A Summary of Terrestrial and Freshwater Invertebrate Conservation in British Columbia

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Introduction

Invertebrates dominate the world's ecosystems, and there are immense challenges to addressing their conservation needs. British Columbia (B.C.) has approximately 50,000 invertebrate taxa (Cannings 1992), 40,000 of which are estimated to be insects (Harding 1997). Very little is known about the distribution, abundance, life history, and habitat requirements of most of these animals, and making assessments on a species-by-species basis to determine if a species is at risk is a formidable task. Even for species groups like butterflies, where the distribution information is well documented, host plant specificity and habitat are not completely known. Regardless of these challenges, interest in the field of invertebrate conservation is growing, and filling in the information gaps is rewarding. There is a strong need for expertise and specialization on a local, regional, and provincial scale for all invertebrate groups. Those wishing to carve a specialist niche in the realm of conservation biology should consider becoming involved in invertebrate conservation.

The protection of invertebrates at risk has been initiated at both the federal and provincial level. The federal *Species at Risk Act* (SARA) provides immediate protection for individuals, residences, and critical habitats for those species which occur on federal lands and are listed as Endangered or Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Other federal acts that aid in the protection of invertebrates at risk include the *Fisheries Act*.

Invertebrates listed by COSEWIC as Threatened, Endangered, or Extirpated will be protected under 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 that occur in provincial parks and protected areas, and incorporates provisions for their management into the parks' master plans. Additionally, invertebrates that are provincially listed as Vulnerable, Threatened, or Endangered, and which are negatively affected by forest and range use practices can be included in the category 'species at risk' under the British Columbia *Forest and Range Practices Act.* The Act provides for the establishment of Wildlife Habitat Areas and

associated General Wildlife Measures to protect these invertebrates from impacts related to forest and range use activities. The implementation of Wildlife Habitat Areas and General Wildlife Measures is addressed through the Identified Wildlife Management Strategy.

The B.C. Conservation Data Centre (CDC) has the difficult task of ranking the province's invertebrates. Data on the distribution of many invertebrates in the province is nonexistent, old, or lacking; thus, accurate ranking is not possible until regional data gaps are filled. Additionally, obtaining records of what is known can present difficulties. Provincial records are held at various institutions including the Royal British Columbia Museum (Victoria), the Pacific Forestry Centre (Victoria), the Spencer Entomological Museum at the University of British Columbia (Vancouver), the Canadian National Collection (Ottawa), and a few institutions throughout the United States. Also, most entomology museums are understaffed, specimens are not identified to species, specimen collection records are not recent, and/or the collection records are not stored within central and accessible databases that are easy to use and which are consistently updated.

The B.C. CDC has assessed the conservation status of select groups of invertebrates through the use of status reports and element status rankings. These groups include the Order Lepidoptera (butterflies only), the Order Odonata (damselflies and dragonflies), and the Class Mollusca (freshwater molluscs [snails, mussels, and clams] and gastropods [terrestrial snails and slugs]) (CDC 2005). Information on these taxa is available partly due to the level of public interest in them. Both professional entomologists and members of amateur naturalist groups are able to identify these groups, and so, have provided important information on these taxa. For example, inventory of the provincial Odonata is in its sixth season; consequently, gaps in distribution information for this Order are narrowing (R.A. Cannings, pers. comm.). Status assessments for many other taxa, however, are extremely difficult to complete. Often, there are few, if any, taxonomic experts in Canada for a given invertebrate group. Despite this, curators, collections managers, and CDC staff are planning to rank additional invertebrate groups over the next five to ten years. Potentially, many of these invertebrate groups will also be tracked (L. Ramsay, pers. comm.).

There are currently more than 70 red- and blue-listed butterfly taxa and approximately 24 red- and blue-listed Odonata taxa in B.C. (CDC 2005). Sixteen terrestrial/freshwater invertebrate taxa assessed by COSEWIC are known to occur in British Columbia. Species-specific recovery and conservation measures have been developed for the fourteen that are listed as Special Concern, Threatened, Endangered, or Extirpated (Table 1).

