Freshwater Molluscs at Risk in British Columbia: Three Examples of "Risk"

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ABSTRACT

Thirteen families of freshwater molluscs, representing both gastropods (snails) and bivalves (mussels and clams), are known to occur in British Columbia. Freshwater molluscs may be at risk due to a variety of reasons including: 1) habitat loss/alteration; 2) restricted niche requirements; 3) confused taxonomy; and 4) a general lack of information on their distribution and ecology. Specifically, these factors may: 1) interfere with the ability of freshwater molluscs to reproduce; 2) impact molluscs directly or indirectly through the introduction of exotic species; and 3) change the amount of habitat that is available to molluscs. We present results for 3 species of snails that were assessed to be at risk in British Columbia. *Physella wrighti* (hotwater physa) is at risk due to restricted niche requirements, while the assessment of risk for *P. hordacea* (grain physa) may be in error due to confused taxonomy within the genus. A lack of information on the distribution of freshwater molluscs led to the incorrect assessment of *Acroloxus coloradensis* (Rocky Mountain capshell) to be at risk. The concept of risk may have many interpretations, but careful laboratory and field studies have led to realistic designations.

Key words: *Acroloxus coloradensis*, freshwater limpet, freshwater molluscs, habitat degradation, hotsprings snail, *Physella hordacea, Physella wrighti*.

Freshwater molluscs are the snails, mussels, and clams that inhabit inland waters. These organisms are components of all aquatic ecosystems and occur in almost every type of freshwater habitat, from large lakes and rivers to small, even vernal, ponds (Pennak 1989). Bivalves (i.e., mussels and clams) are generally suspension feeders, while gastropods (i.e., snails) are primarily surface grazers. As such, molluscs are primary consumers in aquatic ecosystems (Brown 1991, McMahon 1991), and consequently they have been used as environmental indicators (McMahon 1991, Reynoldson et al. 1995). Freshwater molluscs are also prey items for ecologically and economically important aquatic and terrestrial predators (Pennak 1989).

Current taxonomic information indicates that 13 of the 15 families of freshwater molluscs known to occur in Canada are represented in British Columbia by 74 species (Table 1; Clarke 1981). Recent field and museum research indicates that there are additional species records for British Columbia, and that the ranges described for many species are in need of revision (Lee and Ackerman unpubl. data). Beyond species records, there is limited information available as to the ecological and environmental factors that may have led to the present distribution of freshwater molluscs in British Columbia. This lack of knowledge has put freshwater molluscs at risk because conservation requires scientific data as a basis for action.

Table 1. Freshwater mollusc families of Canada (Clarke 1981). The "√" indicates the presence of members of the family in British Columbia.

Class Gastropods (snails)	Class Pelecypoda (mussels and clams)
Subclass Prosobranchia (gilled snails)	
Order Mesogastropods	Order Eulamellibranchia
√ (Family Viviparidae	√ Family Margaritiferidae
√ (Family Valvatidae	√ Family Unionidae
√ (Family Hydrobiidae	√ Family Sphaeriidae
Family Truncatellidae	
Family Bithyniidae	
√ Family Pleuroceridae	
Subclass Pulmonata (lunged snails)	
Order Basommotophora	
√ Family Acroloxidae	
√ Family Lancidae	
√ Family Lymnaeidae	
√ Family Physidae	
√ Family Planorbidae	
√ Family Ancylidae	

Table 2. Three freshwater mollusc species assessed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) as At Risk or Potentially At Risk in British Columbia.

Scientific name	Common name	Original collection		
		Site	Collector(s)	Date
Physella wrighti	hotwater physa	Alpha Stream, Liard River Hotsprings	A.H. Clarke and D. Wright	19 Aug 1973
Physella hordacea	grain physa	(1) Long Lake, Nanaimo, Vancouver Island	A.H. Clarke and B.T. Kidd	31 Jul 1972
		(2) Magic Lake, North Pender Island	MacDougall	15 Jan 1979
Acroloxus coloradensis	Rocky Mountain capshell	Purden Lake, 60 km E of Prince George	A.H. Clarke and D. Wright	8 Aug 1973

From the perspective of conservation biology, the designation of "at risk" can result from a number of causes. For example, a given species may be at risk because: 1) its habitat is being altered or lost; 2) it has restricted niche requirements; 3) its taxonomic status is confused; and/or 4) its distribution and ecology are not well known.

