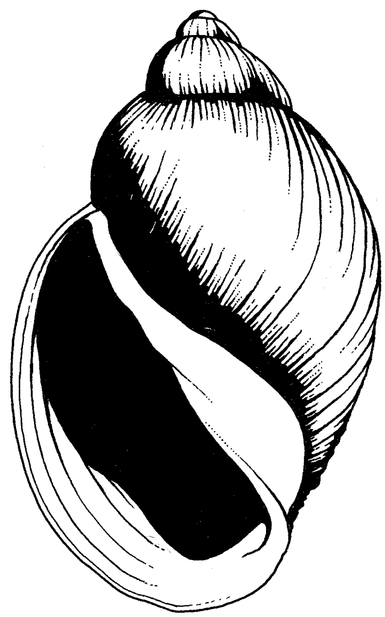
COSEWIC
Assessment and Update Status Report

on the

Hotwater Physa
Physella wrighti

in Canada



ENDANGERED
2008

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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Previous report:

COSEWIC. 2000. COSEWIC assessment and status report on the Hotwater Physa *Physella wrighti* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 25 pp.

Lee, Jacqueline S. and Ackerman, Josef, D. 1998. COSEWIC (Draft) status report on the Hotwater Physa *Physella wrighti* in Canada. Committee on the Status of Endangered Wildlife in Canada. iii + 25 pp.

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COSEWIC would like to acknowledge Jacqueline S. Lee for writing the update status report on the Hotwater Physa *Physella wrighti* prepared under contract with Environment Canada. This report was overseen and edited by Robert Forsyth, Co-chair of the COSEWIC Molluscs Specialist Subcommittee.

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COSEWIC
Assessment Summary

Assessment Summary – April 2008

Common name
Hotwater Physa

Scientific name
Physella wrighti

Status
Endangered

Reason for designation
This small snail is an endemic species living only within the hotsprings complex located in Liard River Hotsprings Provincial Park in British Columbia. The population is small, numbering fewer than 10,000 individuals and occupies an extremely restricted habitat around the margins of two pools and an outlet stream. Population size is believed to fluctuate by at least an order of magnitude in this short-lived snail (~1 year lifespan). The species is a habitat specialist requiring geothermally regulated water and substrates near the water/air interface in areas of no current. The hotsprings complex has been in use by humans for over 200 years. The species has survived structural modification and maintenance of the pools, the introduction of foreign substances such as soaps and shampoos, and trampling. However, a single event such as abrupt changes in water flow, chemical contamination or introduction of exotic species, could significantly affect persistence of this snail.

Occurrence
British Columbia

Status history
Designated Endangered in April 1998. Status re–examined and confirmed in May 2000 and April 2008. Last assessment based on an update status report.

COSEWIC
Executive Summary

Hotwater Physa
Physella wrighti

Species information

The Hotwater Physa, *Physella wrighti,* is a freshwater snail of the family Physidae. This family is characterized by sinistral (left-handed) coiling. The maximum shell length recorded for *P. wrighti* is 9.1 mm but most specimens are smaller.

Within the scientific community, there is uncertainty as to whether *P. wrighti* is biologically distinct from the common, widespread *P. gyrina*. Recent studies of genetic relationships of these snails have not resolved the uncertainties in this group.

Distribution

Physella wrighti occurs only within the Liard River hotsprings complex located in Liard River Hotsprings Provincial Park (LRHPP) in northern British Columbia. The Extent of Occurrence of *P. wrighti* is approximately 16,310 m^2 (0.02 km^2), within which the Area of Occupancy is 1 km^2. Since the snail occupies only a narrow strip at the edges of two pools and an outlet stream, the real area occupied is approximately 4.6 m^2 (4.6×10^{-6} km^2).

Habitat

Physella wrighti occurs in habitat that maintains water temperature of 23–40°C year round. It occupies substrates near a water/air interface in areas of little or no water flow where the snails can position themselves and their eggs at temperatures optimal for life history requirements. This habitat occurs in LRHPP along parts of the margins of Alpha Stream and around the perimeters of Alpha and Beta pools.

Biology

Physella wrighti grazes on algal and microbial growth. As a physid snail, *P. wrighti* is an oviparous (egg-laying) hermaphrodite. In temperate climates, physids generally lay eggs in the spring. The eggs develop directly into juveniles that mature during the summer, lay eggs the following spring, and die. However, physids living at warmer temperature might accelerate these life history traits and exhibit no seasonality of reproduction. No studies have been conducted on *P. wrighti* so no data are available on the growth rate, longevity, age at sexual maturity, egg development rate, or seasonality of reproduction for this species in its natural habitat.

Population sizes and trends

The population of *P. wrighti* at LRHPP occurs in three definable areas: Alpha Stream, lower Alpha Pool and Beta Pool, all of which are probably connected through the movements of wildlife and humans, and by natural events. Three abundance estimates of *P. wrighti* in Alpha Stream found the number of snails to be 2,100 in September 1997, 5,200 in August 2000, and 1,400 in August 2006. Differences in these population estimates might partially be due to differences in the length of the stream surveyed. Additional surveys with standardized protocols are required to assess the population trend within Alpha Stream but the current evidence does not indicate a decline in the population of *P. wrighti*. Two abundance estimates in Alpha Pool found the number of snails to be 2,100 in January 2000 and 23 in August 2006. This difference might be a seasonal population trend similar to that noted for a different species of hotsprings snails in Banff National Park where the population is larger in the winter. Alternatively, the differences in these population estimates could be related to the absence of *Chara* plants in Alpha Stream in 2006. One abundance estimate in Beta Pool found the number of snails to be 910 in August 2006.

Limiting factors and threats

The most obvious natural limiting factors for *Physella wrighti* are its putative requirement for warm water and its requirement to access the water/air interface for respiration. This species is extremely vulnerable to disturbance because it is endemic to the Liard River Hotsprings complex. The source of the heated water in these springs lies outside of LRHPP, and exploratory drilling for oil and gas could potentially be a significant threat to this species if drilling into the fracture results in a redirection of flow away from the springs.

These hotsprings have been developed for human use for many years and have had up to 40,000 visitors per year. Natural or anthropogenic diversion of Alpha Stream could expose *P. wrighti* to lethal ambient air temperatures, and the addition of foreign substances to Alpha or Beta Pools (*e.g.,* shampoo, bath oil) might limit the snail's access to air and/or coat them in substances that could interfere with life processes.

The introduction of turtles, found and removed on at least two occasions, and the potential for introducing other exotic animals into the Liard Hotsprings, is also a serious threat. These could have devastating ecological effects on *P. wrighti* if an aggressive predator or competitor was introduced.

Special significance of the species

Hot water species are of significant scientific interest because they might have arisen from a marginal population that possesses a gene pool more readily able to adapt or acclimate to changing conditions than can congeneric species. *Physella wrighti* is an indicator that in LRHPP the relatively warm northern ecosystem continues to provide appropriate habitat for unique fauna in spite of development and continued human use. *Physella wrighti* is one of several locally endemic plants and animals that are associated with the consistently warm lotic and lentic habitats afforded by this hotspring system.

Existing protection or other status designations

In May 2000, *P. wrighti* was listed as Endangered by the Committee on the Status of Endangered Wildlife in Canada, and based on this designation, it was placed on Schedule 1 of the *Species at Risk Act* (SARA) in 2003. SARA designates Fisheries and Oceans Canada as the responsible jurisdiction for *P. wrighti.* Under the *Fisheries Act* (Canada) protection is afforded by preventing harmful alteration, disruption or destruction of fish habitat and prohibits release of deleterious substances into fish-bearing waters. As a Class A B.C. Provincial Park, LRHPP has its management governed by the *Park Act* (1996), which protects the park's natural resources. In accordance with SARA regulations, a recovery strategy for *P. wrighti* has been developed.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2008)

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

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

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

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

Environment Canada
Canadian Wildlife Service

Environnement Canada
Service canadien de la faune

Canada

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

Update
COSEWIC Status Report

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Hotwater Physa
Physella wrighti

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2008

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SPECIES INFORMATION

Name and classification

Scientific name: *Physella wrighti* Te and Clarke, 1985
English common name: Hotwater Physa
French common name: la physe d'eau chaude

The recognized authority for the classification of aquatic molluscs in the United States and Canada is Turgeon *et al.* (1998), who classify this species as follows:

Phylum: Mollusca
Class: Gastropoda
Subclass: Pulmonata
Order: Basommatophora
Family: Physidae
Genus: *Physella*
Species: *Physella wrighti*

The Turgeon *et al.* (1998) list follows Te's (1978) classification of the family Physidae, which transferred many species from *Physa* to *Physella*. However, some authors (*e.g*., Dillon 2000, Wethington and Guralnick 2004, Wethington and Lydeard 2007) have continued to use the genus name *Physa* for the entire group.

The validity of *P. wrighti* as a distinct species is debated within the scientific community. Te and Clarke (1985) used morphological, anatomical, cladistic and phenetic analyses to describe the species and concluded that "*P. wrighti* is certainly a primitive species not closely related to any other species in northwestern North America and it is virtually impossible that it could have evolved as such a distinct species since the end of the Pleistocene". They suggested that *P. wrighti* might have lived at its type locality for 100,000 years. However, Taylor (2003) synonymized *P. wrighti* with the related *Physella gyrina* based on morphology. *P. gyrina* is a generalist, commonly occurring in almost all perennial aquatic habitats, temporary pools and swamps and is the most widely distributed physid in Canada. Molecular studies are often used to define species relationships but the results for *P. wrighti* have been inconclusive. Interpretation of genetic data has not determined if *P. wrighti* is a unique species or if it is a geographically distinct population derived from *P. gyrina* (see **Genetic Description**).