Table 1. Terrestrial and freshwater invertebrates assessed by COSEWIC which occur in British Columbia (COSEWIC 2004).

English name	*Scientific name*	*COSEWIC status*
Behr's hairstreak	*Satyrium behrii columbia*[a]	Threatened (2000)
Dromedary jumping-slug	*Hemphillia dromedarius*	Threatened (2003)
Dun skipper	*Euphyes vestris* (western population)	Threatened (2000)
Evening fieldslug	*Deroceras hesperium*	Data Deficient (2003)
Hotwater physa	*Physella wrighti*	Endangered (2000)
Island blue	*Plebejus saepiolus insulanus*[b]	Endangered (2000)
Large marble	*Euchloe ausonides*	Extirpated (2000)
Monarch	*Danaus plexippus*	Special Concern (2001)
Mormon metalmark	*Apodemia mormo*	Endangered (2003)
Oregon forestsnail	*Allogona townsendiana*	Endangered (2002)
Puget Oregonian snail	*Cryptomastix devia*	Extirpated (2002)
Rocky Mountain capshell	*Acroloxus coloradensis* (western population)	Not at Risk (2001)
Rocky Mountain ridged mussel[c]	*Gonidea angulata*	Special Concern (2003)
Sand verbena moth	*Copablepharon fuscum*	Endangered (2003)
Taylor's checkerspot[d]	*Euphydryas editha taylori*	Endangered (2000)
Warty jumping-slug[e]	*Hemphillia glandulosa*	Special Concern (2003)

[a]The BC Species and Ecosystems Explorer (April 2005) does not list subspecies of the Behr's hairstreak.
[b]The BC Species and Ecosystems Explorer (April 2005) lists this subspecies as the greenish blue, *insulanus* subspecies (*Plebejus saepiolus insulanus*).
[c]The BC Species and Ecosystems Explorer (April 2005) lists this species as the western ridgemussel.
[d]The BC Species and Ecosystems Explorer (April 2005) lists this subspecies as Edith's checkerspot, *taylori* subspecies.
[e]The BC Species and Ecosystems Explorer (April 2005) lists this species as the warty jumping slug.

Most invertebrates are intricately tied to a specific ecosystem type, but this link is not always fully understood. Ecosystem-based conservation initiatives include preserving wildlife features and maintaining vegetation ecotypes; thus, invertebrates and their habitats are often protected by such initiatives, even when information on their life requirements is unavailable. This paper presents a brief overview of the COSEWIC-listed invertebrates in British Columbia according to their associated ecosystem types: sand dune ecosystems, Garry oak (*Quercus garryana*) ecosystems of southern Vancouver Island, antelope-brush (*Purshia tridentata*) grasslands of the South Okanagan, lowland riparian and deciduous forest habitats of the Lower Mainland, and hotsprings freshwater ecosystems.

Sand Dune Ecosystems

The sand verbena moth (*Copablepharon fuscum*) is a sand dune specialist which depends on the food plant, yellow sand-verbena (*Abronia latifolia*), for all stages of its life cycle. The global distribution of the sand verbena moth includes eight localities: three in the Georgia Strait region of British Columbia and five in the Puget Sound region of Washington State. Recent surveys for the species suggest that the three provincial populations are stable, although threats to the species'

habitat are evident and increasing (Page 2003).

The sand verbena moth's food plant, *Abronia latifolia*, is a long-lived perennial, sand dune-dependent plant that is endemic to the Pacific coast. Its distribution ranges from Santa Barbara, California to the Queen Charlotte (Haida Gwaii) Islands in British Columbia. Approximately 28 sites in British Columbia have *A. latifolia* populations, but it is not known if the sand verbena moth formerly occurred at all of these sites. The three sites in B.C. where the moth is known to occur are located in regional, municipal, and provincial parks (Page 2003).

