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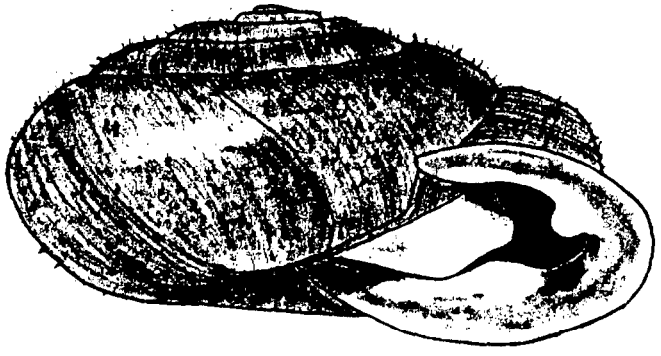
INTERIOR COLUMBIA BASIN MOLLUSK SPECIES OF SPECIAL CONCERN



Cryptomastix magnidentata (Pilsbry, 1940), x7.5

FINAL REPORT

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January 15, 1995

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Each shell, each crawling insect holds a rank
important in the plan of Him who framed
This scale of beings; holds a rank, which lost
Would break the chain and leave behind a gap
Which Nature's self would rue.

-Stillingfleet, quoted in
Tryon (1882)

The fast word in ignorance is the man who says of an animal or plant: "what good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. if the biota in the course of eons has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first rule of intelligent tinkering.

-Aldo Leopold

Put the information you have uncovered to beneficial use.

-Anonymous: fortune cookie from China
Garden restaurant, Seattle, WA

in this "business first" society that we have developed (and that we maintain), the promulgators and pragmatic apologists who favor a "single crop" approach, to enable a continuous "harvest" from the natural system that we have decimated in the name of profits, jobs, etc., are fairly easy to find. They're the "experts" who were trained and our research and development diploma mills, such as the UW, where the funding by business interests (and by government in support of business) dictates agendas and outcomes. Quality will become myth and diversity will vanish.

-J. H. Browne, jr., letter in the
Seattle Post-inteiiigencer

Not ail species can be saved, its a judgement decision, somebody has to play god and decide which will go. in this case I am doing just that, contrary to my staffs recommendations. I make bio-political decisions every day. Right now my main concern is saving the [A]ct. The harvestmen populations will not be listed. I am not about to lose the [A]ct because of a couple of spiders. Some species will have *[sic]* to become extinct. The few *[sic]* times this has happened or will happen are relatively inconsequential to the total biological actions of this program.

-Anonymous USFWS Region 1 state program manager,
quoted in GAO (1979)

Greed is the key.

-Frank V. Zappa

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INTERIOR COLUMBIA BASIN MOLLUSK SPECIES OF SPECIAL CONCERN

INTRODUCTION

Management of forests in the Columbii River Basin and coastal Pacific Northwest has recently become the subject of intense interest. Protection of the Northern Spotted Owl and other old growth (mature forest) species under the Forest Management Act of 1976 and the Federal Land Policy and Management Act is a desideratum to all except the most narrow interests. Listing of the Northern Spotted Owl as Threatened under the Endangered Species Act has provoked an intensive effort to thoroughly assess the biological and economic impacts of mature forest management in the region. It was established early on that the issue involved more than a single species. The future, utilization, management, and conservation of old growth and late successional forests and other ecosystems of the Columbia River Basin states and their associated biota were the real subject. In the last few years, labors to formulate a forest management plan and a Recovery Plan for the Northern Spotted Owl (Johnson et a/., 1991; Thomas et al., 1990, 1993; USFWS, 1992a, b) have been unusually comprehensive and exhaustive. For both the Pacific Coast and Interior Columbia Basin assessment areas, it was deemed desirable to address ecosystem concerns as part of that process. As a result, evaluation of the old growth and late successional (mature) forest ecosystem was attempted on a large scale. This involved some consideration of certain key invertebrate groups. As part of that effort, we were asked to determine mollusk species of special concern occurring within the range of the Northern Spotted Owl, and submitted a brief report on the subject (Frest & Johannes, 1991b). Results from this report were included in the draft and final draft Northern Spotted Owl Recovery Plan (USFWS, 1992a, b), and also in the report of the Scientific Analysis Team (SAT: Thomas et *al.*, 1993). Subsequent to the Forest Conference of April, 1993, the Forest Ecosystem Management Working Group (FEMAT) asked us to participate (with Dr. Barry Roth) in a panel to make viability assessments for, and determine effects of, various management options on mollusks in publicly-owned old growth and late successional forests. To complete this undertaking we reviewed and revised the 1991 report to reflect new information; we also expanded it to cover the somewhat different mandate of the viability panel. The final version of this document was issued in 1993 (Frest & Johannes, 1993c); a companion document was completed at the same time by Roth (1993). Results from these reports have been incorporated in the Forest Ecosystem Management Team's final report (FEMAT, 1993); the Final

Supplemental EIS Statement (FSEIS, 1994a, b), and the suggested standards and guidelines for habitat management (Record of Decision: ROD, 1994).

To date, the Interior Columbia Riier Basin Ecosystem Management Project (or Eastside Ecosystem Management Project), under the direction of the Science Integration Team (SIT) has pursued similar but not completely analogous goals (USFS, 1994; SIT, 1994). As yet, it may be too early in the process for equivalent documents to Johnson eta/. (1991), Thomas et a/. (1990, 1993), FEMAT, or SAT to appear. Considerable efforts for delineation of a management framework, however, have appeared in the form of the various Eastside Forest Ecosystem Health Assessment and Ecosystem Management documents, published by the Forest Service. Much of this is only peripherally relevant to this report, and only those sections directly quoted or commented on below are included in the REFERENCES. Nevertheless, those sections reviewed in formulation of our report are listed here. These should be consulted for background:

USDA Forest Service Pacific Northwest Research Station General Technical Reports PNW-GTR-318 (1994), PNW-GTR-319 (1994); PNW-GTR-320 (1994); PNW-GTR-321 (1994); PNW-GTR-322 (1994); PNW-GTR-323 (1994); PNW-GTR-324 (1994); PNW-GTR-325 (1994); PNW-GTR-326 (1994); PNW-GTR-327 (1994); PNW-GTR-328 (1994); PNW-GTR-329 (1994); PNW-GTR-330 (1994); PNW-GTR-331 (1994).

This document is intended to serve several purposes. It attempts to provide an overview of, and draw attention to, the Interior Columbia Basin states' mollusk fauna and its role in the regional forested-land, semiarid, and arid ecosystems. It also identifies species known presently to be in some risk of extinction in the Interior Columbia River Basin (ICB hereafter). For the purposes of this report, the ICB assessment area is defined as shown on Figure 1 (coverage has evolved somewhat; for background, see SIT, 1994, vs. USFS, 1994). Included are all of the States of Washington and Oregon east of the Cascades crest; all of the State of Idaho; and Columbia drainage' areas of Montana, Nevada, Wyoming, and Utah. Drainage basins in the assessment area include the greater Columbia Basin east of the Cascades crest but excluding Canada (and including all of the Snake and its tributaries); the Oregon Interior Basins, and Upper Klamath Lake. We here emphasize those species known to occur on public lands (particularly those managed by USDA Forest Service, USDI Bureau of Land Management [BLM hereafter), and National Park Service (NPS hereafter), and hence subject to the provisions of the Forest Management Act of 1976, the Federal Land Policy and Management Act of 1976, the National Environmental Policy Act, the Wilderness Act of 1964, or other appropriate legislation or regulation. Complete taxonomy and suggested state and federal status are summarized on Table 1. Occurrences on federal lands are reviewed in Table 2. Table 3 summarizes state occurrences and suggested status on a species by species basis. The following set of tables (Tables 4-10) are lists of Species of Special Concern organized by state. Tables 11-28 show content of the areas of high mollusk endemism defined herein.

Early sections review history, diversity, ecology, distribution, and salient background information on each mollusk group. Included are sections on management practices and their effects and survey

methods. The bulk of the report is the section entitled SPECIES DISCUSSIONS. Individual species entries succinctly review salient information on taxonomy, ecology, distribution, threats, and occurrences on public (state and federal) lands. Recommendations for status of these taxa under state and federal endangered species rules (including the ESA) are also provided. We hope that this report will aid in effective federal and state management of these extraordinarily interesting species. Time constraints made it necessary to make the report somewhat summary and telegraphic. To aid those needing further information, extensive reference is made to the literature, and guides to information resources and a short glossary are also provided. In almost or al cases, additional information is available from the authors and from other sources referenced herein.

GEOLOGIC HISTORY

Needless to say, there is a very extensive geologic and paleontologic literature for the areas included within the ICB assessment area. Entree into this subject can be had most readily through the Mountain Press "Roadside Geology" series for Washington, Oregon, Idaho, Nevada, Utah, Montana, and Yellowstone National Park. This is generally available; but the style and format sometimes result in sacrifice of strict 'accuracy or in oversimplification. Works we found especially useful include: Newman & Goode (1979); Bonnichsen & Breckenridge (1982); Smiley (1985); Vallier & Brooks (1986); Debiche, Cox, & Engebretson (1987); Schuster (1987); Kopp & Cohenour (1987); Reidel & Hooper (1989); and Link, Kuntz, & Platt (1992).

The ICB assessment area can be divided roughly into three geologic provinces: 1) a Rocky Mountain border section, which extends from extreme northeastern Washington along the western Idaho border through western Montana: 2) a Cascades-Olympics portion which involves much of eastern Washington and western and northern Oregon; and 3) a Great Basin-Great basin periphery portion which includes southeastern Idaho and adjacent Wyoming; northern Utah; and the Oregon Interior Basins.

The Rocky Mountain portion made up a good part of the western boundary of the North American continent from about 800 million years ago to about 100 million years ago. To the west of this area was the Pacific Ocean; to the east, a variety of interior seaways and the core continent, including the eastern and central U. S. The Rocky Mountains proper are the product of two major orogenic events, the first of which was initiated about 100 million years ago. The period of about 65-100 million years ago (YBP) was an era of intense geologic activii in western North America. Mountain building, vulcanism, and batholith emplacement occurred; and the last interior seaway dried up, linking the Rockies with the eastern part of

the continent. Another series of mountain-building events took place in this area about 40 million YBP. Glaciation affected the region during the last 2.5 million years, with minor events (the Pinedale and Bull Lake) about 10,000 and 70-130,000 YBP respectively. The most severe ice age appears to have been the last major event of the Late Pleistocene, the 28,000-12,000 YBP Wisconsinan. Continental glaciation characterized the major Plio-Pleistocene episodes (perhaps 7), covering at least half of the region. Mountain glaciation was effective further south.

The rise of the Cascades and Olympics, perhaps beginning in the Oligocene but obvious during the Miocene *(i.e.,* about 20 million YBP) and still ongoing, in essence made Washington and Oregon a permanent part of the continent. Vulcanism was initiated as early as the Eocene (perhaps 40 million YBP), and small islands or isolated land masses or island chains may have been present since the Cretaceous or even earlier. For about the last 100 million years, accretion of new blocks to the western edge of North America occurred sporadically. Major examples of such exotic blocks or accreted terrain were emplaced in the Blue Mountains and along the western border of Idaho, particularly in Hells Canyon and the Salmon River. Many of these may be part of the emplaced Wrangellian Terrain, a zone of activity stretching from Alaska to California. Similar emplacement occurred in the Olympics. Major emplacement of batholiths, as in Montana, occurred near the end of the Cretaceous, notably the Idaho and Kaniksu batholiths. Extensive volcanic sequences formed in Idaho'during the Eocene. Aside from extensive mountain building, the Miocene also saw the initiation of flood basalts of the Columbia and Grande Ronde Groups in the interior of Washington and Oregon, many originating from the Blue Mountains. Such activity continued through the Pliocene. At about the end of the Miocene, downdrop of the Snake River Plain may have occurred. Major flood basalt activii, related to the progress of a diapire from northwestern Nevada and southeastern Oregon across southern Idaho, may have begun in the Miocene. As the diapire moved east and north across Idaho to its current position in Yellowstone National Park, it is accompanied by intense volcanic activity, producing younger and younger basalt flows. As with Montana, the northern portions of Washington and Oregon were affected by identically-timed Plio-Pleistocene glaciation, with effects being most pronounced in the western Cascades.

Initiation of Basin and Range folding may have begun as early as 100 million YBP, with activity definite by 80 million YBP. As with the rest of the region, the Great Basin and peripheral areas were fully nonmarine by the Eocene, with island chain and small land masses present offshore at a much earlier period. As above, extensive vulcanism was prevalent during the Eocene, and flood basalts characterize much of the Miocene and Pliocene. Effects of glaciation were less severe than in the more northerly regions; but still had a pronounced effect on climate.

In general, the Rocky Mountain area seems to have had episodes of mild and moist tropical climate through the Miocene. Coastal areas remained warm and moist through the Eocene; but the rise of the Cascades meant that the interior areas became rather dry, a condition probably initiated in the Miocene but more pronounced from the Pliocene to the Recent, except for interruptions of a sort by glacial periods.

During the Pliocene and Pleistocene glacial advances, extensive pluvial lakes formed in interior Washington, Oregon, Utah, and Nevada, with interglacials and other geologic activii causing periodic shifts in location of lakes, and their extinction; but also profoundly rearranging drainages in the ICB.

These large-scale events had profound effects on the ICB's mollusk fauna. Relatively little is known of either freshwater or land forms for areas west of Idaho before the Eocene, as most of the area was marine. In the Rocky Mountain portions of the area was a rich freshwater fauna, which bears little relationship to more easterly faunas or to the modem malacofauna. Prevalent are large unionids, viviirids, pilids, and other families now either much reduced or extinct in the region (see LaRocque, 1960 and Taylor (1988c) for reviews). Viiiparids extended as far west as the base of the Cascades during the Miocene (Taylor, 1985a) The terrestrial fauna is more poorly understood. Certainly, some genera characteristic of the modem fauna were in place from the Cretaceous (notably *Oreohelix*). This reflects a common theme for continental mollusk faunas. For the most part, terrestrial faunas in North America seem to reflect a Gondwana distribution pattern, with most families present since the Paleozoic (Solem, 1979, 1981, 1984). For freshwater forms, this may be true of many families: but some later migration does take place (Taylor, 1985a, 1988b). Reconnection of the Rocky Mountain area to eastern North America may be indicated by the finding of extralimital forms, suggestive of eastern affines and mixed mesophytic forests, in the Deep River Formation of Montana (Roth & Emberton, 1994). Earliest common records for the eastern portion of the ICB stem from the Eocene. Freshwater mollusk faunas of that period seem to show some relationship with the modem ones, and very little with the earlier Rocky Mountain faunas, save the persistence of Viviparidae for a short while. Land mollusks are comparatively poorly known, except for certain areas, such as the John Day Formation (Eocene) of Oregon. Generally, it would appear that some of the genera present today may have extended into the Rocky Mountain region in the early Tertiary. Late cooling and drying (Eocene-Oligocene) may have separated some of the genera, with some remaining in the Rocky Mountains while others migrated westward or eastward (Roth, 1986).

The Late Tertiary drainage history of the area is well reflected in the freshwater mollusk fauna. As the stream corridors served also as major migration routes for the terrestrial forms, especially as the climate became more severe, remarks apropos the freshwater forms may apply to them also. Major references are Taylor (1966a, 1985a, 1988b, c), Taylor & Bright (1987); Taylor & Smith (1981); and Stokes (1979). As background, the major current drainage basins in the ICB are shown on Figure 4. In general, the Miocene was a time of large, integrated drainages in the region, particularly in the Great Basin and its periphery (Figure 5). The Columbia River probably had a main stem composed of the present lower Columbia and Clearwater, with only Hells Canyon and downstream portions of the Snake present. A major drainage divide likely separated off the rest of the present Snake system. All or most of western Montana at this point would have been excluded from the Columbia Basin, and exited the state somewhere to the south. The Idaho Snake was separated by a drainage divide near the present Raft River into 2 segments, one of which was probably part of an integrated Lahontan drainage, while the upper Snake system probably was

part of a south and southwest flowing system of which the western Montana drainages were a part. Exit of the Lahontan system may have been through some part of central California.

By the Late Pliocene-early Pleistocene (Figure 6), it seems likely that integrated Lahontan drainage had begun to split up, with some portions now internal drainages. Western Montana likely continued, with southeastern Idaho, to be part of a south to southwestern draining system, possibly independent of the core Lahontan. The basalt-dominated Great Basin periphery, however, **may have formed a larger unit,** comprised of the middle Snake River and portions of the Sacramento system and Upper Klamath system, and exiting to the Pacific somewhere near the Oregon-California border. Divides in upper Hells Canyon, between the middle and upper Snake in Idaho, and southwestern and western Montana isolated parts of these areas from their present Columbia Basin or Mississippi Basin connections. Removal of these divides and minor drainage readjustments brought about by Pleistocene glaciation would have yielded the present drainage pattern (Figure 4). A short-lived connection between the Great Basin peripheral drainages and the Columbia River Basin may have existed, likely *via* the Deschutes River or John Day River corridors. Support for these interpretations is found in the present-day mollusk fauna. Many examples have been reviewed by Taylor (1985a and other references cited above). The Columbia-peripheral Great Basin connection, e.g. is supported by the distribution of *Anodonta wahlametensis*, *Vorticifex effusus*, and *Pyrgulopsis* n. sp. 6 (for former, see Taylor, 1985a, for latter, see Figure 12 herein). This recently-discovered lower Columbia River species is a member of a group which is phylogenetically closely related (Gregg & Taylor, 1965; Hershler, 1994) and which is deployed only along the Great Basin periphery. Pyrgulopsis faunas of southeastern Idaho and the Bonneville basin are closely related, while those of the middle Snake are independent and mostly relicts of Pliocene Lake Idaho. Major elements of the Lake Idaho fauna seem to have been derived from Californian ancestors. To the north, the hydrobiid genus *Pristinicola* occurs west of Montana and north of the Great Basin periphery. Upper Klamath Lake and upper Sacramento mollusk faunas are closely related, as indicated also by fish and crayfish distributions. Great Basin elements are disjunct into these systems, and also into the Upper Snake as far east as Jackson Lake.

The course of the Great Basin peripheral system is indicated in a general way by what Taylor (1966b, 1985a) and Taylor & Bright (1987) termed the "fishhook" or the "*utahensis-newberryi*" pattern. This is an area with numerous disjuncts and endemic species, stretching along the eastern California-western Nevada border; thence across southeastern Oregon, southern and southeastern Idaho, and northwestern Utah (Figures 16, 17). The distribution of a disproportionate number of Sensitive mollusk species fits this pattern, and it applies as well to Late Pliocene-Pleistocene fossils as it does to modern mollusks.

One other example can be cited briefly. Across northern Washington (east of the Cascades), northern Idaho, and northwestern Montana is a narrow area of intensely glaciated terrain now tributary to the Columbia Basin. Several mollusk species in this region are disjuncts from the Mississippi drainage. Others

appear to be sibling species, now taxonomically distinct, of eastern genera that are generally rare in or absent from the Columbia drainage.

While it is obvious that great changes have taken place over geologic time in the climate, physiography, and drainage of the ICB, the role of human-induced change may not be properly appreciated. Instances of this are common in several of the ICB Eastside Ecosystem' Forest Health Assessment and Management documents referred to in the INTRODUCTION. Changes of the sort emphasized here take place at two major scales. Landscape-scale changes, such as those brought about by mountain building and by glaciation, affect very large areas but take place at what (to humans) is a very slow pace, with the event proper of very long duration. Catastrophic changes, such as volcanic eruptions (Mt. St. Helens, Mt. Mazama) or floods (Bonneville, Missoula) take place essentially instantly but are themselves of short duration and at less than landscape scales. Attempts to portray the recent geologic history of the ICB as one of very rapid change somewhat confuse the two scales, often as a rationalization of human-induced changes. Most of the climate and other changes of the last three million years in the ICB are best portrayed as landscape-style events. This is not to downplay the importance of catastrophe-style changes, which are very significant in this part of the U. S. However, most late Tertiary extinctions, for example, were brought about by changes at the former scale, not catastrophes. Present change is best compared to the really major catastrophes of earth history, such as those resulting from asteroid impact-a none too flattering comparison, by the way. There is also one very important unique aspect to human activities. Even landscape-style catastrophes are themselves generally of short duration, regardless of cause. Human impact is perhaps unique in that it both occurs at landscape level and appears likely to be of indefinite duration. The effect is similar to repeated and never-ending catastrophes all over the landscape, with no intervening or long-term periods of stability or stasis, as characterizes natural events of both styles. For most geologic events of either style, a significant part of the landscape was missed, unaffected, or remained available to supply individuals and species for repopulation and ecosystem reconstruction. This is not the case for the human-induced changes, where one single activity, for example grazing, affects 70-75% of the total acreage in the western U.S., and where activities and impacts are typically multiple and indefinitely ongoing. Another example may be useful. The U.S. and Canadian unionid (freshwater mussel) fauna consisted of about 300 native taxa. In the last 100 years, at least 21 of these have become extinct, and about 70% are considered endangered, threatened, or of special concern, with only about 20% considered stable (Williams et *al.*, 1992). Should present trends continue (and in reality, most or all of the extinctions have occurred in the last 40 years, and the trend toward extinction is accelerating), the whole fauna would be extinct in less than 3,000 years, an instant in geologic time. Needless to say, no new species are likely to evolve in that time; the pace of change is too rapid and the sustain of impact too severe to allow recovery; and the rate of species origination is comparatively slow. With less than 2% of the nation's streams now having sufficiently highquality features as to merii federal protection (Benke, 1980), species reservoirs are clearly few and far between. With up to 90% of the mature forest removed in a

comparable time, the rate of extinction of terrestrial species is comparable, and islands of high biodiversity are comparably few and small. This is particularly true for low-moderate elevation areas in the western U. S.

As sometime specialists with interests in Late Tertiary paleoenvironments, particularly with respect to biotic change, we were gratified to see the emphasis placed upon the subject in the Ecosystem Management and Health Assessment documents; but somewhat chagrined to see the use made of the subject. Under the best of circumstances, care must be taken with this discipline to avoid **over-**interpretation and ***ad*** hoc hypotheses. **If** invocation of the geologic record can be construed so **as** to support or rationalize past or contemplated management or exploitation plans, especial caution must be taken to guarantee objectivity and validii of the stated conclusions. Pro ***pecuniam*** works are justifiably suspect (including this one); and the biostitute merely one of the latest manifestations of a world-wide human problem.

There is a second and related practice in the published ICB Ecosystem Management and Forest Health Assessment documents that should also be commented on. This is the tendency to selectively evaluate the scientific record and overstate the significance of past research, sometimes with the apparently result of confounding the difference between science as rational and as rationalization. We will focus on just one of many such instances here. We were somewhat disturbed by the interpretation of the ICB Tertiary palynological record. There seemed to be a strong tendency to emphasize supposed examples of rapid and dramatic change in the Pleistocene-Holocene record; and further to make inferences from them on a landscape scale. To begin with, the record in the ICB is very scattered, with the possible exception of Yellowstone National Park. To meke the sort of landscape evaluations and interpretations made therein, one would need many more sites, with sizable groups contemporaneous. This sort of broad-scale interpretation is valid for the Midwest and eastern U.S.; but clearly not here, as yet. Aside from problems with site numbers, location, and ages, the degree of valid inference is exaggerated considerably. To make such inferences possible, much more information on the modem pollen rain in the ICB would be necessary, as a start. Effects of diagenesis, which are considerable for certain pollen types, such as that of conifers, are not well known in this region: they are very significant elsewhere. Moreover, the differences between preserved pollen, which is largely from aerophile-specialist tree species, and the actual flora are not well discriminated in the documents involved. There is also a general lack of comparison data from plant macrofossil studies, which often. yield a very different picture (Gray, 1985). For anything approaching accurate site (let alone more general) interpretation, results from several lines of evidence should be compared, e.g. Baker et a/. (1988). We know of few if any ICB-area studies which would qualify.

Claims of accuracy of resolution to the decade level, or of detection of rapid changes at that time scale, should be viewed with considerable skepticism. They represent a theoretical high point that is seldom achieved in practice: and we again are unaware of any ICB studies which overcome all of the physical and methodological obstacles, let alone a plethora of such studies, as would be required to justify the landscape-wide level of interpretation attempted. **If** rapid vegetational change takes place, it is likely that

concomitant or barely lagging changes in sediment or pollen deposition rate will occur also. This would require very close and repeated dating of the core or other sample (in effect, at decade-equivalent intervals) to detect; and there is no reason to believe that changes in both are coordinate or self-correcting. Sudden increases or decreases in sediment rate or composition may not be physically obvious; but would minimally either dilute or concentrate pollen, if not also modify the preservation picture. Generally, too, the error margin of available dating methods is not such as to allow either particular decades or decade-long time intervals to be so surely identified or correlated. Pollen profiles are best compared with each other, not with current flora; provide a regional or semi-local scale of information [not landscape or precisely local]; and do not allow inference of anything approaching a full picture of either plant or animal diversity. Integration of evidence from several different plant and animal groups, each with their own unique methodological peculiarities, interpretational scale of resolution, advantages, and limitations, must be undertaken to answer questions about past climates or habitats. This has simply not been done frequently in the ICB; so sweeping interpretations of past rates of habiiat change in the ICB should be viewed with great caution as yet.

BIOGEOGRAPHY

TERRESTRIAL MOLLUSKS

Many of the most characteristic land and freshwater mollusk (bivalve and snail) taxa currently living in the West Coast states have very limited geographic ranges. Part of the current freshwater snail fauna, for example, may consist of relatively recent (perhaps 65 million years B. P.) immigrants from Asia, or forms derived from Asian ancestors and not present elsewhere in-the U.S. Most of North America is generally separated into two faunal realms, the Eastern and Western Divisions (Figure 2). Faunas of these two areas are distinct even at the family level. For example, the ICB families Helminthoglyptidae, Oreohelicidae, and Ammonitellidae do not range into the eastern Division. Even in such widespread families as the Polygyridae, western forms are generally distinct at the generic level (e.g., *Vespericola* and *Cryptomastix vs. Mesodon* and *Triodopsis).* Characteristic coastal forms are different from those of the Rocky Mountains *(e.g., Monadenia* vs. *Oreohelix*), and California coastal forms are very distinct from those of most of Oregon, Washington, and Briiish Columbia. In both cases, these differences involve not rare taxa, but the dominant and characteristic genera in the biogeographic unit. Many such taxa are confined to a coastal

belt that extends only from the Cascades to the Pacific, and is believed to be of comparably recent origin geologically.

Within the ICB, there are three distinct land snail provinces widely recognized by malacologists (Henderson, 1931b, Pilsbry, 1948, with modifications by Bequaert & Miller, 1973: Figure 2 herein), all in the Western North American Division. The Oregonian Province extends from coastal British Columbia just into extreme northern California.. Notable are a number of species of the helminthoglyptid genus ***Monadenia*** and the polygyrid genus ***Vespericola.*** Also characteristic is the variety of slugs, notably in such genera as ***Hemphillia*** and ***Prophysaon.*** The Washingtonian Province extends east from the Cascades crest in southern Briiish Columbia to the Idaho Panhandle and northwestern Montana, thence through much of eastern Washington and Oregon to the Cascades foothills north of Klamath Falls. In this province, ***Monadenia*** and ***Vespericola*** are present only at the western fringe, and ***Cryptomastix*** largely replaces ***Vespericola.*** Some genera, such as ***Polygyrella***, ***Microphysula, Udosaryx***, ***Zacoleus***, and ***Magnipelta*** are provincial endemics. ***Oreohelix*** is present but sporadic, with only a few species in one or two lineages present. Some genera are common to the Oregonian and Washingtonian provinces but absent or rare elsewhere. Example include ***Prophysaon, Hemphillia***, and ***Pristiloma***. The large Rocky Mountain Province lies generally south of the Washingtonian; and includes southwestern Montana, southern Idalio, Wyoming, western Colorado, Utah, Nevada, and eastern and northeastern California. It is generally characterized by absences, such as those of many typical eastern genera and genera common to the other western provinces, such ***as Monadenia, Cryptomastk, Pristiloma, Microphysula, Radiodiscus, Hemphillia, Udosaryx***, and ***Magnipelta.*** Particularly notable is the great number of species and morphologies in the genus ***Oreohelix***.

Provincial boundaries are fluid at best, and subject to modification by large-scale geologic events. Those discussed here apply best in the Late Tertiary-modem period, more specifically for the last 30 million years or so. Even at present, characterization of certain areas is not straightforward. The Columbia Gorge, because of its unique position and history, manages to maintain a disparate mix of elements, none of which is greatly speciose but many of which are endemic. Notable are species of ***Monadenia, Vespericola, Cryptomastix***, and ***Oreohelix***, mostly xerophiles and commonly co-occurring. The eastern Cascades in Washington may be another such area, featuring easternmost occurrences of Oregonian Province species with westernmost occurrences of Washingtonian Province taxa, along with a few unique elements.

Distribution of certain typical genera should be noted briefly. ***Oreohelix*** (Figure 9) [or more generally, the family Oreohelicidae] is particularly characteristic of the Rocky Mountain and Washingtonian provinces in the ICB. Note that most occurrences of the genus are in the eastern half of the area. In general, the western occurrences are sporadic and belong to just a few taxa. Substantial endemism is present in the genus in the Hells Canyon area, lower Salmon River valley, southeastern Idaho, Wasatch Range in Utah, and in the northwestern portions of Montana. The genus appears to be absent from large parts of the

most and portions of the ICB but continues with high diversity occurrences into the Rocky Mountains proper. The polygyrid *Cryptomastix* (Figure 10) occurs mostly in the eastern portions of the ICB; and also in the Oregonian Province. In this area, only 2 species are present, both quite different from the Washingtonian taxa. Areas of high endemicity are in Hells Canyon, the lower Salmon River valley, and the Clearwater River drainage. The genus does not occur in the far south areas of the ICB; nor in the Rocky Mountain Province areas. Diversity is bw in the interior areas of both Washington and Oregon; and the genus appears to be absent from large areas in both states. *The* slug genus *Hemphillia* (Figure 11) is typical of both the Washingtonian and Oregonian provinces. Its distribution pattern is similar to that of *Cryptomastix,* but more exaggerated, with major lobes into the mountainous regions of both provinces. As with the shelled polygyrid, species are very different in the west Cascades and Olympics, *versus* Idaho and Montana, although here higher diversity is in the Oregonian Province, not, the Washingtonian. Many genera are distributed more or less uniformly in the ICB assessment area (excepting the drier portions 'of the interior and some other special cases discussed before); but these tend to be the more cosmopolitan genera. A significant number of taxa have the more sporadic distribution suggestive of relict status. Examples in the ICB include *Polygyrella* and *Megomphk* see SPECIES DISCUSSIONS for details.

FRESHWATER MOLLUSKS

The distribution of ICB freshwater mollusks in many ways parallels that of land snails. Considering the obvious differences in habitat, any parallelism is striking. That observed results from the response of aquatic systems to the same major landscape features and tectonic events, particularly those dating from the Cenozoic. Similarly, land snail dissemination tends to be along stream corridors, limited by similar factors to those controlling distribution of stenotopic freshwater mollusks. Like land snails, freshwater mollusks at higher taxonomic levels are mostly conservative and relatively sessile, so that major changes, such as evolution of new families or introduction of a family to a new continent, are comparatively rare. The latest possible examples of such change (and their reality is still a subject of debate by malawlogists) are the bizarre freshwater mollusk faunas of some of the Plio-Pleistocene lakes in the ICB, notably Lake Idaho and Lake Thatcher. Good reviews of this subject and of the place of mollusks in the evolution of freshwater ecosystems as a whole are found in Taylor (1985a, 1988b, c) and Gray (1988).

Much of the area of North America west of the Rocky Mountains is rather new terrain, geologically speaking, being added to the continent as a result of large-scale tectonics, including vulcanism, mountain range formation, and microplate accretion during the last 60-100 million years. As a consequence, drainage evolution has been considerable, much more extensive than that east of the Rockies in the same period. There have been two systematic attempts to define North Ameriin freshwater mollusk

provinces; those of Hannibal (1912) and Henderson (1931 b). Hannibal's idiosyncratic style makes his version difficult to comprehend, let alone apply. Henderson's (1931 b) approach basically yielded provinces very similar to those for terrestrial forms. A modification of this arrangement is used by Burch (1989). Refinement of freshwater mussel provinces in the eastern U.S. has been considerable (Van der Schalie & Van der Schalie, 1950; Johnson, 1970, 1972; Taylor, 1988b), and recent increases in the number of western taxa suggest the need for revision here, too. Nevertheless, the main outlines remain sound.

At present, the major drainage systems in the Pacific Coast states are those of the Columbia Basin, the Interior Basin (Lahontan and peripheral areas), and.two regions of Pacific Coast drainage interrupted by the Columbia River (Burch, 1989, fig. 20; Figure 4 herein). During the late Cenozoic, several large-scale geologic processes have formed and rearranged these drainages. The rise of the Cascade, Coast, and Great Basin ranges considerably modified both drainage and climates. The most extensive mountain-building episodes took place in the Eocene, Oligocene, and Miocene. Vulcanism has been widespread since that same period [in the ICB proper, particularly during the Miocene and Pliocene], and continues today. Some is associated with the formation and development of the major mountain ranges; but other events are connected with the Pliocene-Recent migration of a diapire or hot spot across the Washington-Oregon border through southern Idaho to its present location at Yellowstone National Park. The extensive Columbia Basin and Snake River Plain basalts [e.g., Columbia Group; Grande Ronde Group] are at least partly related to this process. Plio-Pleistocene glaciation and the related Bonneville and Missoula Floods have also affected freshwater mollusk distribution. Formation of the Snake River Plain, an event still not completely understood, is another major cause of drainage modification.

There is a considerable literature regarding the relationship between drainage and geologic' history, particularly for the Columbia Basin, Sacramento system, and Great Basin. The best single work as regards effects on mollusks is Taylor (1985a); some particularly salient points will be summarized here. In the Miocene (approximately 20 million years ago (MYBP), much of the West was included in a few large and integrated drainages. The Columbia system was much smaller, and the Lahontan Basin was a coherent, outward-draining [Pacific tributary] system. During the late Miocene and Pliocene, the rise of the Coast and Great Basin ranges disrupted the Lahontan system, converting it into many internallydraining small basins. Drainage of areas peripheral to the Great Basin was modified considerably during the late Pliocene and Pleistocene. Much territory, including Hells Canyon and the upper Snake, was added to the Columbia system at this time. The Snake proper [current middle and upper Snake drainage] had formerly been a Pacificdraining stream, with connections to the Klamath and Sacramento systems. Many of the large pluvial lakes formed earlier in the late Miocene or early Pliocene either contracted or went dry during the later Pliocene and during Pleistocene interglacials (such as the present). Only a few of these large lakes were incorporated into coastal systems (the Upper Klamath Basin is the best example); but Great Basin forms entered into the Klamath and Sacramento systems *via* such routes; in turn, California forms which

had earlier penetrated into the Snake system were stranded in various isolated drainages. Many of the Pliocene lakes had considerable endemic faunas; only remnants of these persist today (such as some of the listed Idaho cold water species: Frest & Johannes, 1992a). In Washington, late Pleistocene glacial advance removed or relocated much of the freshwater fauna. Areas affected today have limited western faunas; but short-lived drainage connections during the most extensive Pleistocene glaciation allowed a few Mississippi forms to reach the West Coast. In other cases, Miocene-Pleistocene tectonics and glaciation seems to have induced bicoastal speciation in genera present across the continent.

As a result, the freshwater mollusk fauna of each major drainage system is often composite. There is a strong continent- or world-wide component, as well as a generalized western North American element. Certain characteristic western genera, such as *Fluminicola* and *Juga*, have parallels with eastern forms (*e.g., Elimia* and *Somatogyrus*); but their nearest relatives are as likely to be extralimital (e.g., the Chinese *Namrutua* and Japanese *Semisulcospira* for *Juga*; the South American *Potamolithus* for *Numinicola*). In other cases, the differences in "recent" geologic history between western and eastern North America are reflected in different species swarms in the same genera, *e.g. Pyrgulopsis* and *Lyogyrus*. Sphaeriids mostly have continent-wide or even hemisphere-wide distributions; but a couple of species are western endemics. The western unionacean fauna is small compared to the 300 or so eastern forms; none are wmmon to the two regions. The more stable areas generally have core faunas, including some endemics; speciation has been rampant in the interior basins; and major portions of each large system have been added from other systems. Such areas have distinctive faunas, often with sister species in the drainage of origin and in the captured segment. Regions with complex geologic history and varied substrate are likely to have endemics, especially in springs and spring-influenced habitats. In general, the elements most exotic to North America and/or the most characteristic Pacific Coast forms tend to occur coastally or west of the Cascades, while Great Basin and eastern forms tend to be found east of the Cascades. Local biotic interpenetration and mixing are extensive, however.

As regards specific freshwater mollusk provinces (see Burch, 1989, fig. 20 for recent treatment), analogous considerations apply to those outlined for terrestrial mollusks (*q.v.*). The Pacific Drainage is situated similarly to the coastal land snail provinces (Oregonian, Washingtonian, and Californian). The northern part of this area, adjacent to the ICB, is characterized by the presence of large species of the genus *Fluminicola*, *Juga* species of the subgenus *Juga*, and by the absence of most other hydrobiid genera. The Columbia Drainage is a separate unit, analogous to the upper part of the Washingtonian Province. This area has its own large *Fluminicola* fauna; the lymnaeid genus *Fisherola*; and *Juga is* rare, occurring in peripheral regions only. Other hydrobiids (*Amnicola* and *Lyogyrus*) are generally rather rare and spotty in distribution. One exception is *Pristinicola*, common to both the Pacific and Columbia drainages (Hershler et *al.,* 1994). The Interior Drainage province, situated similarly to the southern portion of the Washingtonian Province, makes up part of the ICB in Nevada, Utah, southeastern Idaho, and especially in southern Oregon. Endemic clusters are most notable in the family Hydrobiidae (small

Fluminicola species, ***Lyogyrus, Pyrgulopsis)*** and locally in the pleurocerid genus *Juga* (here, the subgenera ***Oreobasis*** and ***Calibasis*** particularly). Many of the ***Pyrgulopsis*** species clusters are not closely related to those of the core Great Basin; and the distribution of 'the genus ***Tryonia*** lies mostly to the south of the ICB. The family Lancidae, restricted solely to a small part of western North America, is generally coastal in distribution and occurs mostly in a few streams in southwestern Oregon-northwestern California. Additionally, one genus and species occurs in the Columbia Basin, and a relict Endangered species is found at three sites in the Idaho middle Snake drainage. Freshwater species confined to single or a few streams or springs are not unwmmon in western North America. Many small and some large **taxa** are restricted to particular streams or to particular springs or spring sets (nasmodes) in the ICB assessment area.

Relatively few freshwater endemics are yet known from the North Pacific Drainage, which is analogous in position and extent to the Oregonian land snail Province. In the north portion (north of the Columbia River), only a few may occur, due to the effects of Wiswnsinan glaciation. One example is the lake form ***Valvata merge//a;*** we have been unable to recollect any of the old populations. The Oregon and northern California portions of this province have yet to be comprehensively collected; but some species are known to be narrow endemics, such ***as Juga (0.) chacei*** and ***Juga (0.) orickensis.*** At the eastern extreme of the ICB, relatively few strict endemics are known as yet from Montana; and endemic hydrobiids seem to be sparse here (as in Washington and northern Idaho), as compared to Nevada, Utah, Idaho, and eastern Oregon.

Freshwater mussels in the area are few (perhaps 9 species); all are different from eastern species, and all have now lost considerable portions of their range. The small number of **taxa** as compared to central and eastern North America means that essentially all of western North America comprises a single province, the Pacific (Figure 3). This area has boundaries resembling those of the terrestrial mollusk Western American Division, and includes the ICB. Of particular interest is the substantial area that lacks all larger freshwater clams. The smaller fingernail dams or sphaeriids **are** more varied (perhaps 20 species in the ICB); but most are relatively cosmopolitan, and there is little indication of endemism, except for two important **taxa,** both restricted to the Great Basin periphery: ***Pisidium ultramontanum*** (Figure 17) and ***Pisidium*** n. sp. (see **Taylor &** Bright, 1987) for distribution map. Both **taxa** are very **rare** and show the fishhook pattern of distribution.

As with the terrestrial forms, a few areas have strongly composite faunas, difficult to assign to a single province. Notable in the ICB is the Columbia Gorge. This region combines endemic ***Juga (Juga)*** with endemic ***Juga (Oreobasis)*** species; ***has rare Fluminicola*** (and, unlike other areas, these do not occur in springs); and lacks crenophile ***Pyrgulopsis,*** but has endemic ***Lyogyrus.*** The nearby lower Columbia River and Deschutes River have strange faunas combining coastal elements with endemics seemingly derived from Great Basin peripheral drainages. Another such area is the Upper Klamath Lake drainage, which has many surviving Great Basin elements, plus its own endemic swarm of hydrobiids, mostly small ***Fluminicola,***

but including large *Fluminicola*, *Lyogyrus*, and *Pyrgulopsis* species. This region also 'has unusual planorbid diversity, notably in *Helisoma (Carinifex)* and *Vorticifex*; and two rare sphaeriid species. It is worth noting that most of the biogeographically "difficult" freshwater areas present similar problems with their terrestrial mollusk faunas.

Ranges of some of the more significant genera in the ICB are discussed individually here. Pleurocerids (all in the genus *Juga*) are very important to the coastal provinces but only peripherally invade the ICB; occurrences are notable but not common or typical. Pleurocerids are anomalously rare in the present Upper Klamath Lake drainage but diverse in the Columbii Gorge and in the Oregon Deschutes River. They are essentially absent from most of Interior Oregon, eastern Washington, and Idaho and Montana. The lancid *Lanx* is present on the southwestern periphery of the ICB and in the middle Snake River; elsewhere in the Columbia Basin, *Fisherola* is the only lancid present. Distribution of the Hydrobiidae is particularly interesting. The highly speciose and typically endemic genus *Pyrgulopsis 'is* mostly present on the south side of the ICB (Figure 12), with the exception of one disjunct area along the lower Columbia River. Great Basin peripheral forms, e.g. those in Interior Oregon and southeastern Idaho, appear to belong to different lineages than those of the core Great Basin; and while about half belong to a common species group, the remainder seem to make up well-differentiated species clusters (mostly undescribed as yet) characteristic of each area. This sort of distribution *has* been noted in *Pyrgulopsis* elsewhere, *e.g.* in northeastern California, Ash Meadows, Death Valley, etc. (Hershler, 1994 and references therein). While the bulk of *Pyrgulopsis* speciation is western, there is a small group of eastern species, which appear well differentiated from their western congeners (Hershler, 1994). The distribution of *Lyogyrus* is mostly in areas to the north of that of *Pyrgulopsis* (Figure- 13), although overlap occurs, particularly in eastern Wyoming, northern Utah, south central Oregon, and southeastern Idaho, producing unusually diverse faunas in the last 2 areas. Distribution of *Lyogyrus* is patchy in the west, unlike the situation in the eastern U.S. Most western forms were discovered relatively recently. In general, these taxa appear quite different from eastern forms, and may well constitute separate genera or subgenera when better studied. Most distinctive are the southern clusters in the Upper Klamath Lake drainage and in southern Idaho. More northern-occurring taxa bear more resemblance to eastern forms, but are distinct at the species level. Apparent absence of *Lyogyrus* from large areas of the ICB appears to be real, and is evident in the fossil record in some regions as well.

Biogeography of the characteristic western genus *Fluminicola* is somewhat problematic at present, as detailed revision is just now getting under way (Hershler & Frest, in press). It is likely that this genus will be split into several subgenera or genera when taxonomic work is complete. Large species of *Fluminicola* (*s.l.*) occur throughout much of the Pacific coastal drainage region and the ICB, with two important exceptions. This genus historically was virtually absent from Montana; and indeed may now well be extinct there. It also does not occur in much of the Oregon Interior Basins region. Within the area of occurrence, there is considerable differentiation at the species and perhaps higher levels. Coastal large forms are

mostly distinct from those of interior Washington and Idaho; those in the upper Snake drainage and adjoining areas may also be distinct from species occurring lower in the Snake and in its larger tributaries. The large *Fluminicola* species in the lower Columbia River itself and in the Willamette River (Oregon) may well also represent a separate group; and those in the Upper Klamath Lake drainage almost certainly do. *The* small species of *Fluminicola* in part occupy areas outside the range of the larger forms (Figure 15). The is particularly the case. in the Oregon Interior Basins and other areas on the Great Basin periphery. Considerable species differentiation has taken place, if, e.g. the Upper Klamath Lake Drainage and Interior forms are compared. Most of the hydrobiid distributions seem to result from historical factors, rather than lack of habitat. *Pyrgulopsis*, *Lyogyrus*, and both small and large *Fluminicola* species often occupy substantially identical habitat; indeed, they co-occur quite happily in some drainages. There may be physiological as well as historical reasons, however, for the current absence of *Tryonia* from much of the ICB, especially given that it did occur in southeastern Idaho during the Pleistocene, and still is found in central and western Utah (Taylor & Bright, 1987). Many of the hydrobiid species have very patchy distributions, due to habitat limitations (obligate thermiphiles are obvious examples) or later habitat modification, e.g. of cold springs. Still, many of these taxa may have historically been somewhat limited in occurrence, with essentially a relict distribution pattern like that of *Helisoma (Carinifex) newberryi* (Figure 16). Examination of the fossil record and current habitat can often readily distinguish taxa rare as a result of recent, fiuman-caused habitat disturbance from those genuinely rare or limited by recent geologic history.

Many of the few larger bivalve species which occur in the ICB have (or had historically) broad ranges within it. Exceptions are *Anodonta wahlametensis,* disjunct from California into the bwer Columbia River, and *Margaritifera* n. sp. 1, confined to southeastern Idaho. Certain species have the bulk of their distribution in the ICB. Examples are *Gonidea angulata* and *Anodonta oregonensis.* Outside of California and Arizona, most, of the range of the candidate *Anodonta californiensis* is within the ICB. As noted above, most sphaeriids are broadly distributed in the ICB, repeating a pattern common worldwide. The two exceptions are good examples of relict distributions *(e.g., Pisidium ultramontanum*: Figure 17).

LAND SNAILS AND SLUGS

BACKGROUND

Over 150 species of land snails and slugs have to date been ascribed to or described from eastern Washington and Oregon, Idaho, and western Montana. Large numbers of these were described during the classical period of U.S. malacology, *i.e.* from about 1860-1940. Mapr workers during this period included Henry Hemphill, who was active in Idaho, Washington, and Oregon from about 1860-1890; Henry Pilsbry and his collaborators (Vanatta, Ferriss), describing western U.S. forms from about 1910-1948; H. B. Baker, especially active in the West in the 1920s and 30s; and Junius Henderson, working also in the period 1920-1940. Most of the earlier discoveries are summarized in Pilsbry's famous monograph (1939-48), still unsurpassed as a summary of knowledge concerning western U.S. land forms. After a time of relative quiescence marked by the publication of many smaller works, the pace of discovery and description of new forms has once again accelerated. It is quite likely that the land snail and slug fauna will eventually more than double, to approximately 300 forms. The slug fauna of about a dozen species is about half as large as that west of the Cascades, but still extraordinary. Many of the land snail genera occur only in western North America west of the Rocky Mountains; the fauna is thus sharply distinct from that of the rest of the U.S. As detailed below, endemicity is remarkable in certain genera, notably in the shelled genera *Oreohelix* and *Cryptomastix* and the slug *Hemphillia*. A number of distinct endemic clusters occur in various places (Tables 1 l-28). Quite often, this endemicity is paralleled not only in mollusks, but in other animal and even plant groups as well.

OCCURRENCE

Land snails can be found at any elevation and in all situations from coastal lowlands to arid deserts, if the area is relatively undisturbed. As a generality, land snails are most diverse in tropical regions and on certain 'Pacific islands (Solem, 1974, 1984); but temperate diversity on a site basis may be equal to that in more equatorial climes. Solem (1974), Solem, Climo, & Roscoe (1981), Solem & Climo (1985), and Emberton (1995) record sites from temperate New Zealand and Madagascar with land snail diversity exceeding 50 species. Some sites in eastern North America have more than 30 species (Emberton,

1995; Hubricht, unpub.), and Midwestern sites with 20 or more species are not unusual. On a world-wide basis, forested locales are generally most diverse, and the average overall is probably close to 20 (Solem, 1984). In the western U.S., sites with this diversity are less common, although quite possible in coastal sites, e.g. in the Olympics (Branson's (1977, 1980) and Branson & Branson's (1984) sites are much less diverse because efforts were limited to hand collecting). In our experience, litter sampling of coastal fir forests in Washington, Oregon, and northern California, as well as in mixed spruce, fir, or pine forests in northern Washington, northern Idaho, and western Montana generally yields 10-15 species of shelled snails and slugs in relatively intact sites. Other things being equal, diversity declines at high latitudes; and these faunas typically consist mostly of small and widespread forms. Areas that are permanently frozen generally lack land snails.

At the other end of the spectrum, truly arid regions (< 6" of precipitation yearly) also often have low diversity land snail faunas or large regions with no land mollusks. On the other hand, relictual areas in such regions may have surprising diversity (often low abundance), and certain land snail families are specialized for and regions. In North America, two examples are the Mexican-southwestern Urocoptidae and Holospiridae. Semiarid areas (>6 but <12" annual precipitation) generally have land snail faunas, sometimes showing substantial diversity. Often, only one or two species will be found at a site, but regional endemics can be common. Hells Canyon (ID-OR-WA), the lower Salmon River valley (ID), and the Utah Wasatch Range are world-famous for their diverse semiarid land snail faunas. Quite often, families or smaller groupings will show physiological specialization for particular environments, e.g. for arid and semiarid areas. Factors influencing distribution and physiological modifications for land snails of such regions have been discussed by Schmidt-Nielsen et a/. (1971). One example is the western U.S. endemic genus ***Oreohelix.*** Physiological adaptations for aestivation in this genus have been investigated by Rees & Hand (1990, 1991, 1993) and Rees et ***a/.*** (1991). One obvious adaptation by ***Oreohelix*** is the practice of hatching eggs internally, instead of the typical pattern of laying them in favorable locations. Dessication of eggs and juveniles is perhaps the most common cause of land snail death world wide (Solem, 1984), and the problem is acute in arid areas. Hatching the eggs internally provides some insulation; additionally, adults seem to be able to delay release of juvenile if conditions warrant. Despite environment-tuned moisture tolerances, land snails and slugs prefer moist environments, with some taxa being restricted to and many preferring the more typically moist portions of the particular environment in which they occur. Thus, distinct xerophile, mesophile, and notophile species groups may characterize certain portions of any large geographic area. Sometimes, moisture preferences seem to characterize groupings even at the generic level. ***Vespericola,*** for example, is generally a strong notophile, as is the slug genus ***Hemphillia. Holospira*** seem to be a definite xerophile. The more speciose or more widespread genera often have species specialized for particular moisture regimes. Examples in the ICB include the characteristic large genus ***Oreohelix*** and the widespread small genus ***Vertigo.***

Just as land snail diversity (and often abundance) decreases in area with low effective moisture (be these cold xeric conditions such as tundra or warm xeric such as desert), diversity (and often abundance) generally decreases with increasing attitude. High-altitude faunas often consist mostly of small taxa, many of which are not endemics; and site diversity often is 5 or less in the ICB. A few apparent true hypsiphile large taxa do occur in the ICB. Example include ***Oreohelix alpina, Oreohelix elrodi***, and ***Discus brunsoni.*** True ***Oreohelix subrudis*** also seems to prefer such settings.

For other species, temperature preferences may be a more strongly determining factor limiting distribution. Most species in the ***Oreohelix haydeni*** group, for example, seem to prefer warm xeric settings. Certain taxa, such ***as Pristiloma arctica***, ***Vertigo modesta***, ***Vertigo alpestris***, and ***Zoogenetes harpa***, prefer cold environments. Such species as these become more common regionally to the north, where they may be widespread at low elevations, but are rare to the south, where they may be confined to mountain tops. An example among larger taxa is the Federal candidate species ***Discus shimeki (see, e.g.*** discussion in Bequaert & Miller, 1973, and Frest & Johannes, 1993d).

Size analyses of land snails indicate a strongly uneven distribution by height or volume. According to Burch & Pearce (1990), there are four main groupings: 1) minute (< 3 mm in longest (major) dimension); 2) small (3-10 mm major dimension); 3) medium (1 l-30 mm major dimension); and 4) (>30 mm major dimension). Emberton (1995) suggests a very similar arrangement. Quite useful locally is subdivision into three subgroupings: those ≤ 2 mm (which often make up half the diversity of atypical land snail fauna); those 2-10 mm (which may be termed medium-sized); and those > 10 mm (large). Small species, though seldom noticed, are most ubiquitous, as their small size makes concealment from predators and retirement in adverse conditions most practical. Viable populations of small forms may occupy very small areas. At the highest elevations (tundra-like habitat), only small forms are found. Likely genera in the ICB assessment area include ***Pristiloma, Pupil/a, Vertigo, Vallonia***, ***Cochlicopa, Punctum,*** and ***Euconulus*** among small forms; and ***Discus, Zonifoides, Refinel/a,*** and ***Radiodiscus*** among medium-sized. Generally, the larger genera are absent at high elevations; but such forms as ***Oreohelix alpina*** and ***Oreoehlix subrudis may*** be exceptions. Quite often some slugs (e.g., ***Udosarx***, ***Deroceras)*** are present also. On the whole, the alpine land snail fauna is mostly rather widespread and eurytopic forms, many of which may be present at lower elevations as well (examples include ***Oreohelix subrudis, Cochlicopa lubrica***; ***Discus whitneyi, Deroceras*** spp., ***Euconulus fulvus alaskensis***, ***Punctum*** spp., and ***Zonitoides arboreus***), or species which are present at tower elevations to the north (e.g., ***Zoogenetes harpa***, ***Retinella wheatleyi***). Only a few described taxa in the ICB appear to be true alpine endemics (hypsiphiles). The best examples are the large ***Oreohelix alpina*** and small ***Pristiloma arcticum crateris.*** Forms which appear to be restricted to moderately high-high elevations are, however, quite common. Prominent examples in the assessment area include ***Oreohelix subrudis, Oreohelix idahoensis baileyi***, ***Oreohelix hammeri***, ***Oreohelix*** n. sp. 8, and ***Oreohelix sfrigosa*** n. subsp. 1. At lower elevations, substantial numbers from all 3 size groupings may be present. Generally, the large polygyrid land snail genera ***Allogona, Vespericola,*** and ***Cryptomastix***

occur only at low-moderate elevations. Few smell to medium-sized forms seem as restricted, although diversity is generally higher in al three groups at lower elevations (if pristine sites are compared). Thus, there is some suggestion of altitudinal speciation in some genera, but most is likely due more to responses to differences in effective precipitation and temperature than to height *per se.*

Despite the original, essentially ubiquitous distribution of terrestrial mollusks in the assessment area, the modem picture is somewhat different. Were one to, say, divide the whole area into 1 mi. grid squares and sample the comers, at least 8090% or more of the samples would have no mollusks. Much of this is due to human modifications in the last 150 years; however, some is due to other factors. These include unfavorable substrate (e.g. granite); recent formation geologically (e.g. the eastern Snake River Plain); effects of Pleistocene glaciation (e.g. the northern Cascades); and effects of catastrophic geologic events (e.g. interior Washington, as a result of the Missoula Floods). Portions of interior WA and OR even before settlement had relatively few land snails due to the effects of the Pleistocene Bonneville and Missoula Floods. Some of these same areas and the eastern Snake River Plain, ID and upper Deschutes River drainage, OR are volcanic terrain of relatively recent origin. The very patchy distribution of land snails in Yellowstone National Park is due to the same cause. Granitic terrain is generally unfavorable to mollusks; hence, they are rare in the Sawtooth Mountains and Idaho Batholith areas in ID, even though immediately adjacent regions in the same state are unusually diverse. Northwestern WA has a comparatively small fauna due to Pleistocene glaciation. As will be detailed below, provincial boundaries are also due in part to geologic history; Since the Miocene, areas between the Rocky Mountains and the Cascades have become relatively dry, and may lack land snails except locally. Such gaps in distribution are evident when plots of the distribution of the principal genera are compared (see Figures 8-10).

ECOLOGY

Many areas favored by land snails share common features. Most significant are cover, effective moisture availability, and geologic history. Geologically distinctive regions (such as the Hells Canyon-lower Salmon River area of Idaho, eastern Oregon, and southeastern Washington: Figures 4, 7) often have high diversity and many endemics. This is partly due to mollusks' substrate preferences. For example, a large proportion of the eastern U.S. land snail fauna is calciphilous, found only on limestone, dolomite, and similar lithologies and soils derived from them (note listings in Hubricht, 1985). In the ICB, many species of *Oreohelix* are thought to be calciphiles (Pilsbry, 1939). Examples include ***Oreohelix idahoensis baileyi***, ***Oreohelix idahoensis idahoensis, Oreohelix haydeni hesperia, Oreohelix*** n. sp. 14, ***Oreohelix*** n. sp. 16, and *Oreohelix* n. sp. 20. Other land snails similarly limited include ***Discus marmorensis.*** In numerous other cases, highly endemic forms seem similarly limited (e.g., ***Oreohelix haydeni perplexa, Oreohelix elrodi***,

Oreohelix alpina, *Oreohelix hammeri*, *Cryptomastix magnidentata, Ctyptomastix mullani latilabris*); but the limited geographic distribution makes interpretation of substrate preference equivocal. Almost as common is restriction to basalt and basalt-derived soils. Examples here include ***Cfyptomastix (Ctyptomastix)*** n. sp. 2, ***Monadenia fidelis minor, Vespericola columbiana depressa, Oreohelix variabilis***, and ***Oreohelix*** vortex. As with the limestone snails, small geographic range may obfuscate substrate preferences: ***Cryptomastix*** n. sp. 4 is a prime example.

A few rock types seem more or less inimical to these animals. Land snails are often very rare, for example, on granitic terrains, and many of the core Rocky Mountain ranges with predominantly basement (basic igneous lithologies) rocks have reduced or no land snail faunas. The effect on slugs is not as great: but also quite evident. Examples of such ranges are the Idaho Sawtooths and the Tobacco Root Mountains of Montana. Even in these areas, certain more ubiquitous and broadly tolerant taxa are present. Quite often, the minute terrestrial species ***(e.g.,*** species of ***Vertigo, Pupil/a,*** and ***Euconulus)*** are least affected by substrate differences. However, some large forms are also quite catholic in substrate occurrence. ***Oreohelix jugalis***, ***Oreohelix strigosa depressa, Oreohelix subrudis,*** and ***Allogona ptychophora ptychophora*** are prominent examples. Quite often, rock type is of more significance than plant community ***per*** se. Soil pH is thus a good measure of land snail abundance and diversity in the Columbia Basin. Compared to eastern U.S. (Appalachian) faunas, western snails can tolerate moderately acid conditions; but faunas are more diverse (and, often, individuals are more abundant) on soils with slightly alkaline pH. Slugs do not require $CaCO_3$ for their [reduced or absent] shells, and hence would not seem likely to be as restricted; however, alkaline soils are also preferred by many shell-less forms also.

In interpreting the influence of rock type, some caution should be exercised. While limestone, marble, and dolomite are obvious sources of $CaCO_3$, as are many other sedimentary rocks, some igneous lithologies, such as carbonatites and certain granite types, may be quite adequate. Similarly, some metamorphic lithologies can varywidely in $CaCO_3$ content, but are often eminently suitable for maintaining large faunas. Schists, serpentinites, and some metasedimentary terrains are common examples in the Columbia Basin. While having only a small percentage of calcareous matter ***per*** se, this readily becomes part of the soil, making them excellent regolith contributors from the point of view of mollusk diversity. The ability of some larger land snails to thrive on seemingly unsuitable soils is remarkable. ***Oreohelix*** n. sp. ***27,*** for example, is confined to an Ordovician quartzite and is seemingly absent from bordering limestones. Several prominent geologic units in the Columbia Basin have exceptional land snail faunas associated with them in at least part of their outcrop area. Most notable are the Carboniferous Madison Limestone (and equivalents: Lodgepole, Mission Canyon) and Amsden Formation; the Permian Phosphoria Formation; and the Miocene-Pliocene basalts of the Columbia River Group.

Edaphic conditions are likely primary controls for many western species as well. In general, diversity and abundance are highest in areas with persistent and considerable free moisture. Thus, moist forests, slope bases, north slopes, springs, and seeps, edges of floodplains, and rock taluses are areas of

concentration. Shaded and well-vegetated locales are also typically areas with exceptional abundance and diversity. In semiarid regions, such considerations are paramount. Large portions of such areas may lack land snails attogether, or have sparse faunas consisting of a few exceptionally xeric-tolerant forms (e.g., species of *Vallonia*, *Pupilla*, or *Zonitoides).* In such regions, mountainous and rocky areas, with common springs or taluses, may be islands of abundance and/or endemicity for terrestrial mollusks. Many of the dryland forms are specialized for such habitats, and cannot tolerate humidities and moisture levels typical for forest snails. In some cases, particular lineages may be specialized for such environments. Examples include *Oreohelix haydeni* and related forms, *Oreohelix variabilis* and related forms, Allogona *ptychophora solida*, *Cryptomastix populi*, *Cryptomastix hendersoni,* and *Cryptomastix harfordiana* and related forms. As might be expected, most slugs occur in moist environments: *Hemphillia* and *Magnipelta* are essentially restricted to them, and are clearly notophiles. *Prophysaon is* best characterized as a mesophile-moderate notophile. Though essentially mesophilic, some, such as *Deroceras* spp., are quite widespread.

The biology and role of land snails and slugs in the varied ICB ecosystems are closely similar to those of many arthropods (see Olson, 1992 for background). Notable differences are: 1) mollusk diversity is usually much less; and 2) insects are generally much more easily dispersed. Terrestrial mollusks can be considered analogous to flightless insects in several important respects. In general, land snails in this region (as elsewhere in North America) require relatively undisturbed vegetational cover appropriate to the habitat involved, which may range from closed canopy forest to sage scrub or open, rocky talus. Most are somewhat retiring, and avoid areas with strong insolation or exposure. Many cease activii and shelter during dry or exceptionally cold or hot periods. At some times in the year, land snails are most active from dusk to dawn. Genera such *as Monadenia* may be strongly eoan and/or crepuscular; others, such as *Vespericola* and many slugs, may be quite active in daylight. Activity and visibility often increase markedly after rain storms. Many thrive in lowland to middle elevation moist (often riparian) forests and the areas around springs, bogs, or marshes. Rocky taluses or rockslides are another favorite habitat; these may be occupied regardless of cover, but the snails may be difficult to find except under special weather conditions. In this region, occurrences in basalt or limestone taluses are frequent. Coastal areas, because of their relatively high humidity, are another favored area of occurrence. Minor differences in insolation, cover, or availability of moisture, even on the same slope, may result in very different land snail communities (e.g., Roth & Eng, 1980). Thus, colonies can be very local.

Because terrestrial mollusks are relatively small, viable colonies may occupy surprisingly small areas. While the size of long-term viable populations is still somewhat a matter of dispute, examples are known of survival with as few as 1,500 adults in a colony (Frest, 1984). It is safe to say that only a few thousand individuals may be sufficient. For minute forms, colonies of only a few square feet seem to be viable in certain cases (Frest, 1991); however, somewhat larger buffer areas are evidently necessary to maintain such small sites in the long run. Even for larger species, colonies'are not great in areal extent. The largest

Oreohelix colony of which we are aware is about 1 mi. long and 1/4 mi. in width. One of the smaller we have observed is about 12" in width and less than 20' long; another is approximately 6' in length and 2' in width. In both of these cases, the snail genera involved (*Vertigo* and *Oreohelix*) typically are dominants and have large standing populations. Other genera, e.g. *Monadenia* (Roth & Eng, 1980) and *Magnipelta* are typically rather scattered in occurrence. As many as 20 adult *Oreohelix* may occur per 1/4 m quadrat square in such species as *Oreohelix strigosa cooperi*, *Oreohelix haydeni hesperia*, *Oreohelix idahoensis idahoensis*, and *Oreohelix strigosa goniogyra*. In some areas, such species appear to literally cover the ground, and are much more abundant than all co-occurring insects. Interestingly, all of these are xerophiles. Other species, such as *Oreohelix elrodi* and *Oreohelix amariradix*, may occur at densities of less than 1 adult per 1 m square. Some other environments may be equally productive in tenns of biomass. The calcareous fens studied by Frest (1990) had up to 4,000 mollusks per 1/4 m square. In semiarid areas, large-sized snail species colonies may consist of millions of individuals. At rich sites, dead snail shells may litter the ground, outweighing even total live plant biomass.

Regardless of major habitat type, desiccation is the primary reason for land snail mortality even in undisturbed habitats (Solem, 1984). Snails and slugs in each major habitat type have evolved ways of dealing with the problem. Talus-dwellers are often cryptic for most of the year. Most snails shelter or aestivate even in dense forests in the typically dry period from June-September: many hibernate in winter. Snails and slugs frequently shelter under *rocks,* leaves, bark, litter, or logs. Some *Monadenia* and *Prophysaon* individuals shelter in moss on trees far above the ground. Even snails more tolerant of xeric conditions need rocks or loose plant material of some size and volume for diurnal and seasonal shelter. Suitable winter or long-term retreats (hibernaculae) are uncommon at any given site, and may be occupied over many years and by large numbers of individuals. Thus ready availability of coarse woody debris is very important for forest mollusks, as it is for many other forest-dwellers (see Harmon et al., 1986 for a general review; Spies, Franklin, & Thomas, 1988 for Douglas fir forests). Most species seem to prefer to have 'relatively large debris pieces available, *i.e.* logs and major branches, although bark and smaller pieces should be present also. large debris piles do not seem to constitute good mollusk shelter. Loose rock and talus and the root balls, radices, or bases of larger vascular plants serve the same function in and or semiarid areas, with particular plants (generally larger individuals) often considerably favored. Genera such as *Balsamorrhiza*, *Celtus*, *Physocarpus*, *Prunus*, *Sorbus*, and *Artemisia* are very significant as shelter plants in semiarid environments.

Formerly, land snails were thought to occur only in vegetational communities in which deciduous trees or shrubs are an important element (Karlin, 1961). It soon became apparent that land snails occurred just as often in coniferous forests (Kralka, 1986). Still, it remains true that land snail diversity, and sometime abundance, are greatest in plant communities with a significant non-coniferous component. Certain forms, such as some *Vertigo* and other pupillid species, some succineids, some *Oreohelix* species, some slugs, and many others may be most abundant in pure coniferous stands, if these are relatively mature or moist.

In many cases, soil pH is a much better determinant of abundance and diversity than plant community structure *per* se. In the northwestern states, land snails have been found in the following forest plant associations, listed in no particular *order: Picea sitchensis*, *Sequoia sempervirens, Tsuga heterophylla, Pseudotsuga menziesii, Abies amabilis*, *Abies magnifica, Abies lasciocarpa*, *Tsuga mertensiana, Pseudotsuga*/hardwood, *Pinus ponderosa*, *Abies concolor, Abies grandis*, *Pinus contorta, Juniperus occidentalis,* and *Quercus garryana*, as well as the various more open plant communities with *Celtus occidentalis,* various *Artemisia* species, etc. Highdiversity associations are perhaps more likely to occur in the vicinity of *Populus, Betula*, *Acer*, *Salix*, *Physocarpus*, *Comus,* or *Tsuga.* Particularly appealing tree or shrub species are *Acer macrophyllum*, *Acer circinatum, Acer glabrum, Alnus rubrus*, *Alnus rhombifolia, Alnus sinuata*, *Amelanchier alnifolia*, the larger *Artemisia* species, *Betula papyrifera, Betula pumila, Betula occidentalis, Celtus occidentalis, Corylus comuta, Comus nuttalli*, *Comus stolonifera*, *Populus tremuloides, Populus trichocarpa, Prunus virginiana, Prunus emarginata,* and many species of *Salix. Arbutus or Rhododendron* seem less suitable than most, perhaps because these genera have rather tough leaves; a similar effect has been noted in Australian sclerophyl forests. *Gaultheria* stands may also be less diverse, although at least one coastal species, *Pristiloma pilsbryi*, has been found primarily in dense salal. Undoubtedly, there are a number of such associations in the ICB. One treatment of land snail/plant associations in western forests is Frest & Johannes (1993d); the works of Boag and his collaborators should also be consulted.

Slugs are a somewhat special case. The shell-less habitat has perhaps evolved independently at least 11 times on a world-wide basis (Solem, 1974). The lack of shells and special modifications of the slime enable slugs to shelter and move about more readily than most shelled forms. Specialized composition, and the ability to alter composition as required, enables slugs to use slime for protection from dessication, to enhance travel speeds, and to discourage predators. L. Deyrup-Olsen has conducted many elegant studies of the ways in which slugs utilize and modify slime.

Land snails and slugs are mostly herbivores; a few will also consume animal matter of various kinds, and fewer still *(Ancotrema, Haplotrema)* are carnivores, particularly of other snails. Most taxa commonly ingest soil, and very many, in particular slugs, commonly ingest fecal matter of all sorts. Terrestrial mollusks thus contribute substantially to nutrient recycling and breakdown of pbnt detritus and animal wastes. Some forms will digest wood, or chew it into fibers to form suitable locations for egg-laying. A few slugs are characteristically found in decaying togs. and appear to be feeding on partly decayed wood. The small forms generally eat soil, fecal matter, partly decayed leaves, and the small plants and fungi upon them. Leaves from deciduous trees and shrubs *(e.g., Salix, Alnus, Populus, Acer*, and *Cornus*) are particularly liked by some taxa. Some slugs and snails relish larger fungi. More often, green vegetation in the understory is preferred (examples include *Heracleum*, *Rorippa, Rubrus*, and even *Urtica*). Such shelled genera *as Allogona* and *Vespericola*, as well as many slugs, seem to commonly consume green vegetation; but all larger mollusks also eat fallen leaves, soil, and partly decayed matter in it. Some genera

(e.g., Monadenia) prefer fallen leaves or inner bark layers. Juvenile and adult feeding preferences may differ (Roth & Eng, 1980; personal obs.). Terrestrial mollusks are thus primary higher and lower plant and animal waste recyclers in both forested and more open situations. In turn, snails and slugs are consumed avidly by many small mammals (e.g., shrews, voles, shrew moles), amphibians, and by a number of birds. Various insects, including certain beetle, fly, and wasp families, either prey upon snails directly or parasitiie them with their eggs and larvae. Snail shells are used for shelter, domiciles, or egg-laying sites by a variety of insect and other arthropod taxa. Certain of the larger land snails were even utilized as food by Native Americans.

Life history of many taxa is strongly controlled by climate. Neatly all of the small species have one-year life spans and are semelparous. Breeding may take place in the spring, after snow melt; or somewhat later in the fall, especially September-October. Eggs hatch about one month after being laid, and some adults and many young survive the winter. Larger hnd snails are more variable. Intermediate-sized land snails, such as *Discus,* may commonly live for about 2 years. Some species of larger genera, such as Monadenia and *Oreohelix*, e.g., may live for at least 8-10 years; sexual maturity may be reached in these species in two to three years (Walton, 1970). *Vespericola* and *Cryptomastix* appear to have a much shorter life span, perhaps two years or less for most species. Life span may differ between talus dwellers and forest species in the same genus; this has not yet been carefully investigated, but xerophiles appear'to have significantly longer liie spans. The land snail genera *Allogona*, *Ancotrema, Cryptomastix, Haplotrema*, *Oreohelix, Polygyrella*, and *Monadenia* have been observed copulating most frequently in the period from April to June. Eggs and juveniles of the same genera have been seen most often from May to July. Under suitable conditions, egg laying may also take place in some forms in fall. Certain taxa, such as *Prophysaon,* are most likely to reproduce in the period from September to October. Mortality is heavy in the summer and winter. Certain slugs and shelled forms have similar life cycles; however, at least some genera' are iteroparous, and some have life spans greater than one year. As in freshwater mollusks, adults of small forms may die after laying eggs. The larger forms breed and lay eggs in much the same seasons as do the small species; but some genera appear to breed in only one season (or once per year), generally in the spring. In these taxa, adults need not commonly die from reproductive stress. Brood sizes may vary considerably from taxon to taxon. Seasonality of activity, including reproduction, is most strongly pronounced in open-ground, xerii, or talus habitats, and is much less so in perennially-moist environments. While available moisture at certain times is vital, species and genera vary widely in their moisture tolerances. Some forms *(e.g., Vespericola*, *Prophysaon,* and *Hemphillia*) are found only or largely in perpetually very moist areas, often riparian forests or spring and seep borders and are termed notophiles. Others (e.g., certain *Monadenia* and *Oreohelix* species: mesophiles) avoid extremely moist situations. Acid habitats such as bogs often have relatively low diversity faunas, with few large taxa. High diversity is frequently associated with calcareous habitats. The xerophile habit is quite common in the ICB.

Land snail colonies are long-term, with some clearly in the same area since the end of the Pleistocene *(i.e.,* for the last 10,000 years). One such was noted by Clarke & Hovingh (1993); example are wmmon in the semiarid portions of the ICB, in situations where preservation of Holocene and late Pleistocene fossils are likely. Migration may be generally slow; the *Oreohelix* colony described by Clarke & Hovingh, for example, has failed to reoccupy portions of a talus last inundated by the Bonneville Flood. In other situations, stream transport of at least 1.5 mi., due to one event, has been noted (Roth, *pers. comm.* 1993). Most typically, spread occurs the hard way, by crawling; and land snails may typically journey only as far as a 20' radius from their place of birth in a lifetime. Passive transport by stream or flooding or by animals, wind, etc. has been observed; but how typical and successful such events are in establishing long-term range changes needs more study. Methods of transport and colony foundation have been reviewed by Davis (1982) for freshwater forms and by Taylor (1988c).

FRESHWATER MOLLUSKS

BACKGROUND

To date, over 200 species of freshwater snails have been described from western North America. In recent years, the pace of taxonomic work has accelerated. It is likely that the total will exceed 400 in the next 20 years. Most of the new taxa are likely to be hydrobiids. About 30 freshwater bivalves occur west of the Rocky Mountains. Included are about 9 larger mussels (Unionidae, Margaritiferfdae, and Corbiculidae), plus approximately 20 so-called fingernail clams (Sphaeriidae). A few bivalve taxa remain to be described; but the vast majority have. long been known.

OCCURRENCE

Freshwater mollusks can inhabit permanent water bodies of all sizes. Some few can either tolerate, or are adapted specifically for, conditions in temporary or seasonal situations. Flowing-water situations are generally places of high diversity for both dams and snails, but lakes, in particular river lakes or spring-influenced bodies such as Clear Lake (Lake Co., California) or Upper Klamath Lake (Klamath Co., Oregon),

may have exceptional faunas. In the Pacific Coast states, abundance and diversity are often highest in clear, spring-fad streams or large spring pools with cold, well-oxygenated water and stable cobble-boulder substrate. At many sites preferred by West Coast mollusks aquatic macrophyte representation is relatively minor; the wmmon exception is springs, which may have dense stands of flowing-water species such as ***Rorippa, Veronica,*** and ***Cicuta*** along with huge snail populations. Freshwater mollusks can be found at all elevations; however, there is little tendency toward altiiudinal speciation. Perhaps the best example is in the Hydrobiidae. ***Pyrgulopsis*** and larger ***Fluminicola*** species generally occur at low-moderate elevations, while ***Lyogyrus*** can range much higher, into areas affected by Late Pleistocene mountain glaciation.

In Europe, there is a very large cavemiwle or phreatic fauna, perhaps 65 genera and 200 species, mostly hydrobiids. This habiiat range is very incompletely known anywhere in the U. S., with a few forms reported from the eastern U.S. and a substantial number from Texas (for a review, see Hershler & Holsinger, 1990 and references therein. Otherwise, this aspect of the western U.S. fauna is unexplored. Various areas, including the ICB, have substantial limestone karst areas (a prerequisite for most phreatic forms); so the potential is considerable.