Freshwater molluscs are potentially at risk because of the impacts of human activities, which alter aquatic ecosystems and habitats. There are at least 3 ways that freshwater molluscs can be impacted by human activities:

Reproduction

Aquatic organisms living in flowing systems must ensure that their reproductive efforts are not lost downstream. Freshwater mussels in North America have overcome this problem by evolving glochidia larvae that are parasitic on fish (McMahon 1991). After the larvae contact a fish host, they are encysted by fish tissue, where they develop and undergo metamorphosis. After 10–30 days, the juvenile mussel breaks out of the cyst and falls to the bottom in a habitat that may be far upstream from that of its parent. Any process that prohibits the contact of the mussels with their fish hosts (e.g., dam construction or impoundment), or that degrades habitat such that fish hosts are lost, puts freshwater molluscs at risk. This is, in effect, an indirect impact that may limit the reproductive success of the mussels through the removal of fish hosts (Williams et al. 1993).

Exotic Species Introductions

Exotic species introductions can directly or indirectly affect freshwater molluscs. Indirect effects, such as the introduction of exotic fish species, can result in the loss of native fish species that are the hosts of the glochidial larvae. Direct impacts result from introduced species, such as zebra mussels (*Dreissena* spp.). Zebra mussels attach to the shells of native mussels interfering with feeding, respiration, balance, burrowing, and locomotion, and also reduce or remove food resources from the water column (Nalepa and Schloesser 1993, Parker et al. 1998). Interestingly, zebra mussels have free-swimming veliger larvae, a condition that was conserved evolutionarily, and which has facilitated their rapid expansion in North America (Ackerman et al. 1994).

Habitat Loss/Alteration

Aquatic habitats can be lost when wetlands are filled in for development, and when meandering rivers are channelized (e.g., Okanagan River, B.C.; Cannings and Cannings 1996). The alteration of waterfront for recreation, housing, or commercial development can decrease the diversity of habitats available for molluscs. While most landscape alterations are detrimental to freshwater mollusc habitat, a study conducted in the Torpy River watershed in east-central British Columbia indicates that the building of access roads to facilitate timber harvest can augment or create aquatic habitat for the freshwater clam, *Pisidium casertanum* (Lee and Ackerman unpubl. data). Thus, in some special cases, landscape alteration may not have a negative effect on freshwater mollusc habitat. Clearly, our knowledge of the ecology of freshwater molluscs needs improvement.

The present knowledge of the British Columbia fauna of freshwater molluscs led Scudder (1996) to list 14 species of potentially rare or endangered freshwater molluscs in British Columbia. Of these, 3 species, all snails, (*Physella wrighti* [hotwater physa], *P. hordacea* [grain physa], and *Acroloxus coloradensis* [Rocky Mountain capshell]), had only been collected in 1 locality within the province (Table 2). Therefore, these species were selected by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) for further assessment. These 3 species are used in this paper as examples of species at risk.

METHODS

A search of museum records was conducted to ensure that all species location records had been incorporated correctly in Scudder (1996). This search revealed a second location record for *P. hordacea* at Magic Lake on North Pender Island (see Table 2). The first stage of our field research was to attempt to locate the populations at these sites.

Physella wrighti

(Fig. 1) This species appears to be endemic to the Liard River hotsprings complex in northern British Columbia (Te and Clarke 1985). The population of *P. wrighti* was located by following Alpha Stream downstream from its exit out of Alpha Pool in Liard River Hotsprings Provincial Park in 1997. *P. wrighti* was identified by its occurrence in the type locality. The snails were found living within mats of the green alga, *Chara*, on the surface of the soft sediments and on birch leaves (*Betula papyrifera*) that had fallen into the stream. The population size was estimated by pushing an 18-cm-diameter stainless steel sieve (nominal pore size 1.5 mm) under the *Chara* in each area and shaking the algae to dislodge snails. Where the snails occurred on open sediment the numbers were counted within 400-cm^2 quadrats.

Physella hordacea

(Fig. 2a) (1) Long Lake: Three trips were made to Long Lake in 1996 and 1997. Specimens from the family Physidae were located on the undersides of lily-pads (*Nuphar* sp.) in 2 areas of the lake, and were collected by hand. As snail densities were relatively low in this lake, only about one-half of the snails observed were collected in order to minimize impacts to the population. (2) Magic Lake: A collection of physids was made from a park at the west end of Magic Lake in 1998. Here, the physids were abundant and were readily collected by hand from the undersides of lily-pads and by sweeping near-shore vegetation with a stainless-steel sieve.