Sand dunes are fragile ecosystems that have been greatly altered due to recreational activities, trampling, and physical destruction. Additional threats to the sand verbena moth include habitat loss and reduced quantity and quality of its host plant due to the stabilization of open sand dune habitats, which is caused primarily by encroachment of native and invasive plants. Chronic natural disturbance is needed to maintain *A. latifolia* populations in open sand dunes. Further threats to the sand verbena moth include its isolated population structure and the fact that no subpopulations occur within its known dispersal distances; thus, the potential for recolonization or a rescue effect is limited. The quality and quantity of the host plant that is required to maintain a subpopulation of the sand verbena moth is not known. The moth is a monophagous species and, therefore, is more likely to suffer extirpation or extinction than a polyphagous species (Nieminen 1996). Control measures used for moth pest species could also present a threat to sand verbena moth populations. These measures include such things as the use of Btk (*Bacillus thuringiensis* var. *kurstaki*) spray and the intentional introduction of biocontrol agents (e.g., tachinid flies) to eradicate the gypsy moth (*Lymantria dispar*) on southern Vancouver Island (Page 2003; N. Page pers. comm.).

Recovery of the sand verbena moth depends on controlling native and invasive plant species encroachment into sand dune ecosystems and educating the public about the importance of these ecosystems. Research needs for the sand verbena moth include understanding the species' dispersal capabilities (determining rescue effects) and its antennal responses to host volatiles and female pheromones, identifying its viable population size by estimating current population sizes, and determining the amount of area needed for host plant sustainability. Continuing research on the sand verbena moth in British Columbia is being done by Nick Page.

Garry Oak and Associated Ecosystems

Garry oak and associated ecosystems historically occurred throughout the leeward side of the southern portion of Vancouver Island and the Gulf Islands (Lea 2002). Today, these ecosystems occur in fragmented patches throughout this range. These dry meadow habitats support a host of unique flora and fauna, including invertebrate assemblages which occur nowhere else in the province (GOERT 2004). Inventories of Garry oak ecosystems have been limited to opportunistic studies and by-products of other research activities. The butterflies of these ecosystems have been sporadically inventoried, although location records are sparse, incomplete, and inaccurate. The

butterflies of the Garry oak ecosystems in the Greater Victoria area have been identified during annual butterfly counts conducted by the Victoria Natural History Society, which has been actively keeping records at various parks for over 10 years (Victoria Natural History web site http://www.vicnhs.bc.ca/home.html). Such initiatives supply vital information to butterfly recovery efforts. Inventories of, and population information on, the butterflies of Garry oak ecosystems outside the Greater Victoria area are still needed to establish their long-term population trends.

Three butterfly taxa associated with Garry oak ecosystems are listed by COSEWIC: the Taylor's checkerspot (*Euphydryas editha taylori*), large marble (*Euchloe ausonides*), and island blue (*Plebejus saepiolus insulanus*). A fourth COSEWIC-listed species known to occur in Garry oak ecosystems is the dun skipper (*Euphyes vestris* [western population]), although populations of this species occur in other ecosystems as well.

Taylor's checkerspot is a subspecies of Edith's checkerspot (*Euphydryas editha*). The known historic distribution of Taylor's checkerspot in Canada was limited to southeastern Vancouver Island and the adjacent Gulf Islands. There were approximately 10 known sites in the Greater Victoria area and 3 known sites from Mill Bay to Duncan. Most of the populations in the Greater Victoria area persisted until the 1950s, and one remaining population in the Mill Bay area persisted until 1989 (Shepard 2000d) but was extirpated by 1995 (Shepard 1995). The northernmost locations of the Taylor's checkerspot were on Hornby Island; these were extant in 1996 (Shepard 2000d, 2000e) but were thought to be extirpated by 2001 (Guppy and Fischer 2001; Miskelly 2003). This species is likely extirpated from Canada; the last known population was in Helliwell Provincial Park on Hornby Island (Guppy 2001; Miskelly 2003). Outside of Canada, there are approximately five remnant populations in western Washington and Oregon (A. Potter, pers. comm.; D. Grosball, pers. comm.; D. Stinson, pers. comm.).

The large marble is known to have occurred in the Garry oak ecosystems of southern Vancouver Island and Gabriola Island. This species was likely extirpated from Canada prior to 1910 (Shepard 2000e). Recent search efforts have found only one extant global population of the large marble on San Juan Island in Washington State (J. Fleckenstein, pers. comm.).