Endemism is most frequent in springs and spring-fed streams, regardless of size. There are few if any endemic freshwater forms in temporary water bodies. Most endemics occur at low or moderate elevations, regardless of habitat. The candidate Rocky Mountain limpet ***Acroloxus coloradensis*** is an exception; and there could be undiscovered species with similar habitat preferences in the alpine lakes of the Pacific Ranges as well. In streams, it is quite wmmon for species compositions and dominances to change radically from the headwaters to the mouth. Endemic headwaters and large stream forms are frequent, as some amniphile forms are specialized only for headwaters or only for large rivers, e.g. the lower Columbia River endemics. Because of historic factors (discussed above), the freshwater mollusk faunas of larger systems are often not uniform, with particular species and even genera occurring either sporadically throughout or only in certain parts of the system, despite identical habitat being present elsewhere. High-gradient streams often have small and generalized freshwater mollusk faunas, as do areas with mobile substrate. Streams with glacial flour (e.g., Hood and Klickitat rivers, Washington & Oregon) often have small faunas composed only of widely distributed forms.

Prior to human modification -and to an extent still- many Pacific Coast streams provided exceptional mollusk habitat. River conditions historically were exceptionally favorable in the Sacramento, Columbia, Lahontan, and Klamath systems. The very large spring complexes of the Sacramento, Columbia Gorge, and Lahontan drainages also constitute extraordinarily favorable freshwater mollusk habiiat. While lotic habitats are comparatively common in the region, lentic sites are more limited. Notable are the large spring pools of the lower Pit River, California and the large spring-influenced lakes on the east periphery (Upper Klamath Lake, Lower Klamath Lake, Tule Lake, Goose Lake, Pyramid Lake, Lake Almanor, and Eagle Lake). In more than half of these, the native and endemic freshwater mollusk fauna has been seriously

impacted or extirpated. Forms specialized for limnocrenes are not uncommon; and such forms as *Pristinicola* seem to prefer very small springs or seeps (permanent only).

Most North American freshwater mollusk species are sensitive to pollution (Burch, 1989) regardless of source. Relatively few species tolerate warm waters, low dissolved oxygen, or major seasonal fluctuations. Certain pulmonates in the families Physidae, Lymnaeidae, and Planorbidae and some sphaetiid species are major exceptions. Most native Pacific Coast forms, however, are cold-water stenotherms. Such species prefer permanent dear and cold, unpolluted waters with dissolved oxygen (DC) levels near saturation. The cold-water forms are quite sensitive to hypoxic or anoxic conditions, in either the water column or substrate: again, certain lymnaeids and sphaerfids and a few unionaceans are the major exceptions. Very few clams or snails can tolerate algal blooms or dense macrophyte stands; they avoid or are excluded from areas with major diurnal DO fluctuations.

Well-watered areas, regardless of other factors, tend to have more diverse freshwater faunas. This is particularly the case for eucrenic areas and those with substantial nasmodes. On the whole, the best ICB aquatic mollusk habitats are somewhat oligotrophic and cold as compared to high-diversity habitats elsewhere. No instances of the sort of freshwater mussel or pleurocerid diversity achieved in some eastern U. S. streams and riffles (Taylor, 1988c) come to mind. However, co-occurrence of several hydrobiid species is not uncommon; and total site diversity not uncommonly exceeds 20 in spring, river, or lake habiiats. In the Pliocene, Lake Idaho seems to have had a freshwater diversity of about 90 species (Taylor, 1985a; unpub.); more than any other lake credibly examined: and Pleistocene Lake Thatcher in southeastern Idaho also seems to have had a very diverse freshwater mollusk fauna. Current diversity may thus in part be an artifact of the present interglacial climate.

As with terrestrial forms, there is a series of size classes in freshwater mollusks, not necessarily a continuous size distribution. A variety of snail and clam taxa have a minimum dimension of about 4 mm or less; midrange is about 4-10 mm for gastropods; and taxa over 1 cm may be considered large. In North America, exceptionally large native gastropod taxa are rare. For the dams (bivalves), all sphaeriids fall into the small or medium ranges, while all unionids have adults larger than 2 cm. In any given fauna, small mollusks make up a significant proportion of the mollusk biodiversity, and should not be overlooked while sampling. And and semi-and areas may not have well-distributed mollusk faunas; but the methods of dispersal used by some forms virtually guarantee occurrence of at least some species (often physids and sphaeriids) in just about any permanent water body, regardless of size, unless it is heavily polluted. Methods of dispersal have been reviewed by Russell-Hunter (1979), Davis (1982) and Taylor (1988c). Transport of the more widespread species may be passive, by wind, birds, fish, beetles, hemipterans, mammals, etc. Snails and small dams have been found in the plumage of long-distance migrators. Moreover, some mollusks may be able to survive ingestion and hence have another route of passive transport available. Many pulmonates lay thick gelatinous egg masses on aquatic plants that are commonly ingested by birds and other animals. Such masses are not always digested; and can also readily adhere to

fur or feathers. Snails in many families have comeous operculae (e.g. Valvatidae, Viviparidae; Hydrobiidae; Pleuroceridae); and it is thought that occasionally ingested animals in these groups will survive the experience. Sphaeriid clams brood their young; and ingestion of adults with young does not always lead to adult demise, let alone that of doubly-protected maturing young. Interestingly, it is those groups that are most widespread, such as aquatic pulmonates and sphaeriids, that are most avidly consumed by water-loving birds and mammals. Unionid mussels are dependent upon fish hosts for transport of their ectoparasitic larval form. Glochidia range from using single fish species as hosts to utilizing several, but in any case fish distribution, availability, and habiis are. the main determinants of freshwater mussel distribution.

Cold-water forms and perilithon 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 snails pace at best. Such considerations may partially explain the tendency for endemism to be much greater in such families as the Hydrobiidae and in lineages of other families preferring cold stenothermal stream habitats or cold springs. In general, crenocole or crenophile taxa make up a large part of any region's endemic freshwater mollusk fauna in the ICB. In the eastern U. S., however, this is less likely to be the case, as unionid diversity or that of riffle-dwelling pleurocerids or hydrobiids may be phenomenal. In general, spring habitats do not harbor unionids in any numbers, and most taxa are amniphiles. A certain proportion of unionids are well-adapted for lake environments; and there are some limnophile taxa. In the ICB, the species of *Anodonta* are the best example of the latter, while *Gonidea* and *Margaritifera* are almost always streamdwellers. Sphaeriids can be found in almost any permanent water habitat; and some species occur in or prefer temporary ponds or pools. Some sphaeriids are stenothermal as well, with cold-water stenotopes being more frequently encountered in the ICB. There is some indication of altitudinal stratification in the sphaeriids; but much of this is likely due to differences in temperature tolerances. Endemism in sphaeriids is rare, but does occur with at least 3 western U.S. forms, 2 of which occur in the ICB.

ECOLOGY

Trophically, most western U. S. freshwater snails are primary plant consumers. They are typically grazers, largely of aufwuchs (mostly attached diatoms, bacteria, and smaller epiphytic algal taxa) on stones. The majority are obligate perilithon feeders; a few can also graze periphyton, and a small number can also feed upon larger aquatic macrophytes. A few species, notably, including *Valvata humeralis, Helisoma (C.)*

newberryi, and some *Juga* species, are obligate or facultative detritivores, often occurring on or in oxygenated mud substrates. Feeding abilities vary from species to species. Some *Juga,* for example, can eat infallen waterlogged deciduous tree leaves. Whatever the trophic level, freshwater mollusks are very important to the ecosystem. *Juga*, for example, can comprise more than 90% of the invertebrate biomass in some streams (Furnish & Hawkins, 1987), and similar dense occurrences may have been standard in undisturbed aquatic habiits in the region. They can still be observed, with such ICB genera as *Fluminicola, Pyrgulopsis, Lyogyrus, Lanx, Juga*, *Stagnicola*, *Physella*, and *Margaritifera* among the most wmmon community dominants. Effects on substrate and upon periphyton can be substantial. A single detritivore species, *Valvata piscinalis*, may consume more than 36% of the organic detritus found upon a lake floor (Ostrovsky, 1981). Large and small bivalves are very effective filter-feeders, with unionids siphoning as much as 65 gals/day.

Certain freshwater snail species may be especially sensitive to disturbance. The Pacific Northwest endemic family Lancidae, for example, lacks either lungs or gills and has modified 'the shell shape into a limpet-like form. Respiration is accomplished entirely through the mantle; and all species seem especially sensitive to DO fluctuations or to hypoxic or anoxic conditions. The Upper Sacramento drainage form *Lanx patelloides* is one example; the Upper Klamath Lake form *Lanx klamathensis* is another. Many other disturbance-sensitive ICB snails belong to the hydrobiid genera *Fluminicola, Pyrgulopsis,* and *Lyogyrus.* While tolerances of the family vary considerably, these small snails are also often rather sensitive to pollution, siltation, warming, and hypoxia. They inhabit a variety of lentic and lotic environments, generally with cold, dear water, often flowing, high DO, and rocky substrate. Springs and spring-influenced habitats are especially favored. At least half of the ICB endemic freshwater taxa are Hydrobiidae in these 3 genera.

The freshwater clams, large and small, are filter-feeders, extracting diatoms, other unicellular organisms including bacteria, and fine organic detritus from the water column. The larger bivalves are mostly very sensitive to bw oxygen conditions and responsive to changes in water chemistry. Unionaceans accumulate heavy and transition elements in their tissues when they are present in ambient water. They also may filter out and retain organochloride herbicides, pesticides, and certain viruses. For all three substance classes, held concentrations can become autotoxic. Clams filter very large quantities of water, and eventually are also sensitive to bw or fluctuating DO. However, freshwater bivalves' abilii to lower their metabolic rate and close their valves in response to unfavorable conditions gives them some protection from event disturbances. Environmental tolerances of sphaetiids vary considerably. Many are relatively pollution and disturbance-tolerant, but a few are comparatively stenotopic cold water species *(e.g. Pisidium (C.) ultramontanum*, *Pisidium (N.) punctatum*). Most unionaceans prefer warse (sand-gravel, cobble, or boulder) substrate, while many sphaeriids prefer mud-fine gravel.

Oligotrophic mountain streams and springs are particularly prevalent as aquatic habitat in the ICB, as they are also in the Pacific Coast states. A number of freshwater species ate specifically adapted to this

environment. These have been termed “cold water biota” in Idaho; they are of especial interest in that many of the state’s endemic and Threatened and Endangered taxa (aside from mollusks) fall into this group. Preservation of cold water biota is a designated major goal of state water quality regulations in Idaho; one would hope that other ICB and Pacific Coast state and federal jurisdictions will do likewise. Five cold water taxa from the middle Snake River have recently been added to the Endangered Species list (USFWS, 1992d), after extensive study (Taylor, 1982c, d, *e,* f *unpub.;* Frest & Johannes, 1991a, 1992a, b, c; 1993a, b). Habitat characterization for these taxa is the same as that for many ICB and Pacific Coast forms: "[a]ll require exceptionally well-oxygenated, clean water. They are currently restricted to areas with unpolluted, cold, clear, flowing water, and are intolerant of impoundments; turbid water; stack water; water with substantial quantities of dissolved herbicides, pesticides, nitrates, or phosphates; water with substantial quantities of suspended fine sediment; habitats with unstable substrate, regardless of particle size; hypoxic wnditions, regardless of cause; and areas subject to frequent water level fluctuations. None are typically river-edge [amphibious] or lentic species; al prefer lotic habitats” (Frest & Johannes, 1992b, p. 8). Of the freshwater taxa listed in Tables I-3, the following likely fall into the cold water group: all *Juga* species; *Pyrgulopsis* species; all *Lyogyrus* species; all *Fluminicola* species; the species of *Lanx; Fisherola nuttalli, Helisoma (C.) newberryi;* the *Vorticifex* species; the larger bivalves; and *Pisidium (C.) ultramontanum and Pisidium* n. sp. The Idaho taxa are all lotic forms; but a few ICB and Pacific Coast taxa are lentic or can occupy both stream and lake habiiats.

There are also warm spring (thermiphile or thermicole) stenothermal taxa, particularly in the Hydrobiidae. ‘These are generally in the hydrobiid genera *Pyrgulopsis* or *Tryonia,* but include the physid *Physella (Petrophysa);* the former seem to form one or 2 phylogenetically discrete or coherent groups that will likely eventually be given separate generic or subgeneric status. Relatively few thermiphile taxa have yet been. found in the Cascades and Coast ranges. In the ICB, there is a scattering of occurrences, mostly in the Great Basin or Great Basin peripheral drainages. Notable are *Pyrgulopsis* species from the Snake River Plain, Idaho; southeastern Idaho; the Oregon Interior Basins; and central western Montana. *Petrophysa* occurs in Zion National Park, Utah, and in the Oregon Interior Basins region. Most freshwater mollusk species have narrow salinity tolerances (this does not necessarily hold on the generic or family level, particularly for such families as the Hydrobiidae), and most freshwater forms are not tolerant of acidic or very alkaline waters, although a few are specialized for alkali lakes. On average, freshwater mollusks prefer slightly alkaline habitats; as before, some Physidae, Planorbidae, or Sphaeriidae are the exceptions. As regards lithology, many species prefer calcareous substrate or waters derived from calcareous rock units, such as limestone and dolomite. Diversity is often lowest on basic igneous rocks such as granites; in extremely oligotrophic waters originating in areas underlain by such lithologies; or at high elevations, where water supply is mostly ice pack melt-out. A few species, however, either survive or are specifically adapted for such environments Certain species of *Lyogyrus,* for example, are found mostly at high elevations; as are some sphaeriids.

Life history of freshwater mollusks vanes (Calow, 1978, 1983). Most cold water snails are semelparous breeders with single-year life spans. A few taxa, such as *Valvata,* may sometimes live for *two years. Juga* may have a life span of 5-7 years and reach maturity in 3 years (Furnish, 1990). Pulmonates are often iteroparous breeders with up to several-year life spans. However, specialized pulmonates, including cold water stenotherms like the Lancidae, have 1 -year life spans and are semelparous. Most Pacific Northwest Hydrobiidae (*Fluminicola, Lyogyrus, Pyrgulopsis*) are short-lived (1 year), require at least several months to reach breeding age, and are semelparous. A few spring forms may be iteroparous, or may reach maturity in less than three months. Most Sphaeriidae essentially have 1 year life spans. Many of these small clams are iteroparous, though each brood is often small. None of the Pacific Coast freshwater mollusks have free-swimming veliger larvae. Most freshwater snails lay eggs, although a few, and the sphaeriids, are brooders. The bulk of the cold water forms lay small numbers of eggs attached to stones and covered with a tough membrane or capsule. Pulmonates generally lay larger, gelatinous egg masses, often attached to macrophytes; the cold water forms are more likely to lay small numbers of eggs in tough and inconspicuous capsules. *Juga* lays very loose finger-like egg clusters with large numbers of eggs. Many freshwater snails are hermaphroditic, but there are major exceptions, including most Hydrobiidae and Pleuroceridae, which are generally dioecious. Unionacean bivalves are mostly dioecious, have long life spans and are semelparous, often with comparatively long annual breeding seasons. Almost all of these large bivalves have a parasitii larval stage (the glochidial stage) resident for some weeks on the gills of freshwater fishes. The bivalves are dependent on the fish for distribution and successful completion of their life cycle. Host specificity of the glochidial stage varies from species to species; some are quite species-specific. Thus, fish host distribution is as vital to their survival as is availability of proper subadult and adult habit. Many larger freshwater darns are dioecious; sphaeriids are hermaphroditic and brood their young.

The breeding season for many of the Pacific Coast states cold-water snails appears to be between February-May, with egg laying and hatching taking place between March-July. Details and precise timing vary from species to species; but eggs are quite often laid about 1 month after copulation, and the eggs often hatch about 1 month after they are laid. Cold-water stenotherm breeding adults commonly die shortly after laying eggs. Metabolism varies seasonally and diurnally, with greater activii in the spring and summer and in the daytime. Certain species, particularly of freshwater snails, are also strongly photophobic. Seasonality, both in regard to metabolic rate and reproduction, appears to apply to river species more than to spring forms, but is still pronounced in the latter. Some snail species are quite sensitive to variations in insolation or to physical disturbance, often releasing their hold on the substrate if disturbed. Some species are relatively active; but the majoriiy (even of the active forms) do not voluntarily travel far from their place of birth, and thus are sessile for all practical purposes. This is particularly true for forms that are predominantly or totally perilithon feeders, such as *Vorticifex, Lanx,* and *Fluminicola,* and even some of the eurytopic types (such as many Physidae) may not travel far in flowing water habitats.

Substrate is a major factor influencing both diversity and abundance in freshwater mollusk communities (Harman, 1972). In the ICB, the majority of short-range or endemic taxa are those. preferring coarse substrate, such as gravel, boulders, or cobbles. A few of such taxa are limited to soft substrate (e.g., some *Tryonia* and *Pyrgulopsis* species; *Helisoma (Carinifex) newberryi*); but in these cases, mostly to oxygenated soft substrate, a habitat in short supply in polluted circumstances. A major feature of human-related activities in the ICB is that nearly all lead to increased fine-particle runoff, inimical to the majority of native mollusks, which are perilithon grazers and lithophiles. Among such are dams and impoundments; grazing; logging; and road and domicile construction.

Given the foregoing, many Pacific Coast and ICB freshwater mollusk species can accurately be characterized overall as stenotopic (more specifically as cold water stenotherms). These species in particular can be quite vulnerable to major disturbance events, due to certain features of their life history. Annual population turnover in most freshwater mollusk species is considerable (e.g. 90% or more for the hydrobiid *Fluminicola columbiana* and the lancid *Fisherola nuttalli:* Coutant & Becker, 1970; unpublished data), and many breed only once, generally in a well-defined and short season. In disturbed streams, mollusks may be disproportionately affected. This often makes them particularly effective bioindicators of pollution and other forms of environmental disturbance.

Generally, increase in siltation, decrease in flow, nutrient enrichment, pollution, dredging or other channel alterations, and damming or other flow impediments are likely to extirpate the more sensitive species. Most of the endemic or geographically restricted species discussed here prefer unpolluted, swift-flowing, clear, cold, well-oxygenated water. Level bottom and gravel-boulder substrate with relatively little rooted vegetation is also preferable for most. Families such as the Hydrobiidae (especially the Hydrobiinae, Amnicolinae, Nymphophylinae, and Lithoglyphinae), Pleuroceridae, and Lancidae are essentially restricted to such habitats. In some cases the reason is clearly physiological; the Lancidae, e.g., lack lungs and gills. Respiration is managed by the heavily vascularized mantle, and the heart rate is rapid compared to the related Lymnaeidae (Baker, 1925). Highly oxygenated, clean water is the *desideratum,* and the limpets have been observed to succumb quickly in warm, stagnant, or non-flowing water. Sites with mobile substrate, seasonal siltation, warm water, glacial flour, or impoundments have low diversity and few if any endemics or sensitive species. Many of the described freshwater taxa are found mostly at iow to middle elevations in streams and springs; there are a few lake endemics in this region. Destruction of springs by grazing, logging, and human exploitation (troughing or capping for stock use; diversion for human [water supply, fish hatcheries] or stock use) has already caused extensive extinction of species throughout western North America. In general, few of the cold water species can live in impoundments; nor can they tolerate eutropification. As most are obligate perilithon grazers and require stable substrate, siltation (such as that resulting from clear-cutting) generally means loss of habitat and at least local extirpation. Many taxa respond negatively to increases in water temperature, such as caused by increased insolation from removal of vegetation. Many freshwater mollusk species face habitat loss or

degradation from a combination of human actions operating simultaneously. Bonneville Power Administration (BPA) dams on the lower Columbia River, for example, eliminated much rocky substrate and free-flowing river habit. Siltation in the lower Columbia Basin, however, is exacerbated by lumbering and other land-clearing activities, e.g. on Gifford Pinchot and Mt. Hood National Forests, as well as by agriculture. A side effect of lumbering on the lower Columbia River has been pollution of river habiits by fleeting and storage of logs on the river and by discharge of sawmill and paper mill wastes into the river.

Now that many streams in the Pacific Coast, states have been affected by human modification, mollusks and their role in the ecosystem are often overlooked. In undisturbed habits they are often extremely abundant, and in fact frequently dominate the invertebrate fauna, both in terms of biomass and number of individuals. The genus *Juga*, for example, may comprise more than 90% of the total invertebrate biomass in some streams (Hawkins & Furnish, 1987). Similar densities are often encountered in Northwest lotic settings with the genera *Fluminicola*, *Vorticifex*, *Pyrgulopsis*, *Lanx*, and *Corbicula*. The effects of mollusks upon the periphyton, macrophyte, or aufwuchs communities are profound and complex (Hunter, 1980; Jacoby, 1985; Bronmark, 1985, 1989); Catteneo, 1983); Kairesalo & Koskimies, 1987; Sheldon, 1987; McCormick & Stevenson, 1989); Sphaeriids are also often very abundant (often dominant) in soft substrate communities. Examples of all of these occurrences still can be readily found in the less disturbed rivers, particularly the Umpqua, Rogue, Klamath, and Sacramento systems. Similar densities of the large bivalves *Gonidea angulata*, *Margaritifera falcata*, and *Anodonta oregonensis* occur in such streams as the Okanogan (Washington) and Snake (Washington-Idaho) rivers, or in mountain lakes in the Washington Cascades.

'Freshwater mollusks are mostly primary herbivores in freshwater aquatic ecosystems. In turn, the snails serve as food to a variety of freshwater fish, including game fish. Examples include native trout, native salmonids, Dolly vardens, whitefish, sturgeon, and some sculpins and squawfish. Snails are also commonly consumed by larger aquatic insects, particularly larval forms, leeches, crayfish, and by a variety of birds, including ducks, geese, herons, and cranes. There is a very extensive literature on mammal and bird utilization of mollusks as food; and molluscivore fish species are not uncommon. Mollusks are sufficiently important as a food resource that populations are often controlled as much or more by predation than competition or periphyton abundance (Hershey, 1990; Weber & Lodge, 1990; Crowl & Covich, 1990). Large freshwater clams (and some snails) are avidly eaten by raccoons, muskrats, otters, and beavers. These mollusks were utilized extensively for food, tools, and ornament by Native Americans as well. Sphaeriids are consumed in vast numbers by bottom-feeding fish such as sturgeon and whitefish and by many waterfowl as well. The ubiquitousness of freshwater forms (in undisturbed habitats) has resulted in their use as food by a variety of animals. Various species inhabit both warm and cold springs, temporary (including woodland vernal) ponds, swamps, sloughs, and backwaters, as well as the more preferred cold and clean permanent-water habitats.

General background on freshwater mollusk ecology and biology (though with an eastern U.S. slant), is provided in Brown (1991: gastropods) and McMahon (1991: bivalves).

MOLLUSKS AS BIOLOGICAL INDICATORS

In many regards, mollusks are an especially practical group for use in assessing the general health of the terrestrial and aquatic ecosystem. They are present in some numbers in almost any environment. Certain species are eurytopic; however, many species are stenotopic and unusually sensitive to various kinds of disturbance or pollution. Most species respond quickly and obviously to disturbance. As almost all are relatively sessile and complete their life cycles in place, they are particularly convenient for site-specific assessments. Sampling procedures am relatively simple and can be readily quantified. As it happens, many of the Species of Special Concern would be readily useful indicator species (e.g., the species of *Monadenia, Cryptomastix*, *Prophysaon, Pyrgulopsis*, and *Fluminicola*). Mollusk centers of diversity generally correlate well with those determined from other groups; examples are common from plants, fish, salamanders, and insects. Similarly, mollusk abundance tends to peak in particularly high diversity locales.

The presence of a number of local endemics makes mollusks of unusual biogeographic significance. As compared to insects, there are relatively few taxa, many are comparatively large, taxonomy and morphology are comparatively comprehensible and straightforward, and most can be easily identified. About half of the total taxa in old growth forests have already been described, and relatively comprehensive identification manuals are now, or shortly will be, available for them. The shell of most is durable, making them both obvious and also quite likely to be preserved as fossils or subfossils. They are one-part animals, and most can be identified from the shell alone. The extensive fossil record of some provides a long-term background history unavailable with most groups. An extensive literature attempts to relate fossils to past and present climates, drainages, and large-scale geologic and ecological processes.

Freshwater mollusks are used extensively in the eastern and central parts of the U. S. as biological indicators and to monitor physical and chemical, as well as biotic changes of waters. Examples include Clarke (1979a, b) for freshwater gastropods. Bivalves have been used regularly to study uptake of various organic and inorganic pollutants, and are among the most sensitive organisms for such purposes; reviews include Fuller (1974), lmlay (1982) and McMahon (1990).

AREAS OF ENDEMISM

Exigencies of evolutionary plasticity, geologic history, and founding events have combined to result in several areas of substantial terrestrial or freshwater mollusk endemism in the ICB (Figures 7, 8). In order to qualify for discrimination here, a region had to be both geographically clearly definable and contain a substantial number of local endemics. For terrestrial mollusks, there are 13 such areas, mostly in WA, OR, ID, and MT (Figure 7). Many of the 30 or so land snail genera native to the ICB display no substantial endemism. However, there are sizable endemic species clusters in the large shelled genera ***Oreohelix*** and ***Cryptomastix*** and the slug genus ***Hemphillia;*** and a lesser degree of endemism in such genera as ***Discus, Pristiloma, Allogona, Prophysaon,*** and ***Vertigo*** (Table 1). On the generic level, such forms as ***Vespericola, Megomphix, Cryptomastix, Polygyrella, Hemphillia, Prophysaon, Magnipelta, Udosarx,*** and a few others are endemic to the ICB area and immediately surrounding regions. The large number of endemic slug taxa is particularly characteristic. Most of the distribution of ***Monadenia*** and ***Oreohelix is*** within the assessment area. Broad-scale biogeography and that of the most significant genera will be discussed separately (section on terrestrial mollusks in BIOGEOGRAPHY). However, endemic species clusters or centers of origin at the species level are best handled here. As there is considerable coincidence between boundaries of freshwater and terrestrial mollusk areas of endemism, and both can be presumed to result from similar factors, discussion of both in concert in most effective.

For freshwater mollusks, about 10 endemic areas are currently recognized. As with the land forms, the majority of the genera present (about 30) are widespread forms with no narrow endemics. Endemism at the species level, as with terrestrial forms, is confined to a few genera. Most notable are the hydrobiid genera ***Lyogyrus, Fluminicola,*** and ***Pyrgulopsis***; and the pleurocerid genus ***Juga***. ***The*** genus ***Tryonia***, which also has a number of narrow endemics, mostly occurs to the south of the assessment area (Taylor, 1987; Hershler & Landeye, 1988). There are also significant numbers of narrow endemics in ***Stagnicola***, Lanx, and ***Vorticifex.*** Relatively few genera are strictly endemic to the region; the best examples are ***Lanx*** and ***Fisherola*** (Lancidae, the only endemic family); ***Fluminicola***; ***Helisoma (Carinifex)***; ***Vorticifex,*** and ***Pristinicola.*** It is likely that others remain to be described. As with the land forms, the most significant genera are discussed separately (section on freshwater mollusks in BIOGEOGRAPHY). Unlike the eastern and central U.S., the unionid (large freshwater mussel) fauna of the assessment area is small, perhaps 9 species. All are western U.S. endemics, and several are in serious danger of extinction. Distributions are broad except in one or two instances: ***Margaritifera*** n. sp. Taylor, 1988 [see below] is the best example of a local endemic. A few remarks about each endemic area follow.

1) the Columbii Gorge, Washington and Oregon (Table 11). This area displays a range, in rapid succession, of moisture conditions and plant communities ranging from moist forest to semi-arid sage

scrub. The region was affected by Miocene-Pliocene volcanism and flood basalts, and Pleistocene Bonneville and Missoula Floods. Notable ate such shelled species *as Oreohelix variabilis*, *Vesper/co/a depressa, Crypfomastix hendersoni*, and *Monadenia fidelis minor* and the slug *Hemphillia malonei*. The fauna is a hodgepodge of Washingtonian and Oregonian elements, often derived from taxa now occurring to the west or east, with a component clearly related to the lower Deschutes drainage forms. This area has a freshwater equivalent with essentially the same boundaries (Figure 8). The freshwater endemics are mostly in the pleurocerid genus *Juga*, and included representation from 2 of the 3 subgenera. Most species of *Oreobasis* occur in CA and NV; so occurrences here are disjunct. Oddly, the genus *Fluminicola*, generally common in the assessment area and on the west side of the Cascades, is quite rare in the Columbia Gorge, and there appear to be no spring-restricted forms. There are few other hydrobiids in the Gorge area (except in the Columbia River proper: see below); one endemic *Lyogyrus* and the genus *Pristinicola* are the most notable examples.

2) the Lower Columbia River, basically from Wallulla Gap, WA to the mouth (Table 12). This rather limited area of large-river habit has a substantial freshwater endemic component. Included are large-river specialists such *as Vorticifex nerifoides, Physella columbiana*, and *Pyrgulopsis* n. sp. 6. Amniphile *Pyrgulopsis* species are quite unusual: and this recently discovered taxon represents the northernmost occurrence of the genus (Figure 12) and is notably disjunct. The *Fluminicola* fauna of this region also appears unusual; *Fluminicola virens* and possibly *Fluminicola nuttalliana* appear to be restricted to this area and the lowest 20 miles of the Willamette River, OR (Hershler & Frest, in press), as might one other undescribed form now likely extinct. The *Fluminicola* species in this area are currently under study. Human modification of the lower Columbia River has been extensive, and includes the numerous BPA dams. Several species of endemic mollusks in this area are thought to be either extinct or near extinction. These include *Vorticifex neritoides, Physella columbiana*, *Fluminicola nuttalliana*, and an undescribed *Fluminicola.* Two rare unionid species (*Anodonta wahlametensis*, *Anodonta californiensis*) occur in the lower Columbia River, the latter disjunct from CA. Interestingly, discussion of the native invertebrate fauna is almost always absent from the documents of either the governmental agencies or environmental groups concerned with, e.g. salmon issues in the lower Columbia Basin. The native cold-water biota of this area, adapted to cold water, swift current, and coarse substrate, has been largely extirpated (even common taxa). Major geologic influences are the Miocene rise of the Cascades, the Columbia Group basalts of Miocene-Pliocene age, and the Bonneville and Missoula Floods (Pleistocene). The present Columbia River is a composite system, and the course of the lower Columbia River has been altered drastically in the last 20 million years.

3) lower Deschutes River drainage, OR (Table 13). This area wvers the lower 100 miles of the Deschutes River and its major tributaries (Figure 7); the equivalent freshwater endemic region has identical borders (Figure 8). Major geologic influences are the edge of Basin and Range tectonism and recent vulcanism; former drainage connections, as suggested by Taylor (1985), may also be significant

here. As noted above, endemics in this region are most closely related to those of the Columbia Gorge; all are sister species of Gorge taxa. These am xerophile forms, and include the easternmost records for the normally Oregonian Province *Monadenia,* as well as a western border *Oreohelix.* There is a fairly substantial endemic freshwater component in the Deschutes drainage, even though the system is 'not exceptionally large. As with the terrestrial forms, former connection to the Oregon Interior or to the Upper Kbmath or Pit systems is thought to be responsible. It is postulated by Taylor (1985) that *Anodonta wahlametensis* and *Votticifex effusus* arrived in the Columbia *via* a former connection with the ancestral Snake system in SW OR and NE CA, most likely in the Deschutes corridor. Notable are endemic *Juga* species in the subgenera *Juga* and *Oreobasis* and endemic *Fluminicola* species. Spring hydrobiids are uncommon, and limited to *Fluminicola* and *Pristinicola.*

4) Upper Klamath Lake drainage, OR (Table 14). This area, a drop-down basin, is situated at the edge of the Great Basin and shows former connections with the Snake River drainage (Taylor, 1985; Taybr & Bright, 1987). The current freshwater fauna is a mixture of Great Basin elements with endemics related to the upper Sacramento system in CA, as well as its own unique forms, including some limnophile species. In many respects, this is the best surviving example of the Pliocene-Pleistocene pluvial lakes that were common in interior OR and WA and the Great Basin (Frest & Johannes, 19938, 1994, 1995b, c). The freshwater mollusk fauna is exceptionally diverse and includes a number of narrow endemics (at least 21). Many of these are hydrobiids in the genera *Fluminicola* and *Lyogyrus.* The area is currently being surveyed in some detail, and there is a likelihood that one or more newly discovered forms represent endemic genera. The region's terrestrial mollusk fauna is poorly known at present. Endemics include a xeric species of *Monadenia.* There is a *site* for *Vespericola sierranus.* A strongly disjunct occurrence of the Rocky Mountain *Discus shimeki cockerelli* has also been reported from this area.

5) Oregon Interior Basins (Table 15). As yet, there is little indication of land snail endemism in this region, although this is likely partially due to lack of careful exploration. Like the fish fauna, the freshwater mollusk fauna shows considerable endemism (at least 12 taxa, at least 7 of which are narrow endemics). Most of the distributionally limited taxa are hydrobiid springsnails belonging to the genus *Pyrgulopsis.* This area has been subjected to intense vulcanism since the Miocene. Many of the endemic species appear to have Great Basin links. With the breakup of integrated Miocene drainage, speciation seems to have occurred independently in the numerous resulting internally-draining Pliocene-modem pluvial lakes. With Holocene drying, many of the lakes are now extinct, with but a few animal relicts surviving in the springs and now mostly alkali lake basins. Probable direction of the ancestral Snake system though this area to the Klamath or Sacramento drainages (Taylor, 1985, Taylor & Bright, 1987) also influenced current faunal makeup.

6) Blue Mountains, WA-OR (Table 16). This region has an unusual terrestrial mollusk fauna, in which strongly disjunct Oregonian Province-type elements (the narrow endemic *Megomphix lutarius*) are mixed with more typically Washingtonian and Rocky Mountain elements (e.g., *Oreohelix).* There is a near

equivalent endemic region in freshwater mollusks, wit hat least 2 strictly endemic species. This region was unfortunately not well explored in the early phase of western malacobgy, and is now heavy impacted, almost throughout. The Blue Mountains are situated near the edge of the former (Cretaceous) continental margin, and combine relatively recent (Miocene-Pliocene) flood basalts with older accreted terrain blocks, including limestones. Many of the Miocene-Pliocene Columbii River and Grande Ronde lava flows may have originated in the Blue Mountains.

7) the Washington eastern Cascades, north of the Columbia Gorge to the Okanogan drainage (Table 17). This area was strongly affected by Pleistocene glaciation. The fauna is a mix of Oregonian Province elements, such as *Haplotrema* and *Ancotrema,* with more typically Washingtonian and Rocky Mountain genera such as *Oreohelix* (westernmost known sites except for southern CA; see Figure 9) and *Microphysula.* This area has a partial freshwater parallel as well (Figure 8: see discussion in next section).

8) northern Washington and northern Idaho, northwestern Montana (Table 18). This region has at least 9 freshwater endemics, of which 2 so far are known to be narrow endemics. Most of the unusual taxa have wngeners in eastern and central North America, presenting a picture very different from that typical for ICB endemic species. This region was recently glaciated; major drainage rearrangements combine Columbia with former Mississippi connections, and the fauna derives in equal parts from both. one example occurs in the hydrobiid genus Lyogyrus. This genus is generally thought to be eastern in affinity; but recently there have been a number of western species discovered, mostly narrow endemics. Most of these appear very different from eastern forms; but the taxon in this region does resemble some eastern (Mississippi drainage) taxa. The land snail endemic region largely overlaps, but has somewhat different boundaries (Figure 7 and next section).

9) northeastern WA-Idaho Panhandlle (Table 24). Characteristic are Washingtonian taxa, including endemic *Cryptomastix* (C.) species and the monotypic slug *Magnipelta*. At least 9 species are involved, of which several are strict endemics. The history is similar to that described for the foregoing section. This area lies mostly at the western margin of the Cretaceous continent, and shows a mix of Rocky Mountain and Washingtonian Province elements.

10) lower Salmon River, Idaho (Table 19). This region has long been known for its remarkably diverse terrestrial mollusk fauna, especially unusual for an arid area. A minimum of 31 taxa are involved, of which at least 22 are striit endemics. This is the largest number of terrestrial endemics for any of the ICB regions, and is especially interesting in that the geographic area involved is relatively small. A similar endemic region lies immediately west (see next section). The aree shows a diversity of substrates and plant communities. A major fault valley, the lower Salmon River includes numerous blocks of accreted terrain, as well as areas affected by Grande Ronde flood basalts and intrusion of the Idaho Batholith. Species commonly occur on one side of the river only, and have ranges of a few miles or less. Substrate control and altitudinal speciation are very evident. As yet, all terrestrial endemics are large species; but that may reflect overly conservative taxonomy. Endemism is at the species level, and most endemics occur in two

genera, ***Cryptomastk*** and ***Oreohelix.*** There are several (at least 8) freshwater endemics; but only 2 narrow endemics have been discovered thus far.

11) Hells Canyon, ID, OR, and WA (Table ***20).*** Like the last area, this endemic region is small in geographic extent but has an especially diverse terrestrial mollusk fauna. No endemic slugs have been reported as yet; but there are at least 13 large land snail endemics. Thus far, endemism is at the species level only. Most of these ***are*** species of either ***Cryptomastk*** or ***Oreohelix.*** In this area, some species are confined to single small drainages, and major turnover occurs between the north and south portions of the canyon, such that no single large species is common to both. Geologically, this region is on or near the edge of the Cretaceous continent. Many accreted blocks of limestone and other liihologies were emplaced during and after the Cretaceous, and the region **may** be part of the Wrangellia Terrain **(*s.l.*)**. Post-Cretaceous deformation and uplift are considerable, as is Miocene-Pliocene vulcanism. Rapid downcutting occurred late in the area's history, with Hells Canyon being added to the Snake system only perhaps **600,000-800,000** YBP (Wheeler **&** Cooke, 1954; Malde **&** Powers, 1960, Taylor, 1985; Malde, 1991). The freshwater fauna, while including several rare **taxa,** seems to lack strict endemics.

12) middle Snake River, Idaho (Table 21). Another rather limited area geographically, the middle Snake River drainage harbors at least 11 endemics, of which at least 5 are restricted just to this region. Most of these are relicts of Pliocene Lake Idaho, a hrge Pliocene lake which had at least 90 freshwater mollusk species, of which perhaps 75 were strict endemics (Taylor, 1985; Taylor, unpub.; **Taylor &** Bright, 1987). This is perhaps the largest reported fauna for a single lake, fossil or modem. Formation of the Snake River Plain and migration of a hot spot toward Yellowstone National Park, with accompanying vulcanism, influence mollusk distribution and history profoundly. Land snails are very rare throughout this region, and none appears to be endemic. Essentially all federally listed mollusks in the ICB are from this area.

13) southeastern Idaho (Table 22). This portion of the state is part of the Basin and Range Province, except where intersected by the Snake **River** Plain. Mountain range uplift and later vulcanism are salient events influencing the fauna. The freshwater fauna is especially diverse, and includes at least 21 endemics, about 15 strictly confined to the region). Most of these are species of ***Pyrgulopsis*** and ***Lyogyrus.*** Most narrow endemics occur in the limestone mountain ranges, with only a few on the Snake River plain **proper. The** land snail fauna is poorly known, but includes at least 4 narrowly endemic species. As the land snail fauna of the adjacent Wasatch Range in Utah has numerous endemics, it is expected that this region will be similar when completely collected. As with the middle Snake **River,** relatively few species occur on the Snake River Plain itself.

14) the **Clearwater** River drainage (including the **Lochsa** and Selway rivers), Idaho (Table 23) has a substantial endemic terrestrial mollusk fauna, including at least 14 species, more than half of which are strict endemics. Most are large forms. **Faunal** affinities are largely Washingtonian, with a few Rocky Mountain elements. This region has **a** history similar to that of the lower Salmon **River** and Hells Canyon,

except that Idaho Batholith influence is less significant, while Miocene-Pliocene basalt coverage is more extensive. The freshwater mollusk fauna of the Clearwater River drainage is not known to have a large number of endemic taxa, although the lower Clearwater *Fluminicola* likely is (Hershler & Frest, in press). Freshwater mussels in this drainage are in better condition than in much of the ICB.

15) the Bitterroot and Flathead river drainages, northwestern Montana (Table 25). This incompletely known region (Figure 7) has a small number (5 each) of very distinctive endemic forms, both freshwater and terrestrial. Three of the species are strict endemics; and with comprehensive collection, the number is likely to grow. Faunal affinities are with the Washingtonian Province for terrestrial forms; such genera as *Cryptomastix* and *Oreohelix* are common, and *Magnipelta* and *Hemphillia* are also characteristic. The freshwater fauna is a mix of Columbia Basin and presumed Mississippi drainage disjuncts, with relatively few local endemics as yet noted (*Stagnicola elrodi* is the major example). Notable also is the occurrence of *Amnicola* n. sp. 1, a western endemic form allied to the eastern *Amnicola limosa*.

16) the Clark Fork River drainage in central western Montana (Table 26; Figures 7, 8) has a very substantial number of endemic terrestrial forms (at least 10), of which most (9) are strict endemics. many of these forms are very local in occurrence. This region is substantially a part of the Rocky Mountains geologically, although faunal affinities are a mix of Washingtonian and Rocky Mountain elements. Endemics are concentrated particularly in the genus *Oreohelix.* The freshwater mollusk fauna has few endemic elements and shows mostly Columbia Basin affinities, though some eastern disjunct elements may be present also.

17) the Mission Mountains, though a relatively small range, have an interesting cluster of narrowly endemic terrestrial snails, al of which are quite distinctive and limited to a few sites each. Particularly notable are the 3 *Oreohelix* species, which include the spectacular *Oreohelix elrodi* and the unusual, clearly hypsiphile *Oreohelix alpina*. One freshwater taxon, *Stagnicola elrodiana*, is also a strict endemic. The terrestrial mollusk fauna is clearly Washingtonian,- despite proximity to the Eastern American Division provinces. Geologically, this region is a part of the Rocky Mountains, and was strongly affected by Pleistocene glaciation.

18) Jackson Lake, Wyoming, and adjacent parts of the upper Snake River drainage (Figure 8) also harbor some unique molluscan faunal elements, al freshwater forms (Table 28). Two of the 5 forms involved are strict endemics. The area is of interest in that one of the endemics, *Helisoma (Carinifex) newberryi jacksonensis*, has Great Basin affinities, and marks the northernmost penetration of such elements (along with the now-extinct Jackson Lake chub). The second species, the hydrobiid *Pyrgulopsis robusta*, is one of the group characteristic of the Great Basin periphery along the course of the ancient and modem Snake River. This Rocky Mountain region marks the current location of a hot spot or diapire, and is still a highly active area for vulcanism. As far as known, there are no land mollusks endemic to this area (Beetle, 1989), and the fauna is small compared to some portions of ID and UT.

SPECIES OF SPECIAL CONCERN

BACKGROUND

In order to compile the species records listed below, the freshwater and land mollusk fauna of Washington, Oregon, Idaho, Montana, Wyoming, Nevada, and Utah was reviewed. Starting points were Pilsbry (1939-48), Burch (1989), Taylor (1975), and references therein, including Henderson (1924, 1929a, 1936a, and 1936b). The periodical literature published subsequent to 1936-48 was also reviewed, as were available consultant's reports and other "gray" material. We have collected freshwater and land mollusks in these states since 1986; where practical, such records were incorporated also. Information from private collectors and museums was also included, where such material was examined and verified by us. The present compilation is partially based on species lists in' Frest & Johannes (1991 b, 1993c, 1998, 1995a, and 1995b).

Tables 1-3 list a total of 190 mollusk species or subspecies herein regarded as Species of Special Concern (SOSC). These are evenly divided between terrestrial and land forms: 95 are terrestrial (87 snails and 8 slugs) and at least 95 freshwater (88 snails and 7 clams). All are currently known or likely to have ranges partly or wholly within the ICB assessment area, as defined above and in Figure 1. One hundred seventy-two are here regarded as Sensitive Species (Species of Special Concern in the usage of USFWS, 1992a, 1992b; critically sensitive species in imminent danger of extinction if present trends continue). While many are either present or potential candidates for Federal listing, only 5 are presently listed as Endangered or Threatened species. These taxa should be regarded as sensitive by USFS, BLM, NPS, and other federal and state agencies concerned with land management and wildlife. All of the taxa here defined as Sensitive should be regarded as priority species in USFWS usage (as above). Fourteen are Watch List species. These are also Sensitiie species (as well as SOSC) in our usage, and should also be regarded as sensitive by USFS, BLM, NPS, and other federal and state agencies concerned with land management and wildlife. However, these taxa are not regarded as in imminent danger of extinction, and are not considered potential candidates for Federal listing at this time. Four additional species are extralimital taxa which may occur in the assessment area. All are Sensitive species (and SOSC); al 4 should be considered potential candidates for Federal listing in their known range (one is currently). Finally, 8 species are taxa of uncertain status and are not included in the Tables, but are discussed individually under the section entitled **SPECIES DISCUSSIONS.** These are not considered further here,

although additional research may demonstrate that they are valid taxa and in need of special consideration. Thus, we deal with nearly 200 taxa (198) in some detail herein.

The Species of Special Concern represent roughly 40% of the area's total currently described mollusk diversity, and perhaps 20% of estimated actual diversity. Of the Sensitive and Watch List species; 44 occur in Washington, 80 in Oregon, 101 in Idaho, 32 in Montana, 8 in Wyoming, 4 in Nevada, and 5 in Utah (Tables 4-10). Five of the Sensitive species are listed as Federal Endangered or Threatened (USFWS, 19924). One other Sensitive species was listed Federally as Endangered but recently delisted (USFWS, 1993). This species will most likely be relisted as Endangered. Twelve of the Sensitive species, 1 Watch List species, and 1 extralimital species are currently Federal candidates (see Table 1, USFWS, 1994). There is some overlap between the Spotted Owl taxa (Frest & Johannes, 1993c) and the taxa dealt with herein. Of the formerly considered species, 13 of those included in the final Record of Decision document (ROD, 1994) are also discussed in this report.

In general, these species are not on state Threatened or Endangered lists although state Natural Heritage or Biodiversity programs track many, and some are state Species of Special Concern (USFWS, 1992a, b). Malacologists have long been interested in the status of U.S. mollusks, particularly in the eastern and central U.S., and have held various symposia, etc. on them. Hence, some of the taxa discussed herein have been suggested for listing by malacologists previously (e.g. Taylor, 1970, 1981; Smith, 1970; Roth, 1972; Clarke, 1976a; Frest & Johannes, 1991 b, 1993c, 1993e, 1998; and sendings to various federal and state agencies by us, 1988-1994). Recently, the Oregon Natural Resources Council (ONRC, 1993) petitioned USFWS for Federal listing of some 82 mollusk species, including some of those that we cover here. This petition was rejected by USFWS (1994b); and further legal action may be forthcoming.

Our lists and discussions differ from those made previously in that they: 1) are based on more recent information, including research and project collections by Deixis Consultants personnel (T. Frest, E. Johannes, J. Johannes) of many taxa from 1986-1994; 2) include some previously unknown or unconsidered species and subspecies; 3) exclude some taxa now known to be either more broadly distributed than earlier thought or taxonomically suspect; and 4) are restricted to forms known or likely to occur within the assessment area. As in Frest & Johannes (1993c) we have included undescribed taxa and identify known and suspected areas of endemism. Unlike the previous effort, we have included two other groups of taxa: 1) species currently thought extralimital to the assessment area but likely to occur there; and 2) taxa of uncertain status. The listing is conservative in that some taxa now regarded as either extinct or too poorly known for adequate range definition (*i.e.,* occur in relatively unstudied areas; are too recently discovered to be fully evaluated; or occur in poorly studied microhabitats) are deliberately excluded. Further documentation of the species and subspecies listed in Tables l-3 is provided below in the form of short, referenced discussions of each. For reasons of space or to protect taxa of particular

concern, localities are not precise. In most cases, more detailed information is available in the literature, from the authors or other sources, or from both.

Of the 190 mollusk species and subspecies listed on Tables 1-3, some are of especial concern. Important factors in assigning species to the critically Sensitive group were: extremely restricted current distribution or local endemism: occurrence solely or largely in particularly threatened habitat, such as low-elevation old growth or late successional forest, low-elevation springs in semi-arid or arid locales; relatively pristine segments of impounded streams; taluses, or the like; sensitivii; very limited or circumscribed habitat; loss of a majority of historic sites and habitat; or declining populations. Generally, all of the above factors apply to the species in this group. Wiihin this classification, species known or likely to occur on Forest Service or BLM lands were favored strongly for consideration. Similarly, species known or thought to be old growth or mature forest associates or riparian associates were given special emphasis in making selections for inclusion here; most taxa qualify under both criteria. Current candidates, Federally listed taxa, and ROD taxa were automatically considered to be priority species.

In practice, our criteria closely minor those used by Thomas *et al.* (1993, p. 261) for developing a "short list" from the much larger list of species that occur in old growth or late successional forests. These criteria are largely directly applicable to ICB habitats and ecosystems. Most or all taxa considered here would qualify under a combination of two or more of the SAT's 4 Criteria and 9 factors. As can be seen from the species discussions, nearly all taxa were included for two or more of the reasons outlined above. The 190 high-priority taxa that meet these conditions are indicated in Table 1. It should be emphasized, however, that, due to tack of recent collections of some taxa, this listing is particularly conservative. It is likely that all taxa discussed herein are now, or soon will be, subject to similar problems. It is also highly likely that many taxa not discussed here should be included. This listing should thus be considered as somewhat tentative. As time and information growth demands, we hope to revise and reissue it.

SENSITIVE SPECIES

Land Snails

This is the largest group of Sensitive species, with 81 members occurring within the ICB assessment area (Tables l-3). Of these, 18 species occur in Washington, possibly 19 in Oregon, 51 in Idaho, 13 in Montana, and 1 in Utah (Tables 4-10). Sii of the Sensitive species are Federal listing candidates: but none are Federally listed at this time (Table 1). One candidate occurs in Washington, 1 in Oregon, and 7 in Idaho (Tables 4-10). We recommend listing of all but a few of these species as either Threatened or Endangered

on present evidence; other species require further study. Seventy-five of these land snails are known or thought to be found on federal lands; at least 6 others occur on state lands, private inholdings, or areas adjacent to public lands (Table 2). In the assessment area, a total of 4 land snails are considered Watch List species. Three of these **taxa** occur in, Washington, 2 in Oregon, 3 in Idaho, and 2 in Montana (Tables **4-**10). One Watch List **taxon** in Idaho is a Federal listing candidate (Table 1). All the snails on the Watch List are known or thought to occur on federal lands (Table 2). Two extralimital species occur just outside the assessment area in Montana; and 1 of these two occurs just outside the assessment area in Wyoming.

Slugs

We, designate just 7 slugs as Sensitive species (Tables l-3). None are Federally listed or candidates for listing at this time (Table 1). We believe that evidence is sufficient to recommend listing of all 7 species as either Threatened or Endangered. Of the 7 Sensitive species; 1 is found in Oregon, 4 in Idaho and Montana, and possibly 2 are found in Washington. All are known to occur on federal lands (Table 2). Only 1 slug is a Watch List species. This **taxon** occurs in both Idaho and Montana on federal lands,

Freshwater Snails

We regard a total of 79 freshwater snails to be Sensitive species (Tables l-3). Thirteen of these **taxa** occur in Washington, 49 in Oregon, possibly 27 in Idaho, 6 in Montana, 4 in Wyoming, and 1 each in Nevada and Utah. Four of the **taxa** we treat as Sensitive species are Federal listing candidates: only 5 are currently Federally listed. Of the candidates, 2 occur in Washington, 2 in Oregon, 2 in Idaho, 2 in Montana, and 2 in Wyoming. All 5 Federally listed species occur in Idaho. Only 6 Sensitive species are thought to not occur on Federal lands (Table 2). Evidence is sufficient for al 79 Sensitive species to recommend either Endangered or Threatened status (Table 1). There are 7 freshwater snails listed on the Watch List. Four occur in Washington, 3 in Oregon, 7 in Idaho, 6 in Montana, 2 in Wyoming, 1 in Nevada and Utah. All are known or thought to occur on Federal lands (Table 2).

All of these forms can be regarded as riparian associates, and heavily affected by management of terrestrial riparian zones. Association with old growth or mature forest or other non-forest permanent water habitats such as springs is clear for many, although this category is probably underrated herein. Most mollusk species considered herein prefer relatively undisturbed cool and shaded streams, lakes, springs, seeps, or other permanent water habitats.

Freshwater Clams

This group of freshwater mollusks is bw in local diversity and generally robust; only 5 Sensitive species are designated. This does constitute, however, about 20% of the total bivalve diversity. None are Federally listed; but 2 taxa, 1 unionid and 1 sphaeriid, are current Federal listing candidates (Table 1). The included bivalves are more widely distributed in this region than is typical for other mollusk groups, with 2 species found in Washington, 4 in Oregon, 2 in Idaho, and 1 in Wyoming, Nevada, and Utah. All of the Sensitive species are known to occur on federal lands (Table 2). Of the candidates, 1 has been reported from Washington, Wyoming, Nevada, and Utah; both occur in Oregon and in Idaho. Two bivalves are on the Watch List. Both of these occur in Washington, Oregon, and Idaho; one or the other of this pair occurs in Montana, Wyoming, Nevada, and Utah.

DISCUSSION

ADEQUACYOFCURRENTKNOWLEDGE

As noted by Taylor (1981) for California freshwater mollusks, many new species and even genera remain to be discovered and described in the region, particularly of land and freshwater snails. We are aware of a number of such for which we as yet have insufficient knowledge of distribution or ecology to be included herein. Moreover, certain historically common taxa have tended to be overlooked by malacologists, and hence lack or have few recent records. At least one such marine species on the East Coast became extinct by the 1940s, a situation which was not noted until the 1990s (Carlton *et al.,* 1991). It is quite probable, given the poor state of biological inventories on federal lands, that many undescribed regional endemics are already extinct; certainly, some 'previously described taxa have not been successfully re-collected for some years. The lack of careful monitoring of even long-known rare forms has been discussed by Roth (1993).

Malawbgical research and knowledge are not nearly as extensive as are counterparts for certain terrestrial vertebrates and plants. Even so, interest dates to the 1830s, and the main points of taxonomy

and distribution are well established. We thus have considerable confidence that an effort such as this is feasible and likely to produce robust results that can aid materially in proper management of public lands. Additional investigations are required in many areas to establish complete faunas, ecological requirements, and life histories of individual species. As noted by Roth (1993, p. 3) "current mollusk faunal lists tend to **underestimate** diversity and **overestimate** the ranges of individual taxa". A recent review of biotic inventories in the National Park system (Stohlgren & Quinn, 1992) indicated that none had comprehensive inventories of invertebrates, even of major and relatively small groups such as mollusks. There are no completely adequate surveys for freshwater mollusks in this region. Also, there are almost no adequate surveys for either land or freshwater mollusks in the western National Forests or BLM Districts. Closest for land snails are research done by Roth in Trinity National Forest (see Roth (1993) for references), and a recent survey of Black Hills National Forest (Frest & Johannes, 1993c). Less complete such studies are those of Fullington (1979) and Spamer & Bogan (1993). D. Pilmore [Beetle] has undertaken a partial survey of Yellowstone National Park; results of this survey and update to encompass the effects of the severe 1988 fires have not yet appeared. Freshwater suweys are even more limited. We are currently conducting such inventories for southeastern Idaho BLM lands, federal lands in the Upper Klamath Lake drainage, Oregon: and federal lands in the Upper Sacramento and Pi drainages, California. Fairly comprehensive surveys for springsnails have been conducted through much of the Great Basin by R. Hershler and his collaborators: for evaluation of the coverage of this work, see Hershler (in press), Hershler & Frest (in press), and references in the former paper, especially Hershler (1994).

Most of the little inventory work on invertebrates that has taken place on federal lands has been for arthropods. It should be noted that mollusk inventories are conducted in a somewhat different manner and using rather different methods than those appropriate for terrestrial arthropods. It is common to take small numbers of mollusks in pit traps used for beetles, spiders, and salamanders; similarly, some mollusks are secured with Berlese funnels and similar equipment. However, we have found that such methods generally miss most mollusk species and individuals in a sample plot. Description of effective methods is discussed below.

The lack of detailed knowledge about invertebrates on public lands was also a major point of Olson (1992), specifically in regard to arthropods but with implications for all groups. Other conclusions of this report are relevant to mollusks. The high proportion of species with localized ranges led Olson *(op. cit.,* p. 9) to suggest that "proposed conservation areas for the spotted owl may be inadequate as an effective approach to invertebrate conservation". Like Olson, we fear that if only those areas located in existing wilderness areas, RCAs, and the like are protected, then there is a "very high probability that many invertebrate extinctions will occur in areas not covered by protected lands". It should be borne in mind that, of the 198 Sensitive taxa discussed in detail below, at least 158 are known to occur on federal lands; about 20 others very likely occur on federal public lands **(see SPECIES DISCUSSIONS).**

In the ICB, adequacy of knowledge vanes from place to place. The Columbia Gorge has been fairly thoroughly surveyed for both land and freshwater forms. Other areas in which detailed surveys for land snails have been carried out include the Wasatch Range in Utah and the lower Salmon River drainage in Idaho. Considerable information on land snails is available for the Olympics and western Cascades; northern Idaho; and central western Montana. Locally complete information is available for terrestrial forms of much of western Montana; the Washington eastern Cascades; and part of Hells Canyon. Areas in need of more detailed surveying for terrestrial forms include parts of northern Washington, parts of the Washington eastern Cascades; much of the Blue Mountains; selected portions of northwestern and southwestern Montana; the less accessible parts of Hells Canyon; and southeastern Idaho.

As mentioned above, Columbia Gorge freshwater mollusk faunas are relatively well-collected. Several other areas either have comprehensive surveys either nearly completed or likely to be so in the next few years. These include most of the Great Basin (the Smithsonian Great Basin springsnail project, headed by R. Hershler); the Upper Klamath Lake drainage; southeastern Idaho; parts of the Interior Oregon Basins; portions of western Wyoming; and northeastern California and adjacent Nevada. Areas with considerable recent information but needing more work are the lower Columbia River; northern Washington; northern Idaho; western Montana; southwestern Idaho; parts of the Oregon Interior Basins; and portions of western Wyoming.

Within most freshwater mollusk groups, most truly narrow endemics have only been discovered within the last decade and many more remain to be found; if they are, indeed, before they are extirpated. Thus, many of the long-known species here discussed do not represent originally extremely restricted taxa, but ones that have become so recently due to human activities. The recent pace of discovery of new hydrobiids indicates that much remains to be elucidated about freshwater mollusk distribution in this region. Nevertheless, the main outlines have been clear for many years and are unlikely to change. It is highly probable that additional colonies of many of the species discussed herein remain to be found; but almost certainly not enough to alter the status recommendations made in Tables l-2. It is very unlikely that the status recommendations made herein are overly pessimistic, and lack of complete information should not be made a rationalization for lack of action on these taxa. Such dithering, however politically convenient, is likely to increase the chance of extinction or result in the extinction of many taxa; and hence is of dubious legality, not to mention ethical or philosophical concerns. We have been comparatively conservative in choosing species for inclusion: many more taxa could have better claims. However, our lack of sufficient first-hand knowledge of some has resulted in their exclusion at this time. Moreover, the pace of forest cutting and grazing degradation has so accelerated that many sites collected in 1986-88 are now not collectable. We have not had sufficient time to recheck the large number of sites that would be necessary to determine current condition of some taxa. Examples include *Valvata mergella, Gonidea angulata, Margaritifera falcata,* and typical *Fluminicola nuttallianus* and *Fluminicola virens* [most literature citations are wrong; and the former is likely extinct]. Among the terrestrial forms, similar

arguments can be made for many species. Many of the smaller terrestrial forms need detailed re-investigation (Le., species of *Vertigo* and *Pristiloma*) to determine their current status and distribution.

Taxonomic problems remain to be resolved in some groups, which hence were not dealt with here. Notable examples in freshwater forms include all but a few readily recognized species of *Physa*, *Physella*, *Ferrissia*, *Planorbella*, and *Fossaria*. There are similar problems with the *Oreohelix* species (actually species groups) typically subsumed under the *omnia gathera* of *strigosa depressa* and *subrudis*.

WHY PRESERVE INVERTEBRATES?

Rather than belabor the point here ourselves, we will summarize a few comments from E. 0. Wilson (1987): "'The truth is that we need invertebrates but they don't need us. If human beings were to disappear tomorrow the world would go on with little change. Gaia, the totality of life on earth, would set about healing itself and return to the rich environmental states of a few thousand years ago. But if invertebrates were to disappear, I doubt that the human species would last more than a few months. Most of the fishes, amphibians, birds, and mammals would crash to extinction about the same time. Next would go the bulk of the flowering plants and with them the physical structure of the majority of the forest and other terrestrial habitats of the world. The earth would rot. As dead vegetation piled up and dried out, narrowing and closing the channels of nutrient cycles, other complex forms of vegetation would die off, and with them the last remnants of the vertebrates. The remaining fungi, after enjoying a population explosion of stupendous proportions, would also perish. Within a few decades the world would return to the state of a billion years ago, composed primarily of bacteria, algae, and a few other very simple multicellular plants. . . . . ..It needs to be repeatedly stressed that invertebrates as a whole are even more important in the maintenance of ecosystems than are vertebrates. ..... Reserves for invertebrate conservation are practicable and relatively inexpensive. ..... The *ex* situ preservation of invertebrate species is also cost-effective."

CURRENT AND PROPOSED MANAGEMENT PRACTICES

BACKGROUND

There is a wealth of generally neutrally-compiled information to demonstrate that current land management practices of the major public land management agencies, in the ICB as elsewhere in the West, are inadequate. In response to congressional inquiry,. the General Accounting Office (GAO) recently attempted to assess the effectiveness of current management practices of the USDA Forest Service and USDI Bureau of Land Management in protecting and sustaining wildlife on federal lands (GAO, 1991a). The Forest Management Act of 1976 requires the Forest Service to maintain viable populations of each native vertebrate species [or, by some interpretations, all native species] on each management unit. It is possible that this law could be enforced in the future, and extended to include land held by other government agencies. The GAO concluded that "consideration provided to wildlife is below that provided to consumptive uses such as livestock grazing, logging, and mining" (GAO, ***op. cit.,*** p. 18). For example, the General Mining Law of 1872 gives mining primacy over other uses of federal lands. Analyses of the effects of mining and of the Law have generally concluded both that abuses were occurring and that the Law needs revision (GAO, 1986, 1989a). Even National Wildlife Refuges, the only federal lands required by design to be managed primarily for the benefit of wildlife, are affected almost universally by secondary uses (GAO, 1989b). Such secondary and consumptive uses, at least as now practiced, are often directly inimical to species preservation. GAO (1991a) also noted the low levels of funding and staffing provided for wildlife programs. It concluded that, in cases of conflict, consumptive uses were often favored despite acknowledged negative impacts on wildlife. Moreover, most planned wildlife actions were demonstrably not actually being implemented by the managing agencies. Another report (GAO, 1991 b) noted the necessity for better wildlife protection, as current enforcement is selective. Even on paper, wildlife protection or enhancement actions almost always are directed at species perceived as "glamorous" or as favored by the public -particularly the Three F species (furred, feathered, or finned)-. often at the expense of other taxa. Quite often, recovery or conservation efforts for Three F species are undertaken to the detriment of other forms. Most federal lands agency biologists specialize either in fish or in mammals; there are very few invertebrate specialists anywhere in the Forest Service, BLM, or even in USFWS.

The general lack of even roughly complete species inventories of federal lands has been commented upon previously (Frest & Johannes (1993c). In general, there is little detailed knowledge about most invertebrate groups on public lands (Olson, 1992; Frest and Johannes, 1993c). A recent study (Stohlgren and Quinn, 1992) of the National Park system, for example, indicated that none had comprehensive biotic inventories, even of such relatively small and conspicuous groups as mollusks. Most western U.S. National Forests and BLM Districts have in the past few years completed Land and Resource Management Plans or equivalent documents; none that we have seen go much beyond Three F species; most do not mention any invertebrates. Recent proposals to conduct such inventories are a

step in the right direction: but this step will require considerable time and resources to implement, and should not be pursued precipitously. The Forest Service's attempt to use an indicator species approach to monitor biodiversity on its holdings is a case in point. Planning regulations direct that several categories of species are to be represented among the taxa to be monitored. These are 1) endangered and threatened plant and animal species; 2) species with special habitat needs that may be influenced significantly by planned management actions; 3) species commonly hunted, fished, or trapped: and 4) non-game species of special interest. Predictably, category 2 has been emphasized to the point of near exclusion of the other categories. We are aware of no invertebrates so utilized on any unit; this despite the fact that invertebrate species [including mollusks] clearly qualify, minimally under categories 2 & 4, and often under 1) as well. Even with the Three-F bias, the GAO concluded that the monitoring approach appeared expensive and ineffective. Reasons cited were that 1) relationships between indicator species and the habitat characteristics they are supposed to predict are unknown; 2) observed changes may be natural and not require management action; 3) monitoring may be impractical due to personnel shortages during critical periods; and 4) selection of indicator species is "sometimes based on factors other than their biological or ecological representativeness, or their predictive value. Instead, some indicator species have been selected for socioeconomic or political reasons" (GAO; 1991c, p. 3).

On average, even relatively development-restrictive agencies such as the National Park Service have made little progress in documenting or mitigating threats to their public holdings (GAO, 1987). In many of the National Forests, for example, it was impossible for outside examiners to determine the extent of resource deterioration in designated wilderness areas because basic information on conditions in many of them was lacking. However, site visits indicated that many wilderness areas showed signs of adverse impacts [even though these areas are legally mandated to be relatively free of disturbance, according to the Wilderness Act of 1964], and that funding for wilderness management was inadequate (GAO, 1989c).

Similar considerations apply to rangelands and grasslands. The GAO (1988a) found that adequate recent inventory information was often lacking, and condition of much of the public rangeland is not reliably known: but that over 50% of the public rangelands remained in either poor or fair condition. Another recent report (GAO, 1991d) indicated that the Forest Service is not performing needed monitoring of its grazing allotments, and that range managers themselves consider about 25% of the allotments to be in a declining condition and/or overstocked. A similar study found that the BLM likewise was not monitoring at all the status of about 50% of the grazing allotments covered by EISs (GAO, 1992). In many cases, BLM efforts to prevent unauthorized grazing are inadequate (GAO, 1990a): during any given year, "many grazing areas are inspected infrequently or not at all". Outside evaluations of federal grazing practices are generally scathing, as witness Horning (1994).

In the particularly vital riparian areas, both Forest Service and BLM efforts at restoration have recently been criticized (GAO, 1988b). This is particularly unfortunate, as another federal agency has recently concluded that riparian areas "are in the worst shape in history' (EPA, 1990). Even though both agencies

have policies that endorse restoration of riparian areas, only limited numbers of riparian areas have been restored. Successes represent only a small amount of riparian area; support from management for such efforts has been weak; and some field staff daim that "management has taken reprisals against staff who tried to implement riparian management programs in areas with politically powerful permittees"; and in any case, existing inventories of riparian areas are incomplete.

We have commented previously (Frest & Johannes, 1993c, and above) upon the general lack of consideration given to al but a few "glamorous" species in federal agency management plans. Until recently, many BLM districts simply lacked resource management plans, 13 years after the passage of the Federal Land Policy and Management Act of 1976 (GAO, 1990b). The rush to complete such plans has, in our opinion, resulted in inadequate documents in many respects, and no expansion in species coverage. Even with the best of intentions [and we need not concede that those exist here], management is typically focused on a single-species approach, in which the species to be benefited is generally the domestic cow and, at best, unspecified "wildlife", with the unspoken presumption that these are large, huntable vertebrates. One minor example will suffice. "At the Snake River Resource Area in Idaho, one project consisted of making improvements [sic] to a spring so that more water was collected and available for livestock and wildlife. According to the environmental assessment included in the project file, the improvement would also make water available to wildlife when livestock were removed from the allotment" (GAO, 1993). Readers of this report will have noted that springs along the Snake River in Idaho harbor several federally listed taxa; and a variety of other sensitive species are known to inhabit such springs, including many narrow endemics. Most to al of the native fauna is extirpated from springs when they are "improved" in this way. The GAO chose to interpret this case as an example of not fully describing all resources benefiting from range improvements. We would take the opposite tack, and note that the BLM in Idaho seldom if ever knows what species ate present in such habitats generally, let alone specifically; how rare; if listing issues are involved; or what the detriments to the native biota as a whole ate [does not fully describe resources harmed", to use the proper jargon] from spring "improvements". It will not be surprising that "livestock grazing management was the primary objective of 71% of the range improvement projects completed in fiscal years 1990 and 1991" (GAO, 1991, p. 7). After all, what else is there?

This analysis merely skims the surface of the situation, and is perhaps overly generous. Studies by environmental groups tend to be more critical. We quote from one as an example (Losos et *al.*, 1993):

"Natural resource extraction activities are wholly or partly responsible for endangering 62 tO 68 percent of all species that are formally listed as at risk of extinction in this country".

"[These species] are at risk of extinction at least in part from hardrock mining, logging, livestock grazing, water development, and recreation".

'Water development projects -- such as dams, flood control, water diversion, and dredging -- have the most extensive impacts, affecting 29 to 33 percent of all listed species".

"Recreational activities -- primarily off-road vehicle use and general recreation -- damage 23 to 26 percent of federally listed species".

"Livestock grazing harms 19 to 2 percent of endangered and threatened species. Logging affects between 14 and 17 percent. Hardrock mining alone damages 4 to 6 percent, and when all mining activities are considered, the figure increases to 14 to 21 percent".

"Species whose ranges are on federal lands are generally harmed more by logging, livestock grazing, hardrock mining, and recreation -- 50 to 59 percent -- than those inhabiting non-federal lands -- 46 to 55 percent".

Major changes in policy and management will be necessary to supplant and repair past actions. In the last few years, most of the Pacific Coast and ICB states' National Forests and BLM Districts have completed Land and Resource Management Plans or their equivalents. So far, none of those we have seen have adequately addressed biodiversity concerns. Most, for example, go little beyond Three F species: none adequately address invertebrates; and most fail to even mention them. The controversy over the listing of the Northern Spotted Owl has brought such concerns considerable attention. The National Recovery Plan for the species (USFWS, 1992a, b) is one of the few to attempt to address ecosystem concerns, and could serve as a model for such efforts elsewhere. As the mandate for recovery was expanded to include other significant animal and plant species, it was also extended to other habitats, such as riparian zones, which support the bulk of western coniferous forest and arid to semi-arid land biodiversity. In making management recommendations for the ICB mollusk SOSC, we will parallel some of the policies most likely to be implemented in federal lands within the range of the Northern Spotted Owl. Majjr references are Thomas et *a/.* (1990, 1993) and Johnson et *a/.* (1991).

OVERVIEW

In general, any modification of habitat that decreases available moisture or increases insolation is very strongly detrimental to land mollusks, and often id to freshwater species as well. Logging tends to increase insolation to the point that most species are extirpated. Burning of slash, physical disruption of habitat, and destruction of forage plants (often deciduous trees and shrubs and herbaceous forest understory) compounds the problem. Indirect effects, such as stream modification and destruction of springs, have removed much additional habitat, as has human settlement along the coast proper. Tree farms, like Midwest wrn fields, are generally devoid of any native mollusks. Semi-and lands with introduced grasses are in no way comparable to native sage communities in terms of biodiversity. Sometimes, only introduced species, like most commonly seen garden slugs on the West Coast, may thrive in such settings. In our study sites in western Washington, for example, relatively undisturbed sites

had a mean diversity of 10-12 species. Recently clear-cut areas generally had no shelled species. Most areas that had been clear-cut 20-60 years ago regained no more than 2 shelled species. Often, the only mollusks seen alive in recent clear-cuts were found in very limited colonies under protected settings, such as missed trees or unburned debris piles: In our opinion, the long-term viability of such colonies is questionable, let alone their ability to serve as reservoirs to repopulate regrown forests. Generally, only one or two slug species were at all widespread in recent clearcuts or in reforested areas up to 40 years after cutting. Land and freshwater mollusks are also quite susceptible to the effects of forest spraying for pest. and unwanted plant control.

Grazing is also a major factor causing extirpation. Direct trampling is the major problem, but resulting vegetation changes and the usual reduction in plant biomass and effective wver are also significant. With as much as 90% of federal lands in the ICB states allotted to livestock producers, this is an extremely severe problem. Most known *sites* for the genus *Hemphillia* and many other of the particularly unique Oregonian and Washingtonian endemics have been destroyed by logging of lowland old growth and mature forest; many species of special concern seem to be specifically associated with such forests. Many species are now or were originally very limited in distribution. The Malone jumping slug, *Hemphillia malonei*, e.g., occurs only on the slopes of Mt. Hood. Many species of *Oreohelix* and *Cryptomastix* in the ICB have strongly circumscribed ranges. The genus *Megomphix* has similar problems: all known sites for *hemphilli*, e.g., were either in the Puget Sound region or in the more or less completely cut-over Willapa Hills, southwestern Washington. Both *leutarius*[in the ICB] and *californicus* (northern California] have very limited ranges. Very few sites for this genus have been found in recent years, and the whole family Megomphicidae is now quite rare; some southern California species have been previously suggested as Federal listing candidates. Management of Pacific Coast state forests should reflect such considerations if survival of the native land mollusk fauna is to be assured. Similarly, many freshwater endemics are very restricted in occurrence, sometimes to single sites: examples are numerous in *Fluminicola*, *Pyrgulopsis*, and *Lyogyrus*, among others. While this makes them very vulnerable to extinction, another consequence is that protection may be a relatively simple and inexpensive process, if it is deemed a worthwhile goal.

A recent study (Frest & Johannes, 1993c) of one western National Forest may be instructive: studies of Eastern Deciduous Forest land snail communities may not be as directly relevant. The Black Hills National Forest, South Dakota and Wyoming, is dominated by Ponderosa pine and spruce forests. Much of the area with pine cover has been logged recently, and very little intact riparian vegetation remains. Grazing is wmmon on logged terrain and in lowland areas. Large areas were mined long ago, and some operations continue. Forest fires ate common and destructive. Survey of 189 sites by a combination of litter sampling and live collecting yielded some interesting results. Thirty-six species were found to remain in the Forest. A few were new taxa; these included uncommon local endemics and habitat-restricted forms; but the bulk of the fauna was of forms widespread in North America. A number of species previously reported from the area were not found.

Heavily logged and grazed sites had a very small land snail and slug fauna consisting of about six widespread forms. Areas that had been clear-cut did not appear to rewver their snail fauna, even after many years: upland areas were particularly hard-hit. Mined localities were similarly affected. Fires occurring before fire suppression was attempted seem to have had only local effects on the land snail fauna; modem fires effectively sterilize large areas of snails. The native freshwater mollusk fauna of the Forest appears to have been al-most entirely extirpated, even from spring habitats. Even relatively widespread species have been extirpated from most or all of the Black Hills. The richest areas for diversity were the few remaining relatively intact riparian areas and limestone canyons with spruce cover, in part because logging of spruce does not take place. Such sites commonly had diversities of fifteen or more species. Well over half of the total number of species were confined to a small area in the northwest part of the Forest and occurred at only a few sites. Because of extensive habiiat loss, several species were suggested for federal listing, and protection of the few remaining sites for most was strongly recommended.

A general observation resulting from this and other studies is that effects of single practices may be detrimental but bearable; but combinations are especially destructive. A common example in the ICB forests is the logging, followed by grazing; sage brush removal is often followed by grass seeding and grazing in semi-arid lands. Logging in itself has a negative effect ; but common site preparation practices thereafter administer the *coup de gras*, if one was needed. Spring "improvement", by trenching, piping, etc., followed by grazing, is another particularly common procedure, very effective in eliminating nonlivestock species.