Morphological description

Members of the subclass Pulmonata (pulmonates) have a richly vascularized pulmonary cavity formed by the mantle to extract oxygen from air or water. Pulmonates are thin-shelled and lack an operculum, which is the plate-like structure that seals the aperture when the animal is withdrawn into its shell. Snails of the order Basommatophora have their eyes at the base of the tentacles. The family Physidae is characterized by sinistral (left-handed) coiling of the shell (Figure 1). The shell of *P. wrighti* is light horn or yellowish horn in color and the surface is somewhat shiny but not glossy (Te and Clarke 1985). Average shell length of *P. wrighti* is about 5 mm, and the maximum length recorded is 9.1 mm (Lee and Ackerman 1999). Species of physids are particularly difficult to distinguish based on shell characteristics. A detailed morphological description is available in Te and Clarke (1985) but *P. wrighti* is most readily distinguished by its presence at the type locality in Liard River Hotsprings Provincial Park (LRHPP).

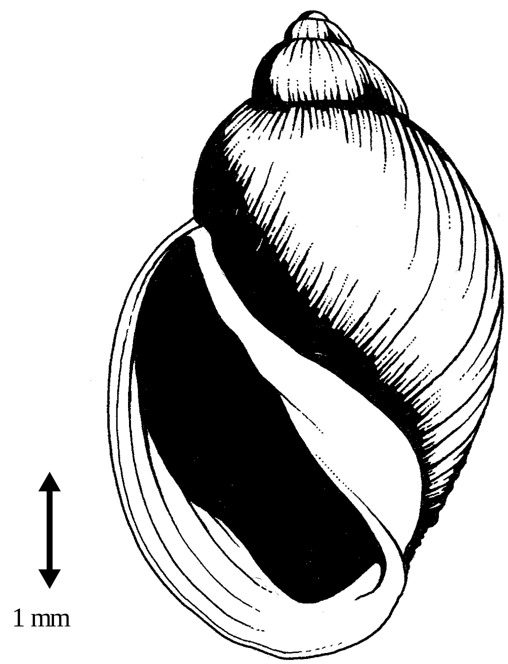

Figure 1. *Physella wrighti*, the Hotwater Physa. Illustration by Trent Hoover; used with permission.

Both Te (1978) and Taylor (2003) used the terminal male reproductive system (the penial complex) to classify physids. Te (1978) found *P. wrighti* (as OTU82) to have penial type-bc, indicating morphology to be intermediate between type-b (*P. gyrina* group; bipartite glandular penial sheath) and type-c (*P. acuta* group; unipartite non-glandular penial sheath), but Wethington and Lydeard (2007) classify *P. wrighti* as having a type-b penis morphology. Taylor (2003) synonymizes *P. wrighti* with *P. gyrina*, and describes this group as having a bipartite penial sheath. Wethington and Guralnick (2004) and Wethington and Lydeard (2007) examined the penial morphology of *P. wrighti* and also placed it in the *P. gyrina* group.

Genetic description

Remigio *et al.* (2001) used the CO1 and 16S regions of mitochondrial DNA (mtDNA) to analyze the relationships of *P. wrighti, P. johnsoni* (the Banff Springs Snail, which is endemic to warm springs within Banff National Park) and *P. gyrina* (the Tadpole Physa, which is broadly distributed in North America). Uncorrected p distances separating *P. wrighti* from *P. johnsoni* were 0.6–1.6% at 16S, 1.4-1.9% at CO1; *P. wrighti* from *P. gyrina* 0.6–1.4% at 16S, 1.2–1.7% at CO1; and *P. johnsoni* from *P. gyrina* 0.0–0.4% at 16S, 0.5–1.2% at CO1.

Using the phylogenetic species concept to interpret the above data, Remigio *et al.* (2001) concluded that *P. wrighti* and *P. johnsoni* are distinct species that are closely related to *P. gyrina*, and that the low sequence divergence at the two mtDNA loci indicated recent colonization of these hot water environments, probably at the end of the last Pleistocene glaciation. Wethington and Guralnick (2004) used these same genetic data, but expanded the breadth of populations analysed by adding data from two additional hot spring endemics, *P. wolfiana* (from Hot Springs, CA) and *P. aurea* (from Hot spring at Bath, VA). They concluded that all the hotspring physids in their study represent one biological species and stated that the genetic distance between members of this group is generally not greater than 6%. Similarly, analyses using two mitochondrial DNA sequences (16S and CO1) and a comparison of penis morphology, (Wethington and Lydeard 2007) support the recognition of a single clade containing two species of physids with type-b penial morphology. Within this clade they lump seven different taxa, including *P. wrighti* and *P. johnsoni* under *P. gyrina*. However, given the recent recolonization proposed by Remigio *et al*. (2001), it is not surprising that mtDNA did not reflect greater divergence. Remigio *et al.* (2001) and Zanatta (pers. comm. 2007) recommend that species relationships might be clarified by analysis of other genes with faster evolutionary rates (e.g., the ND1 gene).

There are no known barriers to gene flow within the single population of *P. wrighti,* but the fine-scale genetic population structure has yet to be investigated. Zanatta (pers. comm. 2007) recommends a fine-scale population genetic analysis using microsatellite DNA, which are rapidly mutating markers useful for working with recently diverged or closely related taxa. Such an analysis would confirm if snails from the Alpha Pool, Alpha Stream and Beta Pool form one locality.

Designatable units

No designatable units below the species level exist. If *P. wrighti* were synonymized with *P. gyrina,* the Liard River Hotsprings Provincial Park (LRHPP) population would then be available for consideration as a designatable unit of *P. gyrina* due to its biogeographical distinctness. These hot water specialist snails may represent unique and important ecological and/or evolutionary units (i.e., DUs under SARA) that still warrant protection. This can be further investigated using molecular markers that evolve more quickly than mtDNA markers (i.e., microsatellite DNA).

DISTRIBUTION

Global range

Physella wrighti is known only from the Liard River hotsprings complex located within Liard River Hotsprings Provincial Park (LRHPP) in northern British Columbia (B.C.), Canada (Figure 2). LRHPP is located at Mile 496 of the Alaska Highway, about 65 km south of the BC/Yukon border (59°25’35”N, 126°06’18”W; NAD27) and lies within the Boreal White and Black Spruce biogeoclimatic zone (Meidinger and Pojar 1991). In comparison, *P. johnsoni* is restricted to the hotsprings complex at Banff, Alberta, and *P. gyrina* is the most widely distributed physid in Canada. Clarke (1981) maps the northern limit of *P. gyrina* from the St. Lawrence River, Quebec, northwest to the Yukon River delta (Clarke 1981). In the United States is it distributed across all of the continental United States, including Alaska (NatureServe 2007). The population of the Hotwater Physa is therefore surrounded by *P. gyrina*.

Figure 2. Range of the Hotwater Physa, *Physella wrighti*.

Canadian range

The population within LRHPP was first discovered in 1973 in Alpha Stream and was further observed in the stream in 1979, 1997, 2000, 2001 and 2006 (Table 1). Recent surveys have identified additional areas inhabited by *P. wrighti* within LRHPP but the Canadian range of this species has not changed from 1973 to 2006 (33 years). The species is known from Alpha Pool, Beta Pool, and Alpha Stream for 200 m downstream from Alpha Pool.

Searches at other nearby hotsprings, including Grayling Springs, Deer River Hotsprings and Toad Springs in northern B.C., and Coal River Hotsprings in the Yukon Territory have not located additional populations of *P. wrighti* (Te and Clarke 1985; Salter 2003). Deer River Hotsprings, approximately 50 km from LRHPP, hosts another species of *Physella* (*P. virginea*), but a genetic comparison between the two populations has not been made (Heron 2007). *Physella virginea* is distributed from B.C. south to California, and species of *Physella* living in hotsprings may not all be narrow endemics. The case for this is strengthened if the phylogeny proposed by Wethington and Lydeard (2007), who lump into *P. gyrina* 11 different hot- and cool-water physid taxa, is correct.

Georeferenced maps at a suitable scale of the LRHPP area are currently unavailable and the 2006 extent of occurrence (EO) for *P. wrighti* was estimated from the park map available at the B.C. Parks website (B.C. Parks 2006; Figure 3). The 2006 EO is an irregular polygon enclosing approximately 16,310 m^2 (0.02 km^2; see Figure 3 and Appendix A). The area of occupancy (AO) is calculated to be 1 km^2, based on a 1 × 1 km grid (A. Filion pers. comm. 2008). A more biologically defensible area of occupancy, which includes only the narrow strip along the margins of water bodies occupied by snails, was calculated to be approximately 4.6 m^2 (4.6×10^{-6} km^2; see Appendix A).

HABITAT

Habitat requirements

The common name of *P. wrighti*, the Hotwater Physa, suggests that this species is a habitat specialist, requiring a geothermally elevated water temperature. Although the dependence of *P. wrighti* on elevated temperature for life history requirements has not been studied, water temperature likely influences many aspects of its life history.

Table 1. Summary of *Physella wrighti* survey information in Liard River Hotsprings Provincial Park 1973–2006.

