

**PETITION BEFORE THE
SECRETARY OF THE INTERIOR**

**Petition to List the
Jackson Lake springsnail (*Pyrgulopsis robusta*),
Harney Lake springsnail (*Pyrgulopsis hendersoni*), and
Columbia springsnail (*Pyrgulopsis* new species 6)
as Threatened or Endangered**

Submitted by:

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EXECUTIVE SUMMARY

Invertebrates comprise nearly 99% of the world's animal diversity and play an invaluable role in maintaining environmental health and integrity. Invertebrates are a part of nearly every food chain, are responsible for recycling plant and animal waste in soils and waters, and are crucial to ensuring the perpetuation of food webs. Mollusks, invertebrates characterized by their shells and which include snails, slugs, clams, mussels, and other creatures, are one of the most diverse group of animals in the world. Worldwide, it is estimated that 50,000-200,000 different mollusk species exist on land and in freshwater. These species exist in an incredible diversity of environments, playing a vital role in sustaining clean and healthy air, soil, water, and vegetation.

In the western United States, which includes the states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, land and freshwater mollusks are probably the most diverse group of animals and comprise an irreplaceable proportion of worldwide diversity. Over a thousand species of snails, slugs, clams, and mussels are found on land and in freshwater. Scientists estimate hundreds more species have yet to be discovered. Some species in the west exist in only one or two locations, such as a desert spring, a stand of ancient forest, or a coastal island, and are found nowhere else in the world. Others are more widespread, but are restricted in range and habitat to the west. Regardless of the nature of their existence, mollusks in the west are a vital part of the web of life.

Unfortunately, land and freshwater mollusks are facing an increasingly uncertain future. Worldwide, a staggering number of extinctions have been reported in the last five centuries. It has been reported that mollusks have the highest number of documented extinctions of any major taxonomic group. Of the 693 extinctions reported since the year 1500, 42% have been mollusks. Of these molluscan extinctions, 99% have been of mollusks found on land and in freshwater. In the western United States, over two dozen land and freshwater mollusks likely have gone extinct just in the last century. These extinctions, unfortunately, are merely the tip of the iceberg.

Throughout the western United States, land and freshwater mollusks have been declining. Extirpations, or the loss of populations, have been extensive. Species are disappearing from states, counties, watersheds, and even ecosystems.

Extinct or Potentially Extinct mollusks from the western U.S. in the last century.

- Florida mountainsnail (*Oreohelix florida*)
New Mexico land snail
- Sangre de Cristo peaclam (*Pisidium sanguinicristi*)
New Mexico freshwater clam
- woebegone floater (*Anodonta dejecta*)
Arizona freshwater mussel
- keeled sideband snail (*Monadenia circumcarinata*)
California land snail
- unnamed snail (*Pristiloma cavator*)
California land snail
- unnamed snail (*Vespericola ohlone*)
California land snail
- keeled rams-horn (*Planorbella traski*)
California freshwater snail
- Emerald valvata (*Valvata virens*)
California freshwater snail
- Sonoma physa (*Archiphysa sonomae*)
California freshwater snail
- dusky pebblesnail (*Fluminicola nuttalianus*)
Oregon freshwater snail
- carinate Duckwater pyrg (*Pyrgulopsis carinata*)
Nevada freshwater snail
- corded springsnail (*Pyrgulopsis nevadensis*)
Nevada freshwater snail
- Fish Lake Valley pyrg (*Pyrgulopsis ruinosa*)
Nevada freshwater snail
- Blue Point pyrg (*Pyrgulopsis coloradoensis*)
Nevada freshwater snail
- thin-ribbed mountainsnail (*Oreohelix tenuistriata*)
Idaho land snail (*cont'd on next page*)

The reasons for mollusk declines in the west are well-known. Habitat loss and degradation resulting from a variety of activities is primarily responsible. By their very nature, mollusks are extremely sensitive to habitat changes and are dependent upon relatively undisturbed environments. Not only are they relatively immobile, but they typically have very specialized habitat needs. Mollusks are also extremely vulnerable to desiccation, or drying out. Compounding the situation is that mollusks are often overlooked by land and resource managers and are typically not surveyed for, monitored, or considered during management actions. As a result, mollusks in the west are exceedingly vulnerable to extinction.

- southern tightcoil (*Ogaridiscus subrupicola*)
Utah, Idaho, Oregon land snail
- Fish Springs pondsnaill (*Stagnicola pilsbryi*)
Utah freshwater snail
- Fish Lake physa (*Utahphysa microstriata*)
Utah freshwater snail
- Bland oregonian (*Cryptomastix mullani blandi*)
Idaho land snail
- Kingston oregonian (*Cryptomastix sanburni*)
Idaho land snail
- Mt. Sampson mountainsnail (*Oreohelix hammeri*)
Idaho land snail
- pixie pebblesnail (*Fluminicola minutissimus*)
Idaho freshwater snail
- Snake River physa (*Haitia natricina*)
Idaho freshwater snail
- Coeur d'Alene physa (*Physella hemphilli*)
Idaho freshwater snail
- rotund physa (*Physella columbiana*)
Oregon-Washington freshwater snail

Extinct or Potentially Extinct mollusks from the western U.S. in the last century, continued.

The loss and decline of mollusks has grave implications. Because they are an integral part of food chains, the loss of mollusks inevitably impacts other animals that depend upon them for food, including native fish, small mammals, birds, amphibians, and reptiles. The loss of mollusks also impacts nutrient recycling, which is vital to maintaining environmental health. And, because mollusks play an important role in sustaining clean air, water, soil, and vegetation, their loss ultimately contributes to the degradation of our environment. Because the health of our own communities is inextricably tied to the health of the environment, the loss of mollusks in the west should be cause for alarm.

The Jackson Lake, Harney Lake, and Columbia Springsnails

The Jackson Lake, Harney Lake, and Columbia springsnails are three critically imperiled species that warrant protection under the Endangered Species Act to prevent their extinction and protect the ecosystems upon which they depend. Throughout the ranges of these species, their aquatic habitats, which include springs, lakes, and rivers, have been destroyed and degraded by a host of factors. As a result, the species have declined and continue to face numerous threats.

Based on the best available scientific information, the Jackson Lake, Harney Lake, and Columbia springsnails meet one or more of the five criteria for listing under the Endangered Species Act. The Jackson Lake springsnail was at one time designated a Candidate for listing under the Endangered Species Act, meaning the U.S. Fish and Wildlife Service believed the species warranted listing. Scientists have recommended that all three of the petitioned species be protected under the Endangered Species Act. Studies have further documented habitat loss and degradation, population declines, and significant threats for all of the petitioned species. The species are ranked G1 or G2, meaning they are critically imperiled throughout their range and at risk of extinction. As will be discussed further in this petition, the best available scientific information strongly indicates the Jackson Lake, Harney Lake, and Columbia springsnails warrant listing for the following reasons:

- **The present or threatened destruction, modification, or curtailment of habitat or range**

Habitat loss and/or degradation has been extensive throughout the ranges of the snails. Spring development, domestic livestock grazing, groundwater withdrawal, water pollution, and dams have destroyed and/or degraded habitat. All three springsnails have suffered population declines as a result and remain threatened.

- **Overutilization for commercial, recreational, scientific, or educational purposes**

The snails have been collected for scientific reasons and in conjunction with other threats to the species, scientific collecting could pose threats.

- **Disease or predation**

Although the snails are naturally preyed upon by a variety of other animals, the petitioned mollusk species may be increasingly threatened by predation in conjunction with the impacts of habitat loss and/or degradation.

- **The inadequacy of existing regulatory mechanisms**

Existing regulatory mechanisms are woefully inadequate to protect the Jackson Lake, Harney Lake, and Columbia springsnails. None of the species or their habitats are protected on private lands and federal and state regulatory mechanisms not only fail to provide adequate protection, but fail to provide for any level of recovery of the petitioned mollusks.

- **Other natural or manmade factors affecting its continued existence**

Herbicide and pesticide use, the introduction and spread of nonnative species, and climate change threaten the Jackson Lake, Harney Lake, and Columbia springsnails. Additionally, because populations of the springsnails are either small, isolated, and/or fragmented, they are more susceptible to extinction.

A recent study suggests the Jackson Lake, Harney Lake, and Columbia springsnails may actually be one species, and may also be the same as the related Idaho springsnail, which is currently listed as endangered under the Endangered Species Act. However, whether taken individually or as one species, the Jackson Lake, Harney Lake, and Columbia springsnails, together with the Idaho springsnail, are still at great risk of extinction and face a number of threats to their habitat and their continued existence. All four snails need protection under the Endangered Species Act, regardless of whether they are all the same species.

Protecting the Jackson Lake, Harney Lake, and Columbia springsnails under the Endangered Species Act will lead to many benefits. Most notably, protection under the Endangered Species Act will ensure these species and the ecosystems they depend upon will receive adequate protection from the threat of continued loss and degradation. Protection of the species not only brings increased protection for the snails and their habitats, but increased protection for other species that also depend upon healthy ecosystem, such as native trout. And, because there is a direct link between healthy populations of snails and a healthy environment, protection of the Jackson Lake, Harney Lake, and Columbia springsnails will ultimately lead to increased protection for our own communities for future generations.

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I. INTRODUCTION

Pursuant to the Endangered Species Act (“ESA”), 16 USC § 1531 *et seq.* and regulations promulgated thereunder, the Administrative Procedures Act, 5 USC § 553(e), and the First Amendment to the Constitution of the United States, Dr. Peter Bowler, Biodiversity Conservation Alliance, the Center for Biological Diversity, Center for Native Ecosystems, Western Watersheds Project, The Xerces Society, and Jeremy Nichols hereby petition for a rule to list the Jackson Lake springsnail (*Pyrgulopsis robusta*), Harney Lake springsnail (*Pyrgulopsis hendersoni*), and Columbia springsnail (*Pyrgulopsis* new species 6) as threatened or endangered under the ESA.

The petitioners request that these species be listed as individual species or, depending on the implications of a recent taxonomic study, together as one species. As petitioners will discuss in more detail below, a recent taxonomic study by Hershler and Liu (2004) synonymizes the Jackson Lake springsnail with the Harney Lake springsnail, Columbia springsnail, and Idaho springsnail (*Pyrgulopsis idahoensis*), which is currently listed as endangered under the ESA. The study argues that all four species are actually one and ascribes them all as *Pyrgulopsis robusta*, the senior taxon. This study has fallen under scientific criticism and appears to have overlooked key information regarding differences between the four species, differences that support recognition as individual species, as well as historic geological and biogeographical information. However, regardless of whether the study is ultimately accepted or not, individually or together as one species, the Jackson Lake, Harney Lake, and Columbia, springsnails warrant listing as threatened or endangered.

Petitioners understand this petition action sets in motion a specific process placing definite response requirements on the U.S. Fish and Wildlife Service (“USFWS”) and specific time constraints upon those responses. See, 16 USC § 1533(b).

II. PETITIONERS

Dr. Peter Bowler is an ecologist and freshwater mollusk expert. He has studied springsnails, including the Idaho springsnail, and other freshwater mollusks for over 25 years and currently teaches at the University of California, Irvine.

Biodiversity Conservation Alliance is a Wyoming-based nonprofit conservation organization dedicated to protecting and restoring native species of plants and animals throughout the Rocky Mountain Region and surrounding areas. Using outreach, education, science, comments, administrative appeals, and litigation, Biodiversity Conservation Alliance works to protect and restore biodiversity, prevent the loss of native species and their habitat, and raise the threshold of public knowledge and appreciation of biodiversity and ecological health.

The Center for Biological Diversity is a nonprofit organization that combines conservation biology with litigation, policy advocacy, and an innovative strategic vision to secure a future for animals and plants hovering on the brink of extinction, for the wilderness they need to survive, and by extension for the spiritual welfare of generations to come.

Center for Native Ecosystems is a Denver, Colorado-based non-profit, science-based conservation organization dedicated to protecting and recovering native and naturally functioning ecosystems in the Greater Southern Rockies, Great Plains, Black Hills, the Great Basin, and elsewhere. Using the best available science, Center for Native Ecosystems participates in policy and administrative processes, legal actions, and public outreach and education programs to protect and restore imperiled native plants and animals.

Western Watersheds Project is an Idaho-based conservation group dedicated to protecting and restoring western watersheds and wildlife through education, public policy initiatives, and litigation.

The Xerces Society is an international nonprofit organization dedicated to preserving the diversity of life through the conservation of invertebrates. The Society works with scientists, land managers, and citizens to protect invertebrates and their habitats by producing information materials, presenting educational activities, implementing conservation projects, and advocacy.

Jeremy Nichols is a Laramie, Wyoming resident who grew up in Boise, Idaho. Mr. Nichols has visited, explored, and enjoyed numerous areas where rare and imperiled mollusks are known to exist, such as Jackson Lake, Wyoming and the Snake River of southern Idaho. Mr. Nichols has taken great joy in observing land and freshwater mollusks in their natural habitats on numerous occasions.

III. THE PETITIONED SPRINGSNAILS

Commonly called the Jackson Lake springsnail, Harney Lake springsnail, and Columbia springsnail, the species are *Pyrgulopsis robusta* (Walker, 1908), *Pyrgulopsis hendersoni* (Pilsbry, 1933), and *Pyrgulopsis* new species 6 (Frest and Johannes 1995a) are three freshwater snail species of the mollusk gastropod family Hydrobiidae and the western North American genus *Pyrgulopsis* (Hershler 1994). The snails exist in the western United States, including the states of Wyoming, Oregon, and Washington, and are found only in freshwater environments. While the species are widely distributed, individually each species exists as an extremely small population with a narrow range (Hershler and Liu 2004). All three species have suffered population declines, extensive habitat loss and degradation, and remain threatened by a host of factors (Frest and Johannes 1995a, 1996). All three species are critically imperiled throughout their ranges and at high risk of extinction (NatureServe 2003). Current regulatory mechanisms are also failing to adequately protect the species and provide for their recovery. All three species have been recommended by scientists for listing as endangered under the ESA (Frest and Johannes 1995a, 1996). The Jackson Lake springsnail was formerly designated a category 2 Candidate species, meaning the USFWS believed the species warranted listing (USFWS 1994d). In 1996, the category 2 Candidate designation was dropped for administrative reasons (USFWS 1996). Since then, the USFWS has not taken any action to protect the Jackson Lake springsnail, Harney Lake, or Columbia springsnails.

A. Taxonomy

All of the species described below are in the family Hydrobiidae (Hershler and Liu 2004). The Jackson Lake springsnail was discovered in 1908 and described based on forms from

Jackson Lake, Wyoming (Walker 1908). Originally named *Pomatiopsis robusta*, the species was subsequently ascribed to the genus *Amnicola* (Pilsbry 1933), then to the genus *Fontelicella* (Gregg and Taylor 1965), and finally to the genus *Pyrgulopsis* (Hershler and Thompson 1987, Hershler 1994). The name *Pyrgulopsis robusta* is accepted today as the scientific name of the species (Turgeon et al. 1998), although a recent study suggests the species' name may be synonymous with *Pyrgulopsis idahoensis*, *Pyrgulopsis hendersoni*, and *Pyrgulopsis* new species 6 (Hershler and Liu 2004).