Some general principles should be stated here first. Lumbering, especially clear-cuts, is essentially disastrous to the Species of Special Concern, as it is also in Douglas fir forests of the Pacific Northwest (Frest and Johannes, 1993c). Lumbering increases insolation; removes cover; increases ground temperature in summer; decreases effective ground temperature in winter (*i.e.*, increases exposure); decreases available moisture and effective humidity; removes shelter, hibernation, and egg-laying sites; removes ground cover, including forage plants for many species; simplifies community structure; and decreases diversity. The removal of coarse woody debris and litter by logging (often followed by burning of slash) is particularly objectionable. Precise effects depend upon methodology, as will be detailed below; in general, clear-cuts are most disastrous: and some thinning may be necessary in forests in which natural fires have been suppressed. The best management technique is none at all, i.e. allowance of natural processes to continue, including fires. Barring this fire management techniques mimicking the natural process in each major plant communities much as possible (Agee, 1993) should be favored. In the fir forests of the Pacific Northwest, various rotations (of 50-200 years/cycle) have been suggested. These may or may not be adequate for relatively mobile species such as birds and mammals; but we doubt their efficacy for relatively sessile forms such as snails, or for species with limited geographic distributions (Olson, 1992; Frest and Johannes, 1993).

Similarly, mining may have drastic effects. Areas directly mined are of course generally sterile of land snails. Regeneration of such areas would be expected to take place rather slowly under the best of circumstances for many species. Likewise, there is little evidence that the Species of Special Concern can survive severe or sustained grazing. Grazing tends to simplify the plant community. resulting in loss of forage species. It tends to increase insolation, shrink or remove cover, litter, hibernation, and shelter sites, decrease winter ground temperature, increase summer ground temperature, decrease effective available moisture and humidity, compact soil, and physically destroy land snail individuals and colonies. Severe forest fires increase insolation, destroy ground cover and litter, increase soil erosion rates, acidii the soil, drastically alter the plant community, remove shelter, hibernation, and egg-laying sites, and alter the forest floor microclimate and soil composition.

In practice, the major human causes of habitat alteration have very similar effects. Land snails, as well as many other forest floor taxa, have relatively slow rates of migration. In the present, largely disturbed conditions typical of much of the ICB, there remain relatively few population reservoirs for many species. Surviving colonies are often geographically restricted and isolated, with large areas of unsuitable habitat intervening. Even comparatively mobile vertebrates have considerable difficulty maintaining populations in such a landscape (Stacey & Taper, 1992); there is virtually no chance for migration or gene exchange between populations for the effectively sessile or slow-moving terrestrial and aquatic mollusks which require active or self-dispersal (the majority of taxa, including almost al endemics and sensitive species). Major disturbance of remaining sites for the very rare SOSC should not be countenanced, as recovery would be slow at best, and most likely would not take place at al at most localities. The best strategy for most of the SOSC is preservation of at least some of the now known sites essentially intact. In some instances, very carefully controlled thinning may be necessary to prevent severe forest fires; but such activities should be undertaken only with great care. Fortunately, land snails are generally most common in areas relatively marginal for large-scale lumbering operations. The tendency to concentrate in certain habitats, such as steep, rocky forested slopes, riparian woodlands, and around springs and seeps is notable for all of the SOSC. In most cases, viable land or freshwater mollusk colonies can be quite small. ***Discus shimeki*** and the ***Vertigo*** species may be present in large numbers in areas of only a few tens of square feet. ***Oreohelix*** colonies with lengths of a mile and widths of 1/4-1/2 mi. are known from several states. In the Hells Canyon and lower Salmon River regions, colonies are generally on the order of several hundred square feet in area. It would not seem unreasonable or unfeasible to carefully preserve undisturbed the relatively small number of parcels necessary to sustain these species.

Because of the small size of many land snail colonies and their current sporadic distribution, certain other activities, mostly related to human stock and recreational use, should also be addressed. In certain instances; development is compatible with many uses; however, these cases are often due to fortuitous physiographic and other features not inherently associated with the activity. Examples will be discussed below. As most land snail species have been extirpated from most of the public lands in the ICB, and as

the SOSC are geographically limited and occur in any case only in relatively unimpacted areas, the potential for conflicts in usage is not that great. However, there is a real potential for difficulties in certain limited areas, particularly in those that have not yet been subjected to intensive management. Ironically, the most attractive features of some areas, e.g. relatively undisturbed forests, deep valleys, and absence of large-scale consumptive operations, to humans for recreational uses coincide with their attractiveness to other species as well. In general, intense recreational usage will extirpate snail colonies. As before, no disturbance is the best policy. When conflicts arise, mitigation may be a viable alternative. However, there is little precedent with land snails, or more particularly with the Species of Special Concern here. Such activities are likely quite possible, relatively inexpensive and uncomplicated, and perhaps worth attempting in particular cases; but only if a core number of original sites have been completely secured in order to guarantee viability of the species concerned.

As the reader will have noted previously, mollusk diversity, whether of terrestrial or of aquatic forms, is concentrated in certain relatively smell portions of the ICB. In particular, many species are confined to calcareous substrate (notably, such units as the Paleozoic Madison, Lodegpole, Mission Canyon, Amsden, and Phosphoria; or the Triassic Martin Bridge). Total outcrop areas of these units make up a small part of the total area of the ICB. Even in the outcrop area of these units, many species, particularly the Species of Special Concern, are limited to a small fraction of the total outcrop area. Certain drainages and narrowly circumscribed geographic areas are particularly significant to mollusk biodiversity, as outlined broadly under AREAS OF ENDEMISM previously. Preeminent are portions of the Columbia Gorge, Hells Canyon, the lower Salmon River, the Clearwater, the Clark Fork, and the Bitterroot drainages. Consewation efforts for most of the significant taxa should be concentrated in this very small portion of the total ICB area. In some instances, other sites are ako very significant, such as a few localities with schist or limestone substrate in western and southeastern Idaho and in western Montana. Similarly, springs in the Upper Klamath Lake drainage, the Columbia Gorge, southeastern Idaho, and specific portions of the Oregon Interior Basins, western Wyoming, and the northern quarter of the ICB. Specific sites are noted under the appropriate headings in the SPECIES DISCUSSIONS. As was made clear in the discussion of areas of endemism and of mollusk biogeography, it is not unusual for both terrestrial and aquatic mollusk SOSC to occur in the same narrow geographic areas- and often at the same sites. Conservation of specific limited habits, such as taluses, cold springs and seeps, and riparian areas, will go far toward ensuring preservation of mollusk biodiversity on public lands. As well, many other rare species are present in sites with mollusk SOSC. Notable are many plant species (both vascular and nonvascular), insect taxa, and reptiles and amphibians.

One example will be cited to indicate the value of a habitat conservation approach to preserving mollusk biodiversity. Recent survey of the remaining sites for the Federally Endangered Iowa Pleistocene Snail led to the discovery of sites for some 8 other mollusk taxa and at least 50 disjunct plant species, all representative of a glacial relict biota characteristic of the upper Midwest. At least 3 of the plants were

themselves already listing candidates. It is suspected that many more rare plant and animal species occupy the same sites. Recovery plans for the biota as a whole envision protection of little more than 4,000 acres total, at a relatively minor cost (Frest, 1984, 1991), and the potential to delist most of the involved species. This is being implemented partly as a special USFWS unit, the Driftless Area National Wildlife Refuge. Similar plans would be relatively easy to apply to most of the species discussed herein.

The practical possibilities for such plans can be evaluated by scrutiny of the Black Hills National Forest mollusk survey (Frest & Johannes, 19934). As indicated above, presewation of very little of the Forest was. recommended to maintain mollusk biodiversity, mostly some small tracts concentrated in the northwest comer of the Forest. Even within the area specified as of particular importance, it was demonstrated that certain specific microhabitats were especially important to Black Hills land snails, particularly the SOSC. These included rocky taluses, springs, seeps, slope bases, and north- and east-facing slopes, particularly if well-forested and shaded (closed or partial canopy). As discussed before, such settings, particularly if accompanied by intact *Pinus ponderosa* or *Picea glauca* series communities with a diverse understory (including some or most of such taxa *as Linnaea borealis, Aconitum* sp., *Viola* spp., including *canadensis, Pyrola* spp. (all), *Moneses uniflora, Adoxa moschafellina, Gymnocarpium dryopteris, Betula* spp., *Salix* spp., *Cornus canadensis, Cornus stolonifera, Aralia* spp., *Circaea alpina*, Rosa *acicularis*, and other taxa mentioned above), and some deciduous tree and shrub admixture (e.g. species of *Acer*, *Alnus*, and *Populus*) are most likely to support diverse land snail faunas.

Many of the areas particularly favored were scheduled for special preservation efforts. for other reasons. The importance of riparian areas to mollusks, particularly of riparian forests, shaded slope bases, and springs, seeps, and permanent streams in more arid regions has also been mentioned repeatedly above. Forest management has long recognized the importance of riparian buffers. However, the common past practice, of relatively intact 100 ft. wide corridors, seems to be inadequate to protect both streams and riparian-related species; and ripariin area s in both federal lands and elsewhere generally now seem to be in the worst condition ever recorded (EPA, 1999). We prefer the definition employed by Thomas et al. (1993), namely of Riparian Habitat Conservation Areas extending "from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges'of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet horizontal distance (800 feet, including both sides of the stream channel), whichever is greatest" *(op.* cit., p. 447). The Spotted Owl controversy has stimulated a thorough reexamination of forest management practices, and the recommendations and evaluations made in Thomas et a/. (1990, 1993) and in Johnson et *al.* (1991) should receive careful consideration here also, as forest communities in the ICB are closely analogous to those of the Pacific Northwest. Similarly, the Association of Forest Service Employees for Environmental Ethics has recently called for implementation of a policy of 100 yard buffer zones nationwide.

SPECIFIC PRACTICES

In order to aid in the management of the ICB public lands, some specific comments will be made here in regard to some common management practices and activities). The order is not systematic; but hopefully it covers some of the major possibilities.

1) Hiking trail construction and maintenance, as well as use of such trails, is quite capable of extirpating snail colonies. One instance of human trail use destroying a population of the Endangered Iowa Pleistocene snail has been documented (see Frest, 1984, 1991, and references therein). The disturbance-induced small size of colonies of, and limited distribution of, many of the SOSC must again be pointed out. Examples of snail colonies suwiving trails across them can also be adduced; but conservative management should be the norm. Damage is particularly likely in arid or semi-arid settings, as human trails or points of particular interest for recreational, scenic, or archaeological purposes tend to be in areas particularly likely to have remaining mollusk colonies. Springs or other permanent water in such settings is also of extraordinary interest to humans as well as mollusks, and particularly likely to have developed trails.

2) Picnic area reconstruction. In general, snail colonies can survive low-use and low-impact picnic areas; but increasing usage will cause extirpation. Colonies are unlikely to survive in such areas proper; and areas bordering picnic facilities will be impacted. Any considerable usage will be damaging.

3) Snow plowing on existing roads is likely to have little or no impact, unless road salting (with either sodium or calcium chloride) is carried out extensively in conjunction with ft. Salt is notoriously harmful to land snails.

4) Road construction is generally disastrous, at least temporarily, if snails (especially SOSC) are present. Again, in the great majority of the ICB, the native mollusk fauna is extirpated or much reduced, so that conflicts are unlikely. The overall effect on an existing colony is to extirpate in the roadway proper, and site preparation often extends the effects. If a sufficient population reservoir remains in the vicinity following construction, partial regeneration of the colony is quite possible; but colonies ate already fragmented and much reduced in area and numbers; allowing continuing attrition is imprudent. Roads form essentially impassible barriers to terrestrial forms. Aside from direct construction effects, road building increases human traffic, including foot traffic; increases exposure and effective ground temperature; generally changes the local plant community; leads to introduction of disturbance plants and non-native and noxious plant and animal species; and stimulates damaging side effects, such as spraying.

5) Timber harvest has been dealt with in part above. Even the effects of selective cutting are likely to be extirpation of sensitive species, such as the SOSC. Very limiting coppicing, as has been practiced in the United Kingdom, can be compatible with survival of many land snail species; but most proposals for western U.S. forests leave ludicrously small numbers of trees. In Washington, some “forests” managed in

this manner have one or two standing trees per acre: the result is grotesque as well as ineffective. As practiced in the U.S., the effects of the heavy equipment standard to most logging operations are much more severe than old-style European coppicing. Selective cutting as done in the area some 60-90 years ago, i.e. without use of heavy mechanical equipment, seems to have left the terrestrial mollusk fauna largely intact, at least in some sites in the Olympics and Cascades. Least damage is done if riparian areas are left intact, as well as areas around permanent springs and seeps, no matter how small. Similarly, retention of a small fraction of the landscape intact, such as slope bases, especially on north-facing slopes, should leave a sufficient population reservoir to prevent extirpation and allow recolonization of the uplands.

We believe that attempts to implement selective logging practices in the Douglas fir forests of the ICB have been ineffective. Sloppy logging often results in fatal damage to the few trees left standing. Overstory removal increases insolation to a considerable extent, and often decreases effective moisture to the extent of exaggerating fires. We do not think that the SOSC would survive such a technique. As forests in these areas are already often somewhat more open and have comparatively thin soils and lesser amounts of debris, ground disturbance and site preparation may have even more severe effects than in Westside forests. In practice, the damage done to the understory is often severe:' and the change in microclimate may be sufficiently severe as to eliminate snail colonies and drastically change the composition of the understory community.

Again, the importance of coarse woody debris to forest floor animal and plant communities should also be reemphasized. Larger pieces are most suitable as refuges or hibemaculae, and mechanical techniques which result in the production of mulch, (ground-up or small-sized debris only) are disastrous to mollusks, and many other more or less sedentary or slow-dispersing organisms. Patch cuts might be acceptable if the allowed rotation time were sufficient to allow migration of surrounding populations. However, most proposed rotation periods are completely inadequate. Moreover, the size of uncut areas often is much less than necessary to sustain more than a fraction of the original community.

There is a sizable literature on forest fragmentation. Even though much is focused on larger vertebrates and plants, it is clear that fairly sizable reserves are necessary to sustain biodiversity. Very few studies have been conducted on relatively immobile animal taxa, such as many forest floor invertebrates, as yet. Precommercial thinning, if a prelude to further lumbering, has bad effects but not as severe as timber "harvesting", and is comparatively irrelevant. One analogy might be machine-gunning an area prior to saturation bombing or shelling.

6) Site preparation is likely to completely extirpate any snails remaining in the area affected. Surviving deadfall and large debris pieces are generally removed or fragmented, destroying remaining shelter or hibernaculae; litter is often dispersed or removed totally to bare mineral soil, and further drying-out of the forest floor ensues. Burning of slash removes much or al of any mollusk fauna remaining. Ground preparation activities such as furrowing are undoubtedly nearly as effective here as they are in Midwest

corn fields in creating monospecific communities. Spraying to kill or inhibit so-called competing plants, such as *Arctostaphylos* or *Sorbus*, would have the double effect of direct poisoning and indirect removal of any remaining or developing cover for mollusks. Both freshwater and terrestrial forms are sensitive to the usual range of herbicides, pesticides, and fertilizers employed, in particular organochlorides or acidifiers. We have no information as to the effects of use of *Bacillus thuringensis* or similar biocides on mollusks.

7) Spring development generally results in loss of all or many species. Effects include drying out of nearly al of the original spring area; disruption of soil, rock, and vegetational cover; encouragement of stock visits (see under grazing, above and below), with concomitant trampling effects and effects of "acidic" manure likely to accumulate in such settings. Unless some part of the source area is left intact and carefully protected, the effect of development is generally to completely extirpate the native freshwater mollusc fauna, as well as most of the diversity in other animal and plant groups. This is an extremely important issue in the ICB, as elsewhere in the West. At least 3,500 springs have been "developed", often at public expense, in Idaho and Montana alone. Such development often fails in its primary function, that of making water more available to stock. Piping, etc. often disturbs the groundwater source or is so inexpertly done as to dry up the spring. Moreover, this activii tends to concentrate stock into an extremely limited area. Trampling and waste fouling effects am exaggerated, and compaction can also cause the spring source to fail more readily than with springs left in the natural state.

In much of the arid and semi-arid portions of the ICB, springs are not only vital sources of water to domestic animals and humans, but are the major locales for biodiversity. Spring development has thus tended to selectively extirpate the relatively few rich islands of plant and animal diversity in many of the more xeric lands in the ICB.

Perhaps the single most deleterious activity in arid-and semi-and ecosystems to both terrestrial and freshwater forms is development of springs. Reasons for this have been discussed above. We can do no better than to supply the following quote:

"Range Improvements" - an Oxymoron

"Range improvement projects are a major BLM management emphasis. These projects would be more accurately termed as livestock management facilities. One of the most wmmon range improvement projects is to run water through a pipe from a natural spring to a watering trough. In Idaho and Montana alone, the BLM and livestock permittees have developed over *3,500* springs on public lands. Some BLM Districts have developed all known springs. Yet in desert ecosystems, natural springs are critical areas for maintaining biological'diversity.

The BLM often states that the purpose of these spring developments is to improve riparian area condition. Yet the BLM does not monitor the effectiveness of these projects for riparian improvements. Diverting spring water to a trough results in a dewatered wetland or spring riparian area, and a net loss of wetlands acreage. This effect is not only inconsistent with the Bureau's publicized

goals for wetland/riparian improvement, but is inconsistent with the national policy of no net loss of wetlands." (PEER; 1994).

8) Spring fencing in general causes little damage *per* se, and there is no irreparable harm. The benefits from fencing to the area protected on the whole far outweigh any negative effects. In practice, however, fencing is often relatively ineffective as a protective measure. To function properly, it must be done with some care; and field crews often do not exercise such care. Moreover, maintenance of such fences is often done inadequately or haphazardly, in our experience. As a mitigation technique, fencing can be done in such a manner as to preserve at least part of the local biodiversity but still make water available for other uses. Spring sources and a few hundred feet of the upper run should be rigorously protected; For many species, this will provide enough habitat to maintain a viable population.

9) Fencing of riparian areas and allotments generally suffers from the same drawbacks as spring fencing. In practice, a certain amount of deliberate sabotage and illegal grazing also takes place for various reasons, and is seldom corrected. An effective program is low-tech and could work well, if sufficient funding, motivation, and personnel are available.

10) Prescribed burning, if carefully conducted, should produce no permanent bad effects. In practice, however, much such is unnecessary, except in already disturbed settings. Mollusks seem able to survive natural fires, but not exceptionally severe fires or those resulting from the past practice of fire suppression. Complete incineration of forest floor litter and of even coarse woody debris appears to be uniformly disastrous for all terrestrial mollusk species. Practices mimicking the natural fire regime for each major plant community, as described, e.g. in Agee (1993) are strongly to be preferred. Fires in sage scrub or other arid or semi-and plant communities may be even more disastrous to mollusks than forest fires. This is because cover is so limited in some such situations that loss of individual plants may be severely damaging to a particular snail colony. This situation is greatly exaggerated by the presence of other factors which already have stressed semi-arid land sites, in particular grazing.

Secondary effects of prescribed burning may be worse than fire itself. Pile and bum methods are particularly mechanically oriented and effective in removing vital coarse woody debris. Jackpot methods are less destructive; but still objectionable. Subsoiling basically may reduce previously-caused compaction; but as a post hoc practice only compounds damage and ensures virtual biological sterilization of the area so treated, at least as regards mollusks. Scarification is also a virtual guarantee of local mollusk extirpation. We do not have sufficient experience with crushing for bitterbrush to evaluate; but would predict similar results to other mechanical vegetation removal activities (disastrous for mollusks). Chippers reduce woody debris into particles too fine to provide much shelter and too allow needed water circulation in the topmost soil.

11) Stream improvement should have only local effects on land snail sites, but must be examined on a case-by-case basis, as there is some potential for extirpation of individual snail colonies. As practiced commonly, we have in general been unimpressed with the long-term effectiveness of many such projects.

Most seem intended to benefit one or two Three F species, with no consideration given to the aquatic ecosystem as a whole. Such projects can have very negative effects on aquatic mollusks. Colonies of the sensitive species are often highly local, and respond negatively to the physical disturbance and increased siltation (even if of short duration). Projects to increase cover in riparian zones are generally very beneficial to all mollusks, including the sensitive species, provided that nutrient enhancement of the water course itself does not occur.

12) Pond construction and dredging must again be considered relatively low-impact activities that should, however, be examined on a case-by-case basis. In relatively natural areas, such projects generally have strongly negative effects on the local aquatic biota, causing extensive local disturbance and sometimes long-term fragmentation of populations or prevention of migration. In the case of rare species. colony or even species extirpation could result. It is very important to inventory aquatic fauna present at a site before undertaking any disruptive management practices. In most cases, rare or sensitive species will not be present; but some taxa are so rare that particular projects could result in a species' extinction.

13) Browse seeding in itself should have little negative effect. Removal, poisoning, or burning of native vegetation to encourage browse growth are strongly detrimental.

14) Beaver and other reintroduction program efforts also should have minimal direct impact.

15) Noxious weed or insect treatment and eradication programs should be carefully monitored, and discouraged or proscribed in areas with surviving colonies of rare mollusk species, including the Species of Special Concern. Many herbicides are quite toxic to all land snail species. Similarly, use of road salt has very negative effects. Herbicide spraying is deleterious in direct proportion to its intensity and effectiveness on vegetation. Both land and freshwater taxa can be 'negatively affected by herbicide spraying, with the effects most pronounced for aquatic forms.

16) Mining exploration varies in its effects according to the methods used; no generalization is possible. Old-style prospecting and prospect pits seem to have had minor negative effects in most instances. Drilling operations can easily be large enough to extirpate a snail colony. Many such tend to be sited in areas unlikely to have Species of Special Concern; but this is again a case-by-case call.

17) Archaeological excavation in general tends to have no impact, as human occupation sites are often not situated in areas with thriving snail colonies; but this judgement again needs to be made individually for a given case. Archaeological methods will cause local extirpation of snails; long-term effects would vary considerably from site to site.

18) Grazing, along with logging, is generally very destructive to land snails, in particular to sensitive taxa such as the Species of Special Concern. Heavily grazed areas often lack land snails altogether, and even moderately grazed sites generally have a depauperate fauna of a few generalist species, as discussed previously. 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 many species and encouragement of others, particularly waste species and heavily protected, tough, or toxic taxa. Grazing also tends to increase insolation. Locally, deposit 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.

In conclusion, we would endorse the basic recommendations of the Eastside Forests Scientific Society Panel in regard to Eastside management practices (EFS, 1993). Also relevant here is the American Fisheries Society position statement on livestock grazing (AFS, 1991) and Fleischner (1994).

COLLECTION AND MONITORING METHODS

General reviews of methods in malacology are fairly common. Examples include Burch (1972, 1973, 1975a, b), Kemey & Cameron (1979); and Malek (1986). For an overview of the advantages and drawbacks of quantitative methods, see Brown (1980). In general, sampling for rare species may present special problems. Quantitative data are hard to secure without use of destructive or overly intrusive methods for some rare or Endangered taxa. Practical limitations of identification mean that small taxa often cannot be collected without some population attriiion or habitat damage. This should be. kept in mind when rare or possibly rare taxa are involved. Wiih proper care, methods can be tailored to allow collection of necessary information.

TERRESTRIAL MOLLUSKS

Many land snail and slug taxa are substrate- or exposure-limited. Hence, it is helpful to review the geology and soils of the study area prior to initiation of field work. As many terrestrial mollusks are

calciphiles, special emphasis should be placed in sampling on the outcrop areas of major limestone, dolomite, or other units which yield a calcareous regolith or soils with comparatively bw pH. However, care should still be taken to place at least a few sites in areas with soils derived from all major rock units, and all lithologies with substantial outcrop area. Similarly, areas with comparatively high annual precipitation levels or with persistent water, e.g. springs, seeps, and permanent stream banks (no matter how small) are favorable to many land snail species. Nevertheless, as a matter of course, some sites should also be collected regardless of moisture regime. Typically, snails and slugs are most common on north- or east-facing slopes, and near slope base; but the other possibilities should also be explored. Rock exposures and talus are very significant habitats, especially in drier areas, and cliff faces and bases are also area of concentration.

As vegetation type (plant community or association) has proven highly significant to the occurrence of certain land snail species, it has proven useful to review the literature on plant communities and flora of the area surveyed prior to the initiation of collection. Certain plant species are often associated with land snail colonies. In the western U.S., e.g., *Oreohelix* is frequently abundant in alder (*Alnus* spp.), poplar (*Populus* spp.), or birch (*Betula* spp.) stands, or associated with *Rhus horribilis*, *Urtica* spp., *Laportea* spp., or *Amelanchier*. Plant associations have been discussed in more detail above; generalizations are that deciduous tree or shrub areas; areas with diverse floras; and areas with considerable forb understory are particularly rich. We have often found Western U.S. rare or endemic mollusk species to co-occur with endemic vascular or nonvascular plant species; alternatively or as well, they occur with species characteristic of rich forests or undisturbed habitats. Accordingly, we typically review the botanical literature to ascertain endemics or other plant species of interest in the region prior to our site visits. In the Black Hills National Forest, e.g., species particularly watched for included the following: *Acer* spp., *Aconitum* spp., *Adoxa moschatellina, Gymnocarpium dryopteris*, *Allium cernuum, Athyrium* spp., *Betula* spp., *Arctostaphylos uva-ursi*, *Chimaphila umbellata*, *Circaea alpina*, *Comus canadensis, Cornus stolonifera, Dryopteris filix-mas*, *Gallium boreale*, *Gentiana* spp., *Mianthemum canadense, Mertensia paniculata, Moneses uniflora,* all Orchidaceae, *Pyrola elliptica*, *Pyrola secunda,* Pyrola *asarifolia*, *Pyrola minor, Ribes hudsonianum,* Rosa *acicularis*, *Salix* spp., *Sambucus* spp., *Saxifraga* spp., *Streptopus amplexifolius*, *Ulmus* spp., and *Viola* spp. (Frest & Johannes (1993d). Slugs are often most easily collected in rich forest or very moist settings, even if acidic in pH. Associations with such species as skunk cabbage, waterleaf, *Cicuta*, etc. are common. In alpine areas, snails shelter under bark and wood, *Salix* spp., cushion-forming composites, and *Comus* stands. Very few terrestrial mollusks are associated with acid-loving *mosses* such as *Sphagnum,* and species are few and rare in habitats with very dense moss cover or polders. Small proportions of such genera as *Rhytidiodelphus* or *Mnium* may be associated with dense colonies. Terrestrial mollusks tend to avoid areas with dense fungal mycelium throughout: but are common on the fringes of such areas or where fungal growth is less luxurious. Terrestrial mollusks tend to be rare in acid bogs and fens, but may be extraordinarily abundant in

calcareous fens (Frest, 1990). These require special collection methods, which will be discussed later. Some species may be limited to such habitats.

In semi-arid or arid areas, cover is probably even more significant than in forests. Mollusks are associated with such genera as *Artemisia*, *Physocarpus, Rhus*, *Prunus*, *Amelanchier, Balsamorrhiza*, and *Utica* Large parts of some arii areas may be very difficult to collect. It should be noted that, while the association of a particular land snail or slug species suite with certain plant species is often quite strong, such associations are not inevitable or invariant. Both plants and snails are reacting to particular sets of physical conditions; and occurrences are mediated by historical circumstances as well. Physically favorable sites, such as north- or east-facing slopes, slope bases, rock exposures, and taluses are very significant refuges for xeric-adapted or occurring mollusks.

Timing is very significant for terrestrial collections. In most areas in the ICB, collections should be made after spring melt-out, perhaps from April-May, or late in the fall, as fall-winter rains occur but before the first heavy freeze, e.g. September-November. Wet conditions i.e. after rain storms, are especially favorable.

Two methods are commonly employed, and use of both is necessary to assure an approach to complete faunal wverage. Hand collecting is necessary to insure collection of substantial numbers of the larger snails and of the slugs. For accurate identification, collection of a full ontogeny of live specimens is necessary. Concentration under logs, bark, large plant debris, stones, bases of larger forbs or shrubs, etc. is typical. Such standard methods in invertebrate zoology as use of pitfalls with ethylene glycol, etc. or Berlese funnels are only partly successful for mollusks. They generally tens to underrepresent diversity and abundance, while being selectively effective for a few species. Hand collecting may be very effective for larger terrestrial forms, if quantitative data s not required. Quantifying distribution of larger forms requires use of large quadrats, generally 1/4-1 m on a side, distributed randomly over the area to be surveyed. The method of choice, especially for small forms, is litter sampling. For this purpose, 1/4 m squares are most effective. The term “litter” is here used in the loose sense for the predominant surface habitat cover, be it duff or loose soil in rock talus. Generally, the quadrats are distributed randomly; from each, the larger debris is excluded, and the area excavated down to the first soil zone (i.e. not more than 2 cm into the soil proper)and bagged. Total litter sample volumes at any one site should be approximately 0.25 $ft.^3$, and represents approximately 2.25 $ft.^2$ of surface area, or about 20 1/4 m squares. This corresponds to a loose volume of about 1 gallon. Land snail litter samples must be treated carefully to avoid loss of specimens. Slugs must be removed immediately. Field drying immediately after collecting may prove necessary to prevent molding. Slow and complete low-temperature (ca. 150-200^{o} F) oven drying for several hours is followed by soaking in water for no less than 1 hour and no more than 12 hours. The sample is then subjected to very careful but vigorous water disaggregation through a standard sieve series (ranging. from Tyler Standard 5-40 mesh [12.5-0.425 mm] openings). Sieved sample fractions should be air-dried and then picked by hand under a binocular microscope. Typically, each litter sample

requires at least two days to process completely. Generally, sampling at any one place will require at least 1 hour; sometimes, much more time will be necessary.

Hand-collected snails and slugs should be placed in marked, warm (not hot) water-filled bottles to which finely crushed menthol crystals are added. All air should be excluded, and the bottles placed in a dark and quiet place. Slugs, shelled large species, and small shelled species should be relaxed in separate bottles. Large numbers of specimens should not be placed in any one bottle. Relaxation will occur in 24-36 hours. Relaxed mollusks should be fixed with 5% formalin for 1-2 days, then transferred to 50% isopropyl or ethyl alcohol. For long-term storage the mollusks should be transferred to buffered (pH 7) 70% ETOH-15% glycerin for long-term storage. A protocol for handling terrestrial mollusk is available from us upon request. Proper identification of many species may be done from shells alone; however, collection of live specimens is necessary in many cases, and should be done whenever possible.

Dissections of preserved materiel should be done using standard methods (e.g., Solem, 1975 for *Oreohelix*). For dissections, drawings, and measurements, we use a Wild M3Z binocular dissecting microscope equipped with a camera lucida and graticule. Where possible, measurements should be cross-checked using Glaube or equivalent calipers.

Site information should be recorded in the field to the extent possible. Plant associates, exposure, etc. should be recorded. We favor the use of USGS 7.5' topographic or smaller scale maps where available. Localities should be described in detail using legal, latitude/longitude, or UTM coordinates as convenient. We use a standard form for sites, also available upon request. Our sites are entered into a field data base (FieldDB™) on a personal computer form the field sheets: this information is downloaded into a larger database (MolluscDB™) in the lab. Use of hard copy backup for both field sheets and data base output has proved necessary and useful.

For monitoring, variations on the same methods should- be used. A good review of such methods is Bishop (1977). We do not advocate repeated litter sampling except at fairly large sites, as the method can be somewhat destructive of habitat (Newell, 1971); however, this is the most comprehensive method. Repeated hand quadrat sampling (e.g. 1/4 m squares) is effective for larger species. After initial identifications are made, it may not be necessary to retain specimens each time, if information on rare taxa is the object. Another fairly effective and relatively nondestructive method (not usable on all large species) is described by Boag and various collaborators (Boag, 1982, 1985, 1990; Boag & Wishart, 1982; Locasciulli & Boag, 1987). Masonite squares of a standard size are left at standard stations in the area to be monitored. After seasoning (for a year is sufficient), squares can be retrieved and their undersides censused at regular intervals. This is best done at regular intervals, preferably annually.

For both land and freshwater taxa, it is best to assume that al or at least some taxa show aggregated (=clumped or patchy) distributions. This certainly is the case with disturbed sites, and probably with more natural situations as well. In such situations, it is reasonable to assume a negative binomial distribution and

make use of many small scattered quadrats. Problems of sampling rare species are discussed in Green (1979) and Green & Young (1993).

FRESHWATER MOLLUSKS

As with terrestrial taxa, freshwater mollusks may occur in a variety of habitats; and al present should be sampled. However, certain areas are especially favorable in the ICB. Many of the rare or endemic taxa are cold-water stenotherms, found only in areas with cold, clear, flowing water. Most taxa, including most of the rare ones in the ICB, are restricted to permanent water bodies (no matter how small; but some taxa are restricted to or prefer impermanent habitats. Coarse substrate is often particularly rich, although some taxa prefer or are restricted to soft substrate. Most or all of the endemic or restricted taxa are found in habitats with continuously high dissolved oxygen content and comparatively high pH. Areas with anoxic or hypoxic conditions have restricted faunas. Habits with substantial water pollution, including nutrient enrichment, heavy metals, or concentrations of pesticides or herbicides, sewage, etc. generally have limited faunas of widespread species. Areas with abundant macrophytes and/or abundant epiphytic algae *(e.g., Cladophora)* also often have limited faunas in this area, particularly if warm or nutrient-enhanced. However, clear-water sites with moderate coverage *by* such taxa *as Rorippa, Cicuta, Chara, Potamogeton, Veronica, Elodea,* and red algae may be very rich, as can be relatively oligotrophic lakes. As compared to other areas, the richest ICB sites are often surprisingly oligotrophic. In general, high-altitude sites have small faunas, although some species are restricted to such locales. Springs, regardless of size, are often the most interesting sites for collection, if at all intact. Large spring pools and spring-influenced stream sites may be exceptionally rich. It should be remembered that headwater forms are often restricted in distribution and quite different from those in downstream areas. Large river faunas may also be quite distinct. In areas with nasmodes, all springs should be collected, as some species will be restricted to one or a few of a group of identical-appearing sites. Similarly, all major subhabiiats should be covered, as colonies of some taxa will be very limited in extent. Cold springs are most likely to have mollusk faunas, and many endemic species are crenophiles or crenocoles; but there are significant numbers of warm spring endemics as well (thermiphiles). Hot springs generally lack mollusks; the threshold appears to be in the 30° C range.

Stream collections are best done at low water stages. For deep water and for lakes, dredging is useful. On soft substrate, PONAR, Petersen, or Ekman dredges are successful for all but larger freshwater clams, although intensive sampling may be called for. On hard substrates, a specially designed trawl dredge is more useful. Kick nets, Surber samplers, or similar samplers are not effective for mollusks. For unionids, snorkeling or HOOKAH or SCUBA diving is sometimes the method of choice.

Standard methods in freshwater malacology have been referenced above (e.g. Malek, 1885; Brown, 1980). Generally, an initial (baseline) survey of the study area should be conducted to evaluate habitat types, possible collection sites, and access. Collection methods may vary according to substrate type and degree of aquatic macrophyte or plant and animal epiphytic cover. Initially, all areas should be visually inspected and then spot sampled to insure completeness of coverage and size and extent of major subhabiiats prior to comprehensive collection.. More systematic methods should be used for formally defined sites or for long-term monitoring. In coarse substrate areas such as cobble-boulder bars, a random sample of stones should be removed along measured transects and the mollusks either hand collected or brushed from them into a 7.5" X 13" tray. Areas with mud, sand, or silt substrate are sampled by excavating small areas of bottom sediment to a depth of about 3 cm using a dip net with an 8" diameter and effective mesh size of 40 [Tyler equivalent 35 mesh: openings 0.425 mm]. We have found that standard cloth or nylon nets as used in sampling aquatic insects are not sufficiently durable and may be too large to function effectively except in a few situations. Many such nets have too large a mesh to be effective for the frequently-encountered small taxa. Areas with rooted aquatic macrophyte vegetation (e.g., shallow portions of deep spring pools and channel edges in slow-moving streams) should be sampled using the same size dip net. Vegetation is retrieved with the net and then placed in 7.5" x 13" trays and vigorously shaken to dislodge al mollusks. In areas with bedrock or cobble-boulder substrate (most of the study area), the bedrock or liths should be scrubbed underwater with a scrub brush, or lifted into a tray underwater, followed by scrubbing at a more convenient locale. Dislodged material can be caught and retained in a submerged 7.5' X 13" tray positioned downstream from the scraped surface. Typically 1 O-30 subsamples should be taken from each sample site: the surface area represented at each generally should total about 1 m2. For more quantitative work or for stations to be monitored regularly, samples are often collected along a 100 ft. (approximately 30 m) transect. Where possible, transects can be situated across the river or other water body; however, some transects on larger streams or lakes are better run parallel to shore. In small springs, large samples are not feasible, and hand and dipnet collections are the chosen methods. Large volumes of specimens were not typical, except from larger springs; these could be treated much as river sites. Where soft substrate (mud-fine gravel is significant, samples can be collected and sieved separately from the coarse substrate samples in the field (to 40 mesh) to eliminate mud. Generally, a 9-16 oz. volume of sieved concentrate from each such site is adequate. Where such samples contain large volumes of substrate (sand-fine gravel) and small numbers of mollusks, mollusk separation and relaxation is not practical, and the sample should be preserved immediately. In general, mollusks should be separated from sediment and from debris as soon as possible: otherwise, relaxation may not be successful. Regardless of origin, the collected material from each subsample from either coarse or fine substrate should be decanted into a labeled container for further treatment. Subsamples are generally run through a standard sieve series (to 40 mesh) in the field to ensure collection of all mollusks and to eliminate very warse and very fine organic debris, mud, and silt. For samples expected or

known to contain difficult to identify species, we routinely employ relaxation, fixation, and preservation using a succession of menthol, dilute formalin, and either isopropyl or ethyl alcohol (Frest & Johannes, 1992b). A protocol is available from us or from R. Hershler (NMNH). Relaxed individuals are necessary to identify many taxa, in particular hydrobiids, and valuable in al cases; often, large samples are needed to insure that enough individuals of both sexes are obtained. At many sites most individuals are parasitized. Samples frequently will contain large volumes of organic material or of such common associated animals as caddis fly larvae, flatworms, or oligochaetes. These must also be removed to ensure relaxation and proper preservation. Sieved samples, generally a concentrate with a volume of 9-16 fluid oz., should be placed in labeled jars. Each site typically will require an average of 1 hour or more to collect. Where available, efforts should be made to collect drift samples; such samples often provide information as to composition and changes in mollusk faunas, at least dating to the last high-water period (Frest & Johannes, 1993a, b). Notes on collection conditions, substrate, habitat, and associated flora and fauna should be made at each site, much as outlined above. We use a standard field data sheet, field data base, and master data base.

Samples should be cleaned again prior to relaxation to remove as much extraneous matter and as many other organisms as possible. If larger mollusks are present, they should be removed and relaxed separately. Water from the site collected or an especially pristine site should be collected each day in the field. Sieved mollusks should be spread in a shallow layer in as many flat-based containers as necessary and covered with habitat water to a depth of several inches. A small amount of menthol and/or propylene phenoxytol is added to each container, and these are left undisturbed over night. After 12 hours, the water is replaced with 4% formalin. In 1-2 days, this is replaced by 70 % isopropyl or ethyl alcohol. Preserved samples are resieved in the laboratory to remove fine sediment and plant and animal detritus, and the full volume should be examined. The whole sample is picked for mollusks under a low-power binocular microscope. With many mollusk taxa (especially certain Physidae and Hydrobiidae), dissection, particularly of relaxed specimens, is necessary for proper identification. Of the species of special interest in the ICB, this can apply particularly to the Pleuroceridae, Physidae, and Hydrobiidae. Dissections and drawings of selected specimens are done using standard methods under a Wild M3 microscope and camera lucida or equivalent. For long-term preservation, the specimens should be placed in 70% ethyl alcohol-15% glycerin, buffered to pH 7. Many different relaxants and preservatives may be appropriate in various circumstances. See Pennak (1989) for general discussion. For mollusks, discussions and references in Malek (1985) and Araujo *et a/.* (1995) are useful.

Techniques for long-term monitoring are very similar to those just outlined above. The same caveats in regard to monitoring of rare or Endangered taxa as mentioned at the outset apply here also. For larger mollusk species in relatively large streams, quantitative sampling within standard squares 0.25 or 1 m on a side may be preferable. In many cases this is not practical, as many fresliwater species are small (<5 mm in length), and immense numbers could occur in a 1 m^2, making counting difficult. The small specimen size often necessitates collection of all mollusks to confirm identifications. This is not practical for small species

in large areas. Moreover, many mollusk populations may be dense but extremely limited areally; large-size quadrats are irresponsible in such a situation. Many of the more cryptic hydrobiids occur only on limited portions of large liths; *i.e.* sides and undersides. In such situations, we have found it practical to use small quadrats scattered more or less randomly through a given colony to estimate density (see, e. *g.*, Frest & Johannes, 1992; 1993, 1994, 1995). For these studies, several quadrat sizes were employed routinely. Squares used were fabricated to our specifications from white opaque polycarbonate plastic 4 mm stock. Where possible, 20 or more counts were made per site. Specimens within each quadrat were counted and. identified to genus or species in the field. They were then collected and preserved to confirm identifications. We make a point of collecting egg masses or capsules as well as hatched individuals. Counts for these are maintained separately. Generally, supplementary non-quantitative collections should be made at each site to ensure complete representation of the mollusk fauna and to obtain representation of widely dispersed taxa and unionids. Again, care must be taken with rare or widely dispersed species to prevent impact on the population. Generally, if specific species are monitoring targets, repeated recollection may not be necessary after the initial baseline survey. Smaller hydrobiids, however, may present special problems if 2 or more species occur together, which is not infrequent. A good example of standard techniques is Mladenka (1992). Where the species can be readily identified, some modification of our quadrat sampling method is preferable. We do not advocate repeated collection of rare taxa unless information needs are critical; and would prefer habitat conservation and minimal impact to population sacrifice in the name of information "needs".

INFORMATION RESOURCES

BOOKS

There are several very useful monograph- or book-length treatments of mollusks. Particularly useful are Morton (1979) and Fretter & Graham (1994). As regards land snails, Solem (1974) is the most useful source; and this work also provides relevant background for mollusks in general For introduction into the ecologic and physiologic literature, McMahon (1991) and Brown (1991) are useful for freshwater bivalves and gastropods respectively. There is currently no such thing as a complete key to U.S. freshwater bivalves or gastropods or to land snails or slugs, let alone ones specifically for the western U.S. For Sphaeriidae, Burch (1972, 1975a) is very useful: the corresponding work for unionaceans are Burch (1973, 1975b). For freshwater gastropods, the best general work is Burch (1989). Users of Burch (1989)

should keep in mind that the latter was more or less fixed in regard to taxonomy around 1982; for later additions, the periodical literature must be consulted. This is particularly necessary for western Hydrobiidae, in which family there has been extensive changes in just the last five years (Frest, 1995). For these very important springsnails, the works of R. Hershler (especially Hershler, 1994 and references therein) and D. Taylor (1987) should be consulted. It should be noted that the family Hydrobiidae is a current focus of active research, and considerable change is expected over the next ten years. The pace of changes or additions to the western U.S. sphaeriid and unionid fauna is much more leisurely. For land snails, the most recent comprehensive work is Pilsbry (1939-l 948), which is still in print. There have been numerous additions and changes since 1948: a partial bibliography is in Miller *et a/.* (1984); but reference should be made to the periodical literature. Research on terrestrial mollusks in the western U.S. lagged somewhat in the last generation; but appears to be again accelerating. Common species names are compiled in Turgeon *et a/.* (1988); however, this work missed many western U.S. species and does not deal with subgenera and subspecies.

JOURNALS

There are a number of journals dedicated exclusively to malawlogy or frequently having mollusk papers. The ones most likely to publish manuscripts on western U.S. land and freshwater mollusks are the following:

The Nautilus (1886-present)
The Veliger (1958-present)
Malacologia (1963-present)
Malacological Review (1968-present)
American Malacological Bulletin (1983-present)

Other journals and institutions historically or currently publishing such material extensively are:
California Academy of Sciences *(Bulletins, Occasional Papers)*
Southern California Academy of Sciences *(Bulletins)*
San Diego Society of Natural History *(Transactions)*
Academy of Natural Sciences of Philadelphia *(Proceedings, Notula Naturae)*
Field Museum of Natural History (*Fieldiana: Zoology)*
Sterkiana [no longer publishing]
Gastropodia
Wassman Journal of Biology

Smithsonian Institution ***(Smithsonian Contributions to Zoology)***

Biological Society of Washington ***(Proceedings)***

University of Michigan Museum of Zoology ***(Occasional Papers, Contributions to Zoology)***

There are many others; and relevant mollusk articles appear in numerous more general-interest publications (e.g. *Oikos*) as well. Regular use of such literature citation/bibliographic services as *BIOSIS* and ***The Zoological Record*** is necessary to maintain currency in the field. Regular consultation with specialists is also extremely valuable.

MUSEUM COLLECTIONS

Many U.S. natural history museums have extensive holdings of western North American land and freshwater taxa. The list in SPECIES DISCUSSIONS below is more extensive; but the majors are as follows:

Academy of Natural Sciences of Philadelphia (land and freshwater)

California Academy of Sciences, San Francisco (land and freshwater)

Delaware Museum of Natural History, Wilmington (land snails of M. Walton)

Museum of Comparative Zoology, Harvard University, Cambridge (land, some freshwater)

Field Museum of Natural History, Chicago (land, some freshwater)

Los Angeles County Museum, Los Angeles (some land, some freshwater)

Santa Barbara Museum of Natural History, Santa Barbara (land and freshwater)

University of Colorado Museum, Boulder (land and freshwater)

University of Michigan Museum of Zoology, Ann Arbor (land and freshwater)

Smithsonian Institution, National Museum of Natural History (land and freshwater)

In addition, there are smaller collections in many places, including the University of Oregon and University of California. Our own holdings in total numbers probably exceed those of most museums, but are concentrated in particular geographic areas and emphasize certain families; most of our records date from the 1980s-1990s. The NMNH collections are by far the best for Hydrobiidae. Other large private research collections include those of D. W. Taylor and B. Roth; note that private collections are not often readily accessible.

it should be emphasized that museum records vary considerably in quality and accuracy. One estimation is that as many as 50% of all such records for mollusks are misidentified. Accuracy generally depends upon present and past curatorial interests, and tends to vary greatly from group to group. In general, an expert malacologist should be retained to evaluate and update museum records, if it is desired to use these for management purposes. Museum records are an exceedingly valuable and irreplaceable

source of information, particularly on past occurrences and sometimes abundances and other data. Many more museum records exist than can be found in the literature (at least twice as many, typically); and literature records should not be regarded as completely reliable unless substantiated by reposited specimens.

LITERATURE RECORDS

Major sources of literature records for the mollusk fauna of the states of WA, ID, MT, OR, NV, and UT are few. Many are scattered through numerous short papers in the journals listed above. The more important of such works are generally cited below in one or more of the **SPECIES DISCUSSIONS,** and are listed in the **REFERENCES.** This section is not, however, intended to be a complete bibliography of works on the mollusks of this region. No such completely comprehensive work exists for the western United States; nor is there a compilation equivalent to that of Hubricht (1985) for states east of the Mississippi River, even though there is a considerable need for such a work. B. Roth (*pers. comm.*, 1994) is writing a thorough review of California land snails. There is no modem equivalent for WA, OR, MT, NV, UT, or OR even in the planning stage. An illustrated update to Beetle (1989) for WY would also be very helpful. Major sources and their limitations will be discussed here.

For land snails, the early works of Henderson. (1924, 1929a, 1935, 1936a, 1936b) are valuable, although taxonomy has evolved considerably since his time. The classic monograph of Pilsbry (1939-1948) is still highly valuable. In Utah, the compilation by Chamberlin & Jones (1929) is valuable, but suffers from the same drawback as regards systematics. Illustrations in Henderson and Chamberlin & Jones are not up to current standards. Many shorter papers by H. B. Baker, S. S. Berry, B. A. Branson, J. Henderson, and H. A. Pilsbry are particularly significant sources of records. For freshwater mollusks, the same Henderson (1929a, 1929b, 1935, 1936a, 1936b) citations are particularly useful, again keeping in mind the necessity to revise the taxonomy by reference to more recent works. Chamberlin & Jones (1929) is similarly worth noting again here also: the comments above in regard to illustrations and taxonomy remain salient. A comprehensive and very useful bibliography through 1975 is available in Taylor (1975). Among shorter works, those of F. C. Baker, B. A. Branson, and R. Hershler contain many site records. Papers by Beetle [Pilmore] on Wyoming should also be mentioned. Taxonomic treatment is somewhat idiosyncratic in both Beetle and in Branson; and thus records from these workers may require interpretation. The taxonomy utilized here will be discussed below. A comprehensive modern illustrated state-by state treatment is needed for WA, OR, MT, ID, OR, UT, and NV, as well as an updated and illustrated version of Taylor (1981) for CA.

Some recent records for both land and freshwater mollusks in this area are accessible through the reports of A. H. Clarke. Many others are found in the reports of Frest & Johannes and Neitzel & Frest (see **REFERENCES).** Perhaps the largest number of records of the western states' freshwater mollusks in general for the period 1950-1990 are those in the collection and notes of D. W. Taylor. These have the advantage of being either personal collections or verifications by Taylor, who is an exceptional freshwater malacologist with equal interests in both the modem and fossil western U.S. faunas. Unfortunately, relatively few of these have been published as yet for the Columbia Basin states. It is to be hoped that this will occur in the future. As with collection records, literature citations should not be used uncritically. The author(s) interests, experience, and areas of specialization are very relevant; and citations backed up by reposit in a well-recognized museum with a history of involvement with malacobgical collections are much to be preferred.

DATABASES

At present, there is nothing approaching a comprehensive computer data base for western U. S. land and freshwater mollusks. Both the University of Michigan Museum of Zoology and Academy of Natural Sciences of Philadelphia maintain at least partial data bases on their mollusk collections that may be used by others. For information on these, contact the appropriate curators, ***i.e.*** D. Eernisse and J. Burch, University of Michigan, and G. Davis, Academy of Natural Sciences of Philadelphia. We maintain a data base for our own and others' recent (and some historic) western U. S. records (MolluscDB™). We have found that the variius state Heritage Program databases are very spotty at best on mollusks. It should be borne in mind here, too, that both museum and literature records for many western taxa are sometimes substantially inaccurate; and that accuracy depends upon the interests of the historic and current curators. The quality and quantity of material in databases may be expected to expand considerably in the near future.

"ORGANIZATIONS

Malacologists are among the better-organized specialist groups. Especially notable are such national organizations as the American Malacological Union, Inc. and the Conchologists of America. In the western U.S., the Western Society of Malawlogists and the California Malacozoological Society should be mentioned. Amateur groups are numerous; some California organizations have been in continuous

existence for 50 years or more. A WA example is the Seattle-based Pacific Northwest Shell Club. Many of these groups issue regular newsletters, ***e.g. Dredgings, Hawaiian Shell*** News, etc. A number of individuals or special-interest groups in malawbgy issue their own professional or semiprofessional journals. In the western U.S., an example would be ***Of Sea and Shore,*** Port Gamble, WA. A historic example of considerable significance ***is*** the ***Minutes of the Southern California Conchological Club,*** which published much original information on occurrences, ecology, etc., for many years. For land snail collectors on a world-wide basis, there are such organs as ***Papuistyla.*** Shell dealers are many, and there is a substantial and lucrative industry specializing in specimen shells. Good current lists of dealers and of malawlogy- and conchology-oriented groups are maintained by T. Rice, editor of ***Of Sea*** and ***Shore.*** A number of private collectors presently have interests in western U.S. land and freshwater mollusks. Particularly striking examples of the significant contributions of private collectors to malacology are provided by the careers of H. M. Walton and Leslie Hubricht. The value of such records should not be overlooked; much of the data is of recent vintage, although professional reidentification is often necessary [not often for the high-caliber work of Walton or Hubricht]. Similarly, a number of private consultants accumulate recent mollusk records as a part. of their business. While identifications vary in quality, some do retain collected specimens, at least for short periods. We actively solicit such material.

SPECIES DISCUSSIONS

INTRODUCTION

Species-level taxonomy used here largely follows Pilsbry (1939-48) for land snails, except where superseded by more recent works. Examples include the papers of B. Roth and his collaborators in California and Oregon (mostly referenced by species below: see also Roth, 1993) and the works of G. Webb (mostly published in *Gastropodia*). Higher taxonomy also is often that of Pilsbry *(op. cit.),* with later modifications: we follow Burch & Pearce (1990) in preference to Vaught (1989). It should be emphasized that higher taxonomy of land snails is currently in flux (see, e.g., Emberton *et al.,* 1990 and Bieler, 1993). For freshwater mollusks, we generally follow Burch (1989) in preference to Vaught (1989). In some significant cases, we follow Taylor (especially 1981) in preference to Burch (1989). Hydrobiid taxonomy is that of Hershler and others (see **REFERENCES:** especially significant are Ponder & Warén (1988) and Hershler (1994)). For comparison of hydrobiid taxonomy of Vaught (1989) with that of others (and substantive reasons for rejecting the former), see Kabat & Hershler (1993). Fundamentally, the Vaught classification is a literature cull of varying thoroughness. Major monographic revisions by lifetime specialists, e.g. Riedel (1980) and Ponder & Warén (1988) are not reflected in it, and treatment of some families is fraught with errors (see, e.g., Kabat & Hershler, 1993, p. 59-60).

Information on some taxa newly discovered over the past few years is included in Frest & Johannes (1993c, 1993e, 1998, 1994, 1995a, 1995b, 1995c). Common names for species are those recognized by Turgeon *et al.* (1988) wherever possible. Roth (1993) and Frest & Johannes (1993c) have added or suggested hter names for some land snails. New coinages herein are for undescribed taxa, missed species, subspecies, or taxa described subsequent to publication of Turgeon *et al.* (1988) and not named by others. Wherever practical we follow the guidelines of Turgeon et *al.* (1988). Note that many valid species (and most subspecies) were either overlooked or not considered for various reasons by Turgeon *et al. (op. cit.).* Especially weak areas are western land snails and Hydrobiidae. Subgenera are not included, and subspecies were incorporated for just a few marine taxa. A revised edition is anticipated in 1995 (B. Roth, *pers. comm.*, 1994).

In order to keep this document to a reasonable length (and because of project timelines), complete taxonomy and illustrations are not given here. However, brief descriptions of new taxa are included to help demonstrate taxonomic validity and aid in field recognition. When possible, reference is made to a more comprehensive description and 'to recent, relatively high-quality illustrations. Our descriptions generally feature characters that can be recognized in the field, or with a hand lens. It should be recognized explicitly that soft-anatomy at the very least provides many more characters and is absolutely necessary for many taxa, such as freshwater snails in the Hydrobiidae (over half the freshwater taxa discussed below) or land snails in the Succineidae. Technical terminology is deliberately kept to a minimum here. For basic land snail terminology, we suggest consultation with such works as Burch (1962); for freshwater snails, the glossary in Burch (1989) is very helpful. The manuals by Burch (1972, 1973, 1975a, b) are good introductions to the terminology for fingernail clams and larger bivalves. Further information is available on

most or all taxa from the authors. Terminology for mollusk habitat includes some unique or uncommon terms, or special usages: for these, consult the GLOSSARY.

Similarly, we do not here include detailed descriptions of known sites: this would have more than doubled {perhaps tripled] the document's length. Again,. consult references for each entry for further information. In most cases, specific sites are included in our western U.S. database (MolluscDB™) or are scheduled for entry in the future. Time and space also do not permit more than summary discussion of ecology, associates, or current threats, except in a few specific instances. It should be assumed that threats referred to in each entry are current and have been recently (within the last 1-6 years) checked in the field to confirm currency. We have attempted to visit type and other significant localities for al taxa involved, and have done so for nearly all (exceptions are specifically mentioned below). We attempted to examine museum material (generally including type specimens) for all taxa listed below. In most cases, we have also collectedand preserved topotype or near topotype material for all taxa dealt with.

Considerations of length have not allowed complete literature citations for each taxon. We have emphasized only major works which represent the current taxonomic consensus; references to others will be found therein. One absence requires comment. We have not dealt with the polygyrid revisions of Vagvolgyi (1968) at any length. These were based solely on a few shell features and rather cursory morphometrics. Museum material for *Cryptomastix* typically is rather sparse; lacks juvenile features; and has been cleaned, removing periostracal hair in almost all cases. Vagvolgyi's revisions were based mostly upon MCZ collections, which are somewhat limited for *Cryptomastix* (much less so for eastern U.S. polygyrids). Even so, it is instructive to compare the rather spare taxonomic treatment of eastern North American *Triodopsis* by Vagvolgyi (1968) with the richly speciose approach of Hubricht (see Hubricht, 1985 for summary and references). This was done recently in an exceptional work which will remain standard for many years: Emberton (1988) used shell, anatomic, and allozyme features to thoroughly revise eastern *Triodopsis* (*s.s.*). Hubricht's approach was vindicated, essentially in *toto*. A later work (Emberton, 1991) reached the same results for the closely related tribe Mesodontini. Emberton, like nearly al modem workers, considers western North American *"Triodopsis"* (*s.l.*) as mostly belonging to different genera, specifically *Cryptomastix*; but Ember-ton's (1988) comments on Vagvolgyi's taxonomy are pertinent here also. Another difficulty with the latter's work is the lack of field experience with the animals involved; such elementary errors as terming the Idaho Salmon River a "small tributary of the Snake" would have been avoided easily. Similarly, correlation (or at least some mention) of substrate, geologic history, and co-occurring genera (notably *Oreohelix*) with *Cryptomastix* occurrences might also have been useful.

We have carefully reviewed essentially the entire'published and much unpublished literature on mollusks in the ICB. 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. We have comparatively limited experience with Physidae, Planorbidae, and Lymnaeidae among freshwater forms and Succineidae among land snails; hence, our treatment of these families is especially conservative.

Institutions whose type and other collections either 1) have been examined for taxa dealt with in this project; 2) are referred to specifically in the species entries; or 3) both of the above are listed below. Collection abbreviations are those of Leviton et *al.* (1985) wherever possible. Most of our collection visits were made in 1985 and 1991. Further such work will be conducted in 1995.

ANSP	Academy of Natural Sciences of Philadelphia
BMNH	British Museum of Natural History, London
CAS	California Academy of Sciences, San Francisco
CHAS	Chicago Academy of Sciences, Chicago
DMNH	Delaware Museum of Natural History, Wilmington
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge
NMC	National Museums of Canada, Museum of Natural History, Ottawa
FMNH	Field Museum of Natural History, Chicago
LACM	Los Angeles County Museum, Los Angeles
SBMNH	Santa Barbara Museum of Natural History, Santa Barbara
UCM	University of Colorado Museum, Boulder
UF	Florida Museum of Natural History, Gainsville
UI	University of Illinois, Museum of Natural History, Champaign-Urbana
UMMZ	University of Michigan, Museum of Zoology, Ann Arbor
USNM	Smithsonian Institution, National Museum of Natural History (NMNH); formerly U. S. National Museum.

Taxa are listed alphabetically within major subheadings, rather than taxonomically, to facilitate location. This means that nominate subgenera may not be the first discussed: and new taxa (forms known to be distinct but not formally described) are treated similarly, largely because placement of new subspecies would be problematic if other arrangements were followed. The large number of undescribed forms dealt with will not be surprising to any one who has studied the western U. S. fauna in any detail, or is familiar with current taxonomic practice. It does not represent, ***i.e.,*** any particular bias on our part toward "splitting", rather than "lumping". There has been considerable work done on western U.S. land and freshwater mollusks; but much more remains to be done. In recent years, there have been relatively few malacologists interested in systematics of western U. S. forms, and many species have lain unworked in the major natural history museum collections, in some cases for as long as a hundred years. Early taxonomy in some instances undoubtedly oversplit some genera (e.g., Gould & Woodruff, **1986,** on

Cerion); but western U.S. examples of overly speciose genera are rather sparse, with neglect or over-conservatism being closer to the norm. Problems of access and of lack of workers, rather than lack of interest, is sometimes the problem, even in areas long known to be exceptional. An example is the lower Salmon River-Hells Canyon area of western ID and eastern OR. Even though this area has been famous for its high land snail diversity since the 1860s; and despite the fact that many malacologists have worked it, species continue to be found in recent times (e.g. Solem, 1975; Fairbanks, 1984; Frest & Johannes, 1995a). In this instance, more careful and complete modem reworking of older taxa has generally led to an increase in the number of full species and total diversity, as well as the prediction that yet more species remained to be discovered (Solem & Clarke, 1974; Solem, 1975). One other example should be cited. Careful work and extensive collection has recently led to considerable increase in the number of species in the polygyrinid genus *Vespericola*, as well as one new genus (see Roth, 1993 and references therein); and many more species (and some higher taxa) remain to be described.

A similar example for western U. S. freshwater mollusks has recently been discussed by Frest (1995). As late as 1989, the hydrobiid snail genus *Pyrgulopsis* had only five accepted species; and with previously known forms allocated elsewhere added, still comprised only some 26 taxa in the last comprehensive compilation (Burch, 1989). Due to sustained efforts by the NMNH's R. Hershler since 1985, the latest revision of the genus (Hershler, 1994) listed 65 taxa, including some 32 species described since 1985. It is likely that about 65 western U.S. *Pyrgulopsis* remain to be described (Kabat & Hershler, 1993; Frest, 1995). As noted in previous sections, diversity is concentrated in only a few genera in both land and freshwater forms, so that such increases will likely prove to be exceptional for the fauna as a whole. Nevertheless, the extent and scientific importance of such species clusters should not be underestimated.

The pace of environmental and habit change in the western U. S. has been so rapid as to outstrip the systematic efforts of taxonomists. There is every reason to believe that many species have already or will go extinct before discovery or description. Again, the premier example is provided by the Hydrobiidae. Of the 65 described *Pyrgulopsis*, over half are currently either extinct, federally listed species, or are listing candidates (Hershler, 1994). Of the 49 western hydrobiid species presently listed as candidates (USFWS, 1994), 40 were described in the last ten years. Such considerations may explain why we choose to deal with undescribed forms here, as far as present knowledge of the regional fauna allows. It should be noted again that only those forms for which we have adequate range and taxonomic data available are so treated; *i.e.* taxonomically valid forms known to be currently exceptionally rare and in clear danger of extinction.

The status suggestions made below are based upon a variety of criteria, We have been involved with mollusk listings under the ESA since about 1980; prepared National Recovery Plans and status reports for USFWS (e.g., Frest, 1984, 1991); and have written reports to be directly used by USFWS to prepare status reports on certain mollusk species (e.g., Frest & Johannes, 1991c, 1993d). We regularly review Proposed and Final Rules for mollusk species under the Act; and regularly examine available rules and

procedures, as published in the Federal Register and 'as made available by USFWS. In general, taxa suggested as Endangered below are regarded as in imminent danger of extinction. Such taxa have relatively few sites known to survive currently; have had much or all of their range surveyed recently; have suffered extensive site and habitat loss in recent years; have had the majority of their habitat lost in historic times; have obvious and clearly definable threats to remaining sites; are known to have suffered considerable population loss in recent years; and are by consensus of informed malawlogists valid taxa. Almost all of these taxa are known to occur on public lands. Taxa suggested as Threatened below are regarded as in definite danger of extinction. Such taxa have relatively few sites known to survive cunently; have had much or all of their range surveyed recently; have suffered considerable site and habitat loss in recent years; have had the majority of their habitat lost in historic times: have obvious and clearly definable threats to remaining sites; are known to have suffered major population loss in recent years; and are, by consensus of informed malawlogists, valid taxa. Almost ail of these taxa are known to occur on public lands. Suggestion of listing status is individualized to reflect site condition, population size, likelihood of future site loss, likelihood and nature and effects of threats to remaining sites. Individual recommendations are thus not completely formulaic, but represent a synthesis of a variety of factors. Among others considered are the following: proximity to urban areas; occurrence in or near active mining areas; occurrence in areas with valuable material commodities; ownership (state or federal) land usage policies; accessibility; location along or near major travel corridors; geologic history and land usage history of the area of occurrence; plant community; fire history of the area; population growth trends (where available); suitability of area for irrigation, grazing, timer harvest, or other disruptive practices; local human population trends, etc. Thus, some species with a number of known sites might be ranked as more at risk than ones with one or several; and estimated overall population size and trends is a major factor. Similarly, state rankings are individualized to reflect each taxon's condition within that state, based on the same factors. Where not all sites are likely to have been discovered, best projections are made based on total potential range vs. known occurrences, with adjustments made to reflect ecosystem conditions and threats in the incompletely surveyed portions of the range.

In making these evaluations, we pool data derived from museum collections; a thorough literature review: our own collections in the region (which involve about 3,000 formally established sites in this region, equally divided between land and freshwater habitats, dating from 1987 to the present, as well as many others either not formally defined or located in areas peripheral to the ICB); examination of the gray literature: examination of priiate collections and those of other environmental consultants; and consultations with malacologists and other professionals with original data not otherwise available.

SENSITIVE SPECIES: CURRENTLY CRITICAL TAXA

Land Snails

Allogona (Allogona) lombardii Smith, 1943 Selway forestsnail

Type locality: Along Meadow Creek, 1 ½ mi. S. of Selway Falls, Idaho Co., ID, elev. 1900'; holotype CAS 7803.

Description: See Smith (1943), Pilsbry (1948), Webb (1968), and Frest & Johannes (1995a). A very distinctive form as compared to the widespread ***Allogona ptychophora ptychophora.*** Specimens with this morphology have not been seen from other portions of ***Allogona ptychophora ptychophora***'s range, ***i.e.*** in WA, OR, MT, or drier portions of ID.

Ecology: This species has been found in relatively intact mixed coniferous forest at elevations ranging from 1500-5800'. It is most frequent in lower-level moist, well-shaded situations in relatively intact forests with considerable duff alongside medium-large streams, particularly at the edge of flood plains (slope base). Most sites have high understory diversity, as well as high land snail diversity. Moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture ***is*** a ***desideratum.*** Noted associates include ***Allogona ptychophora ptychophora, Polygyrella polygyrella, Hemphillia camelus, Zacoleus idahoensis, Anguispira kochi occidentalis, Anguispira nimapuna***, and several ***Crypromastix*** species. A definite mesophile.

Original distribution: Typical populations occurred along the Lochsa, Selway, and uppermost Clearwater River and their major tributaries, northern ID (Clearwater Mountains). The original distribution was probably essentially continuous in this area. A few disjunct colonies of uncertain status (likely an undescribed form) have been noted recently along a small portion of the lower Salmon River drainage at moderate-high elevations (Frest & Johannes,. 1995a).

Current distribution: A few isolated populations suwive in densely forested areas along the lower Lochsa and Selway River and one major Selway tributary. We have recently recollected the type locality and other sites in the previously known and likely range. It is not likely that later work will greatly expand. either the range or number of sites. Current status of some sites (e.g. Branson, Sisk, & McCoy, 1966) needs to be reevaluated.

Threats: Timber harvest and grazing have affected most of the original range. Highways (e.g., US 12) and parks, pulloffs, and other such modifications are concentrated in its preferred habitat along much of the Lochsa and part of the Selway corridors. The species is not found in recently logged or heavily grazed areas.

Criteria for inclusion: Local endemic with rather specialized habitat requirements that has lost much of its original habitat; few known or likely sites: old growth and riparian associate. Much remaining is public land subject to logging, grazing, or other potentially imperiling human activities. Most known and former sites are on public land, including Clearwater National Forest, Nez Perce National Forest, and the Lochsa section of the Clearwater Wild and Scenic River. This species appears to be declining throughout its limited range.

Recommended status: Currently this species has no special status. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and state land and wildlife management agencies. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID) listing as Threatened is warranted, due to limited distribution, loss of habitat, and threats to remaining habitat.

References: Smith (1943); Pilsbry (1948); Webb (1968); Frest & Johannes (1995a); Deixii 1989-94 collections.

Allogona (Allogona) ptychophora solida Vanatta, 1924 dry land forestsnail

Type locality: Cottonwood Tree Canyon, along Snake River, 50 miles south of Lewiston, Nez Perce Co., ID; holotype ANSP 132476 (Vanatta, 1924). No location with exactly this name and description has been found; however, Cottonwood Creek in Hells Canyon, approximately 40 miles south of Lewiston, is the likely type localii.

Description: See Vanatta (1924), Pilsbry (1940), and Frest & Johannes (1995a) for descriptions and comparisons. Limited material, consisting of shells only, was available to Vanatta and Pilsbry. Recent collections demonstrate that this is likely a full species, with distinctive anatomy and body and mantle pigmentation as well as shell features.

Ecology: This moderately xerophilic taxon occurs most frequently in comparatively open and dry large basalt taluses, generally at lower elevations, along a limited portion of the northern Hells Canyon (Snake River) drainage, ID, WA, & OR, the Lewiston and Clarkston area, ID & WA, the lowermost Salmon River drainage, Idaho and Nez Perce cos., ID, plus the lowermost Clearwater River drainage, ID. Covering vegetation. may include *Cettus, Artemisia*, *Prunus*, *Balsamorrhiza*, *grasses, Seligeria*, and some bryophytes. It is most frequent on N.-facing large taluses, often only at their base. While it is a xerophile as compared to the other *Allogona* species, it avoids the most dry sites, *i.e.* areas preferred by *Oreohelix haydeni* subspp. and *Oreohelix idahoensis idahoensis.* Common land snail associates include several small *Cryptomasrix* species (including *magnidentata* at one former *site), Cryptomastix populi*, *Allogona ptychophora ptychophora, Oreohelix jugalis*, and *Oreohelix vortex.* The species has been found occasionally on limestone or metasedimentary substrate.

Original distribution: Probably comparatively frequent in the areas underlain by the Grande Ronde and Columbia River basalts, Snake River, Salmon River, and lower Clearwater River. Most colonies occur at slope base along the major river corridors, not in major tributaries.

Current distribution: This taxon now occurs as isolated colonies in relatively undisturbed portions of the original distribution, *i.e.* roadless areas in the lower Salmon and Hells Canyon. Clearwater and Mission Creek sites appear to be extirpated. Much or all of the known and potential range has recently been surveyed in some detail (Frest & Johannes, 1995a). Other collectors and malawlogists have also explored this area, from the 1860s to the present (e.g., H. Hemphill, H. B. Baker, M. Walton, and A. Solem). It is not likely that later work will greatly expand either the range or number of sites.

Threats: Grazing occurs over much of the original habitat, and the species appears to be absent from heavily grazed areas. Roads are often located preferentially along the bases of large talus piles in the larger river corridors, e.g. US 95. Mining of basalt for road metal and for fill has extirpated colonies since 1990, e.g. near White Bird and Lewiston, ID. Roadside spraying is a problem for some colonies in both WA and ID. The species' total population size and number are declining.

Criteria for inclusion: A local endemic that has lost much of its rather specialized habitat. Remaining colonies are mostly on public lands, including BLM and Nez Perce National Forest properties. Very few sites known or likely. This species is declining throughout its limited range, and colony loss has been observed in recent years.

Recommended status: To date, this species has no special status; it should be considered a sensitive species by the Forest Service, BLM, and state land and wildlife management agencies. There is sufficient recently-collected information, and recent survey work, to recommend Federal and State (ID, WA) listing

as Threatened, and OR listing as Endangered, due to loss of habitat, some historic sites, and increasing human populations and usage of some or all of remaining habitat.

References: Vanatta (1924); Pilsbry (1940); Frest & Johannes (1995a); Deixis collections, 1990-94.

Anguispira nimapuna Baker, 1932 Nimapuna disc

Type locality: Near NE comer sec. 32, T 32 N R 4 E, near South Fork Cleat-water River, across from Chief Joseph monument, Idaho Co., ID. Holotype ANSP 156441a; paratypes UCM 22540; ANSP 156441. See Wu & Brandauer (1982) for UCM types.

Description: See Baker (1932) and Pilsbry (1948). The specific epithet honors the Nez Perce.

Ecology: The Nimapuna disc occurs most commonly at lower elevations in stream side moist coniferous forests with common deciduous understory plants and a diverse forb flora in exceptional condition along major drainages. Commonly, forest sites are well shaded (closed or almost closed canopy). In some circumstances, this species may be found also in moist basalt taluses. In such cases, sites are at least partially shaded and are frequently mossy and N.-facing, with rather large (boulder-cobble-sized) liths. **Moist** valley, ravine, gorge, or talus sites are preferred, ***i.e.*** bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a ***desideratum.*** Talus associates include ***Polygyrella polygyrella*** and ***Oreohelix*** n. sp. 25 (Stites mountainsnail). Forest associates include ***Allogona lombardii*** and ***Allogona ptychophora***, ***Anguispira kochi occidentalis***, ***Oreohelix strigosa*** n. subsp. 1 (Idaho forest mountainsnail) and ***Cryptomastix mullani mullani***. A mesophile taxon.

Original distribution: South Fork Clearwater River, small portion of Clearwater upstream from Kooskia, and lower Lochsa and Selway drainages, ID; probably originally nearly continuous in this area. We have recently revisited the type locality and other sites in the species' range. Some sites are on Clearwater and on Nez Perce National Forest lands; others may be on Nez Perce Tribe properties.

Current distribution: Very rare in isolated colonies in portions of original distribution. We have recently revisited both the type locality and other sites scattered through the known and potential range. The species is now quite rare at the type locality, due in part to talus removal. Recent talus mining is wmmon in the South Fork Clearwater River drainage.

Threats: Grazing and logging in lowland forest part of distribution; road metal and fill mining of taluses in other areas; roadside spraying is a problem for some colonies; and highway construction (e.g., ID 13, US 12) through both habitats. This species does not seem to survive clear-cutting or heavy grazing. It is not likely that later work will greatly expand either the range or number of sites.

Criteria for inclusion: Local endemic; old growth and riparian associate, in part; increasing human usage of habitat; some combination of road building, logging, and grazing throughout much of range; small number of extant sites. The species is declining throughout its range, much of which is public land (e.g., Clearwater and Nez Perce National Forests), and recent loss of historic sites has occurred. The trends for population (number of sites, number of individuals) are downward.

Recommended status: Currently has none. Should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID) listing as Threatened is warranted, due to limited number of sites, loss of historic habitat and sites, concentrated human use of preferred habitat.

References: Baker (1932); Smith (1943); Pilsbry (1948); Deixis collections, 1989-93.

Cryptomastix (Bupiogona) n. sp. 1 Deep Creek Oregonian

Type locality: None designated as yet: undescribed taxon.

Description: Large (to 17 mm), rather flat-spired species, to 5 ½ whorls in adult. Shell thin; greenish yellow in color; lip off-white, thin but wide, edges barely recuwed; columellar insertion far above umbilicus, nearly at whorl midpoint, barely covering any portion of umbilicus. Umbilicus shallow, moderate-sized, about 1/7 full shell diameter. Both upper and lower surfaces distinctly but shallowly convex: the sutures are distinctly impressed.

This species is related to ***Crypromasrix populi*** (see below), ***i.e.*** is a member of the subgenus ***Bupiogona*** Webb, 1970 [for anatomy of this subgenus, see Webb, 1970b, 1990]; but that species has very different color and apertural features. The Kinney Creek Oregonian is much smaller, has a brown shell, and has a strongly revolute lip.

Ecology: Occurs in open to partly forested (***Pinus ponderosa),*** rather dry metasedimentary rock taluses at bw elevations along a single large creek in vicinity of Hells Canyon Dam, south Hells Canyon, Snake River, Adams Co., ID. The taluses are generally N.-facing, with scattered ***Rhus*** and grasses except at the base. Snails occur mostly bw in the talus, in areas with common ***grasses*** and ***Prunus*** and other woody shrubs, plus small ***Populus***, scattered ***Pinus ponderosa,*** and dense local ***Rhus*** stands. Land snails other than ***Cryptomastix*** are rare, but include ***Oreohelix*** spp. An atypically xerophile taxon, for ***Crypromasrix.***

Original distribution: Uncertain; may well have long been confined to single or a few creek drainages.

Current distribution: Currently known only from a single series of colonies along Deep Creek, Hells Canyon, Adams Co., ID. It is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: Dam construction and maintenance has considerably modified the immediate area, restricting the number and extent of rock taluses, and will likely do so in the future. The area is moderately grazed at present, and the snail is confined to areas not easily accessible to stock. Grazed portions of the talus piles do not have live snails, but long-dead specimens may be found in them, indicating loss of habitat. Colony extent and snail numbers have thus demonstrably declined.

Criteria for inclusion: Very local endemic; extensive modification of Snake River valley for' dam construction; occurrence on public lands (Payette National Forest).

Recommended status: Has none at present. Should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID) listing as Endangered is justified, due to very local occurrence, proximity to major dam, grazing, habitat loss.