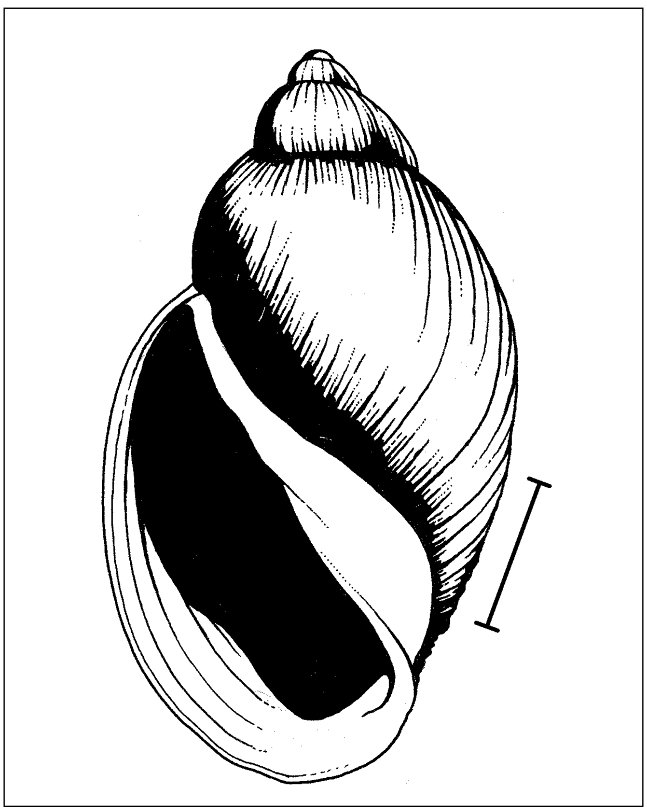

Figure 1. *Physella wrighti* (Te and Clarke 1985). Length of line equals 1 mm.

Acroloxus coloradensis

(Fig. 3) The population of *A. coloradensis* in Purden Lake was located in the summer of 1997. The entire perimeter of Purden Lake was surveyed during the summer. A study of the freshwater molluscs of northern British Columbia revealed populations of *A. coloradensis* at 6 additional sites (Lee and Ackerman 1999*a*). This species is easily recognized by its unique, prominent and extended, acutely pointed apex of the shell, located posteriorly and on the left (Lea 1864). *A. coloradensis* is small and adheres closely to the substrate. Specimens were found by close examination of substrates removed from the water.

RESULTS

Physella wrighti

The entire population of *P. wrighti* is in a 34 X 2 m reach of Alpha Stream. The population estimate made within this reach found 979 snails, which likely represents approximately one-half of the population (i.e., estimated population of about 1,735 snails, based on sampling uncertainty on the

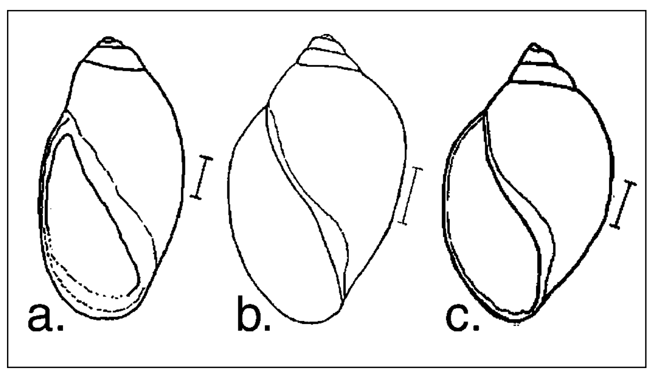

Figure 2. Drawings of Physids: (a) *Physella hordacea* (Lea 1864) from holotype drawing by Dr. S. Wu; (b) Specimen collected at Long Lake, B.C. by Clarke and Kidd, 1972, identified by Te (as per museum label) as *Physella hordacea* and by Wu (pers. comm. 1998) as *Physella* (*Physella*) *heterostropha*; (c) Specimen collected at Magic Lake, B.C. by MacDougall, 1979, and identified by Smith (as per museum label) as *Physella hordacea* and by Wu (pers. comm. 1998) as *Physella* (*Physodon*) *integra*. Length of line equals 1 mm.

Table 3. Museum holdings of *Physella hordacea*. (CMN = Canadian Museum of Nature; MCZ = Museum of Comparative Zoology; UMMZ = University of Michigan Museum of Zoology; USNM = United States National Museum; ANSP = Academy of Natural Sciences; n.d. = no date.)

