is no specific information on the significance of *P. coeruleum*.

With its often-brilliant bluish colouration, *P. coeruleum* is an attractive slug that could become an emblem of invertebrate conservation in British Columbia, together with other interesting species such as the jumping-slugs. Its possible role in the complex interactions involving tree roots, fungi, and animals that disperse their spores poses important research questions and could be of interest to the public.

## **EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS**

*Prophysaon coeruleum* is on the provincial Red List of species at risk (BC Species and Ecosystems Explorer 2005). Species on the Red List include species that are extirpated, endangered, or threatened in British Columbia. The species is considered “critically imperiled” (S1) in British Columbia.

Invertebrates designated by COSEWIC as Threatened, Endangered or Extirpated will be able to be protected through the British Columbia Wildlife Act and Wildlife Amendment Act 2004 once the regulations listing these species are completed. The British Columbia Park Act protects invertebrates at risk in provincial parks and protected

areas (when species are known to reside in the protected area), and provisions for management are incorporated into the park master plan. Invertebrates provincially listed as vulnerable, threatened or endangered and negatively impacted by forest and range practices can be included in the category 'species at risk' under the British Columbia Forest and Range Practices Act. Once included in this category, there is the mechanism for establishing Wildlife Habitat Areas (WHA) and associated General Wildlife Measures (GWM) to protect invertebrates from the impacts from forest and range activities. The implementation of WHAs and GWMs is addressed through the Identified Wildlife Management Strategy. While *P. coeruleum* is not currently listed under these strategies, it could become a candidate for inclusion in a future version of the provincial Identified Wildlife Management Strategy as this species could potentially be adversely affected by forest practices.

In the United States, *P. coeruleum* is relatively widespread and abundant in southwestern Oregon, but it appears to be rare elsewhere within its range based on a scattered distribution pattern and low number of locality records (Cordeiro 2002a, b, c). NatureServe (2005) lists the species as "apparently secure" both globally (G4) and nationally in the United States (N4) and "vulnerable to extirpation or extinction" in Canada (N3). Populations in Oregon are listed as "vulnerable to extirpation or extinction" (S3); no other sub-national ratings for the United States are available from NatureServe (as of April 2005).

In the United States, *P. coeruleum* was designated as a "survey and manage" species under the Northwest Forest Plan, which governs the management of forested federal lands from northern California to Washington State. The "survey and manage" program is presently under revision and in a state of flux (BLM & US Forest Service 2004; N. Duncan, pers. comm.). Many of the "survey and manage" species are retained on the list of sensitive species as a part of the Special Status Species Program of the Northwest Forest Plan (BLM & US Forest Service 2004). This species is in the regional forester's sensitive animal list in Washington State ([http://www.or.blm.gov/issp/USFS/20040721/Enc2\\_RF\\_Sensitive\\_Animal\\_List\\_SandM\\_0704.xls](http://www.or.blm.gov/issp/USFS/20040721/Enc2_RF_Sensitive_Animal_List_SandM_0704.xls)).