References: Deixis collections, 1989.

Cryptomastix (Bupiogona) n. sp. 2 Kinney Creek Oregonian

Type locality: Undescribed taxon; to be designated.

Description: *A* small (to 13 mm) ***Crypromasrix (Bupiogona)*** species; adults with very bw spire, flattened above and below; sutures barely impressed; 5-5 1/2 whorls as adult; shell color light brown. Lip white, flared above and flattened below, slightly and evenly revolute, moderately thick; wlumellar insertion to

upper right of umbilicus, about 1/3 of distance across whorl; umbilicus barely impinged by lip. Umbilicus rather deep, comparatively broad, about 1/6 full shell diameter.

The peculiar apertural shape, small size, and color are distinctive among ***Bupiogona*** species (see populiand n. sp. 1 entries for comparisons).

Ecology: The species at present is confined to large-scale, generally S.-facing, talus piles composed of Late Paleozoic or Tertiary breccia and conglomerate on one side of Kinney Creek. Sites are largely open, with sparse vegetation consisting mostly of ***Celtus, Rhus horribilis,*** grasses, composites, and local moss and spikemoss (***Seligeria***). Interestingly, this species is replaced by another more common ***Crypromastix*** species in the moist riparian talus immediately adjacent to the Kinney Creek drainage itself. It is associated with ***Oreohelix*** n. sp. 17 (the bicarinate mountainsnail) in Kinney Creek itself, but is absent from ***Oreohelix*** colonies in the next two drainages both N. and S. of Kinney Creek. A moderate-strong xerophile.

Original distribution: Probably restricted to one or a few valleys in the S. part of Hells Canyon, Adams Co., ID.

Current distribution: Limited to a few still-viable colonies along Kinney Creek, S. Hells Canyon, on Payette National Forest lands (and possibly on adjoining BLM. lands). It is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: This valley has been heavily grazed. Colonies are limited to larger talus piles and small protected areas on steep slopes not as heavily grazed. The species is declining in area and numbers, with live individuals rare and large areas of talus with old, long-dead specimens only.

Criteria for inclusion: Very local endemic; past mining activities; present and past grazing restricting snail to protected areas; occurrence on public lands.

Recommended status: Currently, has none. It should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID) listing as Endangered, due to limited range and number of sites, ongoing threats.

References: Deixis collections, 1989-91.

Cryptomastix (Bupiogona) populi **(Vanatta, 1924)** **poplar Oregonian**

Type locality: "Cottonwood Tree Canyon, on Snake River 50 miles south of Lewiston, Nez Perce Co., ID" (Vanatta, 1924); holotype ANSP 132939a. This is the ***same site as*** the type locality of ***Allogona ptychophora solida (9.v.)*** and ***is*** also a site for the ***rare Oreohelix*** n. sp. 18 (Limestone Point mountainsnail; 9.v.). We were unable to find a site with precisely this name and description on either current or old maps available to us. However, Cottonwood Creek in Hells Canyon, approximately 40 mi. south of Lewiston, is the likely type locality.

Description: See Pilsbry (1940). The species was based originally on 2 dead specimens only. Live material indicates that the dark blue-black body and wine-red shell color are quite distinctive among described species of ***Cryptomastix,*** as are the apertural features noted by Pilsbry. Anatomy of specimens of this species, collected by W. B. Miller from near Clarkston, WA, was described and illustrated by Webb (1970b, 1990) under the name ***Cryptomastix hendersoni.*** The unique features of the male anatomy were the basis for the new subgenus ***Bupiogona*** Webb, 1970. We have confirmed these features in recently collected ***Crypromastix populi*** (compared with the type material at ANSP in 1991); by analogy with other triodopsinids (see, e.g., detailed studies of Emberton, 1988), they are unusual enough as to justify generic separation, as has been done recently in the related western genera ***Vespericola*** and ***Hochbergellus*** (Roth & Miller, 1992, 1993). Two other Snake River forms ***(Crypromastix (Bupiogona)*** n.

sp. 1 and n. sp. 2 above) are similar in gross anatomy, but differ considerably and consistently in shell and soft part details. For anatomy of typical *Cryptomastix* (*s.s.*), see Pilsbry (1940) and Webb (1970a).

As noted above, it may be necessary to designate a new type species for *Bupiogona,* according to ICZN rules. However, this will not affect the status of this species, the logical choice for neogenotype. To resolve the situation it will be necessary to establish the nature of Webb's specimens and request a ruling under Articles 65B, 671, and 70 (ICZN, 1985). Note that available courses of action do not affect the validity of either *Cryptomastix hendersoni* or *Cryptomastix populi.*

Ecology: This taxon, a moderate xerophile, is found mostly in rather open and dry, large-scale basalt taluses, generally at lower elevations, along a limited portion of the northern Hells Canyon (Snake River) drainage, ID, WA, & OR, the Lewiston and Clarkston area, ID & WA, and the lowermost few miles of the lower Salmon River canyon, Nez Perce Co., ID. The rather limited talus vegetation may include *Celtus, Artemisia, Prunus, Balsamorrhiza,* grasses, *Seligeria,* and some bryophytes. Surrounding vegetation is generally sage scrub. This species usually occurs in steep, N. or E.-facing taluses, often only at their base. It is axerophile as compared to the other *Allogona* species, but avoids the most dry sites, *i.e.* areas preferred by *Oreohelix haydeni* subspp. and *Oreohelix idahoensis.* Common land snail associates include *Cryptomastix* (*Cryptomastix*) n. sp. 2 and 3, *Allogona ptychophora ptychophora, Allogona ptychophora solida,* and various species of *Oreohelix.* This taxon has been found occasionally in metasedimentary taluses as well.

Original distribution: Probably once comparatively frequent in the areas underlain by the Grande Ronde and Columbia River basalts, Snake River, Salmon River, and lower Clearwater River. Most colonies occur at slope bases along the major river corridors, not in major tributaries.

Current distribution: This taxon now occurs as isolated colonies in relatively undisturbed portions of the original distribution, *i.e.* roadless areas in the lower Salmon River canyon and northern Hells Canyon. It is replaced by related species in the central and southern parts of Hells Canyon. Clearwater sites appear to be extirpated. Much or all of the known and potential range has recently been suweyed in some detail (Frest & Johannes, 1995a). The current range is largely coincident with that of *Allogona ptychophora solida,* except that the latter does not appear to range down the Snake as far as Clarkston, WA.

Several years ago, we believed this taxon to be much more widespread; but further collecting and elimination of certain sites within a few years of our first visits in the late 1980s has made us much less sanguine about chances for the species' survival.

Threats: Grazing is extensive in much of the original habitat, and the species, appears to be absent from heavily grazed areas. The former colony at Lime Hill, near Rogersburg, WA, e.g., seems to be extirpated solely due to grazing. Roads are often located preferentially along the bases of large talus piles in the larger river corridors inhabited by the species, e.g. US 95; roadside spraying is a problem for some colonies. Mining of basalt for road metal and for fill has extirpated colonies since 1990, e.g. near White Bird and Lewiston, ID. Very large colonies along US 12 W. of Clarkston have been extirpated by road realignment and maintenance in the last few years.

Criteria for inclusion: A local endemic that has lost much of its rather specialized habitat. Remaining colonies are mostly on public lands, including BLM and Nez Perce National Forest properties. Very few sites known or likely. This species is declining throughout its limited range, and colony loss has been observed in recent years.

Recommended status: Has none at present, but minimally should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (WA, OR, ID) listing as Threatened is warranted, due to loss of habitat and increasing human populations and usage of most or all of remaining habitat.

References: Vanatta (1924); Pilsbry (1940); Frest & Johannes (1995a); Deixis collections, 1990-94.

Cryptomastix (Cryptomastix) harfordiana **(Binney, 1878)** **Salmon Oregonian**

Type locality: Salmon River (Hemphill); Pilsbry (1940, p. 870) states "probably somewhere north of Lucile", Idaho Co., ID (lower Salmon River drainage). Holotype ANSP 11116.

Description: The tangled history of this name has been well reviewed by Pilsbry (1940), which work also has the best previous illustration and description of the shell. See also Frest & Johannes (1995a). Live-collected specimens are generally very sparsely hirsute.

Ecology: This species is most often found in rock taluses (limestone, schist: more rarely basalt or granite) at low elevations. Most are comparatively dry and open, with scattered *Celtus*, grasses, and *Rhus* clumps. On occasion, the species is found in open to more sheltered stream side boulder piles, often with *Salix*, *Cornus stolonifera*, *Rubrus*, and bryophyte cover in part. Common associates include several species of *Oreohelix*, including *idahoensis idahoensis*, *jugalis*, and *waltoni*, plus *Allogona prychophora*, *Helicodiscus salmoneus*, *Vitrina* alaskana, and *Vallonia cyclophorella*. The species can occur in relatively strongly xeric sites, such as sage scrub; but it is usually rare in such settings; it is basically a moderate xerophile.

Original distribution: Lower Salmon River valley between Riggins and Coppewille, Idaho Co., ID. This species was probably extremely abundant originally in its narrow area of occurrence, and is still often the dominant species of *Crypromasrk* locally.

Current distribution: Scattered sites within the original area of distribution. We have recently surveyed this area in some detail (Frest & Johannes, 1995a). As many other malawlogists and collectors, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton, have explored this area, it is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: Grazing over whole of range; talus mining and removal; gold and gravel mining operations; road building (e.g. US 95 corridor, which traverses roughly *50%* of total range); human habitation; roadside spraying. The species tends to occur at the base of major slopes, which are also primary road and human habitation and recreation sites.

Criteria for inclusion: Loss of historic habitat; loss of colonies in recent years (declining number of sites and individuals); continuing heavy grazing in whole range; occurrence on public lands, including BLM and Nez Perce National Forest property; expanding recreational use of Salmon River corridor. The trends for the population as a whole (number of sites, number of individuals) are downward.

Recommended status: Currently has none. Should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID) listing as Endangered should be considered: the species is a local endemic with a very limited distribution. Preferred habitat is limited in occurrence and especially subject to human utilization. The species occurs partly on public lands.

References: Pilsbry (1940); Frest & Johannes (1995a); Deixis collections, 1988-94.

Cryptomastix (Cryptomastix) hendersoni (Pilsbry, 1928) Columbia Gorge Oregonian

Type locality: The Dalles, Wasco Co., OR. Holotype ANSP 145479a.

Description: See Pilsbry (1940) for most complete description and illustrations. As discussed under *Cryptomastix populi* below, anatomical data and illustrations of Webb (1970b, 1990) refer to *Crypromasrix populi*, not *Crypromasrix hendersoni*. As conceived by Webb, *Crypromasrix hendersoni* is a member of *Crypromasrk s.s.* [see Webb, 1970a and Pilsbry, 1940 for anatomy of *Cryptomastix mullani mullani*, type of the genus] and not the subgenus *Bupiogona*. Our dissections indicate that this is correct. We

recognize the subgenus ***Bupiogona*** as defined by Webb, but with ***Cryptomastix populi*** as type species. Full species status is due to Webb (1970b) and is accepted in Turgeon ***et*** al. (1988). Note that permissible courses of action under ICZN rules (ICZN, 1985) do not invalidate either species group name (that is, either ***populi*** or ***hendersoni***). Cited ***as Crypromasrix hendersoni*** (Pilsbry, 1928) in Frest & Johannes (1993c).

Ecology: Low to middle elevations; riparian associate; generally near seeps and springs, sometimes in leaf litter along streams, under logs, among brush, and in basalt talus. A somewhat mesophile-weakly xerophile taxon, sometimes seen at the base of taluses, slopes or valleys with persistent moisture in otherwise quite dry terrain.

Original distribution: Portions of the central and eastern Columbia Gorge, Hood River, Wasco, & Sherman ws., OR, and Skamania & Klickitat cos., WA. Records from Yakima Co., WA are possible, but we have found other species only so far. Records for Umatilla Co., OR, Walla Walla Co., WA, and Adams Co., ID cited by Pilsbry (1940) and Henderson (1929a, 1936b) are another taxon.

Current distribution: Still suwives at a few sites in Klickitat Co., WA and Wasco and Sherman cos., OR. Most sites are in the Columbia River Gorge National Scenic Area or in OR state parks; we resuweyed this 'area in detail in 1988-1992. It is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: Much of the known habitat is traversed by I-84/US 30 or WA 14, as well as by Burlington Northern and Union Pacific Railroad tracks, all of which have disturbed and impacted preferred habitat. The area is heavily utilized for recreation, and is likely to be more so in the future, partly as a result of development of the National Scenic Area; urban expansion from Portland and in The Dalles and Hood River also threaten known sites; localities in The Dalles, for example, have very recently succumbed to urbanization and highway development. Major brush fires in 1994 also impacted sites; eastern Gorge sites are often overgrazed; roadside spraying is a problem for some colonies.

Criteria for inclusion: Riparian associate: probable occurrence on public lands; local endemic. The area of occurrence isheavily utilized for recreation, and is likely to be more so in the future; urban expansion also threatens surviving sites. Some populations certainly extirpated and others declining in recent years. Population trends (number of sites, number of individuals) are downward. This species has a specialized habitat, with many or most sites on public lands.

Recommended status: Currently has none. Should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that this species should be listed as Endangered in WA, OR, and Federally, due to a combination of habitat loss, human usage of its preferred habitat, and loss of historic sites.

References: Pilsbry (1940); Deixis Consultants, 1988-94.

Cryptomastix (Cryptomastix) magnidentata (Pilsbry, 1940) Mission Creek Oregonian

Type locality: Mission Creek, 7-8 mi. above Jacques Spur, Nez Perce Co., Nez Perce Reservation, ID. Holotype ANSP 171243.

Description: See Pilsbry (1940) and Webb (1970b). Another illustration is on the cover of this report. Full species status dates from Webb (1970b) and is accepted in Turgeon ***et al.*** (1988). Live-collected specimens are consistently sparsely hirsute, with individual periostracal hairs relatively prominent and moderately broad-based.

Ecology: The species lives in moist, rocky, well-shaded forest with wmmon forbs and deciduous trees, and in moist and mossy, rather open grassy limestone and mixed limestone-basalt taluses a short distance

above the flood plain of Mission Creek. Common associates are ***Allogona ptychophora solida*** and ***Polygyrella polygyrella.*** A weakly mesophile species.

Original distribution: So far known only from the vicinity of the type locality. Attempts in 1991 and 1994 to find other sites in the immediate area and along the nearer portions of the Clearwater River and some major tributaries were unsuccessful. We also have not found this **taxon** in the lower Salmon River drainage or in Hells Canyon. Drought has also affected much of the talus area, such that most now has dead shells only. Specimens from the vicinity of Kooskia placed in this **taxon** by Smith (1943) are ***Cryptomastix*** n. sp. 1 **(Lochsa** Oregonian). It is unlikely that the range or number of sites will be significantly expanded by future work.

Current distribution: Scattered colonies along a half-mile stretch of Mission Creek (one side only). Most colonies are on the Nez Perce Reservation. Others may be on adjoining State of Idaho lands.

Threats: Much of the type area has been destroyed or greatly modified due to limestone quarrying, which has proceeded sporadically and is ongoing. Sites are along the present quarry haul road, which has impacted taluses in the area substantially. The valley of Mission Creek is heavily used just downstream for agriculture and pasturing, and portions of the **quarry area** have also been heavily grazed. Much of the upland in the immediate vicinity has been logged. The species is absent from these areas, and is evidently declining in numbers and area occupied. Population trends (condition of site, number of individuals) are downward.

Criteria for inclusion: Extremely local endemic; past and current threats in only known area of occurrence; declining trend evident; association with forest and riparian zone.

Recommended status: Currently a Federal (Category 2) candidate (USFWS, **1994).** There is sufficient recently-collected information, and recent survey work, to indicate that should be listed as Endangered Federally and in ID. Should be considered a sensitive species by the Forest Service, BLM, Nez Perce Tribe, and other appropriate land and wildlife management agencies.

References: Pilsbry (1940); Webb (1970b); USFWS (1994); **Deixis** collections, 1991-1994.

Cryptomastix (Cryptomastix) mullani blandi **(Hemphill, 1882) Bland Oregonian**

Type locality: Post Falls, Kootenai Co., ID (Hemphill); syntypes CAS 58841, 58842; paratypes ANSP 62304, according to Baker (1964). See Coan **&** Roth (1987) for CAS types.

Description: The best description and illustrations are those of Pilsbry **(1940),** ***q.v.***

Ecology: Lower elevations in river valleys with relatively undisturbed, perennially wet coniferous forest with a strong deciduous understory. Moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a ***desideratum.*** A mesophile species.

Original distribution: Known with 'certainty only from a limited area in the Coeur **d'Alene** River valley in the vicinity of Post Falls and Coeur **d'Alene,** ID. We examined specimens from near Lake Con-to, Ravalli Co., MT, in ANSP collections ascribed to this subspecies by Pilsbry (1940) and believe that they are aberrant ***Cryptomastix mullani mullani.*** No Montana specimens are in the extensive collections of R. B. Brunson.'

Current distribution: Collected in the vicinity of Coeur **d'Alene** by us in 1990; 1994 revisits to the site and others in the vicinity produced no live specimens. Attempts in recent years by private collectors to find this species have also been unsuccessful (S. Welty, ***pers. comm.***, 1994). **It** is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: Most of potential habitat area has been logged; some is being heavily grazed; and much has been affected by past mining and smelting activities. Both Post Falls and Coeur d'Alene and the intervening corridor have been urbanizing rapidly in recent years.

Criteria for inclusion: Very local endemic, evidently in decline; past and current human activities in habitat; habitat loss, past and ongoing. Population trends (number of sites, number of individuals) are evidently downward.

Recommended status: Has none at present. Should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent suwey work, to indicate that Federal and State (ID) listing as Endangered should be considered, due to habitat loss, local endemic status, and decline in historic populations.

References: Pilsbry (1940); Deixis collections, 1990, 1994.

Cryptomastix (Cryptomastix) mullani clappi **(Hemphill, 1897)** **River of No Return Oregonian**

Type locality: "Salmon River Mountains" (Hemphill); syntypes CAS 58821; ANSP 71479 [paratypes according to Baker (1964); possible syntypes according to Coan & Roth (1987)]; USNM 46905; 58754. As usual, Hemphill's locality citation is vague. The types likely came from the River of No Return area, east of Riggins and west of French Creek, ID.

Description: See Pilsbry (1940) and Frest & Johannes (1995a) for complete description and illustrations. The dark body color, medium size, low subdiscoidal conch, and fine, dense pelage distinguish the form (actually a full species) from related taxa.

Ecology: Found mostly at lower elevations in forested ***areas*** (mostly ***partly*** open ***Pinus ponderosa*** forest), on moist, north-facing slopes. Occasionally common in extensive mossy, north-facing metasedimentary taluses. Most sites have rich understory floras, including grasses, bryophytes, forbs, and shrubs. Moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a ***desideratum.*** See Frest & Johannes (1995a) for further discussion. A mesophile species.

Original distribution: Confined to a narrow area on the south side of the River of No Return between Riggins and the mouth of French Creek, with a few isolated occurrences along the main Salmon from Riggins to Lucile, ID. Specimens ascribed to White Bird and to Slate Creek (Henderson in Pilsbry, 1939) are another taxon.

Current distribution: A few isolated colonies in the area cited above. This region was extensively surveyed in 1993-94 (Frest & Johannes, 1995a). Many other collectors, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton, have explored this area. It is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: Gold mining and road building (e.g., US 95, French Creek Road) in narrow area occupied; talus removal; logging; major fires in 1994. This form is evidently declining; extinct colonies were noted in 1993-94, and habitat modification is extensive. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Very local endemic: decline in absolute numbers and number of sites; continued human activities in preferred habitat; habitat loss: association with relatively intact forest; occurrence on public lands (BLM, Payette and Nez Perce National Forests).

Recommended status: This taxon has none at present: it should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID) listing as Endangered is warranted. Many of the known sites have been negatively affected by grazing, logging, and other activities. The effects of the 1994 fires have not been evaluated but are predictably negative, especially in areas affected by other activities.

References: Pilsbry (1940); Frest & Johannes (1995a); Deixis collections, 1989-1891, 1993, 1994.

Cryptomastix (Cryptomastix) mullani latilabris (Pilsbry, 1940) wide-lipped oregonian

Type locality: Lower two or three miles of John Day Creek, lower Salmon River drainage, Idaho Co., ID; holotype ANSP 175777a.

Description: See Pilsbry (1940) and Frest & Johannes (1995a).

Ecology: Found in moist and shady areas in relatively intact forest, generally on limestone substrate; occasionally in shaded and mossy limestone and schist talus, at moderate elevations, mostly near stream borders. Forest *is Pinus ponderosa* with strong forb and deciduous shrub understory, including *Pyrola* Spp., *Cornus canadensis, Linnaea borealis, Viola* spp., and rich litter. Moist valley, ravine, gorge, or talus sites are preferred, *i.e.* low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a *desideratum.* Associated land snails include *Oreohelix* n. sp. 22 (Slate Creek mountainsnail), *Oreohelix haydeni hesperia, Discus marmorensis, Anguispira kochi occidentalis, Allogona* sp. *cf. lombardii*, *Hemphillia* sp. cf. *came/us, Pristiloma subrupicola*, and *Pristiloma idahoensis.* A mesophile, as are most *Cryptomastix* species.

Original distribution: Probably confined to rich forest at moderate to high elevations along a portion of the lower Salmon River, Idaho Co., ID. Pilsbry (1940) ascribes specimens from a site along the South Fork Clearwater River 34 mi. below Hamster to this species; but examination of the specimens indicates they are better assigned to *mullani mullani.* We revisited this site in 1991.

Current distribution: Found in remnant colonies along two major creeks tributary to the central lower Salmon River, Idaho Co., ID; see Frest & Johannes (1995a) for details. The species is extinct at the type locality, and also at the old site in sec. 35, T 26 N R 1 E, near Lucile. The species is absent from heavily grazed and clearcut areas, such as lower John Day Creek. The area of occurrence was surveyed for land snails in 1993-94 (Frest & Johannes, 1995a); and many other collectors, including H. Hemphill, H. B. Baker, A. Solem, And M. Walton, have explored this area. It is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: Limestone quarrying, past and present; lumbering in most of known and potential habitat; road building along critical stream corridor; heavy grazing in much of lumbered habitat.

Criteria for inclusion: Local endemic; loss of habitat; ongoing threats: occurrence on public lands, including BLM and Nez Perce National Forest parcels; loss of historic sites, including the type locality. The species is definitely declining. Population trends (number of sites, number of individuals) are downward.

Recommended status: Has none at present: it should be considered a sensitive species by the Forest Service and BLM. Federal and State (ID) listing as Endangered is justified on current information, due to loss of historic sites and degradation of most of known and likely habitat: see above.

References: Pilsbry (1940); Frest & Johannes (1995a); Deixis collections, 1989-91, 93-94.

Cryptomastix *(Cryptomastix) mullani tuckeri* **(Pilsbry & Henderson, 1930)** **scaled Oregonian**

Type locality: On the Cleat-water, River near the mouth of Fourth of July Creek, Clearwater Co., ID; holotype UCM 17001a; paratypes UCM 17001 b, c, ANSP 152334. See Wu & Brandauer (1982) for UCM types.

Description: See Pilsbry & Henderson (1930, 1931a); Pilsbry (1940) for description and illustration. The low spire and scale-like hairs are very distinctive features.

Ecology: Very moist, relatively undisturbed ***Pinus ponderosa*** forest with a rich forb and deciduous shrub understory, along a major river corridor and at relatively low elevations, generally at the base of steep slopes with exposed bedrock. Moist valley, ravine, gorge, or talus sites are seemingly preferred, i.e. low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture appears to be a ***desideratum.*** Associated land snails include ***Anguispira nimapuna, Anguispira kochi occidentalis,*** other ***Cryptomastix*** species, ***Aliogona lombardii*** and ***Allogona ptychophora ptychophora.*** A mesophile species.

Original distribution: Along a portion of the mainstem Clearwater River, from Orofino to Kooskia, Clearwater, Idaho, and Nez Perce cos., ID.

Current distribution: Uncertain; the species appears to be extinct in the Orofino area and near the mouth of Fourth of July Creek. Probably survives rarely within original range. It is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: Occurs mostly along a major highway (US 12) that has already much reduced available habitat. Much of historic range has been logged or may be; mining and ore refining near Orofino has much reduced local land snail populations; human habitation and activities are concentrated in its narrow range of occurrence.

Criteria for inclusion: Association with relatively intact forest and riparian corridor; occurrence on public lands, including Clearwater National Forest; loss of historic sites and habitat (the species is declining); very local endemic. Population trends (number of sites, number of individuals) are downward.

Recommended status: This taxon currently has none. It should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID) listing as Endangered should be considered, due to decline in number of historic sites, loss of habitat, and ongoing threats.

References: Pilsbry & Henderson (1930, 1931a); Pilsbry (1940).

Cryptomastix (Cryptomastix) **n. sp. 1** **Lochsa Oregonian**

Type locality: None designated as yet; undescribed taxon.

Description: A small species (diameter to 11 mm) with 4 ½ relatively rapidly expanding whorls; spire depressed, low convex: umbilicus small but distinct, about 1/10 full shell diameter; color cinnamon red; adult strongly hirsute with closely spaced and fine periostracal hairs. Aperture brown, three-lobed, with well-developed white basal, parietal, and columellar teeth: lip comparatively narrow, slightly revolute, no more so on base. Columellar insertion just above midpoint of umbilicus, lip slightly reflected over umbilicus. The species is related to ***Cryptomastix magnidentata*** and ***Cryptomastix sanburni.*** Both of these are much larger, brown in color, and much more sparsely hirsute. This species has a much lower spire and fewer whorls than ***sanburni***; details of the aperture and tooth arrangement, as well as size, color, and pelage, distinguish it from ***magnidentata.*** For example, both of these species have stronger (wider)

white lips and more prominent apertural denticles (teeth). Neither is as strongly hirsute as this species; both are much larger and more dome-shaped. For differences from the Hells Canyon-lower Salmon River tridentate species, see Frest & Johannes (1995a) and below.

Ecology: Found in moist, well-shaded, ***Pinus ponderosa*** forests at moderate elevations, generally associated with springs and seeps; forbs and deciduous shrubs common; soil thin, often rocky; metasedimentary and limestone lithologies predominant as the regolith. Moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a ***desideratum.*** A mesophile species.

Original distribution: Portion of Lochsa River and uppermost Clearwater River corridor, between Kooskia and Powell, Clearwater ***Co.,*** ID. ***This*** taxon ***was*** reported ***as Cryptomastix mullani magnidentata*** by Smith (1943).

Current distribution: This species appears to be confined to a few colonies in relatively pristine forests along a part of the Lochsa River. It may occur in adjoining portions of Idaho Co. as well; but searches there thus far have been unsuccessful. It is unlikely that the range or number of sites will be significantly expanded by future work. Sites include ones on Clearwater National Forest lands.

Threats: Lumbering and major fires have occurred through much of the potential habitat; road building is an ongoing problem: grazing is extensive in portions of the habit; roadside spraying is a problem for some colonies. The species seems to be absent from areas affected by one or a combination of the above factors.

Criteria for inclusion: Local endemic; habitat loss and resulting decline in range and numbers; association with relatively pristine slope and riparian forest; occurrence on public lands, including Cleat-water National Forest and Lochsa portion of Clearwater Wild and Scenic River corridor. Population trends (number of sites, number of individuals) are downward.

Recommended status: Currently, has none. Should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID) listing as Endangered is warranted, due to road usage, lumbering and grazing, fires, very limited number of known and likely sites.

References: Deixis collections, 1989-94.

Cryptomastix (Cryptomastix) n. **sp. 2 Hells Canyon Oregonian**

Type locality: None designated as yet; undescribedtaxori.

Description: A medium-sized ***Cryptomastix*** species (diameter to 13 mm) with 4 ½ relatively rapidly expanding whorls; spire slightly dome-shaped, convex; umbilicus narrow but distinct, about 1/9 full shell diameter; color medium-dark brown; adult not at al hirsute. Aperture white, three-lobed, with well-developed basal, parietal, and columellar teeth: lip white, moderately thick, strongly revolute al around, including base; columellar insertion at midpoint of umbilicus (above), covering perhaps 1/3 of umbilicus. The species is related to ***Cryptomastix magnidentata;*** but that species is hirsute, smaller, more strongly domed, and the apertural lip is not strongly revolute. Details of the apertural dentition differ also. This taxon also somewhat resembles ***Cryptomastix sanburni,*** but the higher, dome-shaped spire, larger number of closely-spaced whorls, and smaller umbilicus of that species are obvious differences.

Ecology: A strong xerophile species, generally found in open, dry basalt taluses with sparse vegetational cover (rare ***Celtus***; sparse grasses; clumps of ***Rhus horribilis***). Frequent land snail associates are ***Oreohelix*** n. sp. 27 (Hells Canyon mountainsnail), ***Cryptomastix populi,*** and ***Cryptomastix*** n. sp. 3 (disc Oregonian).

Original distribution: Northern portion of Hells Canyon (Snake River) and the mouth of the Grande Ronde River, ***i.e.*** from south of Lewiston to the mouth of China Garden Creek, Asotin Co., WA, Nez Perce Co., ID, and possibly Wallowa Co., OR. This area includes portions of Wallowa-Whitman and Nez Perce National Forests.

Current distribution: Known live from less than 5 colonies in the area cited above. We have collected this area in the period from 1988-1992. Sites have also been collected recently by T. Burke (Wenatchee National Forest). It is unlikely that the range or number of sites will be significantly expanded by future work.

Threats: Talus mining and road building; grazing in preferred habitat; roadside spraying. Extinct colonies have been noted in mined taluses in this area; the species is declining. Population trends (number of sites, number of individuals) are believed to be clearly downward.

Criteria for inclusion: Very local endemic; small number of known and potential sites; specialized habitat; occurrence on public lands, including Hells Canyon National Scenic Area.

Recommended status: Thus far, has none: it should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (ID, WA) listing as Endangered is appropriate, due to small number of sites, habitat loss, etc.; see above. Status of this species in OR is uncertain at the moment; more survey work is needed here.

References: Deixis collections, 1989-92.

Cryptomastix (Cryptomastix) **n. sp. 3 disc Oregonian**

Type locality: None as yet; undescribed taxon.

Description: This small ***Cryptomastk*** species has a neatly flat spire of 5 ½ rather closely spaced whorls. Maximum adult size is about 10 mm; but most adults average about 8 mm. The species lacks periostracal hair; is light yellow in color; and has a white, strongly tridentate aperture. The aperture is narrow, strongly inclined, strongly constricted immediately behind the lip, and has a prominent indentation in the area of the parietal tooth, causing the lip to appear L-shaped in side view. Most animals have the mantle lightly spotted with black, although 3 colonies in the vicinity of Lyons Bar consistently have darker mantles. The umbilicus elliptical and comparatively broad, ca. ¼ the full shell diameter in width. The lip is rather narrow, non revolute; the columellar insertion is mostly to the right of the umbilicus, which has only a small proportion covered by it. The shell base is comparatively flat.

This species can be distinguished from most related taxa by the color and flat, disc-like spire. Only the much-larger and quite distinct ***Cryptomastix sanbumi*** has equally slowly expanding whorls.

Ecology: A strong xerophile. This species prefers dry, exposed taluses, most frequently basalt. Cover is limited to grasses, uncommon ***Seligeria*** and mosses, scattered ***Rhus horribilis*** or ***Sorbus*** clumps and occasional ***Celtus*** and ***Prunus***. Commonly co-occurring land snails are ***Cryptomastix populi, Allogona ptychophora solida, Allogona ptychophora ptychophora,*** and several ***Oreohelix*** species, most often ***jugalis*** or vortex.

Original distribution: Limited to a portion of the lower Salmon River, Nez Perce and Idaho cos., ID, from approximately the mouth of White Bird Creek to the confluence with the Snake River in Hells Canyon, thence downstream in the Snake (Nez Perce Co., ID; Wallowa Co., OR, and Asotin Co., WA) to a point a few miles west of Clarkston, WA.

Current distribution: Found in very small numbers in a small number of colonies in the region cited above. The lower Salmon River area was surveyed comprehensively by us recently (Frest & Johannes, 1995); we have collected the N. part of Hells Canyon and the Snake River in WA in the period 1989-l 994. The Snake River corridor near Clarkston has also been collected recently by T. Burke (Wenatchee National Forest) and W. B. Miller (Santa Barbara Museum of Natural History). It is unlikely that many additional sites will be found.

Threats: Essentially all of the Salmon River habitat is grazed, much heavily; as is much of the Hells Canyon area. As with other species in this region, highway corridors are located along some of the suitable habitat, e.g. US 12 in WA. Talus mining and roadside spraying are problems for some colonies, particularly in the WA portion of the range. Some sites west of Clarkston and south of Lewiston collected in the late 1980s have been extirpated by road modification in the last three years; the species is declining in numbers and areal extent. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Local endemic; specialized and limited habitat; small number of known and potential sites: loss of historic sites; occurrence on public lands, including Hells Canyon National Recreation Area.

Recommended status: A newly recognized form with no status as yet. Should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent suwey work, to indicate that Federal and State (ID, WA, OR) listing as Endangered is warranted, due to habitat loss and decrease in historic sites, ongoing threats.

References: Deixis collections, 1989-94.

Crypfomastix (Cryptomastix) n. sp. 4 Juniper Springs Oregonian

Type locality: None designated as yet; newly discovered species.

Description: Medium-sized low, dome-shaped spire; mature specimens *(4* ½ moderately evenly convex whorls) range to 14 mn in diameter. Color rich red brown; shell thin, translucent; apertural lip white, moderate in thickness; slightly erect, edge barely revolute; no dentition; columellar insertion on upper edge of umbilicus,' which is half-covered, slightly flared in umbilical region. Umbilicus deep, narrow, about 1/7 full shell diameter. Sutures moderately impressed; radial growth lines fine but distinct. This species is somewhat similar to both *mullani* and *hendersoni*; but differs from both in shell (and animal) color. Apertural features (including dentition) are different in *al mullani* forms: *hendersoni* has a much larger, more disc-shaped shell and different apertural and umbilical morphology. We have not yet dissected this animal, due to limited material.

Ecology: In portions of dry and largely open, N.-facing basalt talus, at spring headwaters only, above Columbia River: common grasses, *Celtus*, *Salk, Rhus horribilis* locally. Most of surrounding natural vegetation sage scrub; this particular area in part former homestead and orchard. A weak mesophile.

Original distribution: Uncertain; known from a single site, Juniper Springs, Hanford Site (DOE), Benton Co., WA. Could also occur in nearby basalt taluses on the U.S. Army Yakima Firing Center.

Current distribution: As yet known from a single site, as above (see Frest & Johannes (1998) for details). A systematic search of other similar taluses in the immediate vicinity and elsewhere on the Hanford Site was unsuccessful.

Threats: Modification of spring (now partly capped); grazing; possible return of property to private hands. Long-dead specimens are common some distance away from the spring source, under *Salix* and *Celtus*; but live material could only be located in fortuitously protected small areas of talus at spring source. The species has lost most of its habitat at the only known site. It is not likely that many additional sites will be

found, as searches of nearby areas, such as Yakima canyon, have not produced other sites. Population trends (condition of site, number of individuals) are downward.

Criteria for inclusion: Apparently very rare local endemic; past and ongoing human activities, as noted above.

Recommended status: None as yet; should be considered a sensitive species by the appropriate agencies. This taxon seems to have been overlooked in the National Park Service plan for the area (NPS, 1994). There is sufficient recently-collected information, and recent survey work, to recommend Federal and State (WA) listing as Endangered, due to limited range, declining population, and current and potential threats to single known site.

References: Frest & Johannes (1993b); Deixis collections, 1992-93.

Cryptomastix (Cryptomastix) sanburni **(Binney, 1666)** **Kingston Oregonian**

Type locality: Kingston, Shoshone Co., ID; holotype ANSP 11119.

Description: See Pilsbty (1940) for most complete description and illustrations. This species is not at all hirsute as an adult (compare Lochsa Oregonian and Mission Creek Oregonian), the lower lip is strongly revolute, the upper less ***so.*** It differs from ***Cryptomastix magnidentata,*** the most closely comparable species, in that the fatter is hirsute; additionally, ***sanburni*** is relatively taller and has more whorls at comparable sizes. The disc Oregonian also has close whorls; but is much smaller, flatter, has very different apertural morphology, and is a xerophile.

Ecology: This species occurs in lowland and flood plain-edge ***Pinus ponderosa*** forest slopes with a considerable admixture of deciduous shrubs and a rich forb understory. Seeps and springs and small stream borders may be preferred habitat. Moist valley, ravine, gorge, or talus sites seemingly are preferred, ***i.e.*** bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture ***is*** a ***desideratum;*** this is a mesophile species. Land snail associates include ***Cryptomastix mullani mullani***, ***Allogona ptychophora ptychophora,*** and ***Radiodiscus abietum.*** The regolith is variable, with basalt, schist, and metasedimentary rocks noted at various old sites.

Original distribution: ***Cryptomastk sanbumi*** has been reported from about 5 sites scattered along the Coeur d'Alene river drainage from Coeur d'Alene to Kingston (Kootenai and Shoshone cos., ID), and from Hope, Bonner Co., ID.

Current distribution: Uncertain; 'attempts by us to recollect all 5 historic sites and others in the same areas in 1994 were unsuccessful. Amateur collectors have also failed to find this species live in recent years (e.g. S. Welty, ***pers. comm.***, 1994).

Threats: Much of the Coeur d'Alene-Kingston area has been extensively mined, and air pollution from smelting and refining operations has seriously affected plant and animal life over extensive areas. Much of the same region has also been logged, and is currently being grazed. Land snails in general are uncommon to absent in this area. Earlier recollection attempts by ***Grimm*** (1974, ***unpub.)*** were also unsuccessful. The undescribed species of ***Cryptomastk*** reported by Grimm ***(op. cit.) at*** the mouth of Steamboat Creek is apparently also now extinct, due to removal of talus for road building and location of the main river road along the major river corridor, ***i.e.*** the upper Coeur d'Alene. This may be a factor in the loss of sites for this species also.

Criteria for inclusion: Local endemic; loss of historic sites; current and ongoing threats. Population trends (number of sites, number of individuals) are evidently downward.

Recommended status: Currently, has none; it should be considered a sensitive species by the Forest Service and BLM. We recommend Federal and State (ID) listing as Endangered, for the reasons cited above. Despite possible loss of all historic colonies, failure to locate new ones after limited searches, and habitat degradation as described above, it is likely that one or more colonies survive in northern ID, although widespread occurrence is highly improbable.

References: Pilsbry (1940); Grimm (1974, ***unpub.);*** Deixis collections, 1990 & 1994.

Discus brunsoni Berry, 1955 Mission Range disc

Type locality: north shore of McDonald Lake, Mission Range, Lake Co., MT, elev. 3500'. Holotype Berry collection 19139. The senior author examined NMNH paratypes of this species in 1985 and in the collection of R. B. Brunson in 1992.

Description: See Berry (1955) for comprehensive description and illustrations. This very peculiar snail resembles certain Ammonitellidae as much as Discidae, and dissection is a ***desideratum.*** Note that more complete knowledge of generic position will not affect taxonomic validity of the species, whatever the outcome.

Ecology: Large-scale south-facing limestone talus, near base; open, rather dry; common liverworts and bryophytes; scattered ***Sorbus***, grasses. ***Oreohelix elrodi*** occurs in the same talus. A weak xerophile-mesophile taxon, and possibly a calciphile as well.

Original distribution: Found thus far only at a single site, talus on north shore of McDonald Lake, Mission Range, Flathead Indian Reservation, Mission Mountains Tribal Wilderness, Lake Co., MT. Other sites in Flathead National Forest (Mission Mountains Wilderness) are possible.

Current distribution: This species has not been collected in recent years (R. B. Brunson, ***pers. comm.***, 1993; additionally, we made unsuccessful attempts in 1991 and 1992), but still likely survives at the original site, a mile-long talus, or at similar sites in the Mission Mountains. The species is highly localized at the original site.

Threats: Fire and subsequent talus destabilization above and below the site (as occurred in 1991); overcollecting. Much of the Mission Range has been or is slated for logging; and much is also grazed.

Criteria for inclusion: Highly localized endemic; human modifications, including extensive logging, in much of its potential range. R. B. Brunson has collected many western MT sites in the last 40 years without finding other occurrences. It is unlikely that many additional sites will be found. Population trends (number of sites, number of individuals) would seem to be downward.

Recommended status: This taxon currently has none. Minimally, it should be considered a sensitive species by the Forest Service and BLM. Federal and State (MT) listing as Endangered is appropriate, due to extreme rarii and habitat modification.

References: Berry (1955); R. B. Brunson (***pers. comm.***, 1993).

Discus marmorensis Baker, 1932 marbled disc

Type locality: About 2 mi. up middle fork of John Day Creek, lower Salmon River drainage, Idaho Co., ID; holotype ANSP 158442a; paratypes UCM 22545. See Wu & Brandauer (1982) for UCM types.

Description: See Baker (1932) and Pilsbry (1948) for discussion and illustrations. Uminski (1963) after partial dissections ascribed this species questionably to the genus ***Anguispira.*** However, more detailed treatments of Discidae by A. Solem tend to make this assignment implausible, and in any case do not affect species validii, which is unquestioned. Uminski ***(op.*** cit.) also states that the shell of this species "resembles closely" that of ***Anguispira nimapuna-a*** statement that is strangely and patently inaccurate, and contrasts oddly with the later statement in the same paper that **"[i]n** spite of these similarities the shell of ***Anguispira (?) marmorensis*** (H. B. B.) is very characteristic and distinct in form and sculpture from the shells of al other ***Endodontidae"*** (Uminski, ***op.*** cit., p. 82). Turgeon ***et al.*** (1988) retain this species in ***Discus.***

Ecology: Generally found at moderate elevations on limestone terrain in relatively intact, moist, well-shaded (closed to nearly closed canopy) ***Pinus ponderosa*** forests, with diverse deciduous and forb understory. **A** mesophile-weakly notophile species. Occasionally occurs in moist schist taluses in such forests. In both cases, snail colonies are generally near stream edges and at the base of steep slopes. Moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a ***desideratum.*** Common land snail associates include ***Oreohelix*** n. sp. 22 (Slate Creek mountainsnail], ***Allogona ptychophora ptychophora, Anguispira kochi occidentalis, Cryptomastix mullani latilabris,*** and ***Hemphillia*** sp. cf. ***came/us.***

Original distribution: Found only in central portions of a few major tributaries to the lower Salmon River (east side only), in the vicinity of Lucile, Idaho Co., ID.

Current distribution: Suwives in a few colonies in central portions of two creek tributaries to the lower Salmon River Sites are on BLM, Nez Perce National Forest, and private lands. The type locality is still extant (recollected in 1993). The species is declining, due to habitat loss (as described below). Much or all of the area of known and potential occurrence was surveyed by us in recent years (Frest & Johannes, 1995a); many other workers, including H. Hemphill, H. B. Baker, W. Walton, and A. Solem have collected this region. Thus, it is unlikely that many additional sites will be found.

Threats: Much of the original area of occurrence has been logged and is now heavily grazed; the species is absent from such areas. Limestone quarrying has eliminated much or all of one colony in the last 3 years. Roads in the area of occurrence are generally situated such as to fragment or eliminate colonies. All known sites appear to have been reduced in area due to one or more of the factors cited. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Local endemic; past and ongoing threats, as detailed above: intact forest and riparian corridor species, with most sites on public lands.

Recommended status: Currently a C2 candidate (USFWS, 1994); should be considered a sensitive species by. the Forest Service and BLM. There is sufficient recently-collected information, and recent suwey work, to recommend Federal and State (ID) listing as Endangered, due to habiiat loss, ongoing threats, declining numbers.

References: Baker (1932); Pilsbry (1948); Deixis collections, 1989-l 994.

Megomphix lutarius Baker, 1932 — Umatilla megomphix

Type locality: About 5 mi. above Weston, Umatilla Co., OR, above 2000' elevation; holotype ANSP 156443.

Description: Refer to Baker (1932) and Pilsbry (1946) for discussion and illustrations.

Ecology: N.-facing small basalt cliff in ***Pseudotsuga*** menziesiiforest, with bryophytes, ferns, and bushes. Most likely, a mesophilic species. The better-known ***Megomphix hemphilli*** and ***Megomphix californicus*** mostly prefer moist valley, ravine, gorge, or talus sites, ***i.e.*** low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a ***desideratum.*** Most snails in this group (Ammonitellinae, Ammonitellidae, or Megomphicidae in various higher taxonomic schemes) are rare and limited in distribution, closely associated with either relatively intact forest, riparian areas, or both, and several have been suggested as listing candidates elsewhere (Frest & Johannes, 1993c).

Original distribution: Reported from two somewhat widely separated sites in the Blue Mountains, Walla Walla Co., WA and Umatilla Co., OR; probably originally rather well distributed in the Blue Mountains.

Current distribution: Uncertain. We have tried a number of sites in the Blue Mountains between 1991-1994 without finding this taxon. The species is definitely declining, and we have not found it at the type localii and adjacent areas in Umatilla National Forest. Population trends (number of sites, number of individuals) appear 'to be downward.

Threats: Past and continuing intense logging and grazing throughout most of the Blue Mountains. Much of the remaining forest is currently succumbing to insect infestation. Land snails generally are now of rather rare occurrence in this region, occurring mostly in very small areas protected from logging and grazing. Additional areas in Umatilla and Wallowa-Whitman National Forests need to be searched for this species, although it is not likely that large numbers of additional sites will be found.

Criteria for inclusion: Local endemic; probable occurrence on federal lands; past and ongoing human modification of entire known and likely range; loss of historic sites.

Recommended status: This taxon has none at present; it should be considered a sensitive species by the Forest Service and BLM. We recommend Federal and State (WA, OR) listing as Endangered, due to endemism and extensive habitat modification of its known and likely range.

References: Baker (1932); Pilsbry (1946).

Monadenia (Monadenia) fidelis minor (Binney, 1666) Dalles sideband

Type locality: The Dalles, Wasco Co., OR; holotype USNM 5229. The rather vague site is typical for Hemphill collections.

Description: The best description and illustrations available are those of Pilsbry (1939), *q.v.* This species does not closely resemble any other WA or OR ***Monadenia,*** with the exception of the Deschutes sideband (see below for comparisons). Cited under the same name in Frest & Johannes (1993c).

Ecology: Generally in basalt talus, often north-facing, often associated with seeps and springs. Found at lower elevations only; taluses are often comparatively dry and open, but partial cover by ***Celtus,*** grasses, ***Rhus horribilis***, ***Artemisia, Urtica***, and ***Balsamorrhiza*** is typical. Surrounding areas, if natural, are sage scrub, with abundant ***Artemisia*** (several species) and locally common ***Balsamorrhiza*** and ***Celtus.*** Common large land snails in the same colonies are ***Oreohelix variabilis*** and ***Vespericola columbiana depressa.*** A moderately xerophilic taxon.

Original distribution: Likely central and part of the eastern Columbia Gorge, Wasco and Sherman cos., OR and Klickitat Co., WA, to as far E. as the mouth of the John Day River; possibly S. as far as 10 mi. up the Deschutes River valley, OR. The Deschutes specimens far upriver from the mouth are another related undescribed species (see below). Klamath Lake specimens mentioned in Pilsbry (1939) are another species, as suggested by Roth (1981) and confirmed by us in 1991-92.

Current distribution: Survives in a few colonies in the vicinity of The Dalles and in the lower Deschutes River valley [note: the mouth only, upriver colonies are likely another taxon], and near Dog Falls, WA. Most known sites are in the Columbia River Gorge National Scenic Area. The species has been observed to occur at some sites with the candidate Larch Mountain salamander *Plethodon larselli*, and should be managed with this in mind. We have surveyed large parts of the Columbia Gorge between 1988-l 994, so that sizable numbers of additional sites are unlikely to be found.

Threats: Road building and modification (e.g. I-84/US 30 and WA 14) have destroyed or fragmented some colonies. Urban expansion in The Dalles has had similar effects. Much of the original range is heavily grazed; much has had serious fires in the last 2 years; roadside spraying for weed control is a problem at many sites. Railroad activities have further fragmented the range and affected colonies in recent years, e.g. disposal of batteries alongside tracks at one site. The combination of pressures, coupled with extended drought, has reduced populations at most known sites; the species is declining. Extinct colonies have been noted along the I-84/US 30 corridor. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Current federal C2 candidate species (USFWS, 1994); local endemic; occurrence on public lands (State of Oregon and federal).

Recommended status: Currently a Federal (Category 2) candidate: should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent suwey work, to indicate that it should be listed as Endangered Federally and in OR and WA as well.

References: Pilsbry (1939); Roth (1981); USFWS (1994); Deixis collections, 1988-l 994.

Monadenia (Monadenia) fidelis n. subsp. 1 Deschutes sideband

Type locality: None designated as yet; undescribed taxon.

Description: A medium-sized species of *Monadenia* (to 24 mm in adults). The spire is low: the periphery is acutely rounded; shell color mostly carob brown, with bands nearly obsolete, particularly the upper one. Whorls 4 1/2-5 1/2. Umbilicus proportionately wide as compared to *Monadenia fidelis minor,* and more than twice as broad in comparison to total width as in *Monadenia fidelis fidelis.* Upper shell surface with fairly prominent axial striation: radial growth lines unusually strong, fairly regular.

This taxon is most closely related to *Monadenia fidelis minor;* but is smaller, flatter, darker in color, more angular periphery, and has a comparatively wide umbilicus. The shell most closely resembles that of the CA *Monadenia* churchiamong described forms, but is taller. The prominent growth lines are a unique feature.

Ecology: Found mostly in dry, N.-facing basalt taluses along permanent streams and in the vicinity of springs and seeps, at low elevations; a xerophile species. Taluses are comparatively loose and open but partial cover by bryophytes, *Rhus horribilis*, *Clematis, Urtica*, grasses, and *Balsamorhiza* is typical. Surrounding areas, if natural, are sage scrub, with abundant *Artemisia* (several species), plus less common *Balsamorhiza* and *Celtus*. Frequently, *Oreohelix variabilis* n. subsp. and *Vespericola columbiana depressa* occur in the same taluses.

Original distribution: Probably historically common and widespread in the Deschutes River corridor below Bend, OR.

Current distribution: A few widely separated colonies along the Deschutes River in Wasco and Sherman cos., OR. The species is declining, due to habitat loss (as detailed below) and extended drought that has reduced numbers noticeably even at still extant sites. Most sites are on public (BLM) lands. Other may occur on Confederated Tribes of the Warm Springs Reservation property. Localities occur along the

Deschutes Wild and Scenic River corridor. We have collected extensively in the lower Deschutes in recent years, so that large numbers of additional sites are not likely.

Threats: Burlington Northern Railroad and road (US 26, US 197, OR 216) building and maintenance has destroyed and/or fragmented and reduced colonies; roadside spraying for weed control is a problem at some sites. Proposed development of the lower Deschutes corridor for recreation (BLM, 1993a, b) will likely negatively impact this subspecies, as such sites and access roads tend to be placed directly in remaining prime habitat. The lower Deschutes is already heavily used for various forms of recreation, and such usage is anticipated to increase. Much of the area is heavily grazed and subject to catastrophic fires, such as those of 1994 at the mouth of the Deschutes canyon. The species is demonstrably declining, with colony loss and reduction having taken place in recent years.

Criteria for inclusion: Local endemic; occurrence on public lands, past and present threats; declining numbers of sites and individuals.

Recommended status: This taxon currently has no special status. It should be considered a sensitive species by the Forest Service and BLM. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (OR) listing as Endangered *is* a ***desideratum. See*** above for rationale.

References: Deixis collections, 1988-94.

Monadenia (Monadenia) n. sp. 1 Modoc Rim sideband

Type locality: None designated as yet; undescribed taxon.

Description: This comparatively small ***Monadenia*** species has a shell shape much like that of ***Monadenia fidelis fidelis.*** It is typically about 40% smaller (to mm' at 6 -6 1/2 whorls) but has an equal- or slightly larger sized umbilicus (proportionately much wider). The upper surface is generally a dirty yellow, with coarse and irregular radial growth lines and spotty spiral striation. Banding is well-developed; the base and peripheral band are dark brown.

Ecology: Restricted to large-scale dry and open vesicular basalt taluses at lower elevations. Commonly, taluses with this species have accompanying seeps or springs, and snail colonies are found mostly near talus base, ***i.e.*** close to the lake. Plants associated include ***Urtica, Clematis, Sorbus, Prunus***, and ***Celtus***. Surrounding plant community is sage scrub. Few other land snails w-occur. A xerophile species.

Original distribution: Probably once common on both sides of Upper Klamath Lake (Pilsbry, 1939).

Current distribution: A few colonies at the SE end of Upper Klamath Lake, Klamath Co., OR, including sites on Winema National Forest lands. We have been unable thus far to locate surviving colonies on the west side of Upper Klamath Lake. The species appears to be declining in areas occupied and numbers, due to a combination of human modification of habitat and extended dry periods in its area of occurrence.

Threats: Talus mining and quarrying in vicinity of remaining sites; road building and road and railroad track (Burlington Northern) maintenance along the US 97 and OR 140 corridors; roadside and trackside spraying for weed control. This area has suffered recent rock slides (1993, 1994); proposed measures to alleviate that problem may eliminate colonies.

Criteria for inclusion: Local endemic; occurrence on public lands; ongoing threats. Population trends (number of sites, number of individuals) are downward. It is unlikely that many additional sites will be found.

Recommended status: At the present time this species has no special status; it should be considered a sensitive species by the Forest Service and BLM. Federal and State (OR) listing as Endangered is appropriate, due to specialized habitat and obvious threats to that habitat, as well as recent habitat loss.

References: Pilsbry (1939); Deixis collections, 1991-l 994.

Ogaridiscus subrupicola (Dall, 1877) southern tightcoil

Type locality: "Clinton's Cave, east of Lake Point Station, Tooele Co.", Utah (Dall, 1877). The holotype may be lost; paratypes USNM 67356. We have not collected specimens of, this species.

Description: The best summary description and illustration are in Pilsbry (1946); see also Baker (1930, 1931). As regards shell features, the small size, close coiling, and neardiswidal conch readily distinguish this species from anything else in its range. Generic status dates to Chamberlin & Jones (1929); Baker (1930, 1931) and Pilsbry (1946) treated it is a subgenus. However, the most recent comprehensive revision of the Zonitidae (Riedel, 1980, p. 34) cogently argues for generic status: "...die Genitalien sind aber so abweichend gebaut und charakteristich, *dass* man *Ogaridiscus* als selbständige Gattung betrachten soll". This genus is monotypic.

Ecology: A weakly xerophile-mesophile species occurring among rocks and brush; poorly known. The Oregon site is a short, rather dry, N.-facing basalt cliff face and shallow talus in open Ponderosa pine and Douglas fir forest, elev. 2000'. Associates here were such rare taxa as *Megomphix lutarius*, *Pristiloma idahoense,* and *Polygyrella polygyrella, as* well *as Radiodiscus abietum, Microphysula ingersolli,* and some more widespread forms (Baker, 1932). The Idaho site is in the drainage to a tributary to the Coeur d'Alene River, in open Ponderosa pine forest.

Original distribution: Reported reliably from three widely separated sites; Clinton's cave, Tooele Co., UT, E. fork of Willow Creek, Shoshone Co., ID; and Pine Creek Valley, above Weston, Umatilla Co., OR. We have not found this taxon at our ID sites; nor has R. B. Brunson at his western MT sites or T. Burke at his eastern WA localities.

Current distribution: Uncertain; none of the sites has been recollected successfully in recent years, to our knowledge. We did not find this species in a brief search in 1994. R. B. Brunson did not find this species in western MT; neither T. Burke nor S. Welty have found this species at their ID or eastern WA sites.

Threats: The area above Weston is heavily grazed, and most has been logged. The ID site is in an area that has mostly been logged; is grazed currently; and is part of the Coeur d'Alene-Kingston mining district. Some of this area has been severely affected by smelter emissions and mining wastes. Probably, population trends (in number of sites and number of individuals) are downward.

Criteria for inclusion: A regional endemic, reported from a few, widely scattered sites; lack of recent collections; threats in areas of known past occurrence; monotypic genus.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal listing as Threatened may be appropriate for the reasons cited above. Similar status (Threatened) is suggested for the States of OR, ID, and UT.

References: Baker (1930, 1931); Pilsbry (1946).

Oreohelix alpina (Elrod, 1901) alpine mountainsnail

Type locality: Sinyalemin Mountain, Mission Range, Lake Co., MT, elev. 8500'. Holotype and paratypes formerly at University of Montana; recently transferred to NMNH. Topotypes at ANSP and in Deixis collections.

Description: See Elrod (1901, 1902) and Pilsbry (1939) for description and illustrations. Pilsbry, working only from a couple of rather poor dead shells, expressed some doubt as to the validity of this taxon (although accepting it as a full species): "The special features of this form, small size and thin, angular shell of few whorls, are those of immaturity, and are characteristic of some races at high elevations and in other unfavorable situations. It is therefore possible that when collections are made atintermediate elevations some connecting links may be found with the large, elevated *Oreohelix subrudis* of lower levels (Pilsbry, *op.* cit., p. 501). This was done by R. B. Brunson (*pers. comm.*, 1993), who collected extensively on McDonald Peak and Sinyalemin Mountain over a period of many years. Examination of his material, which included many specimens of *Oreohelix alpina*, make it dear that this is a distinct taxon, and that the original description of Elrod does indeed pertain to adult individuals. We examined Pilsbry's ANSP material in 1991. We also recently examined the Elrod holotype, paratypes, and apparent topotypes from a later collection. While more than one species of *Oreohelix* is present on Sinyalemin Mountain (one quite large, thus belying Pilsbry's argument), it is clear that Brunson's later collections and Elrod's type material represent the same species, *Oreohelix alpina.* Relationships of this taxon are to *Oreohelix amariradix*, rather than *0 subrudis.*

Ecology: High elevations (above treeline, fringing glaciers) in rather open terrain; limestone bedrock and talus. This is the only species of *Oreohelix* thus far known exclusively from alpine environments, although several others species (e.g., *Oreohelix subrudis)* may occur at simihr or lower elevations. Exclusively hypsiphile taxa are rare in this region.

Original distribution: Two sites in the Mission Range, Lake Co., MT, Mission Mountains Tribal Wilderness. Other sites here and in Flathead. National Forest (Mission Mountains Wilderness, Missoula Co.) are possible, although it is not likely that large numbers of additional sites will be found.

Current distribution: Likely survives at at least one of original sites.

Threats: Fires and other factors causing talus destabilization; disturbance by mountain climbers.

Criteria for inclusion: Local endemic; very unusual ,-habitat for genus; limited range: probable occurrence on public lands. Population trends (number of sites, number of individuals) may be downward.

Recommended status: Presently, this species has none; it should be considered a sensitive species by the Forest Service, Flathead Tribe, and BLM. We support Federal and State (MT) listing as Threatened; see above for discussion.

References: Elrod (1901, 1902); Pilsbry (1939); R. B. Brunson (*pers. comm.*, 1993); Deixis collections, 1992.

Oreohelix amariradix Pilsbry, 1934 Bitterroot mountainsnail

Type locality: Bitterroot Mts., along bluffs of Lolo Creek, elev. 5000'; possibly SW¼ SE% sec. 36, T 12 N R 21 W, Carlton Lake quad.; see Fairbanks (1980, p. 27); holotype ANSP 79801.

Description: See Pilsbry (1939) for shell and Fairbanks (1980) for anatomic description.

Ecology: Small rock taluses in rather open and dry *Pinus ponderosa* forest; common grasses; scattered *Amelanchier, Physocarpus.* Snails occur primarily in basal portions of talus. Associated taxa include *Cryptomastk mullani mullani*, *Vitrina limpida*, and *Allogona ptychophora ptychophora.* At one site, a larger taxon related to *Oreohelix amariradix* (*Oreohelix* n. sp. 5 [Brunson mountainsnail]) also occurs. The Missoula Co. sites were on dry, open, rocky hillsides, S.-facing, with scattered shrubs and grasses. This species is a moderate-strong xerophile.

Original distribution: Bitterroot Mts., in the drainage of Lolo Creek. Other localities formerly near Ravenna and the site of Nimrod, Clark Fork River valley, Missoula Co., MT.

Current distribution: Suwives at at least two sites in the Lolo Creek drainage, one possibly on Lolo National Forest lands. The colony at the locality cited by Fairbanks (1980) may now be extinct: as recent visits by us and by private collectors (S. Welty, *pers. comm.*, 1992, 1993) have been unsuccessful. The species is declining, both in absolute numbers and in number of known and potential sites. We attempted to recollect the Missoula Co. sites unsuccessfully in 1994. R. B. Brunson collected the species at only a couple of sites despite extensive efforts in western MT from the 1940s-1970s. It is unlikely that many additional sites will be found.

Threats: Much of the Bitterroots has been logged, followed by intensified grazing; roadside spraying for weed control is also a problem for this species. Portions of the, Lolo Pass and lower Lolo Creek area were subject to fires in 1991 and 1993. Highway improvements have removed extensive portions of the taluses in the Lolo Creek drainage.

Criteria for inclusion: Local endemic; limited range; continuing threats; habitat loss.

Recommended status: To date, this species has no special status; it should be considered a sensitive species by the Forest Service and BLM. Federal and State (MT) listing as Endangered is recommended; for rationale, see above. This species was included in a draft Rule for listing as a C2 species (USFWS, 1988); but was not included in the final Rule (USFWS, 1989).

References: Pilsbry (1939); Fairbanks (1980); Deixis collections, 1989, 1992, 1994.

Oreohelix carinifera Pilsbry, 1912 keeled mountainsnail

Type locality: Near Garrison, Powell Co., MT; holotype ANSP 99253a.

Description: See Pilsbry (1912, 1934, 1939) for illustrations and description. Affinities of this species are with the yavapai mariae species group,

Ecology: A strong xerophile found on a S.-facing Jurassic outcrop in mostly open and dry mixed sage and juniper scrub, generally under bushes or reptant *Juniperus.* Rare specimens of *Vallonia cyclophorella* and *Catinella* sp. were the only other land snails noted.

Original distribution: Known from the type locality (near Garrison) and from other localities near Ravenna and the site of Nimrod, Missoula Co., MT; all in a limited portion of the Clark Fork River valley.

Current distribution: Known to survive only at a portion of the type locality. Our attempts to recollect the Missoula Co. (Beavertail Hill) sites in 1994 were unsuccessful. R. B. Brunson collected many land snail sites in western MT from the 1940s through the 1970s, finding this species at only a couple of sites. It is unlikely that many additional sites will be found.

Threats: Grazing and logging in the species' limited habitat; road construction and maintenance, e.g. I-90 and US 12; urban encroachment. The type locality has been reduced by highway encroachment and by expansion of Garrison. Exacerbated by recent drought, the species' proven and potential habitat has

been much reduced, and the type colony has been areally restricted. The species is extinct over much of the remaining area at the type locality due to heavy grazing, although dead shells can still be found, suggesting recent increased impact. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Local endemic; declining numbers and sites. Likely occurrence on adjoining public lands (State of Montana, Deerlodge National Forest, Lolo National Forest).

Recommended status: To date, this species has no special status; it should be considered a sensitive species by the Forest Service and BLM. Federal and State (MT) listing as Endangered is recommended; for rationale, see above. This species was included in a draft Rule for listing as a C2 species (USFWS, 1988); but was not included in the final Rule (USFWS, 1989). It is very unlikely that future finds will significantly increase either the number of sites or the known range.

References: Pilsbry (1912; 1934; 1939); R. B. Brunson (*pers. comm.*, 1993); Deixis collections, 1992, 1994.

Oreohelix elrodi (Pilsbry, 1900) carinate mountainsnail

Type locality: North shore of McDonald Lake, Mission Range, Mission Mountains Tribal Wilderness, Flathead Indian Resewation; holotype ANSP 78740a.

Description: See Pilsbry (1900, 1902b, 1905, 1939) and Fairbanks (1984) for description and illustrations. Our dissections indicate that affinities of this species are probably with the yavapai mariae group.

Ecology: Large-scale south-facing, rather dry and open limestone talus, *elev. 3000-7500';* sparse *Pinus* ponderosa forest, with *Sorbus*, *Amelanchier*, grasses, local bryophytes and *Seligeria*. *Discus'brunsoni is* present in limited portions of the same talus, but may not w-occur. Other land snails, with the exception of *Vitrina alaskana,* were not noted by us in surviving colonies at the type locality, although present elsewhere in the immediate area. See Elrod (1902) for further details. This species appears to be weakly-moderately xerophilic. It may be a hypsiphile.

Original distribution: Two sites at moderate-high elevations in the Mission Range and Swan Range, Lake Co., MT. R. B. Brunson collected many sites over all of western MT from the 1940s through the 1970s without finding sites other than these.

Current distribution: Survives in small numbers at the type localii. The Swan Range site (Flathead National Forest) needs rechecking. Other sites are possible elsewhere in the Swan and Mission Ranges, Flathead Indian Reservation and Flathead National Forest This species was formerly present in large numbers, judging from Elrod (1902), large museum lots, and repeated visiis by R. B. Brunson over a number of years (*pers comm.*, 1993). In recent years, only small numbers have been found in very limited areas at the type locality (R. B. Brunson, *q.v.*; Deixis, 1991-1993).

Threats: Logging and grazing over much of the Mission and Swan ranges; fire and other factors enhancing talus destabilization: possible overcollecting. This species has since its discovery been well known as one of the most spectacular U.S. land snails, and hence has unusual appeal to collectors.

Criteria for inclusion: Local endemic; declining numbers; occurrence on public lands. Population trends (extent of sites, number of individuals) are downward. It is unlikely that many additional sites will be found.

Recommended status: To date, this species has no special status. It should be considered a sensitive species by the Forest Service, BLM, and other land management agencies. Federal and State (MT) listing

as Endangered is appropriate, due to declining numbers and endemicity. This species was included in a draft Rule for listing as a C2 species (USFWS, 1988); but was not included in the final Rule (USFWS, 1989).

References: Elrod (1902); Pilsbry (1900, 1902b, 1905, 1939); Fairbanks (1984); Deixii collections, 1989, 1991; R. B. Brunson (*pers. comm.*, 1993).

Oreohelix hammeri Fairbanks, 1994 Mt. Sampson mountainsnail

Type locality: Mt. Sampson, Seven Devils Mts., elev. 5500', NE¼ sec. 22, T 23 N R 1 W, Rapid River drainage, Idaho Co., ID, Nez Perce National Forest. Holotype USNM 809997, paratypes USNM 809998; other paratypes H. L. Fairbanks 432, Deixis collections.

Description: See Fairbanks (1984) for discussion and illustrations. Affinities of this species are with the *intersum* species group; but it is not closely similar to that or any of the new species in this group mentioned below. One of the most distinctive *Oreohelix* species, with shell features most closely similar to *Oreohelix elrodi* but quite different soft anatomy.

Ecology: Dry, open S.- and SW-facing limestone outcrops and talus: scattered grasses, *Physocarpus*, *Mertensia*, glacier lily, *Amelanchier.* Other, possibly new species of *Oreohelix* occur in the immediate vicinity. A moderately xerophile taxon; and possibly a calciphile and hypsiphile.

Original distribution: Known only from the type locality.

Current distribution: May survive at the type locality, which was included in a severe forest fire in 1994. Searches of the Rapid River area by us and by private collectors from 1989-l 994 have not resulted in the finding of other sites. A survey of over 200 sites in the lower Salmon River valley (Frest & Johannes, 1995a) produced no additional sites for this species, which was also not found by earlier collectors. Systematic collection of the lower Salmon and tributary valleys began in the 1860s and has continued to the present. It is unlikely that many additional sites will be found.

Threats: Forest fires; continued logging and grazing in area. This area (Rapid River-Seven Devils) was the scene of extensive prospecting and mining in the past, some of which continues.

Criteria for inclusion: Local endemic: past and continuing threats: occurrence on public lands. Population trends (number of sites, number of individuals) are likely downward.

Recommended status: Has no special status at present; it should be considered a sensitive species by the Forest Service, BLM, and other land management agencies. We recommend Federal and State (MT) listing as Endangered, due to very limited range and past and present threats.

References: Fairbanks (1984); R. B. Brunson (*pers. comm.*, *1993).*

Oreohelix haydeni hesperia Pilsbry, 1939 western mountainsnail

Type locality: North-facing limestone talus 2 ½ mi. up John Day Creek, lower Salmon River valley, Idaho Co., ID; holotype ANSP 174022a (for more'detailed location of this site, see Frest & Johannes, 1995a).

Description: See Pilsbry (1939) for description and illustrations. The only other named *Oreohelix* species with even closely similar shell features is the rare Colorado form *Oreohelix haydeni betheli*. In Idaho.

possibly more than one species is involved (each would be quite rare if this surmise is correct); see Frest & Johannes (1995a) for discussion. We prefer to keep all known sites under this rubric pending further study.

Ecology: Generally found on limestone outcrops and limestone talus in rather open *Pinus ponderosa* forest, at moderate elevations. The type locality is a comparatively open and dry large-scale talus with grasses, *Sorbus*, *Amelanchier*, and *Rhus*. Common large land snail associates are *Cryptomastix mullani latilabris* and *Allogona prychophora ptychophora.* At forested sites, associates include other *Cryptomasrix* spp., *Anguipsira kochi occidentalis,* and *Allogona ptychophora prychophora.* At one site, *Discus marmorensis* was also found with this taxon. The forest sites are comparatively dry and open; in moist and riparian sites, this species is very rare or absent; a xerophile. This taxon occurs at a range of elevations.

Original distribution: Probably at one time widespread over several tributaries of the lower Salmon River (E. side only), in the vicinity of John Day Creek. Long-dead shells are still common at many sites in which live individuals were no longer present.

Current distribution: Restricted to a few remnant colonies in the area of its original distribution, on private, BLM, and Nez Perce National Forest lands. Known and potential range were surveyed recently (Frest & Johannes, 1995a). Many other malacologists have collected in this area, both private and professional, beginning in the 1860s.

Threats: Logging, grazing, forest fires, and agricultural use of most of the original range. Areas heavily grazed and/or cleat-cut lack this species. Wiihin the original range, literally millions of dead shells may be found in areas so treated, which now either lack the species entirely or have it restricted to fortuitous small rock outcrops. The species has probably lost more than 90% of its original range. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Local endemic; habitat loss, as detailed above and in Frest & Johannes (1995a); occurrence on public lands.

Recommended status: Currently this taxon has no special status; it should be considered a sensitive species by the Forest Service, BLM, and other land management agencies. Federal and State (ID) listing as Endangered, due to habitat loss, population declines, and other factors outlined above, should also be considered.

References: Pilsbry (1939); Deixis collections, 1989-l 994.

Oreohelix haydeni perplexa Pilsbry, 1939 enigmatic mountainsnail

Type locality: Twilegar Gulch, sec. 35 T 26 N R 1 E, Idaho Co., ID, lower Salmon River drainage; holotype ANSP 174024a.

Description: See Pilsbry (1939) for description and illustrations. The unique (for *Oreohelix)* shell ornament with crossed, equally-strong spiral ribs and lirae (cancellate pattern) make it one of the most unusual U.S. land snails, and hence easily subject to overcollecting.

Ecology: Open, rather dry sage scrub with small-scale limestone talus (mostly W.-facing) and outcrops; grasses, *Artemisia* spp., *Amelanchier*, *rare Opuntia*, and *Physocarpus.* Associated land snails include *Cryptomastix harfordiana*, *Helicodiscus salmoneus,* and *Allogona ptychophora ptychophora.* The known site is at moderate elevations and is bordered on all sides by other *Oreohelix* spp. colonies. This taxon appears to be a moderate-strong xerophile, and could be a calciphile also.

Original distribution: A single extended colony in Twilegar Gulch. This colony is bordered on three sides by colonies of other ***Oreohelix*** species, notably ***Oreohelix idahoensis idahoensis*** and ***Oreoehelix*** n. sp. 20.

Current distribution: Small remnant colonies in protected areas within the limits of the original sites. Common dead shells indicate that at least 70% of the original site no longer has living individuals. Reduction in numbers has been observed during several visits, 1989-1994.

Threats: Heavy grazing; fires, which have occurred in the immediate area in recent years; overcollecting.

Criteria for inclusion: Extremely local endemic; ongoing and past threats; observed decline in area occupied and live population size.

Recommended status: Surprisingly, this taxon has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management agencies. Federal and State (ID) listing as Endangered, due to extremely limited geographic range and declining numbers and condition of habitat, should be undertaken.

Reference%: Pilsbry (1939); Deixis collections, 1989-1994.

Oreohelix idahoensis baileyi (Bartsch, 1916) Seven Devils mountainsnail

Type locality: Seven Devils Mts., Idaho, "on a limestone ridge on the side of a rapid creek" (Bartsch, 1916), elev. 3700'; holotype USNM 133221; paratypes USNM 133221a. Thii rather vague locality could refer either to the Hells Canyon or Rapid River sides of the Seven Devils.

Description: See Bartsch (1916) for description and illustrations of shell (holotype). We examined the two paratypes also in 1991; they are essentially identical in morphology to the holotype. See discussion in Frest & Johannes (1995a). Specimens referred to this form by Winslow (1920) and Pilsbry (1939) [in part] are placed herein in either ***Oreohelix*** n. sp. 18 (Limestone Point mountainsnail) ***or Oreohelix*** n. sp. 20 (Sheep Gulch mountainsnail) [*q.v.*]. This species is more depressed; has more convex whorls: and has a much larger umbilicus than either of the new forms. It is also smaller than ***Oreohelix*** n. sp. 18. The week peripheral rib is also distinctive: ***Oreohelix*** n. sp. 18 has a very strong peripheral rib; while ***Oreohelix*** n. sp. 20 has an angulate periphery.

Anatomy of this taxon is unknown, and we were unable to determine juvenile shell characters sufficient to assign this taxon to a species group, though it obviously is distinct at the subspecies level or higher. Affinities are uncertain, as some forms we would place in the ***Oreohelix intersum*** species group (see discussion below) may be similar in shell morphology. Most likely relationships ***are*** to the ***Oreohelix idahoensis*** species group.

Ecology: Occurs on limestone outcrops and in limestone talus, often rather dry and open, at moderate elevations. Details and associates are unknown. Probably a strong xerophile and calciphile.

Original distribution: Known from the type locality only; not relocated or recollected in recent years. Specimens ascribed to this species from the lower Salmon River canyon (except possibly for areas very near the mouth) belong to another species, ***Oreohelix*** n. sp. 20 [see below and Frest & Johannes (1995a)]. Other Hells Canyon specimens with somewhat similar morphology are assigned to ***Oreohelix*** n. sp. 18. The other vaguely similar Hells Canyon species, the Pittsburg Landing mountainsnail, is distinctive in a number of ways (see ***Oreohelix*** n. sp. 30). We have not found this taxon as yet at any of our Hells Canyon or lower Salmon River sites.

Current distribution: Uncertain. Likely to occupy a small stretch of the Seven Devils terrain, ID, sandwiched between better-known taxa. The elevation suggest it likely occurs on Nez Perce or Payette

National Forest lands in the Seven Devils Mountains, though it could occur on BLM (Hells Canyon National Recreation Area) or on priiate inholdings.

Threats: Grazing; logging; forest and range fires; mining or other development on private lands in southern and central Hells Canyon. As these factors are extensive throughout the likely area of occurrence, population trends (number of sites, number of individuals) are highly likely to be downward.

Criteria for inclusion: Local endemic; restricted habitat; past' and ongoing threats; likely decline in sites and population; possible occurrence on public lands, including Hells Canyon National Area, Wallowa-Whitman and Nez Perce National Forests.

Recommended status: Currently, has none; it should be considered a sensitive species by the Forest Service, BLM, and other land management agencies. In our opinion, Federal and State (ID) listing as Endangered would be appropriate; rationale discussed above. It is unlikely that many additional sites will be found.

References: Bartsch (1'916); Winslow (1920); Pilsbry (1939); Frest & Johannes (1995a); Deixis collections, 1989-l 990.