Author(s)	Publication Date	Data Collected	Site	Distance Surveyed	Search Effort: hours	No. of snails	Habitat Area	Top 31m of Alpha Stream: no. of snails	Top 31m of Alpha Stream: habitat area
Te and Clarke	1985	1973, 1979	Alpha Stream	-	0.4	Observed	-	-	-
Lee and Ackerman	1999	1997	Alpha Stream	50 m	6.0	2,127*	3.5 m^2	2,127	3.5 m^2
Salter	2001	2000, 2001	Alpha Stream	0-140 m	-	2,306	96 m	-	-
			Alpha Stream	140-200 m	-	2,880	240 m	-	-
			Alpha Pool	Perimeter	-	2,100	1.4 m^2	-	-
Salter	2003	2000, 2001	Alpha Stream	-	-	Observed	-	-	-
			Beta Pool	-	-	Observed	-	-	-
Lee		2006	Alpha Stream	95 m	12.0	1,426	3.0 m^2	769	1.8 m^2
			Alpha Pool	Perimeter	0.4	23	-	-	-
			Beta Pool	Perimeter	1.0	910	0.2 m^2	-	-

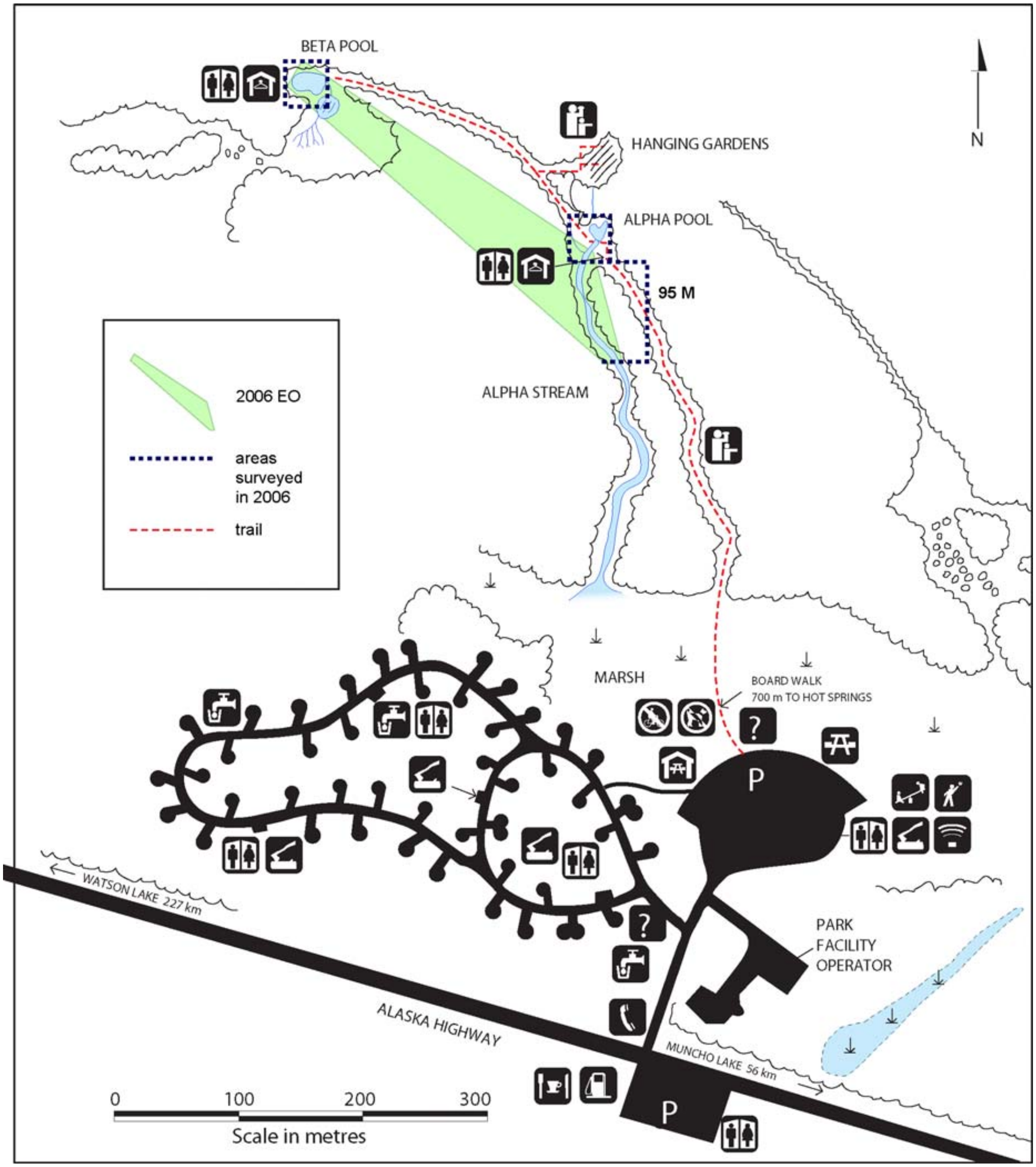

Figure 3. Liard River Hotsprings Provincial Park showing the Extent of Occurrence of *Physella wrighti* habitat accessible during the 2006 survey.

Conductivity of the water in Alpha Stream is about 1100 µS/cm (Table 2) indicating a high level of dissolved ions in the water, but as other *Physella* species in northern B.C. have been found in waters with conductivity as low as 77 µS/cm (Lee 2000) it is not certain that high ion content of the water is a requirement for this genus or species.

Table 2. Habitat parameters measured in Alpha Stream in Liard River Hotsprings Provincial Park during surveys for *Physella wrighti*.

Source	Range of temperature in Alpha Stream (°C)	pH	Dissolved Oxygen (% saturation)	Conductivity (µS/cm)
Te and Clarke 1985*	23.0 - 35.0	7.9	-	1100
Lee and Ackerman 1997**	23.5 - 36.5	7.8	67	1155
Salter 2003***	28.9 - 36.3	-	-	-
2006 survey****	35.5 - 40.0	-	-	-

* Temperature measured below Fern Creek

** Temperature measured in Alpha Stream from dam to 50 m downstream; other data at dam

*** Site unknown

**** Measured in Alpha Stream from dam to 95m downstream

The Liard Hotsprings area is unusual compared to other hotsprings in the region including Banff, Radium and Fairmont, in that it is considered a large-yield deep source, with a high flow rate of 81 L/s, and the chemistry is calcite-sulphite, not just calcite (Gilles Wendling, pers. comm.).

While Te and Clarke (1985) noted that snails occurred only on *Chara* plants in Alpha Stream, subsequent observations have located snails on the sediment surface, fallen leaves of Paper Birch (Lee and Ackerman 1999) and submerged debris, as well as on substrates within the pools (Salter 2001, 2003). Data for animals held in captivity suggest that a specific food requirement does not restrict habitat used by this species.

As pulmonates, physids use a pulmonary cavity for respiration. Some physids rely on aerial respiration and are somewhat amphibious (Brown *et al*. 1998) whereas others fill the pulmonary cavity with water and use it as a derived gill (Russell-Hunter 1978). Access to surface air is obtained by crawling along the substrate to the surface or by "spinning", in which the snail attaches a mucus trail to the substrate or surface film and changes its specific gravity to enable movement up and down the water column (Pennak 1989). The relative reliance of *P. wrighti* on aerial or dissolved oxygen is unknown but snails are always found near the water/air interface in areas of little or no water flow.

Based on observations of *P. wrighti in situ*, the environmental requirements are a habitat that offers food and a secure anchoring surface near a water/air interface in areas of little or no water flow where the snails can position themselves and their eggs at temperatures optimal for life history traits (see **Life history and reproduction**). This habitat occurs in LRHPP along parts of the margins of Alpha Stream and at the perimeters of Alpha and Beta pools.

Habitat trends

The habitat in which *P. wrighti* lives has been highly modified to accommodate human use. Use of the hotsprings is recorded as far back as 1837 (Camsell 1954) and the area became a B.C. park in 1957. The original weir is thought to date back to the construction of the Alaskan highway completed in the 1940s (Sue Pollard, pers. comm.). LRHPP features a campground and two hot pools that are used by an estimated 40,000 bathers annually, with day use and camping statistics remaining reasonably consistent over time (A. Hansen, pers. comm.). Despite the building of change rooms, walkways and entry stairs, Beta Pool remains largely in its natural state. Alpha Pool has been modified by the diversion of cool water into the incoming springs, and by the construction of change rooms, walkways and entry stairs as well as a concrete dam. The outflow from Alpha Pool around the dam creates Alpha Stream. Some park users also explore Alpha Stream as evidenced by footprints along the margins noted in 2006.

In all surveys in LRHPP, snails have been present in Alpha Stream. The structure of the habitat in Alpha Stream has changed over time. Te and Clarke (1985) described the type locality as “the reach extends from the mouth of Fern Creek (which enters Alpha Stream about 25 m below Alpha Pool) downstream for 34 m”. Later surveys have been unable to locate Fern Creek and snails have been found for a much shorter distance downstream from Alpha Pool (see **Population sizes and trends**). Te and Clarke (1985) reported the water temperature in the reach inhabited by *P. wrighti* to range from 23–35°C; Lee and Ackerman (1999) 23.5–36.5°C; and Salter (2001) 23-36°C in August 2000 and up to 33°C in January 2001 (see Table 2). In 1997, water temperature at the outflow from the dam was 36.5°C and while temperatures of 36°C were measured at some points up to 40 m downstream, the temperature was never higher than at the dam (Figure 4). In 2006, water at the dam was 36°C and with the exception of two points on the west bank, continued at this or greater temperature for the 95 m downstream that was surveyed, reaching a maximum of 40°C at a point on the east bank (see Figure 4). If the discharge from Alpha Pool were the sole source of water for Alpha Stream, the water temperature should decline with distance from the source. As previous surveys had found water temperature to be unchanged for some distance downstream of the dam, there must be hot water seepage into Alpha Stream.

It is unknown if this increased temperature might have changed the previously observed distribution of *P. wrighti* within Alpha Stream. All studies prior to 2006 reported the snails to be most abundant within the *Chara* on the margins of Alpha Stream. Te and Clarke (1985) noted that the snails occurred only on *Chara*, and Lee and Ackerman (1999) and Salter (2001) also found the snails to be most abundant within *Chara.* In 2006, there was no submerged vegetation in Alpha Stream, perhaps due to the increased water temperature. However, it is also possible that the tolerance of these snails to temperature was reached. An increase in temperature and loss of the submerged macrophytes could have reduced snail abundance in the upper portion of Alpha Stream but higher temperatures might also extend the reach of Alpha Stream that provides optimal conditions for *P. wrighti* (see **Population sizes and trends**).