The Harney Lake springsnail was discovered in 1929 and was described based on forms from springs south of Burns, Oregon. Originally named *Paludestrina* sp., the species was subsequently ascribed to the genus *Amnicola* (Pilsbry 1933), then to the genus *Fontelicella* (Gregg and Taylor 1965), and finally to the genus *Pyrgulopsis* (Hershler and Thompson 1987, Hershler 1994). The name *Pyrgulopsis hendersoni* remains valid (Turgeon et al. 1998), although a recent study suggest the species may be a synonym of *Pyrgulopsis robusta* (Hershler and Liu 2004).

The Columbia springsnail was reported in 1995 as an unnamed species (Frest and Johannes 1995a). The species has been named *Pyrgulopsis* new species 6, but has not yet been formally named. The species is distinct from other related species by its unpigmented tentacles, common yellow and orange pigment granules on the body, and distinctive penile features (Id.). Although the species has not been formally named, a recent study suggests the species may be a synonym of *Pyrgulopsis robusta* (Hershler and Liu 2004).

A recent taxonomic study suggests the Jackson Lake, Harney Lake, and Columbia springsnail species are actually a part of a larger clade, the *Natricola* clade, which also includes the Idaho springsnail. The study synonymizes all four springsnails and ascribes them all as *Pyrgulopsis robusta*, the Jackson Lake springsnail, which is the senior taxon. Scientists have expressed significant concerns over the conclusions of Hershler and Liu (2004). Citing obvious morphological differences, ecological differences, behavioral differences, and long-term biogeographical isolation, scientists have flatly rejected the findings of Hershler and Liu (2004) (Bowler 2003, Frest 2004a, 2004b). In comments submitted June 16, 2003 to the USFWS on Hershler and Liu's conclusions, Peter Bowler with the Department of Ecology and Evolutionary Biology at the University of California, Irvine stated:

The present [Hershler and Liu] study convincingly demonstrates that *P. idahoensis* is morphologically distinct from *P. robusta* and the suite of other taxa examined. All four of the taxa considered (*P. robusta*, *P. idahoensis*, *P. hendersoni*, and sp. A) are visually separable and have other differences not well treated in this paper. While some characters seem to be shared among the "*Natricola* clade," according to data presented in Table 2 [of the Hershler and Liu study], *P. idahoensis* is statistically significantly distinct in shell height/shell width from the other five populations sampled (this is obvious in all figures I have seen of both from Pilsbry to Burch to Hershler and Liu; see attachments), and it differs significantly from *P. robusta* and the three *P. hendersoni* populations in shell height/aperture height, shell height/height of body whorl, and number of shell whorls, not being statistically separable only from the lower Columbia River sp. A. (p. 2)

Bowler (2003) continued:

Although not a standard taxonomic character (it has been used elsewhere in hydrobiids by researchers like Davis), *P. idahoensis* is behaviorally/ecologically different as well (mildly photophobic; Bowler, 1991). *Pyrgulopsis idahoensis* is a cryptic sediment dweller living in the interstitial environment and is also found beneath rocks, while *P. robusta* occurs in broad daylight on rock and other substrate surfaces, and all of the taxa examined have different algal, macrophyte and other aquatic ecosystem differences. From my observations in the field and lab of *P. idahoensis* and *P. robusta*, they are very different behaviorally and clearly come from different aquatic ecologies; *P. hendersoni* is also very different ecologically (based on descriptions of its habitats; I have not seen it in the field), as is sp. A, existing in large-river impoundments. These species likely have differing temperature and other ecological setting differences since *P. robusta* is a headwater, coldwater, primarily spring inhabiting taxon; *P. hendersoni* is a warmer water, isolated species; and *P. idahoensis* occurs in the Middle Snake River at the spring confluences of Bancroft Springs and in the mainstem Snake River. (pp. 2-3)

Table 1. Differences between Jackson Lake, Harney Lake, Columbia, and Idaho springsnails.

Species	Morphology	Behavior	Habitat	Ecosystem
Jackson Lake springsnail (<i>Pyrgulopsis robusta</i>)	shell height 5.5-6.3 mm, 5-5.5 whorls, shell ovate- to narrowly-conic and large umbilicate, broader central teeth than other springsnail species, consistently smaller than Idaho and Columbia springsnails (Hershler 1994, Hershler and Liu 2004)	occurs in broad daylight (i.e., not photophobic) on surface of rocks; perolithon grazer (Frest and Johannes 1995a)	cold springs in and around Jackson Lake and in cold spring-influenced creeks with sand, gravel, or cobble substrate; sometimes dense cress (<i>Rorippa</i> sp.) beds common; predominantly a crenophile, although found in lake habitats as well (Frest and Johannes 1995a, Frest 2004b)	upper Snake River aquatic ecosystem, characterized by lake and small stream environments; co-occurs with malacofauna typical of upper Snake River (Frest and Johannes 1995a, Hershler and Liu 2004)
Harney Lake springsnail (<i>Pyrgulopsis hendersoni</i>)	shell height 4-6.5 mm, 4.5-5.5 whorls, ovate- to low-conical shell; dark pigmentation; well developed oviduct coil rare, smaller than Idaho and Columbia springsnails (Hershler 1994, Hershler and Liu 2004)	aufwuchs grazer, apparently not photophobic, mud specialist (Frest and Johannes 1995a, Frest 2004b)	mildly thermal springs and spring pools with typically fine substrates; which are generally shallow and generally have moderate flow; dense cress (<i>Rorippa</i> sp.) beds common; considered a crenophile, meaning it prefers spring environments (Frest and Johannes 1995a, Frest 2004a, 2004b)	Great Basin aquatic ecosystem, characterized by isolated springs and spring pools; co-occurs with few mollusks (Frest and Johannes 1995a, Hershler 1998, Hershler and Sada 2002)
Columbia springsnail (<i>Pyrgulopsis</i> new species 6)	distinctive penial features; yellow pigmentation, larger than Jackson Lake and Harney Lake springsnails (Frest and Johannes 1995a)	occurs on undersides of rocks, most likely photophobic; perolithon grazer (Frest and Johannes 1995a)	lower Columbia River in areas of relatively deep cold water with constant flow and a rocky substrate; macrophytes uncommon; considered an amniphile (Frest and Johannes 1995a, Frest 2004b)	lower Columbia River aquatic ecosystem, characterized by large, deep stream environments; co-occurs with malacofauna typical of lower Columbia River (Frest and Johannes 1995a)
Idaho springsnail (<i>Pyrgulopsis idahoensis</i>)	shell height 5-7.5 mm, 5-6 whorls, narrowly- to elongate-conic shell, more slender shell than other springsnail species, dark pigmentation; well developed oviduct coil more common, larger than Jackson Lake and Harney Lake springsnails (Hershler 1994, Hershler and Liu 2004)	photophobic, a cryptic sediment dweller; perolithon grazer (Frest and Johannes 1995a, Bowler 2003, Lysne 2003)	cold spring-influenced riffles of the mainstem Snake River with cobble substrate, inhabits interstices of sediment (USFWS 1992, Lysne 2003); macrophytes present, but do not form dense beds; considered an amniphile, meaning it prefers river environments (Frest and Johannes 1995a, Frest 2004b)	middle Snake River aquatic ecosystem, characterized by large river and spring tributaries; co-occurs with malacofauna typical of middle Snake River (USFWS 1992, Frest and Johannes 1995a)

Indeed, Hershler and Liu (2004) appear to have overlooked major differences that support, recognizing the Jackson Lake, Harney Lake, Columbia, and Idaho springsnails as distinct species (Crandall et al. 2000, Fraser and Bernatchez 2001, Moritz 2002). See, Table 1. As Table 1 demonstrates, the Jackson Lake, Harney Lake, and Columbia springsnails are in fact very distinct from each other, as well as the Idaho springsnail, in terms of morphology, behavior, habitat, and the ecosystems they depend upon for survival, thus supporting continued recognition of the snails as distinct taxa (Bowler 2003, Frest 2004a, 2004b). The isolation of the Jackson Lake, Harney Lake, Columbia, and Idaho springsnails from each other, and the lack of gene flow between the species (Hershler and Liu 2004), also favors continuing to recognize them as distinct taxa (Bowler 2003, Frest 2004a, 2004b). Based on these distinctions, there is strong evidence for continuing to recognize the Jackson Lake, Harney Lake, and Columbia springsnails as distinct species (Crandall et al. 2000, Fraser and Bernatchez 2001, Moritz 2002, Bowler 2003, Frest 2004a, 2004b).

Further discounting the conclusions of Hershler and Liu (2004) is the geological history of the region where the snails are located, as well as biogeographic history. Bowler (2003) explains:

It doesn't make biogeographic sense for all of these to be a single species, and it would certainly be an incredible distributional achievement unique among western hydrobiids for a single species to have been in existence in Blanford deposits (3.5 million years in the Middle Snake River area), have presence in Snake River headwater areas isolated until recent times and part of an Upper Snake River malacofauna very distinct from that in the modern Middle Snake River, exist in southwestern Oregon (another fauna sharing little with the Middle Snake River), and the Lower Columbia. As is shown by Figure 9 [of Hershler and Liu], *P. idahoensis* is and has long been isolated from *P. robusta*, *P. hendersoni*. and sp. A. These areas would have been connected perhaps in the Miocene, but have essentially been separated since then (until relatively recent connections). Taylor (1966 and 1985) listed this species as being a part of the Blanford Glenns Ferry Formation (Lake Idaho) fauna, which was also noted in his 1982 status review. In his 1985 paper Taylor places this species among "snails of larger perennial waters" in his Table (3) of "Late Tertiary Record of Extant Species of Freshwater Molluscs in the United States West of Continental Divide." The other taxa are not a part of that fauna. Since the Glenns Ferry is dated at around 3.5 million years, this suggests that *P. idahoensis* has been around far longer than suggested by the molecular estimates. Because Lake Idaho didn't include the range of *P. robusta*, that species might have been part of either a separate species group or have been derived from *idahoensis* or a common ancestor long ago. At any rate, if Taylor is correct and *P. idahoensis* was a Lake Idaho species, the concept of it being distinct – as it is morphologically and in body pigmentation – from *P. robusta* and the others is strengthened. The fact that one can distinguish these species on the basis of shell morphology and pigmentation coupled with clear biogeographic isolation suggests that this is a group of separate taxa that is linked today by the modern Snake River drainage but has biogeographically segregated for a very long period. I don't buy ecomorphotypes (simple variation) as explaining this. This seems like a classic case of a cluster of species that have long been separate (since the Miocene) and today are part of a

modern drainage (they are certainly now isolated from each other by dams but natural waterfalls also kept them apart). Were these taxa all lined up along the Middle Snake River or some other clear biogeographic unit, it would be an exciting case of adaptive radiation/speciation as shown by differing morphologies – and it would be back to the drawing board to find the correct molecular way to show the clear and ongoing separation. But it is not that way in this case: the hydrologic and potential genetic links are ancient followed by isolation and clear shell and other divergence. (p. 3)

Hershler and Liu (2004) do not address geological or biogeographical history implications in relation to the distribution and evolution of the Jackson Lake, Harney Lake, Columbia, and Idaho springsnails, raising serious questions over whether they have appropriately assessed the taxonomic status of these species.

B. Descriptions

1. Jackson Lake springsnail

Hershler (1994) describes the Jackson Lake springsnail as follows:

Shell ovate- to narrow-conic; height, 5.5-6.3 mm; whorls, 5.0-5.5. Protoconch with small, very weakly punctate area near apex, otherwise smooth except for faint suggestion of spiral striae adapically. Teleoconch whorls moderately convex, shouldered; sculpture of weak growth lines. Aperture adnate to very slightly separated from body whorl. Inner lip complete, thickened. Outer lip slightly thinner, prosocline. Umbilicus narrowly rimate to perforate. Periostracum thick, brown.

Operculum ovate, amber, darker centrally; nucleus slightly eccentric; dorsal surface frilled. Attachment scar margin moderately thickened almost all around, sometimes broadly so along inner edge and between edge and nucleus; callus moderately-strongly developed.

Central radular tooth with weakly indented dorsal edge; lateral cusps, 5-06; central cusp rounded, much longer, slightly broader than laterals; basal cusps, 1, small, curved, with small dorsal support. Basal process very broad; basal sockets deep. Lateral margins thickened; neck moderate.

Cephalic tentacles pale except for small internal pigment patch just distal to eyespots. Snout light to dark gray-brown. Foot pale-dark gray. Opercular lobe pale or with small patch of internal pigment along inner edge. Neck pale except for central patch of internal pigment. Pallial roof, visceral coil black.

Ctenidial filaments, 32, tall, very broad. Osphradium centered slightly posterior to middle of ctenidial axis. Kidney opening white. Stomach caecum large, broadly triangular.

Testis, 1.75 whorls, overlapping stomach edge of style sac. Prostate gland with large (40%) pallial section; pallial vas deferens with proximal kink. Penis large; base broadly rectangular; filament medium length, narrow, tapering; lobe about as long as filament, stout. Dg1 elongate, extending from base of filament (slightly overlapped) along right

edge, posterior portion curving inward, slightly raised; Dg2 short, horizontal or tilted toward Dg3, sometimes broken into two units; Dg3 small (sometimes absent), borne on pronounced proximal lobule. Dorsal penis also sometimes ornamented with 1-3 small glandular dots centrally and/or along near right side. Terminal gland elongate, transverse, slightly curved, borne along distal edge (mostly on ventral surface). Ventral gland borne on swelling near base of filament (gland sometimes absent), sometimes with adjacent glandular dot. Filament dark.

Ovary, 1 whorl, overlapping posterior stomach chamber. Pallial albumen gland short or absent. Capsule gland as long as albumen gland. Genital aperture a terminal slit with vestibule. Coiled oviduct of two overlapping horizontal loops positioned slightly behind pallial wall. Oviduct and bursal duct join just behind pallial wall. Bursa copulatrix ovoid, posterior end often blunt, long (67%), broad (58%), with 33%-67% of length posterior to albumen gland. Bursal duct relatively narrow, short. Seminal receptacle pouch-like, broad, short, overlapping anterior bursa copulatrix, extending to posterior edge of albumen gland. (pp. 62-63).

The Jackson Lake springsnail's radula also has broader central teeth than the Harney Lake springsnail and Columbia springsnail (Hershler and Liu 2004).

2. Harney Lake springsnail

Hershler (1994) describes the Harney Lake springsnail as follows:

Shell ovate- to low-conical; height, 4.0-6.5 mm; whorls, 4.5-5.5 whorls. Early protoconch weakly punctate, otherwise nearly smooth. Teleoconch whorls moderately convex, rarely slightly shouldered; sculpture of weak growth lines and faint spiral striae. Aperture ovate, large, broadly adnate to slightly separated from body whorl. Inner lip complete, thin to moderately thick; columellar lip occasionally slightly reflected. Outer lip thin to moderately thick, orthocline to slightly prosocline. Umbilicus narrowly rimate to near absent. Periostracum olive-tan.