Oreohelix idahoensis idahoensis (Newcomb, 1866) costate mountainsnail

Type locality: Specimens received from the original collector (Henry Hemphill) bear labels reading "between Idaho City and the Coeur d'Alene mining district [about 200 mi.]", "Lucile", and "Salmon River Mountains". As Hemphill collected extensively in the area about Lucile, lower Salmon River, Idaho Co., ID, it is generally accepted that this region is the source of Hemphill's specimens. Holotype ANSP 10857a. Probable paratypes (certainly topotypes) from Hemphill's collection are widely scattered in major U.S. and foreign museum and priiate collections, including our own.

Description: See Pilsbry (1939) for description and illustrations and Solem (1975) for modern dissection: see also Frest & Johannes (1995a). This form may not actually be closely related to true ***idahoensis baileyi***, although in the same species group. The higher spire, larger number of whorls, high, widely spaced white ribs and brown (bandless) ground color, small umbilicus, and deflected aperture are distinctive feature. Rib spacing in ***Oreohelix*** n. sp. 18 [Limestone Point mountainsnail] is closer; transverse ribs are not as prominent; the spire is not as high; there is a distinct peripheral rib; there is little contrast in color between transverse ribs and interspaces; and the umbilicus is proportionately smaller. ***Oreohelix*** n. sp. 20 [Sheep Gulch mountainsnail] has a small, much more depressed spire, wide umbilicus, weak to absent peripheral keel, and fine, more closely spaced transverse ribs.

The only other taxon with any close resemblance is the final known member of the species group, the Pittsburg Landing mountainsnail, ***Oreohelix*** n. sp. 30. This species has a somewhat similar shell shape; however, the umbilicus is larger; spiral striation is not well developed; the radial ribs, though prominent, are narrower and more narrowly spaced, more ***as*** in ***Oreohelix peripherica newcombi*** than in the other ***idahoensis*-group taxa;** and the two typical color bands of ***Oreohelix*** (absent in ***idahoensis)*** are well developed. The Hells Canyon taxon also lacks any kind of peripheral keel, rib, or angulation.

Ecology: Restricted to low-middle elevation limestone and calcareous schist outcrops and talus, generally in sage scrub: typically in rather dry and open terrain with common ***Artemisia*** and grasses; less common ***Amelanchier***, ***Celtus***, ***Opuntia.*** Usually occurs in monospecific colonies, occasionally with ***Cryptomastix harfordiana*** and ***Succinea*** sp. See Frest & Johannes (1995a) for further information. A strongly xerophilic species and a calciphile.

Original distribution: A small area a few miles long on both sides of the lower Salmon River, Idaho Co., ID, in the vicinity of Lucile.

Current distribution: Restricted to a few colonies within the original area of distribution. The area of known and likely occurrence has been visited many times by malacologists; the most recent survey is by Frest & Johannes (1995).

Threats: Grazing; gold mining; talus and limestone quarrying; range fires. One large colony is now near extinction due to a combination of grazing and recent fires. Dead shells mark an area more than 20 times the present live occurrence. Building in Lucile has also impacted sites. In one area, sheep grazing has eliminated most of one colony, while remnants on the opposite side of the road (protected from grazing) have abundant snails. Similar effects from grazing and other causes can be observed at all remaining sites. Apparently extinct colonies occur N. of Riggins. The species is declining. This species, termed by Pilsbry "one of our prettiest land shells", is also a favorite of collectors. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Local endemic with specialized habitat; declining populations and area of occurrence; current and past threats; occurrence on federal (BLM) lands.

Recommended status: We favor Federal State (ID) and listing as Threatened, if BLM Lucile ACEC sites can be thoroughly protected; otherwise Endangered. This species is currently a federal Category 2 candidate (USFWS, 1994). It should be considered a sensitive species by the Forest Service, BLM, and other land management agencies. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995). Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is unlikely that many additional sites will be found.

References: Pilsbry (1939); Solem (1975); Deixis collections, 1988-l 994.

Oreohelix intersum (Hemphill, 1880) deep slide mountainsnail

Type locality: Stone piles at the foot of a steep bluff back some distance from the banks of the Little Salmon River, Idaho Co., ID; lectotype SBMNH 33930; paralectotypes CAS 58867; 54557; 54558; 54561; USNM 363248: AMNH 61704; 61705. See Coan & Roth (1987) for discussion of accurate lectotype designation for this species, vs. Hanna & Smith (1939).

Description: Pilsbry (1939); regarded as a full species by Berry (1932), Hanna & Smith (1939) and Solem (1975); see discussion in Solem (1975) and Frest & Johannes (1995a). Dissection indicates that this species is not particularly closely related to *Oreohelix jugalis*, as Pilsbry originally thought. Species with closely comparable anatomy have so far been noted by us only in the Little Salmon River-lower Salmon River area of ID and constitute a distinct species group.

Ecology: Found primarily in rather dry and open basalt and (rarely) schist talus slides, all at lower elevations; grasses, scattered clumps of *Rhus horribilis* and *Sorbus*; *Celtus*, and *Amelanchier* and *Opuntia* are the usual plant associates. Colonies are generally surrounded by sage scrub (*Arfemisia, Balsamorrhiza*). Despite the common name, rock taluses with this species need not be large or deep. This taxon often is the only large land snail present at a site. See Frest & Johannes (1995a) for further details. A moderately-strongly xerophilic taxon.

Original distribution: Lower few miles of Little Salmon River drainage, including larger tributaries, Idaho Co., ID.

Current distribution: Scattered sites within area of original distribution. See Frest & Johannes (1995a) for summary.

Threats: Grazing; road construction, e.g. US 95 corridor; talus mining; irrigation system construction; roadside spraying for weed control. Each of the above has been observed to impact at least one colony in

recent years. In heavily grazed areas, colonies are absent or limited to small areas protected by fortuitous circumstances. The species is declining, both in terms of absolute numbers and area occupied. Population trends (number of sites, number of individuals) are downward.

Crlteria for inclusion: Occurrence on public lands (BLM); local endemic with rather specialized habiiat; observed threats, declining numbers; habitat loss.

Recommended status: At present, this species has no' special status. It should be considered a sensitive species by the Forest Service, BLM, and other land management agencies Federal and State of ID listing as Endangered is recommended for the reasons stated above. Comprehensive recent surveys of the lower Salmon, part of the Little Salmon, and Rapid River drainages for this and other land snail species were conducted by Frest & Johannes (1995a). Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is unlikely that many additional sites will be found.

References: Pilsbry (1939); Hanna & Smith (1939); Solem (1975); Deixis collections, 1988-1994.

Oreohelix junii Pilsbry, 1934 Grand Coulee mountainsnail

Type locality: Upper end of Blue Lake, Grand Coulee, Grant Co., WA; holotype ANSP 147014a.

Description: See Pilsbry (1934, 1939) for best description and illustration. Examination of the holotype (USNM 5441) of ***Oreohelix srrigosa srrigosa*** (Gould, 1843) by us in 1991 indicates that it is identical to this species, at least in shell features. The supposed type closely matches Gould's illustration, even to configuration of one damaged and repaired area. The features of the juvenile and immediate post-hatching whorls, relatively subdued striation on the adult whorls, and strongly depressed shape are all suggestive of ***Oreohelix junii*** and differ from the Spokane specimens used by 'Pilsbry (1939) as the basis for his definition of ***Oreohelix strigosa strigosa,*** not to mention the ID specimens ascribed to this taxon by Solem (1975) [for this material, ***see*** entry for ***Oreohelix*** n. sp. 25 below]. While this may necessitate name changes in various forms of ***Oreohelix,*** this particular entity remains unchanged in occurrence, as there is good reason to suspect that the type locality was in the Entiat, WA area (Smith, 1937). Searches of this area by Smith, and more recent and comprehensive searches by us, 1987-1993, indicate that there is only one species of ***Oreohelix*** living in the Entiat vicinity. "***Oreohelix srrigosa strigosa"*** citations from other locations than the distribution of ***junii*** cited above belong to other taxa. Pending completion and publication of our work on this species complex, it seems best to retain the basic classification and species names used by Pilsbry, which were almost always well conceived and described.

Ecology: A xerophile found mostly in basalt talus and outcrops, often associated with permanent springs and seeps, generally at lower elevations along major river valleys. Surrounding vegetation is sage scrub; talus plants include ***Clematis, Urtica, Rhus horribilis,*** scattered grasses, and ***Balsamorrhiza.*** Generally, colonies have only this species; occasionally ***Cryptomastix mullani olneyae*** or ***Allogona prychophora ptychophora*** are present also. The species is occasionally found sparingly in igneous taluses (granite or gneiss) as well.

Original distribution: Grand Coulee and a portion of the mainstem Columbia River from Wenatchee to Okanogan; Chelan, Okanogan, and Grant cos., WA. This or a closely related form is also found rarefy at a few sites in the Yakima drainage in the Ellensburg area, Kittiias Co., WA.

Current distribution: Still found in scattered colonies in portions of original area of occurrence. Some sites are on Wenatchee National Forest; Okanogan National Forest, and BLM property. Sites in the Grand Coulee area may also be on public property (Bureau of Reclamation).

Threats: Highway corridors are located preferentially in areas preferred by this species, e.g. WA 17, 151, US 97. Talus removal in this area has been extensive, both for roads and fill (ongoing) and dam

construction (mostly in the past) and is ongoing. Grazing has reduced most or all known sites; urban expansion in the Wenatchee area and range fires have also taken their toll in recent years; roadside spraying for weed control is also a problem at some sites. Diversion of springs for irrigation has also removed substantial areas of habitat. Extinct colonies are not uncommon; the species is declining, due primarily to human activities. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Local endemic; occurrence on public lands (BLM, Forest Service); ongoing threats: declining numbers and sites.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (WA) listing as Threatened is appropriate for the reasons just cited. The species' range has been surveyed previously (e.g. by J. B. Henderson), and more recently by us (see references below). It is unlikely that many additional sites will be found.

References: Pilsbry (1934, 1939); Henderson (1929, 1936b); Deixis collections, 1987-l 993.

Oreohelix n. sp. 1 Chelan mountainsnail

Type locality: None designated as yet; undescribed species.

Description: A medium-sized (to 18 mm diameter) species with up to 4 ½ whorls. The spire is moderately tall, somewhat as in *Oreohelix variabilis*. The typical two color bands are well developed; the shell surface is moderately evenly striate throughout, with periostracal lirations present on both surfaces to adulthood. The aperture is rounded, not thickened, and only slightly oblique; the parietal callus is very thin. Umbilicus moderate in size, about ¼ shell maximum diameter, deep.

This land snail may be most closely related to the Yakima mountainsnail (*Oreohelix* n. sp. 2; *q.v.*); but that species has an angular periphery; is larger, has a smaller umbilicus; and lacks periostracum-fringed lirations. This species was cited as *Oreohelix* n. sp. 1 in Frest & Johannes (1993c).

Ecology: This species is found associated with large-scale E.-facing schist talus in Douglas fir forest at a moderate elevation. Bryophytes, liverworts, and *Seligeria*, as well as *Physocarpus*, *Sorbus*, grasses, and *Heuchera* are frequent on the talus. Surrounding forest consists of mature to young *Pseudotsuga menziesii*, as well as a significant deciduous shrub and forb component. Associated large land snails include *Monadenia fidelis fidelis.* A mesophile.

Original distribution: A single site in Wenatchee National Forest, Twenty-five Mile Creek area, Chelan Co., WA. This same species was likely referred to by Smith (1937, p. 77) as follows: "Farther up the river, on the steep slope bordering the south side of Lake Chelan, a totally different race was collected." We were unable to locate these specimens in the CAS collections. This species probably occurs at other sites with similar phenology and physiography in Chelan and Okanogan cos., WA.

Current distribution: One site, as above. This appears to be a moderate elevation species, rather different in habitat than the lowland talus-dwelling *Oreohelix strigosa strigosa* and *Oreohelix junii* of this part of the Columbia Valley. The nearest relative is another undescribed species from Yakima Canyon. This species apparently does not occur in eastern WA.

Threats: Highway corridors are located preferentially in areas preferred by this species, e.g. South Lakeshore Road, US 97. Talus removal in this area has been extensive in the last 5 years, both for roads and fill (ongoing). Logging and grazing or both have occurred or are contemplated in most of the potential range. The only known site has been reduced by talus removal and road building. Major forest and range fires have occurred on the S. side of Lake Chelan, including the Twentyfive Mile Creek area, in 1993 and 1994. Habitat loss and reduction of talus at single known site indicate the species is declining.

Criteria for inclusion: Local endemic; occurrence on public lands; old growth associate.

Recommended status: Has none at present. Frest & Johannes (1993) suggested listing of this taxon. It should be considered a sensitive species by the Forest Service, BLM, and other land management agencies. The species should be State (WA) and Federal Endangered, for the reasons indicated above. It is unlikely that many additional sites will be found.

References: Frest & Johannes (1993c); Deixis Consultants, 1992.

Oreohelix n. sp. 2 Yakima mountainsnail

Type locality: None designated as yet; undescribed species.

Description: A medium-sized (to 20 mm diameter) species with a low, dome-shaped spire. Whorls 5-5 ½, rounded except for slight peripheral angulation that continues to the aperture. Surface rough, with poorly developed and sporadic spiral striation and strong, moderately regular, close-spaced growth lines that are equal on both surfaces. Shell moderately thick; aperture rounded, slightly reinforced, moderatefy oblique, deflected at termination only; lip slightly expanded along columellar margin. Color bands variable, often thin and multiple, interrupted or indistinct. Much of upper surface light purplish brown. umbilicus narrow, deep, elliptical, about 1/5 maximum shell diameter.

This species most closely resembles *Oreohelix variabilis*; however, the latter is taller, generally mottled purplish-brown, and has much more irregular and coarse growth lines. The slightly angular periphery of this species is also a distinguishing feature. For comparisons to the Chelan mountainsnarl, see above.

Ecology: A xerophile, closely associated with rather dry and open basalt taluses that have some perennial seepage or are near permanent springs; generally at talus base only. Surrounding vegetation (if natural) is sage scrub; commonly associated plants are *Clematis, Rhus horribilis, Urtica, Celtus, Sambucus,* and grasses. The species avoids perpetually wet portions of taluses. Associated brger land snails include *Cryptomastix mullani olneyae.*

Original distribution: Along the Yakima River and major tributaries in part of Yakima Canyon (central section only) and two adjacent major creek drainages, Kiiitas Co., WA. Some sites are in Wenatchee National Forest; Yakima Canyon sites are partly on BLM lands.

Current distribution: Local colonies in the area cited above.

Threats: Talus removal and modification for roads (especially WA 821); grazing of most of Yakima Canyon and adjacent canyons; range fires; roadside spraying for weed control. Most taluses in this area, even if they appear suitable, lack the species or now have only long-dead shells. The species is declining, mostly due to human modification of its habitat, and is very rare at almost all sites.

Criteria for inclusion: Local endemic; occurrence on public lands; declining populations and habitat loss. Population trends (number of sites, number of individuals) are downward.

Recommended status: At present, this species has no special status. It should be considered a sensitive species by the Forest Service, BLM, and other land management agencies. We believe that Federal and State (WA) listing as Endangered is appropriate, for the reasons cited above. This area has been previously examined for land snails (notably by J. B. Henderson) and we have conducted more recent searches. This species was not found in a recent survey of the nearby Hanford Reservation (Frest & Johannes, 1993b). It is unlikely that many additional sites will be found.

References: Deixis collections, 1988-l 993.

Oreohelix n. sp. 3 Bearmouth mountainsnail

Type locality: None designated as yet: undescribed taxon.

Description: Medium-sized *Oreohelix* with up to 5 ¼ whorls (diameter to 18 mm). Affinities of this taxon *are* to the ***yavapai mariae*** complex, and more specifically to ***Oreohelix carinifera.*** That species is much smaller; more strongly carinate; has a proportionately larger umbilicus; and lacks interrupted lirae on the base. There is some possibility that the "lost" taxon ***Oreohelix haydeni bruneri*** (*q.v.*) is the Bearmouth mountainsnail; but that form may be unrecognizable due to lack of a type series.

Ecology: This species occurs at bw elevations at the base of rather open and dry basalt and limestone taluses, generally S.-facing. Associated plants are mostly grasses and ***Clematis,*** with occasional ***Populus*** and ***Celrus*** stands locally. The species generally occurs in small monospecific colonies with very limited areal extent. A strong xerophile.

Original distribution: Clark Fork River valley in the area between Clinton and Garrison, Granite and Powell cos., MT.

Current distribution: Survives in a few very small colonies in the Bearmouth area. Occurrence of this species in portions of Lolo National Forest or in nearby State of Montana lands is quite possible.

Threats: Removal of talus for fill and road construction. Some colonies collected by R. B. Brunson in the 1940-l 960s are no longer extant, and construction and maintenance of I-90 & US 12 and associated frontage roads has impacted sites. Other threats include grazing, which is pandemic in the area occupied, and roadside spraying. The species is declining, both in number of sites and absolute numbers, due primarily to human activities.

Criteria for inclusion: Local endemic; habitat loss and continuing threats; possible occurrence on public lands.

Recommended status: Federal and State (MT) listing as Endangered is appropriate, in our opinion. The area of occurrence was collected heavily by R. B, Brunson from the 1940s through the 1960s; we have recently begun resurvey of the same region. It is unlikely that many additional sites will be found, or that the geographic range will be extensively increased.

References: Deixis collections, 1989. 1991.

Oreohelix n. sp. 4 Drummond mountainsnail

Type locality: None selected as yet; undescribed taxon.

Description: Shell small, depressed, slowly expanding, 5 ½ whorls; convex, but with slight peripheral keel; suture deeply impressed; small, diameter to 11 mm. Aperture moderately oblique, circular; periphery incomplete across parietal wall. Umbilicus shallow, about ¼ maximum diameter. Color bands narrow; upper 1/3 of whorl surface light brown. Shell with moderately strong and sparse transverse ribs on upper surface, much as in ***Oreohelix waltoni***. This small species is a member of the ***Oreohelix yavapai mariae*** complex with shell features somewhat similar to the anatomically dissimilar ID species ***Oreohelix waltoni (9.v.).***

Ecology: Limestone outcrops and talus, south-facing; associated plants include ***Populus*** and grasses; base of outcrop only; low elevations. The snails are found in rather moist *Populus* litter and may prefer less xeric sites than other species that occur in the vicinity. The known colony and the extinct site appear monospecific as far as larger taxa are concerned. One extinct site was on a dry, open, S.-facing Jurassic outcrop. The species appears to occur only at lower elevations, ***i.e.*** near slope bases, along a major river corridor.

Original distribution: This taxon may once have been common along the Clark Fork River valley between Clinton and Garrison, Granite and Powell cos., MT.

Current distribution: Limited to a single small remnant site less than 6' long along a road cut near the site of Nimrod. An additional colony in this area near the site of Nimrod collected some time ago by R. B. Brunson and another E. of Bearmouth collected by L. H. Russell appear to be extirpated. Colonies in nearby portions of Lolo National Forest, or on BLM or State of Montana lands, are possible; at least one of the former sites appears to have been on BLM lands, and undiscovered sites could remain.

Threats: Road building and maintenance; roadside spraying; grazing, which is extensive in the area; logging. The species is declining due to human activities in its very limited geographic range. Preferred habitat appears to be in areas particularly likely to be utilized for roads or for human habitation.

Criteria for inclusion: Extremely rare and local endemic; site and habitat loss: possible occurrence on public lands. Population trends (number of sites, number of individuals) are downward.

Recommended status: Federal and MT listing as Endangered, due to limited range, ongoing threats, and declining populations. The area of occurrence was collected extensively from the 1940s through the 1960s; we have recently begun resurveying of the same area. It is very unlikely that either many additional sites will be found, or that the geographic range will be considerably expanded by future finds.

References: Deixis collections, 1991, 1993; R. B. Brunson ***(pers. comm., 1993).***

Oreohelix n. sp. 5 Brunson mountainsnail

Type locality: Will be designated when the species is formally described.

Description: Shell large for genus (to 30 mm); to 5 ½ whorls: spire depressed, very bw subturbinate, depressed. Whorls convex, evenly rounded periphery; aperture slightly expanded, moderately oblique, slightly deflected, oval. Umbilicus deep, expands to ca ¼ shell diameter in last whorl. Upper and lower bands well-developed, narrow; 'shell irregularly brown above upper band; lower surface white. Shell surface with strong growth lines above, weak below periphery; minor or no spiral striation. Sutures moderately impressed; juvenile with peripheral keel, smooth surface.

This species superficially resembles northern states forms sometimes referred to ***Oreohelix strigosa depressa,*** a species with a Colorado type locality; however, juvenile sculpture, impressed sutures, and anatomy indicate relationship of Montana specimens [only] to ***Oreohelix amariradix.***

Ecology: This species is usually found in small numbers in rather dry, partly open, rocky areas with sparse *Pinus ponderosa* forest. ***One*** site has limestone substrate; but occurrence on other lithologies is probable. Sites are at low-moderate elevations. The species is moderately-weakly xerophilic.

Original distribution: Bitterroot Mountains, Sage Mountains; Gallatin Co.; Missoula Co., including sites in Lolo National Forest.

Current distribution: Known to survive at one site in the Bitterroot Mountains.

Threats: Areas with this species have been strongly negativefy affected in recent years by forest fires, road building, and logging. Population trends (number of sites, number of individuals) are likely downward.

Criteria for inclusion: Endemic taxon with spotty distribution; past and present threats to habitat.

Recommended status: Federal and State (MT) listing as Threatened is justified, due to site loss; occurrence on public lands; and limited distribution. R. B. Brunson has collected extensively in western MT from the 1940s through the 1960s, finding just the sites listed above. It is unlikely that many additional sites will be found.

References: R. B. Brunson (*pers. comm.*, 1993); Deixis collections, 1991.

Oreohelix n. sp. 6 Kintla Lake mountainsnail

Type locality: None designated as yet; undescribed taxon.

Description: Shell low, depressed subturbinate; juveniles with strong peripheral keel and strongly convex, smooth upper whorl with deeply impressed suture. Adults moderate in size, to 20 mm; typically with 5 ¼-5 ½ whorls. Aperture simple, rounded except for prominent peripheral keel, moderately oblique. Umbilicus prominent, deep; ¼-1/5 maximum shell diameter. Adult with strong peripheral keel; strong lirae above (l-3; generally 2) and below periphery (5-9; generally 6); strongly striate below; weakly striate above, with strong radial growth lines on upper whorl only.

This rather striking member of the haydenicomplex is notable as by far the most northern occurrence of the group. The resemblance to some Utah *haydeni* colonies is interesting; but this taxon consistently has strong radial ornament and only one or 2 lirae above.

Ecology: Uncertain. The Rattler Gulch site is a dry, rocky hillside with common small rock exposures and small-scale sedimentary talus. Surrounding vegetation ranges from rather open to closed-canopy *Pinus ponderosa* forest; the site appears to be unusually open and grassy. This site suggests that the species is rather strongly xerophilic; but the Glacier National Park site needs characterization. Elevation ranges from low to moderate. This was the only large land snail found at both known colonies.

Original distribution: Two rather widely separated colonies; Rattler Gulch (mostly BLM lands), Garnet Range, Granite Co., MT; and near Upper Kintla Lake, Glacier National Park, Flathead Co., MT.

Current distribution: Uncertain. Some sites in Rattler Gulch were tried unsuccessfully in 1994; the Upper Kintla Lake site has not been revisited in recent years.

Threats: Heavy grazing and logging in Rattler Gulch; road construction and talus mining.

Criteria for inclusion: Very local endemic; continuing and past habitat losses and modifications in part of range. Population trends (number of sites, number of individuals) are likely downward.

Recommended status: This species has no special status at present; obviously, it should be considered sensitive by state and federal (e.g., BLM) land and wildlife managers. We recommend Federal and State (MT) listing as Endangered: the Glacier National Park site may be secure, but needs rechecking. The only other known site may be extirpated. R. B. Brunson has collected land snails extensively in western MT from the 1940s through the 1960s without finding sites additional to those listed above. It is unlikely that many additional sites will be found.

References: R. B. Brunson (*pers. comm.*, 1993); Deixis collections, 1991-1994.

Oreohelix n. sp. 7 Kitchen Creek mountainsnail

Type locality: None designated as yet; undescribed taxon.

Description: A moderate-sized species (to 30 mm; average 22 mm diameter) with .much-depressed whorls; slight peripheral angulation on body whorl; 4 ½-5 whorls on adults. Aperture strongly oblique; parietal callus incomplete; umbilicus large, to 1/3 diameter; shell silky; fine growth lines on both surfaces. Color bands warm brown: lower distinct; upper 1/3 of whorl uneven light brown.

This taxon is a member of the *jugalis* species group. It most closely resembles the WA *Oreohelix junii*, from which it diiers in its smaller size, absence of striae on adult whorls, flatter spire, and color. The apertural features are distinct from those of Idaho *jugalis*, from which it also differs in its flatter spire, color, and microsculpture.

Ecology: Found in rather open and-dry Ponderosa pine forest on steep slopes, sometimes S.-facing, in thin rocky talus (probably Jurassic in age); also in similar situations near the Bitterroot River. Known sites are near slope bases, along major river corridors. A moderate xerophile.

Original distribution: A few colonies in and around Kitchen Gulch, John Long Mountains, Lolo National Forest, Granite Co., and near Corvallis, Ravalli Co., MT.

Current distribution: Known to survive at one site, recollected in 1994, near the mouth of Kitchen Gulch. Comparison with past collections from this site indicate recent steep decline in numbers. Could occur at other sites in adjoining portions of Lolo National Forest and Bitterroot National Forest.

Threats: Adjoining Forest Service road and public highways; mining; grazing; nearby private inholding; logging. As with many *Oreohelix* species, areas of colony occurrence tend to be near slope bases but just out of, or at the edge of, adjoining floodplains, exactly the preferred location for roads and other human modifications.

Criteria for inclusion: Local endemic; ongoing modification by road-building and logging in immediate vicinity; past and present mining activities in area. Population trends (number of sites, number of individuals) appear to be downward.

Recommended status: Currently, this species has no special status. Minimally, it should be considered sensitive by state and federal (e.g., BLM) land and wildlife managers. We recommend Federal and State (MT) listing as Endangered, due to endemicity, ongoing threats, and declining populations. R. B. Brunson conducted extensive surveys for this and other land snail species in western MT from the 1940s through the 1960s. It is unlikely that many additional sites will be found.

References: R. B. Brunson (*pers. comm.*, 1992); Deixis collections, 1994.

Oreohelix n. sp. 8 Squaw Creek mountainsnail

Type locality: None at present; undescribed taxon.

Description: Medium-sized (to 14 mm) species with up to 5 whorls. Shell biconvex; upper surface almost flat; color greenish-yellow. Strong peripheral keel with periostracal fringe; other less pronounced periistracal wreaths on low lirae developed on tower surface only; upper with about 7-9 fine, closely spaced lirae; lower with 4-6 rather widely spaced fringed lirae. Growth lines strong on both surfaces; sutures barely impressed. Color bands absent. Umbilicus deep, wide, about 40% of shell diameter.

This species is a member of the *haydeni* complex. It does not closely resemble any other Salmon River taxon. Among known forms, it is closest in shell characters to two species. The Lava Springs mountainsnail (9.v.) of SE ID is similar in color but that taxon has a larger shell, with flatter dorsal surface; fewer lirae, especially on the upper surface; and much less prominent periistracal fringes. ***Oreohelix barbata*** Pilsbry, 1905 has similar cuticular wreaths, but the bearded mountainsnail is brown, less broadly umbilicate, less depressed, and has a strongly oblique aperture. Internal anatomy of the Arizona-New Mexico *Oreohelix barbata* is similar in many respects to that of *Radiocentrum* species (Pilsbry, 1939), while that of this taxon is similar to members of the *Oreohelix haydeni* species group (which does not occur in Arizona or New Mexico).

Ecology: Found in dry, open, small to large-scale basalt talus, generally west-facing, generally near the talus base only, at moderate elevations; a moderate-strong xerophile. Associated plants include common *Sorbus* and grasses, less common *Balsamorhiza*, *Celtus*, and *Artemisia*. A small bryophyte component is sometimes present also. Most often, this is the only large land snail found. At one site rare dead *Cryptomastix mullani* (subsp. uncertain) were also noted. E.-facing and lower, more moist taluses in the same drainage lacked this species. A moderately xerophile species.

Original distribution: Probably confined to a portion of the Little Salmon River drainage, Idaho Co., ID.

Current distribution: Confined to a few small colonies along Squaw Creek. Most basalt taluses in the area lack the species or have only long-dead shells; the species is rare at known sites, and evidently declining.

Threats: Talus mining; road construction and maintenance (FS 517); grazing is heavy in the area despite the prevalence of moderately steep and poorly vegetated talus. Heavily disturbed and shallow taluses lacked liie specimens, although long-dead shells indicated former occurrence in some areas.

Criteria for inclusion: Very focal endemic; habitat loss and continuing threats; occurrence on public lands (BLM and Nez Perce National Forest; see Frest & Johannes, 1995a for details). Comprehensive recent surveys of the lower Salmon and part of the Little Salmon and Rapid River drainages for this and other land snail species were conducted by Frest & Johannes (1995a). Many other mabwlogists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. Population trends (number of sites, number of individuals) are downward. It is very unlikely that many additional sites will be found.

Recommended status: This species has no special status at present; it definitely should be considered sensitive by state and federal (e.g., BLM) land and wildlife managers. We suggest Federal and State (ID) listing as Endangered, due to current rarity, habitat loss, and continuing threats.

References: Deixis collections, 1993-l 994.

Oreohelix n. sp. 9 Bluebird Canyon mountainsnail

Type locality: Yet to be designated; undescribed taxon.

Description: Shell small for genus; thin to moderately thick, to 11 mm diameter; adults with 5 ½ whorls; whorls convex, sutures deeply impressed; spire low and broadly conical. Color bands very faint; transverse ribs white, interspaces light purplish brown. Whorls with strong, somewhat irregularly spaced transverse lirae, equal on both shell surfaces. Umbilicus deep, well-like, about 1/8 maximum shell diameter. Final ¼ whorl often weakly-strongly deflected; not reinforced.

A small species of *Oreohelix* related to the Utah Wasatch Range *Oreohelix peripherica* group. The ID taxon is distinguished from the UT members of the group by it smaller size, bandless shell with a unique mottled color pattern, and details of the microsculpture and anatomy.

Ecology: The live occurrence is in an E.-facing shallow limestone talus (live at talus base only). The site is open and grassy, and rather dry; this species is a moderate xerophile. Surrounding vegetation includes *Celrus, Physocarpus*, and *Prunus*; nearby areas with *Celtus*, *Artemisia,* and *Balsamorrhiza* are much more typical.

Original distribution: Known live only from a portion of a single talus in Bluebird Canyon; Lost River Range, Challis National Forest, Custer Co., ID. Nearby sites in the Pass Creek drainage and elsewhere in the Lost River Range do not have this species.

Current distribution: See above. Occurrence at other sites in Challis National Forest, e.g. in Butte Co., is possible, although it is unlikely that many additional sites will be found.

Threats: Grazing; road-building; portions of this talus have been leveled and removed, presumably for a pulloff and picnic area. The snail now occurs live only in a portion of the remaining talus and is absent from nearby similar-appearing habitat. Other Idaho Great Basin limestone ranges have been extensively mined for phosphate. Population trends (number of sites, number of individuals) are believed to be downward.

Criteria for inclusion: Local endemic; limited range; grazing and road building at only known site; occurrence on public lands.

Recommended status: None as yet, either federally or in ID; requires more detailed surveying. The species should be regarded as sensitive by federal (Forest Service) land and wildlife managers. There is a good possibility that this taxon is a narrow endemic which will be found to require protection.

References: Deixis collections, 1991 & 1993.

Oreohelix n. sp. 10 Missoula mountainsnail

Type locality: None designated as yet; undescribed species.

Description: Shell high turbinate, diameter to 18 mm, 5-5 ½ rather close whorls, moderately thin, often reddish-brown except for two narrow whitish bands near periphery; sutures slightly impressed. Surface with numerous very fine, somewhat irregular growth lines; spiral striation generally completely absent. Periphery weakly keeled, with angulation diminishing in last ¼ whorl; aperture rounded, complete but thin across parietal wall, somewhat thickened except parietally, slightly expanded, especially in wlumellar area, strongly oblique, descending in last 1/16 whorl. Umbilicus deep, narrow, less than 1/5 maximum shell diameter.

This medium-sized species is a member of the *Oreohelix strigosa* complex. It is characterized by its relatively slow rate of whorl expansion, thin and domed-shaped shell, and non-striate surface. The ID Stites mountainsnail *(Oreohelix* n. sp. 25; *q.v.*) is closest in general appearance; but shell color, thickness, and striation readily differentiate the two.

Ecology: Occurs at low-medium elevations in somewhat dry *Pinus ponderosa* forest, often in small rock taluses or bedrock exposures. This species is somewhat intermediate in its moisture preferences, preferring neither strongly xeric or mesic sites.

Original distribution: Low-moderate elevations, Missoula and Granite cos., MT. Specific areas include Mt. Jumbo and Mt. Sentinel.

Current distribution: Still likely survives at some sites in the original area of occurrence. Some old sites are no longer collectable (R. B. Brunson, *pers. comm.*, 1993). The species is definitely declining, both in range and in absolute numbers.

Threats: Road building and maintenance; logging; grazing; urban expansion in the Missoula area and elsewhere in Granite and Missoula ws., MT.

Criteria for inclusion: Local endemic; increasing threats; habitat and historic site loss. R. B. Brunson has collected extensively in western MT for this and other species from the 1940s through the 1960s. It is unlikely that many additional sites will be found.

Recommended status: At present, this species has no special status. In our opinion, it should be considered sensitive by state and federal land and wildlife managers. We believe that Federal and State (MT) listing as Threatened may be appropriate.

References: R. B. Brunson (*pers. comm.*, 1993): Deixis collections, 1991, 1993.

Oreohelix n. sp. 11 subcarinate mountainsnail

Type locality: Has yet to be designated; undescribed taxon.

Description: Shell large for genus (diameter to 26 mm); subturbinate (generally) to depressed; generally 4½-5 whorls. Whorls convex to slightly flattened, sutures slightly-moderately impressed. Surface rough, with fine but sharp growth lines above, smoother below. peripheral keel moderately strong on last 3/4 whorl, often accentuated at aperture. Aperture with expanded and slightly reinforced lip, broadly oval and oblique, over half maximum diameter of shell. Lower band prominent; upper generally absent. Upper half of whorl generally irregularly dirty brown.

A large member of the *strigosa* complex, unique in that the last 3/4 whorl is carinate while preceding whorls (excepting the neantic and immediate postneantic, inevitably keeled in *Oreohelix) are* well rounded.

Ecology: Occurs in pure colonies in fairly moist and floristically diverse relatively intact *Pinus ponderosa* forests, in stream valleys at moderate elevation (3,700-3,900'). Moist valley, ravine, gorge, or talus sites are preferred, *i.e.* bw on a slope and near permanent or persistent water, but not normally subject to regular orcatastrophic flooding. Persistence of moisture is a *desideratum.* A moderate mesophile.

Original distribution: Known from perhaps three sites in Mission Canyon, Mission Range, Mission Mountains Tribal Wilderness, Lake Co., MT.

Current distribution: Likely survives in one or two of the historic sites. Could also occur in adjoining portions of Flathead National Forest.

Threats: Extensive recent logging in much of known habitat area in Mission Range. Population trends (number of sites, number of individuals) are believed to be downward.

Criteria for inclusion: Local endemic; past and ongoing threats; possible occurrence on public lands. R. B. Brunson has collected extensively in western MT for this and other species from the 1940s through the 1960s without locating additional sites. It is unlikely that many additional sites will be found.

Recommended status: This species has no special status at present; it should be regarded as sensitive by state, federal (e.g., Forest Service), and other land and wildlife managers. We recommend Federal and State (MT) listing as Endangered, due to its apparently limited area of occurrence, ongoing threats throughout its range, and other factors mentioned above.

References: R. B. Brunson (*pers. comm.*, 1993).

Oreohelix n. sp. 12 hackberry mountainsnail

Type locality: To be designated when species is described.

Description: Shell large for genus, to 22 mm at 5 ½ whorls (maximum adult size). Spire bw conical, with somewhat convex whorls, weak peripheral keel, and slightly impressed sutures. Keel continues to aperture; aperture thin, not deflected; strongly oblique, rounded except on parietal wall; parietal callus thin. Umbilicus moderately deep, elliptical, ¼-1/5 maximum shell diameter. Shell with large, low, slightly irregular transverse ribs, more or less evenly spaced. Ribs slightly stronger above shell periphery. Spiral striation absent. Color bands generally 2; thin; about equal above and below periphery; upper surface sometimes light brown; both surfaces occasionally with additional very thin color bands.

A large member of the ***Oreohelix intersum*** group, characterized by a large, rather high spire; large umbilicus; ribbing more distinct on upper surface.

Ecology: This strong xerophile lives on relatively open mixed alluvial and limestone talus slopes. All are dry and poorly vegetated (largely open), with grasses and Celtus the most wmmon species. Colonies are almost monospecific, with occasional individuals of ***Allogona ptychophora ptychophora*** the only other large land snail.

Original distribution: Probably confined to a portion of the lower Rapid River valley, Liile Salmon River drainage, Idaho Co., Idaho, E. side of the Seven Devils Mountains, and absent from high elevations and moist lowland situations.

Current distribution: Known live from about three colonies in the lower Rapid River drainage. One or more appear to be on Nez Perce National Forest lands.

Threats: The whole known range is heavily grazed, and colonies appear to be confined to fortuitously protected areas. Dead shells indicate former much more widespread occurrence. Colonies are on or near horse/foot trails into Rapid River back country; the slope with surviving sites has been sapped, possibly to provide material for an adjacent Idaho Power fish hatchery.

Criteria for inclusion: Very local endemic; impacts on all known sites. Population trends (number of sites, number of individuals) are downward.

Recommended status: To date, this species has no special status. We believe that it should minimally be regarded as sensitive by state, federal (e.g., Forest Service), and other land and wildlife managers as appropriate. We suggest Federal and State (ID) listing as Endangered, due to the limited area of occurrence, ongoing threats, reduced number and size of sites, and other threats discussed previously. Comprehensive recent surveys of the lower Salmon and part of the Little Salmon and Rapid River drainages for this and other land snail species were conducted by Frest & Johannes (1995a). Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is unlikely that many additional sites will be found.

References: Frest & Johannes (1995a); Deixis collections, 1990-l 994.

Oreohelix n. sp. 13 Rapid River mountainsnail

Type locality: To be designated when the species is described.

Description: Shell in mid range for genus; diameter at 5-5 ½ whorls (maximum adult size) about 16 mm. Spire low, sutures moderately impressed; surface with' coarse, broad, rather widely-spaced, and somewhat irregular ribs, equal on both shell surfaces. Color bands generally thin, equal; secondary thin

bands sometimes present on both surfaces; upper whorls light brown except for ribs. Umbilicus rather deep, abrupt, somewhat well-like, about ¼-1/3 full shell diameter. Periphery distinctly angulate; angulation continues to aperture; aperture very strongly oblique.

A medium-sized member of the *Oreohelix intersum* group, characterized by a rather low spire: large umbilicus: distinct coarse ribbing on both surfaces. the nearest relative is ***Oreohelix*** n. sp. 12; aside from just-noted differences, the proportionately wider and less well-like umbilicus (lower whorls more evenly rounded) are distinctive.

Ecology: This strong xerophile lives on relatively open mixed alluvial and limestone talus slopes. All are dry and poorly vegetated (largely open), with grasses and Celtus the most common species. Colonies are almost monospecific, with occasional individuals of ***Allogona ptychophora ptychophora*** the only other large land snail.

Original distribution: Probably confined to a portion of the lower Rapid River valley, Liile Salmon River drainage, Idaho Co., Idaho, E. side of the Seven Devils Mountains, and absent from high elevations and moist lowland situations.

Current distribution: Known live from about three colonies in the lower Rapid River drainage. One or more appear to be on Nez Perce National Forest lands.

Threats: The whole known range is heavily grazed, and colonies appear to be confined to fortuitously protected areas. Dead shells indicate former much more widespread occurrence. Colonies are on or near horse and foot trails into Rapid River back country; the slope with surviving sites has been sapped, possibly to provide material for the adjacent Idaho Power fish hatchery.

Criteria for inclusion: Very local endemic; impacts on all known sites. Population trends (number of sites, number of individuals) are downward.

Recommended status: This species has no special status at present. It should be regarded as sensitive by state, federal (e.g., Forest Service), or other land and wildlife Managers. We recommend Federal and State (ID) listing as Endangered, due to the limited area of occurrence, known and predictable future impacts to all known sites, and other reasons cited above. Comprehensive recent surveys of the lower Salmon River and part of the Little Salmon R. and Rapid R. drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and W. Walton. It is unlikely that many additional sites will be found.

References: Frest & Johannes (1995a); Deixis collections, 1990-l 994.

Oreohelix n. sp. 14 limestone mountainsnail

Type locality: To be designated when species is described.

Description: Shell small-medium sized; maximum diameter at adulthood (5 ½ whorls) about 13 mm; comparatively thin except for slightly thickened aperture. Spire very low, almost discoidal; whorls slightly convex; sutures deeply impressed: pronounced peripheral keel. Transverse ribs pronounced, widely spaced, cord-like, more or less regular; equal on both shell surfaces. Lower surface more convex; almost with basal angulation; umbilicus elliptical, well-like even though shallow and broad, about 1/3 shell diameter. Color bands faint-absent; shell ranges from slightly brownish to off-white. with transverse ribs often slightly lighter in color than interspaces. Aperture oblique, almost trapezoidal, sometimes barely adnate.

This very striking species is a small member of the *Oreohelix intersum* group. Distinctive features are the low, almost discoidal shell; relatively prominent ribbing, strong peripheral keel, small size; and large

umbilicus. *Oreohelix hammeri*, the only local snail with at all similar features, is much larger, has fewer, very large and bw radial ribs; and a much smaller umbilicus.

Ecology: A strong xerophile living on relatively open limestone outcrops and talus slopes. Sites are dry and poorly vegetated (largely open), with grasses, *Celtus, and Balsamorrhiza* the most common species. Colonies typically have occasional individuals of *Allogona ptychophora ptychophora, Oreohelix* n. sp. 13 (Rapid River mountainsnail), and *Cryptomastix* spp.

Original distribution: Probably confined to a portion of the lower Rapid River valley, Liile Salmon River drainage, Idaho Co., Idaho, E. side of the Seven Devils Mountains, and absent from high elevations and moist lowland situations.

Current distribution: Known live from perhaps three nearby colonies in the lower Rapid River drainage. One or more appear to be on Nez Perce National Forest lands.

Threats: The whole known range is heavily grazed, and colonies appear to be confined to fortuitously protected areas. Dead shells indicate former, much more widespread occurrence. Colonies are on or near horse/foot trails into Rapid River back country. Live individuals are rare at all sites, one of which is a rockpile only a few feet in width.

Criteria for inclusion: Very local endemic; impacts on all known sites. Population trends (number of sites, number of individuals) are downward.

Recommended status: Currently, this species has no special status. Minimally, it should be regarded as sensitive by federal (e.g., Forest Service) or other land and wildlife managers. Federal and State (ID) listing as Endangered is needed, in our opinion, due to the limited area of occurrence, ongoing threats to existing populations, and other factors discussed above. Comprehensive recent surveys of the lower Salmon River and part of the Little Salmon River and Rapid River drainages for this and other land snail species were conducted by Frest & Johannes (1995a). Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and W. Walton. It is unlikely that many additional sites will be found.

References: Frest & Johannes (1995a); Deixis collections, 1988-l 994.

Oreohelix n. sp. 15 speckled mountainsnail

Type locality: Will be designated when the species is formally described.

Description: A medium-large species, reaching a maximum diameter of 23 mm at 4 ½-5 whorls. Spire depressed, sutures slightly impressed; weak peripheral keel visible in side view but aperture well-rounded. Shell comparatively thin; aperture not thickened parietal callus very thin; aperture not jugate. Color bands weakly developed; subperipheral very thin; supraperipheral band wider; upper whorl with light pinkish brown background color and well-developed irregular small white spots and blotches, roughly paralleling growth lines; growth lines slightly raised into irregular, thin but distinct transverse nbs; ribs generally streaked with white. Lower shell surface white; both surfaces with moderately well-developed striae, slightly stronger on upper surface. Umbilicus shallow, well-rounded; small, diameter about 1/5 maximum shell width.

A member of the *jugalis* species group, differing from its better-known Idaho congener in size, shell color; apertural morphology; and relative umbilicus size.

Ecology: This *Oreohelix* is a comparative mesophile, occurring in steep mixed schist/ or conglomerate/alluvial slopes and taluses. Sites are generally N.-facing; may be perennially moist due to seeps or springs; and are mostly at comparatively bw elevations. Partly open *Pinus ponderosa* forest, with common small deciduous trees and extensive moss and *grass* cover, is a *desideratum* for this

species. It is absent from relatively dry sites, even when the canopy is comparatively extensive. The most frequent large land snails found with this taxon *are Cryptomastix mullani clappi* and *Allogona ptychophora ptychophora.* Small land snails, such *as Vitrina limpida*, *Discus whitneyi,* and *Helicodiscus salmoneus*, are frequent also. See Frest & Johannes (1995a) for site faunal lists and more details.

Original distribution: This species likely once was widespread in a limited portion of the River of No Return valley, from Riggins to French Creek Bridge, Idaho Co., ID.

Current distribution: Survives at a few scattered colonies within the limits of its original range, mostly on the S. side of the River of No Return, within the limited stretch indicated above. The species is rare live at all sites, and common finds of long-dead shells suggest a former, much more extensive population much reduced in recent years. Some known sites are on BLM and Payette National Forest sites. Additional sites on the N. side of the River of No Return (Nez Perce National Forest and BLM public lands) are possible.

Threats: The French Creek Road has had major impact on al existing sites. Occasional long-dead shells can be found in the road berms for a distance of several miles; but live colonies are very limited in area. Much of the area above the road has been heavily grazed, and snails generally survive only in the steepest and most unstable slope areas.

Criteria for inclusion: Local endemic; impacts to known sites; reduction in range and size of populations; occurrence on public lands. Population trends (number of sites, number of individuals) are downward.

Recommended status: Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and W. Walton. Older collections do not include specimens of this species. It is unlikely that many additional sites will be found. At present, this species has no special status; minimally, it should be regarded as sensitive by federal (e.g., Forest Service, BLM) or other land and wildlife managers. Federal and State (ID) listing as Endangered is needed, in our opinion, due to the limited area of occurrence, ongoing threats to existing populations, and other factors discussed above.

References: Frest & Johannes (1995a); Deixis collections, 1989-l 994.

Oreohelix n. sp. 16 rugose mountainsnail

Type locality: None designated as yet for this undescribed taxon.

Description: Large for genus (to 30 mm); adults.5 ½-6 whorls. Shell biconvex in side view, nearly flat on upper surface; very strong and irregular peripheral keel and rib. Early whorls slowly expanding, strongly convex upper surface and deeply impressed suture, protrusive peripheral keel appearing shortly after nepionic whorls. Later whorls more rapidly expanding, with 6-12 sharp but small ribs (lirae) on both surfaces, commonly interrupted by prominent but irregular growth lines, giving shell rugose appearance overall. Aperture subtrapezoidal in shape; generally thin, not at al or just slightly deflected; complete but thin across parietal wall. Lower surface with prominent basal keel; umbilicus wide, 1/3-nearly ½ shell diameter. Striation (actually, narrow lirae) well-developed on both surfaces between major lirae; most prominent on base. Typical *Oreohelix* color bands generally not developed; whole shell except raised lirae and keel often light pinkish-brown in color.

This species is a member of the *haydeni* species group. The bw whorl profile, rugose surface, basal keel, and extremely prominent peripheral keel are distinctive. The shell shape recalls such distantly related taxa as the southwestern U. *S. Oreohelix metcalfi acutidiscus* but has no close Idaho parallels. The only other Snake-Salmon *Oreohelix* with a basal keel is *Oreohelix* n. sp. 17 [the bicarinate mountainsnail; *q. v.*], and this feature is rare in the genus generally.

Ecology: This species occurs on N.-facing, relatively dry and open steep slopes and shallow talus. The regolith is Triassic Martin Bridge Limestone; most of the area is grass-covered, but *Artemisia* and *Celtus* are focally common. The species generally occurs in scattered, sometimes rather dense monospecific colonies. A strongly xerophilic taxon; only dead shells were found in an area with an active, *Cornus stolonifera*-covered seep.

Original distribution: Probably widespread in the single creek drainage in which it now occurs. Dead specimens are common in many areas no longer occupied by live colonies, and the S.-facing side of the drainage also lacks live specimens, although semi-fossil material is widespread.

Current distribution: Found as scattered colonies on one side of a single drainage in the south part of Hells Canyon, entirely on Payette National Forest lands, Allison Creek, Adams Co., ID. This species may occur also on BLM lands at the mouth of the canyon.

Threats: Grazing is extensive in the range of this species, and the species is absent from heavily-grazed areas. Horse and walking trails also impact colonies, with dead shells [only] in such areas.

Criteria for inclusion: Very local endemic, confined to part of one drainage; reduction in numbers and area occupied: habitat damage; occurrence on public lands. Population trends (number of sites, number of individuals) are downward.

Recommended status: This very distinctive taxon has no status at present; minimally, it should be considered a sensitive species by BLM, Forest Service, and other land management and wildlife agencies. Federal and State (ID) listing as Endangered is recommended, due to limited range, specialized habitat, habitat loss. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). We have also done recent survey work in Hells Canyon. Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is unlikely that many additional sites will be found.

References: Deixis collections, 1990-l 992.

Oreohelix n. sp. 17 bicarinate mountainsnail

Type locality: Will be designated when the species is formally described.

Description: A medium-sized (to 25 mm) species, generally with 5 ½-6 whorls when adult. Shell biconvex, with strong, definitely protrusive peripheral keel and thick rib. Both surfaces with numerous equal fine lirae, interrupted by coarser growth lines, giving whole shell somewhat irregular outline and rugose appearance. Base with well-like umbilicus bordered by distinct basal carina; umbilicus width approximately 1/3 greatest shell diameter. Aperture generally thin, strongly oblique, subtrapezoidal in shape. Lower and upper peripheral bands generally distinct, wide, and dark brown; rest of shell light pinkish brown-white. Sutures on juvenile prominent, deeply impressed: adult whorls with only faint or obsolete sutures generally; some specimens with slightly disjunct later whorls; juveniles almost discoidal.

Anatomically, this species is a member of the *haydeni* complex. Shell characters agree with this assessment; but this species is unusual in two respects. The basal keel is seldom seen in adults in this genus (though universal in juveniles). Paedomotphosis occurs sporadically, however, throughout *Oreohelix.* The only other Idaho *Oreohelix* with a basal keel is *Oreohelix* n. sp. 16, which occurs nearby. However, that species has coarse transverse ribs, a strongly rugose surface, irregular and strongly protrusive peripheral keel and rib, no color bands, and bw discoidal conch shape. Superficially, this species also ***resembles Oreohelix strigosa goniogyra*** **(*q.v.*),** in that both may be similar in size, have apparently strongly but finely lirate shell sculpture, and a moderate peripheral keel. Internal anatomy does not indicate close relationship: moreover, basal and juvenile shell features differ considerably, and the apparent fine ribbing in *goniogyra* turns out to be very strong spiral striation (incised lines, rather than fine raised ridges).

Ecology: This species, a moderate to strong xerophile, is found in rather dry, S.-facing rock talus (slightly metamorphosed limy breccia and conglomerate). Common plants include *Rhus horribilis*, *grasses, Celtus*, *Amelanchier*, and composites; locally, *Cystopteris*, *Artemisia*, bryophytes, and *Seligeria* are common also. Land snail associates include *Allogona ptychophora ptychophora* and *Cryptomastix (Bupiogona)* n. sp. 2 [Kinney Creek Oregonian], as well as small taxa such as *Helicodiscus salmoneus.* Interestingly, this species does not occur in the moist riparian talus close to Kinney Creek proper, where it is replaced by another *Oreohelix* species.

Original distribution: Probably widespread along two creek valleys in the vicinity of Kinney Creek, S. Hells Canyon, Adams Co., ID, on BLM and Payette National Forest lands.

Current distribution: Limited to a few still-viable colonies along one side of Kinney Creek, S. Hells Canyon, on Payette National Forest and adjoining BLM lands.

Threats: This valley has been heavily grazed. Consequently, colonies are limited to larger talus piles and small protected areas on steep slopes not as heavily grazed. The species is declining in area and numbers, with live individuals rare and large areas of talus with old, long-dead specimens only. In the unnamed valley to the S. of Kinney Creek, only one small fortuitously-protected colony remains.

Criteria for inclusion: Very focal endemic; past mining activities; present and past grazing restricting snail to protected areas; occurrence on public lands. Population trends (number of sites, number of individuals) are downward.

Recommended status: This species has no status at present. Minimally, it should be considered a sensitive species by appropriate federal, state, and other land management and wildlife agencies, Federal and State (ID) listing as Endangered is suggested, due to limited range and number of sites, ongoing threats. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). We have also done recent survey work in Hells Canyon. Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and W. Walton. It is unlikely that many additional sites will be found.

References: Deixis collections, 1989-91.

Oreohelix n. sp. 18 Limestone Point mountainsnail

Type locality: None designated as yet; undescribed species.

Description: See Winslow (1920) for shell description. This species appears closely related to *Oreohelix idahoensis baileyi* and to *Oreohelix* n. sp. 20 (Sheep Gulch mountainsnail: *q.v.*). It differs from *baileyi* in that it is larger; more strongly turbiniform; has less convex whorls; and has a much narrower umbilicus. *Oreohelix* n. sp. 20 is much smaller; has much finer ribs; and has a still narrower umbilicus. This species has a distinct peripheral raised rib, as strong as, or stronger than, the radial ribs. In this feature it differs from *Oreohelix idahoensis baileyi*, *idahoensis idahoensis,* and *Oreohelix* n. sp. 20, all of whom have angular peripheries but much stronger radial ribs. *Oreohelix idahoensis idahoensis* has stronger radial ribs, a higher spire, and a proportionately much smaller umbilicus.

This form appears anatomically to be most closely similar to *Oreohelix idahoensis idahoensis,* based on Pilsbry (1934) dissections of specimens from Cottonwood Tree Creek [which he ascribed to *Oreohelix idahoensis baileyi*] and Pilsbry's (1939), Solem's (1975), and our own work on *idahoensis idahoensis.*

Ecology: A strong xerophile, found on scattered limestone outcrops and talus. Associated vegetation is mostly grasses and sage scrub, with local scattered *Artemisia*, *Amelanchier*, *Prunus*, *Physocarpus*, and *Celtus*. Occurrence on limestone in sparse *Pinus ponderosa* forest has also been noted. Generally

occurs alone or with *Cryptomastix populi*, *Oreohelix strigosa* subspp., and *Helicodiscus salmoneus.* This species may be a calciphile.

Original distribution: Known with certainty from 2 sites in the north end of Hells Canyon: Limestone Point, Nez Perce Co., ID; and Lime Hill, Asotin Co., WA. A third site is given as "Snake River Canyon, Idaho, eight miles below the mouth of the Salmon R." (Winslow, 1920). This would be in the vicinity of China Garden Creek, Craig Mountain, Nez Perce Co., ID. Another old site was "Cottonwood Tree Creek, S. of Lewiston", Nez Perce Co., ID. For discussion of this locality, see entry for *Cryptomastix populi.*

Current distribution: Known to survive at one site, Limestone Point. Probably restricted to a few sites within the original range in WA, ID, and possibly OR. The large colony at time Hill, Asotin Co., WA [confounded in Pilsbty (1939) with the ID Lime Point site, located on the opposite side of Hells Canyon).is now' apparently extinct, due primarily to heavy grazing. This colony stretched over more than half a mile laterally, and many thousands of dead shells attest to former abundance. We did not find sites for this species in the nearby lower Salmon River Canyon.

Threats: Heavy grazing in much of known area of occurrence; encroachment from nearby housing (Rogersburg, WA); range fires; limestone quarrying.

Criteria for inclusion: Local endemic; decline in number of sites; past and ongoing threats; potential occurrence on public lands. Population trends (number of sites, number of individuals) ate downward. Sites on Walbwa-Whitman National Forest; Nez Perce National Forest; BLM lands; and Hells Canyon National Recreation Area are possible.

Recommended status: This rather distinctive species has no status at present; minimally, it should be considered a sensitive species by appropriate federal, state, and other land management and wildlife agencies. We recommend Federal and State (ID, WA) listing as Endangered; the status of this taxon in OR is uncertain (no sites definitely survive). The species seems to be very local; and despite some protection anticipated for portions of its range, is unlikely to be completely secure, e.g. from grazing. Two old sites are on private lands. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). We have also done recent work in Hells Canyon. Many other malawlogists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and W. Walton. It is unlikely that many additional sites will be found.

References: Winslow (1920); Pilsbry (1939) [in part]; Deixis collections, 1989-l 990.

Oreohelix n. sp. 19 Shingle Creek mountainsnail

Type locality: Will be designated when the species is formally described.

Description: Shell small for genus; to 13 mm at 4 ½-5 whorls (adult size); spire bw conical: moderately impressed sutures; whorls convex; moderately distinct peripheral keel (but not a rib or pronounced); transverse ribs coarse, irregular, equally strong on both shell surfaces, Radial striation moderately developed on both sides. Color bands narrow but distinct, equal; small additional bands common on lower surface only: upper surface light reddish brown except for transverse ribs, which are generally white. Umbilicus moderately deep, somewhat well-like, about ¼ maximum shell width.

Anatomically, this species is a member of the *intersum* species group. The shell features somewhat 'recall those of *Oreohelix waltoni*; but the juvenile sculpture differs considerably, as does the anatomy. The color pattern rib spacing, and spire height of the two also consistently differ. This small *Oreohelix is* probably most closely related to *Oreohelix intersum;* but is much smaller; has a lower spire; coarser and more widely spaced transverse ribs; transverse ribs equally strongly developed on the base: and a proportionately larger and deeper umbilicus despite the lower spire. Known colonies are quite consistent in morphology.

Ecology: A comparative mesophile; found on rock (basalt) outcrops in shaded terrain at bw elevations. Vegetation is rather moist Ponderosa pine forest with a well-developed understory, with grasses, bryophytes, and forts diverse and common. Associated land snail species include Cryptomastix mullani ***mullani***, ***Allogona ptychophora ptychophora,*** and ***Discus whitneyi.***

Original distribution: Probably originally common in part of the Little Salmon River valley and major tributaries, Nez Perce National Forest, Idaho Co., ID.

Current distribution: Survives at 3 small colonies in Shingle Creek and on the lower Salmon River, Idaho Co., ID. One site is believed to be on Nez Perce National Forest and State of Idaho lands.

Threats: Much of the surrounding area has been cleared and is heavily grazed by sheep. Low-elevation forest is **now very rare** in the Liile Salmon and Lower Salmon drainages. Colonies have also been affected by road building (Rapid River Road). population trends, in terms of number of individuals and area occupied, are downward.

Criteria for inclusion: Local endemic, occurrence on public lands; past and ongoing threats.

Recommended status: This species has no special status at present. It shauld be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (ID) listing as Endangered is appropriate for the reasons just cited. Comprehensive recent surveys of the lower Salmon and parts of the Little Salmon and Rapid River drainages for this and other land snail species were conducted by Frest & Johannes (1995a). Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and W. Walton. It is unlikely that many additional sites will be found.

References: Frest & Johannes (1995a); Deixis collections, 1990-l 993.

Oreohelix n. sp. 20 Sheep Gulch mountainsnail

Type locality: Has yet to be designated; taxon is undescribed.

Description: Shell low tutbinate; whorls convex except for moderate peripheral angulation, rather narrow; 5-5 ½ whorls in adult; last ½ commonly strongly deflected, sometimes almost disjunct; sutures deeply impressed. Aperture periphery sometimes reinforced, especially across parietal margin; aperture oval, strongly oblique. Maximum diameter about 11 mm. Shell moderately-strongly ribbed, equally above and below; ribs somewhat irregular, spacing about half that of ***Oreohelix idahoensis idahoensis.*** Umbilicus well-like (periphery nearly angular), comparatively wide, about 1/4 maximum diameter. Shell unbanded; radial ribs whitish; interspaces brownish. Spiral striation weak as compared to ***Oreohelix idahoensis idahoensis.***

Shell shape and size in this taxon are somewhat similar to ***Oreohelix waltoni***; but ribbing in that species is much less prominent; there is a distinct pigment pattern not present here; and ***waltoni*** is more depressed and has a much wider umbilicus. Comparisons with ***Oreohelix idahoensis*** idahoensis, the only other equally (or more) strongly-ribbed Idaho species have been made above; additionally shell shape and proportionate umbilical width are markedly different than in that species. Anatomically, this species is a member of the ***idahoensis*** species group.

Ecology: A strong xerophile, found in comparatively open areas with scattered limestone outcrops and talus; more rarely on limy schists, Associated vegetation includes grasses and ***Artemisia***, with rare ***Celtus***, common Opuntia, scattered buckbean. A probable calciphile. Associated land snails include rare ***Allogona ptychophora ptychophora*** and small ***Cryptomastix*** spp. A medium-elevation species.

Original distribution: A small area (probably *ca.* 15 mi.^{2}) near the lower Salmon River NE, E., & SE of Lucile. Colonies of this taxon generally occur at slightly higher elevations than nearby ***Oreohelix***

idahoensis idahoensis and ***Oreohelix haydeni perplexa.*** An old site which we have not recollected occurs on Nez Perce National Forest lands.

Current distribution: Found only in small areas of the original range well protected from grazing. Occurrence on State of Idaho lands, Nez Perce National Forest, and BLM lands is quite possible.

Threats: The whole range of this taxon is currently heavily grazed, and the snails survive only in areas too rocky to be completely grazed out. This area also has scattered mines and prospects, and has been utilized for quarries and gravel pits also.

Criteria for inclusion: Local endemic; loss of habitat and range; ongoing threats. Population trends (number of sites, number of individuals) are downward.

Recommended status: Thii species has no status at present. Minimally, it should be considered a sensitive species'by appropriate federal, state, and other land management and wildlife agencies. Federal and State (ID) listing as Endangered should be undertaken, due to limited range and habitat loss. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other malacologists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is not likely that later work will greatly expand the range or result in location of substantial numbers of additional sites.

References: Pilsbty (1939); Frest & Johannes (1995a); Deixis collections, 1988-l 994.

Oreohelix n. sp. 21 Box Canyon mountainsnail

Type locality: To be designated when the species is described formally.

Description: Shell small-medium in size (maximum at 4 ½-5 whorls 18 mm; some populations much smaller): low, depressed spire; whorls moderately convex; upper whorl surface often slightly stepped; moderately strong peripheral keel; sutures weakly impressed. Spiral striation strongly and consistently developed; growth lines distinct, regular, slightly raised, and fine on upper surface: lower surface much smoother. Lower color band thin but consistently present; upper band diffuse, sometimes not discernible; upper whorl often light brown; narrow white band on periphery. Aperture strongly oblique; often slightly deflected in last 1/8 whorl; commonly jugate; thickened; slightly flared all around except for parietal wall. Umbilicus moderately deep, round, with broadly rounded border; diameter about 1/3-¼ maximum shell diameter.

This species somewhat resembles a miniature *Oreohelix* n. sp. 23 (Lucile mountainsnail). However, it differs from that species in its smaller size, lack of a basal brown patch, angulate periphery, and prominent spiral striation, easily visible to the unaided eye. It was present in old collections (dating to Henry Hemphill) in very small numbers, either unidentified or confounded with *Oreohelix jugalis*. Anatomy has not been completely worked out: but it appears to be related to the "*strigosa*" species group, rather than to the *jugalis* group. The closest Idaho relative would be *Oreohelix* n. sp. 23.

Ecology: This species is found on metasedimentary outcrops and thin talus, generally at low elevations. A strong xerophile, it occurs in relatively open terrain, most often with grasses, *Celtus*, Opuntia, and local bryophytes and the common plant associates. Land snails which co-occur include *Allogona ptychophora ptychophora, Cryptomastix harfordiana*, and *Helicodiscus salmoneus*; at one *site, Vallonia cyclophorella, Pupil/a hebes, Cochlicopa lubrica*, and *Oreohelix waltoni* are close associates.

Original distribution: Probably relatively ubiquitous in the lower portions of a few ravines in the Box Canyon area, lower Salmon River drainage, Idaho Co., ID. We did not find this species on the W. side of the river, even near Box Canyon (see Frest & Johannes, 1995a for further details).

Current distribution: A few very small colonies in the immediate vicinity of Box Canyon, as above. At least one site is on BLM lands.

Threats: Most of the range has been severely affected by talus removal and road building along the US 95 corridor. Much of the area above the highway itself has been heavily grazed. The snails occur only in the few areas which still have talus or are too rocky for most cattle to traverse frequently. Mining was formerly extensive in this area: and some prospects are still worked nearby. The best remaining site could easily be removed for road material or fill, as has happened recently in this area (see, e.g., entry for *Oreohelix jugalis*).

Criteria for inclusion: Very local endemic; occurrence on public lands; decline in habitat and numbers: ongoing threats. Population trends (number of sites, number of individuals) are downward.

Recommended status: Currently, this species has no special status. Minimally, it should be considered a sensitive species by appropriate federal, state, and other land management and wildlife agencies. Federal and State (ID) listing as Endangered is needed, for the reasons cited above. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other malawlogists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and W. Walton. It is not likely that later work will greatly expand either the range or number of sites.

References: Deixis collections, 1988-l 994; Frest & Johannes (1995a).

Oreohelix n. sp. 22 Slate Creek mountainsnail

Type locality: Will be designated when the species is formally described.

Description: Shell turbinate; low dome-shaped in first three whorls, more rapidly expanding and taller in final two whorls; adults (5-5 ¼ whorls) medium-sized, to 20 mm diameter. Shell moderately thick; ornamented with numerous fine, closely spaced, raised, slightly irregular growth lines (transverse ribs), often slightly coarser on upper surface. Spiral striation well-developed, evenly spaced, strong on both surfaces, intersecting transverse ribs to give shell finely beaded appearance. Banding variably developed; the two peripheral bands thin, often not present; several irregularly spaced very thin bands on both upper and lower surfaces the most wmmon pattern; these bands often interrupted or broken into mottles, purplish brown; upper surface often with purplish brown tinge throughout, stronger where bands intersect. Umbilicus narrow, less than 1/5-1/6 full shell diameter, deep, with well- rounded border. Aperture circular, slightly oblique, deflected slightly in last 1/8 whorl, generally slightly thickened, flared slightly where not in contact with earlier whorls.

This species somewhat resembles the Utah-SE Idaho *peripherica* species group in general appearance. Anatomically, however, it appears related to the *"strigosa"* species group. The bw dome-shaped early whorls, later change in coiling parameters, and regular, narrowly-sized and -spaced radial ribs are distinctive features not shared with other "*strigosa*" group taxa.

Ecology: This species is most common on moist, high-diversity *Pinus ponderosa* forest, with limestone outcrops and substrate but also with a well-developed duff layer. It occurs more sparingly in moist limestone and limy schist talus. Forests have a strong deciduous component, including *Physocarpus, Acer, 'Comus stolonifera*, and other small trees and shrubs, as well as such understory plants as *Comus canadensis, Pyrola* spp., *Linnaea, Viola,* bryophytes, and *Asarum.* Persistence of moisture is a *desideratum.* This species is a mesophile. The Slate Creek mountainsnail also appears to be a calciphile, confined to areas on or in the vicinity of a single "exotic terrain" limestone block (other such blocks in drainages to the N. and S. lack this species and have their own very distinctive endemics). It occurs at moderate elevations only. Associated larger mollusks include *Anguispira kochi occidentalis, Allogona* cf. *lombardii, Cryptomastix mullani* subsp., *Discus marmorensis, Discus "whitneyi"*, and *Hemphillia.* This species is absent from those portions of Slate Creek with basalt substrate.

Original distribution: Probably confined originally to a limited area (essentially, the outcrop area of one large exotic (accreted terrain) limestone block) in the middle Slate Creek drainage, lower Salmon River, Idaho Co., ID.

Current distribution: Restricted to relatively unimpacted areas in the middle elevations of the Slate Creek drainage, including sites on Nez Perce National Forest, and probably on adjoining BLM lands as well.

Threats: Heavy grazing in lower part of areas of occurrence, where now confined to less cow-friendly talus; limestone quarrying, which has continued episodically to the present, with one recent round just concluded in the last year; road building (FScampground and Slate Creek access road). Dead shells indicate nearly ubiquitous former occurrence in the middle Slate Creek area; but heavily impacted areas, regardless of cause, have long-dead shells only; and this applies to the majority of the former range.

Criteria for inclusion: Very local endemic; specialized habiiat; occurrence on public lands; declining numbers and habitat; past and ongoing threats. Population trends (number of sites, number of individuals) are downward.

Recommended status: At present, this species has no status; minimally, it should be considered a sensitive species by appropriate federal (Nez Perce National Forest, BLM) and state land management and wildlife agencies. Federal and State (ID) listing as Endangered is recommended. A local endemic now much reduced in numbers and area occupied and with continuing, dearthreats. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snaij species were conducted by Frest & Johannes (1995a). Many other malawlogists and collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and W. Walton. It is not likely that later work will greatly expand either the range or number of sites.

References: Deixis collections, 1990-l 994; Frest & Johannes (1995a).

Oreohelix n. sp. 23 Lucile mountainsnail

Type locality: To be designated when species is formally described.

Description: Shell large for genus, to *25* mm diameter at full adult size (5-5 ½ whorls); moderately thick; comparatively tall. Growth lines thin, irregular, fine, slightly stronger on upper surface; striation patchy, sometimes prominent for short stretches, often absent; surface overall rather smooth for the genus. Whorls slightly angular except for last; last whorl well-rounded, slightly inflated: deflected slightly as aperture approached; aperture slightly flared, thickened, commonly jugate, very oblique. Umbilicus moderate-sized, somewhat deep; well-rounded border; diameter about 1/3 maximum shell width. Color bands well-developed, subequal; brown patch on lower surface at border of umbilicus; upper surface slightly brownish; typically extra bands seldom developed on either surface.

This species is among the early finds of Henry Hemphill, but has been overlooked in collections, largely because of lack of specific locality data but also due to confusion with *Oreohelix jugalis* (one of Binney's (1885) figures of *"jugalis"* is this species). It is more closely related anatomically to the *"strigosa"* species group than to the *jugalis* species group. It differs in shell features from the latter in that it is much taller; larger; more closely wiled, has an angular periphery; and has a brown pigment patch on the base. The only closely similar Idaho taxon is the Box Canyon mountainsnail (9.v.); but that taxon differs in several obvious features (see discussion under *Oreohelix* n. sp. 21 above). The very broad umbilicus and tall spire are unusual features for *"strigosa"* species group taxa.

Ecology: This species occurs primarily near and in metasedimentary outcrops and small-scale talus, and occasionally in boulder piles above the high water mark. It is a relatively mesophilic taxon. Common plants are grasses, *Rhus horribilis*, *Celtus*, *Sorbus*, and *Balsamorhiza*. Land snails noted at the same sites as this species include *Cryptomastk harfordiana*, *Allogona ptychophora ptychophora, Helicodiscus*

salmoneus, and ***Oreohelix jugalis.*** This species once ranged onto the same alluvial slope as ***Oreohelix waltoni*** at the Lucile colony; but is now extinct at this site. The species is not found on limestone substrate (common near Lucile) or in very dry area, and hence does not occur, e.g., in areas occupied by ***Oreohelix idahoensis idahoensis*** or ***Oreohelix haydeni perplexa very*** near Lucile.

Original distribution: Found on both sides of the bwer Salmon River for several miles N. and S. of Lucile, on private and BLM lands, Idaho Co., ID. For details, see Frest & Johannes (1995a).

Current distribution: Restricted to a few colonies in less-impacted-area within the original range. Sites on BLM lands remain viable. See Frest & Johannes (1995a) for further information.

Threats: Heavy grazing in much of area of occurrence; gold mining; road and human habitation construction along the US 95 corridor; talus and gravel mining. The snail is absent from heavily grazed areas. At least one mining claim within a colony's boundaries was being worked in 1992-l 994. Dead shells from former colonies are wmmon along US 95 near Lucile. Mining operations have disturbed or removed many of the boulder-cobble areas along the banks of the lower Salmon River, while creating others. The mining discard piles, though some are quite old, have not been re-inhabited by this species.

Criteria for inclusion: Local endemic; occurrence on public lands; definable and ongoing threats; decline in habitat area and in numbers. Population trends (number of sites, number of individuals) are downward.

Recommended status: As yet, this species has no special status. Minimally, it should be considered a sensitive species by appropriate federal (e.g., BLM) and state land management and wildlife agencies. Federal and State (ID) listing as Endangered is suggested, for the reasons outlined above. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995). Many other collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is not likely that later work will greatly expand either the range or number of sites.

References: Deixis collections, 1988-l 994; Frest & Johannes (1995a).

Oreohelix n. sp. 24 Wet Gulch mountainsnail

Type locality: To be designated when species is described.

Description: Shell with bw depressed spire, sometimes sublenticular; small (to 10 mm); generally 5 ½ rather narrow whorls as adult; whorls with slightly convex sides; upper whorl surfaces somewhat stepped; sutures deeply impressed; periphery slightly angular and with distinct but narrow rib. Growth lines faint: moderately prominent, low, somewhat irregular transverse ribs on both surfaces, equally prominent on lower; fine raised spiral ribs (generally 5-7 on both upper and lower surfaces; spiral striation even faint but consistent over whorl surfaces. Shell thin; aperture moderately oblique, not thickened, not flared, slightly deflected in final 1/16 whorl. Color bands faint; peripheral bands sometimes absent; several faint bands sometimes present on either or both whorl surfaces, whole shell often very light tan, with several narrow white bands and thin, darker brown bands. Umbilicus about ¼ shell diameter, deep, with well-rounded border; slightly elliptical.

This species, because of its small size, convex whorls, bw spire, and large umbilicus, somewhat resembles ***Oreohelix waltoni.*** However, that species has very different juvenile sculpture and anatomy; prominent radial ribs; and tacks transverse ribs. ***Waltoni*** is a member of the ***idahoensis*** species group; while anatomy indicates links between this species and the ***haydeni*** species group.

Ecology: This moderate xerophile is found on a largely open, dry, and exposed schist ridge and talus. Vegetation is sparse; but includes ***Celtus*** and grasses. This is the only large land snail found live, although recently dead specimens of ***Allogona ptychophora ptychophora*** and ***Cryptomastix harfordiana*** occur in

the vicinity. Long-dead ***Oreohelix haydeni hesperia*** were also noted; but these could be wash-down from farther up Wet Gulch.

Original distribution: Only known from one site as yet, near the mouth of Wet Gulch, lower Salmon River, Idaho Co., Idaho. See Frest & Johannes (1995a) for details.

Current distribution: Same as above.

Threats: This area has been heavily grazed, and live snails are confined to a narrow area protected by steep rocky terrain and the location of a fence line (the species is not found live on the other side of the fence line). The area has been damaged by fence line placement and is subject to landslides. Ownership is unclear; it may be within the US 95 right-of-way.

Criteria for inclusion: Extremely local endemic; past and ongoing threats, reduced colony size and numbers. Population trends (size and condition of site, number of individuals) are downward.

Recommended status: Currently this species has no special status; minimally, it should be considered a sensitive species by appropriate federal (e.g., BLM) and state land management and wildlife agencies. Federal and State (ID) listing as Endangered is suggested, for the reasons outlined above. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton, without finding other sites for this species. It is not likely that later work will greatly expand either the range or number of sites.

References: Frest & Johannes (1995a); Deixis collections, 1994.

Oreohelix **n. sp. 25 Stites mountainsnail**

Type locality: Designation is deferred to the time when the species is formally described.

Description: Shell bw dome-shaped, with faintly angular periphery and moderately convex sides; medium-sized, with up to 6 whorls, diameter to 20 mm. Aperture obliquely rounded, moderately oblique, slightly thickened; minor flare in last 1/16 whorl; slightly deflected typically. Shell moderately thick; principal color bands faint, sometimes interrupted; both whorl surfaces with varying amounts of purple-brown suffusion, but stronger on upper surface. Growth lines and spiral striation rather faint and irregular, equal above ad below periphery. Umbilicus, small, well-rounded border, deep, about 1/5=1/6 maximum shell diameter, slightly elliptical.