Records of the island blue show that its range extended from south of Campbell River to Victoria on Vancouver Island, and partially overlapped with that of Garry oak ecosystems. However, the species was last recorded in 1979 and is now thought to be extinct (Shepard 2000c). There are various opinions as to why the species no longer inhabits Vancouver Island, including the loss of its native food plants, the spread of invasive plant species, and the control of fires which historically restricted forest encroachment into open meadow habitats (Shepard 2000c). In 2003, an inventory of the subalpine areas of Vancouver Island was conducted because there were a few records of this species in higher elevation areas, but no individuals were located (Guppy 2003). Considerable areas of potentially suitable habitat on Vancouver Island have not been surveyed for the island blue; it is possible that this species still occupies some of these areas.

Few inventories have been conducted in Garry oak ecosystems for species other than butterflies; however, one recent study characterized the late summer flying and ground beetle communities in a Garry oak ecosystem at Rocky Point and Mary Hill on the Department of National Defence lands on southern Vancouver Island (McLean 2003). A second ongoing study (with the support of Parks Canada) has targeted select ecosystems on Saturna Island in the recently established Gulf Islands National Park Reserve (pers. obs.). For this study, a group of volunteer entomologists targeted their respective taxonomic groups within select ecosystems on Saturna, Tumbo, and Cabbage Islands. In addition, pitfall trapping was done monthly from June through October 2004. Sorting and specimen identification has not been completed, but it is estimated that more than 100 different invertebrate species have been identified from the trap catches. Information gained from these collections will be useful for identifying native invertebrate species' distributions and alien species' range expansions.

Threats to Garry oak ecosystems and the butterfly habitat they provide include encroachment by native trees and shrubs and control of natural fires which historically restricted forest encroachment into open meadow habitats (GOERT 2002). Further threats to COSEWIC-listed butterflies in Garry oak ecosystems include delayed senescence of host plants due to conifer encroachment into the moister areas of the native grasslands, urban and rural land conversion of native Garry oak meadow habitats, livestock grazing, ill-planned and improper vegetation management, recreational activities, and insecticide application, including the use of Btk to control the gypsy moth (Shepard 2000c, 2000e).

Upcoming COSEWIC assessments will be done for the Bremner's fritillary (*Speyeria zerene bremnerii*)[1], moss' elfin *(Callophrys mossii mossii*), propertius duskywing (*Erynnis propertius*), and Blackmore's blue (*Icarica icarioides blackmorei*)[2] (COSEWIC 2004).

South Okanagan Invertebrates

The South Okanagan grasslands have the greatest documented number of invertebrate taxa at risk in the province (G. Scudder, pers. comm.). These ecosystems represent the northern extent of the bunchgrass grasslands of the Great Basin region of the western United States (Pitt and Hooper 1994). Within the South Okanagan, the antelope-brush shrub-steppe is the ecosystem of greatest importance to biodiversity conservation. Most of this ecosystem has been lost to agricultural and urban development (Schluter et al. 1995); only about 35% of the antelope-brush/needle-and-thread grass community (*Purshia tridentata/Hesperostipa comata*) remains in good natural condition (T. Lea, pers. comm.).

The South Okanagan grassland ecosystems currently support three COSEWIC-listed butterfly taxa: the Behr's hairstreak (*Satyrium behrii columbia*), Mormon metalmark (*Apodemia mormo*)

[1]The BC Species and Ecosystems Explorer (April 2005) lists this subspecies as the zerene fritillary, *bremnerii* subspecies.
[2]The BC Species and Ecosystems Explorer (April 2005) lists this subspecies as Boisduval's blue, *blackmorei* subspecies (*Plebejus icarioides blackmorei*).

(Southern Mountain population), and monarch (*Danaus plexippus*). Additional butterfly species associated with this ecosystem that are in the queue for COSEWIC assessments in May 2005 include the sooty hairstreak (*Satyrium fuliginosa*) and Sonora skipper (*Polites sonora*). Arthropods scheduled for assessments at later dates include *Copablepharon absidum* and the Mormon fritillary, *erinna* subspecies (*Speyeria mormonia erinna*).