## TECHNICAL SUMMARY

### ***Prophysaon coeruleum***

Blue-grey Taildropper slug

Limace-prophyse bleu-gris

Range of Occurrence in Canada: Vancouver Island, British Columbia

<b>Extent and Area Information</b>	
<ul style="list-style-type: none"> <li>• <i>Extent of occurrence (EO)(km<sup>2</sup>)</i> <b>Minimum polygon method from distribution records in Canada up to Aug 2004</b></li> </ul>	About 150 km <sup>2</sup>
<ul style="list-style-type: none"> <li>• <i>Specify trend in EO</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in EO?</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Area of occupancy (AO) (km<sup>2</sup>)</i></li> </ul>	< 5 km <sup>2</sup>
<ul style="list-style-type: none"> <li>• <i>Specify trend in AO</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in AO?</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Number of known or inferred current locations</i></li> </ul>	5
<ul style="list-style-type: none"> <li>• <i>Specify trend in #</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in number of locations?</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Specify trend in area, extent or quality of habitat</i></li> </ul>	Declining
<b>Population Information</b>	
<ul style="list-style-type: none"> <li>• <i>Generation time (average age of parents in the population)</i></li> </ul>	Ca. 1 year
<ul style="list-style-type: none"> <li>• <i>Number of mature individuals</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Total population trend:</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>% decline over the last/next 10 years or 3 generations.</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in number of mature individuals?</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>Is the total population severely fragmented?</i></li> </ul>	Yes
<ul style="list-style-type: none"> <li>• <i>Specify trend in number of populations</i></li> </ul>	Possibly declining due to habitat trends
<ul style="list-style-type: none"> <li>• <i>Are there extreme fluctuations in number of populations?</i></li> </ul>	Unlikely
<ul style="list-style-type: none"> <li>• List populations with number of mature individuals in each: 1 severely fragmented population on southern Vancouver Island; number of individuals unknown; the degree of genetic exchange, if any, among slugs from the 5 known sites is unknown.</li> </ul>	
<b>Threats (actual or imminent threats to populations or habitats)</b>	
Habitat loss and fragmentation primarily due to urban expansion; habitat degradation by human activities and by invasion of introduced plants and animals; competition with introduced gastropods; predation by native and introduced species, especially in small habitat patches	
<b>Rescue Effect (immigration from an outside source)</b>	
<ul style="list-style-type: none"> <li>• <i>Status of outside population(s)?</i> <b>USA:</b> Common in southern Oregon, rare elsewhere. Considered a sensitive species in Washington State. Designations: S3 (Oregon); To be assessed in Washington State</li> </ul>	
<ul style="list-style-type: none"> <li>• <i>Is immigration known or possible?</i></li> </ul>	Unlikely
<ul style="list-style-type: none"> <li>• <i>Would immigrants be adapted to survive in Canada?</i></li> </ul>	Possibly
<ul style="list-style-type: none"> <li>• <i>Is there sufficient habitat for immigrants in Canada?</i></li> </ul>	Possibly
<ul style="list-style-type: none"> <li>• <i>Is rescue from outside populations likely?</i></li> </ul>	No
<b>Quantitative Analysis</b>	
Insufficient data	
<b>Current Status</b>	
British Columbia: S1, Red-listed COSEWIC: ENDANGERED (April 2006)	

### Status and Reasons for Designation

<b>Status:</b> Endangered	<b>Alpha-numeric code:</b> B1ab(iii)+2ab(iii)
<p><b>Reason for Designation:</b>  This species has a very small extent of occurrence (~ 150 km<sup>2</sup>) and area of occupancy (&lt; 5 km<sup>2</sup>), and a continuing decline is projected in quality of habitat. It is found in remnant patches of older forest with a deciduous component. It is currently known from only 5 locations on southern Vancouver Island. Threats at these locations include heavy recreational use and the impacts of introduced plants and animals, including introduced invasive slugs and snails.</p>	
<p><b>Applicability of Criteria</b></p>	
<p><b>Criterion A:</b> (Declining Total Population): No information available to apply this criterion: Current and past population sizes are unknown; the species was first documented in Canada in 2002, and only 14 live specimens have been found.</p>	
<p><b>Criterion B:</b> (Small Distribution, and Decline or Fluctuation): Endangered B1ab(iii)+2ab(iii). Extent of Occurrence is ~ 150 km<sup>2</sup> and Area of Occupancy is &lt; 5 km<sup>2</sup>; species is known to exist at only 5 locations; species occurs in forested habitats in the Coastal Douglas-fir Biogeoclimatic Zone where only ~ 5% of forested land-base is in protected areas - habitats outside protected areas are declining due to urban development and associated infrastructure and habitats in protected areas are often degraded by heavy recreational use and introduced plants and animals.</p>	
<p><b>Criterion C:</b> (Small Total Population Size and Decline): The number of mature individuals in the population is unknown; hence, this criterion cannot be applied.</p>	
<p><b>Criterion D:</b> (Very Small Population or Restricted Distribution): D2 applies for threatened because the species is known to exist at only 5 locations and the Area of Occupancy is less than 5 km<sup>2</sup>.</p>	
<p><b>Criterion E:</b> (Quantitative Analysis): Not applicable.</p>	

## ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

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## INFORMATION SOURCES

- BC Species and Ecosystems Explorer. 2005.  
<http://srmapps.gov.bc.ca/apps/eswp/jsp/results.jsp?pager.offset=10> (accessed April 2005)
- BLM (Oregon/Washington Bureau of Land Management) & US Forest Service. 2004. Survey and Manage Program of the Northwest Forest Plan.  
<http://www.or.blm.gov/surveyandmanage/> (accessed September 2004)
- Burke, T.E., N. Duncan, and P. Jeske. 2000. Management recommendations for terrestrial mollusk species: *Prophysaon coeruleum*, blue-gray taildropper and *Prophysaon dubium*, papillose taildropper v.2.0. USDA Forest Service and USDI Bureau of Land Management. 49 pp.  
[http://www.or.blm.gov/surveyandmanage/MR/TM4Species/2000-015\\_3.pdf](http://www.or.blm.gov/surveyandmanage/MR/TM4Species/2000-015_3.pdf) (accessed August 2004)
- Cameron, R.A.D. 1986. Environment and diversities of forest snail faunas from coastal British Columbia. *Malacologia* 27:341–355.
- Cockerell, T.D.A. 1890. New northwestern slugs. *Nautilus* 3:111–113.
- Cordeiro, J. 2002a. Washington status factors (*Prophysaon coeruleum*).  
[http://oregonstate.edu/ornhic/survey/prophysaon\\_coeruleum\\_wa.pdf](http://oregonstate.edu/ornhic/survey/prophysaon_coeruleum_wa.pdf) (accessed August 2004)
- Cordeiro, J. 2002b. Oregon status factors (*Prophysaon coeruleum*).  
[http://oregonstate.edu/ornhic/survey/prophysaon\\_coeruleum\\_or.pdf](http://oregonstate.edu/ornhic/survey/prophysaon_coeruleum_or.pdf) (accessed August 2004)
- Cordeiro, J. 2002c. California status factors (*Prophysaon coeruleum*).  
[http://oregonstate.edu/ornhic/survey/prophysaon\\_coeruleum\\_ca.pdf](http://oregonstate.edu/ornhic/survey/prophysaon_coeruleum_ca.pdf) (accessed August 2004)
- CRD (Capital Regional District). 2001. Capital Region Indian Reserves.  
[http://www.crd.bc.ca/regplan/RIS/Maps/documents/Indian\\_Reserves\\_2001.pdf](http://www.crd.bc.ca/regplan/RIS/Maps/documents/Indian_Reserves_2001.pdf) (accessed April 2005).