Anatomy of this species has been described by Solem (1975) under the name ***Oreohelix strigosa strigosa.*** The species is characterized by a combination of size, spire shape, and the general rufous tint noted by Solem (1975). Comparisons between this taxon and sometimes w-occurring ***Oreohelix vortex*** were discussed at length by Solem (1975), who established beyond doubt that both are separate species.

Ecology: This species is a moderate to weak xerophile, found typically in somewhat dry, open basalt taluses, often at low elevations. ***Balsamorhiza***, ***Celtus***, grasses, and ***Sorbus*** are wmmon associates; but other taxa, such as ***Salix***, ***Populus***, ***Sambucus***, ***Rhus***, ***Urtica***, and various composites occur at some sites. The most frequent co-occurring land snail is ***Allogona ptychophora ptychophora;*** but small ***Cryptomastix*** spp. and ***Cryptomastix mullani mullani*** may be common in the same taluses also; ***Polygyrella polygyrella*** and ***Oreohelix*** vortex were noted at one or more sites with this taxon.

Original distribution: Probably once one of the more wmmon land snail species in the lower portions of the drainage of the South Fork Clearwater River and N. of Lucile in the lower Salmon River valley, where these have basalt talus or substrate. This fon has not been noted in the N. portion of Hells Canyon, which

also has extensive basalt outcroppings and rock piles, nor in the lower Salmon River valley S. of Riggins (also basalt substrate).

Current distribution: Sporadically distributed within the original range. Many basalt taluses in the same general area have other species of ***Oreohelix***, such as ***jugalis*** or vortex.

Threats: Talus mining and road improvements (one such, near White Bird in 1994, has almost completely destroyed perhaps the largest known site, and long-term survival here is unlikely); grazing; location of human habitations and roads.

Criteria for inclusion: Local endemic; past and ongoing threats; occurrence on public lands, including BLM, Nez Perce National Forest, and Nez Perce Tribe parcels. Population trends (number of sites, number of individuals) are downward.

Recommended status: Presently, this species has no special status; minimally, it should be considered a sensitive species by appropriate federal (e.g., BLM) and state land management and wildlife agencies. Federal and State (ID) listing as Threatened is suggested, for the reasons outlined above. Comprehensive recent surveys of the lower Salmon River drainage and adjacent parts of the lower Clearwater R. drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other collectors (both professional and amateur) have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is not likely that later work will greatly expand either the range or number of sites.

References: Solem (1975); Frest & Johannes (1995a); Deixis collections, 1989-l 994.

Oreohelix n. sp. 26 Sam Hill mountainsnail

Type locality: To be designated when the species is formally described.

Description: Shell medium-sized for genus (to 20 mm); very low, depressed spire; convex whorls no peripheral angulation; deeply impressed sutures. Shell thick; whorls expanding at moderate rate: adult with 4 ½-5 ¼ whorls. Growth lines faint, thin rather irregular, closely spaced, stronger above periphery; spiral striations weak and patchy at best. Principal color bands consistently developed; lower about twice width of upper: most of shell somewhat smooth, chalky white. Umbilicus moderately shallow, elliptical, well-rounded border; about ¼ maximum shell diameter. Final 1/8 whorl deflected slightly; aperture strongly oblique, elliptical, slightly flared.

A somewhat disjunct member of the ***jugalis*** species group, interesting also in that it does not occur in identical habitat on the Oregon side of the Columbia in the E. Gorge, but is replaced by ***Oreohelix variabilis***. This species is smaller than WA ***junii***, less strongly striate, lacks angular periphery, and lacks purple-brown coloration on the upper half of the whorl. It is more depressed than ***ID jugalis*** and has a different apertural morphology, less clearly jugate.

Ecology: Occurs sporadically in a few rather dry, S.-facing basalt taluses, often with seeps or basal springs. Generally this is the only snail present; at one ***site, Vespericola columbiana depressa*** and ***Cryptomastix hendersoni*** (9.v.) occur also. Commonly, the springs have ***Rorippa*** and ***Mimulus***; much of the talus may have ***Rubrus*** and local ***Urtica***, ***Rhus*** or ***Sorbus***. Talus bases with this species are commonly mossy. This species is a weak to moderate xerophile.

Original distribution: Probably common along a limited portion of the eastern Columbia Gorge (WA side only), Klickitat Co., WA.

Current distribution: Found only at 4 sites within a few miles of the Sam Hill Bridge, Klickiiat Co., WA. We extensively surveyed much of the Columbia Gorge between 1987-l 993, and many more additional sites are not likely.

Threats: This snail is absent from areas accessible to heavy grazing. Removal of or modification of talus along the Burlington Northern Railroad tracks has also impacted colonies and considerably reduced potential habitat. Population trends (number of sites, number of individuals) are downward. It is not likely that later work will greatly expand either the range or number of sites.

Criteria for inclusion: Local endemic; past and ongoing threats; likely occurrence on public lands.

Recommended status: Presently, this species has no special status; minimally, it should be considered a sensitive species by appropriate federal (e.g., BLM) and state land management and wildlife agencies. Federal and State of WA listing as Threatened is suggested, for the reasons outlined above. There is sufficient recently-collected information, and recent survey work, to justify this action.

References: Deixis collections, 1987-l 993.

Oreohelix n. sp. 27 Pass Creek mountainsnail

Type locality: Will be designated when the species is described.

Description: Shell medium-sized for genus (to 17 mm); adult with 5 ¼ whorls; moderately high turbinate spire; moderately thick; aperture rounded, slightly flared; very oblique, deflected in last 1/8 whorl slightly; columellar lip reflected slightly over umbilicus. Transverse ribs irregular, strong, crowded, varying widths, equal on both whorl surfaces; spiral striation strong but irregular, beading surface in some areas, equal above and below periphery. Color bands not developed; shell irregularly mottled with brown; ribs mostly white; surface as a whole appears rugose, but slightly glossy. Umbilicus deep, circular, with well-rounded border, narrow, about 1/9 full shell diameter.

UT *peripherica* mostly are lower, have a slight peripheral keel; and the transverse ribs are narrow, more regular, and more widely spaced (interspaces are distinct and exceed rib width). The umbilicus of *peripherica* is proportionately larger also.

Ecology: Found in dry limestone terrain at a moderate elevation. The site is open and grassy; sage scrub is the dominant vegetation type locally. The slope is steep and S-facing. This species appears to be a xerophile and calciphile. No other land snails were noted in the vicinity.

Original distribution: Lost River Range, Challis National Forest, Custer Co., ID.

Current distribution: Known from a single site in the Pass Creek drainage, Custer Co., ID. Sites in adjacent Butte Co. are possible also.

Threats: The site is heavily grazed; and snails were found only under an overhang partly protected from grazing by its location.

Criteria for inclusion: Local endemic; occurrence on public lands; current threats to only known site.

Recommended status: This species has no special status at present. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. On present, rather limited evidence, it probably should be listed as Endangered Federally and in ID; but more survey work needs to be done in the Lost River Range. We do not recommend listing at this time.

References: Deixis collections, 1990.

Oreohelix n. sp. 28 quartzite mountainsnail

Type locality: None designated as yet; undescribed taxon.

Description: Shell depressed, discoidal, greenish-yellow, thin; moderate size, to 16 nun as adult (4 ½-5 whorls; moderately rapidly expanding. Peripheral angulation sharp, but not strongly produced; peripheral lira only moderately strong. Single medium-width strong lira on upper surface; 5-7 on lower; numerous fine lirae on both surfaces, but interrupted sporadically by moderately strong growth lines, particularly well-developed on upper surface. Umbilicus deep, but not bordered by basal keel; somewhat narrow, about 1/5 full shell diameter. Aperture subtrapezoidal, moderately oblique; peristome only slightly expanded at columella, slightly or not at all thickened. Color bands absent.

This species most closely resembles the Salmon River *Oreohelix* n. sp. 8 in color and shell shape, but that species is smaller, has prominent periostracal fringes (completely absent here), and a proportionately shallower and wider umbilicus. For other comparisons, see entry for Papoose Creek mountainsnail above. A member of the *Oreohelix haydeni* species group.

Ecology: Found thus far only in a large-scale, Ordovician-age, S.-facing quartzite talus (with relatively calcareous soil, however). Common plants included grasses, scattered *Pinus*, *Celtus*, *Sorbus*, *Rhus*, *Artemisia*, and composites. This was the only large land snail present, although other *Oreohelix* species occur in the vicinity. The occurrence on quartzite is somewhat unusual.

Original distribution: Probably limited to portions of the northern Portneuf Range, Bannock Co., ID.

Current distribution: A single colony above Lava Hot Springs, Bannock Co., ID. Searches in the vicinity (1991, 1993, 1994) located other *Oreohelix* colonies, but no others of this species. It could occur on adjoining portions of Caribou National Forest, although it is not likely that later work will greatly expand either the range or number of sites.

Threats: This area is heavily grazed. The talus also has been modified to protect the Union Pacific Railroad tracks, which run along the base. Dead specimens of this species are common throughout the talus; but live specimens are very rare and confined to very limited and most favorable areas. We have only seen a few live specimens despite searches under optimum conditions.

Criteria for inclusion: Local endemic; current and past threats; possible occurrence on federal lands (Caribou National Forest). Population trends, as evidenced from areal reduction of the only known site, and small number of live vs. dead individuals noted in several visits) are downward.

Recommended status: This species has no special status at present: minimally, it should be considered a sensitive species by appropriate federal and state land management and wildlife agencies. We recommend Federal and State (ID) listing as Endangered, for the reasons outlined above. Recent (1991-1994) searches of the Lava Hot Springs area and elsewhere in SE Idaho by us produced no other sites.

References: Deixis collections, 1991-l 994.

Oreohelix n. sp. 29 Hells Canyon mountainsnail

Type locality: Will be designated when the species is described.

Description: Shell medium-sized for genus, to 20 mm: adult with 4 ½-5 ½ whorls; bw turbinate in shape, slowly expanding, with low, almost flat, initial whorls. Shell moderately thin; aperture definitely reinforced, slightly deflected, not strongly oblique; distinctly flared, and slightly reflected over umbilicus. Growth lines faint on adult whorls, low, widely spaced, irregular; lower surface almost smooth; spiral striation absent on mature whorls; surface dull or with slight sheen. Two principal color bands thin but almost always present;

secondary bands uncommon; shell generally chalky off-white, except for faint brown suffusion above upper color band. Umbilicus small, deep, well-rounded border: elliptical; diameter about 1/5-1/6 total shell width.

This medium-sized species somewhat resembles taxa from other parts of the range ascribed by Pilsbry (1939) to *Oreohelix strigosa cfepressa.* It differs from type material and other lots from CO in that it is higher; has fewer and more convex whorls; has a smaller umbilicus; and generally lacks spiral striation. Anatomically, it is a member of the "*strigosa*" species group.

Ecology: A strong xerophile, found on several lithologies in sage scrub; but particularly common on limestone. Most colonies occur in small-scale, N.-facing talus or rock piles. Common associates include *Artemisia, Balsamorrhiza*, grasses, *Celtus*, *Opuntia*, and *Rhus*. More frequent large land snails found with this species include *Allogona ptychophora ptychophora, Cryptomastix populi*, and additional small *Cryptomastix* species. This species generally occurs at lower elevations in major stream valleys.

Original distribution: Probably quite common along the middle and northern parts of Hells Canyon, the Snake River Canyon to a point a few miles W. of Clarkston, WA; and along the lower few miles of the Grande Ronde River. In the southern portion of Hells Canyon, *i.e.* Seven Devils Mountains and S., this species is replaced by others. This taxon appears to have been utilized as a food resource by early aboriginal peoples in Hells Canyon.

Current distribution: Scattered sites within the original range, including Nez Perce National Forest (e.g., the vicinity of Pittsburg Landing), Wallowa-Whitman National Forest, Hells Canyon National Recreation Area, and Snake Wild and Scenic River: narrow portions of Idaho and Nez Perce cos., ID; Asotin and Whitman cos., WA; and Wallowa Co., OR.

Threats: Trail and road development in Pittsburg Landing area; heavy grazing in most of its range; development on inholdings in the northern Hells Canyon area; road building and maintenance in the Clarkston area (e.g., colonies along US 12 have been extirpated in the last few years); expansion of Clarkston, WA and Lewiston, ID. Populations are declining in terms of absolute numbers and number of sites. It is not likely that later work will greatly expand either the range or number of sites.

Criteria for inclusion: Local endemic; past and current threats (as outlined above); loss of historic sites; declining numbers; occurrence on public lands.

Recommended status: This taxon has no special status at present. Minimally, it should be regarded as a sensitive species by the relevant Forest Service, BLM, and state land management and wildlife offices. We recommend Federal and State (ID, OR, WA) listing as Threatened, for the reasons discussed previously.

References: Deixis collections, 1988-l 994. Old specimens of this taxon are in museum collections (e.g. ANSP).

Oreohelix n. sp. 30 Pittsburg Landing mountainsnail

Type locality: To be designated when the species is formally described.

Description: Shell small-medium sized (to 13 mm); adults with 5-5 ¼ evenly spaced, convex, rather closely coiled whorls. Shell moderately thin; sutures somewhat impressed; no peripheral keel, angulation, or rib. Transverse ribs moderately prominent, sometimes broad, fairly regular, interspaces less wide than ribs; equal above and below periphery; growth lines in interspaces: spiral striation very patchy, mostly on broader ribs. Color bands always present; both thin rest of shell off-white, generally with faint brownish blotches, particularly on upper whorl and in interspaces; transverse ribs white. Aperture rounded, slightly deflected and flared in last 1/16 whorl, slightly reinforced. Umbilicus deep, narrow, and well-like: periphery rounded, abrupt border; diameter about 1/6 maximum shell diameter.

This species has a shell shape somewhat similar to that of ***Oreohelix idahoensis idahoensis;*** however, the umbilicus is larger; spiral striation is not well developed; the radial ribs, though prominent, are narrower and more narrowly spaced; and the two typical color bands of ***Oreohelix*** (absent in ***idahoensis)*** are well developed. This species also lacks a peripheral keel, rib, or angulation. It also bears some resemblance to coarser-ribbed members of the ***peripherica*** species group, ***e.g. Oreohelix peripherica newcombi*** and ***Oreohelix peripherica wasatchensis;*** but this ID-UT group has no members in western ID, and is anatomically somewhat close to ***Oreohelix strigosa depressa (s.l.).*** Anatomically, the Pittsburg Landing mountainsnail is a member of the ***idahoensis*** species group. Aside from this, it differs from the UT snails in that both have very narrow umbilici; ***wasatchensis*** is much larger, has pyramidal upper whorls, and has a strong peripheral keel. ***Newcombi*** is similar in size, ribbing, and color banding; but this species is taller, has very different juvenile whorls, and a descending aperture.

Ecology: Confined to small talus piles and the base of a sharp cliff face; apparently a calciphile, as, nearby schist outcrops lack the species. Vegetation is sage scrub, mostly replanted with grasses. Scattered ***Celtus, Balsamorrhiza,*** and ***Sorbus*** were noted locally. A strong xerophile.

Original distribution: Known only from a single colony in the Pittsburg Landing area, Nez Perce National Forest, Idaho Co., ID.

Current distribution: Very narrow (<1 2" wide) area along part of cliff base and scattered talus remnants in the same area. The species has invaded part of an old stone fence, now collapsed to rock piles, and a pioneer grave site.

Threats: Heavy grazing has extirpated the colony over much of the original site, so that only dead shells were noted in most areas in several visits. The portion of the colony on the W. side of Kurry Creek (most of it) was destroyed by excavation for road fill and "improvements". Some of this took place in 1993, after we had informed the Forest Service of the location of this colony and its significance (letter of 2/26/91 to E. Cole, Hells Canyon National Recreation Area; copy to R. Mason, Wallowa-Whitman National Forest); some similar work had been done earlier. The 1993 road improvements caused substantial erosion in the lower reaches of Kurry Creek, cutting into the area now and formerly occupied by the snail. Dead shells are still (1994) common in this area, indicating the former extent of the colony. Populations are declining in terms of absolute numbers and area occupied. It is not likely that later work will greatly expand either the range or number of sites. The sole known site is likely to see much greater human traffic as a result of recent Forest Service work to "improve" the road and increase access to Pittsburg Landing. Landslides have also occurred in the Pittsburg Landing area (Vallier & Miller, 1974); and recent road modifications may exacerbate this problem.

Criteria for inclusion: Local endemic; past and current threats (as outlined above); reduction in area of only known site; declining numbers; occurrence on public lands.

Recommended status: This taxon has no special status at present. Minimally, it should be regarded as a sensitive species by the relevant Forest Service, BLM, and state land management and wildlife offices. We recommend Federal and State (ID) listing as Endangered, for the reasons discussed previously. There is sufficient recentlycollected information, and recent survey work, to support this action.

References: Deixis collections, 1991-l 994.

Oreohelix n. sp. 31 Byrne Resort mountainsnail

Type locality: None designated as yet; undescribed taxon.

Description: Medium-sized ***Oreohelix*** with up to 5 1/2 whorls (diameter to 16 mm). Whorls generally convex; spire low, depressed; sutures deeply incised. Umbilicus broad, up to 1/3 full diameter of shell. Shell with several moderately strong, narrow lirations on each whorl surface; color off-white, typical color

bands 'not present; striation minor or absent. Peripheral rib present; but periphery generally well-rounded; peripheral keel weak-absent.

At first glance, this species appears to be a member of the *haydeni* complex; and it was reported earlier (e.g., Pilsbry, 1939; Henderson, 1924) ***as Oreohelix haydeni oquirrhensis.*** Examination of the anatomy and of the **early** whorls, however, indicate that it is not a member of the *haydeni* group (*q.v.*), despite convergence in some shell characters'. Typical ***oquirrhensis*** has rather different shell morphology in **any** case, including a well-developed peripheral keel and rather weak **lirations**. In shell features, this species superficially bears a stronger resemblance to ***haydeni haydeni*** than to ***oquirrhensis.*** Affinities of this **taxon** ***are*** to the ***yavapai mariae*** complex, and ***more*** specifically to ***Oreohelix carinifera and to Oreohelix*** n. sp. 3. The former species **is** much smaller; more strongly **carinate;** has a proportionately smaller umbilicus; and lacks **lirae** on the base. The latter is about the same size, but has a distinct peripheral keel, the typical supraperipheral and subperipheral color bands, and **has very** weak interrupted **lirae,** rather than continuous, ***haydeni*-like** ribs.

Ecology: This species occurs at bw elevations at the base of an open limestone talus, with major **warm** springs, and also sparingly in adjoining rather open and dry limestone and basalt talus, generally S.-facing. Associated plants ***are*** mostly grasses and ***Clematis,*** with occasional ***Populus***, **Cornus** stolonifera, ***Salk*** spp., and ***Celtus*** stands locally. The species generally occurs in small monospecific colonies with very limited **areal** extent. A strong xerophile, absent from the wet areas in the spring complex.

Original distribution: Clark Fork River valley near Bearmouth, Granite Co., MT.

Current distribution: Survives in a few very small colonies in the old Byrne Resort area. Occurrence of this species in portions of **Lolo** National Forest or in nearby State of Montana lands is quite possible.

Threats: Removal of talus for fill and road construction. Some colonies collected by R. B. Brunson in the 1940-l 960s are no longer extant, and construction and maintenance of I-90 & US 12 and associated frontage roads has impacted the area. Other threats include grazing, which is pandemic in the area occupied (mostly horses currently), and roadside spraying. The area was also impacted by the former resort, of which little trace now remains. Much of the talus at the principal sites now has dead shells only. The species is declining, both in number of sites and absolute numbers, due primarily to human **activities.**

Criteria for inclusion: Local endemic; habitat loss and continuing threats; possible occurrence on public lands.

Recommended status: Federal and State of MT listing as Endangered is appropriate, in our opinion. The area of occurrence was collected heavily by R. B. Brunson from the 1940s through the **1960s;** we have recently begun resurvey of the same region. **It** is unlikely that many additional sites will be found, or that the geographic range will be extensively increased.

References: Deixis collections, 1989, 1991.

Oreohelix strigosa delicata Pilsbry, 1934 Blue mountainsnail

Type locality: Walla Walla Canyon, four miles up South Fork, **Walla Walla** River, above Milton, Umatilla Co., OR. Holotype ANSP **158425a;** paratypes ANSP 158424, 158425

Description: See Pilsbry (1934) for original description and illustrations. Distinctive features are the relatively thin and finely striate shell, neither of which seem likely related to edaphic conditions. **Basalt-**restricted ***Oreohelix*** frequently have thick shells (e.g., ***junii***, ***variabilis,*** also found on Columbia **River** Group **basalts),** and loess overlying the basalt is comparatively calcium-rich.

Ecology: The type locality is in a moderately steep basalt creek canyon with short basalt cliffs and **small-**scale talus piles in some areas. **Fairly** open ***Pinus ponderosa*** and ***Pseudotsuga menziesii*** forest, with

some deciduous understory and wmmon grasses, characterize the type locality, and suggest that this is a mesophile or weakly xerophilic species.

Original distribution: Noted with any degree of precision only from the type locality. This species could have been historically rather widespread in the Blue Mountains, as other specimens from indefinite localities in this range in both OR and WA are found in museum collections.

Current distribution: Uncertain; we have been unable to relocate this species in the South Fork Walla Walla River Canyon. It should be looked for in more intact portions of the Blue Mountains, e.g. some areas in Umatilla and possibly Wallowa-Whitman National Forest. It should also be noted by appropriate land and wildlife personnel in these two national forests that Pilsbry (1939, p. 425) alludes to another, undescribed subspecies of *Oreohelix srrigosa* in the Blue Mountains. We were unable to resolve the status of this taxon; but it should be sought for. ***See Oreohelix srrigosa*** n. subsp. 2 below.

Threats: Grazing, logging, and road construction in the area of the type locality. Much of the Blue Mountains has been logged; much of the remainder is affected by insect infestation. Severe forest fires have also affected large areas in the Blue Mountains in recent years, e.g. in 1993. It is not likely that new finds will greatly alter the taxon's presumed range, or that large numbers of undiscovered sites remain.

Criteria for inclusion: Local endemic; severe and ongoing modification of known and potential habitat; probable loss of type locality. Probable population trends (number of sites, number of individuals) are downward.

Recommended status: This taxon has none at present; it should at least be considered a sensitive species by Forest Service and other federal and state land and wildlife agencies in SE WA and NE OR. We recommend consideration of federal and State (OR, WA) listing of this taxon as Endangered.

References: Pilsbry (1934, 1939).

Oreohelix strigosa goniogyra Pilsbry, 1934 striate mountainsnail

Type locality: "On lower Race Creek below forest, ¼ mile from the mouth and 2 miles north of Riggins, Idaho" (Pilsbry, 1939); holotype ANSP 158421a. Pilsbry (1939) cites the original description as dating from 1933; but the cover of separates include the line "Published March 3, 1934".

Description: See Pilsbry (1934, 1939) for description of both shell and anatomy. For further details, see Frest & Johannes (1995a). No other species in the "strigosa" species group has a strongly carinate adult shell with prominent spiral lines. This species superficially somewhat resembles the bicarinate mountainsnail *(Oreohelix* n. sp. 17); but the basal carina, fine ribs rather than incised lines, and *haydeni* species group anatomy are obvious *differentiae*.

Ecology: This snail is found mostly on forested outcrops (*Pinus ponderosa* forest), with lithologies ranging from greenish schist to limestone. Commonly, sites have a partly-completely closed canopy and diverse forb and deciduous understory. Reported colonies have substantial faunas, including *Polygyrella polygyrella*, *Cryptomastix mullani mullani, Allogona ptychophora ptychophora, Anguispira nimapuna,* and *Hemphillia camelus.* One *site* is also the type locality for *Allogona lombardii*. The elevation range for this species is considerable.

Original distribution: Originally reported from the Race Creek drainage, lower Salmon River valley, Idaho Co., Idaho. Subsequently, Smith (1943) recorded sites also from the Selway River (Clearwater River) drainage. Taxonomy of specimens from the Selway sites needs to be verified.

Current distribution: May be limited to a few remnant colonies in the Race Creek drainage. The type locality has been grazed out (now in a horse pasture); but a colony remains nearby, presumably on public

(BLM) lands and protected on one side by a fence We and private collectors have revisited Smiths (1943) two Selway River sites and others in the vicinity recently, but did not find this species. These sites are on Nez Perce National Forest lands.

Threats: Grazing; logging in both the Selway and Lower Salmon valleys, road location and modifications; forest fires. The colonies along the upper part of the Race Creek drainage were huge, judging by dead shells, which number in the millions. Relatively recent clearcutting and fire have reduced these sites in Nez Perce National Forest to small remnants, with the snail mostly surviving in rocky areas offering some refuge from summer desiccation. Population trends (number of sites, number of individuals) are downward.

Criteria for inclusion: Local endemic; past and continued threats, as noted above; occurrence on public (National Forest and BLM) lands.

Recommended status: At present this taxon is a federal C2 candidate (USFWS, 1994). It should at least be considered a sensitive species by Forest Service and other federal and state land and wildlife agencies. We recommend Federal and State (ID) listing of this taxon as Endangered. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other collectors, both professional and amateur, have worked this area for over 130 years, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is not likely that later work will greatly expand either the range or number of sites.

References: Pilsbry (1934, 1939); Smith (1943); Frest & Johannes (1995a); Deixis collections, 1989-1993.

Oreohelix strigosa n. subsp. 1 Nez Perce mountainsnail

Type locality: To be established when the species is formally described.

Description: Shell large, low, depressed, 5-6 whorls, diameter to 30 mm; moderately thick; whorls convex, sutures only slightly impressed; slight peripheral keel occasionally; accentuated in last half whorl only. Growth lines very fine, low, moderately regular, crowded; spiral striation strong, striae moderately widely spaced, crossing growth lines to produce finely reticulate pattern not visible to naked eye; surface appears somewhat smooth. Aperture rounded, not reinforced, moderately oblique. Umbilicus moderate in size and depth, border well-rounded, circular, about 1/3 maximum shell diameter. Color bands generally present; subsidiary bands variable in size and position; shell ground color off-white, generally with varying amounts of purple-brown or purple-red suffusion or mottles or both, especially on top surface.

This large-sized taxon appears from shell and anatomical features to be a member of the ***"strigosa"*** species group. Distinguishing features are the low spire, fine growth lines, and prominent and consistent spiral striae.

Ecology: This mesophilic taxon is found exclusively in moderate-high elevation *Pinus* ponderosa forests, generally in areas with some rock exposure. it has been noted primarily on limestone; but occasionally on basalt as well. Moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a ***desideratum.*** Common associates are *Physocarpus*, *Prunus*, soapberry, and bryophytes. Sometimes found with such taxa as ***Allogona ptychophora ptychophora, Anguispira kochi occidentalis, Cryptomastix mullani mullani***, and ***Radiodiscus abietum***. This species is not as sensitive to disturbance ***as, e.g., Hemphillia camelus;*** but is absent from severely grazed or otherwise heavily disturbed areas. It does not seem to prefer talus situations, although sometimes found there. See Frest & Johannes (1995a) for further information.

Original distribution: Probably very widespread in medium-high elevations in the Seven Devils Mountains area, Nez Perce and Payette National Forest; in undisturbed sites it is the most frequently

encountered large land snail. It is now absent from the vast majority of its range, where long-dead shells often still attest to its former occurrence.

Current distribution: Restricted to relatively undisturbed sites in Nez Perce National Forest; particularly those with limestone or other calcium-rich substrate. See Frest & Johannes (1995a) for some specifics. This species was mostly overlooked by earlier collectors, because of access problems in high portions of the Hells Canyon-lower Salmon River area. Still, at least one historic site (along Squaw Creek) is known to have been extirpated (see Frest & Johannes, 1995a for discussion).

Threats: Severe grazing; logging; severe forest fires; road building and maintenance.

Criteria for inclusion: Local endemic; habitat reduction and possible site loss throughout range. Population trends (number of sites, number of individuals) are downward. It is not likely that later work will greatly expand either the range or number of sites.

Recommended status: This taxon has no special status at present; it should at least be considered a sensitive species by Forest Service and other federal and state land and wildlife agencies. We recommend consideration of federal and State (ID) listing of this taxon as Threatened. Extensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton, from the 1860s to the present; a few old records indicate widespread former occurrence.

References: Frest & Johannes (1995a); Deixis collections, 1990-l 994.

Oreohelix tenuistriata Henderson & Daniels, 1916 thin-ribbed mountainsnail

Type locality: A canyon between Lava Hot Springs and McCammon, about 2 mi. SW of Lava Hot Springs, on the S. side of the Portneuf River, Bannock Co., ID. Holotype UI 18602; paratype ANSP 112801, UCM 6497; some later-collected specimens (UI 18603) referred to this species by Pilsbry (1939) are another form of *Oreohelix.* See also UCM 7151, 7152. See Wu & Brandauer (1982) for UCM types.

Description: The best description and illustration are those of Pilsbry (1939); see also Henderson & Daniels (1916, 1917) and Pilsbry (1917). We have examined a fair number of museum specimens of this species and find that the well-rounded form is distinctive and typical, *contra* Pilsbry (1940, p. 478), with the later collection with an angular periphery representing another species and from a different site. As opined by Pilsbry, this is a member of the *haydeni* species group, with the distinct fine striae and small, rounded whorls distinguishing features not readily compared to other *haydeni*-group taxa.

Ecology: The type locality is said to be a canyon, with the snails occurring "under shrubs and mats of the radical leaves of *Balsamorrhiza sagittata* (Nutt.), overhanging small piles of limestone in open places among the mountain mahoganies" (Henderson & Daniels, 1916). The available information suggests a low-elevation xerophilic and probably calciphilic taxon.

Original distribution: Known only from the type locality. Other species of *Oreohelix,* including members of the *haydeni* and "*strigosa*" species groups, still occur in the same general area.

Current distribution: Uncertain. We have made several unsuccessful attempts to locate a live population of this species in the area between Lava Hot Springs and McCammon, 1991-l 994.

Threats: Much of the potential area of occurrence is heavily grazed. Limestone areas have been affected by road construction (especially US 30), railroad construction (Union Pacific Railroad), and expansion of Lava Hot Springs and its associated resorts.

Criteria for inclusion: Very local endemic; failure to find additional populations and to relocate the only previously-known site; possible occurrence on State of Idaho, BLM, or Forest Service lands in this area. It seems likely that population trends are downward. Sites for this taxon may remain elsewhere in the Portneuf Range. However, it is not likely that later work will greatly expand either the range or number of sites.

Recommended status: At present this species has no special status. It should at least be considered a sensitive species by Forest Service and other federal and state land and wildlife agencies. We recommend federal and State (ID) listing as Endangered, as there is sufficient recently-collected information, and recent survey work, to support this action.

References: Henderson & Daniels (1916, 1917); Pilsbry (1917, 1939).

Oreohelix variabilis Henderson, 1929 variable mountainsnail

Type locality: Near Celilo, Wasco Co., Oregon (another rather vague Hemphill site); holotype CAS 2987; paratypes CAS 2988, 2989.

Description: See Henderson (1929b); Pilsbry (1934, 1939) for description and illustrations. The distinctive features of this species are the extensive rough irregular transverse sculpture, general lack of the two typical color bands, and the whitish shell variegated with small irregular light-brown or purple-brown blotches. A member of the "*strigosa*" species group. The nearest relatives are *Oreohelix variabilis* n. subsp. and *Oreohelix* n. sp. 2. The former is smaller; has a lower spire and much broader umbilicus, and a different color pattern; for comparisons with the latter, see entry above. Note that when the Deschutes mountainsnail is described, this species would more properly be referred to *as Oreohelix variabilis variabilis* (Henderson, 1929).

Ecology: This species occurs mostly in N.-facing basalt talus piles. Common vegetation includes grasses, *Balsamorhiza*, *Celtus*, *Rhus*, *Sorbus*, and *Artemisia*; sometimes *Utica* is present also. Surrounding vegetation is generally sage scrub. Taluses with this taxon usually have associated springs and seeps; but this species is a moderate xerophile and does not generally occur in the seasonally wettest portions. Land snail associates include *Monadenia fidelis minor* and *Vespericola columbiana depressa.*

Original distribution: Probably widespread in the central and eastern portions of the Columbia Gorge, Oregon side only, Wasco and Sherman cos, The variable mountainsnail does not occur far inland from the Columbia River, e.g. only about 6-10 miles up the Deschutes River, where it is replaced by *Oreohelix variabilis* n. subsp. 1 (see next taxon entry).

Current distribution: A few scattered sites along the Columbia and a few tributaries, within the original range. We have recently (1987-l 992) surveyed a major part of the Columbia Gorge, so that few additional localities are likely to be found. Most colonies are remnants, with dead and subfossil shells indicating much greater. range in the recent past. One example is a quarry-gravel pit near Rufus, OR. Here, over a half mile-long operation (formerly a single extensive talus) the species occurs live only in one 6 ft. long *Utica* patch. Material from this site was used to construct John Day Dam and as road fill along the I-84 corridor. Sites occur along the Deschutes Wild and Scenic River corridor, Columbia Gorge National Scenic Area, and on BLM lands.

Threats: Much of the eastern and central Columbia Gorge is heavily grazed; and the species is absent from such areas. Many taluses were removed for dam construction (e.g. John Day Dam) or for construction of I-84/US 30 and along the Union Pacific Railroad right of way. Increasing popularity of the Gorge for recreation and for human habitation has further impacted sites. Extinct colonies are not uncommon in the area, e.g. one of Henderson's (1929) original sites near Biggs, OR. Fires have been severe in recent years, including 1994; we have not yet assessed the results of the 1994 fire between the mouth of the Deschutes River and Biggs, *i.e.* through most of the species' range. Disposal of trash along the

Burlington Northern Railroad tracks, in particular batteries used by the railroad, has badly impacted one site recently.

Criteria for inclusion: Local endemic; rather specialized habitat; past and continuing threats. Population trends in this species, whether evaluated in terms of number of sites, site area, or population size, are downward.

Recommended status: At present this species has no special status. It should at least be considered a sensitive species by Forest Service and other federal and state land and wildlife agencies. We recommend Federal and State (OR) listing as Endangered, for the reasons cited above. The region has been collected frequently before; starting with H. Hemphill, and including J. Henderson and W. B. Miller. We have collected it extensively since 1987. It is not likely that later work will greatly expand either the range or number of sites for this species.

References: Henderson (1929b); Pilsbry (1934, 1939); Deixis collections 1987-l 993.

Oreohelix variabilis n. subsp. 1 Deschutes mountainsnail

Type locality: None as yet; undescribed taxon.

Description: Shell moderately thick, with low, depressed turbinate spire; medium-sized (to 17 mm diameter); 5-5 ½ whorls. Whorls convex, sutures barely impressed; very slight peripheral angulation. Transverse ribs low, slightly irregular, with shallow interspaces of variable width: ribs stronger on upper whorl surface: striation variably developed, usually weak and patchy. Typical two color bands present; subperipheral band widest; upper band thin, sometimes interrupted. Upper whorl generally with red-brown to purple-brown pigment: secondary bands usually on lower surface only: same colors as upper often present over about 50% of surface area. Shell surface moderately glossy. Last ¼ whorl deflected, aperture flared, particularly near wlumellar axis. Aperture generally oval in shape. Umbilicus moderately deep, elliptical; border well-rounded; diameter about ¼ maximum shell width.

This species is closest to *Oreohelix variabilis;* but is smaller, more depressed, has a proportionately wider umbilicus, and has the two typical *Oreohelix* color bands. The coarser and more irregular transverse ribs also distinguish variabilis from this form.

Ecology: This moderate xerophile occurs mostly in basalt talus piles and at the base of basalt cliffs, generally N.- and E.-facing. Typically small permanent springs and seeps are associated, although this species avoids the wettest areas. Vegetation includes *Artemisia*, *Balsamorrhiza*, *grasses, Cysropteris, Rhus*, *Urtica*, *Rosa,* and *Rubrus.* Surrounding areas generally have sage scrub. At some sites this species occurs with *Monadenia fidelis* n. subsp. 1 (*q.v.*) and *Vespericola columbiana depressa* (*q.v.*).

Original distribution: Probably once widespread in the lower Deschutes corridor from about the city of Bend to the Columbia Gorge, Wasco and Sherman cos., OR.

Current distribution: A few scattered colonies from Maupin to within 6-10 miles of the Columbia River, Wasco and Sherman cos., OR. Sites occur on private and BLM lands, including the Deschutes Wild and Scenic River. Sites on lands of the Confederated Tribes of the Warm Springs Reservation are also possible. We have partly surveyed the range (1988-1993), so that large numbers of additional sites are not likely.

Threats: Much of the area of occurrence is heavily grazed and the species appears to be absent from such areas. Talus has been removed for fill and to improve roads and tracks in the area, e.g. along OR 216 and the Burlington Northern tracks, which enter the canyon near South Junction and continue to the mouth of the river. Contemplated campgrounds and roads envisioned in the BLM Lower Deschutes River management plan (BLM, 1993a, b) may negatively impact this species.

Criteria for inclusion: Local endemic; past and continuing threats; occurrence on public lands. Population trends (number of sites, number of individuals) are downward. It is unlikely that future work will greatly expand the number of sites or the geographic range.

Recommended status: At present this species has no special status. It should at least be considered a sensitive species by Forest Service and other federal and state land and wildlife agencies. We recommend Federal and State (OR) listing as Endangered; there is sufficient recently-collected information, and recent survey work, to support this action.

References: Deixis collections, 1988-l 993.

Oreohelix vortex Berry, 1932 whorled mountainsnail

Type locality: "Salmon River, White Bird, Idaho, Co., Idaho"; holotype Berry collection 7283; paratypes Berry collection 4655; holotype of ***Oreohelix flammulifer*** Berry, 1932, a synonym, Berry Collection 7284, paratypes Berry collection 4656 (same type locality). For probable location of this site, see Solem (1975) and Frest & Johannes (1995a).

Description: The best shell description and illustration are by Pilsbry (1939); but see also anatomy and illustrations in Solem (1975). This species, another Hemphill discovery, does not closely resemble any other Salmon River ***Oreohelix*** species. Distinctive shell features are the rather close coiling, fine periostracum-fringed lirae, impressed sutures, and wide umbilicus. It was first discovered in the same period as many other Salmon River species (1860-l 880); but like many, remained undescribed until much later. Pilsbry had specimens of this species at ANSP under ***abavia*** (a ***nomen nudum);*** other such specimens are at CAS.'

Pilsbry (1939) synonymized ***vortex*** and ***flammulifer*** and regarded this taxon as a subspecies of ***jugalis***: anatomical data were not available for any of the three. With this additional information, it is clear that vortex is a full species not particularly closely related to ***jugalis***; while ***flammulifer*** is a synonym, as Pilsbry surmised (Solem, 1975). See also Frest & Johannes (1995a).

Ecology: A xerophile, restricted mostly to large-scale basalt taluses. Sites are typically rather dry and open. Most common vegetation ***is*** grasses; ***at*** some ***sites, Balsamorhiza, Artemisia, Celtus, Rhus,*** and ***Sorbus*** may be locally common. The species prefers low to medium elevations in large stream valleys. Generally, it occurs tow in the larger taluses. Common associates among larger ***land*** snails are ***Allogona ptychophora ptychophora*** and ***ptychophota solida, Oreohelix jugalis,*** and ***Crypromastix*** n. sp. 3. See Frest & Johannes (1995a) for more information.

Original distribution: Probably quite widespread in the northern portion of the lower Salmon River valley, roughly from Slate Creek to the river mouth. This species is absent from basalt terrain of similar age, physiography, and history in the lower Clearwater River valley, northern Hells Canyon, and northern Little Salmon River valley.

Current distribution: Remains in a few isolated colonies in the most undisturbed parts of its original range, particularly along a short stretch of the lowermost Salmon River and lower parts of two of its larger creek tributaries. The range has been recently surveyed (Frest & Johannes, 1995a) and has been visited repeatedly by malacologists since the 1860s. It is very unlikely that future finds will substantially increase the geographic range or number of viable colonies. Many sites are on public lands (BLM). The original status survey for OES recommended Federal listing as Threatened (Solem & Clarke, 1974). Population trends (number of sites, number of individuals) are downward.

Threats: Heavy grazing in much of its range; talus mining in the bwer Salmon River valley, which has recently destroyed some old sites; highway construction and maintenance, including US 95 and smaller roads in the vicinity of White Bird. One largely destroyed site was used as a quarry, and the colony persists only as small remnant patches.

Criteria for inclusion: Local endemic; occurrence on pubic lands; past and ongoing threats.

Recommended status: This taxon, although a Federal C2 candidate (USFWS, 1994), has no special status at present. Minimally, it should be considered a sensitive species by BLM, Forest Service, and other land management agencies. Federal and State (ID) listing as Threatened is appropriate, in our opinion. Comprehensive recent surveys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995a). Many other collectors have worked this area for over 130 years, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. It is very unlikely that substantial expansion of whether range or number of live sites will occur from future work.

References: Berry (1932); Pilsbry (1939); Solem (1975); Frest & Johannes (1995a); Deixis collections, 1989-1994.

Oreohelix waltoni Solem, 1975 lava rock mountainsnail

Type locality: "Idaho, Idaho Co., more than 1.6 km up John Day Creek from the Salmon River, north of Lucile"; holotype FMNH 182000; paratypes FMNH 98141, 98151, 170711, 170741; NMC 72060; others in DMNH (unnumbered).

Description: Solem (1975) provides excellent illustrations and descriptions of both shell and anatomy. This species was overlooked by earlier collectors, largely because of its rarity. Unusual features are the small, flattened shell, broad umbilicus; prominent ribs; and juvenile sculpture. It is a member of the *Oreohelix idahoensis idahoensis* species group, as defined above. Some members of the *Oreohelix intersum* species group (*q.v.*) superficially resemble this taxon (notably the Shingle Creek mountainsnail, *Oreohelix* n. sp. 19); but the coarse ribs and juvenile sculpture, together with lesser characters such as its shell color pattern (discussed by Frest & Johannes, 1995a), distinguish this species. The Wet Gulch mountainsnail (*Oreohelix* n. sp. 24) is superficially similar also; but this species is a member of the *haydeni* species group, with weaker radial ribs and equally prominent lirae, as well as a juvenile typical of its species group.

Ecology: This species is a typical xerophile, found in rather dry, open areas in sage scrub vegetation. The common name suggests association with basalts; this is true of the type locality, but other sites are on mixed schist/alluvium. Most commonly associated plants are grasses, *Artemisia*, and *Celtus*; *Sorbus*, *Prunus*, and *Physocarpus* occur locally. This taxon is the dominant at most sites; but co-occurrence with *Oreohelix jugalis* and *Oreohelix* n. sp. 21 (Box Canyon mountainsnail) was noted at one site each. More frequent associates are *Allogona ptychophora ptychophora* and *Cryptomastix harfordiana.*

Original distribution: The lava rock mountainsnail may once have been common in the central part of the lower Salmon River, *i.e.* between Riggins and White Bird, on suitable substrate.

Current distribution: This species survives in perhaps four sites in the vicinity of Lucile and John Day Creek. The type locality has been much affected by cattle grazing, and the species is currently very rare and found in only a limited part of the talus. The second colony mentioned by Solem (1975) may be extinct, as we have been unable to find live individuals there in the last 2 years (last seen live at this site in 1990). At least one locality is on BLM lands. Finds of recently dead material by us and by S. Welty (*pers. comm.*, 1993) in 1990 and 1991 along the White Bird Creek road indicated the possible presence of a colony in this area (alluded to also by Solem, 1975); however, this area was massively modified for grade improvement and for a home site in 1994, and there is no chance of survival at this site. We searched the relevant portion of the White Bird Creek valley in 1993 and again in 1994 anyway, unsuccessfully.

Threats: All known sites are impacted by grazing; the Lucile colony may have been extirpated by sheep grazing; the type locality has been heavily grazed by cattle. The other sites are similarly affected. Road construction and maintenance have considerably reduced the site along US 95. Talus mining, especially

for basalt gravel, has affected taluses in the immediate vicinity of al sites. Gold mining and prospecting impacts sites in schist lithologies. Population trends (number of sites, number of individuals) are very clearly downward.

Criteria for inclusion: Very local endemic; small number of sites; historic site loss and population decline in recent years; occurrence on public lands.

Recommended status: Currently, this species is a Federal C2 candidate (USFWS, 1994). It should minimally be considered a sensitive species by BLM, Forest Service, and other land management agencies. Comprehensive recent suweys of the lower Salmon River drainage for this and other land snail species were conducted by Frest & Johannes (1995). Many other collectors have worked this area, including H. Hemphill, H. B. Baker, A. Solem, and M. Walton. Status surveys for ***Oreohelix*** species were also' conducted in this area in 1973-l 974 (Solem & Clarke, 1974); listing was recommended at that time (Solem & Clarke, 1974; Solem, 1975). It is very unlikely that later work will greatly expand either the range or number of sites for this species.-We strongly recommend Federal and State (ID) listing as Endangered.

References: Solem & Clarke (1974); Solem (1974, 1975); Frest & Johannes (1995a); Deixis collections, 1990-l 994.

Pristiloma (Pristinopsis) arcticurn? crateris Pilsbry, 1946 Crater Lake tightcoil

Type locality: One mile south of Crater Lake, Klamath Co., OR; holotype ANSP 147788a; paratypes ANSP 147788; other paratypes should be in UCM collections; but not listed by Wu & Brandauer (1982).

Description: See Pilsbry (1946) for best description and illustration; this is the undescribed species referred to by Henderson (1929a). Taxonomy follows Riedel (1980). The anatomy is unknown. This taxon was referred to as ***Pristiloma arcticum crateris*** Pilsbry, 1946 in Frest & Johannes (1993c).

Ecology: Uncertain. Related species found at high elevations live along small streams, in leaf litter in forest, near the edges of seeps or bogs, and under cushion plants in open mountain meadows. Persistence of moisture for a good part of the year is a ***desideratum.***

Original distribution: A single site in Crater Lake National Park, Klamath Co., OR.

Cwrrent distribution: Uncertain; has not been recollected recently. Occurrence in adjoining portions of Umpqua and Winema National Forests, including areas considered for protection of the Northern Spotted Owl, is possible.

Threats: Uncertain; most of the area surrounding Crater Lake National Park have been logged and are currently being grazed,

Criteria for inclusion: Local endemic; occurrence on public lands.

Recommended status: This species has no special status at present. It was recommended as a listing candidate by Frest & Johannes (1993c). At the least, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (OR) listing as Threatened is appropriate for the reasons just cited.

References: Henderson (1929a); Pilsbry (1946); Frest & Johannes (1993c).

Pristiloma (Pristinopsis) idahoense (Pilsbry, 1902) thinlip tightcoil

Type locality: Stevens Ranch, Weiser Canyon (Weiser River), Adams Co., ID. Holotype ANSP 82353.

Description: The best summary description and illustration are in Pilsbry (1946); see also Baker (1931). As regards shell features, the close coiling and yellowish vitreous shell color distinguish this species from the related ***Pristiloma lansingi*** and ***Pristiloma arcticum***.

Ecology: A somewhat mesophilic species occurring generally in rather open-largely closed-canopy Ponderosa pine-Douglas fir forests, at rather bw elevations, on a variety of substrates. In general, moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture for at least part of the year is a ***desideratum.*** Land snail associates include species of ***Crypromasrix*** (especially ***mullani mullani***) and ***Allogona, Radiodiscus abietum, Microphysula ingersolli***, and some more widespread forms (Baker, 1932). On occasion, this species has been found with such ***rare*** taxa as ***Megomphix lutarius***, ***Polygyrella polygyrella, Oreohelix haydeni hesperia, Pristiloma subrupicola,*** and ***Crypromastix mullani latilabris***.

Original distribution: Reported formerly from the following ID counties: Adams, Boise, Benewah, Boise, Clearwater, Idaho, Kootenai, and Shoshone. Included are sites currently in Payette, Nez Perce, Clearwater, and the Idaho Panhandle National Forests.

Current distribution: Uncertain; we have not found this taxon at many of the old sites; nor has Brunson at his western MT sites. T. Burke (***pers. comm.***, 1994) has not collected this species in eastern WA. Recently collected at one site in the lower Salmon River drainage (Frest & Johannes, 1995a). S. Welty (***pers. wmm.,*** 1994) has also repeatedly tried unsuccessfully to recollect this species at some of the old sites, e.g. Rabbit Creek.

Threats Most of the former range has been logged and is now grazed. Other sites are part of the Coeur d'Alene-Kingston mining district. Some of this area has been severely affected by smelter emissions and mining wastes. Certainly, population trends (in number of sites and number of individuals) are downward.

Criteria for inclusion: A regional endemic, reported from a small number of widely scattered sites; lack of recent collections; threats in areas of known past occurrence: occurrence on public lands.

Recommended status: This taxon has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (ID) listing as Threatened may be appropriate for the reasons cited above.

References: Pilsbry (1902a, 1946); Baker (1932); Deixis collections, 1990.

Pristiloma (Priscovitrea?) wescoense (Hemphill, 1911) shiny tightcoil

Type locality: The type locality is a characteristically vague Hemphill site (Wasco Co., OR). We have not seen the holotype of this species; most specimens are in the ANSP.

Description: See Pilsbry (1946) for description and illustrations. The comparatively large size, perforate umbilicus, and numerous, closely spaced whorls seem distinctive. We have not examined material from all reported sites; but suspect that the species is composite. Were this the case, the ranges of each resultant taxon likely would be rather narrowly circumscribed. The anatomy is unknown.

Ecology: Most reported localities are from Douglas fir and Ponderosa pine forests, at moderate-high elevations. Associates are uncertain, due to lack of recent records. Cascades sites have such species as ***Haplotrema vancouverense, Ancotrema sportella***, ***Euconulus fulvus*** alaskensis, and Pristiloma

lansingi. The eastern WA record is a relatively moist, shaded basalt cliff and talus with *Populus* cover. Associated land snails included ***Anguipira kochi occidentalis*** and ***Cryptomastix mullani olneyae***.

Original distribution: This species was reported by Pilsbry (1946) from about 5 sites: Washington, Adams, Boise, and Shoshone cos., ID, and Walbwa Co., OR. Branson (1980) has more recent records from the WA Cascades (Mount Rainier National Park). The earlier record from the Olympics (Branson, 1977) is doubtful, and the Cascades specimens need to be compared with Wasco Co., OR material.

Current distribution: We have recently collected this species from one site each in western and eastern WA. The species does not seem to occur in western MT, according to R. B. Brunson, and has not been reported in recent collections from northeastern WA (T. Burke). We have tried a number of sites in Wasco *Co.* without finding this taxon. Our Shoshone Co. and lower Salmon River localities also have not produced this species. Glacier National Park (MT) and CA Sierras specimens are best relegated to other taxa.

Threats: Much of the area within the original range has been logged or is slated for logging. Much of the clear-cut area is heavily grazed afterwards, essentially precluding recolonization.

Criteria for inclusion: Local endemic; occurrence on public lands; loss of historic sites and habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (WA, OR, ID) listing as Threatened is appropriate for the reasons just cited.

References: Hemphill (1911); Pilsbry (1946); Deixis collections, 1990-l 993.

Vespericola columbiana depressa (Pilsbry & Henderson, 1936) Dalles hesperian

Type locality: The Dalles, Wasco Co., OR; holotype UCM 22519 (former Stanford University 5870?); paratypes ANSP 162435. See Wu & Brandauer (1982) for UCM types.

Description: The best description and illustrations are those of Pilsbry (1940); see also Pilsbry & Henderson (1936). This is likely at least a full species, anatomically very different from ***Vespericola columbiana (see*** redescription of this species in Roth & Miller, 1993b). Conchologically, there are several obvious ***differentiae:*** the shell is more depressed; generally greenish-yellowish brown instead of dark cinnamon red; has a flattened, rather than convex, base; is generally not at all hirsute; and has a distinctly open, though small, umbilicus. This taxon was cited incorrectly as ***Vespericola depressa*** in Frest & Johannes (1993c).

Ecology: Found in lowland forests and in basalt taluses, with and without cover. Common plant associates are ***Celtus, Prunus, Balsamorrhiza, Rhus, Rubrus, Rosa,*** and ***Clematis.*** This species sometimes occurs with ***Cryptomastix hendersoni, Monadenia fidelis minor,*** or ***Oreohelix variabilis.*** Lowland forest colonies are often rather sparse; deciduous understory plants are common, and association with very moist areas (sometimes with such plants as skunk cabbage) is the rule. In such situations, moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. This species can occur right next to permanent streams, and is a strong mesophile; it is moderately notophilic, though not so much ***as*** many ***Vespericola*** species. Persistence of moisture is a ***desideratum.*** In drier areas, association with springs or seeps (often with ***Mimulus, Rorippa,*** and ***Cicuta*** cover) in basalt taluses is almost invariant.

Original distribution: Columbia Gorge from about Vancouver, WA to Rufus, OR; Clark, Skamania, and Klickitat Cos., WA and Hood River, Wasco, and Sherman ws., OR.

Current distribution: Survives at very scattered localities in the original range, which includes sites in Hood River National Forest and Columbia River Gorge National Scenic Area (possibly, sites in Gifford Pinchot National Forest as well). Can occur with the candidate Larch Mountain salamander ***Plethodon larselli,*** and should be managed with this in mind.

Threats: Much of the original range has been selectively impacted by highway (OR 216, I-84) and railroad track (Burlington Northern, Union Pacific) placement, and by development in the Columbia Gorge. Several extinct colonies have been noted in the eastern Gorge area. Talus spring sites have been impacted by dam and highway construction and by diversion for fish hatcheries and human and stock water supply. Much of the eastern Gorge area is heavily grazed, which has essentially extirpated some colonies. Recent intense fires have also impacted sites severely. Downward trends in population and number of sites are evident.

Recommended status: At present, this species has no special status. Frest & Johannes (1993c) recommended its listing. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient evidence exists to support Endangered listing federally and in WA and OR. A distinct taxon at the species level or higher. We conducted extensive surveys in the Gorge for this and other taxa, 1987-I 992. It is unlikely that the range or total number of live colonies will be significantly expanded by future work.

References: Pilsbry (1939); Frest & Johannes (1993c); Deixis Consultants, 1987-92.

Vespericola n. sp. 1 Oak Springs hesperian

Type locality: None designated as yet; undescribed taxon.

Description: This species is reddish-brown in color, with a thin, reddish-brown apertural lip lacking dentition; no parietal tooth is present, either. The shell is low-spired, with a distinctly convex, well-rounded base and minute umbilicus. The periostracum is completely and finely hirsute, somewhat as in ***Vespericola pilosa.*** Internally, this species bears some resemblance to ***Vespericola columbiana depressa;*** and does not closely resemble typical forms such ***as pilosa.*** It differs from ***depressa*** in the convex base: reddish color; very small umbilicus; and dense pelage. Anatomically this taxon more closely resembles ***depressa*** than ***pilosa.***

Ecology: Found in portions of a single nasmode; a definite notophile. Common plant associates are ***Cornus stolonifera, Salix*** spp., ***Physocatpus, Rhus, Rubrus, Rosa,*** and ***Clematis. This*** species occurs with ***Monadenia fidelis minor*** and ***an Ancotrema*** of uncertain affinities. One colony occurs in rather dry sage scrub; but the areas with this species have perennial seeps, and association with very moist areas is typical. The substrate is basalt. Persistence of moisture is a ***desideratum.*** In drier areas, association with springs or seeps (often with ***Mimulus, Rorippa,*** and ***Cicuta*** cover) in basalt taluses or short cliffs is invariant.

Original distribution: Central portion of the Lower Deschutes River corridor, mostly in the vicinity of Maupin, Wasw Co., OR.

Current distribution: Survives at very scattered localities in the original range, which includes sites in the Lower Deschutes Wild and Scenic River; and apparently on BLM-Prineville lands as well.

Threats: Much of the original range has been selectively impacted by road and railroad track (Burlington Northern placement, and by development in the Deschutes River valley. Several extinct colonies have been noted in the Maupin area. Talus sites have been impacted by hatchery and road construction and by diversion for fish hatchery and human and stock water supply. Much of the Lower Deschutes River corridor area is heavily grazed, which has essentially extirpated some colonies. Recent intense fires have also impacted sites severely. Downward trends in population and number of sites are evident.

Recreational usage of this area has increased dramatically in the last few years. Plans by the BLM for more 'roads, campgrounds, and other recreation enhancements (BLM, 1993a, b) will impact this species negatively unless done carefully.

Recommended status: At present, this species has no special status. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient evidence exists to support Endangered listing federally and in OR. A distinct taxon at the species level or higher. We conducted extensive suweys in the nearby Columbia Gorge and Deschutes corridor for this and other taxa, 1987-l 993. It is unlikely that the range or total number of live colonies will be significantly expanded by future work.

References: Pilsbry (1939); Deixis Consultants, 1987-93.

Vespericola sierranus (Berry, 1921) Siskiyou hesperian

Type locality: Two miles north of Weed, Siskiiou Co., CA; holotype Berry 5087; paratype ANSP 130455.

Description: The best description and illustrations at present are those of Pilsbry (1940). We anticipate more thorough treatment sometime in the future by B. Roth. There is some possibility that this species is composite: in particular, the Upper Klamath Lake population has distinctive shell features. We have not yet had time to examine the anatomy of this form.

Ecology: Spring seeps, deep leaf litter along stream banks, and under debris on ground (Roth, 1993). Moist valley, ravine, gorge, or talus sites are prefened, *i.e.* bw on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a *desideratum,* and this species may occur in areas with running water or alongside streams and spring pools. It has been found on such plants *as Rorippa,* in association with other *Vespericola* species, *Prophysaon, Oxyloma*, and *Deroceras.* A strong notophile.

Original distribution: Broadly scattered sites in the following counties: OR, Jackson, Klamath; CA, Siskiiou, Plumas, Nevada, Placer, El Dorado (Roth, 1993).

Current distribution: Cited by Roth (1993) from about 17 localities. Among other areas, there are sites in Shasta and Trinity National Forest. Other localities apparently with this species are in Rogue River National Forest and on BLM lands (Medford District). Recently (1994), a single site was found in Klamath Co., OR (Upper Klamath Lake).

Criteria for inclusion: Old growth and riparian associate; occurrence on public lands.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal listing as Threatened is appropriate for the reasons just cited. Note extensive recent searches by Roth, Miller, and Frest & Johannes (summarized in Roth (1993) and Frest & Johannes (1995c)). It was recommended for listing by Frest & Johannes (1993c).

References: Pilsbry (1940); Roth (1972, 1993); Frest & Johannes (1993c, 1994, 1995c); Deixis Consultants, 1991-94.

Slugs

Hemphillia came/us Pilsbry & Vanatta, 1887 pale jumping-slug

Type locality: Old Mission (most likely near site of Cataldo Mission, not current Old Mission State Park), Kootenai Co., ID; holotype ANSP 63926a.

Description: The best description is Pilsbry (1948); but see Pilsbry & Vanatta (1897, 1898) also.

Ecology: This mesophile-notophile slug species is found mostly in relatively intact ***Pinus ponderosa-Pseudotsuga menziesii*** forest, generally at lower elevations along near major streams. Moist valley, ravine, gorge, or talus sites are preferred, i.e. low on a slope and near permanent or persistent water, but' not normally subject to regular or catastrophic flooding. Persistent moisture and a rich, flora, including a diverse understory and well-developed duff layer, are characteristic, Sites at which we have collected this species had a diverse deciduous understory, rich forb, and nonvascular flora as well, and tended to be closed- nearly closed-canopy forests with large, widely-spaced conifers. Substrate was predominantly basalt; but limestone- and schist-derived soils were noted at some old sites. The accompanying land snail fauna is generally diverse also, and includes such species ***as Anguispira nimapuna, Anguispira kochi occidentalis, Polygyrella polygyrella***, ***Cryptomastix mullani*** subspp. and other ***Cryptomastix*** species, ***Allogona lombardii***, ***Allogona ptychophora ptychophora,*** and the slug ***Zacoleus idahoensis.***

Original distribution: Portions of the upper Coeur d'Alene River drainage, including the lower St. Joe River valley; portions of the upper Clearwater River drainage, including the Selway River valley and South Fork Clearwater River valley: ?part of the lower Salmon River valley: Kootenai, Shoshone, Clearwater, and Idaho cos., ID. Historic sites were in Clearwater National Forest; St. Joe National Forest; Nez Perce National Forest; and possibly on Nez Perce Tribe lands.

Current distribution: Survives at relatively undisturbed sites in portions of its old range. We have recently collected specimens along the South Fork Clearwater River and Selway River drainages. Slugs of this genus reported from the lower Salmon River area may be another species (Frest & Johannes, 1995a). We were unable to collect this species at several of the old sites, including the type locality, in 1991 and 1994. R. B. Brunson (*pers. comm.*, 1992) did not find this species in western Montana.

Threats: Logging and forest fires in much of the original habitat. This species, like most ***Hemphillia***, ***is*** relatively sensitive to disturbance, unlike some other slug genera. Much of the area logged has been grazed; and the species is absent from grazed areas. Highway location along the major river corridors has also substantially reduced habitat, e.g. ID 3, 14, & 50, US 12. Mining, smelting, and wastes from such operations have severely affected portions of the historic range also.

Criteria for inclusion: Local endemic; reduced habitat and ongoing threats; loss of historic sites. Population trends (number of sites, number of individuals) are downward.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (ID) listing as Threatened is appropriate for the reasons just cited.

References: Pilsbry (1946); Pilsbry & Vanatta (1897, 1898); Deixis collections, 1991-l 994.

Hemphillia danielsi Vanatta, 1914 marbled jumping-slug

Type locality: Camas Creek, Bitterroot Mountains, Ravalli Co., MT; holotype ANSP 110052.

Description: For best description and illustrations, see Pilsbry (1948); see also Vanatta (1914). This is evidently a well-marked species, at the edge of the known distribution for the genus.

Ecology: This species appears to be characteristic of moderate-elevation, relatively rich *Pinus ponderosa* forest. A diverse understory, comparatively moist conditions, and intact litter (duff) layer would seem to be *desiderata.* Moist valley, ravine, gorge, or talus sites are preferred, *i.e.* low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a significant feature. Occurrence with such species *as Udosarx lyrata lyrata, Cryptomastix mullani mullani,* and *Allogona ptychophora pfychophora* has been noted. A mesophile-slight notophile.

Original distribution: Found at several sites on the eastern slope of the Bitterroot Mountains, Ravalli Co., MT (Biierroot National Forest).

Current distribution: Uncertain, has been collected very seldom recently. We have not found this species as yet on the eastern (Lemhi Co., ID) side of the Bitterroots.

Threats: Logging and grazing in much of the lower and middle elevations of the Bitterroots; resort development at one old site.

Criteria for inclusion: Local endemic; occurrence in relatively limited habitat; past and ongoing human modifications of preferred habitat: occurrence on public lands. The species would seem to be declining in terms of numbers and habitat. It is unlikely that future research will significantly expand the geographic range.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (MT) listing as Threatened is appropriate for the reasons just cited.

References: Vanatta (1914); Pilsbry (1948); Deixis collections, 1991 .

Hemphillia malonei Pilsbry, 1917 Malone jumping-slug

Type locality: Tawney's Hotel, Salmon River, 12 mi. from Mt. Hood, Clackamas Co., OR; holotype ANSP 115577.

Description: See Pilsbry (1948); and more complete information in Kozloff & Vance (1958). Cited in Frest & Johannes (1993c) as *Hemphillia malonei* Pilsbry, 1917.

Ecology: Generally in partly open but uncut forest, at low to high elevations (type locality at 1,600'; others at 3,900'); typically in rather moist Douglas fir forest with diverse forbs and well-developed litter. Moist valley, ravine, gorge, or talus sites are preferred, *i.e.* low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a *desideratum.* A mesophile-slight notophile.

Original distribution: Western and central Columbia Gorge in Hood River Co., Clackamas Co., Clatsop Co., and Multnomah Co., OR; could also extend into WA (particularly Clark and Skamania cos.). Extralimital sites mentioned by Pilsbry (1948) are more plausibly assigned to other *Hemphillia* species, such as *Hemphillia dromedarius* (for discussion of this species and its distribution see Branson (1972, 1980)). Pilsbry had rather limited material of this species available to him. Alcohol specimens tend to lose pigment readily, and his comparisons to *Hemphillia came/us* were based on preserved material only, and seem somewhat far-fetched if live or recently preserved material of both is compared.

Current distribution: Known to survive at Larch Mountain, Multnomah Co., OR (Kozloff & Vance, 1958; recollected in 1990). Other sites are in Clatsop State Forest, Mt. Hood National Forest, and the Columbia

River Gorge National Scenic Area (see, e.g., Branson & Branson, 1984). This species may co-occur with the Larch Mountain salamander *Plethodon larselli.*

Criteria for inclusion: Old growth and riparian association; local endemic; occurrence on public lands, including Mt. Hood National Forest, Clatsop State Forest, and Columbia Gorge National Scenic Area.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (OR) listing as Endangered is appropriate for the reasons just cited. At present, no populations from WA are known; and no status recommendations for that State are made. It is unlikely that the range of this taxon will be expanded significantly by future work. Frest & Johannes (1993c) recommended listing of this taxon previously.

References: Pilsbry (1948); Kozloff & Vance (1958); Branson & Branson (1984); Frest & Johannes (1993c); Deixis Consultants, 1989-90.

Magnipelta mycophaga Pilsbry, 1953 spotted slug

Type locality: Lolo Pass, Clearwater National Forest, Idaho Co., ID; holotype CAS 32540; other specimens USNM 850557.

Description: For best description and illustration see Pilsbry & Brunson (1954); see also Pilsbry (1953) and Webb & Russell (1977). This monospecific genus does not closely resemble any other described North American slug.

Ecology: Like various *Hemphillia* species, this taxon prefers moist, cool, and relatively undisturbed forest with a diverse understory and intact duff (litter) layer. Moist valley, ravine, gorge, or talus sites are preferred, *i.e.* low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture *is* a *desideratum.* This taxon appears to be mesophilic to slightly notophilic. At the best-known site, this species was associated with *Allogona ptychophora pfychophora* and *Cryptomastix mullani mullani,* in *Picea englemani-Abies lasiocarpus* forest (Pilsbry & Brunson, 1954). At the type locality, the rather open subalpine forest is primarily *Pinus albicaulus* and *Abies lasiocarpus*. Mollusk associates include *Cryptomastix mullani mullani, Zacoleus idahoensis,* and *Udosarx lyrata lyrata*. Elevations at sites range from 4,500-7,500'.

Original distribution: Portions of western MT (Salish Mountains, Flathead National Forest, Flathead Co.; Sapphire and Garnet ranges, Lolo National Forest, Missoula Co.), the ID Panhandle (Bitterroot Mountains, Clearwater National Forest, Idaho Co.), and NE WA (Ferry Co.). The WA sites were discovered by T. Burke, Wenatchee National Forest.

Current distribution: Survives in limited colonies within the original range.

Threats: Much of the original range has been logged or is slated for logging. Much of the logged terrain is currently being grazed. The slug is absent from all but relatively undisturbed sites. Urban expansion in Missoula area is also of concern.

Criteria for inclusion: Local endemic; monospecific genus; past and continued threats to habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (WA, ID, MT) listing as Endangered is appropriate for the reasons just cited. Substantive expansion of the range of this large and distinctive taxon due to future work is unlikely.

References: Pilsbry (1953); Pilsbry & Branson (1954); Webb & Russell (1977).

Prophysaon humile Cockerell, 1890 smoky taildropper

Type locality: Location of holotype uncertain; type locality woods around Coeur d'Alene Lake, Kootenai Co., ID.

Description: See Cockerell (1890) and Pilsbry (1948) for best descriptions and illustrations.

Ecology: A strong mesophile-notophile, found mostly in low-medium elevation pine and spruce forests. Sites with perennial moisture and much downed wood are preferable, especially if accompanied by a diverse understory with a strong deciduous and forb component. Moist valley, ravine, gorge, or talus sites are preferred, *i.e.* low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a *desideratum.* Associates include *Hemphillia camelus*, *Allogona ptychophora ptychophora, Anguispira kochi occidentalis, Cryptomastix mullani mullani* and other *Cryptomastix* spp., *Polygyrella polygyrella,* and *Radiodiscus abietum.* Substrate includes basalt and various igneous lithologies. Most old sites were in river and major stream valleys, at the base of major slopes. Allowing for differences in dominant tree species, habitats for western Cascades and Coast Range *Prophysaon* species are quite similar. See Frest & Johannes (1993c) for discussion.

Original distribution: Probably originally very widespread in the Idaho Panhandle, *i.e.* in the Bitterroot Range Benewah, Clearwater, Kootenai, and Shoshone cos., ID. This taxon should occur in adjoining portions of MT and WA as well, although definite recent records are lacking. Old sites are in Clearwater National Forest and St. Joe National Forest. Site on the Coeur d'Alene Reservation are possible also.

Current distribution: Still survives in Shoshone Co. (collected 1994); likely to occur in scattered sites within the original range, e.g. Branson, Sisk, & McCoy (1966). We have unsuccessfully tried to recollect some of the old sites (1994).

Threats: Development around Coeur d'Alene Lake is extensive and recent. Mining and smelting operations in the Coeur d'Alene District have been widespread and have had long-term (still ongoing) effects. Roads along the major river corridors within the range (e.g. I-90; ID 3; Co. 4, 50) are likely to have been placed in optimum habitat for this species.

Criteria for inclusion: Local endemic: loss of habitat: loss of historic sites; ongoing and past habitat modification and threats. The range is unlikely to be significantly expanded by future finds.

Recommended status: This species has no special status at present. It should at least be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (ID) listing as Threatened is appropriate for the reasons just cited.

References: Cockerell (1890); Pilsbry (1948); Deixis collections, 1992-l 994.

Udosarx lyrata lyrata Webb, 1959 lyre mantleslug

Type locality: "About 2.5 miles down from the crest of Lolo Pass, Clearwater County, Idaho; and about 39 miles from Lolo, Montana" (Webb, 1959); this would be in Clearwater National Forest, about 2 mi. W. from US 12 on FR 595. See also Webb (1980). Location of the type is not known; presumably in Webb collection.

Description: See Webb (1959, 1980) for description and illustrations.

Ecology: Subalpine mixed pine and fir forest with common forbs and fallen wood characterize the type locality. Other sites are as typical for mesophile species: moist valley, ravine, gorge, or talus sites are preferred, ***i.e.*** low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture for a significant ***part*** of the year ***is*** a ***desideratum.*** Associated larger mollusks in the Lolo Pass area include ***Polygyrella polygyrella, Hemphillia danielsi, Cryptomastix mullani mullani, Radiodiscus abietum, Microphysula ingersolli, Oreohelix subrudis, Anguispira kochi occidentalis,*** and ***Euconulus fulvus alaskensis.***

Original distribution: Scattered sites in the Bitterroot Mountains and upper Clearwater River and Clark Fork drainages, Clearwater National Forest, Idaho and Clearwater cos., ID and Lolo National Forest, Missoula Co., MT.

Current distribution: Known to survive in scattered sites in the original range. We collected one Idaho Co., ID site in 1993.

Threats: Much of the region has been or is slated for logging; much is currently being grazed; and the species seems to be absent from heavily modified areas. Major forest fires within the upper Clearwater (Lochsa and Selway drainages), both in 1910 and more recently, have considerably reduced the potential range also.

Criteria for inclusion: Local endemic; occurrence on public lands; monospecific genus.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (ID, MT) listing as Threatened may be appropriate for the reasons just cited.

References: Webb (1959); Webb (1980); Deixis collections, 1993.

Udosarx lyrata russelli Webb, 1980 Russell mantleslug

Type locality: S.-facing slope one mi. W. of Potomac, Missoula Co., MT, above Union Creek overflow ponds. Types presumably in Webb collection.

Description: See Webb (1980) for description and illustration; also Burch & Pearce (1990), who illustrate this taxon under the name ***Zacoleus lyrata russelli.*** Transfer of this taxon to ***Zacoleus*** could be justified (although note Webb's (1959, 1980) explicit rejection of this possibility); but has not yet been substantiated in any way by Burch & Pearce (T. Pearce, ***pers. comm.***, 1994).

Ecology: The type (and only known) locality is open and moist coniferous forest; altitude 3,500'. Available information suggests that this taxon is a mesophile, with typical requirements. Moist valley, ravine, gorge, or talus sites are likely preferred, ***i.e.*** low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture for a significant part of the year is a ***desideratum.***

Original distribution: A single localii in the Garnet Range; this site may be on Lolo National Forest lands.

Current distribution: Presumably survives at the type locality, although this has not been rechecked recently.

Threats: Grazing; logging and clearing in the Union Creek floodplain.

Criteria for inclusion: Local endemic; occurrence on public lands; past and future land modifications in vicinity of only known site.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (MT) listing as Threatened may be appropriate for the reasons just cited.

References: Webb (1980); Burch & Pearce (1990).

Freshwater Snails

Amnicola n. sp. 1 Washington duskysnail

Type locality: Will be designated at time of formal description.

Description: Shell similar to that of ***Amnicola limosa*** (see Hershler & Thompson, 1988); height to. 5.0 mm: ovate-conic, well-rounded whorls; comparatively thin; 4-5 whorls in adult; small umbilicus. Body similar to ***Amnicola limosa***, but dark pigment on mantle concentrated in bar parallel to edge of pallial cavity, then in dark streak along intestine and digestive gland; no bar on outside cephalic tentacles, although a faint central band is sometimes present. This taxon is illustrated as ***Amnicola limosa*** in Taylor & Bright (1987).

Ecology: Found in kettle lakes among aquatic macrophyte beds, generally on soft but well-oxygenated substrate, e.g. marl. Absent from dense macrophytes or in areas with anoxic sediments. Depth generally 2-6'+. This species grazes periphyton, apparently from macrophyte surfaces, but is also a detritivore. It is apparently a limnophile, unlike Amnicola limosa, which occurs in streams as well.

Original distribution: Probably once common in kettle lakes E. of the Cascades crest and W. of the Mississippi drainage, in a narrow band in northern WA, the ID Panhandle, and NW MT.

Current distribution: Known currently from 3 sites, 2 in northern WA and 1 in NW MT.

Threats: This species is not found in strongly eutropified kettle fakes, nor in streams. Lakes used as part of irrigation systems, with untreated sewage, or having other sources of nutrient enrichment, seem to lack the species. Many of the kettle takes in the area of occurrence have heavily developed shorelines, including housing with inadequate provisions for sewage and runoff management. Siltation in many of these formerly cobble-bottom oligotrophic environments is also a problem, exacerbated by logging, grazing, and residential development. Lakes with extensive treatment to kill out aquatic macrophytes or to stock game fish or modify the native fish fauna also seem to lack this species. The great majority of northern WA, ID, and NW MT kettle lakes have one or several of such problems.. The species is definitely declining in terms of populations and number of individuals.

Criteria for inclusion: Local endemic; occurrence on public lands; ongoing major threats; very substantial reduction in habitat. Habitat and range for this taxon are unlikely to be substantially expanded by future work.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent suwey work, to indicate that Federal and State (WA, MT) listing as Endangered is appropriate. No recommendation for ID populations (ii any) can be made at present.

References: Deixis collections, 1991-l 993.

Fisherola nuttalli **(Haldeman, 1843)** **shortface lanx**

Type locality: "Lower Columbia River" near the old mouth of the Willamette River near Portland, Multnomah Co., OR (could have been from the Willamette River itself also: see Frest & Neitzel (in press, a)); Holotype of ***Ancylus crassus=Fisherola nuttalli*** ANSP 124320; paratype of ***Ancylus crassus*** ANSP 350079 (both said to be from Spokane River, WA); other Nuttall specimens USNM 169958, from the Willamette River near Portland, OR.

Description: The best description and illustrations are those of Frest & Neitzel (in press, a); see also Burch (1989).

Ecology: Generally found in unpolluted swift-flowing, highly oxygenated cold water on stable boulder-gravel substrate, often in the vicinity of rapids, in small to large rivers. Macrophytes are generally rare to absent at sites with this species, as is epiphytic algae. This species sometimes occurs with ***Fluminicola columbiana***. For details, see Frest & Neitzel (in press, a).