Antelope-brush is the larval food plant of the Behr's hairstreak. Threats to antelope-brush habitat include urban, rural, and agricultural development; habitat degradation; invasive species encroachment; livestock grazing; and fragmentation and general loss of quality habitat (Shepard 2000a). Recovery efforts for the Behr's hairstreak have centered on the inventory and preservation of known used sites and sites with quality patches of antelope-brush. The second year of a population and dispersal study of the Behr's hairstreak is being conducted by researchers at Okanagan University College (St. John and Desjardens 2003). Stewardship and public education initiatives in the South Okanagan have furthered conservation efforts for this butterfly. For the past three years, a 'Behr's Blitz' has been organized to inventory antelope-brush habitats for this species. The third year of the blitz is planned for 2005.

The Mormon metalmark has two populations in Canada: the Southern Mountain population, which is confined to a small area of the Similkameen Valley in B.C., and the Prairie population which occurs in Grasslands National Park, Saskatchewan. The B.C. population is a small, disjunct, northern outlier of the species' main range which occurs in the southwestern United States (St. John 2003). Public education initiatives involved an inventory blitz and assessment of grassland habitats for this species in August 2004. Another blitz is planned for August 2005.

The monarch butterfly is a global icon of butterfly conservation. This species is rarely seen in British Columbia. Sightings typically occur in the South Okanagan, although records exist from west of the Rocky Mountains to the Pacific coast. The monarch is dependent on milkweed (*Asclepius* spp.) and wildflowers (goldenrods, asters, and purple loosestrife [*Lythrum salicaria*]) (Crolla and Lafontaine 1997). Threats to this species, which are applicable to British Columbia, include the widespread use of herbicides and the control of the milkweed larval food plant, which is considered a noxious weed in most areas of Canada (Crolla and Lafontaine 1997).

Lowland Riparian- and Deciduous Forest-dependent Invertebrates

The Lower Mainland and southern Vancouver Island regions of British Columbia support moist, productive mixed-wood and deciduous forests and riparian areas. These areas are in high demand for urban and rural development, as well as timber extraction. COSEWIC-listed invertebrates at risk that occur in these areas include the Oregon forestsnail, (*Allogona townsendiana*), Puget Oregonian snail (*Cryptomastix devia*), dun skipper, dromedary jumping-slug (*Hemphillia dromedarius*), and warty jumping-slug (*Hemphillia glandulosa*).

The Oregon forestsnail is a land snail that is endemic to western North America. It is at the northern extremity of its geographic range in the lower Fraser and Chilliwack River valleys. One

population of this species exists near Westholme on Vancouver Island (Forsyth and Ovaska 2002). Populations of the Oregon forestsnail occur in the deep, mull-type litter layers of low elevation mixed-wood and deciduous forests and riparian areas (Forsyth and Ovaska 2002). Threats to the Oregon forestsnail include fragmentation of its forest habitats, mainly from land development. Although forested hillsides adjacent to low elevation forests may act as refuges for this species, habitat quality may be compromised by recreational use. The snail has a long maturation period and poor dispersal ability, and it requires a continually moist microhabitat. All of these biological factors are thought to limit its distribution. Exotic species of gastropods may also pose a threat to this species due to predation and competition for resources (Forsyth and Ovaska 2002). Research on the Oregon forestsnail should include gathering information on its distribution, ecology, and population dynamics; conducting intensive inventories within suitable habitat types; and clarifying the threats to the species.

The Puget Oregonian snail is known from historic records (1850–1905) from southwestern British Columbia. Globally, the species was known to occur only in B.C., Washington, and northern Oregon (Ovaska and Forsyth 2002). Puget Oregonian snails inhabit older, moist, mixed-wood forests which have a significant component of bigleaf maple (*Acer macrophyllum*) (Ovaska and Forsyth 2002). Although the species has been extirpated from its Canadian range, recovery efforts focus on conducting surveys in likely habitats, assessing habitat suitability for possible future reestablishments, and initiating public education programs to raise awareness of at-risk gastropods.