Operculum broadly ovate, amber (nuclear region and adjacent inner edge near red); nucleus slightly eccentric; dorsal surface smooth. Attachment scar margin broadly thickened all around, distinctly raised between nucleus and inner edge; callus moderate.

Central radular tooth with moderately indented dorsal edge; tooth face square; lateral cusps, 3-6; central cusp rounded, broader and slightly longer than laterals; basal cusps, 1, short, curved, with strong dorsal support. Basal process broad; basal sockets shallow. Lateral margins thickened, neck very weak.

Snout dark purple; pigment light to dark on foot, neck. Cephalic tentacles usually dark at least proximally. Opercular lobe with dark internal pigment in anterior half. Pallial roof, visceral coil black.

Ctenidial filaments, 36, very tall, broad. Osphradium centered posterior to middle to ctenidial axis. Kidney opening white. Stomach caecum prominent, triangular, darkly pigmented.

Testis, 1.5 whorls, overlapping stomach to edge of style sac. Prostate gland very broad posteriorly, thickened, with large pallial section (40%). Pallial vas deferens thickened, with proximal kink. Penis very large, extending well beyond edge of mantle collar; base elongate-rectangular; filament very short, narrow, tapering; lobe large, broad. Dg1 elongate, extending along right edge (sometimes slightly overlapping proximal filament), to mid-penis; gland curving inward posteriorly where weakly raised; smaller glandular dots sometimes present to left of above. Dg2 usually short, sometimes fused with Dg3, sometimes fragmented into or accompanied by several short strips; Dg3 borne on well-defined lobule. Terminal gland elongate, transverse, straight, borne along distal edge of lobe, usually ventrally. Ventral gland small, stalked, centrally positioned (sometimes absent). Filament darkly pigmented internally.

Ovary, 1.5 whorls, overlapping stomach to edge of style sac. Pallial albumen gland large (30%). Capsule gland longer than albumen gland. Genital aperture a short terminal slit; vestibule very short or absent. Coiled oviduct a horizontal loop (kinked proximally) well behind pallial wall near posterior end of albumen gland. Oviduct and bursal duct join anterior to oviduct coil behind pallial wall. Bursa copulatrix ovoid, about as long and as wide as albumen gland, with most of length (about 70%) posterior to gland. Bursal duct medium width, very short. Seminal receptacle finger-like, short, overlapping anterior bursa copulatrix, extending to posterior edge of albumen gland. (pp. 40-41)

3. Columbia springsnail

Frest and Johannes (1995a) describe the Columbia springsnail as follows:

This species is similar in shell morphology to *Pyrgulopsis robusta* and *Pyrgulopsis idahoensis*, in that it has a comparatively large elongate spire. The unpigmented tentacles, common yellow and orange pigment granules on the body, and features of the penis are distinctive. (p. 202).

C. Biology/Ecology

The Jackson Lake, Harney Lake, and Columbia springsnails are adapted solely for aquatic life, having gills and other specific adaptations for life in the water (Hershler 1998). All of the species exist in spring or spring-influenced environments (Frest and Johannes 1995a, Hershler 1998). The Harney Lake springsnail inhabits rheocrenes, or springs that emerge from the ground as a flowing stream, and is considered to be a crenophile, meaning it exists entirely in spring environments (Hershler 1998). Limnocrenes, natural pools formed by springs, may also be utilized by the Harney Lake springsnail (Frest and Johannes 1995a, Hershler 1998). The Columbia springsnails is considered to be an amphiphile, meaning it exists primarily in larger streams (Frest and Johannes 1995a). The Jackson Lake springsnail is considered to be a limnophile, meaning it exists primarily in lake environments or prefer lake-like environments (Hershler 1994, Frest and Johannes 1995a). However, the Jackson Lake springsnail also exists in spring-influenced environments of small streams (Frest and Johannes 1995a).

Water depth, temperature, flow rate, salinity, and other conditions vary among the species' habitats (Frest and Johannes 1995a, Hershler 1998). Despite these variations, each species has adapted to the unique conditions of their habitats and are very sensitive to changes in local water conditions (Frest and Johannes 1995a, Hershler 1998, Lysne 2003). Hershler (1998) noted that springsnails "often decline dramatically in density downflow from spring sources, presumably reflecting their requirement for the well-known stable temperature, chemistry, and flow regime characterizing headsprings" (p. 11). The species are considered to be cold-water stenotherms, preferring cold water environments (Frest and Johannes 1995a). Studies have found that lower water temperatures are more beneficial to some springsnail species (Lysne 2003). However, the Harney Lake springsnail is reported to occur in mildly thermal springs and may be somewhat of a thermophile (Frest 2004a, 2004b). Desiccation is also a threat to all of the species (Frest and Johannes 1995a, Lysne 2003). Although permanent removal from water will likely kill the Jackson Lake, Harney Lake, and Columbia springsnails, even periodic dewatering of the species' habitats can lead to significant mortality among populations of the species (Lysne 2003). The specialized habitat needs of the species makes them more susceptible to declines and extinctions as a result of natural or anthropogenic influences upon water quality and quantity (Mladenka 1992, Frest and Johannes 1995a).

At many sites preferred by the species, aquatic macrophyte representation is relatively minor. However, springs that support the Harney Lake springsnail and to some extent the Jackson Lake springsnail may have dense stands of flowing-water plant species. Species of *Pyrgulopsis* are commonly found among aquatic vegetation, especially *Rorippa* (Frest and Johannes 1995a). Trophically, the snails are grazing primary plant consumers and are obligate perolithon feeders, although the Harney Lake springsnail may graze upon larger aquatic macrophytes (Frest and Johannes 1995a, Hershler 1998).

The snails are typically found on hard substrates, including bedrock, pieces of travertine, sand, or gravel (Frest and Johannes 1995a, Hershler 1998, Lysne 2003). Coarse substrates seem to be inimical to the Jackson Lake and Columbia springsnail (Frest and Johannes 1995a, Hershler 1998). However the Harney Lake springsnail appears more adapted for life in soft-sediments, or muds, although only in highly oxygenated sediments (Frest and Johannes 1995a, Frest 2004a, 2004b). Disturbance of snails may cause them to detach from substrate (Lysne 2003). In flowing water habitats, such a response could be detrimental, potentially placing individuals in uninhabitable and potentially lethal environments, rendering them more vulnerable to predation, or otherwise inhibiting their ability to reproduce.

Mollusks of the family Hydrobiidae are reported to live approximately one year and require several months to reach breeding age (Frest and Johannes 1995a, Lysne 2003). The snails are dioecious, meaning they have separate sexes (Hershler 1998). Hydrobiid species are reported to be semelparous breeders, meaning they breed only once in their lifetime and then die (Frest and Johannes 1995a). Breeding is reported to occur only once a year for Hydrobiid species (Lysne 2003). Species of *Pyrgulopsis* have been found to be oviparous, with the female laying single, small egg capsules on hard substrates (Mladenka 1992, Hershler and Ponder 1998). Species of *Pyrgulopsis* copulate via an anterior opening to the glandular oviduct, with the penis entering the anterior most section of the ventral channel (Hershler and Ponder 1998). The breeding season

for mollusks is believed to be between February and May, with egg laying and hatching taking place between March and July (Frest and Johannes 1995a). Egg laying is believed to take place a month after copulation and hatching is believed to take place around a month after egg laying.

Seasonal and diel activity among springsnail species has been reported (Lysne 2003). Typically, springsnails are dormant during the winter and more active during the summer (Frest and Johannes 1995a, Lysne 2003). The Columbia springsnail is reported to be photophobic, coming out only during night to forage (Id.). The Harney Lake and Jackson Lake springsnails on the other hand are not entirely photophobic and have been observed in broad daylight (Frest and Johannes 1995a).

Populations of the mollusk species may vary. Densities of 1000-10,000 snails/m² have been reported for several Great Basin limnocyprids, while higher densities are reported for smaller rheocyprids (Hershler 1998). Population size, although informative, does not seem to accurately reflect the status of the Jackson Lake, Harney Lake, or Columbia springsnails or the threats they face. Given that most species are extremely limited by habitat and physical needs, abundant populations appear just as vulnerable to extinction as smaller populations (Frest and Johannes 1995a, Hershler 1998, 1999, Lysne 2003).

The dispersal ability of the snails is extremely limited, primarily by physiological factors. The species are considered to be “functionally sessile” (Frest and Johannes 1995a, p. 29). Among populations, movement of the species is limited by substrate, water temperature, water flow, water depth, predation, and competition with other aquatic mollusks (Frest and Johannes 1995a). Human impacts also limit movements. Dams, water diversions, spring developments, influx of pollution, stream modifications, recreational developments, among other impacts, pose barriers to dispersal of the snails (Frest and Johannes 1995a, Hershler 1998, Hershler and Liu 2004).

Although not specifically documented, passive transport, such as by wind, birds, fish, insects, or other animals, may facilitate movements of some springsnails. Liu et al. (2003) postulate that passive dispersal of the Oasis Valley springsnail (*Pyrgulopsis micrococcus*) historically occurred on the feet and plumage of wading birds and waterfowl. Although passive transport may be a possibility for mollusks adapted to warmer conditions, the possibility of passive transport for many aquatic mollusks is considered to be extremely remote (Frest and Johannes 1995a). Frest and Johannes (1995) state:

Cold-water [mollusk] forms and perolithon feeders may be rather limited in their ability to survive passive transport by any of the means cited. These species tend to be sensitive to warming and may also be unable to tolerate low-oxygen conditions or removal from relatively oxygen-saturated waters for more than a small period of time. Such taxa would be limited to active migration, which in these often functionally sessile taxa would literally proceed at a snail’s pace at best. (p. 29)

For the Jackson Lake, Harney Lake, and Columbia springsnails, it is believed their current distribution is the result of active transportation that occurred as a result of prehistoric water systems (Hershler and Liu 2004).

Most North American freshwater mollusk species, including the Jackson Lake, Harney Lake, and Columbia springsnails, are sensitive to pollution regardless of source (Burch 1989, USFWS 1992, 2004, Frest and Johannes 1995a, Hershler 1998). The species do not tolerate excessively warm waters, low dissolved oxygen, or major seasonal fluctuations of water (Frest and Johannes 1995a, Lysne 2003). The species are, for the most part, cold-water stenotherms and prefer permanent, clear, cold, unpolluted waters with dissolved oxygen levels near saturation (USFWS 1992, Frest and Johannes 1995a). Most cold-water forms are quite sensitive to hypoxic or anoxic conditions, in either the water column or substrate (USFWS 1992). Even species that are considered thermiphiles or that are otherwise adapted to unique aquatic environments are sensitive to changes in water chemistry and temperature (Hershler 1998).

The species are all reported to be sensitive to habitat disturbance and loss (USFWS 1992, Frest and Johannes 1995a, Hershler 1998, Lysne 2003). Population declines have occurred as a result of habitat destruction and degradation (Hershler 1994, 1998, Frest and Johannes 1995a). Recovery from habitat loss and degradation may be impossible for the snails (Frest and Johannes 1995a, Hershler and Liu 2004). Recovery is hindered by specialized habitat needs, physiological requirements, habitat fragmentation, and/or geographic isolation (Id.).

The Jackson Lake, Harney Lake, and Columbia springsnails play a vital role in maintaining aquatic ecosystem health (Wilson 1992, Frest and Johannes 1995a, Frest 2002a, 2002b, Lydeard et al. 2004). As primary consumers, the species all play a vital role in recycling nutrients and in cleaning water sources (Wilson 1992, Lydeard et al. 2004). The species also serve as food to a variety of freshwater fish and are commonly consumed by larger aquatic insects, particularly larval forms, leeches, crayfish, amphibians, reptiles, and by a variety of birds, including ducks, geese, herons, and cranes (USFWS 1992, Frest and Johannes 1995a).

D. Habitat

While the habitats of the Jackson Lake, Harney Lake, and Columbia springsnails vary, there are common features. All the species are dependent upon perennial water sources (Frest and Johannes 1995a, Hershler and Liu 2004). All populations of all species live in springs or spring-influenced environments with clean water and coarse to fine substrates, including sand, gravel, and cobbles, and even mud in some cases (Frest and Johannes 1995a, Frest 2004b). The species graze on perolithon or aufwuchs growing on underwater surfaces, and thus require environments that are conducive to the growth of such organisms, such as streams and springs with stable substrate and typically free of very fine sediments (Id.). Aquatic macrophytes are generally a minor component of the species' habitat, although the Harney Lake and Jackson Lake springsnails may inhabit springs with dense cress (*Rorippa* sp.) cover (Frest and Johannes 1995a). Wherever the species are found, they are dependent upon relatively undisturbed habitat and are reported to be extremely sensitive to habitat degradation and modification (Frest and Johannes 1995a, Hershler 1998).

1. Jackson Lake springsnail

Frest and Johannes (1995a) report the Jackson Lake springsnail “Lives in cold springs and also in spring-influenced creeks and a large lake” (p. 212). The species is considered a creoncole, meaning it prefers spring or spring-influenced environments and is a lithophile (Frest

and Johannes 1995a, Bowler 2003). Sites supporting the snail may have dense beds of cress (*Rorippa* sp.) and have coarse substrate, such as sand, gravel, or cobble (Id.).

2. Harney Lake springsnail

The Harney Lake springsnail occurs in small to large mildly thermal springs and spring pools that have moderate flow and are generally shallow (Frest and Johannes 1995a, Frest 2004a, 2004b). Springs where the species occurs have dense macrophytes. The species is considered a “mud-specialist” or pelophile, and is found primarily in well-oxygenated, fine sediments, although it does not burrow into mud (Frest 2004b). The snail is an aufwuchs grazer, mostly from the sides of stones and sometimes from stable macrophytes (Frest and Johannes 1995a). The species may also be a detritivore, grazing organic particles from the upper mud surface of the substrate where it occurs.

3. Columbia springsnail

The Columbia springsnail is found in deep water river habitats with rocky substrate and constant flow, without many macrophytes (Frest and Johannes 1995a). Frest and Johannes (1995a) state, “The general association is that probably common to the Lower Columbia River prior to human modification” (p. 203). The species is an amphiphile. Epiphytic algae may be common at sites supporting the species (Frest and Johannes 1996). Frest and Johannes (1996) report, “Snails are found on relatively bare undersides of uncemented cobbles” (p. 81).

E. Status

The Jackson Lake, Harney Lake, and Columbia springsnails were once relatively common and abundant throughout their ranges, but are currently limited to 11 locations. The Jackson Lake springsnail is currently known from one location, Polecat Creek, in northwestern Wyoming (Hershler 1994, Frest and Johannes 1995a). The Harney Lake springsnail is currently known from four sites in Oregon (Hershler 1994, 1998, Frest and Johannes 1995a, Hershler and Liu 2004). The Columbia springsnail is currently known from six sites in the states of Oregon and Washington (Frest and Johannes 1995a, Hershler and Liu 2004). See, Figure 1.