Original distribution: Formerly widespread in the lower Columbia River, Snake River, and a few major tributaries, WA-OR-ID-MT-BC. For details, see Frest & Neitzel (in press, a). Most of the old sites are known to be extirpated, e.g. Frest & Johannes (1993g); Neitzel & Frest, 1989, 1993; Frest & Neitzel (in press, a).

Current distribution: The lower Columbia River populations are largely extinct due to habitat modification caused by Bonneville Power Administration [BPA] dams and impoundments, although one occurrence is known near Bonneville Dam (from NMFS collections, 1990): still suwives in the Hanford Reach, WA; the lower Deschutes River and the John Day River, OR; part of the Snake River (middle Snake, ID; Hells Canyon, OR-ID); the Salmon River, ID, and the Methow and Okanogan rivers, WA: see Neitzel & Frest (1989, 1992, 1993), Frest & Neitzel (in press, a), and Frest & Johannes (1991a, b; 1993c) for details. Many of these areas are on (or influenced by management practices on) federal lands, e.g. Hanford Site (DOE), Deschutes Wild and Scenic River, Hells Canyon National Recreation Area: Okanogan National Forest; Gifford Pinchot National Forest; Mt. Hood National Forest; and Bonneville Power Administration.

Threats: Impoundment and damming of much of the original habitat; sedimentation; orchard runoff; nutrient enrichment due to agricultural practices; pulp mill effluents; metal smelting residues and discharges.

Criteria for inclusion: Riparian associate; current federal candidate; occurs on public lands.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. NPS (1994) seems barely aware of this taxon. Recommended as Federally Threatened; Threatened in WA; Threatened in OR; Endangered in MT; and Endangered in ID. Note extensive recent surveys specifically for this taxon. Currently a Category 3 Federal candidate USFWS, 1994a). Recommended for listing by Frest & Johannes (1993c). USFWS (1994b) recently rejected a petition to upgrade the status of this species.

References: Taylor (1982a); Neitzel & Frest (1989, 1990, 1992, 1993); USFWS (1991, 1994a, b); Frest & Neitzel (in press, a): Frest & Johannes (1991a, b; 1993b, c); Deixis collections, 1987-1994.

Fluminicola fuscus **(Haldeman, 1841)** **Columbia pebblesnail**

Type locality: Type not located; type locality "Oregon"; claimed (Baker, 1964) holotype and paratypes (ANSP 27772, 27774) may not be (see Hershler & Frest (in press); lectotype and paralectotypes of *Amnicola hindsi* Baird, 1863, type locality "River Kootanie" *[sic:* Kootenay River, British Columbia], BMNH 1863.2.4.17A, 1863.2.4.17, to be designated by Hershler & Frest (in press); lectotype of ***Numinicola columbiana*** Hemphill in Pilsbry, 1899 ANSP 27767; type locality Columbia River, probably at Wallula, Walla Walla Co., WA. Coan (1985) and Coan & Roth (1987) ascribe the species to Keep (1887) as ***Fluminicola nuttalliana columbiana*** Keep, 1887, unlike essentially all other authors. They may be technically correct (ICZN, 1985, Articles 10-12, 50), for even though the name is first mentioned in Hemphill (1881), it was there unaccompanied by a description, definition, or indication; and a short description is supplied in Keep (1887). However, the situation for this and other Hemphill and Carpenter species described under similar circumstances may not be so straightforward.

Contra Coan & Roth (1987, p. 327), there is no compelling reason to believe that ***Fluminicola nuttalliana columbiana*** Keep, 1887 is the ***same as Fluminicola columbiana*** Hemphill in Pilsbry, 1899 [more properly, ***Fluminicola columbiana*** Pilsbry, 1899, according to ICZN (1985) rules, if it is assumed that the description in Pilsbry (1899) was wriien by Pilsbry and not derived from communications with Hemphill; in the latter case, the traditional usage would be correct], even if both were derived from Hemphill lots. According to Coan & Roth (1987, p. 322) Hemphill "lumped together under a single locality specimens from numerous stations". If this is so, the only way to be even reasonably 'certain that the specimens in Keep's collection were the same taxon as other Hemphill specimens ascribed by Hemphill to the same taxon, let alone from the same locality, would be by direct comparison. Moreover, the types for the 1887 names would have to be drawn from the material in Keep's possession, e.g. "if, ***on*** the other hand, a name was made available by "Pilsbry, ex Hemphill MS", or the like, then the converse is the case: supposed Hemphill syntypes have no standing: the type material is only that which Pilsbry (or some other author) consulted" (Coan & Roth, 1987, p. 324). We agree that this follows from Coan & Roth's assumptions; but in this case, much of the type material accepted by Coan & Roth (1987) is incongruent with their choice of author and date for the involved taxa. As far as we can determine, no Keep types for these taxa were originally designated; nor are Keep type lots, from which valid subsequent designations could be made, known to exist (Coan, 1985); this is not surprising, as Keep was not a taxonomist. It is also quite possible that the description used by Keep (1887) derives from Hemphill; in which case the onty real addition by Keep is publication. Under such circumstances, the name would be validated; but as Hemphill in Keep, 1887. Further, the descriptions in Keep (1887) are very brief, so much so as to be only dubiously adequate. Again, Keep's intent should be borne in mind; it was not to provide a scientifically credible description. If the descriptions are inadequate, as sometimes stated by Coan (1985), then the Keep names should at best be considered ***nomina dubia,*** or at worst unrecognizable.

It is also questionable that Keep can be considered "alone responsible both for the name and for satisfying the criteria of availability other than publication" (ICZN, 1985, p. 91 [Article 50 (a)]). Keep himself ascribes the names to other authors; and the sources of'these names, which include Hemphill (1881), Hemphill labels, Carpenter labels, and a Carpenter ms. [and may well also have included personal correspondence], are known. The same consideration also applies to Pilsbry (1899) in regard to ***Fluminicola columbiana*** Hemphill in Pilsbry, 1899. If it may equally be doubted that the ascribed authors, rather than the authors responsible for publication, in these cases satisfy the requirements for availability, this does not particularly enhance the case for ascription to the publication authors, but rather that for considering the names dubious, unavailable at that point, or unrecognizable.

Keep was essentially a popularizer, not a taxonomist, as his whole published corpus makes clear (Coan, 1985). It is evident that he did not intend to formally describe ***as*** new ***Fluminicola columbiana or*** any of the other taxa in Keep (1887) whose names are ascribed to him by Coan (1985). The work involved is very obviously intended as a popular-level treatment of already-named taxa. Keep himself ascribed these taxa to other authors: and later workers, almost without exception, did so likewise [note, e.g. that Burch, 1982 assigned ***Numinicola columbiana*** to Hemphill, not Keep as asserted by Coan (1985); this is consistent with Burch & Tottenham, 1980 and Burch, 1989]. We think that, in the meaning of Article 50, it is clear that responsibility for the Keep (1887) names themselves, other than publication, is due to other authors; hence the species are properly ascribed to these authors, not to Keep. Under these circumstances, it is perhaps better either to 1) retain traditional usage and consider the Keep name for each as a ***nomen nudum***, ***nomen dubium*** or ***species inquirenda;*** or alternatively 2) to ascribe the names to the original authors as "---- in Keep, 1887'. If conservation of the 'I---- in Keep, 1887" name is desirable, then consideration of either 1) designation of a neotype from material labeled as type material by the species author [not Keep] or reasonably believed to be such; or 2) restriction of the 1887 name to

the [missing or nonexistent] Keep types, e.g. as done by Paul (1971) for missing cystoid holotypes may be preferable.

In short, we argue that the names in question originate with Hemphill or Carpenter; Keep's specimens came from Hemphill or Carpenter; Keep was not a taxonomist; Keep (1887) is not a taxonomic work but a popular work listing what Keep evidently thought were described species; and Keep himself ascribed the species to Hemphill or Carpenter. The first descriptions of these taxa, which occur in Keep (1887), are so brief as to make it difficult to recognize the species involved, and their authorship is not clear. If the descriptions are inadequate, then Keep's use of the names *at* best creates a *nomen dubium,* and traditional usage is correct. The critical question, if the descriptions are accepted as adequate, is their source. If they derive from Hemphill or Carpenter (e.g., letters or mss., such as the one later published as Hemphill (1890a)), then publication is the only contribution of Keep to the names; and they should therefore be credited to Hemphill or Carpenter in the format "_____ in Keep, 1887" under the provisions of Article 50 (ICZN, 1985). We regard the descriptions in Keep (1887) as inadequate and clearly not intended to describe new taxa but merely to differentiate them from other described taxa; and would prefer not to recognize the names as validated in the 1887 publication. Much of the justification for the few former usages of Keep names, e.g. Palmer (1958); Ponder (1985); and Coan (1985), in our view derives from usage of the earlier version of the Code (ICZN, 1964), in which the wording of Article 50 is somewhat different.

Description: See Hershler & Frest (in press) for shell and anatomy. This species until very recently was confused with several other taxa, and most commonly is cited *as Fluminicola columbiana* Hemphill in Pilsbry, *1899. Fluminicola nuttalliana columbiana* Keep, 1891, *Fluminicola columbiana* (Pilsbty, 1899), and *Fluminicola hindsi* (Baird, 1863) have been demonstrated to be synonyms (Hershler & Frest, in press). Cited as *Fluminicola columbiana* Hemphill in Pilsbry, 1899 in Frest & Johannes (1993c).

Ecology: Restricted to small-large rivers, in swift current on stable gravel to boulder substrate in cold, unpolluted, highly oxygenated water, generally in areas with few aquatic macrophytes or epiphytic algae. Sometimes co-occurs with *Fisherola nuttalli.* For detailed discussion, see Frest & Neitzel (in press, b).

Original distribution: Lower Columbia River and a few of its major tributaries in WA, OR, ID, and BC (and probably MT as well). For details, see Frest & Neitzel (in press, b). The record in Branson, Sisk, & McCoy (1966) is erroneous.

Current distribution: Possibly extinct in the lower Columbia River, WA-OR, and definitely extinct in most of the middle and upper Columbia River, WA, MT, and Briiish Columbia; and in the Payette River, ID; still survives in the Okanogan and Methow rivers, WA; the Hanford Reach, WA; and a limited portion of the Snake River and possibly a few of its tributaries (Frest & Neitzel, in press, b). Many of the remaining sites are on, or influenced by management practices on, federal lands, e.g. Hanford Site (DOE), Hells Canyon National Recreation Area; Okanogan National Forest; Gifford Pinchot National Forest; Mt. Hood National Forest; and Bonneville Power Administration. Lower Columbia River rocky and free-flowing lotic habitat largely has been eliminated by BPA dams and impoundments; siltation in this area has also been affected by agricultural practices and by clear-cutting on adjacent National Forests.

Threats: Impoundment and damming of much of the original habitat; sedimentation: orchard runoff; nutrient enrichment due to agricultural practices; pulp mill effluents; metal smelting residues and discharges.

Criteria for inclusion: Current federal candidate: occurrence on public lands; riparian associate.

Recommended status: Currently a Federal Category 2 candidate (USFWS, 1994a). At present has no special or protected status: minimally, this species should be considered sensitive by Forest Service, BLM, and other appropriate land management and wildlife personnel. It should be considered Endangered Federally and in WA, OR, and ID (Frest & Neitzel, in press). No recommendation is possible for MT at this time. Note extensive recent surveys specifically for this taxon. Recommended for listing by Frest & Johannes (1993a). USFWS (1994b) recently rejected a petition to upgrade the status of this species.

References: Pilsbry (1899a); Taylor (1982b); Neitzel & Frest (1989, 1990, 1992, 1993); USFWS (1991, 1994a, b); Frest & Johannes (1993c); Frest & Neitzel (in press, b).

Fluminicola minutissimus Pilsbry, 1907 pixie pebblesnail

Type locality: Price Valley, Weiser River drainage, Washington [now Adams] Co., ID; lectotype ANSP 94273. See Hershler & Frest (in press) for discussion of possible location of this site.

Description: Best description is by Hershler & Frest (in press). The anatomy remains unknown.

Ecology: Unknown. Appears to be a spring-dwelling taxon. Price Valley is in the headwaters of the Weiser River drainage, at moderate elevation. Much of the area is *Pinus ponderosa* forest, often with more recent Douglas fir plantings.

Original distribution: Known only from the type locality, mostly in Payette National Forest.

Current distribution: Has not been recollected in recent years, despite several attempts (Hershler & Frest, in press). The taxon could be extinct; but comprehensive survey of the upper Weiser drainage has not been undertaken as yet. Some surrounding areas, e.g. parts of eastern OR, Hells Canyon, and much of southern ID, have recently been suweyed in some detail for spring snails; but this taxon has not turned up, either at our sites or those of Hershler and his collaborators.

Threats: Much of the potential area of occurrence has been heavily grazed and logged, both of which activities continue. Springs in Price Valley have recently been diverted and capped for water supply., A large lumber mill is located near the mouth of Price Valley.

Criteria for inclusion: Local endemic; probable occurrence on public lands; ongoing and past threats to area of potential occurrence; apparent loss of historic site (type locality).

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (ID) listing as Endangered is appropriate for the reasons just cited above; recent surveys have been conducted, unsuccessfully (Hershler & Frest (in press). There is sufficient recently-collected information, and recent survey work, to indicate that listing is justified.

References: Pilsbry (1907); Hershler & Frest (in press).

Fluminicola n. sp. 1 Klamath pebblesnail

Type locality: None, as the species has yet to be described.

Description: See Frest & Johannes (1995b) for description. The tall subglobose conch, dark tentacles and eye patches but light body; and sickle-shaped, moderately large penis are distinctive features. This taxon was cited as *Fluminicola* n. sp. 1 in Frest & Johannes (1993c).

Ecology: This species occurs in Upper Klamath Lake, a few major tributaries, and part of the Klamath River, generally in areas with gravel-boulder substrate, spring influx, and some flow. This species, like most *Fluminicola,* prefers clear, cold, oligotrophic flowing water with high DO. It is found only rarely in springs and avoids areas with dense macrophyte beds. It sometimes occurs with other endemic

Fluminicola spp., *Lanx alta* or *Lanx klamathensis*, *Lyogyrus* spp., *Helisoma (Carinifex) newberryi*, or *Pisidium ultramontanum*. Predominantly a perilithon grazer and lithophile.

Original distribution: Klamath River, Siskiiou Co., CA, and Klamath Co., OR; Upper Klamath Lake, Klamath Co., OR; probably once very widespread in this area.

Current distribution: Middle and upper Klamath River, but now very sporadic (absent from impoundments and polluted stretches), Siskiiou Co., CA; Upper Klamath Lake and major spring-fed tributaries, Klamath Co., OR, including sites in Winema and Rogue River National Forests and Upper Klamath Lake National Wildlife Refuge. Other localities are on Medford District BLM lands.

Threats: Much of Upper Klamath Lake is strongly eutropified, so that live populations of this species are restricted to areas with spring influx or influence, even though dredged shells indicate past ubiquity in the lake. This hydrobiid is absent from or rare in slow-moving or polluted impoundments, such as reservoirs. Springs in the lake bottom proper are badly affected by past dredging to facilitate log transport and by current severe nutrient enhancement and sedimentation. The species does not occur in areas with dense beds of such macrophytes as *Myriophyllum* and *Elodea*, nor in area subject to eutropification or periodic hypoxic episodes. Many springs in the area are so heavily grazed as to completely extirpate or greatly reduce this species. Others are connected to irrigation canal systems: resulting sedimentation and eutropification either eliminates or greatly reduces this species. Channeling for such systems, and for log transport long ago, has also much reduced habitat, even when water quality remains excellent.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; ongoing and past threats; very substantial reduction in habitat. This species is undoubtedly declining in numbers and in number of sites. We are currently engaged in a comprehensive survey of Upper Klamath Lake freshwater mollusks; from first-year results (Frest & Johannes, 1995b) we do not anticipate major increase in either the geographic range of, or the number of sites with, this taxon.

Recommended status: This species has no special status at present. It was recommended for listing by Frest & Johannes (1993c). It should minimally be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (OR) listing as Endangered is appropriate, in our opinion. In mitigation for listed and candidate fish species in the Upper Klamath Lake area, care should be taken to avoid impact to this species, which can occur in sucker spawning areas.

References:, Frest & Johannes (1993c, 1995b); Deixis Consultants, 1991-94.

Fluminicola n. sp. 2 tall pebblesnail

Type locality: None designated: undescribed species.

Description: See Frest & Johannes (1995b) for description. The tall conical conch, moderate size, black body, tentacles, and viscera, and flanged penis are distinctive features. The distinctive verge of this and several other Upper Klamath Lake drainage taxa may merit separation as a genus. This taxon was cited identically in Frest & Johannes (1993c).

Ecology: Confined to large undisturbed, very cold oligotrophic springs draining into Upper Klamath Lake, Klamath Co., OR. The species occurs on pebbles and cobbles and is a perilithon grazer. Few macrophytes are present, except for local *Veronica.* Most striking at one site are large numbers of *Nostoc pruniforme,* which in some areas cover the substrate like cobbles. A crenophile, and perhaps limnocrene only, species. A perilithon grazer and lithophile.

Original distribution: Likely restricted to larger springs tributary to Upper Klamath Lake and related drainages, CA-OR (especially Klamath Co., OR).

Current distribution: Known from a few sites, on private land adjacent to Winema National Forest, on nearby Upper Klamath Lake National Wildlife Refuge, and on Winema National Forest lands.

Threats: Springs in the lake bottom proper are badly affected by past dredging to facilitate log transport and by current severe nutrient enhancement and sedimentation. The species does not occur in areas with dense beds of such macrophytes as *Myriophyllum* and *Elodea*, nor in area subject to eutropification or periodic hypoxic episodes. Many springs in the area are so heavily grazed as to completely extirpate or greatly reduce this species. Others are connected to irrigation canal systems; resulting sedimentation and eutropification either eliminates or greatly reduces this species. Channeling for such systems, and for log transport long ago, has also much reduced habit, even when water quality remains excellent. Areas used for log transport or storage still have not regained populations of this species.

Criteria for inclusion: Local endemic; likely occurrence on public lands; riparian associate. We are currently engaged in a comprehensive survey of Upper Klamath Lake freshwater mollusks (Frest & Johannes, 1995b), and do not anticipate that further finds will greatly expand either the range or site totals.

Recommended status: Has none at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to indicate that this species should be federally listed as Endangered; it should be listed similarly in OR.

References: Frest & Johannes (1995b); Deixis Consultants, 1991-94.

Fluminicola n. sp. 3 Klamath Rim pebblesnail

Type locality: None has been designated yet for this recently discovered species.

Description: See Frest & Johannes (1995b). Distinctive features of this taxon are the small size, rather evenly gray body and tentacles, and narrow, elongate, sickle-shaped penis. This taxon was cited under the same name in Frest & Johannes (1993c).

Ecology: Small cold spring run; very shallow water; gravel-cobble substrate; no macrophytes present. The snail occurs only in shaded areas and may be photophobic. A perilithon grazer and lithophile.

Original distribution: Uncertain; likely restricted to the middle portion of the Klamath drainage, *i.e.* below Upper Klamath Lake and above Copw Reservoir; Klamath Co., OR and Siskiyou Co., CA.

Current distribution: Single site in Klamath Co., OR, on Medford District BLM lands. The area is currently badly grazed; adjacent springs do not have this species. We are currently engaged in a comprehensive survey of Upper Klamath Lake freshwater mollusks (see Frest & Johannes (1995b); it is unlikely that future work will expand the geographic range and number of sites sufficiently as to militate against listing.

Threats: Grazing is severe in the region, and badly affects the only known sites. Springs in the area either lack mollusks due to heavy grazing or have other mollusk species. Diversion and capping of springs for stock usage is widespread in this area, and has eliminated many springs.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Federal and State (OR) listing as Endangered is appropriate; this species was recommended for listing previously by Frest &

Johannes (1993c). There. is sufficient recently-collected information, and recent survey work, to demonstrate that listing is justified.

References: Frest & Johannes (1993c, 1995c); Deixis collections, 1 991.

Fluminicola n. sp. 4 Metolius pebblesnail

Type locality: None designated as yet; undescribed species.

Description: This is a medium-sized (height 3-5 rrrn) low subturbinate form with 3 1/2-4 1/2 whorls. The wlumellar margin is only slightly reinforced; the shell is green; there is either a minor basal crescent or none at all; umbilicus closed. The body is gray with darker snout, tentacles, and edges of the foot, the penis is unpigmented, narrow, and sickle-shaped.

Ecology: This species is found in large springs and spring-fed creeks, generally very cold, clear, and oligotrophic. Macrophytes include *Rorippa* and *Mimulus*; *Nostoc*, *Rivularia*, *Chara*, and *Veronica may* be locally wmmon also. In some areas with this species, *Elodea*, *Myriophyllum*, and bryophytes are abundant. The substrate ranges from silt to cobbles; basalt is the predominant source. A perilithon grazer and lithophile.

Original distribution: Spring-fed tributaries to the Metolius River and possibly other upper Deschutes River drainage streams. This species has remained undescribed for some time; it was included on a map of the distribution of *Fluminicola turbiniformis* by Taylor (1966b) and is discussed briefly in Taylor (1985a). Comparison with type *Fluminicola turbiniformis* (Hershler & Frest, in press) indicates that this is another species.

Current distribution: Known from a few large-scale springs and spring-fed creeks in the upper Metolius system, Deschutes National Forest and adjoining private lands, Jefferson Co, OR. Many springs in its range either are dry, diverted for human and stock use, or no longer have a native mollusk fauna.

Threats: Grazing and pasturing; logging; development of springs in its range (e.g., Black Butte Ranch, near Camp Sherman). We visited the Black Butte area-in 1994 and found that most mapped springs could no longer be found, due to expansion of housing and resort development; those that remained did not have this species. In one case, water from a swimming pool was drained into spring run. This run currently is almost devoid of mollusks.

Criteria for inclusion: Local endemic; past and ongoing modifications to habitat; specialized habitat; decline in area of potentiál habitat. This species is definitely declining.

Recommended status: This species has no special status at present; minimally, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to indicate that Federal and State (OR) listing as Endangered is justified, in our opinion.

References: Taylor (1966b, 1985a); Deixis collections, 1991, 1994.

Fluminicola n. sp. 5 Tuscan pebblesnail

Type locality: Will be designated when species is described.

Description: This is a medium-sized (height 3-5 mm) subglobose form with 3 1/2-41/2 whorls. The wlumellar margin is moderately reinforced; the shell is green; there is generally a minor basal crescent; umbilicus barely rimate. The body is pale with gray snout, tentacles, and edges of the foot, the penis is unpigmented, narrow, and sickle-shaped.

Ecology: Occurs in large cold springs and strongly spring-fed streams. Typically, these are oligotrophic, clear, rather swift, and have stable sand-cobble substrate. Area bedrock is basalt. Aquatic macrophytes include ***Rorippa, Mimulus,*** and ***Veronica;*** locally, bryophytes are wmmon also. Associates include ***Juga (Oreobasis)*** n. sp. and ***Pristinicola hemphilli.*** A perilithon grazer and lithophile.

Original distribution: Springs and spring-fed streams in the lower Deschutes River drainage, Wasco and Sherman ws., OR. Could also occur on the Warm Springs Indian Reservation.

Current distribution: Survives at one large spring complex, Oak Springs, which is used as a state fish hatchery and is included in Deschutes River Recreation Lands, and partly in the Deschutes Wild and Scenic River corridor. Searches of many other springs in the lower Deschutes River valley and Columbia Gorge,. 1987-1993, did not yield any other sites for this species.

Threats: Development and diversion of the springs for the hatchery and for domestic water supply. Impacts of adjacent Burlington Northern tracks; grazing in unutilized portions of the spring complex.

Criteria for inclusion: Local endemic; past and continuing threats.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done, and recently collected information is available, to suggest that Federal and State (OR) listing as Endangered is appropriate.

References: Deixis collections, 1988-l 993.

Fluminicola **n. sp. 8** **Malheur pebblesnail**

Type locality: Will be designated when the species is formally described.

Description: Small (to 4 mm height), emerald-green, subturbinate shell with about 3 1/2 whorls. Aperture large, columellar margin strongly reinforced, penis unpigmented, moderate length, blade-like.

Ecology: Occurs only in clear cold permanent springs, generally with sand, gravel, and cobble (mostly basalt) substrate, moderate to swift flow, shallow water, and some aquatic macrophytes (generally ***Rorippa*** and ***Mimulus).*** Mollusks associated include ***Physella gyrina, Stagnicola*** sp., and ***Pisidium insigne.*** This species occurs on sides and undersides of pebbles and cobbles and in undisturbed springs is generally the most common mollusk present, if present at all. Surrounding vegetation is sage scrub, generally dry and open, with trees, grasses, and bushes likely to be concentrated at the spring source. A perilithon grazer and lithophile.

Original distribution: Probably once widespread in the OR Interior Basin, ***i.e.*** Lake, Harney, and Malheur cos.

Current distribution: Known to survive in a few springs in Hamey and Malheur ws., OR. At least one site is on BLM lands.

Threats: Nearly all of the range is grazed, sometimes heavily. "Development" and capping of springs for stock and domestic use has been considerable. One site is in a campground and has been modified considerably in the last *2* years, resulting in loss of most of the snail population.

Criteria for inclusion: Local endemic; loss of sites and decrease in populations; occurrence on public lands. This species is definitely declining, owing to specialized habitat and human usage of that habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent suwey work, to indicate that Federal and State (OR) listing as Endangered is appropriate for this taxon.

References: Deixis collections, 1989-l 993.

Fluminicola n. sp. 7 Tiger Lily pebblesnail

Type locality: Will be designated when the species is described.

Description: This is a small-medium sized bw conical species with convex whorls; dark gray body; black snout and tentacles; moderate-length sickle-shaped unpigmented verge with moderately wide base and folds on the basal third; round aperture, with barely reinforced wlumella. For details, see Frest & Johannes (1995b).

Ecology: Occurs only in medium-large oligotrophic cold, dear springs, generally with common wood fragments: mud-cobble (basalt and pumice) substrate; common *Rorippa* and *Mimulus*. Sites are generally in rich, partly open meadows and *edges* of *Pinus ponderosa* forest, with abundant sedges and grasses; *Saxifraga; Aconitum*; *Pyrola* spp.; *Spiranthes; Viola,* and other forbs. Springs are commonly associated with bogs or marshes. Water depth is shallow, and moderate to swift flow is characteristic. This crenophile species is primarily a lithophile and grazer of aufwuchs on stone surfaces, usually sides and undersides on cobbles. In quiet areas, this species will graze aufwuchs from macrophyte surfaces as well.

Original distribution: Probably abundant in the W. and N. parts of the Upper Klamath Lake drainage, Klamath Co., OR.

Current distribution: Still present in the less damaged portions of the larger springs on the NW side of Upper Klamath Lake. Some sites are on public lands, including Winema National Forest, BLM, and Klamath Lake National Wildlife Refuge. We are currently conducting a detailed survey of the Upper Klamath Lake drainage, with the first report (Frest & Johannes, 1995b) due out soon.

Threats: Many springs in the area are so heavily grazed as to completely extirpate or greatly reduce this species. Others are connected to irrigation canal systems; resulting sedimentation and eutropification either eliminates or greatly reduces this species. Channeling for such systems, and for log transport long ago, has also much reduced habitat, even when water quality remains excellent. Areas used for log transport or storage still have not regained populations of this species. This taxon does not do well in impounded areas.

Criteria for inclusion: Local endemic; occurrence on public lands; loss of much of habitat. This species has undoubtedly declined from pre-settlement population levels.

Recommended status: This species has no special status at present. It should minimally be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. We recommend Federal and State (OR) listing as Threatened; there is sufficient recently-collected information, and recent survey work, to support this action.

Reference&: Frest & Johannes (1995b); Deixis collections, 1990-l 994.

Fluminicola n. sp. 8 Lost River pebblesnail

Type locality: None designated as yet; undescribed species.

Description: See Frest & Johannes (1995b). The comparatively large globose shell; flanged verge; and body pigment pattern are distinctive.

Ecology: At present, found only in springs or strongly spring-influenced portions of a medium-sized river. The species seems to prefer cold, clear water, coarse (gravel-cobble) substrate, and slow to swift, constant flow. This species is a lithophile and grazer of aufwuchs on stone surfaces, usually sides and undersides on cobbles. In quiet areas, this species will graze aufwuchs from macrophyte surfaces as well. Areas with this species have dense *Rorippa* stands, often with beds of other macrophytes (*Ceratophyllum*, *Elodea*, *Potamogeton crispus*, and *Potamogeton filiformis* nearby. The species is absent from areas which are strongly eutropified or seasonally have hypoxic or anoxic conditions. At one site, this species occurs with an unusual *Vorticifex* sp., *Pyrgulopsis* n. sp. 2 [Big Spring springsnail, *q.v.*], and common *Physella gyrina*.

Original distribution: Probably once widespread in the Lost River portion of the Upper Klamath drainage, Klamath Co., OR.

Current distribution: Found only in a couple of springs in the Lost River drainage. We are presently conducting a detailed survey of the Upper Klamath Lake drainage, with the first report (Frest & Johannes, 1995b) due out soon.

Threats: Much of the Lost River receives nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sectionsshow periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Flow is now very slow and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; drastic decline in habitat condition and area.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to suggest that Federal and State (OR) listing as Endangered is appropriate for this taxon.

References: Frest & Johannes (1995b); Deixis collections, 1994.

Fluminicola n. sp. 9 Wood River pebblesnail

Type locality: Will be designated when the species is formally described and named.

Description: See Frest & Johannes (1995b). Distinctive features of this species are the small, blunt-topped subconical shell; gray body; and open umbilicus.

Ecology: Found in small-large spring complexes, generally with mixed mud-gravel (white pumice) substrate. Common bryophytes, ***Rorippa, Mimulus***, sometimes ***Myriophyllum***, ***Poramogeron filiformis***, ***Rivularia*** and small ***Nostoc***; most sites are well-shaded, in largely closed, rich ***Pinus ponderosa*** forest. This species is often found in small numbers in springs with other ***Fluminicola*** spp.; evidently an obligate crenophile, mostly a perilithon grazer.

Original distribution: Probably widespread on the N. end of Upper Klamath Lake, Including part of the Williamson River and its major tributaries.

Current distribution: Known from a few large spring sites near the source of the Wood River and on the NE end of Upper Klamath Lake. Some of the known sites are on State of Oregon or Winema National Forest lands. We are currently conducting a detailed survey of the Upper Klamath Lake drainage, with the first report (Frest & Johannes, 1995b) due out soon.

Threats: Much of the Wood River valley is heavily used for agriculture, including grazing. Large areas receive nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. flow is now very slow and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; heavy human impacts to most of habitat.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that Federal and State (OR) listing as Endangered is appropriate.

References: Frest & Johannes (1995b); Deixis collections, 1991-l 994.

Fluminicola turbiniformis (Tryon, 1885) turban pebblesnail

Type locality: Roaring Springs, Catlow Valley, Co., OR; lectotype ANSP 27779a; paralectotypes ANSP 27779.

Description: The best description and illustrations are in Hershler & Frest (in press). Taylor (1966b, 1985a) in essence placed all small peripheral Great Basin ***Fluminicola*** in this taxon. With detailed study, it has become evident that at least several distinct species (and perhaps even genera) of lithoglyphinids occur in this area. Systematic revision of these taxa is now underway (Hershler & Frest, in press).

Ecology: Small-large oligotrophic springs in semiarid sage scrub; springs very cold, with abundant ***Rorippa*** and common ***Mimulus***; substrate mud, sand, gravel, and cobbles; basalt bedrock dominates the area of occurrence. This species is a crenophile, lithophile, and perilithon and periphyton grazer.

Original distribution: Probably once common in portions of the OR Interior Basin and adjacent NW NV; Lake and Malheur cos., OR and Washoe Co., NV.

Current distribution: Still survives in very few sites in the original range; see Hershler & Frest (in press) for details.

Threats: Diversion of springs for domestic and stock water supply; grazing, which is extensive throughout the range; geothermal development; drawdown of groundwater.

Criteria for inclusion: 'Local endemic; limited and specialized habitat particularly subject to human usage and modification; occurrence on public lands (BLM). The range is currently being surveyed for springsnails by R. Hershler and associates and by us; it is unlikely that it will be expanded greatly, or that large numbers of additional sites will be found.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that Federal and State (OR, NV) listing as Endangered is appropriate.

References: Tryon (1865a); Hershler & Frest (in press).

Helisoma (Carinifex) newbenyi newberryi (Lea, 1858) Great Basin rams-horn

Type locality: Rising River, Hat Creek, Shasta Co., CA. Probable holotype USNM 120991; probable paratype USNM 9256.

Description: The best description and illustrations are in Baker (1945); see also figures in Burch (1989). *Carinifex* has often been accorded separate generic status, which seems reasonable in view of its internal anatomy, at least as described by Baker (1945) and very different ecology from *Helisoma* (*s.s.*). Be that as it may, we follow Taylor (1981) and Burch (1989) for the time being in regarding *Carinifex* as a subgenus.

Burch (1989), noting comments of previous authors, opined that there may be only a single living species of *Carinifex,* and relegated most of the former species to the status of subspecies. It is amusing to note that the major author so quoted, Henry Pilsbry, was himself the author of two additional subspecies. This (sub)genus needs detailed work; however, we would note that, at least as described by Baker (1945) there appear to be very substantial anatomical differences between *jacksonense* and *ponsonbyi,* treated by Burch as a form of *newberryi newberryi*. One form, *Helisoma (Carinifex) minor* (J. G. Cooper, 1870). was overlooked by Burch (1989); this is likely a full species, as indicated by Taylor (1981). Cited as *Helisoma (Carinifex) newberryi newberryi* (Lea, 1858) in Frest & Johannes (1993c).

Ecology: "Larger lakes and slow rivers, including hrger spring sources and spring-fed creeks. The snails characteristically burrow in soft mud and may be invisible even when abundant." (Taylor, 1981). Can occur with *Pisidium ultramontanum*, *Lanx klamathensis*; or several other endemic mollusks, particularly *Fluminicola* spp. Areas with this species generally have well-oxygenated but soft substrate: macrophytes such as *Chara*, *Myriophyllum*, *Elodea*, *Veronica,* and *Potamogeton filiformis* common but not abundant; and clear, very cold, slowly flowing water. Typically, they are very large spring pools or strongly spring-influenced areas in larger streams or lakes.

This pelophile species generally occurs just below the sediment surface and is a detriius feeder. The ecology, need for continually well-oxygenated soft substrate, and detritus-feeding habitat have long been known to be unusual for the family (Planorbidae) generally. Very few other planorbids are crenophiles or prefer limnocrenes; very few are cold-water stenotherms. The most closely analogous planorbids are members of the genus *Vorticifex. See* discussion in Frest & Johannes (1993c, 1994, 1995b).

Original distribution: Taylor & Smith (1981) and Taylor (1985a) illustrate a total of 14 historic sites for all forms of the species.: 1 in western WY, 3 in southwestern OR; 1 in UT; 7 in northeastern CA; and 2 in eastern CA. Many of these are either now known to be extinct or have not been recollected recently. The specialized habitat guarantees that not many more sites can be found; in any case, recent collection of the Upper Klamath Lake and Pit R. drainages by us (see, e.g., Frest & Johannes, 1993c, 1994, 1995b, 1995c) and of the Great Basin by R. Hershler and hi collaborators, including us, indicates that few sites survive.

This species had an extensive distribution in the Plio-Pleistocene and even Holocene lakes in the Great Basin and Oregon Interior Basin; see Taylor (1985a) and Figure 16 herein.

Current distribution: "In California known from six local drainages, in which the species survives in probably only four....Sheepy Creek [Siskiiou County; may now (visited in 1991) be extinct]...Pit River, including the large spring-pools and their outflows of Fall River and Hat Creek; known downstream to above Squaw Creek, but probably extinct in the lower segment of its range. Eagle Lake, Lassen County. Lake Tahoe and adjacent slow segment of its outflow, Truckee River...." (Taylor, 1981, p. 158). The UT (Utah Lake) and Owens Valley, CA populations are extinct. Some of the CA and OR sites are within the range of the Northern Spotted Owl. Surviving sites are in Winema National Forest, Upper Klamath Lake National Wildlife Refuge and in Lassen National Forest (e.g. Eagle Lake); others may be located on BLM lands in the vicinity of Fall River Mills, CA. Other sites am known from tributaries to Upper Klarnath Lake (see Frest & Johannes, 1995b).

Threats: Springs in Upper Klamath Lake proper are badly affected by past dredging to facilitate log transport and by current severe nutrient enhancement and sedimentation. The species does not occur in areas with dense beds of such macrophytes *as Myriophyllum* and *Elodea*, nor in areas subject to eutropification or periodic hypoxic episodes. Many springs in the Great Basin and Oregon Interior Basin are so heavily grazed as to completely extirpate or greatly reduce this species. Others are connected to irrigation canal systems; resulting sedimentation and eutropification either eliminates or greatly reduces this species. Channeling for such systems, and for log transport long ago, has also much reduced habitat in the Upper Klamath Lake area, even when water quality remains excellent. Areas used for log transport or storage still have not regained populations of this species.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; very specialized and uncommon habitat; past and current threats to habitat; reduction in numbers and loss of historic sites.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to demonstrate that this taxon should be Federal and State (OR and CA) Endangered, in our judgment.

References: Taylor (1981); Taylor & Smith (1981); Taylor (1985a); Frest & Johannes (1993c, e; 1994; 1995b, c); Deixis collections, 1989-l 994.

Helisoma (Carinifex) newberryi jacksonensis (Henderson, 1932) Jackson rams-horn

Type locality: Jackson Lake, Teton Co., WY. Holotype UCM 17759a; paratypes UCM 17759; UI 3925; USNM 510045. See Wu & Brandauer (1982) for UCM types.

Description: See Henderson (1932) and Baker (1945) for description and illustrations. The best illustrations are those of Burch (1989). If the anatomical data reported by Baker (1945) are correct, this species is substantially different from nominal *Helisoma (Carinifex) newberryi*. This needs to be checked. Burch (1989, p. 283) supports correction of the species name to *jacksonense.*

Ecology: Spring-fed areas in Jackson Lake, on stones and in soft, oxygenated sediment. Habitat is apparently similar to that of other *Carinifex* species.

Original distribution: Several sites in and in the immediate vicinity of Jackson Lake, Co., WY, including areas in Grand Teton National Park.

Current distribution: Uncertain; has not been recollected in recent years. S. Welty (*pers. comm.*, 1993) attempted unsuccessfully to relocate this taxon during the recent drawdown of Jackson Lake for dam reconstruction.

Threats: 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 take floor during the 1993 drawdown and repairs may have destroyed the springs in the lake bottom formerly reported in the vicinity of the dam by Henderson (1932, 1933). Revisits to other springs on the E. side of the lake in 1993 were also unsuccessful. Some historic sites are now in Grand Teton National Park.

Criteria for inclusion: Local endemic; past and ongoing threats; occurrence on public lands; loss of historic sites and extensive habitat modification.

Recommended status: Currently (USFWS, 1994a) a C2 candidate under the name *Helisoma newberryi jacksonense.* It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient information is available to suggest that this taxon should be Federal and State (WY) Endangered on present evidence.

References: Henderson (1932, 1933); Baker (1945); Burch (1989).

Juga (Juga) hemphilli dallesensis (Henderson, 1935) Daiies juga

Type locality: Mill Creek, The Dalles, Wasco Co., OR. Holotype UCM 16016a; paratypes UCM 16016b-d. See Wu & Brandauer (1982) on UCM types.

Description: See Henderson (1935) for best descriptions and illustration. The best illustration is that of Burch (1989). This subspecies can be distinguished from related taxa by its uniform green color and white nacre. *Cited* as *Juga (Juga) hemphilli dallesensis* (Henderson, 1935) in Frest & Johannes (1993c).

Ecology: Large springs and small-medium creeks, always at bw elevations; stable gravel substrate, but fast-flowing, unpolluted, highly oxygenated, cold water. Relatively few macrophytes or epiphytic algal taxa are present, with *Rorippa* being the most frequently encountered. Primarily a perilithon grazer and lithophile.

Original distribution: Uncertain. Probably in the central-eastern Columbia Gorge, WA-OR.

Current distribution: Most of Mill Creek has succumbed .to urbanization and agricultural pollution. The species still survives in a small part of Mill Creek. A few isolated populations in the central and eastern Columbia Gorge from Hood River to The Dalles, WA-OR; more specifically Hood River and Wasco cos., OR and Skamania Co., WA, including sites in Mt. Hood and Gifford Pinchot National Forests and the Columbia Gorge National Scenic Area. We have systematically collected much of the eastern part of the Columbia Gorge from 1987-l 992, so that substantial additions to the range or increase in number of sites are highly unlikely.

Threats: Increasing urbanization in The Dalles and Hood River areas; diversion and capping of springs for orchard, irrigation, and water supply, agricultural impacts on much of Mill Creek; sewage discharge into Mill Creek in The Dalles.

Criteria for inclusion: Local endemic; occurrence on public lands, including National Forest and National Scenic Area sites; riparian associate.

Recommended status: Currently has none. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent information is available to demonstrate that this taxon should be Federal and State (WA, OR) Endangered. Frest & Johannes (1993c) recommended listing this subspecies previously.

References: Henderson (1935, 1936b); Burch (1989); Frest & Johannes (1993c); Deixis Consultants, 1987-1992.

Juga (Juga) hemphilli hemphilli (Henderson, 1935) barren juga

Type locality: Portland, Multnomah Co., OR; where uncertain, possibly Johnson Creek. Holotype UCM 21167a; paratypes UCM 21167, 21167b & c; CAS. See Wu & Brandauer (1982) for UCM types.

Description: For best description and original illustrations, see Henderson (1935). The best illustration is in Burch (1989). A moderate-sized *Juga* with moderately high spire with nearly flat-sided whorls: nacre white; whorls nearly smooth; plications extending about 1/3 of way down spire: early whorls usually decollate. Frest & Johannes (1993c) list this taxon under the same name.

Ecology: Small-medium creeks, generally at bw elevations. Found only in level-bottom, highly oxygenated, cold-water, oligotrophic streams, unpolluted and with stable gravel-boulder substrate. These typically lack aquatic macrophytes and have little epiphytic algae; velocity is moderate. Primarily a lithophile, although also found on mud substrate; both a perilithon grazer and detriiivore; also grazes periphyton from deciduous leaf surfaces.

Original distribution: Uncertain. Sporadic in some of the small drainages on the west end of the Columbia Gorge, WA-OR, east of the Willamette River; probably once widespread in this area. Specimens ascribed to this subspecies by Branson & Barrett (1981) are another taxon.

Current distribution: Type localii (ii it was Johnson Creek) still viable. Still survives in a few isolated Columbia Gorge populations in WA and OR, in mostly urbanized areas: Clark and Skamania cos., WA and Multnomah Co., OR, including sites in the Columbia River National Scenic Area and Mt. Hood National Forest. May range onto Gifford Pinchot National Forest also. We have systematically collected much of the Gorge from 1987-1992, so that substantial additions to the range or increase in number of sites are highly unlikely.

Threats: Encroaching urbanization from the Portland area; increasing recreational usage of the Columbia Gorge; highway (e.g., I-84, WA 14) and railroad (Burlington Northern, Union Pacific) right-of-way construction and maintenance; siltation from logging; diversion of streams for public water supply.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: Currently has none. It should at least be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient information of recent vintage is available to support listing of this taxon as Federal and State (OR and WA) Endangered.

References: Henderson (1935, 1936b); Burch (1989); Frest & Johannes (1993c); Deixis Consultants, 1987-1992.

Juga (Juga) hemphilli maupinensis (Henderson, 1935) Deschutes juga

Type locality: Deschutes River, near Maupin, Wasco Co., OR; holotype UCM 17754a; paratypes 17754, 11754b. See Wu & Brandauer (1982) for UCM types.

Description: Consult Henderson (1935) for description and illustrations. This subspecies is distinguished by its large size; single color band; and light purple nacre from the other ***hemphilli*** subspecies. Alcohol specimens of this species in museum collections often lose the nacre coloration and it appears white.

Ecology: This taxon is a large-stream form found mostly in well-oxygenated and minimally impacted gravel-cobble (mostly basalt) riffles. It is somewhat more tolerant of siltation and of slack water than ***Juga (Oreobasis) bulbosa***; but both are much less so than such species as ***Juga (Juga) silicula*** and ***plicifera***. Epiphytic algae and aquatic macrophytes are generally rare or absent. Common associates ***are Fisherola nuttalli, Fluminicola*** sp., and ***Juga (Oreobasis) bulbosa.*** This species is somewhat sensitive to physical disturbance and dislodgment. An amnicole, primarily a perilithon feeder, occasionally feeding upon partly decayed deciduous leaves.

Original distribution: Probably widespread in the Deschutes River drainage, including major tributaries, Wasco, Sherman, and Jefferson cos., OR.

Current distribution: Restricted to a few portions of the lower Deschutes River below Pelton Dam and the lower Warm Springs River, Wasco and Sherman cos., OR, including the Deschutes Wild and Scenic River corridor and lands on the Warm Springs Indian Reservation. We have collected the Deschutes from 1988-1993; it is unlikely that substantial expansion of the geographic range will occur from future work, or that numerous new sites will be found.

Threats: Increasing human usage of the Deschutes Wild and Scenic River is a major concern; this species appears sensitive to repeated disturbance. Any factors-tending to downgrade water quality, including nutrient enhancement, would negatively impact this taxon. The surrounding area is heavily grazed; and runoff tends now to add nutrients. This species appears to be absent now from the more impacted upper reaches of the Deschutes system.

Criteria for inclusion: Local endemic; occurrence on public lands (BLM-Prineville District): past and ongoing impacts to rather specialized habitat; increasing recreational usage of the lower Deschutes (BLM, 1993).

Recommended status: Currently has none; minimally it should be considered a sensitive species by the BLM and other land management and wildlife agencies. Sufficient recent data are available to demonstrate that it should be considered for Federal and State (OR) listing as Endangered.

References: Henderson (1935, 1936b); Deixis collections, 1968-l 993.

Juga (Juga) hemphilli n. subsp. 1 Indian Ford juga

Type locality: None designated as yet; undescribed taxon.

Description: This taxon somewhat resembles ***Juga (Juga) hemphilli maupinensis;*** it is relatively large juga; but the nacre is white: the juvenile is narrower than in ***maupinensis;*** the shell darker brown and with two dark brown bands (vs. yellow-brown and one band in ***maupinensis);*** the shell is more elongate; and there are several lirations (small raised ribs) on the mature whorls.

It should be noted that this taxon is not the taxon described ***as Juga (Juga) hemphilli*** n. subsp. in Frest & Johannes (1993c).

Ecology: Found in mixed basalt cobble-mud substrate; macrophytes and epiphytic algae rare; the site is almost monospecific as far as snails are concerned. This species is a perilithon grazer. The only known site is a medium-sized spring-fed creek.

Original distribution: May have been widespread in the upper Deschutes system, Deschutes Co., OR.

Current distribution: Known from a single site in Deschutes National Forest, near Black Butte, Indian Ford, Indian Ford Creek, Deschutes Co., OR.

Threats: Many of the springs in the Black Butte area are in a resort development (Black Butte Ranch); we tried most of these and found no interesting mollusks (very few of any kind survive). Others in the area are now dry due to groundwater mining and diversion and capping for stock and for human water supply, e.g. in Cold Spring Camp Ground. Most springs in this region are heavily grazed. Indian Ford Creek now goes dry downstream from the site, due to recent increases in diversion and groundwater pumping.

Criteria for inclusion: Local endemic; occurrence on public lands; current and ongoing threats. In general, ***Juga*** is rare on the E. side of the Cascades (R. Wisseman, ***pers. comm., 1994;*** we have found this to be true also; note absence from the springs in the nearby Metolius River headwaters), except in the lower Deschutes system, and this is a rather strongly disjunct occurrence.

Recommended status: This taxon has no special status at present, but it should minimally be considered asensitive species by the Forest Service, BLM, and other land management and wildlife agencies. It should probably be Federal and State (OR) Endangered.

References: Deixis collections, 1994.

Juga (Juga) n. sp. 1 brown juga

Type locality: None designated as yet; undescribed taxon.

Description: This is a slender form of ***Juga*** with uniformly medium brown, only slightly convex whorls, generally lacking lirae. The spire is typically decollate, and plications are confined to the upper whorls only (hence seen only on young specimens). This taxon could include the type specimens (and one or two museum lots) of "***Juga (Oreobasis) draytoni*** (Lea)", but the diagnostic characters are not preserved on Lea's types, which may thus constitute an unrecognizable species. This taxon was cited under the same name in Frest & Johannes (1993c).

Ecology: Small spring-fed streams and springs, including spring sources, western and central Columbia Gorge, WA-OR. Prefers cold, fast-flowing well-oxygenated water and gravel substrate: most frequently found in very small and shallow but perennial spring-fed streams and springs. Often narrowly localized in such drainages and restricted to small springs and spring sources, generally at low to medium elevations. Mostly a small-scale crenophile and perilithon grazer, although also feeding upon partly decayed deciduous leaves.

Original distribution: Uncertain. Most likely the western two-thirds of the Columbia Gorge.

Current distribution: Sporadic in several Columbia Gorge streams and associated springs, especially on the WA side, in the western end of the Gorge. Also occurs at one or two sites in the central Gorge, Skamania Co., WA and Multnomah and Hood River cos., OR, including sites in the Columbia Gorge National Scenic Area and Mt. Hood National Forest. Likely occurs in Gifford Pinchot National Forest. Between 1987 and 1993, we surveyed many spring sites in the Gorge; it is unlikely that many more sites for this taxon will be discovered, or that the range will be substantially increased.

Threats: Most springs in the Gorge have been impacted in various ways, including diversion for public, priiate, and stock water supplies; for state and federal fish hatcheries; and lumber mills. Others have been destroyed for highway (e.g., I-84, WA 14, OR 216) and railroad (Burlington Northern, Union Pacific) rights-of way. Much of the Gorge has been logged or grazed in the past. The species is definitely declining, in terms of number of sites and area occupied.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; loss of most of rather specialized habitat due to human activities; ongoing threats.

Recommended status: Currently, this species has none. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. We recommend Federal and State (OR and WA) listing as Endangered, based on more than sufficient recently-accumulated records.

References: Deixis Consultants, 1987-l 993.

Juga (Juga) n. sp. 2 three-band juga

Type locality: None as yet; undescribed taxon.

Description: A moderate-large-sized *Juga* with weak plications confined to the upper 1/6 of the spire. Spire comparatively short; whorls barely convex. Ground color yellow, with three to five prominent brown-reddish-brown bands. Nacre white. Early whorls often decollate; plications regular, much weaker than in most *Juga* (*Juga*) species; generally confined to upper part of the spire, and some portion usually retained even on decollate adults.

Examination of the USNM holotype of ***Goniobasis bairdiana*** Lea, 1862 suggests the possibility that this species is a synonym; however, Lea's type (and only specimen) is decollate; and could also be what is here termed ***Juga (Oreobasis)*** n. sp., or some other species. Lea's type locality is Astoria, Oregon; we have found no material agreeing with the type specimen in morphology in this area, although ***Juga (Juga) silicula*** occurs commonly.

Ecology: This species occurs in small-large springs and permanent seeps, sometimes associated with talus. Most often, these are covered by dense brush (*Rubrus*); *Mimulus*, bryophytes, and are often abundant locally, as are *Rhus* and *Urtica* on the banks or sides of the flowage. Rarely, this species occurs in smaller spring-fed streams. Bedrock is basalt; substrate ranges from bare rock faces to mud and sand; flow is slow and shallow typically. Common associates are mostly such land taxa ***as Vespericola columbiana depressa;*** Often, this is the only or major snail species present. ***Pisidium insigne*** is a common mollusk associate; ***Juga (Oreobasis)*** n. sp. 1 [one-band juga] ***or Juga (Oreobasis)*** n. sp. 2 [basalt juga] sometimes occur with this species. The same spring and associated talus may have such land snail species as ***Vespericola columbiana depressa, Cryptomastix hendersoni,*** or ***Oreohelix variabilis***. This taxon is a strong crenophile, almost always a perilithon feeder, and generally a lithophile.

Original distribution: Probably quite widespread in the eastern and central parts of the Columbia Gorge, WA and OR, as far E. as the mouth of the John Day River.

Current distribution: Scattered sites, mostly in the eastern Columbia Gorge: Hood River, Wasco, Sherman, and Gilliam cos., OR, and Skamania and Klickitat cos., WA. Between 1987 and 1993, we surveyed many spring sites in the Gorge; it is unlikely that many more sites for this taxon will be discovered, or that the range will be substantially increased.

Threats: Most springs in the Gorge have been impacted in various ways, including diversion for public, private, and stock water supplies; for state and federal fish hatcheries; and lumber mills. Others have been destroyed for highway (e.g., I-64, WA 14, OR 216) and railroad (Burlington Northern, Union Pacific) rights-of way. Much of the Gorge has been logged or grazed in the past. The species is definitely declining, in terms of number of sites and area occupied.

Criteria for inclusion: Local endemic; occurrence on public lands: riparian associate; loss of most of rather specialized habitat due to human activities; ongoing threats.

Recommended status: This species has no special status at present; minimally, it should be considered a sensitive species by the Forest Service; BLM, and other land management and wildlife agencies. Sufficient recently collected information is available to indicate that it should be Federal and State (OR and WA) Endangered.

References: Deixis Consultants, 1987-l 993.

Juga (Oreobasis) bulbosa (Gould, 1847) bulb juga

Type locality: Said to be from the Columbia River, Oregon; holotype MCZ 169067; paratypes MCZ 169068; USNM 5563 (see Johnson, 1964). This is the only bt claimed or seen by us from the Columbia proper: it does not occur there currently, but does occur in the Deschutes River, the type locality for the supposed synonym *Goniobasis newberryi* Lea. As the species seems to be primarily a medium-river form, we suspect that the mouth of the Deschutes was the more likely source of Drayton's specimens, although it is conceivable that a few strays could have occurred in the Columbia nearby before it was converted into a series of impoundments.

Description: A very distinctive large-sized form with very convex (bulbous) whorls, generally with three strong bright yellow and two black bands; and dewllate early whorls. Very rarely, this species may have fewer bands or be unbanded. See illustration in Burch (1989). The very convex whorls, large size, and striking color bands distinguish it from other three-banded *Juga* in the Columbia Gorge area.

This species is very rare in collections. Specimens (USNM 473801) from a tributary of the John Day River; Grant Co., OR, ascribed to this taxon by Morrison (1954) are another species. The range is given in Burch (1989) as "Lower Columbia River in Oregon and Washington and several of its tributaries (Deschutes and Owyhee rivers) (Pilsbry, 1899f)". As noted above, ascriptions to the Lower Columbia River proper are dubious. We know of no valid Owyhee records; we found none in the major collections (including ANSP, Pilsbry's primary affiliation for nearly all of his long career); and none of our Owyhee sites have this or any other *Juga* species. The Owyhee is a Snake River, not a direct Columbia River tributary, as implied by Pilsbry (1899b); and none of the other Snake River tributaries *has Juga* either, so far as we are aware.

Ecology: Found primarily in gravel-boulder riffles and rapids edges in moderately swift current. Generally, macrophytes and epiphytic algae are rare to absent at such sites. Water is dear and cold. Common associates are *Fisherola nuttalli*, *Fluminicola* sp., and *Juga (Juga) hemphilli maupinensis.* This species is generally absent from pools and areas with mud or bare rock substrate. An amniphile, lithophile, and perilithon grazer.

Original distribution: Deschutes River, from at least Bend to the mouth, Jefferson, Wasco, and Sherman cos., OR. We have not found this species in springs or in tributaries, with the exception of the mouth of one large spring-fed tributary.

Current distribution: Very sporadic in the lower Deschutes River below Pelton Dam, Wasco and Sherman cos., OR; absent from the mouth and from most sites. Sites may occur on the Warm Springs Reservation; known sites are on BLM lands, in the Deschutes Wild and Scenic River. We have explored most of the Columbia Gorge streams in recent years, as well as major parts of the Deschutes system. Large numbers of additional sites or substantive range extensions are very unlikely.

Threats: The Deschutes in recent years has been increasingly heavily used for recreational purposes. This species seems to be absent now from the portions of the river above Pelton Dam, which are affected by discharge from Bend. It occurs only in the most undisturbed portions of the riier, and seems to be sensitive to physical disturbance.

Criteria for inclusion: Local endemic; loss of historic sites; occurrence on public lands.

Recommended status: Currently has none. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Management plans for the lower Deschutes River reflect little wncern for the species (BLM, 1993a, b). Sufficient recently-collected information is available to support the recommendation that it should be Federal and State (OR) Endangered.

References: Deixis collections, 1988-l 992.

Juga (Oreobasis) n. sp. 1 one-band juga

Type locality: None has been designated as yet.

Description: Large *Juga* with slender, attenuate spire of about 12 whorls when complete; nacre generally white, except for brown patch near base of columella; shell generally yellow-green or brown-green, with single red-brown band about l/4-1/3 of the distance from the whorl base. Whorls flattened; sutures prominent; occasional sculpture of a few narrow, raised thread-like ribs, developed particularly on the final whorl. This species was cited as *Juga (Oreobasis)* n. sp. 1 in Frest & Johannes (1993c).

Ecology: Small-medium streams, large springs. Can occur on both mud and gravel bottom, but always in spring-fed streams and large springs with level bottom, cold water, fast flow, and high dissolved 02. Low-mid elevations only; if in streams, only in low-gradient streams, generally spring-fed. Epiphytic algae rare; aquatic macrophytes uncommon except in muddy area; generally *Rorippa* and little else. This species is somewhat of a generalist, seemingly as much at home as a crenocole or amniwle; and nearly as much a pelophile as a lithophile. It has been noted acting as a detritivore on mud: a periphyton grazer (on leaves) but also consuming the leaves themselves, and as a perilithon grazer.

Original distribution: Probably widespread in the central and eastern Columbia Gorge.

Current distribution: Uncommon in a few of the central and eastern Columbia Gorge tributaries, WA only, Skamania and Klickitat ws., including sites in Gifford Pinchot National Forest and Columbia Gorge National Scenic Area. We have explored most of the Columbia Gorge streams in recent years, as well as major parts of such tributary streams as the Klickitat and White Salmon rivers, WA. Large numbers of additional sites or substantive range extensions are very unlikely.

Threats: Concentration of human impact on springs for various reasons is the biggest problem for this taxon. Most springs in the Gorge have been impacted in variius ways, including diversion for public, private, and stock water supplies: for state and federal fish hatcheries; and lumber mills. Others have been destroyed for highway (e.g., l-84, WA 14, OR 216) and railroad (Burlington Northern, Union Pacific) rights-of way. Much of the Gorge has been logged or grazed in the past. The species is definitely declining, in terms of number of sites and area occupied.

Criteria for inclusion: Local endemic; occurrence on public lands: riparian associate: loss of most of rather specialized habitat and past and ongoing threats to that habitat.

Recommended status: So far has no special status. At the very least, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to indicate that it should be Federal and State (WA) Threatened. It was previously suggested for listing by Frest & Johannes (1993c).

References: Frest & Johannes (1993c); Deixis Consultants, 1987-l 991.

Juga (Oreobasis) n. sp. 2 basalt juga

Type locality: Species undescribed; none designated as yet.

Description: Moderate-sized, somewhat low-spired *Juga* with barely convex whorls and shallow sutures. Nacre white: shell with 3-numerous color bands, generally with three yellow and several brown, pink or tan; initial whorls smooth. This species may look much like *Juga (Juga)* n. sp. 1 [three-band juga) if the initial whorls are absent; but that species generally has a much more consistent dark brown and yellow banding pattern, and generally retains enough of the early whorls that the plications, though weak, are easily visible. This species was previously cited as *Juga (Oreobasis)* n. sp. 2 by Frest & Johannes (1993c).

Ecology: A crenophile, restricted to springs in small drainages tributary to the Columbia River, at low elevations. Prefers gravel substrate and requires unpolluted water; mostly in very small and shallow but permanent, undisturbed springs. These commonly have abundant *Rorippa* and local *Mimulus*; immediately surrounding vegetation may include *Urtica, Rubrus*, and *Cornus stolonifera*. The area as a whole is predominantly sage scrub. this species is often the dominant mollusk, the most common associate is *Pisidium insigne.* Occasionally, this species occurs with *Juga (Juga)* n. sp. 1 [three band juga, *q.v.*] or with *Pristinicola hemphilli.* The same spring and associated talus may have such land snail species as *Vespericola columbiana depressa* or *Oreohelix variabilis.* Generally a perilithon feeder and lithophile.

Original distribution: Uncertain; recently discovered taxon. Probably central and eastern Columbia Gorge only.

Current distribution: Sporadic in springs in the central and eastern portions of the Columbia Gorge, OR side only: Hood River and Wasco cos., OR, including sites in Mt. Hood National Forest and sites in Columbia Gorge National Scenic Area. We have surveyed much of the Columbia Gorge in some detail: it is very unlikely that further work will greatly enlarge the geographic distribution or add substantially to the number of known sites.

Threats: Concentration of human impact on springs for various reasons is the biggest problem for this taxon. Most springs in the Gorge have been impacted in various ways, including 'diversion for public, private, and stock water supplies; for state and federal fish hatcheries: and lumber mills. Others have been destroyed for highway (e.g., I-84, WA 14, OR 216) and railroad (Burlington Northern, Union Pacific) rights-of way. Much of the Gorge has been logged or grazed in the past. The species is definitely declining, in terms of number of sites and area occupied. Recently extinct sites for this taxon have been noted, and severe 1993 range fires affected much of the known range.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; loss of most of rather specialized habitat and past and ongoing threats to that habitat.

Recommended status: So far has no special status. At the very least, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent suwey work has been done to indicate that it should be Federal and State (OR) Threatened. Listing was suggested in the FEMAT report (Frest & Johannes, 1993c).

References: Frest & Johannes (1993c); Deixii Consultants, 1988-1993. One very old museum lot (NMNH) may be this species.

Juga (Oreobasis) n. sp. 3 purple juga

Type locality: Species undescribed; none designated as yet.

Description: Shell medium-sized, even deep brown in color; surface smooth, nacre rich royal purple; spire acuminate, whorls flattened, sutures not prominent. This species does not closely resemble any described taxon. The only closely similar species is an undescribed taxon known from a few springs in the Upper Sacramento River drainage, CA.

Ecology: Occurs in large cold springs and spring runs, with sand-cobble substrate or exposed basalt bedrock, associated with one or more endemic *Fluminicola* spp. and *rare Pristinicola hemphilli.* Epiphytic algae and macrophytes am rare in areas inhabited by this species, although *Rorippa* may be locally abundant, and scattered *Mimulus* common. The immediately surrounding vegetation is oak scrub; the area is predominantly sage scrub. This crenophile taxon is mostly a perilithon feeder and lithophile.

Original distribution: Uncertain; recently discovered taxon. Probably central lower Deschutes River springs only.

Current distribution: Nine sites in a single large nasmode along the central lower Deschutes River, Co., OR. Localities are very near to elements of a state fish hatchery; and the Burlington Northern tracks, which have considerably modified the lower part of the spring complex. Road and trackside spraying and diversion of part of the spring complex to the hatchery, have also impacted the known sites. We have surveyed much of the lower Deschutes corridor and Columbia Gorge between 1987-l 993; it is thus very unlikely that future work will substantially increase the range of, or number of sites for, this taxon.

Threats: Springs in the Deschutes River valley have been extensively diverted and/or capped for domestic and stock water supply, and some historic ones are now dry for this reason. Railroad right-of-way (Burlington Northern) and road (e.g. OR 216 and Deschutes River Road) construction has impacted or destroyed many springs, and continues to affect others. The bulk or all of the range is heavily grazed. Range fires have damaged or extirpated other spring sites in the immediate area. Increasing recreational impact, and BLM plans for more roadways and other amenities (BLM, 1993a, b), are also current problems in this area.

Criteria for inclusion: Local endemic; riparian associate; occurrence on public lands (BLM-Prineville and Deschutes River Wild and Scenic River); concentrated human impacts to the species' somewhat limited and specialized habitat; past and ongoing threats.

Recommended status: Currently has none. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient information and recent survey work is available to indicate that this species should be Federal and State (OR) Endangered.

References: Deixis Consultants, 1989-92.

Juga (Oreobasis) n. sp. 4 Crooked River juga

Type locality: Species undescribed; none designated as yet.

Description: This is a small juga with prominent amber and reddish-black bands and moderately convex whorls. Commonly, the early whorls are dewllate in adults. There am only two somewhat similar species. *Juga (Oreobasis) bulbosa* is much larger, and has distinct yellow and black bands, a more squat spire, and *very* wnvex whorls. *Juga (Oreobasis)* n. sp. 2 is larger, has flatter whorls, and a much different color band pattern.

Ecology: A crenowle, occurring in small-medium-sized cold springs and spring runs, on exposed basalt bedrock cliff faces or more rarely on sand-cobble substrate. Generally, this is the dominant mollusk species, with *Pisidium insigne* being the most wmmon associate. Springs with this species have few macrophytes; but *Rorippa* or *Mimulus* (or both) may be quite abundant. Springs are in dry, open, and exposed areas in major river valleys; immediately surrounding vegetation includes *Urtica, Rosa, Rhus,* and

Cornus stolonifera. The predominant vegetation except in the immediate vicinity of the springs is sage scrub. *Pristinicola hemphilli* occurs at one site. A perilithon grazer and lithophile.

Original distribution: Uncertain; recently discovered taxon. Probably central lower Deschutes River and lower Crooked River springs only.

Current distribution: Five sites in three spring complexes along the central lower Deschutes River and Crooked River, Jefferson and Wasco ws., OR.

Threats: Power plant operation and construction has considerably affected some sites, likely extirpating most in one area. Springs in the Deschutes River and Crooked River valleys have been extensively diverted and/or capped for domestic and stock water supply, and some historic ones are now dry for this reason. Road construction has impacted or destroyed many springs, and wntinues to affect others. The bulk of the range is heavily grazed. Range fires have damaged or extirpated other spring sites in the immediate area. Increasing recreational impact, and BLM plans for more roadways and other amenities in the Deschutes Wild and Scenic River corridor (BLM, 1993), are also current problems in this area.

Criteria for inclusion: Local endemic; occurrence on public lands (BLM-Prineville and Deschutes Wild and Scenic River); riparian associate; site loss and heavy impacts to specialized habitat; past and ongoing threats.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient information and recent survey work is available to indicate that this species should be Federal and State (OR) Endangered.

References: Deixis Consultants, 1989-92.

Juga (Oreobasis) n. sp. 5 Blue Mountains juga

Type locality: Species undescribed; none designated as yet.

Description: A large species with evenly dark yellow.-green whorls with slightly impressed sutures. The closest relative is probably *Juga (Oreobasis) nigrina,* rather than the Columbia *Gorge Oreobasis* species. The nearest confirmed *nigrina* colonies are in NE CA. The Blue Mountains represent a rather strongly disjunct *Juga* occurrence.

Ecology: Occurs in medium to large-sized cold springs and spring runs, on mixed mud, sand, and gravel substrate. The surrounding vegetation is high elevation open grassy, very moist, partly boggy meadow, with wmmon sedges, *Saxifraga*, and other forbs. *Rorippa* is very abundant in less impacted areas. This is the only wmmon mollusk in the limited area of its occurrence. This species seems as much a pelophile as a lithophile, and may be a detritiiore as well as a perilithon grazer.

Original distribution: Uncertain; recently discovered taxon. Probably once widespread in the southern Blue Mountains in OR. This taxon was misidentified as *bulbosa* in Morrison (1954).

Current distribution: Several sites in a single large nasmode, Phipps Meadow, source to Middle Fork John Day River, Malheur National Forest, Grant Co., OR. We have tried a number of other sites in the Blue Mountains without finding this species, 1988-1994.

Threats: The spring complex with this species has been heavily grazed. This has destroyed some springs mapped earlier, and restricted the snails to less accessible portions of the largest members of the complex. Even more heavily grazed downstream areas and other smaller nearby springs lack this species. Diversion and capping of springs for stock use is prevalent throughout the Blue Mountains.

Criteria for inclusion: Local endemic; proximity to public lands (BLM-Prineville) and; riparian associate.

Recommended status: None at present. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient information and recent survey work is available to indicate that this species should be Federal and State (OR) Endangered.

References: Deixis Consultants, 1989-92.

Lanx alta (Tryon, 1885) highcap ianx

Type locality: Klamath River (no specific locality). Holotype ANSP 21960a.

Description: The best description and illustrations are those of Baker (1925). see also illustrations in Burch (1969). Distinctive shell features of this lancid am the relatively large, evenly dark red , shell and height about 2/3 of greatest shell length. Burch (1989) recognizes subgenera in *Lanx*; but, like Taylor (1981) we see no reason at present for distinguishing *Walkerola* Hannibal, 1912, which is based solely on the low shell.

Ecology: "Large rivers and major tributaries, on boulders or rock in current" [Taylor (1981, p. 157)]. Low to medium elevations; the species is an amniphile, perilithon feeder, and lithophile found in areas with stable cobble-boulder substrate and excellent water quality. Like other lancids, this species respires through an unusual system unique for pulmonates; a heavily vascularized mantle and enlarged heart are elements (Baker, 1925). Lack of gills or lungs typical of many pulmonates limit the habitat of the lancids generally to areas not subject to hypoxia or anoxia, and generally to cold, clear, flowing waters, especially oligotrophic streams and areas with considerable spring influence.

Original distribution: "Drainages of Umpqua and Klamath rivers, OR, -to South Fork of Trinity River (tributary to Klamath River), California; Smith River, California" (Taylor, 1981, p. 157). Counties are Josephine, Jackson, and Curry on the Rogue River (including sites in Siskiyou National Forest: sites in Rogue River National Forest may be extirpated); and Del Norte, Humboldt, and Siskiiou cos. [CA], plus Khmath Co., OR (Klarnath River). Old sites were in Winema, Klamath, Sii Rivers, and Trinity National Forests. Some of these sites are known to survive. The species also occurs in the Rogue National Wild and Scenic River. Relevant to this work are occurrences in the upper part of the Klamath River below Link River and, in the Williamson River.

Current distribution: Recently (1991-94) collected alive by us in the Klamath River in CA and Rogue River in OR; now extinct in most of the Klamath River and part of the Rogue River; status in other rivers in its range uncertain. Umpqua specimens are better assigned to *Lanx subrotundata* (*q.v.*), as in Burch (1989). Systematic position of populations in the Williamson River, collected by us from 1991-l 994, is not yet clear, although these bear some resemblance to *Lanx altus*. *See* Frest & Johannes (1995b) for discussion. We are currently surveying the Upper Klamath drainage for this and other freshwater mollusk species. The first report from this survey is nearly completed (Frest & Johannes, 1995b).

Threats: Much of the upper Klamath River is impounded: the species does not generally occur in such areas. *Lanx altus* is also absent from areas downstream from waste water returns, *i.e.* below as well as in John Boyle Reservoir. Warm, slow, nutrient-enriched, or turbid water also lack this species, so that much of the Klamath and Rogue rivers are now unsuitable habitat.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: Currently has none. We recommended listing of this species previously (Frest & Johannes (1993c). Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Existing evidence is sufficient that this species should be Federal and State (OR and CA) Endangered.

References: Taylor (1981); Burch (1989); Frest & Johannes (1993c, 1995b); Deixis Consultants, 1991-94.

Lanx klamathensis Hannibal, 1912 scale lanx

Type locality: South end of Upper Klamath Lake, Klamath Falls, Klamath Co., OR. Types in CAS collections.

Description: See Hannibal (1912) and Baker (1925); the illustration in Burch (1989) is also helpful. The low and thin shell, many times wider and longer than high, is quite characteristic. Hannibal (1912) erected the subgenus *Walkerola* for this species; Burch (1989) recognizes this; but we, like Taylor (1981) see no reason at present to do so. Shell height vs. width in *Lanx* is better regarded as a species-level character.

Ecology: A form restricted to large, spring-fed lakes and streams and limnocrene springs. The species, like all lancids, is an obligate perilithon grazer and lithophile, and occurs on cobbles and boulders, generally in areas with current and always at sites with oxygenated, high-quality clear water. This species commonly is found with a variety of other rare forms, including *Pyrgulopsis archimedis*, *Pyrgulopsis* n. sp. 1, *Lyogyrus* spp., *Fluminicola* spp., and *Vorticifex klamathensis klamathensis*. Lack of gills or lungs typical of many pulmonates limit the habitat of the lancids generally to areas not subject to hypoxia or anoxia, and generally to cold, clear, flowing waters, especially oligotrophic streams and areas with considerable spring influence.

Lake-living species of *Lanx* appear to have been relatively widespread in some of the OR Interior Basin Pliocene-Pleistocene lakes, such as that once existing near Ft. Rock. Most such lakes are either now dry or are alkaline, which condition is inimical to most mollusk species, including this one. This appears to be the last surviving lake species.

Original distribution: Upper Klamath Lake basin, Klamath Co., OR and Siskiyou Co., CA, likely including Lower Klamath Lake and Tule Lake as well as Upper Klamath Lake. Occurrence in Lake of the Woods uncertain.

Current distribution: Survives at a few spring-buffered sites in the Upper Klamath Lake, area, including the Link River and localities in Winema National Forest and Upper Klamath Lake National Wikflife Refuge. The Tule Lake population (Tule Lake National Wildlife Refuge) may be extinct. Other sites are possible in the same areas and in Rogue River National Forest. Population trends in this species, both in terms of sites and numbers, are clearly downward. We are currently surveying the Upper Klamath drainage for this and other freshwater mollusk species. The first report from this survey is nearly completed (Frest & Johannes (1995b). Significant range extensions or the location of large numbers of additional sites are very unlikely.

Threats: Much of the lake habitat for this Upper Klamath Lake drainage endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Agency Lake populations appear to be extinct, dating at least from the drying of this area in 1993. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining spring pools and spring-fed creeks, the species seems to be confined to limited areas with the best water quality. Most large springs and spring-fed pools are also heavily grazed currently; the species does not seem able to tolerate such disturbance.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; extensive human modification to rather specialized habitat; ongoing threats.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient information of recent vintage exists to establish that this species should be Federal and State (OR and CA) Endangered.

References: Baker (1925); Taylor (1981); Burch (1989); Frest & Johannes (1993c, 1995b); Deixis Consultants, 1991-94.

Lanx n. sp. 1. Banbury Springs lanx

Type locality: To be designated when species is described.

Description: See USFWS (1992d) for best short description. The small, very high, evenly cinnamon red shell, with central sharp apex and height often exceeding width, is unique.

Ecology: Occurs on cobbles and boulders in relatively swift current in large, cold, and clear, very large springs and spring runs. Typically, epiphytic algae and aquatic macrophytes *(Veronica, Rorippa)* are rare in areas with this species. For details, see Frest & Johannes (1992a) and USFWS (19924). A crenocole, lithophile, and perilithon grazer, found generally on sides or undersides of pebble to boulder-sized rocks.

Original distribution: Possibly once much more common in the large spring complexes in the middle Snake River drainage, central southern ID.

Current distribution: Known from only three populations in limited areas in three large nasmodes, Snake River drainage, Gooding Co., ID. At least one site also has the listing candidate Shoshone sculpin.

Threats: The middle Snake River, the Snake groundwater aquifer, and the surface springs are becoming nutrient-enriched due to agricultural and piscicultural discharges. Diversion and capping of springs for power generation, fish farms, human water supply, stock use, and other reasons is pervasive, with most spring complexes affected, including the three with this species. In these, the species is now confined to relatively tiny areas in large complexes. Rather extensive recent surveys in the middle Snake drainage (referenced in USFWS, 1993 and herein under Frest & Johannes, in part) make it very unlikely that major augmentation of either geographic range or site numbers will occur from future research. We have recently (1991-l 994) surveyed over 350 sites in SE Idaho without finding this taxon.

Criteria for inclusion: Very local endemic; past and ongoing threats; documented loss of most of possible historic range.