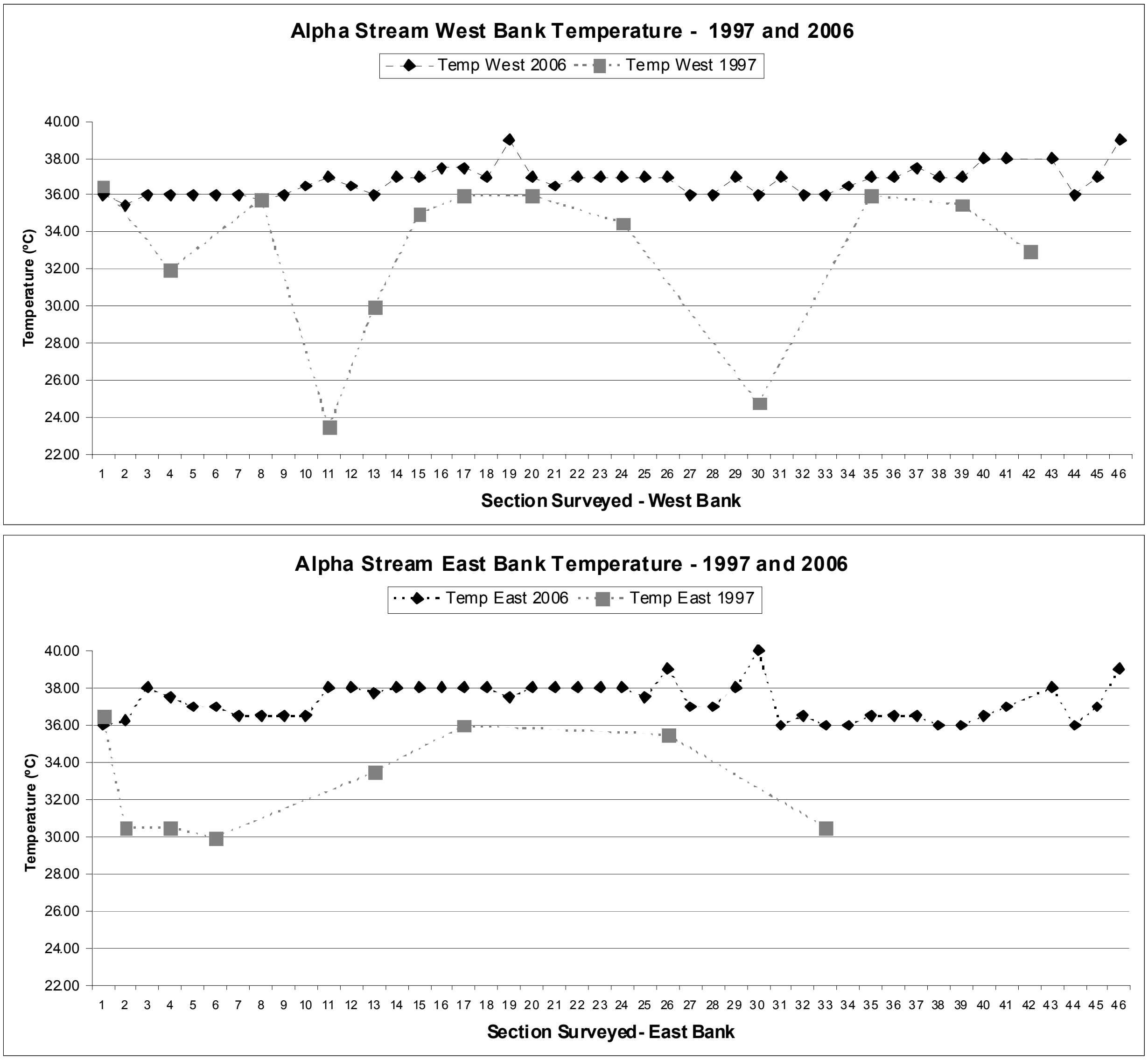

Figure 4. Water temperatures measured in 1997 and 2006 along (a) west and (b) east banks of Alpha Stream in sections designated in 2006.

Water quality parameters of pH and dissolved oxygen have also been measured in Alpha Stream (see Table 2). Te and Clarke's (1985) data came from water analysis and measured pH of 7.9. Lee and Ackerman (1999) measured directly in the stream at the dam and found pH of 7.8 and dissolved oxygen at 67% saturation.

Habitat protection/ownership

Both provincial and federal regulations protect *P. wrighti* and its habitat. Provincially, *P. wrighti* is protected under the B.C. *Park Act* (1996), which states that "natural resources … must not be granted, sold, removed, destroyed, damaged, disturbed or exploited except as authorized by a valid and subsisting park use permit". The goals of the LRHPP Master Plan (Preepre 1990) are to preserve the outstanding natural hotsprings and warm swamp ecosystem while allowing for compatible recreational uses; natural processes will be allowed to occur without interference; existing water quality will be maintained; wildlife habitat enhancement will not be considered unless a species population is threatened, particularly by human activities in the park; and existing downstream water flow will be maintained by a policy of non-intervention in the hotsprings hydrology. The park's master plan pre-dates the original status designation of this species, and any future plan for the park would undoubtedly have to fully consider this species. The park is now staffed 24 hours a day year round, although the hotsprings are not under constant surveillance (Doug Biffard, pers. comm.).

Federally, *P. wrighti* was listed and protected under Schedule 1 of SARA in 2003 based on the status designation of Endangered granted by COSEWIC in 2000. Actions that result in killing, harming, harassing, capturing or taking *P. wrighti*, or that result in the destruction of its critical habitat are legislated under SARA. SARA designates Fisheries and Oceans Canada as the responsible jurisdiction for *P. wrighti.* The *Fisheries Act* (Canada) prohibits works that may result in harmful alteration, disruption or destruction of fish habitat (Section 35) and prohibits the release of deleterious substances, such as contaminants, into fish-bearing waters (Section 36). In accordance with SARA regulations, a recovery strategy for *P. wrighti* has been developed (Heron 2007).

BIOLOGY

The biology of freshwater pulmonates is generally well known because this group lives in accessible habitats, has relatively short generation times and survives well in captivity. No studies have been conducted on *P. wrighti* and no data are available on life history traits such as growth rate, longevity, age at sexual maturity, egg development rate, or seasonality of reproduction for this species in its natural habitat.

Life cycle and reproduction

Ectothermic animals, such as physids, cannot regulate their body temperature and so are predisposed to seek temperatures that optimize life history processes. Physids are oviparous (egg-laying) hermaphrodites. Eggs develop directly into substrate-dependent, crawling juveniles. In temperate climates, eggs are generally laid in the spring and juveniles mature into adults during the summer, lay eggs the following spring, and die. However, physids living at warmer temperature accelerate these life history traits (review in McMahon 1975). In Banff National Park, Alberta, juvenile *P. johnsoni* have been observed year round (Lepitzki *et al.* 2002). Elsewhere in Alberta, *P. gyrina* was found to reproduce year round in thermal effluents ranging from 15–31°C, although no egg development occurred at 32°C (Sankurathri and Holmes 1976). Captive *P. wrighti* in a heated aquarium with water from LRHPP laid egg masses containing 6–18 eggs above the water line at 25°C; hatching occurred after nine days (Lee and Ackerman 1999). As incoming water temperature at LRHPP probably remains relatively constant year round, the air temperature probably determines where the snails position themselves and their eggs. In August 2006 at ambient air temperature of 20°C, most snails and all egg cases were observed above the water/air interface. In September 1997, when the ambient temperature was much cooler, most visible snails were submerged (J. Lee, pers. obs.). *P. wrighti* positions itself and its eggs at optimal temperature to facilitate life history requirements.

Diet

Physids are generally considered to be detritivores and/or bacterial feeders (Brown 2001). *Physella wrighti* probably grazes on the aufwuchs, the algal and bacterial growth covering the submerged substrates on which it lives. *P. wrighti* kept in captivity in water from Alpha Pool survived and reproduced on a diet of mixed brewer's yeast and fish food for 14 months (Lee and Ackerman 1999).

Predation

Nothing is known about direct predation of *P. wrighti* by other species. The shorebird *Tringa flavipes* (Lesser Yellowlegs) grazes in the marshes of LRHPP and might prey on *P. wrighti,* since the diet of this bird includes snails (Ehrlich *et al*., 1988). However, these two species have historically co-existed at this site, so predation by this bird would not appear to be a significant limiting factor for *P. wrighti*.

Physiology

Physella wrighti appears to be physiologically adapted or acclimated to its hot water habitat. Both adults and eggs are found at water margins and a sudden drop or change in water flow that exposes them to ambient air temperature might be lethal. These snails can only live in areas with no or very slow water flow.

Dispersal/migration

Freshwater snails disperse passively by being carried by wildlife or humans that inadvertently or purposefully pick up snails and deposit them in another water body. One example of snail dispersal is the observation that migratory birds might store snails in their feathers as a food source (Rees 1965). Wildlife or humans could pick up *P. wrighti* but if continuous warmth is required, it is unlikely that individuals would survive if introduced outside the current range.

The entire known population of *P. wrighti* is found within an EO of 0.02 km^2 so there is no migration and no possibility of rescue effect from other areas. Rescue effect from outside populations of *P. gyrina* is unknown.

Interspecific interactions

Physella wrighti does not display obvious reliance on other species for its survival at any time during its life cycle with the exception that it grazes algal and bacterial growth on *Chara* and other surfaces.

Adaptability

Physids in general are able to withstand widely fluctuating temperatures (reviewed in McMahon 1975, Wethington and Guralnick 2004), and the degree to which *P. wrighti* is dependent on warm temperature is unknown. *P. wrighti* can tolerate changes such as loss of *Chara* as the preferred habitat, and specimens held in captivity tolerated changes to both habitat and food.

POPULATION SIZES AND TRENDS

The population of *P. wrighti* in LRHPP occurs in three definable areas: Alpha Stream, lower Alpha Pool and Beta Pool. These areas probably remain connected by wildlife and human movements, and by flood events. Beta Pool is uphill from and has an exit stream in the direction of Alpha Pool and Stream. It is likely that snails from Beta Pool could be washed downhill during heavy rains, flooding or snow melt and mix with Alpha snails. The snails at LRHPP probably constitute one population although confirmation of this would be obtained by microsatellite studies (see **Genetic description)**.

Several documents are available regarding the presence of *P. wrighti* in LRHPP (see Table 1). These are Te and Clarke (1985), Lee and Ackerman (1999), Salter (2001), Salter (2003) and the 2006 survey by Lee reported here. Abundance data were collected by Lee and Ackerman (1999), Salter (2001) and during the 2006 survey.