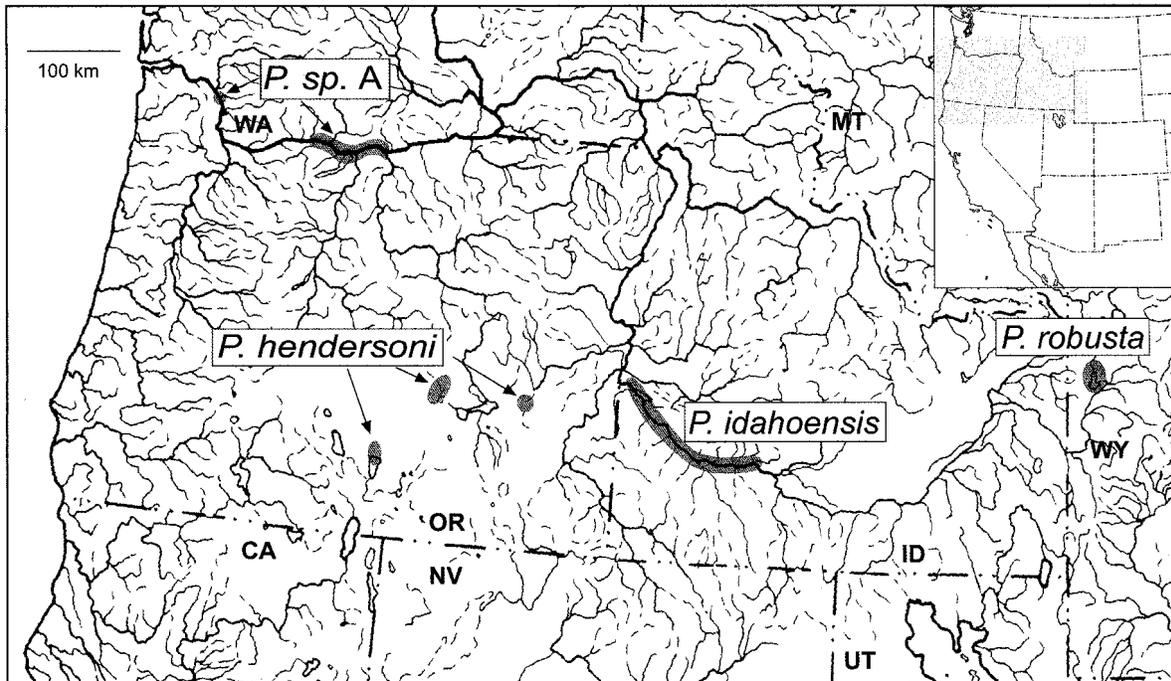


Figure 1. Range of Jackson Lake springsnail (*P. robusta*), Harney Lake springsnail (*P. hendersoni*), and Columbia springsnail (*P. sp. A*) as documented by Hershler and Liu (2004). Range of Idaho springsnail (*P. idahoensis*) also included.

Throughout their ranges, populations of the Jackson Lake, Harney Lake, and Columbia springsnails have declined for a number of reasons (Frest and Johannes 1995a, Hershler 1994, 1998). Habitat loss, degradation, and/or modification has been identified as a primary factor causing declines, and remains a prominent threat to the species throughout their ranges (Hershler 1994, 1998, Frest and Johannes 1995a, Sada and Vinyard 2002). Domestic livestock grazing, water pollution, spring development, dams and diversions, groundwater withdrawal, stream and lake modification, and recreational developments and activities have all negatively impacted the habitat of one or more of the three species throughout all or a significant portion of their ranges and continue to pose threats to the species (Burch 1989, Fleischner 1994, Hershler 1994, 1998, 1999, Frest and Johannes 1993b, 1995, 1996, Winter et al. 1998, Belsky et al. 1999, Hovingh 1999, Berkamp 2000, Frest 2002a, 2002b, Sada and Vinyard 2002, Bartolino and Cunningham 2003, Hershler and Liu 2004). The species also remain threatened by a host of other factors, including, but not limited to, herbicide and pesticide application, competition with and/or predation by nonnative species (e.g., New Zealand mudsnail (*Potamopyrgus antipodarum*), nonnative crayfish), population isolation and fragmentation, and climate change (Brown 1978, Brooke 1991, 1993, Frest and Johannes 1995a, EPA 1997, 1998a, 1998b, 1998c, Hershler 1998, McCarty 2001, Richards et al. 2001, Hershler and Liu 2004).

If, as Hershler and Liu (2004) suggest, the three species are all the same, they would exist as four widely distributed, isolated populations—one in the Jackson Lake/Upper Snake River area of northwestern Wyoming, one in the Oregon Interior Basin region, and one in the Lower Columbia River of Oregon and Washington (Frest and Johannes 1995a, Hershler and Liu 2004). These populations were isolated from each other by natural and human-caused factors, a

situation that prevents any gene flow between populations and any possibility of natural recovery should one or more populations become extirpated (Wilcox and Murphy 1985, Lande 1993, Frest and Johannes 1995a, Hershler and Liu 2004). Although Hershler and Liu (2004) claim that intervening habitats are undersampled, this does not appear to be an accurate assessment. Extensive survey work has been completed in the Columbia River drainage (Neitzel and Frest 1989, 1990, 1992, 1993, Frest and Johannes 1993, 1996, 1995), in the Snake River drainage (Frest and Johannes 1995a, USFWS 2004), in the Jackson Lake area (Hershler 1994, Frest and Johannes 1995a), and in the Oregon Interior Basin region (Frest and Johannes 1995a, Hershler 1998, 1999). Thus, while the species would be relatively widespread and more abundant than historically reported if Hershler and Liu (2004) are correct in their taxonomic reappraisal, the species would remain as vulnerable to extinction as a result of population crashes and isolation and fragmentation of populations (Allee et al. 1949, Petersson 1985, Wilcox and Murphy 1985, Goodman 1987, Lacy 1987, Brussard and Gilpin 1989, Lande 1993, Hanski et al. 1996).

The Jackson Lake, Harney Lake and Columbia springsnails, which may all be the same species, have been identified as critically imperiled, in need of conservation attention, and have even been recommended for listing under the ESA by scientists (Frest and Johannes 1995a, Hershler 1998, NatureServe 2003). Recent reports have identified western springsnails as one of the most imperiled groups of organisms in the world (Lydeard et al. 2004). See, Table 2. The best available scientific information clearly demonstrates that the Jackson Lake, Harney Lake, and Columbia springsnails warrant listing as threatened or endangered, whether individually as separate species or together with the Idaho springsnail as one species.

Table 2. Status of Jackson Lake, Harney Lake, and Columbia springsnails (USFWS 1994d, Frest and Johannes 1995a, NatureServe 2003, Hershler and Liu 2004).

Species	Population Status	State of Occurrence	ESA Status	Global Heritage Ranking	Listing Recommendation (Frest and Johannes 1995a)
Harney Lake springsnail (<i>P. hendersoni</i>)	extant at four sites; once widespread in Harney Lake, parts of Malheur River basin; extirpated at type locality	OR	none present or historically	G1	Endangered
Jackson Lake springsnail (<i>Pyrgulopsis robusta</i>)	extant at one site; extirpated from Jackson Lake	WY	former category 2 Candidate	G1	Endangered
Columbia springsnail (<i>P. new species 6</i>)	extant at six sites; once widespread in undisturbed habitats of lower Columbia River	OR, WA	none present or historically	G2	Endangered

1. Jackson Lake springsnail

Although Hershler and Liu (2004) suggest the Jackson Lake springsnail includes three other springsnail species, as discussed above there appears to be strong evidence for continuing to recognize the Jackson Lake springsnail as a species distinct from the Idaho, Harney Lake, and Columbia springsnails (Crandall et al. 2000, Fraser and Bernatchez 2001, Moritz 2002, Bowler 2003, Frest 2004a, 2004b).

The Jackson Lake springsnail was historically reported from Teton County, Wyoming, from springs along the eastern edge of Jackson Lake, Wyoming, from springs around Elk Island within Jackson Lake, and from Polecat Creek, a tributary to the upper Snake River (Beetle 1989, Hershler 1994, Frest and Johannes 1995a). Beetle (1989) reports the species from Lincoln County, however this report appears inaccurate (Hershler 1994, Frest and Johannes 1995a, Hershler and Liu 2004). Recent surveys have been completed elsewhere along the Snake River in Wyoming, including areas in Lincoln County, and have failed to find the species (Frest and Johannes 1995a). Before 1994, the species had been reported extant at at least four sites (Hershler 1994).

Recent surveys have found the species to be extant only in Polecat Creek, where the snail has been adversely impacted by the nonnative, invasive New Zealand mudsnail and remains threatened by the nonnative snail (Frest and Johannes 1995a, Bureau of Reclamation 2001, Richards et al. 2001, Hershler and Liu 2004). In discussing the impacts of the New Zealand mudsnail to the Jackson Lake springsnail in Polecat Creek, the Bureau of Reclamation (2001) reports, “The decline of a native species of snail (*Pyrgulopsis* sp.) was documented during the rapid population growth of New Zealand mudsnail in Polecat Creek, a tributary of Jackson Lake” (p. 90). Hershler and Liu (2004) report the Jackson Lake springsnail is “currently threatened by introduced [New Zealand mudsnail] *Potamopyrgus antipodarum*” (p. 66).

Populations in and around Jackson Lake are now reported to be extirpated, most likely as a result of modification of Jackson Lake by the Bureau of Reclamation (Frest and Johannes 1995a). Although Jackson Lake is a natural lake, a dam and spillway have been constructed and the lake is managed for water storage and flood control (Bureau of Reclamation 2001). While historical sites have been inundated, in 1993 the lake was drawn down for dam repairs and the lake bottom was bulldozed and remolded, destroying the species’ habitat and likely contributing to the extirpation of the species from Jackson Lake (Frest and Johannes 1995a). Recent surveys have failed to relocate the species in and around Jackson Lake (Hershler 1994, Frest and Johannes 1995a). The Bureau of Reclamation does not give and has not given any attention, conservation or otherwise, to the species (Frest and Johannes 1995a, Bureau of Reclamation 2001, McClendan 2004).

The Jackson Lake springsnail was once a category 2 Candidate species, meaning the USFWS believed listing was likely warranted, but that sufficient information did not exist to fully support listing (USFWS 1994d). The species was dropped as a Candidate in 1996 due to the elimination of the category 2 Candidate designation, not because the species’ status had improved or for other biological justifications (USFWS 1996). The Jackson Lake springsnail has clearly declined as a result of habitat loss and degradation, and currently survives in less than 25% of its

former range and only at one location (Hershler 1994, Frest and Johannes 1995a). The remaining population continues to face threats, and has been recommended for listing under the ESA (Frest and Johannes 1995a, Richards et al. 2001, Hershler and Liu 2004).

2. Harney Lake springsnail

Although Hershler and Liu (2004) suggest the Harney Lake springsnail is the same species as the three other springsnail species, as discussed above there appears to be strong evidence for continuing to recognize the Harney Lake springsnail as a species distinct from the Jackson Lake, Columbia, and Idaho springsnails (Crandall et al. 2000, Fraser and Bernatchez 2001, Moritz 2002, Bowler 2003, Frest 2004a, 2004b).

The springsnail was historically widespread in the Harney Lake-Malheur Lake area in the Oregon Interior Basin (Frest and Johannes 1995a). Subfossil and fossil shells of the species have been found on the shores of Harney and Malheur Lakes, indicating a more abundant distribution in the recent past (*Id.*). The species is currently found at only four spring sites in the Harney Lake-Malheur Lake area of Harney County, Oregon and one spring site in the Lake Abert area of Lake County, Oregon (Frest and Johannes 1995a, Hershler 1998). All known sites are widely isolated from each other (Hershler and Liu 2004). Extensive surveys have been completed within the range of the species, strongly indicating that few additional sites remain to be discovered (Frest and Johannes 1995a, Hershler 1998, 1999). Frest and Johannes (1995a) state, “there is little chance of substantive range extension or large increase in the number of live sites” (p. 196). Many springs that once supported the species are now dry, primarily as result of groundwater withdrawal (Frest and Johannes 1995a). The species is reported to be extirpated from its type locality (Hershler 1994). Spring development and domestic livestock grazing have also negatively impacted the species and its habitat throughout its range and pose ongoing threats (Frest and Johannes 1995a, Hershler 1998, Sada and Vinyard 2002). The spread of the nonnative Asian snail (*Melanoides tuberculata*), which is spreading throughout the Great Basin, may also pose threats to the species (Sada and Vinyard 2002, Rader et al. 2003).

The Harney Lake springsnail is currently ranked G1, meaning it is critically imperiled throughout its range and at great risk of extinction (NatureServe 2003). The species has clearly declined because of habitat loss and degradation and currently survives in a fraction of its former range (Frest and Johannes 1995a, Hershler 1998). While once widespread, the species now is known only from four isolated locations, all of which are suffering from habitat loss and/or degradation (Frest and Johannes 1995a). Because of population declines, habitat loss and degradation, the species’ limited occurrence, and ongoing threats, the Harney Lake springsnail has been recommended for listing as endangered under the ESA (Frest and Johannes 1995a).

3. Columbia springsnail

Although Hershler and Liu (2004) suggest the Columbia springsnail is actually the Jackson Lake springsnail, as discussed above, there appears to be strong evidence for continuing to recognize the Columbia springsnail as a distinct species (Crandall et al. 2000, Fraser and Bernatchez 2001, Moritz 2002, Bowler 2003, Frest 2004a, 2004b). The Columbia springsnail is a recently discovered species and was named *Pyrgulopsis* new species 6 by Frest and Johannes (1995a). While the snail is similar to the Idaho springsnail and Jackson Lake springsnail, the

species is distinguished by unpigmented tentacles, common yellow and orange pigment granules on the body, and unique penile features (Frest and Johannes 1995a).

The historical population size and distribution of the snail are not known since the species was only recently discovered. However given the snail's habitat needs, it is believed the population was once "ubiquitous" in the lower Columbia River from the eastern Columbia Gorge to Wallula Gap (Frest and Johannes 1995a, p. 203). Frest and Johannes (1996) report, "Previous occurrence to the river mouth is quite likely" (p. 81). The species is currently known from only six sites "which retain substrate, flow, and faunal characteristics similar to those of the pre-impoundment Columbia River in the Dalles, John Day, and Umatilla pools, WA and OR" (*Id.*). The species is reported from Wasco, Sherman, and Umatilla Counties, Oregon and presumably from Cowlitz, Skamania, and Klickitat Counties, Washington (Frest and Johannes 1995a, Oregon Natural Heritage Program 2001). Extensive surveys at over 500 locations throughout the Columbia River strongly indicate that few, if any, extant populations remain to be discovered in much of the Columbia River system (Neitzel and Frest 1989, 1990, 1992, 1993, Frest and Johannes 1995a, 1996).

Population declines are attributable primarily to impoundments (*i.e.*, dams) on the Columbia River, which have destroyed and degraded much of the species' habitat throughout its range (Frest and Johannes 1995a, 1996, USFWS 1998). Extant populations remain threatened by siltation caused by existing impoundments, water pollution caused by agricultural runoff and impoundment, stream channel modifications undertaken to facilitate river navigation, and nonnative species such as the New Zealand mudsnail (Frest and Johannes 1995a, 1996, USFWS 1998, Richards et al. 2001). The New Zealand mudsnail has been reported from the lower Columbia River and could pose threats to the species (Chapman 2003). The best available scientific information also strongly indicates impoundments prevent or at least significantly hinder movement between populations of the species, heightening the risk of extinction (Frest and Johannes 1995a, 1996 Hershler and Liu 2004).