The dromedary jumping-slug is a forest-dwelling slug that is endemic to southern British Columbia and western Washington, although there are unconfirmed records from northern Oregon. Only eight localities are known for this species, and it exists at the northernmost limits of its range on southern Vancouver Island (Ovaska and Forsyth 2003). The habitat requirements of the dromedary jumping-slug are poorly known, although occurrence records for Vancouver Island characterize the species as an inhabitant of mature and old-growth forests. The dromedary jumping-slug likely requires abundant coarse woody debris and moist microhabitats in which to lay eggs and take cover. It appears to be vulnerable to microclimatic changes that remove both the overstorey and understorey thus resulting in both small-scale microhabitat alteration and larger scale habitat modification (Ovaska and Forsyth 2003). The research needs for this species are similar to those for the other gastropods at risk. Continuing research on gastropods at risk in British Columbia is being done by Kristiina Ovaska and Lennart Sopuck.

The dun skipper (western population) is one of B.C.'s most elusive butterflies. This chocolate brown, nondescript insect is very rare. Usually, only one or two specimens are observed at a time. Its known distribution extends from the southern Fraser Canyon through the Lower Mainland and up the Sunshine Coast as far as Powell River, and includes Hornby and Saltspring Islands and the southeastern portion of Vancouver Island from Comox south (Shepard 2000b). It is difficult to characterize the habitat of this species as it is often seen along roadsides and power line and railroad right-of-ways, and in ditches, open moist meadows, and fields. It is known to feed on

plants of the *Carex* and *Cyperus* genera, which have a widespread distribution (Shepard 2000b). Although over its entire range the dun skipper uses dozens of different host plant species, it is polyphagous on one or two host plants in a given location. This biological factor likely contributes to the species' rarity (Shepard 2000b).

The main threats to the dun skipper include improper management of protected habitats that support populations of the butterfly; encroachment of introduced and native plant species into its habitat; lack of information on the species' population structure, habitat, and host plant specificity; and overall destruction of suitable habitat types due to such things as private land development, draining of wetlands and flooded areas, improper vegetation management, and natural forest succession. To address these threats and knowledge gaps, intensive inventory and detailed habitat descriptions are required.

Hotsprings Invertebrates

The hotwater physa (*Physella wrighti*) is a freshwater snail that is known from only one location—Liard River Hotsprings Provincial Park in northern British Columbia. The snail was first described in 1973; since then, no other occurrence locations have been documented (Lee and Ackerman 1998). Liard River Hotsprings Provincial Park is a unique complex of thermal springs which provide consistently warm lotic and lentic habitat for several populations of animals, and a localized warm climate for plant species. The hotwater physa is threatened primarily by its small, localized, spatially isolated population and its habitat specificity, and by introduced species; changes in water quality and the natural flow regime of the hotsprings; destruction/alteration of both riparian and aquatic hotsprings habitats; and destruction of individuals and the *Chara* spp. floating plant mats on which the snails source tufa calcium deposits (S. Salter, pers. comm.).

Conclusions

The recovery of British Columbia's invertebrates is being undertaken by three groups: the B.C. Terrestrial/Freshwater Invertebrates Recovery Team, the South Okanagan Invertebrates Recovery Implementation Group, and the Garry Oak Invertebrates Recovery Implementation Group. Linkages with additional recovery teams are ongoing and changing, as recovery efforts involve multi-species approaches.

An immense amount of research is needed to fill the knowledge gaps for most of British Columbia's invertebrate species at risk. Researchers and consultants interested in carving themselves a niche of expertise should consider working in the field of invertebrate conservation. Post-secondary institutions offering biological studies and environmental training programs should incorporate invertebrate species at risk into their curriculum. There is a strong need for expertise and specialization on a local, regional, and provincial scale for all invertebrate groups, with the priority being on butterflies and moths, molluscs, damselflies and dragonflies, and tiger

beetles, as these taxonomic groups are now being considered for assessment by COSEWIC. Assessment of additional invertebrate groups will follow; therefore, demand for expertise in the taxonomic identification of all species groups will increase. Interest in invertebrate conservation is increasing, and becoming involved in this field provides exciting opportunities for all those who are interested in the conservation of the natural world.

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