Search effort

In August 1973, Clarke spent 0.4 hours collecting "*Physa* in main stream" at LRHPP (Clarke 1973). Te and Clarke (1985) reported that in 1979, the whole population of *P. wrighti* was in Alpha Stream although other springs and pools within the park were searched. Based on Clarke's information, Lee and Ackerman (1999) restricted their survey to Alpha Stream spending 6.0 hours collecting population data. Salter (2001) was the first to report *P. wrighti* from lower Alpha Pool, and Salter (2003) reported *P. wrighti* from Beta Pool. During the 2006 survey, *P. wrighti* was found in all these sites; search effort was 12.0 hours in Alpha Stream (2 people for 6 hours), 0.4 hours in lower Alpha Pool and 1.0 hour in Beta Pool collecting population data (see Table 1).

Abundance

Lee and Ackerman (1999)

This survey was conducted in September 1997 and found *P. wrighti* to inhabit a reach of Alpha Stream extending from 5–31 m below the dam at the outflow from Alpha Pool. Most *P. wrighti* were within partially submerged *Chara* mats that occurred in 11 areas along this reach. To estimate the *P. wrighti* population, the size of each *Chara* mat was measured and an 18 cm diameter stainless steel mesh net on a pole was pushed under the mat and was then shaken to dislodge snails. Live and empty shells were separated; live snails were counted and immediately returned to the *Chara* and empty shells were retained for measurement. The number of live snails collected in the net area (254 cm^2) was used to estimate the total number of snails in each *Chara* mat. As this method was disruptive to the habitat, no replicate samples were collected. When shaken *Chara* was subsequently examined, this method appeared to remove only 1/3 of the live snails; thus, the abundance data were adjusted accordingly. When the 1997 data from Lee and Ackerman (1999) were examined for this report, an error in calculation was found in that the net area used was 364 cm^2 and not 254 cm^2. The abundance estimates were therefore recalculated. Within the *Chara*, 1,526 snails were found in a habitat area of 3.2 m^2 on the west and east banks. Snails were also found on open sediment on the west bank and were counted within several quadrats for an estimated 601 snails in 0.3 m^2 of habitat. Water temperature was recorded at each collection site (see Figure 4). Therefore, the reach of Alpha stream extending from 5-31 m below the dam contained 2,127 snails in suitable habitat of approximately 3.5 m^2 (see Table 1 and Appendix B). Most snails occurred in *Chara* or on open sediment on the west bank (1,388; 65%) where most of the habitat was found (2.7 m^2; 73%; see Appendix B). To facilitate plotting and comparison with 2006 data, the distance below the dam was reported as per the sections identified in 2006 and the habitat area was calculated as number of 100 cm^2 quadrats. The abundance of snails was found to be correlated with the amount of habitat available in 100 cm^2 areas on both the west and east banks (Figure 5a, b); Spearman rank correlation coefficients were R=0.76 and R=0.70 for the west and east banks, respectively, and R=0.72 overall.

Salter (2001)

This survey was conducted in August 2000 and found *P. wrighti* to inhabit a reach of Alpha Stream that extended 200 m below the dam. This reach was divided into two sections; within the 0–140 m section, *P. wrighti* was found in *Chara* mats and on small and large woody debris, and within the 140–200 m section was found within a continuous border of *Chara* and on the adjacent sediment substrate.

To estimate snail abundance within the *Chara* mats, a 10 cm diameter stainless steel mesh kitchen sieve was inserted under the *Chara* and this section of the plant was removed. Snails were counted and returned to the same area. Visual estimates were made on woody debris, *Chara* border and substrate. Within the 0–140 m section, 82 linear metres of *Chara* mat contained an average of 23 snails/m for a total of

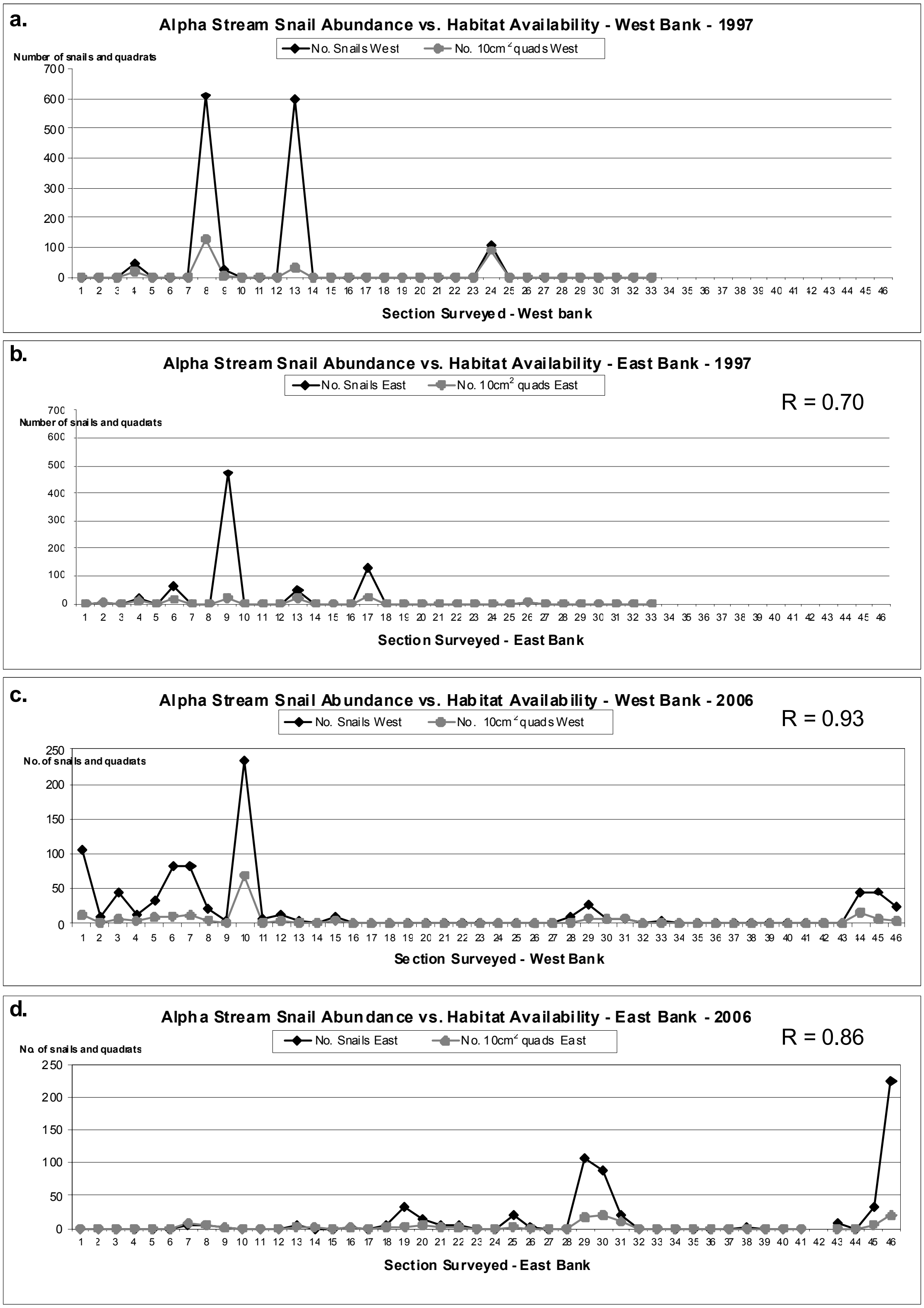

Figure 5. Correlation (R) of abundance of *Physella wrighti* to amount of available habitat in sections downstream of dam in Alpha Stream: a) west bank 1997 b) east bank 1997 [1997 R=0.72] c) west bank 2006 d) east bank 2006 [2006 R=0.86].

1,886 snails, and 14 m of woody debris supported an average of 30 snails/m for a total of 420 snails. Within 140–200 m section, the 120 m of *Chara* border contained an average of 16 snails/m for a total of 1,920 snails, and the 120 m of adjacent substrate held an average of 8 snails/m for total of 960 snails. Thus, the upper 140 m of Alpha Stream contained 2,306 snails and the lower 60 m contained 2,880 snails for a total of 5,186 snails in this 200 m reach (Table 3).

Table 3. Survey data for *Physella wrighti*: August 2000 (Salter 2001).

Distance below dam (m)	Habitat Type	Habitat Length (m)	No. Snails per m	Snail Abundance
0–140	*Chara* mats	82	23	1,886
0–140	Woody debris	14	30	420
140–200	Continuous *Chara*	120	16	1,920
140–200	Substrate	120	8	960
		Total abundance of *Physella wrighti*		5,186

In January 2001, Salter surveyed lower Alpha Pool. The pool diameter was about 28 m, and approximately 75 snails/m were found in a 5 cm band both above and below the water surface around the sediment perimeter and on wooden structures for a total estimate of 2,100 snails in a habitat area of 1.4 m^2 (see Table 1).

<u>2006 Survey</u>

This survey for *P. wrighti* was conducted in August 2006 and included the reach of Alpha Stream extending 95 m below the dam. While all previous surveys noted the seemingly preferential use of *Chara* by snails, the 2006 survey found no submerged vegetation within Alpha Stream (see **Habitat trends**) and all snails were found on sediment or woody debris. The area immediately below the dam was wide and shallow with large woody debris and was designated “Section 1”. Below Section 1, each side of the stream was marked at 1 m intervals and data were collected within each 1 m long, consecutively numbered section except when stream curve necessitated inclusion of an extra metre to keep the start of each section relatively even on both banks. The 1 m measurements continued to 45 m below the dam on the east bank and thereafter data were collected within 10 m long sections of the stream. The water temperature (see Figure 4) and distance across the stream (Appendix B) were measured for each section. At about 85 m downstream the stream made an abrupt turn to the west, and about 10 m beyond this turn the sediment became too soft to continue the survey although suitable temperatures and habitat for *P. wrighti* appeared to continue for some distance down the stream. Geoposition data within this reach were recorded with a hand-held GPS (Garmin eTrex Legend®) at the dam and approximately every 10 m downstream (see Appendix B).