The Columbia springsnail is currently ranked G2, meaning it is critically imperiled throughout its range (NatureServe 2003). The species has clearly declined because of habitat loss and degradation and currently survives in a fraction of its former range (Frest and Johannes 1995a, 1996). While once thought to be widespread, the species now is known only from six isolated locations, all of which are suffering from habitat loss and/or degradation (Frest and Johannes 1995a). Because of population declines, habitat loss and degradation, the species' limited occurrence, and ongoing threats, the Columbia springsnail has been recommended for listing as endangered under the ESA (Frest and Johannes 1995a, 1996).

4. Status of springsnails in relation to other freshwater mollusks from the western U.S.

The decline and endangerment of the Jackson Lake, Harney Lake, and Columbia springsnails is not an anomaly, but rather mirrors that of dozens of other springsnail species from throughout the western United States (*e.g.*, USFWS 1992, 2002a, Frest and Johannes 1995a, 1997b, 1998, 2000, Hershler 1998, 1999, Oliver and Bosworth III 1999, Lydeard et al. 2004). Springsnails from the western United States have been identified as one of the most threatened groups of mollusks in the world (Lydeard et al. 2004). Worldwide, mollusks have the highest number of

documented extinctions of any major taxonomic group, of which 99% of all documented extinctions are of nonmarine mollusks (i.e., terrestrial or freshwater mollusks) (*Id.*). Extinction of springsnails in the western United States are, unfortunately, a regularly reported occurrence (*see e.g.*, Hershler 1998). The status of the Jackson Lake, Harney Lake, and Columbia springsnails therefore reflects a more disturbing and widespread trend and their status must be understood in the context of this biodiversity crisis.

F. The Petitioned Mollusk Species as Ecological Indicators

The Jackson Lake, Harney Lake, and Columbia springsnails are considered to be excellent indicators of aquatic ecosystem health (Frest and Johannes 1993, 1995a, 1995b, 1996, 1998, 2000a, Black et al. 2001, Niwa et al. 2001, Frest 2002a, 2002b, Hurt 2004), and are an “especially practical group for use in assessing the general health of the terrestrial and aquatic ecosystem” (Frest and Johannes 1995a, p. 35). The species are present in many aquatic environments, have specialized habitat needs, and are effectively sessile. The snails also typically respond quickly and are more vulnerable to disturbances and/or anthropogenic habitat change (Frest and Johannes 1995a, 1998, 2000a, Frest 2002a, Lydeard et al. 2004). The status of mollusk populations can therefore provide a window into the overall health of an aquatic ecosystem, an invaluable relationship that provides innumerable social and environmental benefits. For instance, an understanding of the health of mollusk populations can aid in understanding overall ecosystem health, in assessing ecosystem restoration projects, in assessing the status and health of other species, and in measuring the effects of land management activities (Frest 2002a, 2002b, Hurt 2004). Furthermore, because there is a direct link between healthy mollusk populations and a healthy ecosystem, protection of the Jackson Lake, Harney Lake, and Columbia springsnails together ultimately protects the ecosystems upon which they depend in accordance with USFWS policies (USFWS 1994a, 1994b).

IV. CRITERIA FOR LISTING UNDER THE ESA

Several sections of the regulations implementing the ESA (50 CFR *et seq.*) are applicable to the status of the Jackson Lake, Harney Lake, and Columbia springsnails. Those concerning the listing of the species as threatened or endangered are as follows:

424.02(e) “Endangered species” means a species that is in danger of extinction throughout all or a significant portion of its range.”... (k) “species” includes any species or subspecies that interbreeds when mature.

“Threatened species” means a species that “is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range” (16 USC § 1532(20))

424.11(c) “A species shall be listed...because of any one or a combination of the following factors:

1. The present or threatened destruction, modification, or curtailment of habitat or range;
2. Overutilization for commercial, recreational, scientific, or educational purposes;
3. Disease or predation;
4. The inadequacy of existing regulatory mechanisms; and

5. Other natural or manmade factors affecting its continued existence.

Scientists have already recommended that the Jackson Lake, Harney Lake, and Columbia springsnails be listed as endangered under the ESA (Frest and Johannes 1995a, 1996). The Jackson Lake springsnail was also a candidate species under the ESA (USFWS 1994d). Currently, the Jackson Lake and Harney Lake springsnails are ranked G1, meaning the species are critically imperiled and at great risk of extinction (NatureServe 2003). The Columbia springsnails is ranked G2, meaning the population is critically imperiled (*Id.*). And, as will be discussed in more detail below, at least one, and in many cases three or more, of the factors set forth in § 424.11(c) are applicable to the present status of all populations of the Jackson Lake, Harney Lake, and Columbia springsnails.

A. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Species of the genus *Pyrgulopsis* are generally reported to be sensitive to habitat loss and/or degradation (Hershler 1994, 1998, Frest and Johannes 1995a). Throughout the western United States, habitat loss and/or degradation is reported to be one of the primary threats to the continued existence of dozens of springsnail species (*see e.g.*, USFWS 1976, 2002a, Frest and Johannes 1993, 1995a, 1995b, 1995c, 1996, 1997a, 1997b, 1998, 2000, Hershler 1995a, 1995b, 1998, 1999, Hershler and Frest 1996, Oliver and Bosworth III 1999, Frest 2002a, 2002b, New Mexico Game and Fish 2002, Arizona Game and Fish 2003, 2004) The Jackson Lake, Harney Lake, and Columbia springsnails are reported to be extremely sensitive to habitat destruction and degradation (Frest and Johannes 1995a, Hershler 1998). Present and threatened habitat loss and degradation are reported threaten the continued existence of the Jackson Lake, Harney Lake, and Columbia springsnails throughout their ranges (Frest and Johannes 1995a, 1996, Hershler 1998, Frest 2004a, 2004b). All populations of the species are reported to have suffered significant range reductions (Hershler 1994, 1998, Frest and Johannes 1995a, 1996).

In particular, the Jackson Lake, Harney Lake, and Columbia springsnails have experienced habitat and range reduction and/or modification and/or are threatened by habitat and range reduction and/or modification as a result of the following activities:

1. Modification of Jackson Lake, Wyoming

Modification of Jackson Lake in northwestern Wyoming has destroyed the habitat of the Jackson Lake springsnail and contributed to the extirpation of the species from the Lake (Frest and Johannes 1995a). Frest and Johannes (1995a) report:

Jackson Lake is a regulated water body; the dam at its original outflow has been modified several times (most recently in 1993), generally to increase the impoundment area. Bulldozing and “smoothing” of the exposed lake floor during the 1993 drawdown and dam repairs may have destroyed the springs in the lake bottom formerly reported in the vicinity of the dam by Henderson (1932). Revisits to other springs on the E. side of the lake in 1993 were also largely unsuccessful. (p. 213)

Frest and Johannes (1995a) also report, “draining and modifications to Jackson Lake bed in 1993 may have extirpated (and certainly drastically reduced) sites for this taxon” (p. 213). This

scientific information strongly indicates that modification of Jackson Lake, Wyoming has destroyed and/or degraded habitat for the Jackson Lake springsnail and contributed to rangewide population declines.

2. Water Pollution

Water pollution is reported to have degraded habitat for the Columbia springsnail and is reported to continue to threaten the species (Frest and Johannes 1995a, 1996). Sediment pollution and nutrient enrichment from agricultural runoff have been identified as key threats to the species (Frest and Johannes 1995a). Sediment pollution can destroy habitat for the species, which is considered to be a lithophile and is unable to persist in fine substrates (Frest and Johannes 1995a, 1996). Nutrient enrichment can lead to increases in algae and aquatic vegetation and decrease dissolved oxygen concentrations, both of which are detrimental to the Columbia springsnail and its habitat (*Id.*). Both the States of Oregon and Washington have identified several portions of the Columbia River as suffering from excessive pollution (Oregon Department of Environmental Quality 2002, Washington Department of Ecology 2004), strongly indicating that water pollution threatens the Columbia springsnail.

3. Dam construction and maintenance

Inundation of spring habitats and other habitats associated with free-flowing streams, erratic flows from dams, altered flow regimes, fragmentation of habitat, and degradation of water quality are all adverse impacts related to the construction and maintenance of dams and diversions on streams (Frest and Johannes 1995a, 1998, 2000a, Hovingh 1999, Hershler et al. 2003). Worldwide, dams are reported to negatively impact freshwater mollusk species (Berkamp et al. 2000). Dams and diversions throughout the western United States are reported to have destroyed and/or degraded habitat for freshwater mollusks, leading to population declines and potentially extinctions (Frest and Johannes 1995a, 1995c).

Dams and diversions are reported to have negatively impacted the Jackson Lake and Columbia springsnails and continue to pose threats to the species (Frest and Johannes 1995a, 1996). Frest and Johannes (1996) identify “impoundments” on the Columbia River as the primary threat to the Columbia springsnail (p. 82). The species is reported to be absent from “typical impoundment conditions” (*Id.*, p. 81). Continued operation of impoundments on the Columbia River is reported to threaten the springsnail (Frest and Johannes 1995a, 1996). Construction and maintenance of Jackson Lake dam is reported to have destroyed habitat for the Jackson Lake springsnail, leading to population losses (Frest and Johannes 1995a). Frest and Johannes (1995a) report, “Most old sites have been inundated by the rise in Jackson Lake” (p. 213). The snail remains threatened by the maintenance of Jackson Lake dam (*Id.*).

4. Domestic livestock grazing

Domestic livestock grazing is generally destructive to aquatic mollusks and their habitats and is reported to be a major threat to the survival of the Harney Lake springsnail (Armour 1991, Fleischner 1994, Belsky et al. 1999, Frest 2002a, 2002b, Frest and Johannes 1995a, 1995b, Hershler 1995a, 1998). Frest (2002a) states, “Livestock grazing is a major factor causing regional extinction or reduction of both land and freshwater mollusks” (p. 48). Frest and Johannes (1995a) also report, “Grazing is a major factor causing [mollusk] extirpation” (p. 54). Frest and Johannes (1995a) elaborate:

We know of no instances in which moderate to heavy grazing can be said to have improved or allowed to remain stable either diversity or abundance of either terrestrial or aquatic mollusks, and literally thousands of sites at which reduction or extirpation has taken place. Damage results from many factors. Physical compaction and trampling of soil extirpates snail colonies; it also tends to dry up springs and seeps and is a major factor inducing change in plant communities. Grazing itself (that is, physical consumption of plants) is likely to result in elimination of species and encouragement of others, particularly waste species and heavily protected, tough, or toxic taxa. Grazing also tends to increase insolation. Locally, deposits of large quantities of manure and urine can change edaphic conditions and degrade water quality. Soil erosion is generally enhanced in grazed areas, and litter is often largely or totally absent in heavily used sites. Moreover, associated activities such as “improvements” to springs, seeps, bogs, riparian areas, or other unique and uncommon microhabitats to accommodate stock, also have major deleterious effects. Even light grazing has substantial negative effects on land snail diversity and abundance: to ensure survival of sensitive species, grazing should not be allowed at all at significant colony sites. (pp. 63-64)

Grazing has adversely impacted and threatens to cause the extinction of mollusks throughout the Great Basin, where the Harney Lake springsnail is primarily found (USFWS 1976, Frest and Johannes 1995a, Oliver and Bosworth III 1999, Hershler 1995a, 1998, 1999, Sada and Vinyard 2002). Hershler (1998) describes domestic livestock grazing as “the predominant source of disturbance” to aquatic habitats in the Great Basin (p. 14). Hershler (1998) further reports:

Smaller, basin floor springs in particular were often profoundly disturbed by cattle, which modify the habitat both physically and chemically by trampling, removing aquatic and riparian vegetation, and depositing urine and feces. The resulting habitat often is largely unsuitable for *Pyrgulopsis*, although snails may persist in a small, upflow “refuge” of clean, flowing water which cows cannot reach. (p. 14)

Reports also strongly indicate domestic livestock grazing may have caused the extinction of at least two freshwater snails—the carinate Duckwater pyrg (*Pyrgulopsis carinata*) and Fish Lake Valley pyrg (*Pyrgulopsis ruinosa*)—from the Great Basin (Hershler 1998).

Domestic livestock grazing has destroyed and/or degraded the habitat of the Harney Lake springsnail throughout its range (Frest and Johannes 1995a). Frest and Johannes (1995a) report all sites where the Harney Lake springsnail has been found have been “heavily impacted by cattle and horse grazing” (p. 196). The BLM, which is charged with managing much of the habitat of the Harney Lake springsnail, has even disclosed that domestic livestock grazing has destroyed aquatic habitats within the species’ range (BLM Oregon 2003f). Domestic livestock grazing is reported to continue to threaten the Harney Lake springsnail and its habitat throughout its entire range (Frest and Johannes 1995a, Hershler 1998, Sada and Vinyard 2002). Indeed, the BLM continues to allow domestic livestock grazing throughout the species’ range (e.g., BLM Oregon 2002b, 2003b, 2003c, 2003e), strongly indicating the species and its habitat remains threatened by the negative effects of domestic livestock grazing.

5. Spring development

Spring development refers to activities that modify springs. Such developments include, but are not limited to, troughing, capping, diverting (through pipes or ditches), and spring box construction. According to Frest and Johannes (1995a), “Spring development generally results in loss of all or many species” (p. 61). Frest (2002b) reports:

Destruction of springs by livestock grazing, logging, and human exploitation (such as troughing, capping, or diverting for stock use, or appropriating for human water supplies) has already caused extinction of species throughout western North America. The Great Basin has many such examples. In some Bureau of Land Management (BLM) districts, 90 percent of all named springs have had their native mollusks completely extirpated owing to these causes. (p. 214)

Spring developments cause sites to dry out, disrupt soil and rock, disturb vegetative cover, and encourage domestic livestock impacts. Aquatic mollusks suffer tremendously as a result of spring development, usually disappearing altogether (Frest and Johannes 1995a, Hershler 1995a, 1998). The issue of spring development is critical in many areas of the western United States, where the climate is more arid and water resources more scarce (Frest and Johannes 1995a, Hershler 1998). Frest and Johannes (1995a) explain, “Perhaps the single most deleterious activity in the arid and semi-arid ecosystems to both terrestrial and freshwater forms is development of springs” (p. 61).

Spring developments have destroyed and/or degraded habitat for the Harney Lake springsnail throughout its range (Frest and Johannes 1995a, Hershler 1998). Spring development is reported to be a nearly ubiquitous threat to freshwater mollusks throughout the Great Basin and eastern Oregon (Frest 2002a, Frest and Johannes 1995a, Hershler 1995a, 1998, Sada and Vinyard 2002, Lydeard et al. 2004). Frest and Johannes (1995a) identify “diversion and capping of springs for stock, industrial, and domestic water supply” as a major ongoing threat to the springsnail and its habitat (p. 196). Indeed, the BLM, which is charged with managing much of the habitat for the Harney Lake springsnail, continues to authorize spring developments throughout the range of the species (e.g., BLM Oregon 2003a), strongly indicating the species and its habitat remains threatened by spring developments.