Location	Museum holding and date
BRITISH COLUMBIA	
Long Lake, Nanaimo	(CMN ML067486 - 1972)
Magic Lake, North Pender Island	(CMN ML 086048 - 1979)
Vancouver Island	(MCZ 55263 - 1924; UMMZ 193163 - n.d.)
WASHINGTON	
Columbia River at Vancouver	(CMN ML 055081; USNM 170764 - n.d., but as holotype/paratype, collected in 1864 or earlier)
Vancouver Island	(UMMZ 124596 - n.d.; UMMZ 193163 - n.d.)
OREGON	
Vancouver Island	(ANSP 17231 - n.d.; MCZ 302538 - 1924)
Empire City	(USNM 29208 - n.d.)
Small stream entering Wilmot River, 6 miles above Portland	(ANSP 112435 - 1912/1913)
Oregon	(USNM 99307 - n.d.; ANSP 123965 - prior to 1882; UMMZ 115664 - n.d.)

different substrate types). The full report of the current status of *P. wrighti* is available in Lee and Ackerman (1999*b*).

Physella hordacea

This species appears to be restricted to British Columbia, Washington, and Oregon (Burch 1989). A summary of known museum holdings is given in Table 3. The information supplied on the locations has been somewhat problematic. The holotype and paratype localities should concur, but the holotype locality description (Lea 1864) is "Vancouver Island, Oregon," while the paratype location description is "Columbia River at Vancouver, Washington." Clarke's (1981) publication of this species in Long Lake, B.C., as well as the uncertainty about the precise type locality has led some authors to believe that Long Lake may be the type locality.

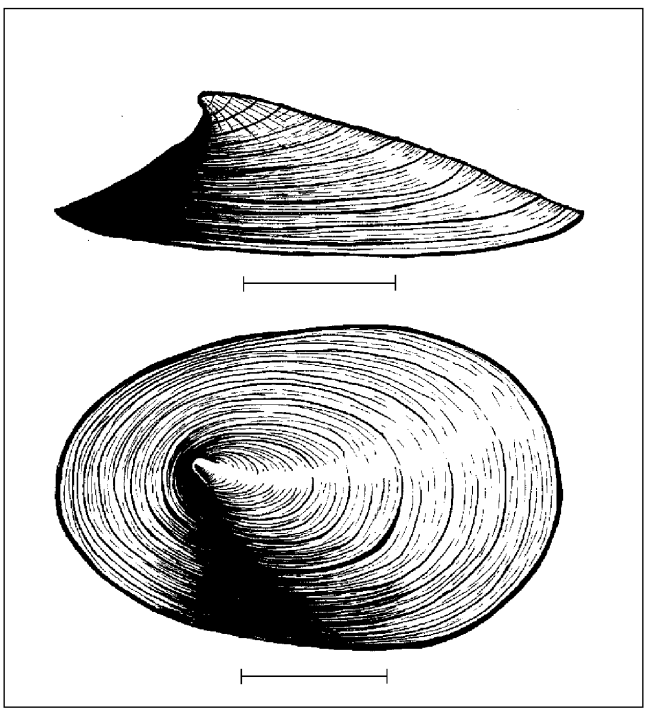

Figure 3. *Acroloxus coloradensis* (J. Henderson 1930). Length of line equals 1 mm.

The average population density for physids in Long Lake was calculated to be 4.3 x 10^{-5} physids/m^2 of surface area, based on the size of the lake (i.e., 4.2 x 10^5 m^2 surface area). Thus, we estimate a population size of 20 physid snails in the entire lake. Clarke (1972) expended 1.33 person-hours of search effort at Long Lake and his collection in the Canadian Museum of Nature contains >50 specimens of physids. The maximum number of physids observed during our 1.5 person-hours of search effort was 16. This suggests that in 1972 physids were much more common in Long Lake than they were during the current study. No population estimate was made at Magic Lake.

Acroloxus coloradensis

This species displays a seemingly rare and disjunct distribution (Bryce 1970). In Canada, there are 9 published records of collections of *A. coloradensis* (2 in Alberta [Mozley 1930]; 5 in Ontario and Quebec [Clarke 1970]; 1 in British Columbia [Clarke 1981]; and 1 in Alberta [Paul and Clifford 1991]).

During the surveys of Purden Lake, the variability in the observed density of *A. coloradensis* and the narrow range of depths that could be examined from the shore precluded the possibility of making an accurate population estimate. However, there appears to be a large (i.e., at least several hundred) and nonlocalized population of *A. coloradensis*

Table 4. Locations, substrate, and protection for *Acroloxus coloradensis* sites in British Columbia.