Snails visible on the substrate in each section were counted and a 10 cm × 10 cm (100 cm^2) quadrat was used to estimate the amount of apparently suitable habitat available. *P. wrighti* occurred most abundantly in the area extending from the dam to Section 33, or to about 37 m along the east bank, and 1,041 snails were counted within this reach. From Section 34 to 43 (37–65 m along the east bank), only 11 snails were counted on both sides of the stream; the reach had relatively high flow and provided little habitat. The stream widened and slowed in Section 43 (65 m) and suitable snail habitat was again available. Within the remaining 30 m that could be surveyed (65-95 m), 374 snails were counted. There were undoubtedly many *P. wrighti* beyond this point that could not be surveyed. Therefore, the reach of Alpha Stream that extended 95 m below the dam contained 1,426 snails in an area of suitable habitat of about 3.0 m^2 (see Table 1 and Appendix B). Most snails occurred on the west bank (836; 59%) where the most habitat was found (2.0 m^2; 67%; see Appendix B). The abundance of snails was found to be correlated with the amount of habitat available in 100 cm^2 areas on both the west and east banks (Figure 5c, d); Spearman rank correlation coefficients were R=0.93 and R=0.86 for the west and east banks, respectively, and R=0.86 overall.

The perimeters of upper and lower Alpha Pool were searched. The temperature in the upper pool was 43–48°C at the stairs and no snails were seen. The temperature in the lower pool was 36°C at the stairs and 23 snails were counted around the perimeter, occurring on the wooden stairs and just above the water line on the sediment walls of the pool.

The perimeter of Beta Pool was also searched. The water temperature at the stairs was 41.5ºC. Twenty snails were counted on the support structures of the pool deck in an area of 0.02 m^2. On the north bank near the small stream that exits from the pool, the water temperature was 36–38°C and many snails were found just above the water/air interface. Counts were made within several 100 cm^2 quadrats for an estimate of 890 snails in 0.2 m^2 of habitat. Therefore, 910 snails were found in a 0.2 m^2 area of Beta Pool.

The abundance estimate for *P. wrighti* in LRHPP in August 2006 was 2,359 snails (see Table 1).

Fluctuations and trends

Alpha Stream

Three abundance estimates of *P. wrighti* in Alpha Steam have been made with Salter's (2001) estimate of 5,186 snails the highest and the 2006 estimate of 1,426 snails the lowest (see Table 1 and Figure 6). The reduced snail abundance noted in 2006 in the upper reach of Alpha Stream appears to be due to a loss of submerged macrophytes, which may be the result of an increase in water temperature. In 1997, all 2,127 snails were in the first 31 m of Alpha Stream in 3.5 m^2 of habitat, and in 2006 this same reach had only 769 snails or 36% of the previous population estimate (see Figure 6), in 1.8 m^2

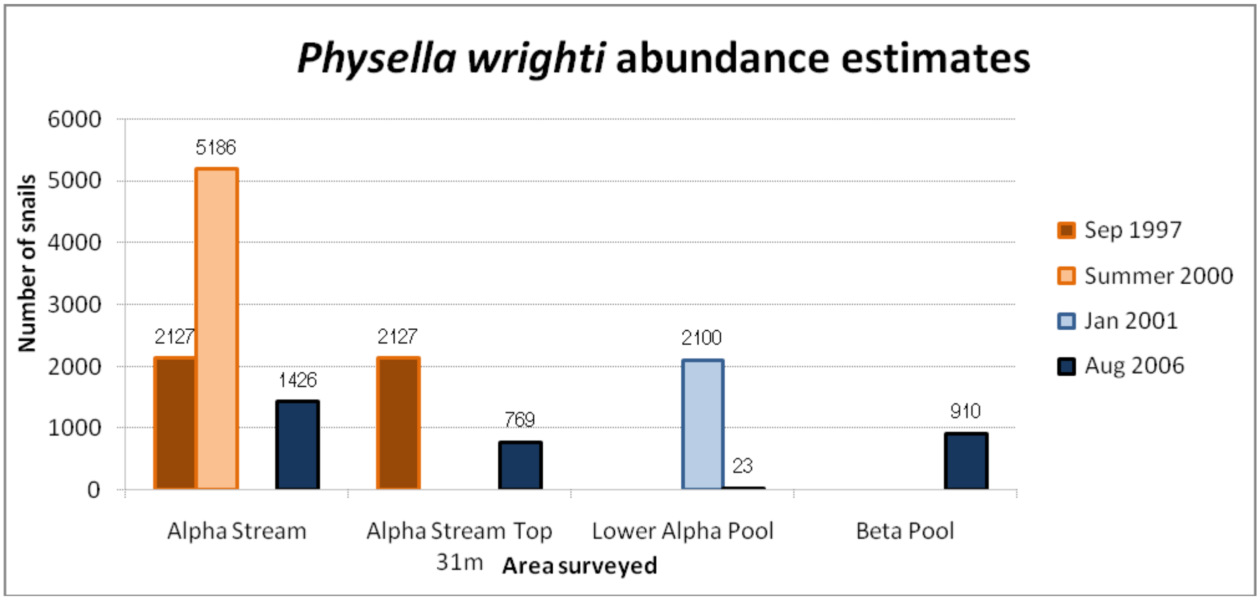

Figure 6. Abundance estimates of *Physella wrighti* in Alpha Stream, lower Alpha Pool and Beta Pool.

of habitat or 55% of the previous habitat observed. However, while the water temperature increase measured in 2006 might be responsible for loss of *Chara* and the consequent reduction in *P. wrighti* abundance in this upper reach, this temperature increase might also extend the reach of the stream optimal for *P. wrighti*, so the population might be redistributed rather than reduced. The stronger correlation of snail abundance to habitat available in 2006 vs. 1997 (R=0.93 and R=0.71, respectively) suggests that under the circumstances of loss of preferred habitat, *P. wrighti* is more strongly exploiting the remaining suitable habitat.

Additional surveys with standardized protocols are required to assess the population trend within Alpha Stream but the current evidence does not indicate a decline in the population of *P. wrighti*.

<u>Alpha Pool</u>

In lower Alpha Pool, 2,100 snails were estimated in January 2001 and 23 were counted in August 2006 (see Table 1 and Figure 6). This might be a seasonal population trend. Observations on *P. johnsoni* in Banff National Park from 1996 to 2006 have shown that the population typically fluctuates by two orders of magnitude annually with lows occurring during the summer and highs during the winter (COEWIC 2008).

<u>Beta Pool</u>

While many *P. wrighti* were observed in Beta Pool in November 2001 (Salter 2003), the 2006 abundance estimate of 910 snails are the only data available (see Table 1 and Figure 6).

Rescue effect

As there is only one population of *P. wrighti*, there is no possibility of rescue effect. If a catastrophic event were confined to Alpha Pool/Stream or Beta Pool, snails from the other pool could be used to repopulate restored habitat. Rescue effect from outside populations of *P. gyrina* is unknown. It is uncertain if *P. wrighti* and *P. gyrina* are conspecific, and it is uncertain how *P. gyrina* would adapt to the hotsprings environment.

LIMITING FACTORS AND THREATS

The limiting factors for *P. wrighti* are its putative requirement for warm water and its need to access the water/air interface for respiration. The small population size and very limited geographic distribution make this species extremely vulnerable to disturbances due to anthropogenic activities.

An estimated 40,000 bathers use the hotsprings annually, and monitoring of the pools and stream is limited. Although soaps and shampoos are prohibited and signs ask bathers to shower before entering the hotsprings, the introduction of soaps, shampoos, sunblock or insect repellents is still possible. Large or cumulative quantities of such substances might accumulate and interfere with respiration or other life processes. As part of regular maintenance, Alpha Pool is cleaned weekly (A. Hansen, pers. comm., 2008). It seems likely that bathing and pool cleaning activities could crush or remove snails and eggs, since snails have been observed on the steps in lower Alpha Pool. Trampling may also be a threat, as some park visitors explore the margin of Alpha Stream.

The introduction of exotic animals or plants into the hotsprings could pose a threat to *P. wrighti*. Recently there have been two known introductions of turtles into the hotsprings (Hansen, pers. comm.; Elliott, pers. comm., cited in Heron 2007). These animals were found and removed. However, there is potential for highly devastating ecological effects from the introduction of a species that is an aggressive predator or competitor. For example, the extinction of the Banff longnose dace (*Rhinichthys cataractae smithi*) was the result of the introduction of a mosquito fish (*Gambusia affinis*) into Banff Hotsprings (COSEWIC 2006).

A change in the flow of water could threaten this species. Many years before the presence of *P. wrighti* was known, the natural flow of water from Alpha Pool to Alpha Stream was changed by the building of the dam. Routine maintenance and repair of the dam and weir are conducted to maintain the integrity of Alpha Pool and Stream, and maintains Hotwater Physa habitat. A catastrophic dam failure could cause a flood that could dislodge snails or disturb habitat. Decreased water flow, or diversion, during maintenance could also expose snails to drying, lethal air temperature, or altered water temperature as the hot and the cold water sources would not be pre-mixed.

Drilling associated with oil and gas exploration into the fracture zone where heated water from the recharge zone travels to the spring is identified as a potentially serious threat (Heron 2007). While not considered imminent because there is no exploration occurring in this area currently, northern B.C. is undergoing significant exploration, and the status of this threat could change in the future. The recharge zone is believed to be north of the springs, outside of the park boundary. Heated water enters through the subterranean fracture, although the exact pathway is unknown. The pathway is believed to reach an approximate maximum depth of 3.4 km below earth surface and maximum temperature of 120°C (Gilles Wendling, pers. comm.). Drilling into the fracture could redirect flows and dry out the springs.