6. Groundwater withdrawal

Groundwater withdrawal or extraction generally leads to depletions of aquifers that are often the primary source of water for springs, streams, and other aquatic habitats (e.g., wetlands, seeps) in the Great Basin (Winter et al. 1998, Leake et al. 2000, Bartolino and Cunningham 2003). This depletion can lead to decreases in spring flows and decreases in riparian vegetation, in turn degrading habitat for freshwater snails (Frest and Johannes 1995a, Hershler 1998, Leake et al. 2000, USFWS 2002d, Bartolino and Cunningham 2003). In some cases, depletions can be so severe as to cause springs to stop flowing altogether, destroying habitat and aquatic mollusk populations (e.g., USFWS 2002d).

Groundwater withdrawal is a nearly ubiquitous threat to the Harney Lake springsnail and its habitat throughout its range (Frest and Johannes 1995a, Hershler 1998, Sada and Vinyard 2002), and is reported to threaten aquatic mollusks elsewhere in the western United States (Frest and

Johannes 1998, Lang 2002, Sada and Vinyard 2002, USFWS 2002a, 2002b). Reports have demonstrated substantial groundwater declines throughout the range of the Harney Lake springsnail and have reported declines in surface water flow and riparian habitat as a result (Leake et al. 2000, Bartolino and Cunningham 2003). Frest and Johannes (1995a) report, “The presumed type locality [for the Harney Lake springsnail], as well as other springs in the Burns area, are now dry, evidently from groundwater mining in the Burns area” (p. 196). Groundwater withdrawal is reported to be an ongoing threat throughout the range of the Harney Lake springsnail. The BLM has authorized the development of several water wells throughout the range of the species, strongly indicting that the snail remains threatened by groundwater withdrawal (e.g., BLM Oregon 2001, 2002a, 2003d, 2003g). The best available scientific information strongly indicates groundwater withdrawal has destroyed and/or degrade habitat for the Harney Lake springsnail, caused population declines, and continues to threaten the species.

Groundwater withdrawal may also threaten the Columbia springsnail (Frest and Johannes 1995a, Bartolino and Cunningham 2003). Indeed, Bartolino and Cunningham (2003) report, “Ground-water development of the Columbia River Basalt aquifer of Washington and Oregon for irrigation, public-supply, and industrial uses has caused water-level declines of more than 100 feet in several areas” (p. 3). This report strongly indicates that groundwater withdrawals are contributing to the loss and degradation of the habitat for the Columbia springsnail throughout its range.

7. Other threats

Modification of stream banks (e.g., placement of rip rap) threatens the Columbia springsnail and its habitat (Frest and Johannes 1995a, 1996, USFWS 1998). Reports also strongly indicate the Columbia springsnail and its habitat have been negatively impacted by road construction and maintenance, logging, and mining activities, and remain threatened by these activities (Frest and Johannes 1993, 1995a, 1996, USFWS 1998). Road construction may have directly destroyed habitat for the springsnail and continued use and maintenance of roads near populations of the Columbia springsnail may lead to increased erosion, water pollution, and increased access, potentially leading to the introduction of nonnative species (Frest and Johannes 2000a). Logging has been cited as a threat to freshwater mollusks in the northwestern United States, primarily because it has led to increased soil erosion and to the drying out of spring and wetland habitats (Frest and Johannes 1995a, 1996, 2000a). Logging has been extensive in the northwest (Branson and Branson 1981, Frest and Johannes 1993b, 1996, 1998, 2000a), posing concomitant threats to the Columbia springsnail and its habitat (Frest and Johannes 1995a, 1996). Modification of stream banks to facilitate navigation, road construction, and other developments also threatens the Columbia springsnail and its habitat (Frest and Johannes 1995a, Hershler and Frest 1996). Frest and Johannes (1995a) identify “Harbor and channel ‘improvements’ in the vicinity of The Dalles and John Day Dam” as major threats to the springsnail (p. 203).

B. Overutilization For Commercial, Recreational, Scientific, or Educational Purposes

The Jackson Lake, Harney Lake, and Columbia springsnails have been collected for scientific and educational purposes (Frest and Johannes 1995a, Hershler 1998, Hershler and Liu 2004) and in conjunction with other threats, such as habitat loss and degradation, may make the species more vulnerable to population declines and losses.

C. Disease or Predation

The Jackson Lake, Harney Lake, and Columbia springsnails are preyed upon by amphibians, reptiles, fish, birds, insects, and insect larvae (Frest and Johannes 1995a). In conjunction with other threats, such as habitat loss and degradation, predation may increasingly threaten the petitioned mollusk species.

D. The Inadequacy of Existing Regulatory Mechanisms

Existing regulatory mechanisms provide entirely inadequate protection to the Harney Lake, Jackson Lake, and Columbia springsnails. On private lands, these species and their habitats have no protection whatsoever. In addition, federal and state regulatory mechanisms are failing to stem the decline of these species and their habitats and failing to recover these irreplaceable species (Frest and Johannes 1995a, Hershler and Liu 2004). Furthermore, scientific studies have roundly criticized the lack of adequate mechanisms in place to protect and recover imperiled invertebrates, such as the Harney Lake, Jackson Lake, and Columbia springsnails (Frest and Johannes 1995a, 1996, Black et al. 2001, Lydeard et al. 2004).

The Harney Lake springsnail exists to a large extent on lands managed by the Bureau of Land Management (“BLM”) (Frest and Johannes 1995a). While the Oregon BLM has designated the species as “sensitive,” this designation confers no adequate protection to the species or its habitat (Oregon Natural Heritage Program 2001, BLM Oregon-Washington 2003). The BLM is not prohibited from adversely impacting sensitive species or their habitats and are not required to provide for their recovery (BLM Oregon-Washington 2003). The species may exist on the Malheur National Wildlife Refuge, which is managed by the USFWS, although surveys have failed to discover the species (Frest and Johannes 1995a). Although the USFWS may be utilizing its authority to protect the species on the Refuge, this authority is not adequate to ensure protection and recovery of the species. In total, the Harney Lake springsnail is known only from four sites, most of which are on lands managed by the BLM and the rest of which are on privately owned lands (Frest and Johannes 1995a, Hershler and Liu 2004). If the USFWS could utilize its authority to protect the Harney Lake springsnail on the Malheur National Wildlife Refuge, if it even exists there, it would protect only a very small portion of species’ overall range and habitat. State laws also provide inadequate protection to the springsnail (Oregon Natural Heritage Program 2001).

The Jackson Lake springsnail exists within Grand Teton National Park, which is managed by the National Park Service (Frest and Johannes 1995a). Unfortunately, while the National Park Service may have some authority to protect the Jackson Lake springsnail and its habitat, it appears this authority fails to ensure adequate protection of the species. Of greatest concern is that National Park Service has been unable to stem the spread and proliferation of the New Zealand mudsnail in Polecat Creek (Richards 2001, Bureau of Reclamation 2001, Hershler and Liu 2004). The National Park Service also lacks authority to regulate Bureau of Reclamation management of Jackson Lake, which has been cited as a major threat to the snail (Frest and Johannes 1995a). There are also no mechanisms in place to ensure the Bureau of Reclamation manages Jackson Lake in such a way that adequately protects and/or restores the Jackson Lake springsnail and its habitat (McClendan 2004). The Jackson Lake springsnail therefore remains vulnerable from Bureau of Reclamation management activities that may further destroy and/or degrade the species’ habitat.

State regulatory mechanisms are also inadequate to protect the Jackson Lake springsnail. Currently, the State of Wyoming does not even have a mechanism for protecting and recovering threatened, endangered, or other rare and imperiled species, let alone the Jackson Lake springsnail. The Wyoming Natural Diversity Database, which tracks and records the status of rare and imperiled species in the State of Wyoming, does not even track invertebrates (Wyoming Natural Diversity Database 2003).

The Columbia springsnail is found in the lower Columbia River, which is influenced and/or managed by the Bureau of Reclamation, the Bonneville Power Authority, and the Army Corps of Engineers (Frest and Johannes 1995a). Population declines, habitat loss and degradation, and ongoing threats strongly indicate federal regulatory mechanisms are entirely inadequate to protect the springsnail and its habitat. Because the springsnail is not listed under the ESA (Frest and Johannes 1995a), none of these agencies have any obligation to protect the species and its habitat. State laws also provide wholly inadequate protection to the springsnail in that they fail to protect and recover the habitat of the species (e.g., Oregon Natural Heritage Program 2001). Although Washington laws may limit collecting of the species, because overcollecting has not been identified as a threat or otherwise a problem (Frest and Johannes 1995a), these laws fail to provide any meaningful protection (Washington Department of Fish and Wildlife Species of Concern List 2004).

The Jackson Lake springsnail, Idaho springsnail, Harney Lake springsnail, and Columbia springsnail exist in the Interior Columbia River Basin, or at least have been the subject of attention through the recently developed Interior Columbia Basin Ecosystem Management Project (Quigley et al. 1996). Recently, several federal agencies entered into a Memorandum of Understanding (“MOU”) to implement the Interior Columbia Basin Strategy (“Strategy”) in an effort to implement a “scientifically sound, ecosystem-based strategy” for managing federal lands in the Interior Columbia Basin (Interagency MOU 2002). According to the MOU, the Strategy is supposed to “guide” the development and implementation of programmatic land management plans and individual project implementation. Notwithstanding the fact that the MOU provides no legally binding or enforceable direction to federal agencies to protect the springsnails or their habitats in the Interior Columbia Basin, the MOU and the Strategy provide entirely inadequate protection in a number of ways. For instance, the Strategy does not actually require federal agencies to adopt the principles of the Interior Columbia Basin Strategy through programmatic land management plans or individual projects (Interagency MOU 2002). Instead, the Strategy states federal agencies should adopt the principles “as appropriate.” Unfortunately, the Strategy does not explain when and where adoption of the principles of the Interior Columbia Basin Strategy may be appropriate and provides no guarantee that the principles will be adopted even where “appropriate.” Moreover, the Interior Columbia Basin Strategy seems nothing more than a statement of general principles, failing to provide any actual and substantive direction to federal agencies. Overall, the Strategy is replete with vague guidance that entirely fails to provide hard, substantive, and enforceable direction that would remotely ensure even meager protection of the Jackson Lake, Idaho, Harney Lake, and Columbia springsnails and their habitats.

The Jackson Lake springsnail was at one time designated a category 2 Candidate species by the USFWS (USFWS 1994d). A category 2 Candidate species was defined as a species:

[F]or which information now in possession of the [U.S. Fish and Wildlife] Service indicates that proposing to list the species as endangered or threatened is possibly appropriate, but for which conclusive data on biological vulnerability and threats are not currently available to support proposed rules at this time (56 Fed. Reg. 58804).

However, in 1996 the category 2 Candidate designation was eliminated and the species lost its Candidate status (USFWS 1996). Although the Jackson Lake springsnail has been declining and continues to face numerous threats, the species has not regained its Candidate status. Similarly, although the Jackson Lake, Harney Lake, and Columbia springsnails have been recommended by scientists for listing under the ESA, the USFWS has taken no action on these scientific recommendations.

E. Other Natural or Manmade Factors Affecting the Continued Existence of the Springsnails

1. Herbicide and pesticide application

Herbicides and pesticides are generally detrimental to aquatic mollusks (Brown 1978, Brooke 1991, 1993, Frest and Johannes 1995a, 1995b, 1997b, South 1990, Schuytema et al. 1994). Pesticides and herbicides may cause mortality of mollusk species as a result of direct contact or as a result of ingestion (Brooke 1991, 1993, Schuytema et al. 1994). Throughout the ranges of the Harney Lake, Jackson Lake, and Columbia springsnail, weed control through the application of herbicides, especially along roadsides, and pesticide application pose threats to the species and their habitats (Frest and Johannes 1995a). Recently, the Animal and Plant Health Inspection Service authorized widespread pesticide application throughout the western United States to control grasshoppers and mormon crickets (Animal and Plant Health Inspection Service 2002). The Environmental Impact Statement prepared for this pesticide application program strongly indicates freshwater mollusks and their habitats throughout the western United States, including the Jackson Lake, Harney Lake, and Columbia springsnails, will be detrimentally impacted.

2. The invasion of nonnative species

The best available scientific information strongly indicates the introduction and proliferation of nonnative species threatens the Jackson Lake, Harney Lake, and Columbia springsnails.

Many freshwater snails in the Great Basin, including the Harney Lake springsnail, may be threatened by competition with the introduced Asian snail (*Melanoides tuberculata*) (USFWS 1976, Sada and Vinyard 2002, Rader et al. 2003). Springsnails throughout the Bonneville Basin of Utah and Nevada are reported to be threatened by competition with the Asian snail (Sada and Vinyard 2002, Rader et al. 2003). The likelihood of the Asian snail invading the habitats of the Harney Lake springsnail appears high. The Asian snail prefers warmer habitats (Rader et al. 2003), indicating the mildly thermal waters currently inhabited by the Harney Lake springsnail may be more susceptible to invasion by the Asian snail (Frest 2004b).

Competition with the introduced New Zealand mudsnail (*Potamopyrgus antipodarum*) threatens the Jackson Lake, Harney Lake, and Columbia springsnails (Frest and Johannes 1995a,

Hershler 1998, Richards 2001, Richards et al. 2001). According to recent reports, the New Zealand mudsnail has been found at locations in the Great Basin and is continuing to spread (Vinson 2002, Noda 2003). See, Figure 2. Continued proliferation and spread of the mudsnail in the Great Basin could threaten the Harney Lake springsnail (Frest and Johannes 1995a, Richards et al. 2001). The best available scientific information also indicates the Columbia springsnail may be threatened by the New Zealand mudsnail. The nonnative snail has been reported from the Columbia River, potentially within the range of the Columbia springsnail (Chapman 2003). The best available scientific information clearly demonstrates the Jackson Lake springsnail is at great risk of extinction because of the spread and proliferation of the New Zealand mudsnail in Polecat Creek, the only location where the species is known to be extant. According to Richards (2001):

Dr. Dan Gustafson has been studying the New Zealand mudsnail in Polecat Creek. In 2000, he found 2,000 New Zealand mudsnails for every *Pyrgulopsis robusta*. In 2001, the ratio was 20,000:1. Densities of other snails were also “nose diving”: the common *Valvata humeralis* was barely detectable. Gustafson is attributing these decreases to the New Zealand mudsnail. *P. robusta* used to occur throughout the drainage, but is now found only in Polecat Creek.

Declining populations of the Jackson Lake springsnail in Polecat Creek are attributed to the New Zealand mudsnail (Bureau of Reclamation 2001, Richards 2001).

Introduced crayfish and nonnative fish species may also threaten the Jackson Lake, Harney Lake, and Columbia springsnails (Hershler 1998, Hovingh 1999, Sada and Vinyard 2002). Hershler (1998) reports nonnative crayfish have been “widely introduced into the [Great Basin] region’s waters and, although omnivorous, often feed on small gastropods.” (p. 14). Nonnative crayfish have been reported from throughout Wyoming, although not specifically within the range of the Jackson Lake springsnail (Hubert 1990).