- CRD (Capital Regional District). 2003. Report on the environment: monitoring trends in the Capital Regional District. <http://www.crd.bc.ca/rte/report/p-c1.htm> (accessed July 2004).
- CRD (Capital Regional District). 2004a. Fact Sheets. <http://www.crd.bc.ca/regplan/ris/facts/index.htm> (accessed August 2004)
- CRD (Capital Regional District). 2004b. Parks and protected areas. <http://www.crd.bc.ca/parks/> (accessed August 2004)
- Deyrup-Olsen, I., A.W. Martin, and R.T. Paine. 1986. The autonomy escape response of the terrestrial slug *Prophysaon foliolatum* (Pulmonata: Arionidae). *Malacologia* 27(2):307 - 311.
- Drake, R.J. 1963. The history of nonmarine malacology in British Columbia. *National Museum of Canada Bulletin* 185:1–16.
- Environment Canada. 2002. Climate Change. <http://www.pyr.ec.gc.ca/EN/Climate/index.shtml> (accessed Dec 2004)
- Forsyth, R. 2004. Land snails of British Columbia. *Royal BC Museum Handbook*. Royal BC Museum, Victoria, BC. 188 pp.
- Frest, T.J., and R.S. Rhodes II. 1982. *Oxychilus draparnaudi* in Iowa. *The Nautilus* 96:36–39.
- Gates, D.M. 1993. *Climate change and its biological consequences*. Sinauer Assoc, Inc., Sunderland, MA. 280 pp.
- Hand, C. and W.M. Ingram. 1950. Natural history observations on *Prophysaon andersoni* (J.G. Cooper), with special reference to amputation. *Bulletin of the Society of California Academy of Sciences* 49:15 – 28.
- Hawkes, V. 2004. Surveys for significant flora and fauna at Heals Rifle Range. Unpublished report prepared by LGL Limited for Natural Resources of Canada, Canadian Forest Service, Pacific Forestry Centre, under DND/CFS MOU for Natural Resources Program, Victoria, BC. vii + 45 pp + appendices.
- Kelley, R., S. Dowlan, N. Duncan, and T. Burke. 1999. *Field Guide to Survey and Manage Terrestrial Mollusk Species from the Northwest Forest Plan*. USDI Bureau of Land Management, Oregon. 114 pp.
- MacKinnon, A. and M. Eng. 1995. Old Forests: Inventory for Coastal British Columbia. *Cordillera: A Journal of British Columbia Natural History* 1995 (Summer):20–33.
- McGraw, R., N. Duncan, and E. Cazares. 2002. Fungi and other items consumed by the Blue-Gray Taildropper slug (*Prophysaon coeruleum*) and the Papillose Taildropper slug (*Prophysaon dubium*). *The Veliger* 45:261–264.
- Meidinger, D., and J. Pojar. 1991. *Ecosystems of British Columbia*. BC Ministry of Forests, Victoria, BC. 330 pp.
- Miller, E.A., O.C. Schumacher, C.J. Melotti, and J.S. Applegarth. 1999. Habitat preferences of four terrestrial molluscs in the Western Cascade Range of Oregon. A report to the Eugene District Bureau of Land Management, Eugene, Oregon. <http://www.greendrake.org/e/mollusk.htm> (accessed August 2004).
- MSRM (BC Ministry of Sustainable Resource Management). 2004. Sensitive Ecosystem Inventories. East Vancouver Island & Gulf Islands ecosystems. [http://srmwww.gov.bc.ca/sei/van\\_gulf/index.html](http://srmwww.gov.bc.ca/sei/van_gulf/index.html) (accessed August 2004)
- MWLAP (Ministry of Water, Lands and Air Protection). 2002. BC Parks. <http://wlapwww.gov.bc.ca/bcparks/> (accessed August 2004)