Location	Substrate	Protection
Purden Lake	undersides of rocks in shallow water	Westernmost portion of lake is a provincial park. *A. coloradensis* has been collected from waters adjacent to the park.
Shane Lake	submerged wood and debris such as fiberglass	Adjacent land owned by provincial government and leased to city of Prince George. It is managed as a park by Forests for the World (a non-government agency).
Carp Lake	submerged wood and rocks	Entire lake is in Carp Lake Provincial Park.
Gataiga Lake	submerged wood	Lake is in a B.C. Ministry of Forests Recreation Site.
Babine Lake pond	submerged deciduous leaves	Pond is entirely within Red Bluffs Provincial Park.
Topley rest area pond	decaying outside leaves of cattails (*Typha latifolia*)	North shore of pond was accessed from Ministry of Highways rest area. Status of remainder of area adjacent to pond is not known.
Decker Lake	rocks and submerged wood	The only area searched was adjacent to private property.

in Purden Lake. The 7 known sites in British Columbia for *A. coloradensis*, the substrate types from which it was collected, and the protection of these sites is given in Table 4. With the report of an additional site for *A. coloradensis*, in a lake northeast of Edmonton, Alberta (T. Hoover, University of Northern British Columbia, December 1998, pers. comm.), there are now 16 known sites for *A. coloradensis* in Canada (Fig. 4).

DISCUSSION

Physella wrighti

It is difficult to say why the snails inhabit such a limited area of the stream, but they have been found in no other locations within this hotsprings system, and no other snail populations were located at other hotsprings surveyed in the area (Te and Clarke 1985). Given that this single population lives