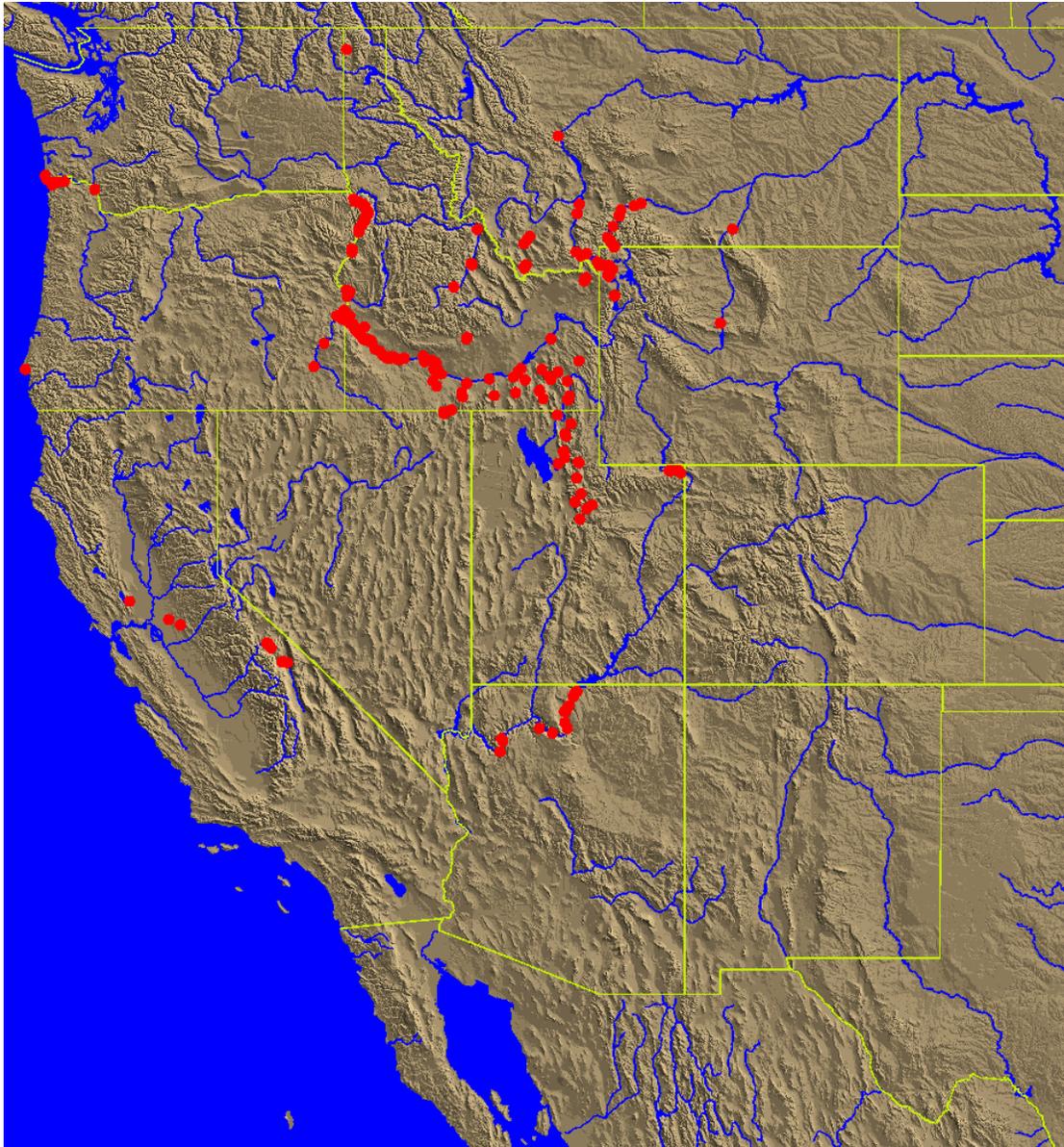


Figure 2. Occurrence of New Zealand mudsnail (*Potamopyrgus antipodarum*) in the western United States (New Zealand Mudsnail in the Western USA 2004)

3. Climate change

Climate change is reported to be a significant threat to the well-being of Jackson Lake, Harney Lake, and Columbia springsnails (Frest and Johannes 1995a). According to the Environmental Protection Agency (“EPA”) (1998b), “The earth’s climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases – primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons” (p. 1). The agency reports temperature increases, changes in precipitation, soil moisture, and sea level as effects of climate change (EPA 1997, 1998a, 1998b, 1998c). Average temperatures in Oregon, Idaho, Washington, and Wyoming have already been increasing from anthropogenic climate change (*Id.*). The agency predicts that over the next

century, the climate may change even more. Climate change within the range of the Jackson Lake, Harney Lake, and Columbia springsnails could lead to hotter, drier weather that could increase the frequency and intensity of wildfires, lead to droughts and increase drought severity, and lead to reductions in forests, thus increasing threats to the species and their habitats (Solem 1974, Frest and Johannes 1995a, 1996, Hershler 1998). Climate change also has the potential to push ecological zones upward, thus reducing the availability of suitable habitat for terrestrial and freshwater mollusk species (EPA 1997, 1998a, 1998b, 1998c, McCarty 2001). McCarty (2001) reports, “Ongoing climate change is an additional source of stress for species already threatened by local and global environmental changes, increasing the risk of extinction” (p. 325).

4. Environmental stochasticity

Because the Jackson Lake, Harney Lake, and Columbia springsnails exist as small, isolated, and/or fragmented populations, they are at risk of extinction because of environmental stochasticity, which may exacerbate the effects of anthropogenic environmental change and lead to irreversible population crashes (Lande 1993, Hanski et al. 1996, Hershler 1998, Frest and Johannes 1995a). Physical limitations, such as lack of mobility, naturally low population growth, high rates of mortality, and other factors also heighten the risk of environmental stochasticity (Frest and Johannes 1995a). The ability of the Jackson Lake, Harney Lake, and Columbia springsnails to recover from an environmental catastrophe may be impossible given the species’ limited distributions, isolated populations, habitat needs, and physical limitations (Frest and Johannes 1995a, 1996, Hershler 1998, Hershler and Liu 2004). In conjunction with other threats to the species and their habitats, environmental stochasticity poses significant risks to the well-being of the petitioned mollusk species.

5. Demographic and genetic stochasticity

Demographic stochasticity encompasses random events influencing individual birth and death rates (Brussard and Gilpin 1989, Lande 1995). Such factors that can vary randomly include “sex ratio, age of first reproduction, number of offspring, distribution of offspring over the lifetime of an individual, and age at death” (Brussard and Gilpin 1989). Larger populations are less influenced by demographic stochasticity because the greater number of individuals decreases the relative importance of the contribution of any one individual to the structure of the population as a whole.

The short lifespan of the petitioned springsnails, their limited dispersal abilities, specialized habitat needs, and documented population declines all exacerbate the susceptibility of the Jackson Lake, Harney Lake, and Columbia springsnails to extinction. This is especially the case with the Jackson Lake springsnail, whose population densities have declined in Polecat Creek as a result of competition with the nonnative, invasive New Zealand mudsnail. As populations of the Jackson Lake, Harney Lake, and Columbia springsnails continue to decline, the species could become more vulnerable to the Allee effect or similar dynamics, where decreasing population density results in a decrease rate of reproduction (Allee et al. 1949, Petersson 1985).

Small, fragmented, and isolated populations also have fewer opportunities for genetic flow. Breeding partners are often limited to those found in the immediate area, and loss of fitness due to inbreeding depression could potentially result. Lacy (1997) states:

Inbreeding has been observed to cause higher mortality, lower fecundity, reduced mating ability, slower growth, developmental instability, more frequent developmental defects, greater susceptibility to disease, lowered ability to withstand stress, and reduced intra- and inter-specific competitive ability (Allendorf and Leary, 1986; Darwin, 1868, 1876; Falconer 1989; Ledig, 1986; Lerner, 1954, Ralls et al., 1988; Wright, 1977). (p. 321)

Inbreeding depression is often more severe when coupled with harsh or variable environmental conditions (Lerner 1954, Schmitt and Ehrhardt 1990, Keller et al. 1994, Miller 1994, Lacy 1997, Frankham 1998). As fitness is lost from inbreeding, population size continues to diminish, and further inbreeding becomes even more likely (Brussard and Gilpin 1989) while at the same time survivors become more vulnerable to extinction from demographic or environmental stochasticity (Goodman 1987, Lacy 1997).

There are several mechanisms that cause inbreeding depression. Without reliable sources of immigration, genetic diversity may quickly be lost through the random process of genetic drift, and deleterious mutations and alleles may spread throughout a population. These deleterious alleles can become fixed in small populations because allele frequencies in populations with fewer than a thousand breeding individuals are usually influenced more by random genetic drift than natural selection (Kimura 1983, Lacy 1987, Lacy 1997). As these maladaptive genes accumulate, populations decline and genetic drift may occur even more rapidly, creating the positive feedback termed “mutational meltdown” (Lacy 1997, Frankham 1998, Vucetich and Waite 1999). When only a few individuals establish a new population or survive a population bottleneck, their progeny are highly vulnerable to the effects of genetic drift and loss of genetic variability (Lande 1995, Lacy 1997).

Inbreeding depression may also result from the loss of the competitive advantage conveyed by heterozygosity, or heterosis. Reed and Frankham (2003) found that measures of population size, heterozygosity, and genetic variation were all “positively and significantly correlated with population fitness” (p. 233). As heterozygosity is lost, populations are less able to adapt to change because there are simply fewer combinations of alleles available (Lande and Shannon 1996, Myers 1996). As Lacy (1997) summarizes:

Burger and Lynch (1995) found that fluctuations in genetic variance in small populations can reduce the rate of adaptation sufficiently to cause small populations to go extinct in the face of environmental change to which large populations would be able to adapt. We cannot know what adaptations will be required for persistence in future environments, but we do know that the rate of environmental change is much more rapid presently than perhaps at any time in past evolutionary history. (p. 321)

Although it is unknown how large springsnail populations must be to maintain adaptive genetic variation, the best available scientific information strongly indicates that as populations continue to decline, the Jackson Lake, Harney Lake, and Columbia springsnails will become more susceptible to the loss of heterozygosity.

Since populations of the Jackson Lake, Harney Lake, and Columbia springsnails exist in isolation, dispersal between them is virtually impossible (Frest and Johannes 1995a, Hershler and Liu 2004). Thus, the impacts of inbreeding depression may be irreversible. Lacy (1997) writes:

When a population is the only representative of its taxon, or exchange with other populations is not possible, then reversal of genetic depletion would come about only if the population can recover to large numbers and survive the 100s-1000s of generations needed for new mutations to restore variation. (p. 331)

Clearly, this will not be possible if populations and habitat of the Jackson Lake, Harney Lake, and Columbia springsnails continue to decline.

6. Vulnerability of small, isolated populations

Due in part to past and present habitat destruction and degradation, the size and extent of populations of the Jackson Lake, Harney Lake, and Columbia springsnails has been reduced and fragmented (Frest and Johannes 1995a, 1996, Hershler 1994, Hershler 1998, Hershler and Liu 2004). The small size and isolation of extant populations now makes the snails more susceptible to declines and extinction as a result of environmental stochasticity and potentially demographic and genetic stochasticity (Allee et al. 1949, Petersson 1985, Goodman 1987, Lacy 1987, Brussard and Gilpin 1989, Hanski et al. 1996).

Indeed, the Jackson Lake springsnail now exists as only one population within its former range (Frest and Johannes 1995a). While once more widespread, the Harney Lake springsnails now exists as four populations, all of which are isolated from each other by unsuitable habitat and between which genetic flow is nonexistent (Frest and Johannes 1995a, Hershler 1998). Similarly, the Columbia springsnail has been reduced to only four populations, all of which are isolated from each other by unsuitable habitat and barriers to dispersal (e.g., impoundments) (Frest and Johannes 1995a). Because of the extremely small size and isolation of populations of the Jackson Lake, Harney Lake, and Columbia springsnail, the species are more vulnerable to irreversible population losses as a result of stochasticity, and extinction.

7. Habitat fragmentation

Fragmentation of aquatic habitat is a serious threat to the continued survival of the Jackson Lake, Harney Lake, and Columbia springsnails (Wilcox and Murphy 1985, Frest and Johannes 1995a, Hershler 1998, Hershler and Liu 2004). Dams, diversions, and habitat degradation has fragmented the habitat of the Columbia springsnail throughout its range, effectively isolating populations and limiting gene flow and movement of individuals (Frest and Johannes 1995a, Hershler and Liu 2004). The species is reported from the Columbia River between in sparse habitats between The Dalles and John Day dams, between John Day and McNary dams, and above McNary dam, strongly indicating that dams have fragmented the species' habitat throughout its range (Frest and Johannes 1995a).

Habitat degradation has also fragmented the habitat of the Harney Lake springsnail throughout its range, leaving populations isolated (Frest and Johannes 1995a, Hershler 1998). In addition, the best available scientific information strongly indicates habitat degradation and nonnative species has fragmented the habitat of the Jackson Lake springsnail (Frest and Johannes

1995a). Habitat fragmentation limits the ability of aquatic mollusk populations to recover from stochastic events and also makes populations more susceptible to declines and losses (Frest and Johannes 1995a, Hovingh 1999). The best available scientific information strongly indicates the Jackson Lake, Harney Lake, and Columbia springsnails have experienced habitat fragmentation, have been negatively impacted as a result, and remain threatened by fragmentation (Frest and Johannes 1995a, Hershler and Liu 2004).

V. STATUS OF THE IDAHO SPRINGSNAIL

If the findings of Hershler and Liu (2004) are correct, then the Jackson Lake, Harney Lake, and Columbia springsnails are all the same as the Idaho springsnail, which is currently listed as endangered under the ESA (USFWS 1992). If this turns out to be the case, then the entire species warrants listing under the ESA. Indeed, already the best available scientific information strongly indicates the Jackson Lake, Harney Lake, and Columbia springsnails meet at least three of the five criteria for listing under the ESA. Furthermore, the best available scientific information indicates the Idaho springsnail continues to warrant protection as endangered under the ESA. If taken together, all four species warrant listing as threatened or endangered under the ESA.

The Idaho springsnail is presently listed as endangered under the ESA, meaning the USFWS has already determined the population is threatened with extinction (USFWS 1992). The species has declined significantly and its range has been reduced by nearly 80% (USFWS 1992). The species was historically collected from 10 sites (USFWS 1992), but is currently known with certainty from five sites (Frest and Johannes 1995a, USFWS 2004). Habitat loss and degradation throughout the species' range has led to population declines (Lengenstein and Bowler 1991, USFWS 1992, Bowler et al. 1993, Bowler 1995). Its status since 1992 has not improved enough to warrant downlisting or delisting by the USFWS (Frest and Johannes 1995a, Hershler and Liu 2004, USFWS 2004). The snail has very specialized habitat needs and continues to be threatened by ongoing habitat degradation throughout its range (EPA 2002, Lysne 2003, USFWS 2004). The invasion of nonnative species, in particular the New Zealand mudsnail, also continues to pose threats to the snail throughout its range (Bowler 1991, Bowler and Frest 1992, Rader et al. 2001, USFWS 2004).