- NatureServe Explorer. 2005. An online encyclopedia of life.  
<http://www.natureserve.org/explorer>. (Accessed April 2005).
- Ovaska, K., W.P. Leonard, L. Chichester, T.E. Burke, L. Sopuck, and J. Baugh. 2004. *Prophysaon coeruleum* Cockerell, 1890, Blue-gray Taildropper (Gastropoda: Arionidae): new distributional records and reproductive anatomy. *Western North American Naturalist* 64:538–543.
- Ovaska, K. and L. Sopuck. 2002. Surveys for terrestrial and freshwater molluscs on DND lands near Victoria, Vancouver Island, British Columbia. Unpublished report prepared by Biolinx Environmental Research Ltd. for DND/CFS Natural Resources Management Program, CFB Esquimalt, Victoria, BC. 37 pp.
- Ovaska, K. and L. Sopuck. 2004a. Surveys for terrestrial gastropods at NRS Aldergrove, Matsqui TX site and Colwood Supply/Fuel Oil Depot. Unpublished report prepared by Biolinx Environmental Research Ltd. for DND/CFS Natural Resources Management Program, CFB Esquimalt, Victoria, BC. 37 pp.
- Ovaska, K. and L. Sopuck. 2004b. Distribution and status of rare forest slugs in western Canada. Unpublished report prepared for the Endangered Species Recovery Fund (World Wildlife Fund and Environment Canada), Ottawa, Ont. 76 pp.
- Ovaska, K. and L. Sopuck. 2005. Surveys for terrestrial gastropods in the Pacific Rim, Gulf Islands, and Gwaii Haanas National Park Reserves. Unpublished report prepared by Biolinx Environmental Research Ltd. for Parks Canada (Coastal British Columbia Field Unit), Victoria, BC. 49 pp.
- Parks Canada. 2004. Gulf Islands National Park Reserve of Canada.  
[http://www.pc.gc.ca/pn-np/bc/gulf/index\\_e.asp](http://www.pc.gc.ca/pn-np/bc/gulf/index_e.asp) (accessed August 2004)
- Pilsbry, H.A. 1948. Land Mollusca of North America (north of Mexico), volume 2 part 2. *Monographs of the Academy of Natural Sciences of Philadelphia* (3), Philadelphia, 640 pp.
- Reise, H., J.M.C. Hutchinson, R.G. Forsyth, and T.J. Forsyth. 2000. The ecology and rapid spread of the terrestrial slug *Boettgerilla pallens* in Europe with reference to its recent discovery in North America. *The Veliger* 43:313–318.
- Rollo, C.D. and W.G. Wellington. 1975. Terrestrial slugs in the vicinity of Vancouver, British Columbia. *The Nautilus* 80:107–115.
- Rollo, C.D. and W.G. Wellington. 1979. Intra- and inter-specific agonistic behavior among terrestrial slugs (Pulmonata: Stylommatophora). *Canadian Journal of Zoology* 57:846–855.
- Sierra Club, 2003. Vancouver Island: How much has been logged?  
<http://www.sierraclub.ca/bc/Campaigns/VancouverIsland/vimaps.html> (accessed August 2004)
- van Kooten, G.C. 1995. Modeling public forest land use tradeoffs on Vancouver Island. *Journal of Forest Economics* 1: 191–218.  
<http://www.urbanfischer.de/journals/jfe/content/1995/van%20Kooten.pdf> (accessed August 2004)
- Wilke, T. and N. Duncan. 2004. Phylogeographical patterns in the American Pacific Northwest: lessons from the arionid slug *Prophysaon coeruleum*. *Molecular Ecology* 13:2303 – 2315.



## BIOGRAPHICAL SUMMARY OF REPORT WRITER

Kristiina Ovaska, Ph.D., M.Sc., received her doctoral degree (biology) from the University of Victoria in 1987, after which she completed two post-doctoral studies in animal behaviour and population biology. Presently, she is a partner in Biolinx Environmental Research Ltd. and a research associate at the Department of Forest Sciences, University of British Columbia. Over the past 15 years, Dr. Ovaska has prepared numerous environmental impact assessments, status reports, and recovery plans and conducted research on a variety of wildlife, including endangered species. Her experience with terrestrial gastropods includes the preparation of status reports and recovery strategies, research into effects of forestry, and numerous surveys for species deemed to be at risk in British Columbia. Her photographs of gastropods appeared in the Royal BC Museum Handbook "Land Snails of British Columbia" by R. Forsyth. Dr. Ovaska is the author of more than 40 publications in the refereed scientific literature, including several recent papers on terrestrial gastropods.

Lennart Sopuck, M.Sc., RPBio, has studied a wide variety of wildlife species over the past 25 years, including several species at risk, and specializes in research on the effects of human activities on wildlife. 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 the RENEW recovery strategy for the Coastal Giant Salamander and for two species of terrestrial gastropods.

## COLLECTIONS EXAMINED

The following institutional collections were consulted. Only the Royal British Columbia Museum holds specimens of *Prophysaon coeruleum* from British Columbia.

Canadian Museum of Nature, PO Box 3443, Stn. D, Ottawa, ON, Canada K1P 6P4  
Carnegie Museum of Natural History, 4400 Forbes Ave, Pittsburgh, PA 15213-4080,  
USA

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

The Field Museum of Natural History, 1400 S. Lake Shore Drive, Chicago, IL, USA  
60605-2496

Royal British Columbia Museum, 675 Belleville Street, Victoria, BC, Canada V8V 1X4  
Royal Ontario Museum, 100 Queen's Park, Toronto, Ottawa, ON, Canada M5S 2G6