SPECIAL SIGNIFICANCE OF THE SPECIES

Physella wrighti is the only known endemic aquatic snail in B.C. It is one of several locally endemic or rare plants and animals that are associated with the consistently warm lotic and lentic habitats afforded by the Liard Hotsprings system in LRHPP, including the Plains Forktail Damselfly (*Ischnura damula*), mayfly (*Caenis youngi*), a distinct population of the Lake Chub (*Couesius plumbeus*), Hudson Bay Sedge (*Carex heleonastes*), Tender Sedge (*Carex tenera*), White Adder's-Mouth Orchid (*Malaxis brachypoda*), and Yukon Lupine (*Lupinis kuschei*). In particular, the Hotwater Physa and a physically isolated and thermally adapted population of the Lake Chub share habitat in the hotspring complex (Heron 2007). *Physella wrighti* is an indicator that this relatively warm northern ecosystem continues to provide appropriate habitat for unique components of the aquatic fauna in spite of development and continued human use. Hot water species are of significant scientific interest because they might have arisen from marginal populations that possess a gene pool more readily able to adapt or acclimate to changing conditions than can congeneric species (Scudder 1989). The species is not known to have any traditional First Nations uses.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

This species is considered critically imperiled globally (G1Q), in Canada (N1), and in British Columbia (S1) (NatureServe 2007). COSEWIC designated *P. wrighti* as Endangered in May 2000. In June 2003, *P. wrighti* was listed and protected as Endangered under Schedule 1 of the *Species at Risk Act* based on the status designation by COSEWIC in May 2000. As such, *P. wrighti* is protected under SARA from killing, harming, harassing, capturing or taking and from the destruction of their critical habitat once identified.

Protection is afforded by the *Fisheries Act* (Canada) and the *Park Act* (B.C.). The *Fisheries Act* prohibits works that may result in harmful alteration, disruption or destruction of fish habitat and prohibits the release of deleterious substances, such as contaminants, into fish-bearing waters. Under the *Park Act* the disturbance or destruction of habitat is prohibited except for the development of recreational services.

In accordance with SARA regulations, a recovery strategy for *P. wrighti* has been developed for this species (Heron 2007). The short-term objectives (by 2011) of the recovery strategy are: to ensure that the species' current distribution in Alpha and Beta pools and Alpha Stream is maintained; to refine the understanding of the current distribution to better quantify this objective; to observe that the species' current relative abundance is maintained; and to develop a methodology that increases survey precision. The recovery strategy recommends additional work to determine factors that define critical habitat; further recommendations to address threats and recovery are: population monitoring, protection through the LRHPP Master Plan, threat monitoring, and education to minimize impacts of recreational use within the park. An action plan will be completed by 2011.

TECHNICAL SUMMARY

Physella wrighti
Hotwater Physa — Physe d'eau chaude
Range of Occurrence in Canada: British Columbia

Demographic Information

Generation time (average age of parents in the population)	Unknown
Population trend and dynamics	
Observed percentage of reduction in total number of mature individuals over the last 10 years.	Unknown
Projected percentage of reduction in total number of mature individuals over the next 10 years.	Unknown
Observed percentage reduction in total number of mature individuals over any 10 year period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible?	
Are the causes of the decline clearly understood?	
Are the causes of the decline clearly ceased?	
Observed trend in number of populations	Stable
Are there extreme fluctuations in number of mature individuals?	Unknown
Are there extreme fluctuations in number of populations?	No

Number of mature individuals in each population

Population	**N Mature Individuals**
Values for different lengths of Alpha stream sampled	1,426 (Sep 1997) 5,186 (Aug 2000) 1,426 (Aug 2006)
Grand Total	Number of mature individuals in the total population unknown

Extent and Area Information

Estimated extent of occurrence (km²) *16,310 m^2, 2006 survey area measured using scale on park map*	0.02 km²
Observed trend in extent of occurrence	Stable
Are there extreme fluctuations in extent of occurrence?	No
Estimated area of occupancy (km²) using 1x1 km² grid *Actual AO based on habitat occupied: ~ 4.6 m²*	1 km²
Inferred trend in area of occupancy	Stable
Are there extreme fluctuations in area of occupancy?	No
Is the total population severely fragmented?	No
Number of current locations	1
Trend in number of locations	Stable
Are there extreme fluctuations in number of locations?	No
Observed trend in area of habitat	Unknown

Quantitative Analysis

Not available	

Threats (actual or imminent, to populations or habitats)

1. Recreational use of the hotsprings continues.
2. The small population size and very limited geographic distribution makes this species extremely vulnerable to disturbance brought about by anthropogenic activities.
3. Rapid temperature change could occur in Alpha Stream if the outflow from Alpha Pool were diverted, exposing species to potentially lethal ambient air temperature. This would be most likely to occur through stochastic events or through the actions of recreational users altering the dam or creating alternative outflows.
4. Trampling caused by park users exploring Alpha Stream

Rescue Effect (immigration from an outside source)

Status of outside population(s)? Not applicable - Species is endemic to the Liard Hotsprings complex	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Not applicable
Is there sufficient habitat for immigrants in Canada?	Not applicable
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Endangered, April 2008	

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B1ac(iv)+2ac(iv)

Reasons for Designation:
This small snail is an endemic species living only within the hotsprings complex located in Liard River Hotsprings Provincial Park in British Columbia. The population is small, numbering fewer than 10,000 individuals and occupies an extremely restricted habitat around the margins of two pools and an outlet stream. Population size is believed to fluctuate by at least an order of magnitude in this short-lived snail (~1 year lifespan). The species is a habitat specialist requiring geothermally regulated water and substrates near the water/air interface in areas of no current. The hotsprings complex has been in use by humans for over 200 years. The species has survived structural modification and maintenance of the pools, the introduction of foreign substances such as soaps and shampoos, and trampling. However, a single event such as abrupt changes in water flow, chemical contamination or introduction of exotic species, could significantly affect persistence of this snail.

Applicability of Criteria

Criterion A:
Not applicable. There is no evidence that the population is declining or will decline over the next 10 years.

Criterion B:
Meets B1: EO ~ 0.02 km² (< 5,000 km²) for Endangered, and B2: 1 km² (< 500 km²) for Endangered a: Number of locations, 1 (less than or equal to 5, Endangered), c(iv): extreme fluctuations in mature individuals observed annually in a species that is believed to have a lifespan of ~ 1 year.

Criterion C:
Not applicable. The number of individuals is most likely > 2,500 but < 10,000, but the number of mature individuals is not believed to be in decline at present nor is it projected to decline in the next 10 years.

Criterion D:
Meets D2 for Threatened because: AO 1 km² (< 20 km²), there is only 1 locality (less than or equal to 5), the species is an habitat specialist, the locality is heavily used by humans for recreation, and a single catastrophic event could eliminate the entire population.

Criterion E:
Does not apply; not available.

AUTHORITIES CONSULTED

Name of jurisdiction	Name of contact(s)	Date Contacted
Canadian Wildlife Service	Kevin Fort	19-Jun-06
	Trish Hayes	19-Jun-06
Fisheries and Oceans Canada	Laurie Convey	26-Jun-06
	Jim Boutillier	26-Jun-06
Manager, B.C. Fisheries Science Section	Ted Down	30-May-06
B.C. Species at Risk Specialist	Dave Fraser	9-Jul-06
B.C. Conservation Data Centre	Leah Ramsay	9-Jul-06
COSEWIC Secretariat for information on sources of Aboriginal Traditional Knowledge	Gloria Goulet	9-Jul-06
B.C. Ministry of Environment, Invertebrates Specialist	Jennifer Heron	9-Jul-06

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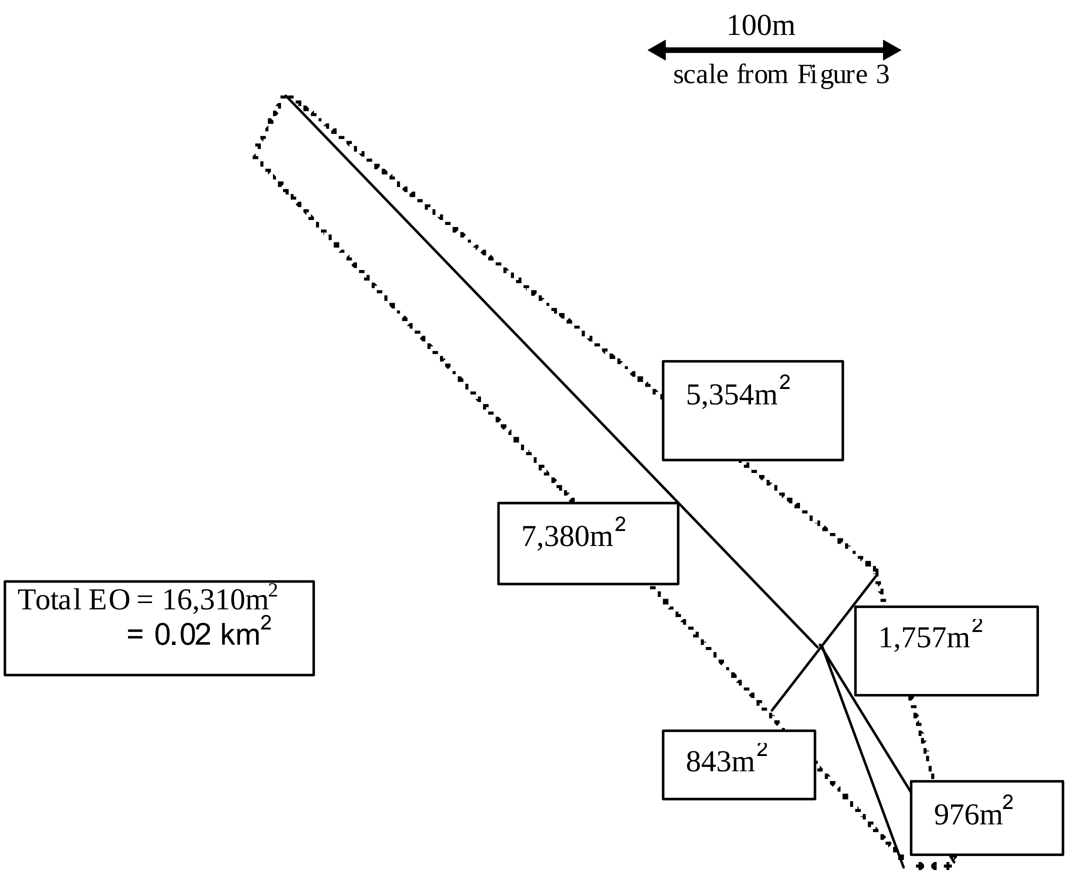
B.Sc. (Honours) Biology, Simon Fraser University, Burnaby, B.C., 1981. M.Sc. (Biology), University of Northern British Columbia, Prince George, B.C., 2000.