Most recently, the USFWS gave permission to the Idaho Power Company to operate dams along the Middle Snake River in such a way that would adversely impact the Idaho springsnail and its habitat. In particular, the USFWS authorized the Idaho Power Company to operate the C.J. Strike and Bliss dams in load-following mode for two of the next five or six years, and for at least 16 days a year for the next 35-50 years (Id.). Load-following is the practice of increasing or decreasing releases from dams depending on energy demands. Scientists have flatly criticized this decision because of the adverse impacts to the Idaho springsnail. Scientists have expressed serious concerns over the impacts of load-following operation to the Idaho springsnail, as well as to other endangered mollusks in the Middle Snake River of Idaho (Id.). Operation of dams on the Middle Snake River also promotes the spread of the New Zealand mudsnail and degrades water quality, both of which are significant threats to the Idaho springsnail (USFWS 1992, 2004).

Although listing the Idaho springsnail provides strong protection for the species and its habitat, it is unclear to what extent the current listing rule will apply to the population in the near future. The current taxonomic revision suggests the taxon *Pyrgulopsis idahoensis* is no longer valid, indicating the population may not qualify for listing under the current rule (Hershler and Liu 2004). Although the Secretary of the Interior has the authority to revise the original listing rule and extend ESA protection to all other populations of the Jackson Lake springsnail (16 USC § 1533(c)(1), it is unclear whether or not this will occur. If the species is delisted for taxonomic reasons, it would leave the population as vulnerable and threatened as it was before listing. For instance, if the population was not listed, the Army Corps of Engineers would not be under any obligation to protect the snail and its habitat when issuing Clean Water Act permits (USFWS 1992). Additionally, current dam operators would not be required to protect the snail or its habitat, potentially leading to the extinction of the snail (USFWS 1992, 2004, Frest and Johannes 1995a, Bureau of Reclamation 2001). Finally, if the population was not protected under the ESA, no federal or state agency would be under any obligation to increase populations or restore habitat for the species (USFWS 1992). Thus, the species would remain vulnerable to stochastic events and other factors that threaten small, fragmented, and isolated populations.

The State of Idaho and the Idaho Power Company recently submitted a petition to remove the Idaho springsnail from the list of threatened and endangered species (State of Idaho and Idaho Power Company 2004). The thrust of the petition is that the Idaho springsnail is no longer a valid taxon and/or is more widespread and abundant based on the findings of Hershler and Liu (2004). As thoroughly discussed above however, if the findings of Hershler and Liu (2004) are correct, combining the Idaho springsnail with the Jackson Lake, Harney Lake, and Columbia springsnails does not change the fact that all four species are incredibly rare, have declined, have lost habitat, and remain threatened by a host of factors to the extent that all four—individually or together—warrant listing as threatened or endangered under the ESA.

The State of Idaho and the Idaho Power Company (2004) also claim that the Idaho springsnail is more widespread in the Middle Snake River than previously thought. While the present distribution of the Idaho springsnail may be more widespread, even extending as far downriver as Weiser, Idaho, this does not change the fact that populations have declined and that only five populations are known to exist today (USFWS 2004). The best available scientific information further indicates that these five populations remain threatened by a host of factors including, but not limited to, water pollution, reduced water flows, dams and dam operation, competition with nonnative species, habitat and population fragmentation and isolation, and environmental stochasticity (Frest and Johannes 1995a, USFWS 2004). Although the State of Idaho and the Idaho Power Company claim that additional populations may exist, these claims are suspect. For example, the Idaho Power Company has mistakenly identified the nonnative, invasive New Zealand mudsnail as the Idaho springsnail (USFWS 2004), raising serious concerns over the Company's ability to accurately identify the species without scientific verification.

The best available scientific information therefore strongly indicates that the Idaho springsnail continues to warrant protection under the ESA, whether on its own or combined with the Jackson Lake, Harney Lake, and Columbia springsnails.

VI. SPECIES THAT HAVE NOT YET BEEN FORMALLY NAMED

This petition requests the USFWS list the Columbia springsnail, which has only recently been discovered and has yet been given a formal scientific name. Although formally naming a species undoubtedly aids in our understanding of a particular species and in gaining scientific consensus, and will most likely be undertaken for all undescribed species in this petition, it should not be a determining factor in deciding whether or not this petition presents substantial scientific information indicating the Columbia springsnail warrant listing as threatened or endangered under the ESA.

To begin with, nowhere in the ESA or in regulations implementing the ESA are species that have not yet been formally named exempt from the provisions of the Act. The ESA is clear that the only creatures not falling under the purview of its statutory requirements are “species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming risk to man.” 16 USC § 1532(6). The ESA simply requires the USFWS to utilize the “best scientific and commercial data available” to determine whether a species warrants listing because it meets one or more of the five factors set forth at 16 USC § 1533(1). Although the definition of “species” varies (e.g., Wiley 1978, de Quieroz 1998, Moritz 2002), malacologists have generally defined mollusk species based on morphological, anatomical, and, where available, genetic distinctiveness (see e.g., Frest and Johannes 1993, 1995a, 1995b, 1996, 2000a, 2002a, Hershler 1994, 1998, 1999, Hershler and Frest 1996, Hershler and Ponder 1998, Hershler et al. 2003). Unless the “best scientific and commercial data available” indicates that a species that has not been formally named is scientifically unsupported or truly not distinct from another species, then the USFWS must give such species equal consideration when determining whether listing may be warranted.

The USFWS has recognized this, placing several species that have not been formally named on the list of threatened and endangered species. For example:

- In 1985, the USFWS proposed to list the Bruneau hot springsnail, which was at the time a species that lacked a formal scientific name, as endangered under the ESA (USFWS 1985);
- In 1988, the USFWS determined that nine mollusk species that had not been formally named—the Chupadera spring snail, Roswell spring snail, Alamosa spring snail, Pecos assiminea snail, Gila spring snail, New Mexico hot spring snail, Pecos spring snail, Koster’s spring snail, and Sangre de Cristo pea-clam—warranted listing under the ESA (USFWS 1988);
- In 1992, the USFWS finalized a rule listing two mollusk species that had not yet been formally named—the Banbury Springs limpet and the Bliss Rapids snail—as endangered under the ESA (USFWS 1992); and
- In 1994, the USFWS finalized a rule listing the Cherokee darter, a fish species that had not been formally named, as threatened under the ESA (USFWS 1994e).

As is evident, the fact that a species lacks a formal scientific name at the time of petitioning has not been a hindrance to utilizing the ESA in order to further species conservation and prevent extinction. The USFWS has clearly recognized that as long as a species that lacks a formal scientific name is truly distinct and scientifically defensible, based on the best available scientific and commercial information, and meets one or more of the factors set forth in 16 USC § 1533(1), conservation under the ESA is warranted.

Conservation of species that have not yet been formally named is in fact a critical issue. As studies worldwide have found, biologists are in a race against time to discover and name species before they become extinct. Too often, the race is lost and countless species are being lost even before they can be discovered (Wilson 1992). In conjunction with the increased pace of development worldwide, including deforestation, excessive range utilization, dewatering of river systems, mining, agriculture, and urbanization, a lack of funding, researchers, time, and public education too often places undiscovered species and species that have not yet been formally named at great risk (Wilson 1992, Frest and Johannes 1995a). With regards to the Columbia springsnail the situation is all the more poignant. As Frest (2002b) discusses:

In the West, even in comparatively well studied groups like mollusks, we face the real and tragic problem of centinelean species – that is, species unknown to science before their extinction and hence never recorded. Currently, there is little support or funding for finding and describing new species, and there are few taxonomists who can do so. Hence, we may lose a sizable part of our own native biodiversity with very little trace. Scientists are in a race against time to find and describe native biodiversity. (p. 212)

Examples of mollusk species that have not yet been formally named becoming extinct in the western United States are, unfortunately, a known occurrence. Frest (2002b) recounts:

After long neglect, the western U.S. spring biota has begun to attract scientific attention. In 1982, about 400 freshwater snail species were reported from the whole United States. By 1999, the number had reached about 700. Most new ones are western. Smithsonian malacologist Bob Hershler visited some 2,000 sites in his major Great Basin springsnail project. In the genus *Pyrgulopsis* alone, he discovered and described 58 new species. However, by the time the study was published, 2 had already become extinct. At that rate of loss (2 species in three to four years), less than a century would be required to extirpated all. No new taxa will arise during the same period, and one can only wonder how many have already disappeared in the 150 years of western settlement and development preceding Hershler's study. (p. 212)

Indeed, Hershler (1998) reports that two springsnail species—the carinate Duckwater pyrg and Fish Lake Valley pyrg, both from the Great Basin—may have gone extinct before they were formally named.¹ Numerous species that have not yet been formally named in the Interior Columbia Basin of the western United States may also be extinct, partly as a result of inadequate monitoring (Frest and Johannes 1995a). With an estimated rate of loss of at least two mollusk species every three to four years, the USFWS must utilize its conservation authority to protect

¹ It is important to note that the cause of extinction was domestic livestock grazing (Hershler 1998).

species that have not yet been formally named and the ecosystems that they depend upon under the ESA before they are lost forever, to the ultimate detriment of our society.

Although concerns over the taxonomy of undescribed species are valid and have been expressed by the USFWS in the past with regards to mollusk species in the western U.S. (see e.g., USFWS 1994c), scientists have made great efforts to ensure the Columbia springsnail is, in fact, distinct and worthy of conservation attention based on prevailing notions of distinctiveness (see e.g., Pilsbry 1939, Frest and Johannes 1995a, Hershler and Ponder 1998, Crandall et al. 2000, Fraser and Bernatchez 2001, Moritz 2002). As Frest and Johannes (1995a) report:

We have carefully reviewed essentially the entire published and much unpublished literature on mollusks in the ICB [Interior Columbia Basin]. Only those taxa are treated for which there exists general consensus or solid, recently collected evidence for validity. In some cases, this has led to the treatment of undescribed forms. This was done only for those groups which are widely accepted to be of conservation significance and for which we both have considerable recent collections and have reviewed museum material as well. This procedure has resulted in the exclusion of many forms which will probably prove valid taxa with further study; but a conservative approach was deemed most appropriate. (pp. 78-79)

The best available scientific information strongly indicates that the Columbia springsnail is distinct and deserving of conservation.

The general scientific consensus is that many new species of mollusks remain to be discovered in the western United States (Taylor 1981, Frest and Johannes 1995a). This notion has been upheld, time and time again, as new reports are continually arising naming new mollusk species from the west (see e.g., Roth 1998, Roth and Miller 2000, Hershler 1998, 1999, Hershler et al. 2003). Furthermore, there is overwhelming scientific concern that threats and declines facing many mollusk species in the western U.S. are outpacing the ability of scientists to formally name newly discovered mollusks (Frest and Johannes 1995a). The extinction of species that have not yet been formally named is well-documented and is a disturbing trend and testimony to the threats facing the Columbia springsnail. In conjunction with the fact that the USFWS has taken action to protect such species in the past and the fact that the ESA does not exclude species that have not yet been formally named from its provisions, and with support from the best available scientific information, the Columbia springsnail deserves listing as threatened or endangered under the ESA.

VII. DOCUMENTS CITED

Petitioners hereby incorporate by reference every document cited in this petition and/or cited in the References below. We are happy to provide copies of any of these documents upon request.

VIII. THE BENEFITS OF ESA PROTECTION

The Jackson Lake, Harney Lake, and Columbia springsnails are critically imperiled freshwater snail species that warrant listing as threatened or endangered under the ESA. Although a recent study suggests these three species may be the same, the best available scientific information demonstrates that taken individually or together, the snails need the protection of the ESA to prevent their extinction. The benefits of ESA protection for the Jackson Lake, Harney Lake, and Columbia springsnails are substantial, as we suggest throughout this petition.

- Listing will require that federal agencies enter into Section 7 consultation with FWS, and carefully consider the potential impacts of ongoing and proposed activities under their jurisdictions to the Jackson Lake, Harney Lake, and Columbia springsnails. The result will be significantly improved protection on federal lands from domestic livestock grazing, spring development, groundwater withdrawal, dams and diversions, and other potentially detrimental activities in the form of a proactive approach to implementing conservation actions prior to allowing any of the species' habitat to be impacted.
- Projects involving a federal nexus will also require Section 7 consultation; therefore the benefits of listing will extend to populations occurring on non-federal lands as well.
- Listing will result in the development of a recovery plan aimed at biological recovery of the Jackson Lake, Harney Lake, and Columbia springsnails, as well as recovery of the ecosystems they depend upon.
- Listing will help make management of the Jackson Lake, Harney Lake, and Columbia springsnails and their habitats consistent across land management boundaries.
- Listing will require protections that are not occurring now and will not occur otherwise through requirements for Section 7 consultation and Section 9 prohibitions on take.
- Listing will bring much-needed protection to the habitats where the Jackson Lake, Harney Lake, and Columbia springsnails exist and historically existed. Further, protection of the ecosystems they depend upon has the potential to benefit several other imperiled species, including rare and imperiled fish, insects, amphibians, and birds. Protection of the snails and the aquatic ecosystems they depend upon now will also help to secure a foundation for future and possibly more widespread ecosystem protection and restoration.

IX. SUMMARY

The best available scientific information clearly demonstrates that the Jackson Lake, Harney Lake, and Columbia springsnails, taken together or individually, need listing under the ESA to prevent their extinction and to protect the ecosystems upon which they depend. At least three and potentially all five factors set forth in § 424.11(c) are applicable to the present status of the species:

- **The present or threatened destruction, modification, or curtailment of habitat or range**

Habitat loss and/or degradation has been extensive throughout the ranges of the snails. Spring development, domestic livestock grazing, groundwater withdrawal, water pollution, and dams have destroyed and/or degraded habitat. All three springsnails have suffered population declines as a result and remain threatened by ongoing habitat loss and degradation.

- **Overutilization for commercial, recreational, scientific, or educational purposes**

The snails have been collected for scientific reasons, and in conjunction with other threats, such as habitat loss and degradation, may pose increasing threats to the species.

- **Disease or predation**

The snails are naturally preyed upon by a variety of other animals, and in conjunction with the impacts of habitat loss and/or degradation, may face increasing threats from predation.

- **The inadequacy of existing regulatory mechanisms**

Existing regulatory mechanisms are woefully inadequate to protect the Jackson Lake, Harney Lake, and Columbia springsnails. None of the species or their habitats are protected on private lands and federal and state regulatory mechanisms not only fail to provide adequate protection, but fail to provide for any level of recovery of the petitioned mollusks.

- **Other natural or manmade factors affecting its continued existence**

Herbicide and pesticide use, the introduction and spread of nonnative species, and climate change threaten the Jackson Lake, Harney Lake, and Columbia springsnails. Additionally, because populations of the springsnails are either small, isolated, and/or fragmented, they are more susceptible to extinction.

Petitioners expect to receive a formal acknowledgement of this petition and a decision as to whether this petition presents substantial scientific information indicating the petitioned action may be warranted on or before 90 days of its receipt.

Respectfully submitted,

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