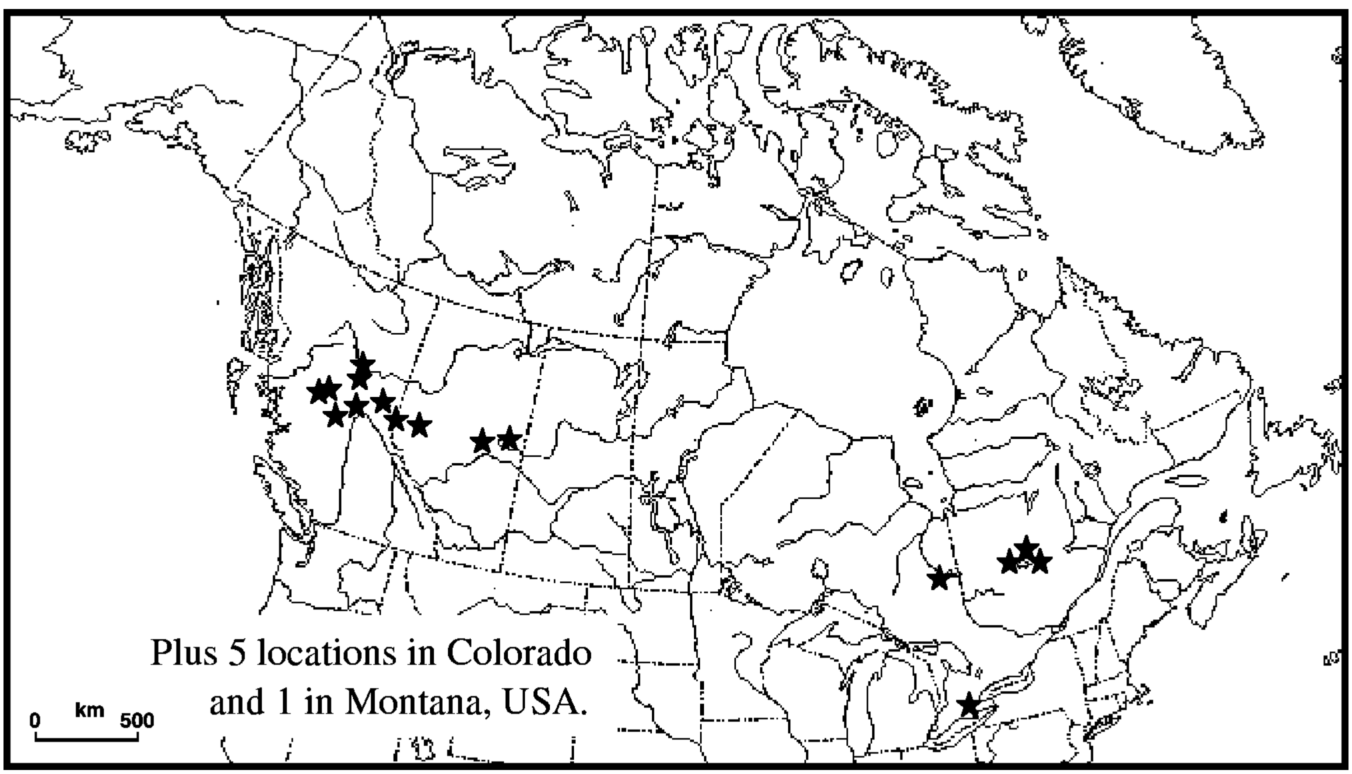

Figure 4. Approximate locations of 22 known sites for *Acroloxus coloradensis* in North America.

downstream of a pool estimated to be used by 100,000 bathers per year (W. Woodhouse, British Columbia Parks, 1997, pers. comm.), this species is at risk. The largest threat to these snails would likely come from the inadvertent addition of substances (e.g., soap, shampoo, oil) to the pool, from a sudden change in the flow if the outlet to Alpha Stream were blocked, or from direct human contact. Recently, bathers who had illegally climbed a fence in Banff National Park to swim in a hotspring pool caused the death of an estimated 100 *P. johnsoni*, a species listed as Threatened by COSEWIC (Bachusky 1999). Due to the possibility that the entire population of these snails could be eliminated by a single event, *P. wrighti* has been listed by COSEWIC as Endangered. Potential conservation efforts may benefit from the observation that we have cultured *P. wrighti* ex situ for >1.5 years.

The status of *P. wrighti* is an example of where our current knowledge of British Columbia's freshwater mollusc fauna has yielded a unique species, which is only found in a unique habitat. In this case, the species is at risk because of restricted niche requirements.

Physella hordacea

Based on the examination of specimens and photographs sent to him, Dr. Shi-Kuei Wu (Professor of Natural History, University of Colorado, Boulder, CO) is of the opinion that the collection of physids made at Long Lake in 1972 were identified incorrectly. He has identified the physid collections from Long Lake as *Physa* (*Physella*) *heterostropha*. (Different authors use different generic names within the family Physidae, in that *Physa* or *Physella* can be used to refer to the same species. The use can depend on the date of the publication and/or the taxonomic preference of the author. We use the nomenclature convention of the particular scientist cited.). Wu has also re-identified the Magic Lake collections as *Physa* (*Physodon*) *integra* and supplied a copy of his drawing of the holotype for *P. hordacea* (Fig. 2a).

Using conformity to holotype shell morphology as an identifying characteristic, it is evident that Figures 2b and 2c are different from Figure 2a. Figures 2b and 2c appear to be similar, but Wu has concluded that these 2 collections are actually from different subgeneric groups because of important differences in internal structures. Based on Wu's re-identifications and our own assessment of comparative shell morphology, it does seem that the Long Lake and Magic Lake specimens may have been identified incorrectly. The type specimens may indeed be from the Oregon/Washington area as indicated on their collection labels.

Our current assessment of the status of *P. hordacea* (Lee and Ackerman submitted *a*), which is under review by COSEWIC, is that until such time as there is more conclusive evidence of its occurrence in Canada, *P. hordacea* should be classified as Indeterminate, as *P. hordacea* is a species for which there is insufficient scientific information to support status designation. Notwithstanding this recommendation, there is still concern for the population of physid species in Long Lake. This is an example of where confused taxonomy has led to the assessment of a species to be potentially at risk.

Acroloxus coloradensis

The evidence suggests that *A. coloradensis* has a more widespread distribution and is adapted to a much wider range of habitats than was described previously. There are now 22 known locations for *A. coloradensis*, 16 in Canada and 6 in the United States (U.S. Department of the Interior 1994; Fig. 4). Our current assessment of the status of *A. coloradensis* (Lee and Ackerman submitted *b*), which is under review by COSEWIC, is that *A. coloradensis* be considered Not at Risk. This is an example of where the lack of information on the distribution and ecology of British Columbia's freshwater molluscs has led to the incorrect assessment of a species to be potentially at risk.

MANAGEMENT IMPLICATIONS

Factors that put freshwater molluscs at risk in British Columbia fall into several categories, all of which pose current threats to the native fauna of British Columbia. Assessment of the immediate risk to particular species, such as those reviewed above, is hampered by the lack of information on the distribution and ecology of British Columbia's freshwater molluscs. As freshwater molluscs are important components of British Columbia's inland waters, management requires a better understanding of this group of organisms for the maintenance of these essential ecosystems.

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