During undergraduate work at Simon Fraser University, Ms. Lee attended a semester of courses at the Bamfield Marine Station and became fully engaged in marine biology, working at the Station for the next 10 years collecting and maintaining collections of all types of marine organisms, including molluscs. Later, in Victoria, B.C., she worked as a naturalist in many provincial parks on southern Vancouver Island and then was employed by The Nature Conservancy as the Assistant Data Manager at the B.C. Conservation Data Centre. This job inspired her interest in freshwater molluscs and led her to further study. At the University of Northern British Columbia, in Prince George, she completed her M.Sc. degree in 2000 with her thesis entitled “The Distribution and Ecology of the Freshwater Molluscs of Northern British Columbia”. During this time she also wrote COSEWIC status reports for three potentially endangered freshwater snails including the Hotwater Physa, *Physella wrighti*, which is now listed by COSEWIC as endangered. She spent 2½ years surveying for molluscs throughout the American Midwest with Ecological Specialists, Inc. and now lives in Vancouver, B.C. Though not employed as a biologist, she continues to pursue her interest in freshwater molluscs as a private consultant. She is a former member of the COSEWIC Mollusc Species Specialist Subcommittee.

APPENDIX A

Calculation of Extent of Occurrence and Area of Occupancy for *Physella wrighti* – August 2006.

Extent of Occurrence (EO) – taken and enlarged from Figure 3



Area of Occupancy (AO)		
Survey	**Site**	**AO**
Salter (2001)	Lower Alpha Pool	1.4 m^2
2006	Beta Pool	0.2 m^2
2006	Alpha Stream	3.0 m^2
	Total AO	4.6 m^2

APPENDIX B

Survey Data for *Physella wrighti*: 1997 and 2006.

1997 Data

Section	Start West 2006 (m)	End West 2006 (m)	Start East 2006 (m)	End East 2006 (m)	No. Snails West	No. 100 cm^2 quads West	Temp West 1997 (ºC)	No. Snails East	No. 100 cm^2 quads East	Temp East 1997 (ºC)	Notes 1997
1	0	2.5	Dam	5			36.5	0		36.5	
2	2.5	3.5	5	6				5	4	30.5	
3	3.5	4.5	6	7							
4	4.5	5.5	7	8	47	20	32	21	9	30.5	snails in Chara
5	5.5	6.5	8	9							
6	6.5	7.5	9	10				60	15	30	snails in Chara
7	7.5	8.5	10	11							
8	8.5	11.5	11	12	609	129	35.8				snails in Chara
9	11.5	12.5	12	13	25	4		472	20		snails in Chara
10	12.5	14.5	13	14							
11	14.5	15.5	14	15			23.5				
12	15.5	16.5	15	16							
13	16.5	17.5	16	17	601	31	30	47	20	33.5	snails on sediment
14	17.5	18.5	17	18							
15	18.5	20.5	18	19			35				
16	20.5	21.5	19	20							
17	21.5	22.5	20	21			36	129	22	36	snails in Chara
18	22.5	23.5	21	22							
19	23.5	24.5	22	23							
20	24.5	25.5	23	24			36				
21	25.5	26.5	24	25							
22	26.5	27.5	25	26							
23	27.5	28.5	26	27							
24	28.5	29.5	27	28	106	90	34.5				snails in Chara
25	29.5	30.5	28	29							
26	30.5	31.5	29	30				5	6.25	35.5	snails in Chara
27	31.5	32.5	30	31							
28	32.5	33.5	31	32							
29	33.5	34.5	32	33							
30	34.5	35.5	33	34			24.8				
31	35.5	36.5	34	35							
32	36.5	37.5	35	36							
33	37.5	38.5	36	37						30.5	
34	38.5	39.5	37	38							
35	39.5	41.5	38	39			36				
36	41.5	42.5	39	40							
37	42.5	43.5	40	41							
38	43.5	44.5	41	42							
39	44.5	45.5	42	43			35.5				
40	45.5	46.5	43	44							
41	46.5	47.5	44	45							
42	47.5	57.5	45	55			33				

2006 Data

Section	Start West 2006(m)	End West 2006(m)	Start East 2006(m)	End East 2006(m)	Width 2006(m)	Zone	East	North	Error	Temp West 2006(ºC)	Temp East 2006(ºC)	No. Snails West	No. 100 cm^2 quads West	No. Snails East	No. 100 cm^2 quads East	Notes 2006
1	0	2.5	Dam	5	480	9V	664453	6591645	±9m	36.00	36.00	105	12	0	0	*snails in upper centre area
2	2.5	3.5	5	6	220					35.50	36.25	11	2	0	0	
3	3.5	4.5	6	7	313					36.00	38.00	44	6	0	0	
4	4.5	5.5	7	8	280					36.00	37.50	12	4	0	0	
5	5.5	6.5	8	9	292					36.00	37.00	32	9	0	0	
6	6.5	7.5	9	10	325					36.00	37.00	82	11	0	0	
7	7.5	8.5	10	11	315					36.00	36.50	82	11.5	6	8	
8	8.5	11.5	11	12	280					35.75	36.50	20	5	5	5	200m on W to compensate for stream curve
9	11.5	12.5	12	13	334					36.00	36.50	3	1	1	0.5	200m on W to compensate for stream curve
10	12.5	14.5	13	14	335	9V	664447	6591630	±7m	36.50	36.50	234	69.3	0	0	*two areas where density 50 in 1Q egg mass noted within one dense area
11	14.5	15.5	14	15	200					37.00	38.00	8	1.5	0	0	
12	15.5	16.5	15	16	212					36.50	38.00	14	4	0	0	
13	16.5	17.5	16	17	230					36.00	37.75	5	1.5	6	3	
14	17.5	18.5	17	18	254					37.00	38.00	2	1	0	2	
15	18.5	20.5	18	19	310					37.00	38.00	9	5	0	0	200m on W to compensate for stream curve
16	20.5	21.5	19	20	280					37.50	38.00	0	0	2	1	
17	21.5	22.5	20	21	300					37.50	38.00	0	0	0	0	
18	22.5	23.5	21	22	310					37.00	38.00	0	0	5	2.5	
19	23.5	24.5	22	23	290					39.00	37.50	0	0	34	3	island in middle; 2 snails in 50Q
20	24.5	25.5	23	24	275					37.00	38.00	0	0	14	5	island in middle; 14 snails in 5Q
21	25.5	26.5	24	25	240	9V	664455	6591622	±9m	36.50	38.00	0	0	5	2	
22	26.5	27.5	25	26	150					37.00	38.00	0	0	4	1	
23	27.5	28.5	26	27	166					37.00	38.00	0	0	0	0	
24	28.5	29.5	27	28	166					37.00	38.00	2	0.5	0	0	
25	29.5	30.5	28	29	166					37.00	37.50	0	0	21	3	
26	30.5	31.5	29	30	182					37.00	39.00	0	0	1	0.25	1 snail on leaf
27	31.5	32.5	30	31	182					36.00	37.00	1	0.25	0	0	
28	32.5	33.5	31	32	160	9V	664449	6591604	±11m	36.00	37.00	10	2	0	0	snails on W in footprint at cooler temp
29	33.5	34.5	32	33	115					37.00	38.00	26	8	107	17	some snails on E in footprint @ 20C
30	34.5	35.5	33	34	150					36.00	40.00	6	6	89	20	
31	35.5	36.5	34	35	160					37.00	36.00	8	8	21	10	other inverts noted in stream
32	36.5	37.5	35	36	195					36.00	36.50	0	0	0	0	
33	37.5	38.5	36	37	240					36.00	36.00	4	1	0	0	

2006 Data (continued)

Section	Start West 2006(m)	End West 2006(m)	Start East 2006(m)	End East 2006(m)	Width 2006(m)	Zone	East	North	Error	Temp West 2006(ºC)	Temp East 2006(ºC)	No. Snails West	No. 100 cm^2 quads West	No. Snails East	No. 100 cm^2 quads East	Notes 2006
34	38.5	39.5	37	38	245					36.50	36.00	0	0	0	0	
35	39.5	41.5	38	39	250					37.00	36.50	0	0	0	0	200m on W to compensate for stream curve
36	41.5	42.5	39	40	150					37.00	36.50	0	0	0	0	
37	42.5	43.5	40	41	140	9V	664459	6591608	±8m	37.50	36.50	0	0	0	0	
38	43.5	44.5	41	42	168					37.00	36.00	0	0	1	0	
39	44.5	45.5	42	43	186					37.00	36.00	0	0	0	0	
40	45.5	46.5	43	44	213					38.00	36.50	0	0	0	0	
41	46.5	47.5	44	45	220	9V	664464	6591608	±8m	38.00	37.00	0	0	0	0	
42	47.5	57.5	45	55	220							1	0.5			compass direction 148 magnetic
43	57.5	67.5	55	65	180	9V	664466	6591596	±7m	38.00	38.00	0	0	9	0	compass direction 144 magnetic sediment 5-10cm from bank; snails tumbling
44	67.5	77.5	65	75	380	9V	664472	6591584	±9m	36.00	36.00	44	16	0	0	compass direction 183 magnetic small stream diversion on upper E; some snails
45	77.5	87.5	75	85	230	9V	664471	6591576	±10m	37.00	37.00	46	6	34	6	compass direction 175 magnetic
46	87.5	97.5	85	95	225	9V	664472	6591567	±7m	39.00	39.00	25	3.5	225	19	compass direction 222 magnetic stream takes curve to west here had to stop as sediment too soft to walk
Lower Alpha Pool										36.00		23				most at undercut area on SW bank
Upper Alpha Pool										42.8 - 48		0				
Beta Pool		post post				9V	664271	6591889	±9m	41.50		4 16	1 1			on deck support structures
Beta Pool		Area A								38.00		550	11			behind log on north bank near exit stream
Beta Pool		Area B								36.00		340	6			on north bank at exit stream; eggs on wood