Recommended status: Currently listed as Endangered (USFWS, 1990, 1992d). Should be listed similarly in Idaho, and regarded as a sensitive species by appropriate federal (e.g., BLM) and state wildlife and land management agencies. Listing of this species is currently being contested in court.

References: Taylor (1985a); Frest & Johannes (1992a); USFWS (1992d); Deixis collections, 1988-l 992.

Lyogyrus n. sp. 1 Columbia duskysnail

Type locality: None designated as yet.

Description: This small spring snail (length less than 1.5 mm) has a small flat protoconch; broadly domed upper whorls, oval aperture; black mantle; and evenly light gray body and tentacles. Both penial lobes are unpigmented. The species somewhat resembles taxa from the Blue Mountains and from SE ID and

adjacent parts of SW MT and W. WY; but the Blue Mountains ***Lyogyrus*** has a larger, more evenly conical orange shell; different body pigment pattern; and slightly different male genital anatomy. ***Lyogyrus greggi*** has 'a much larger, more attenuate spire; darkty pigmented body; and pigmented penis. This taxon was cited as ***Lyogyrus*** n. sp. 1 in Frest & Johannes (1993c).

The genus ***Lyogyrus*** has recently been split into subgenera (Thompson & Hershler, 1991; see also Hershler & Thompson, 1988). However, the detailed anatomy of all of the western and some of the eastern U.S. species remains to be elucidated, and it is not clear if western species belong to any of the described subgenera.

Ecology: Springs and spring outflows, from low to high elevations, in cold, pure, well-oxygenated water. Often in very small springs; most common on soft substrates, in shallow, rather slow flows. Prefers oligotrophic pristine flowages with no macrophytes, but can be found in larger springs with ***Rorippa*** and ***Cicuta***. Sometimes found with other Species of Special Concern, such as ***Juga (Oreobasis)*** spp., especially in the Columbia Gorge. An especially common associate is ***Pristinicola hemphilli (9.v.).*** This crenocole taxon has been noted on both mud and coarse substrate; it appears to feed mostly as a perilithon and periphyton grazer, even in muddy areas.

Original distribution: This species is a Columbia Gorge endemic, found on both sides from E. of Portland to Hood River. Most sites are in Gorge tributaries; a few other sites occur in drainages originating from Mt. Hood. We have not found this form on the W. side of the Cascades in WA, nor on the W. side of the Willamette valley in OR. Similarly, it seems to be absent from the Deschutes River and its major tributaries in OR.

Current distribution: Very sporadic in the central and eastern Columbia Gorge, WA and OR. About a dozen sites am known from private lands and from the Columbia Gorge National Scenic Area, Gifford Pinchot National Forest, and Mt. Hood National Forest, Klickitat and Skamania cos., WA, and Multnomah, Clackamas, and Hood River cos., OR. Some sites are in state parks (Beacon Rock, Benson, Wahkeena Falls). This species is associated with federal listing candidate arthropods at some localities.

Threats: Many (most) Gorge springs and spring-fed streams have been used for water supply or hatcheries; diverted or destroyed by highway construction; or impacted by logging and/or severe fires. Such usages and events are common on public as well as private lands, and continue to occur. Human usage of the Gorge for recreation has increased steadily and heavily in the last few years. The small springs preferred by this species, and many western ***Lyogyrus*** species, are particularly vulnerable to human-induced modification.

Criteria for inclusion: Local endemic; occurrence on public lands: riparian associate.

Recommended status: Currently has none. We have previously (Frest & Johannes (1993c) recommended listing of this taxon. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR and WA) Endangered. We have surveyed the Columbia Gorge sufficiently recently to state that many more sites are not to be expected.

References: Frest & Johannes (1993c); Deixis Consultants, 1988-l 991.

Lyogyrus n. sp. 2 masked duskysnail

Type locality: None as yet; undescribed taxon.

Description: Very high-spired, tall, with evenly convex whorls and round, unreinforced aperture margin, with up to 8 whorls as an adult. Large for genus; to 2 mm length. Mantle light in color; tentacles light, with single distinct yellow bands when live; "mask' of black pigment on neck and around and between eyes. The shell shape and pigment pattern are distinctive as compared to previously described forms. This

species more closely resembles eastern U.S. species than do most of the recently discovered western novelties. This taxon was cited as *Lyogyrus* n. sp. 2 in Frest & Johannes (1993c).

Ecology: Kettle lakes on the periphery of the Columbia drainage in northern and central WA, in areas heavily affected by Late Pleistocene glaciation. This limnophile species occurs on oxygenated mud substrates in areas with some aquatic macrophytes (*Potamogeton crispus*, *Elodea*, *Myriophyllum spicatum*, *Ceratophyllum densum*, *Chara*). Sizable numbers of waterlogged deciduous leaves (*Alnus*, *Populus*) are always present. Occurs with another rare endemic (outside the range of the Northern Spotted Owl), *Amnicola* n. sp. 1 at one site. This pelophile species appears to graze periphyton from leaf and other plant fragment surfaces; but may partly be a detritiiore as well.

Original distribution: Probably quite common at one point in northern and central WA on the east side of the Cascades east to the Rocky Mountains, in heavily placated valleys, in Pend d'Oreille, Stevens, Ferry, Okanogan, and Chelan counties, WA. This taxon could also be found in adjacent parts of the Idaho Panhandle and NW MT with similar geologic history.

Current distribution: Known from two large kettle lakes, one in Ferry Co. and the other in Wenatchee National Forest, Chelan Co., WA.

Threats: Most large kettle lakes in northern WA and ID and NW MT have either been heavily poisoned and stocked; serve as preferred sites for human habitation; or have been included in irrigation systems, with resultant eutropification and extirpation or reduction of the native mollusk fauna. Many such lakes now lack mollusk faunas or have very reduced, low-diversity, generalized faunas, even though dead shells of other taxa may be common in lake sediments just under the surface. Eutropification problems have resulted in citizen complaints and initiation of cleanup programs in both areas with this species.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: Has none currently. We have previously (Frest & Johannes (1993c) recommended listing of this taxon. On present evidence, should be listed as Endangered both federally and in WA. Clarke (1976b) surveyed a number of WA kettle lakes while finding only one site; earlier workers (e.g. Henderson, 1929a, 1936b) had examined many more without finding this taxon. We have recently begun surveying additional kettle lakes in WA, MT, and ID, with very limited success to date.

References: Clarke (1976b); Frest & Johannes (1993c); Deixis Consultants, 1988-93.

Lyogyrus n. sp. 3 Klamath duskysnail

Type locality: Undescribed taxon; none yet designated.

Description: This small (under 1.5 mm as adult) species has a light yellow, mostly translucent shell, small flat protoconch, and low conical spire of about 3 convex whorls. The shell surface is smooth except for the initial whorls; the mantle is unpigmented, as is the body, including snout, tentacles, and external male genitalia. The aperture is rounded, slightly thickened on the columellar side, and has a sinuous outline, as well as being slightly prosocline. Nearest relationships are to the nodose duskysnail and a sister species confined to small portions of the Pit River drainage, Northern CA (Frest & Johannes, 1993c, e, 1994, 1995c). The nodose duskysnail has a nodose shell with a distinctly higher spire. The CA species is smaller and has a more depressed spire, with a simply rounded peritreme. This taxon was cited as *Lyogyrus* n. sp. 4 in Frest & Johannes (1993c).

Ecology: Lives on undersides and sides of boulders and cobbles in a large lake, in areas with spring influence. Macrophytes are generally absent at its sites, and the species appears to be photophobic. This species frequently occurs with other rare mollusk taxa, such as. *Lanx klamathensis*, *Pyrgulopsis*

archimedis, Pyrgulopsis n. sp. 1, and ***Vorticifex klamathensis klamathensis.*** A perilithon grazer and lithophile, as are many of the western U.S. species in this genus.

Original distribution: Upper Klamath Lake (both sides), including the Link River, Klamath ***Co.,*** OR.

Current distribution: Known to survive at about 4 sites, all somewhat sheltered from eutropification by spring influx, on private land and in Upper Klamath Lake National Wildlife Refuge and Winema National Forest. Other sites are possible in the same areas. We are currently doing a comprehensive survey of the Upper Klamath Lake drainage.

Threats: Much of the lake habiit for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Agency Lake populations appear to be extinct, dating at least from the drying of this area in 1993. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining spring pools and spring-fed creeks, the species seems to be confined to limited areas with the best water quality, Most large springs and spring-fed pools are also heavily grazed currently; the species does not seem able to tolerate such disturbance. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. Most sites are themselves remnants, with large areas now lacking this species due to an earlier cycle of habitat modification (see Frest & Johannes, 1995b [in prep.]).

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Comprehensive survey of the Upper Klamath drainage is now underway; to date there is little reason to expect that many more site will be found (Frest & Johannes, 1995b).

Recommended status: Currently has none. We have previously (Frest & Johannes (1993c) recommended listing of this taxon. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered.

References: Taylor (1985a); Frest & Johannes (1993c, e, 1994, 1995b); Deixis Consultants, 1990-94.

Lyogyrus n. sp. 4 nodose duskysnail

Type locality: Recently discovered taxon; none as yet.

Description: This diminutive (less than 1.5 mm spire height) taxon has a yellow translucent shell with about 3 convex whorls, a low conical spire, and prominent nodes on the upper whorls. It much resembles ***Lyogyrus*** n. sp. 3; but is taller, and that species lacks nodes. This taxon was cited as ***Lyogyrus*** n. sp. 5 in Frest & Johannes (1993c).

Ecology: Occurs on undersides and sides of cobbles and boulders in spring complex draining into Upper Klamath Lake and rarely in spring-influenced outflow from lake; ***Rorippa*** present, but snails on rocks only; species appears photophobic. Occurs with other Species of Special Concern, including ***Pyrgulopsis archimedis, Pyrgulopsis*** n. sp. 1, ***Lanx klamathensis,*** and ***Vorticifex klamathensis klamathensis.*** This lithophile species is a perilithon grazer and appears also to be a limnophile, absent from the numerous large springs and spring pools around Upper Klamath Lake

Original distribution: Upper Klamath Lake and major spring tributaries, Klamath Co., OR.

Current distribution: Known from two sites on Upper Klamath Lake, one in Winema National Forest; very rare at one site. A few other sites are possible in the Upper Klamath Lake basin, e.g. Upper Klamath Lake National Wildlife Refuge. We am currently doing a comprehensive survey of the Upper Klamath Lake drainage (Frest & Johannes, 1995b).

Threats: Much of the lake habitat for this Upper Klamath Lake drainage endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Agency Lake populations appear to be extinct, dating at least from the drying of this area in 1993. Most of the large springs draining directly into Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining such spring pools and spring-influenced lake stretches, the species seems to be confined to limited areas with the best water quality. These are also Endangered sucker spawning areas, and care must be taken to avoid extirpating or further limiting the mollusk in order to enhance sucker populations.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Sufficient recent survey work has been done to indicate that this species is a very narrow endemic in need of protection, with' most former habiit now lacking the species.

Recommended status: Has none at present. We have previously (Frest & Johannes (1993c) recommended listing of this taxon. The species should be listed as Endangered federally and by the State of OR. Sites are threatened by eutropification, urban and industrial pollution, and habitat modification to accommodate Endangered sucker species.

References: Frest & Johannes (1993c, 1995b); Deixis Consultants, 1992-4.

Lyogyrus n. sp. 5 mare's egg duskysnail

Type locality: Recently discovered, undescribed taxon; none yet designated.

Description: This taxon was cited as *Lyogyrus* n. sp. 6 in Frest & Johannes (1993c). The small size, low but attenuate spire, and dark mantle are distinctive.

Ecology: Occurs on undersides of cobbles and boulders and of very large *Nostoc* colonies (locally termed mare's eggs) in spring-influenced sites in a large lake and a large, spring-influenced creek. Can occur with other Species of Special Concern, such *as Lanx klamathensis, Helisoma (Carinifex) newberryi,* and *Fluminicola spp.* A crenophile, lithophile, and perilithon feeder, perhaps photophobic as well.

Original distribution: Upper Klamath Lake and vicinity, Klamath Co., OR.

Current distribution: So far found at 3 sites only, one on private land interfingered with units of Winema National Forest and Upper Klamath Lake National Wildlife Refuge and the others apparently on Winema National Forest lands. A small number of additional sites could exist, in the areas mentioned previously and Upper Klamath Lake National Wildlife Refuge. We are currently doing a comprehensive survey of the Upper Klamath Lake drainage; the first report is nearing completion (Frest & Johannes, 1995b). Substantial range extension or increment of currently known live sites are very unlikely.

Threats: Much of the past or potential lake habitat for this Upper Klamath Lake drainage endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects: the species is absent from most areas so modified. Even in the best remaining spring pools, spring-influenced lake areas, and spring-fed creeks, the species seems to be confined to limited portions with the 'best water quality. Most large springs and spring-fed pools are also heavily grazed currently; the species does not seem able to tolerate such disturbance.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate; modification and loss of most habiiat;'threats to rest of habitat.

Recommended status: At present has no special status. We have previously (Frest & Johannes (1993c) recommended listing of this taxon. Should be a federal and State of OR Endangered species. Upper Klamath Lake is badly eutropified, and this species seems to occur only in relatively unpolluted areas with strong, permanent spring influence. These are also commonly sucker spawning sites, hence subject to modification to enhance habitat for three listed Upper Klamath Lake fish species.

References: Frest & Johannes (1993c, 1995b); Deixis Consultants, 1992.

Lyogyrus n. sp. 6 Snake duskysnail

Type locality: Will be designated when the species is formally described.

Descriptioni A smell form with strongly convex whorls; light mantle; only scattered melanin granules on the body; and pigmented penial filament.

Ecology: Occurs in small cold springs and seeps, generally at bw elevations, on gravel to cobble substrate, usually basalt. Macrophytes (generally patchy *Rorippa* only) and epiphytic algae are rare; depth is usually under 2"; much woody debris may be present. This taxon appears to be photophobic; and is a perilithon and periphyton grazer. Very few other mollusks are found in this microhabitat.

Original distribution: Probably common in the upper Snake River and Bear River drainages, SE ID.

Current distribution: Survives at a few sites within the original range, in Bingham and Franklin cos., ID. We are currently surveying SE ID for springsnails (1991-1994), as is R. Hershler *et* al. (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. Known sites are on Caribou National Forest and (apparently) BLM lands.

Threats: Most small springs in SE ID have been heavily impacted by grazing and either are dry or no longer have mollusks. Diversion and capping, even of small springs, for stock use, even on public lands, is very common. The small springs preferred by this species, and many western ***Lyogyrus*** species, are particularly vulnerable to human-induced modification,

Criteria for inclusion: Local endemic; loss of most of known and potential habit; occurrence on public lands.

Recommended status: This taxon has no special status at present; minimally, it should be considered sensitive by Forest Service, BLM, and other land management and wildlife agencies. There has been sufficient recent survey work to justify Federal and State (ID) listing of this species as Endangered.

References: Deixis collections, 1990-l 994.

Lyogyrus n. sp. 7 Blue Mountains duskysnail

Type locality: Will be designated when the species is formally named and described.

Description: Small ***Lyogyrus*** with dark mantle, gray body and external genitalia, and low-medium conic, orange shell. Comparisons with other western species have been made above (see entry for ***Lyogyrus*** n. sp. 1).

Ecology: This species occurs generally in moderate elevation, very cold springs and spring-fed small streams. Sometimes, it and *Pisidium insigne* are the only mollusks present. Sites are very cold, clear, have

moderate to swift flow, and sand, gravel, an cobble substrate. Generally, *Rorippa* and bryophytes are the only obvious aquatic vegetation. This species occurs commonly with *Pristinicola hemphilli.* A crenophile, lithophile, and perilithon feeder.

Original distribution: Probably wmmon in the southern part of the Blue Mts., including the headwaters of the John Day (Columbia River tributary) and Malheur rivers (Snake River tributary), Grant and Baker cos., OR.

Current distribution: Occurs at a few sites within the original range. The best remaining sites ate in Malheur National Forest. One is in Strawbeny Mountain Wilderness (a fact that has not prevented either piping of local springs for campground use or grazing damage).

Threats: Most springs in the Blue Mountains are now either dry or have been capped or piped for stock and human usage; this practice is particularly pervasive in the BLM Baker District. Much of the area has been logged and smaller springs are often exposed and dry. Sever forest fires and insect infestations have affected much of the area, in good part due to monoculture of an inappropriate tree species; much is also severely grazed. The small springs preferred by this species, and many western *Lyogyrus* species, are particularly vulnerable to human-induced modification.

Criteria for inclusion: Local endemic; occurrence on public lands; severe modification of the vast majority of possible and known habitat; specialized and limited habitat.

Recommended status: This taxon has no special status at present; minimally, it should be considered sensitive by Forest Service, BLM, and other land management and wildlife agencies. There has been sufficient recent suwey work to justify Federal and State (OR) listing of this species as Endangered.

References: Deixis collections, 1990-l 993.

Physa (Haitia) natricina Taylor, 1988 Snake River physa

Type locality: Snake River, Gooding Co., ID, in rapids on E. side, SW ¼ SE ¼ sec. 21. T 6 S R 13 E; holotype LACM 2256.

Description: For best description and illustrations, see Taylor (1982c *unpub.,* 1988b). Live specimens of this species are very distinctive, particularly in terms of mantle and body color.

Ecology: Occurs in relatively unimpacted areas, often with spring influence, in a medium-sized river; sites are rapid or riffles and generally have moderate-swift current: gravel-boulder substrate (generally basalt-derived); and few macrophytes or epiphytic algae. Associates include *Fluminicola* sp., *Taylorconcha serpenticola,* and *Vorticifex effusus*. The lithophile tendencies and perilithon feeding habits are unusual for physellids.

Original distribution: A limited reach of the middle Snake River,, Elmore, Gooding, and Owyhee cos., ID; see discussion in Taylor (1982c *unpub.,* 1988b) and USFWS (1992d) for fossil and recent historic range.

Current distribution: Survives at very few sites within the original range.

Threats: Much of the middle Snake River is rapidly becoming eutropified, due to agricultural runoff, fish farms, and urbanization along the river corridor. Much of the river is impounded behind a series of small dams: this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. A recent (1994) landslide impacted some of the historic sites. Introduction of exotic mollusk species (Bowler, 1991) may also be a factor in the species' decline. This taxon is declining, in terms of area occupied and number of sites and individuals. Recent rather extensive survey of much of

. the middle Snake (see references under Frest & Johannes, e.g.; see also USFWS (1992d)) make it highly unlikely that significant range expansion or increase in the number of sites will occur. We have recently (1991-l 994) surveyed over 350 sites in SE Idaho without finding this taxon, except as a fossil.

Criteria for inclusion: Local endemic; loss of historic sites; substantial decrease in available habiiat and its condition.

Recommended status: Currently listed as Endangered federally (USFWS, 1990, 1992d); this is now under court challenge. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There has certainly been more than sufficient recent survey work on this taxon to demonstrate that it should be Federal and State (ID) Endangered.

References: Taylor (1982c *unpub.*, 1988b); USFWS (1992d); Deixis collections, 1988-l 990.

Physa (Physa) megalochlamys Taylor, 1999 large-mantle physa

Type locality: Lily pond beside US 26/89/187, NW 1/4 sec. 19, T 45 N R 114 W, Teton Co., WY (Snake River drainage). Holotype LACM 2255; paratypes UCM 30260. See Wu & Brandauer (1982) for UCM types.

Description: Best description and illustrations are those of Taylor (1988b), *q.v.* The large, thin shell and extensive overfolded mantle are distinctive.

Ecology: "Mostly found in extensive marshes or ponds, fluctuating or even drying seasonally" (Taylor, 1988a, p. 61). Substrate is often fine muds; *Typha-Scirpus* marshes are frequent locations for colonies. Feeding habits unknown; a pelophile species.

Original distribution: Probably widespread across southern Canada and the Pacific Northwest and Rocky Mountain states E. of the Cascades to western MT, UT, and CO: Taylor, (1988b, p. 61).

Current distribution: Taylor, (1988b, p. 61) lists and maps about 16 scattered historic sites, 2 in Saskatchewan; 2 in western MT; 1 in UT; 1 in CO; 1 in ID; 4 in NW WY; and 5 in the Interior Basin of OR. Relevant here are the MT, OR, and WY sites, which include ones in the National Bison Range near Moiese, Lake Co., MT; Yellowstone National Park, and Hamey and Malheur National Wildlife Refuge and adjacent BLM lands, Malheur Co., OR.

Threats: Draining and dredging of marshes; treatment of wetlands and marshes with insecticides and pesticides: eutropification from agricultural runoff and irrigation diversion and returns; urbanization and other construction-related destruction of marshes and swamps.

Criteria for inclusion: Regional endemic known from relatively few sites; known impacts to historic sites and to rather limited habitat generally.

Recommended status: Currently has none. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other relevant land management and wildlife agencies. Should probably be a Federal and State (OR, UT, MT, and WY) Threatened species and ID Endangered species.

References: Taylor (1988b).

Physella (Petrophysa) n. sp. 1 Owyhee wet-rock physa

Type locality: None as yet; the taxon will be described formally in the future.

Description: This species closely resembles the UT C2 (see USFWS, 1994a) candidate species *Physella (Petrophysa) zionis* (Pilsbry, 1926). It differs slightly in body and shell color. The best description of *zionis* is by Pilsbry (1926); the best illustration is in Burch (1989). For further information on the UT (Zion National Park) sites for *zionis*, see Clarke & Hovingh (1991) and Whipple (1987). This species is similar in appearance and habits. Shell color and body pigment appear to differ from the UT species. Some authors (e.g. Taylor & Bright, 1987) regard *Petrophysa* as distinct on the generic level. This does not affect species-level taxonomy.

Ecology: This taxon is a warm-spring snail, found mostly in very shallow water in small spring runs and seeps, including rock (cliff) faces. Very few other mollusks occur in this habitat, and this is often the dominant taxon where *it* occurs. Local *Rorippa* and *Mimulus* are the common aquatic plants. Substrate vanes from basalt bedrock to sand, gravel, and cobbles. A rare hemipteran, *Ambrysus* sp., occurs in some runs; a thermiphile *Pyrgulopsis* (*Pyrgulopsis* n. sp. 4 below) is common in some of the same runs. The area is in a major river canyon, with exposed basalt and other volcanic lithologies, in open and dry sage scrub. This species appears to be a perilithon feeder and lithophile.

Thermiphile physellid species all are very rare and highly endemic, as witness this species, *zionis*, and the Canadian *Physa johnsoni* Clench, 1926 and *Physella (P.) wrighti* Te and Clarke, 1985.

Original distribution: Uncertain.

Current distribution: Limited to a few nearby warm springs in a single complex along the Owyhee River, Malheur Co., OR. Much or all of the area is BLM lands. Searches of warm springs by us and by R. Hershler and his associates through much of Interior OR and southern ID from about 1989-l 994 have not resulted in location of additional sites.

Threats: The area is grazed rather heavily. Past modification of the springs for a bathing pool seems to have impacted the snail population, as they are absent from such areas though occurring immediately below and above. The current road access crosses some spring runs but is not heavily used.

Criteria for inclusion: Very local endemic with very limited range; specialized habitat; current and ongoing threats.

Recommended status: Currently has none. It should be considered a sensitive species by the -Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered.

References: Deixis collections, 1988, 1990.

Physella (Physella) columbiana (Hemphill, 1890) rotund physa

Type locality: Lower Columbia River at The Dalles, Wasw Co., OR. Synypes in CAS collections (58939, 58940, 58941); other Hemphill specimens in UCM (21826) and ANSP (32940, 3294i) collections. See Wu & Brandauer (1982) for UCM types. See Coan & Roth (1987) for CAS specimens,

Description: See Hemphill (1890a) and Te (1978) for description. The best illustration is that of Burch (1989). The rather large, rotund, solid shell, prominent growth lines, and reddish apertural callus are distinctive. Burch (1989), like essentially all other authors, credits the species to Hemphill (1890a). Coan (1985) and Coan & Roth (1987) credit the species to Keep, as Keep (1887) marks the first description. The name, which Coan & Roth (1987) consider at that point a *nomen nudum,* first appeared in a Hemphill catalogue (Hemphill, 1881). This may be technically correct (ICZN, 1985), even though the name originates with Hemphill; Keep's specimens came from Hemphill; Keep was not a taxonomist; Keep (1887)

is not a taxonomic work but a popular work listing what Keep evidently thought were described species; and Keep himself ascribed the species to Hemphill. The first description occurs in Keep (1887), even though it is so brief as to be difficult to recognize the species. If the description is inadequate, then Keep's use of the name at best creates a *nomen dubium*, and traditional usage is correct. The critical question, if the description is accepted as adequate, is its source. If it derives from Hemphill (e.g., a letter or the ms. later published as Hemphill (1890a)), then publication is the only addition to the name; and it should therefore be credited to Hemphill as Hemphill in Keep, 1887 under the provisions of Article 50 (ICZN, 1985). We regard the description in Keep (1887) as inadequate.

Ecology: Nothing certain in the literature. A large-river physid, probably restricted to relatively pure, deep, well-oxygenated water. Found on undersides of, rocks associated with *Juga (Juga) plicifera* and *Fluminicola* sp. at one site, in areas normally covered by several feet or more of water. Substrate preference likely gravel-boulders. Low elevations only. This species is likely a lithophile and perilithon grazer.

Original distribution: Probably endemic to the lower Columbia River, likely from The Dalles to its mouth: Wahkiakum, Cowlii, Clark Skamania, and Klickiiat cos., WA and Clatsop, Columbia, Multnomah, Hood River, and Wasw ws., OR. About half of the range is in the Columbia River Gorge National Scenic Area. For map of well-verified localities, see Taylor (1985a). Burch (1989) and Te (1978) accept scattered records of this species from western WY and MT W. to WA and OR in a few major Columbia Basin streams. Taylor (1977, *unpub.;* 1985a) accepts only lower Columbia River records. We concur with Taylor. Even were the WY and MT records accepted, they are very few, all in rivers subject to much the same problems as the lower Columbia River.

Current distribution: Uncertain; could be extinct This species is one of several likely driien to extinction or near extinction, either throughout their range or in a major part of it, from BPA dams and their effects. The others are *Vorticifex neritoides*, *Fisherola nuttalli*, *Fluminicola columbiana, Anodonta californiensis*, *Anodonfa wahlametensis,* and an undescribed *Pyrgulopsis* (n. sp. 6; see below). We know of no recent records for *columbiana*. However, some rocky habitat does survive in limited areas, and survival of *Fisherola nuttalli* has recently been confirmed. Several lots in museum collections were examined by us in 1991. The references to occurrences in WY and MT in Burch (1989) derive from Te (1978) and are incorrect, in our opinion. Only lower Columbia River specimens closely match the type specimens. Recent studies of Lower Columbia River benthos sponsored by the Lower Columbia River Bistate Commission (Tetra Tech, 1991-l 993, 1993) did not find this taxon in habitat now typical of the lower Columbia River.

Threats: Impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run off.

Criteria for inclusion: Local endemic; possible occurrence on public lands: riparian associate; extensive recent modification of nearly all of the known habitat.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Between surveys concentrated specifically on the lower Columbia and more general surveys of the Columbia River, (see, e.g., Frest & Neitzel (in press, a & b) for summary), there is certainly enough recent survey information to confirm that this species should be Federal and State (OR and WA) Endangered.

References: Taylor (1985a); Deixis Consultants, 1988-l 991.

Planorbella (Pierosoma) oregonensis (Tryon, 1665) lamb rams-horn

Type locality: "Pueblo Valley, on boundary of Oregon, sixty miles west of east boundary" (Tryon, 1865a, Baker, 1945). Holotype not recognized with certainty; likely UI (Baker collection) 1096; see also USNM 35679, UCM 21186, ANSP 21339. See Wu & Brandauer (1982) for UCM types.

Description: Tryon (1865b); for best anatomical and shell illustrations, see Baker (1945). The many forms of U.S. *Planorbella* are in need of revision; nevertheless, available illustrations and anatomical data indicate that this is a valid species, as recognized by Burch (1989, p. 284) and Turgeon et *a/.* (1988).

Ecology: Poorly known; but detailed information is available for one site, Borax Lake, Hamey Co., OR (Furnish, Mclver, & Teisler, 1993). Borax Lake is a geothermally heated alkaline lake, with numerous hot springs, effectively making this species both a thermiphile and limnocrene taxon. For flora, water chemistry, and invertebrate macrofauna, see Furnish, Mclver, & Teisler (1993). The Endangered Borax Lake tui chub lives in this lake.

Original distribution: Cited from three widely separated localities; Pueblo Valley, OR; Tooele Co., UT; and near Gerlach, NV (Tryon, 1865b; Baker, 1945).

Current distribution: It appears that the NV and UT sites are no longer extant. The rather vague Pueblo Valley type localii is in all likelihood Borax Lake, which is in this same valley on the E. side of the Steens Mountains, Hamey Co., OR. The species survives at Borax Lake. We have not found this species in other alkali lakes in the Oregon Interior Basin. Other sites could exist; but there are unlikely to be large numbers.

Threats: For such sites in general, grazing and diversion of water for stock and domestic or agricultural use; geothermal development; ground water drawdown. The Borax Lake site is owned by The Nature Consewancy; but there are plans for geothermal development in the vicinity. Care should be taken that hot spring sources to Borax Lake are not disrupted or changed by such activities.

Criteria for inclusion: Local endemic; loss of historic sites; specialized habitat; past and ongoing threats to known population; possible occurrence on public lands (BLM).

Recommended status: At present this species has no special status; minimally, it should be considered a sensitive species by the appropriate federal and state land management and wildlife agencies. Based on recent surveys in much of the potential and known habitat in NV, UT, and OR by R. Hershler et a/., P. Hovingh and A. Clarke, and by us, we recommend listing of this taxon as Endangered, both Federally and by the State of OR.

References: Tryon (1865b); Baker (1945); Furnish, Mclver, & Teisler (1993).

Pyrgulopsis archimedis Berry, 1947 Archimedes pyrg

Type locality: Upper Klamath Lake in vicinity of Algoma, Klamath Co., OR.

Description: For comprehensive description and illustration of both shell and soft part morphology see Hershler (1994). There are only two strongly carinate western North American *Pyrgulopsis* species: this and the genotype, *Pyrgulopsis nevadensis.* This species is more strongly carinate; larger; and has a less attenuate spire.

This species was first reported from Upper Klamath Lake some time before its description (Henderson, 1924, 1929a, 1936b; Hanna, 1930; Clench, 1940). Berry (1947) was the first to recognize its distinctness, which has since been conclusively demonstrated (Hershler, 1994). Limnophile *Pyrgulopsis* species are unusual, although more common in the Interior Basin (OR) Pliocene-Pleistocene pluvial lakes. This species was cited identically in Frest & Johannes (1993c).

Ecology: Large-lake hydrobiid, now surviving only in areas with spring influenceto counter eutropification and subsequent periodic low DO_2. This taxon prefers areas with gravel-boulder (basalt and pumice)

substrate and few macrophytes. It occurs with several other Species of Special Concern, namely ***Lanx klamathensis, Pyrgulopsis*** n. sp. 1, ***Pisidium ultramontanum, Lyogyrus*** n. sp. 4, ***Fluminicola*** n. sp. 1, and ***Vorticifex klamathensis klamathensis***. It is a perilithon feeder, generally grazing on lower and lateral sides of larger stones, and a lithophile.

Original distribution: Upper Klamath Lake and Tule Lake, Khmath Co., OR and Siskiiou Co., CA; likely occurred also in Lower Klamath Lake as well. The related (and now likely extinct) genotype ***Pyrgulopsis nevadensis*** occurred in Walker and Pyramid Lakes, NV.

Current distribution: Known now from 4 spring-influenced sites in Upper Klamath Lake, Klamath Co., OR. Two sites are in Winerne National Forest. Sites in Upper Klamath Lake National Wildlife Refuge (W. side of Upper Klamath Lake) are probable. The Tule Lake population is likely extinct. A comprehensive survey of the Upper Klamath Lake drainage freshwater mollusks is now under way; the first report is nearing completion (Frest & Johannes, 1995b). Substantial range extension or increment of currently known live sites are both very unlikely.

Threats: Much of the lake habitat for this Upper Khmath Lake endemic is considerably eutropified, has soft substrate, or both: the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Comprehensive survey of the Upper Klamath drainage is now underway; to date there is little reason to expect that many more sites will be found (Frest & Johannes, 1995b).

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered. The species lives only in the limited areas of the lake not completely affected by eutropification, as they have considerable spring influx. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

References: Berry (1947); Hershler (1994); Frest & Johannes (1995b); Deixis Consultants, 1992-l 994.

Pyrgulopsis bruneauensis Hershler, 1990 Bruneau hot springsnail

Type locality: Springs along W. side of Bruneau River, about 100 m down flow from the confluence of Hot Creek, SW 1/4 sec. 34, T 7 S R 6 E, Owyhee Co., ID; holotype USNM 860507; paratypes 860508.

Description: For comprehensive description and illustration of both shell and soft part morphology see Hershler (1990, 1994). The long penial filament, short base and accessory lobe, and simple penial ornament (single small terminal lobe) are distinctive.

This is one of a small group of western U.S. thermiphile ***Pyrgulopsis*** species, most or all of which tend to be highly endemic. Known occurrences are typically of single endemic species from single springs or spring groups widely separated from each other geographically. Other examples ***are Pyrgulopsis*** n. sp. 8 [Indian Hot springsnail, ***q.v.***]; ***Pyrgulopsis*** n. sp. 4 (Owyhee hot springsnail), the extinct ***Pyrgulopsis brandi*** (Drake, 1953); and C2 candidate ***Pyrgulopsis thermal/s*** (Taylor, 1987). For summary information, see USFWS (1985, 1993).

Ecology: This is a thermiphile species, found in small spring runs and very smell (probably formerly confluent) seeps. Macrophytes are generally absent; flow is often over bare basalt bedrock surfaces. Very

few other mollusks occur with this taxon. For detailed ecology and presumed life history, see Mladenka (1992). The species is primarily a lithophile and an aufwuchs grazer, mostly from rock surfaces, but also from plants and wood.

Original distribution: Uncertain; thermiphile *Pyrgulopsis* mostly are highly endemic. The ground water table in the area of occurrence has been lowered considerably by overpumping ("mining") for agriculture, and flow in the largest spring inhabited reduced to a trickle, as contrasted to former status as one of the larger ID springs.

Current distribution: Limited to a small stretch along lower Hot Creek and adjacent Bruneau River, Owyhee Co., ID.

Threats: Groundwater withdrawals; grazing; overcollecting; human sabotage.

Criteria for inclusion: Local endemic; loss of most of historic habit; specialized habit; occurrence on public lands (mostly BLM).

Recommended status: Recently (USFWS, 1985, 1993) listed federally as Endangered. The listing has been challenged successfully in court; appeal and relisting procedures are currently under way. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Obviously should be Federal and State (ID) Endangered. USFWS handling of this species has been criticized in an independent study (GAO, 1993a).

References: Taylor (1981); Hershler (1990, 1994); Mladenka (1992).

Pyrgulopsis hendersoni (Pilsbry, 1933) Harney Lake springsnail

Type locality: Spring S. of Bums, Hamey Co., OR; holotype ANSP 145951; paratypes ANSP 396668.

Description: For comprehensive description and illustration of both shell and soft part morphology see Hershler (1994). This is one of a group of related species occurring along the periphery of the Great Basin, Placed in the separate genus and subgenus *Fontelicella (Natricola)* by Gregg & Taylor (1965). The closest relative is the Endangered *Pyrgulopsis idahoensis*; for comparisons, see Hershler (1994).

Ecology: Occurs in small to large cold springs and spring Pools. These generally have moderate flow; runs may be quite shallow; and quite often have dense *Rorippa* cover. Rather few mollusks, aside from *Pisidium insigne*, co-occur. Substrate is generally coarse, ranging from sand to basalt or vesicular basalt cobbles. The species is an aufwuchs grazer, mostly from sides of stones but occasionally from stable macrophytes, and lithophile.

Oiiginal distribution: Probably once widespread in the Hamey Lake-Malheur Lake area, Oregon Interior Basin, Harney Co., OR.

Current distribution: The presumed type locality, as well as other springs in the Bums area, are now dry, evidently from groundwater mining in the Bums area. Other springs in the area have been capped or diverted for stock, industrial, or domestic water supply. Known from about four sites currently, al heavily impacted by cattle and horse grazing. Most sites are on BLM lands. Sites on Malheur National Wildlife Refuge property are possible also, although recent surveys of much of the known and potential range by us and by R. Hershler and his collaborators (1988-l 993) indicate that there is little chance of substantive range extension or large increase in the number of live sites. Subfossil and fossil shells are common along the shores of Harney and Malheur lakes, indicating much broader distribution in the recent past.

Threats: Overpumping of ground water; grazing; diversion and capping of springs for stock, industrial, and domestic water supply.

Criteria for inclusion: Very local endemic; loss of historic sites, including the type locality; past and ongoing threats.

Recommended status: This taxon currently has no special status. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Enough recent suwey work has been done by us and by Hershler *et al.* to demonstrate that this species should be Federal and State (OR) Endangered.

References: Pilsbry (1933); Hershler (1994); Deixis collections, 1990, 1992.

Pyrgulopsis idahoensis (Pilsbry, 1933) Idaho springsnail

Type locality: Snake River at Homedale, Owyhee Co., ID; lectotype ANSP 152677; paralectotype ANSP 396966. See Hershler (1994) and Baker (1964).

Description: For comprehensive description and illustration of both shell and soft part morphology see Hershler (1994); see also Taylor (1982 f unpub.). This species is one of several included in. *Fontelicella (Natricola)* by Gregg & Taylor (1965). Despite synonymy by Hershler (1994), the group remains somewhat distinctive in morphology and distribution. Details of the shell, penis, and internal anatomy distinguish this taxon from *Pyrgulopsis hendersoni*, the most closely related species.

Ecology: A medium-river form, found mostly on cobble substrate in clear, cold, water, in spring-influenced riffles. Macrophytes (including *Ceratophyllum*, *Elodea*, *Potamogeton crispus* and *filiformis*) and epiphytic algae may be present, but not as dense beds. This species is a perilithon grazer and lithophile, *as are* many *Pyrgulopsis* species. Common associates include such cold-water forms as *Fluminicola* sp., *Taylorconcha serpenticola*, and *Fisherola nuttalli.*

Relatively few *Pyrgulopsis* species are amniphiles or amnicoles; most are crenophilic. The related lower Columbia River springsnail *Pyrgulopsis* n. sp. 7 and *Pyrgulopsis* n. sp. 14 [Teton River springsnail; *q.v.*] are the best analogues.

Original distribution: Middle Snake River, probably from about the Weiser area to Glenns Ferry, i.e. Canyon, Ada, Owyhee, and Elmore cos., ID. The record in Branson, Sisk, & McCoy (1966) is erroneous.

Current distribution: In recent years, found only in about 4 sites: see USFWS (1993) for details. The condition of these sites, all downstream from the Bliss landslide of 1993, needs to be rechecked.

Threats: Much of the middle Snake River is rapidly becoming eutropified, due to agricultural runoff, fish farms, and urbanization along the river corridor. The area has been declared waterquality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. Much of the middle Snake is also impounded, and this species does not seem to tolerate such impoundments. A recent (1993) landslide near Bliss, ID may have impacted all of the historic sites. Introduction of exotic mollusk species (Bowler, 1991) may also be a factor in the species' decline. This taxon is declining, in terms of area occupied and number of sites and individuals. Recent rather extensive survey of much of the middle Snake (see references under Frest & Johannes, e.g.; see also USFWS (1993)) make it highly unlikely that significant range expansion or increase in the number of sites will occur. We have recently (1991-l 994) surveyed over 350 sites in SE Idaho without finding this taxon.

Criteria for inclusion: Local endemic; occurrence on public lands (BLM); serious and ongoing degradation of all of habitat; loss of historic sites, including the type locality.

Recommended status: This species is at present federally listed as Endangered (USFWS, 1990, 1992d). A legal challenge to the listing is currently being pursued. It minimally should be considered a

sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (ID) Endangered; much recent information and survey work is available (see above).

References: Pilsbry (1933); Taylor (1982f unpub.); Hershler (1994); Deixis collections, 1988-l 992.

Pyrgulopsis intermedia (Tryon, 1865) Crooked Creek springsnail

Type locality: Crooked Creek, Owyhee River drainage, Malheur Co., OR; types originally segregated by Baker (1964) as ANSP 27958a; lectotype ANSP 27958; paralectotypes ANSP 396959 (Hershler, 1994).

Description: For comprehensive description and illustration of both shell and soft part morphology see Hershler (1994). ***Pyrgulopsis*** n. sp. 1 [Klarnath Lake springsnail] is similar; but has a shorter, blunter spire and differs in body pigmentation. The citation in Frest & Johannes (1993c) is the same.

Ecology: Occurs primarily in large, low elevation cold springs, but also in spring-influenced. creeks, generally with gravel-boulder substrate. Generally the dominant mollusk, may occur with ***Pyrgulopsis hendersoni*** and with ***Fluminicola*** sp. Occurrences are in cold, clear, and moderately swift waters, generally with ***Rorippa*** beds in the vicinity. This species is a perilithon feeder (aufwuchs grazer), like many ***Pyrgulopsis*** species, and a lithophile.

Original distribution: Originally thought to range along the periphery of the Great Basin along old course of the Snake River, i.e. from the OR-ID border to northern CA (in the Pit drainage): Harney, Malheur, and possibly Lake and Klamath cos. OR and Shasta, Lassen, and Modoc cos., CA. See Taylor (1985a) and Hershler (1994) for discussion. Frest & Johannes (1993c, e) accepted the broad distribution outlined above; but recent examination of specimens from the type locality, the Upper Klamath Lake area, and from NE CA indicates that populations from all three likely are distinct new species; we have not yet collected the Barren Valley (OR) population. The distribution should probably be limited to the Owyhee drainage and possibly the Barren Valley populations, Hamey and Malheur cos., OR. Subfossil specimens indicate rather recent former widespread occunence in the Hamey and Malheur lakes region. See ***Pyrgulopsis*** n. sp. 1 [Klamath Lake springsnail] below for further discussion.

Current distribution: As defined above, known from about three scattered sites in Hamey and Malheur cos., OR (on private and BLM lands).

Threats: Spring sites in the area of occurrence are mostly heavily damaged (or destroyed) by grazing; diversion for domestic, industrial, or stock use; ground water mining; and other causes.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: Currently, this species has no special status; it minimally should be considered sensitive by the BLM, Forest Service, and other appropriate land management and. wildlife agencies. Listing as Endangered, both Federally and in OR, is appropriate in our opinion. Sufficient recent survey work has been done in CA (Frest & Johannes, 1993e, 1994, 1995c; Hershler, in press), the Upper Klamath Lake drainage (Frest & Johannes (1995b), and in the OR Interior Basin (by Frest & Johannes and by Hershler and his collaborators, 1988-l 993) to clarify its status and justify listing.

References: Henderson (1929a, 1936b); Taylor (1981); Deixis Consultants, 1989-92.

Pyrgulopsis n. sp. 1 Klamath Lake springsnail

Type locality: New species, none designated at present.

Description: This species ***was cited*** as ***Pyrgulopsis*** n. sp. 1 in Frest & Johannes (1993c). It is similar to the crenophile ***Pyrgulopsis intermedia,*** but has dark tentacles and darker body pigmentation and blunt upper whorls.

Ecology: Found on cobbles and boulders in spring-influenced areas of a large lake. It occurs with several other Species of Special Concern, namely ***Lanx klamathensis, Pyrgulopsis archimedis, Pisidium ultramontanum, Lyogyrus*** n. sp. ***4,*** and ***Vorticifex klamathensis klamathensis,*** and ***Vorticifex effusus dalli.*** Primarily a liihophile and perilithon feeder.

Lake-dwelling (limnophile) ***Pyrgulopsis*** species are now somewhat unusual, though apparently widespread in the OR, CA, and NV Great Basin Plio-Pleistocene pluvial lakes. Other Western U. S. examples are ***Pyrgulopsis newadensis*** and ***Pyrgulopsis archimedis;*** for a fossil example, see Taylor and Smith (1981).

Original distribution: Upper Klamath Lake, Klamath Co., OR. This species seems to be an Upper Klarnath Lake endemic, with different ecology and morphology than the closely related ***Pyrgulopsis intermedia*** and another undescribed spring and stream form from NE CA.

Current distribution: Known to survive at two sites, both on the east side of the lake. One site is in Winema National Forest. Other sites are possible in the vicinity. We are currently doing a comprehensive freshwater mollusk survey of the Upper Klarnath Lake drainage; the first report is due shortly (Frest & Johannes, 1995b). It is unlikely that the range or total number of sites will be expanded greatly in the future, given recent (1990-1994) work in the Upper Klamath Basin, NE CA, and Interior Basin of OR by us and by R. Hershler ***et*** a/.

Threats: Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Even in the best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. Most sites are themselves remnants, with large areas now lacking this species due to an earlier cycle of habitat modification (see Frest & Johannes, 1995b).

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Comprehensive survey of the Upper Klamath drainage is now underway; to date there is little reason to expect that many more sites will be found (Frest & Johannes, 1995b).

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered. The species lives only in the limited areas of the lake not completely affected by eutropification, as they have considerable spring influx. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

References: Frest & Johannes (1995b); Deixis Consultants, 1991-94.

Pyrgulopsis n. sp. 2 Big Spring springsnail

Type locality: None; to be designated when species is described.

Description: This species is a member of the ***intermedia*** group, typified by having penes with penial, terminal, and ventral glands only (Hershler, 1994): Details of penial morphology, shell size and shape, and female internal anatomy distinguish the species. This is perhaps the smallest member yet discovered.

Ecology: Found in a large cold spring complex, with abundant ***Rorippa***; some ***Mimulus at*** sides; ***Chara*** in deep areas; other rnacrophytes in impacted areas on Lost River side of complex (***Ceratophyllum***, ***Elodea***, ***Potamogeton crispus***, ***Potamogeton filiformis***, although the snail is rare or absent in such areas. Flow slow-moderate; substrate mud, sand, minor gravel and cobbles. Thii species is most common on mud substrate (ii a pelophile) and appears to be a detritivore. Common associates at one site include ***Fluminicola*** n. sp. 5 [Lost River pebblesnail, ***q.v.***], ***Votticifex*** sp., and ***Physella gyrina.***

Original distribution: Probably once common in the Lost River drainage. So far, this species has not been found in the rest of the Upper Klamath drainage; nor in such adjoining areas as the Goose Lake, NE CA Great Basin, and upper Pit River drainage, although related ***Pyrgulopsis*** species occur there, and these areas have been surveyed recently in some detail (Frest & Johannes, 1993e, 1994, 1995c; Hershler, in press).

Current distribution: Known from a single large spring complex tributary to the Lost River, Klamath Co., OR. We are currently surveying the freshwater mollusks of the Upper Klamath Lake drainage, with the first report due shortly (Frest & Johannes, 1995b). It is unlikely that the geographic range of this taxon will be greatly expanded by future work, nor that large numbers of addiiional sites will be found. Sites on Klamath District BLM lands are possible.

Threats: Much of the Lost River receives nitrogen- and phosphorous-enriched runoff from farming, and the river is extensively integrated into the Upper Klamath Project. Much is heavily affected by siltation, and is choked with macrophyte beds. Large sections show periodic or seasonal hypoxia or anoxia and are turbid during much of the year. Flow is now very sbw and reduced in volume seasonally in much of the system. Sections affected by the factors listed above have lost much of the native mollusk fauna, which includes this species. Many of the springs in this area have been diverted, capped, or otherwise altered, to the point of not providing habitat for native mollusk species. Groundwater recharge for some springs is 'also nutrient-enriched, presumably from farm runoff. This species is definitely declining, in terms of both numbers and habitat area and condition.

Criteria for inclusion: Local endemic; drastic decline in habitat condition and area; possible occurrence on public lands.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. There is sufficient recently-collected information, and recent survey work, to suggest that Federal and State (OR) listing as Endangered is appropriate for this taxon.

References: Frest & Johannes (1995b); Deixis collections, 1994.

Pyrgulopsis n. sp. 3 Lake Abert springsnail

Type locality: None; to be designated when species is described.

Description: This species is a large member of the ***intermedia*** group. This species assemblage is typified by having penes with penial, terminal, and ventral glands only (Hershler, 1994). Details of penial morphology, shell size and shape, and female internal anatomy distinguish the species. Most or all members occur on the periphery of the Great Basin, in the OR Interior Basin and adjacent areas of CA. This species was referred to as ***F.*** [***Fontelicella***] sp. by Taylor and Smith (1981).

Ecology: A cold-water crenophile, as are most ***Pyrgulopsis.*** This taxon apparently prefers medium-sized springs with ***Rorippa,*** clear cold, water, and substantial velocity. It occasionally may be associated with undescribed small ***Fluminicola*** species. A lithophile and perilithon grazer.

Original distribution: Lake Abert basin, Abert Rim, Lake Co., OR.

Current distribution: Known to survive in at least one site in the original distribution. This site was known since at least 1976 (Taylor & Smith, 1981). Impacts to most springs and recent survey work by Hershler ***et*** al. (1993, 1994) indicate that few additional sites are likely, and substantial range extension unlikely. Sites on BLM lands are quite possible.

Threats: Springs in this area have frequently been diverted for stock and occasionally for human water supply. Most are heavily grazed, which usually extirpates species such as this one. Ground water drawdown and geothermal projects are other current concerns in this basin.

Criteria for inclusion: Local endemic; specialized habit; modification and impacts to most or all of habitat.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent searches have been conducted to indicate that this species should be Federal and State (OR) Endangered.

References: Taylor & Smith (1981).

Pyrgulopsis n. sp. 4 Owyhee hot springsnail

Type locality: None; to be designated when species is described.

Description: Similar to ***Pyrgulopsis bruneauensis,*** except that the shell is more strongly globose; is smaller: the penial filament is short; and the accessory lobe is prominent; there are several other differences in internal anatomy.

Ecology: This taxon is a thermiphile species, found mostly in very shallow water in small spring runs and seeps, including rock (cliff) faces. Very few other mollusks occur in this habitat, and this is often the dominant taxon where ***it*** occurs. Local ***Rorippa*** and ***Mimulus*** are the common aquatic plants. Substrate varies from basalt bedrock to sand, gravel, and cobbles. A rare hemipteran, ***Ambrysus*** sp., occurs in some runs: a thermophile physid, ***Physella (Costatella)*** n. sp. 1 (***q.v.***), is common in some of the same runs. The area is in a major river canyon, with exposed basalt and other volcanic lithologies, in open and dry sage scrub.

Thermiphile ***Pyrgulopsis*** species are generally very rare and highly endemic, as witness this species: see discussion under ***Pyrgulopsis bruneauensis*** also.

Original distribution: Uncertain; likely confined to a portion of the Owyhee drainage.

Current distribution: Limited to a few nearby warm springs in a single complex along the Owyhee River, Malheur Co., OR. Much or all of the area is BLM lands. Searches of warm springs by us and by R. Hershler and his associates through'much of Interior OR and southern ID from about 1989-1994 have not resulted in location of additional sites.

Threats: The area is grazed rather heavily. Past modification of the springs for a bathing pool seems to have impacted the snail population, as they are absent from such areas though occurring immediately below and above. The current road access on the E. side of the Owyhee River crosses some spring runs but is not heavily used.

Criteria for inclusion: Very local endemic with very limited range; specialized habitat; current and ongoing threats.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent work has been done to indicate that this species should be Federal and State (OR) Endangered.

References: Deixis collections, 1988, 1990.

Pyrgulopsis n. sp. 5 Malheur springsnail

Type locality: None; to be designated when species is described.

Description: This is another member of the ***intermedia*** group, with unique penial features. This taxon is a D. **W.** Taylor discovery which has remained undescribed for at least 20 years. It has been cited under the name ***Fontelicella malhorica*** (Taylor, 1977, ***unpub.),*** a ***nomen nudum.***

Ecology: Crenophile, living in medium-large cold springs. May be the primary mollusk present: springs with this species have common ***Rorippa***, sand, gravel, and cobble (basalt) substrate, are cold and clear, and have moderate velocity. A lithophile and perilithon feeder.

Original distribution: Probably confined to portions of the Owyhee River drainage, Hamey and Malheur cos., OR.

Current distribution: Known from a single site in the headwaters of Crooked Creek, on BLM lands. Interior OR has recently begun to be comprehensively surveyed for springsnails, e.g. by us and by R. Hershler ***et al.***; large range or site number increases are very unlikely.

Threats: Springs in this area have commonly been capped or diverted into irrigation systems: converted for stock water sources; or are heavily grazed, as is this one. In al of these cases, springsnails are unlikely to survive if disturbance is protracted.

Criteria for inclusion: Local endemic; occurrence on public lands; current ,and past threats to habitat.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent work has been done to indicate that this species should be Federal and State (OR) Endangered.

References: D. W. Taylor (1977, ***unpub.).***

Pyrgulopsis n. sp. 8 Columbia springsnail

Type locality: Has yet to be designated; undescribed and recently discovered taxon.

Description: This species is a member of what Gregg & Taylor (1965) termed ***Natricola***, a group of species particularly characteristic of the periphery of the Great Basin. 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. For comprehensive discussion of related species, see Hershler (1 9 9 4) .

Ecology: Generally in relatively deep water on rocky (mostly basalt pebble-cobble) substrate in areas maintaining constant flow; absent from mud-silt substrate and typical impoundment conditions. Macrophytes are generally uncommon at sites with this species; ***Ceratophyllum*** and ***Potamogeton crispus*** are most commonly noted. Epiphytic algae may be common. Snails are found on relatively bare undersides of uncemented cobbles. Common mollusk associates include ***Vorticifex*** sp., ***Fluminicola*** sp., ***Juga (Juga) plicifera, Stagnicola apicina, Pisidium compressum,*** and ***Corbicula fluminea.*** Freshwater arthropods, such as crayfish and amphipods, are also wmmon at localities with this species. The general association is that probably common to the Lower Columbia River prior to human modification. This taxon is a lithophile and perilithon feeder. It is one of the few amniphile ***Pyrgulopsis*** species. The closest relatives are such species as the Endangered Idaho springsnail ***Pyrgulopsis idahoensis.***

Original distribution: Probably ubiquitous in a portion of the lower Columbia River from the eastern Columbia Gorge to Wallula Gap.

Current distribution: A few 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. This species was noted originally in the Dalles Pool by a USFWS research team in 1988. Recent surveys of both the Hanford Reach upstream and the stretch from Bonneville Dam to the mouth have failed to find this species (e.g., Tetra Tech, 1991-l 993, 1993). Similarly, search of nearly 500 Columbia Basin sites between 1988-1994 turned up no sites (Neitzel & Frest, 1989, 1990, 1993; Frest & Neitzel, in press a, b). We located it at 4 localities within the original range in 1994.

Threats: Impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of The Dalles and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run off.

Criteria for inclusion: Localized endemic; habitat reduction and continued human impacts;. recent threats to remaining sites.

Recommend& status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR and WA) Endangered, due to very considerable habitat reduction, small number of remaining sites; impact of federal projects (e.g., the BPA dams) on habitat; continuing threats to remaining sites.

References: Deixis collections, 1994.

Pyrgulopsis **n. sp. 7 Benson springsnail**

Type locality: None; to be designated when species is described.

Description: This small species is a member of a group of undescribed taxa restricted to portions of the SE ID Snake River and Bear River drainages. We are currently working on this taxon (with R. Hershler).

Ecology: This taxon is a crenophile preferring large and swift cold springs. ***Rorippa*** and ***Veronica*** are abundant in much of the area inhabited by this snail; locally ***Chara*** may be abundant also, and a small epiphytic algal component is present also. The most wmmon associated mollusk is ***Fluminicola*** sp. Substrate ranges from local mud to gravel and cobbles. This species appears to be a perilithon and periphyton feeder.

Original distribution: Probably confined to the Sublett Range and vicinity, Power and Cassia cos., upper Snake River drainage, ID.

Current distribution: Currently known from a single spring complex in Power Co., ID. We are currently surveying SE ID for springsnails (1991-1994), as is R. Hershler *et al.* (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. The Sublett Range is divided between private, BLM, and Sawtooth National Forest ownership.

Threats: This spring complex is used as a source for a private fish hatchery. It is also grazed: many springs in this area lack mollusks due to heavy grazing.

Criteria for inclusion: Very local endemic; current and ongoing threats; possible occurrence on public lands.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1992.

Pyrgulopsis n. sp. 8 Indian Hot springsnail

Type locality: None; to be designated when species is described.

Description: This small subglobose snail is a member of a group of species with much reduced penial glands. This taxon has none; the accessory lobe is absent, and the penial base and filament are essentially continuous. We are currently working on this taxon (with R. Hershler).

Ecology: A thermiphile taxon at home in both warm, shallow, and low-velocity seeps and larger, swift spring runs with abundant macrophytes (some introduced; also *Potamogeton filiformis* and *Elodea*) and various warm spring algal epiphytes and encrusting forms, including both red and calcareous green algae. The substrate ranges from mud to travertine gravel and sand to basalt cobbles. This species is primarily a lithophile and periphyton grazer.

Original distribution: Probably confined to a few warm springs in the Deep Creek Mountains, Power Co., ID.

Current distribution: Confined to portions of a priiate resort. We are currently surveying SE ID for springsnails (1991-1994), as is R. Hershler *et al.* (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. Most of the Deep Creek Mountains are BLM public lands.

Threats: Further resort development; groundwater drawdown in the immediate area; conflicting water rights on the drainage including the sites; heavy grazing of most other springs in this area. Introduced fishes and mollusks are wmmon at the sites. Other warm springs in the Deep Creek Mountains have been grazed out or are now dry from various causes. Additional sites for this taxon are very unlikely.

Criteria for inclusion: Very local endemic with very unusual habitat; possible occurrence on public lands.

Recommended status: Currently has none. It at least should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to show that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1992, 1994.

Pyrgulopsis n. sp. 9 Birch Creek springsnail

Type locality: None; to be designated when species is described.

Description: This relatively large, high conical species is a member of a group of species characteristic of parts of the upper Snake River and Bear River (including Lake Bonneville) drainages. It was regarded by Taylor (1985a) as a member of the ***Fontelicella (Natricola)*** species group of Gregg & Taylor (1965). We are currently working on this taxon (with R. Hershler). This species was first found by D. W. Taylor in the late 1950s-early 1960s. Affinities are with such species ***as Pyrgulopsis robusta*** and other peripheral Great Basin forms. Taylor (1977, ***unpub.)*** had selected the name ***Fontelicella betulina*** (currently a ***nomen nudum)*** for this taxon.

Ecology: A lithophile species, feeding on both perilithon and periphyton organisms. This species prefers larger cold springs and spring pools, but can range to spring sources. It is found at depths ranging from less than an inch to about 14". Substrate ranges from minor mud to limestone and basalt gravel and cobbles. Macrophytes are common at sites, and include ***Rorippa, Veronica, Chara, Myriophyllum,*** and ***Mimulus.*** The most frequent associate is ***Stagnicola hinkleyi.*** Much of the area is bog and fen, with seven rare plant species, including the narrow endemic and federal listing candidate ***Primula alcalina: see*** Mosely (1992) for comprehensive discussion of the plants.

Original distribution: Probably restricted to portions of the Birch Creek Valley, between the Lemhi Range and Beaverhead Mountains, Lemhi and Clark cos., ID.

Current distribution: Known only from a few springs tributary to Birch Creek, mostly on Targhee National Forest and ID Department of Fish & Game lands, Lemhi Co., ID. We are currently suweying SE ID for springsnails (1991-l 994), as is R. Hershler ***et a/.*** (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. Other lands in the area are owned by Salmon District BLM or are private. This species seems once to have inhabited Birch Creek, but runoff, grazing, and channel modification now seem to limit it to tributaries.

Threats: Much of the area is heavily grazed (horses and cattle), which has eliminated much or all of the native mollusk fauna from some springs in the complex. Many of the springs in this valley have been trashed by stock usage and/or diversion; some mapped are now dry.

Criteria for inclusion: Local endemic; occurrence on private lands; current and ongoing threats.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent suwey work has been done to show that this species should be Federal and State (ID) Endangered.

References: Taylor (1977, ***unpub.,*** 1985a); Deixis collections, 1990, 1991, 1994.

Pyrgulopsis n. sp. 10 Rock Creek springsnail

Type locality: None: to be designated when species is described.

Description: This large, subconical species was regarded by Taylor (1985a) as a member of the ***Fontelicella (Natricola)*** species group of Gregg & Taylor (1965). It is related to such species as ***Pyrgulopsis robusta.*** We are currently working on this taxon (with R. Hershler). This species was first found by D. W. Taylor in the late 1950s-early 1960s. The manuscript name (Taylor, 1977, ***unpub.;*** a ***nomen nudum)*** for this taxon was ***Fontelicella petricola.***

Ecology: A lithophile species, feeding on both perilithon and periphyton organisms. This species prefers larger cold springs and spring-fed creeks, and is largely a crenocole. Substrate ranges from minor mud to limestone gravel and cobbles. Macrophytes are common at sites, and include *Rorippa*, *Veronica, Chara, Myriophyllum*, and *Mimulus*. The most common mollusk associate is *Fluminicola* sp. Depth ranges from about 2" to more than 12"; this snail can range to spring sources.

Original distribution: Probably widespread in the Rockland Valley, between the Sublett Range and Deep Creek Mountains, Power Co., ID (upper Snake River drainage).

Current distribution: Occurs at a couple of sites on BLM public lands, in one fork of Rock Creek.

Threats: The sites are in a public campground, with human usage and grazing causing some impacts. Most springs mapped in this valley are now dry or grazed to the point that none of the native mollusk fauna remains. As we are currently surveying SE ID for springsnails (1991-1994), along with R. Hershler *et* al. (1993-1994), significant range extension or discovery of sizable numbers of new sites are not to be expected from future work.

Criteria for inclusion: Local endemic: loss of most potential habitat; current and continuing threats.

Recommended status: Currently, this species has no special status. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to show that this species should be Federal and State (ID) Endangered.

References: Taylor (1977 *unpub.*; 1985a); Deixis collections, 1992-l 993.

Pyrgulopsis n. sp. 11 Pauline springsnail

Type locality: None; to be designated when species is described.

Description: This small, high-spired form with strongly convex whorls is a member of a group of undescribed taxa restricted to portions of the SE ID Snake River and Bear River drainages. We are currently working on this taxon (with R. Hershler).

Ecology: This hydrobiid is a crenophile preferring smaller cold springs. *Rorippa* and *Mimulus* are abundant in much of the area inhabited by this snail; locally *Chara* may be abundant also, and a small epiphytic algal component is present also. The most wmmon associated mollusk is *Fluminicola* sp. Substrate ranges from local mud to basalt gravel and cobbles. This species appears to be both a perilithon and periphyton feeder. The snail is found mostly in very shallow water, with moderate velocity flows.

Original distribution: Probably confined to the Arbon Valley, between the Deep Creek Mountains and the Bannock Range, Power and Oneida cos., upper Snake River drainage, ID.

Current distribution: At present known from a single spring complex in Power Co., ID. We are currently surveying SE ID for springsnails (1991-l 994), as is R. Hershler *et al.* (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. Much of the Valley is private; the Deep Creek Mountains are largely administered by the BLM; the Bannock Range is largely in Caribou National Forest. A few sites in these areas are possible.

Threats: This spring complex has been heavily impacted by highway construction and maintenance (Arbon Valley Hwy.). Parts of the spring complex have been dug out, other areas are diverted into an irrigation ditch. The snail is absent from these areas. Most of the surviving colony is on the highway right-

of-way, while the bulk of the spring complex is on the Ft. Hall Indian Reservation. Most of the complex is also grazed; many springs in this area are dry or lack mollusks due to heavy grazing.

Criteria for inclusion: Very local endemic; current and ongoing threats; occurrence on public lands.

Recommended status: At present, this species has no special status. It should at least be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1992-l 994.

Pyrgulopsis n. sp. 12 Bannock Range springsnail

Type locality: None; to be designated when species is described.

Description: This large species is a member of a group with unique penial characters inhabiting limited portions of the upper Snake River and Bear River drainages, SE ID. We are currently working on this taxon (with R. Hershler).

Ecology: This taxon is a crenophile inhabiting larger cold springs and their runs. *Rorippa* and *Veronica* are abundant in much of the area inhabited by this hydrobiid; locally, *Chara, Elodea,* and *Ceratophyllum* may be abundant also, and a small epiphytic algal component is present also. The most common associated mollusk is *Lyogyrus* sp. cf. *greggi.* Substrate ranges from local mud to basalt gravel and cobbles; but in some areas is largely travertine "sand" and gravel. This species appears to be both a perilithon and periphyton feeder. Most areas with it are very cold; clear, and shallow.

Original distribution: Probably confined to the northern Bannock Range, Bannock Co., Portneuf River (upper Snake River) drainage, ID. Could have once occurred in the Portneuf River valley between the northern Bannock and Portneuf ranges, Bannock Co., although searches in the area involved in the 900,000 YBP Portneuf basalt flow have thus far been unsuccessful.

Current distribution: Currently known from a single nasmode and nearby individual spring in Bannock Co., ID. We are now surveying SE ID comprehensively for springsnails (1991-1994), as is R. Hershler *et al.* (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. Much of the Bannock Range is largely in Caribou National Forest. A few sites in these areas are possible.

Threats: This spring complex has been grazed; many springs in this area are dry or lack mollusks due to heavy grazing. Part of the spring flow has been diverted for use as the Pocatello municipal water supply.

Criteria for inclusion: Very local endemic; current and ongoing threats; occurrence on public lands.

Recommended status: At present, this species has no special status. It should at least be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1992-l 994.

Pyrgulopsis n. sp. 13 Brush Creek springsnail

Type locality: None; to be designated when species is described.

Description: This medium-sized, bw conical *Pyrgulopsis* is a member of a group with unique penial characters inhabiting limited portions of the upper Snake River and Bear River drainages, SE ID. We are currently working on this taxon (with R. Hershler). This taxon was originally discovered in the late 1950s-early 1960s by D. W. Taylor.

Ecology: This taxon is a crenophile inhabiting cold springs and their runs. *Rorippa* is abundant in much of the area inhabited by this hydrobiid, and a sizable epiphytic algal component is present also, the latter likely due to pollution by cattle. Substrate is mostly travertine sand and gravel; water is cold, fast, and shallow. This species appears to be both a perilithon and periphyton feeder, and occurs with few other mollusks (mostly small sphaeriids).

Original distribution: Probably confined to the Marsh Valley and southern Bannock and Portneuf ranges, Bannock Co., Portneuf River (upper Snake River)drainage, ID. Could have once occurred in the Portneuf River valley between the northern Bannock and Portneuf ranges, Bannock Co., although searches in the area involved in the 600,006 YBP Portneuf basalt flow have thus far been unsuccessful.

Current distribution: Currently known from a single spring and its run in Bannock Co., ID; the old Taylor site is now extirpated We are now surveying SE ID comprehensively for springsnails (1991-l 994), as is R. Hershler *et* a/. (1993-l 994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. Much of the Bannock Range is in Caribou National Forest. The southern Portneuf Range has extensive areas of State of Idaho lands, possibly including the site with this species. A few, additional sites in these areas are possible.

Threats: The only live site has been grazed; many springs in this area, including one in this group, are dry or lack mollusks due to heavy grazing. The lower site has been impacted by agricultural use; ground water apparently carries a heavy nutrient load. Highway realignment and construction (l-l 5; US 91) also seems to have impacted the original site.

Criteria for inclusion: Very local endemic; current and ongoing threats to habitat; occurrence on public lands.

Recommended status: At present, this species has no special status. It minimally should be considered a sensitive species by the Forest Service, BLM, State of Idaho, and other land management and wildlife agencies. Sufficient recent survey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1992-l 994.

Pyrgulopsis n. sp. 14 Teton River springsnail

Type locality: None; to be designated when species is described.

Description: This large-sized, low conical *Pyrgulopsis* is a member of a group with unique penial characters inhabiting limited portions of the upper Snake River and Bear Riier drainages, SE ID. We are currently working on this species (with R. Her-shier). This taxon was originally discovered in the late 1950s-early 1960s by D. W. Taylor. It has been considered (Taylor, 1977, *unpub.;* 1985a) a member of the genus *Fontelicella (Natricola).* The manuscript name (Taylor, 1977, *unpub.;* still a *nomen nudum) was Fontelicella tetonica.*

Ecology: This taxon is a crenophile inhabiting large cold springs, their runs, and spring-influenced creeks and a small river. ***Rorippa*** is abundant in much of the area inhabited by this hydrobiid, and a small epiphytic algal component is present also. Sites commonly have extensive ***Elodea***, ***Ceratophyllum***, ***Chara***, ***Potamogeton filiformis***, ***Veronica,*** and occasionally ***Myriophyllum*** beds. The substrate is variable; but commonly includes mud, sand, some gravel, and a minor basalt cobble component; water is very cold and clear; flow ranges from fast to slow; and depth from a few inches to nearly 3 ft. This species appears to be primarily a pelophile, and hence a detritiiore; but also may engage in perilithon and periphyton feeding as well. It occurs with wmmon sphaeriids and ***Fluminicola*** sp.

Original distribution: Probably confined to the Teton Basin, Teton River (Henrys Fork-upper Snake River) drainage, Teton Co., ID. Could once have occurred throughout the valley between the eastern Big Hole Mountains and western Teton Range (mostly Targhee National Forest) Teton Co., although searches elsewhere in the area have thus far been unsuccessful.

Current distribution: Currently known from a few sites in the headwaters of the Teton River; At least one of the 2 old Taylor sites is now extirpated. We are now surveying SE ID comprehensively for springsnails (1991-1994), as is R. Hershler ***et al.*** (1993-l 994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. Much of the NW part of the Basin is heavily agriculturalized, and we have thus far found no remaining live sites here. In general, sites in the Henrys Fork area, involved in comparatively recent volcanism and caldera formation (especially the Island Park Caldera), lack ***Pyrgulopsis***.

Threats: The Basin was once extensive marsh and fen-bog terrain. Much has been drained and channeled, and is now being grazed. Many springs in this area, including one in the headwaters, may lack mollusks due to heavy grazing. The river has been affected by agricultural use, including nutrient and chemical runoff and channeling. Ground water in some areas apparently carries a heavy nutrient load. Road location, maintenance, and spraying have sometimes affected sites and potential sites.

Criteria for inclusion: Very local endemic; current and ongoing threats to habitat; possible occurrence on public lands.

Recommended status: At present, this species has no special status. It minimally should be considered a sensitive species by the Forest Service, BLM, State of Idaho, and other land management and wildlife agencies. Sufficient recent survey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1992-l 994.

Pyrgulopsis n. sp. 15 Blackfoot springsnail

Type locality: None; to be designated when species is described.

Description: A very distinctive subglobose form with a ribbon-like penial base and unique configuration of penial glands. No other Idaho species closely resembles this taxon. We are currently working on this species (with R. Hershler).

Ecology: Occurs in a medium-sized spring and associated pool, in limestone terrain. The spring is very cold, clear, and swift in the areas where the hydrobiid is abundant. ***Rorippa*** is abundant near the source, and ***Mimulus*** common. ***Veronica*** and ***Chara*** are wmmon in the pool. The substrate near the source is limestone cobbles. A crenophile species, not successful in establishing itself in the large creek of which the spring is a tributary. This taxon is predominantly a lithophile and hence a perilithon grazer.

Original distribution: Probably confined to the Blackfoot Mountains and adjoining upper Blackfoot River valley, Bingham Co., ID.

Current distribution: Known only from a single site just outside of BLM public lands in the Blackfoot Mountains. None of the other springs in this drainage had this species (or other hydrobiids). We are now surveying SE ID comprehensively for springsnails (1991-1994), as is R. Hershler *et* a/. (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. The Blackfoot Mountains have substantial State of Idaho, BLM, and private holdings.

Threats: Most of the springs in this area have been heavily grazed, and now have small, no, or uninteresting mollusk faunas. Others have been capped and/or diverted for stock water supply. The only known site for this species has been modified; a berm and pipe creates an artificial pool, in which the hydrobiid does poorly. It is thus limited to a few tens of square feet of source area.

Criteria for inclusion: Very local endemic; current and ongoing threats; possible occurrence on public lands; recent surveys of much or all of known and potential habitat.

Recommended status: Currently, this recently discovered taxon has no special status. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1994.

Pyrgulopsis n. sp. 18 Warm Springs springsnail

Type locality: None; to be designated when species is described.

Description: A distinctive mid-sized subwnical form with a unique configuration of penial glands, related to a group of species found only in the upper Snake River and Bear River drainages. We are currently working on this species (with R. Hershler).

Ecology: This taxon is found in about half of the springs in a single sizable nasmode. The springs (which are cold, not warm) are very cold, clear, and slow-moderate in the areas where the hydrobiid is abundant. *Rorippa* is abundant in shallow areas, and *Mimulus* locally common. *Veronica* and *Chara* are wmmon in the deeper areas and pools. The substrate ranges from mud to limestone gravel and cobbles. Travertine is locally abundant, and sometimes a major substrate contributor. A crenophile species, not successful in establishing itself in the large run of which the springs are sources. This taxon is predominantly a lithophile and hence a perilithon grazer.

Original distribution: Probably limited to the S. flank of the Snake River Range and adjacent upper Snake River valley, Bonneville Co., ID.

Current distribution: Known only from a single spring complex in Targhee National Forest. Other springs in the vicinity (e.g. Antelope Flat) lacked this species. We are now surveying SE ID comprehensively for springsnails (1991-1994), as is R. Hershler *et al.* (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. The Snake River Range has substantial Targhee National Forest and private holdings.

Threats: Most of the springs in this area have been heavily grazed, and now have little, no, or uninteresting mollusk faunas. Others have been capped and/or diverted for stock water supply. The sites for this species has been modified to varying degrees. Modifications include channeling, road rip-rap and diversion, and impoundment. Much of the area is indicated as Bureau of Reclamation and agency power withdrawals.

Criteria for inclusion: Very local endemic; current and ongoing threats; occurrence on public lands; recent surveys of much or all of known and potential habitat.

Recommended status: Currently, this recently discovered taxon has no special status. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1994.

Pyrgulopsis n. sp. 17 Wilson Flat springsnail

Type locality: None; to be designated when species is described.

Description: A distinctive mid-sized subconical form with a unique configuration of penial glands, related to a group of species found only in the upper Snake River and Bear River drainages. We are currently working on this species (with R. Hershler).

Ecology: This taxon is found in about half of the springs in a single large formation spring nasmode. The springs range from cold to very cold; most area with hydrobiids are also dear, and have slow-moderate flow. This species is abundant in limited areas of spring run, spring source, and limnocrene. *Rorippa is* abundant in shallow areas, and *Mimulus* locally common. *Veronica* and *Chara* are wmmon in the deeper runs and pools. The substrate is mostly travertine sands, gravel, and cobbles. This taxon is a crenophile, absent from nearby creeks without spring influence. It is predominantly a lithophile and hence a perilithon grazer. In most occurrences, it is the dominant mollusk.

Original distribution: Probably limited to the E. edge of the Blackfoot Lava Field, upper Blackfoot drainage, Caribou Co., ID.

Current distribution: Known only from a single spring complex in mixed private and BLM ownership. Other springs in the area (e.g. Chesterfield Range) lacked this species. We are now surveying SE D comprehensively for springsnails (1991-l 994), as is R. Hershler *et* a/. (1993-1994). Significant range extension or discovery of sizable numbers of new sites are not to be expected from future work. The area has substantial Bureau of Reclamation, BLM, and priiate holdings.

Threats: Most of the springs in this complex have been heavily grazed, and now have little, no, or uninteresting mollusk faunas. Some mapped springs are now completely dry. Others in the area have been capped and/or diverted for stock water supply. The sites for this species has been modified to varying degrees. Modifications mostly involve channeling, diversion, and impoundment. This is an excellent, and one of the few surviving examples of a formation spring complex in ID, second in quality only to TNC's Formation Springs Preserve near Soda Springs, ID (Bear River drainage).

Criteria for inclusion: Very local endemic; current and ongoing threats; occurrence on public lands; recent surveys of much or all of known and potential habitat.

Recommended status: This recently discovered taxon has no special status currently. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent suwey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Deixis collections, 1994.

Pyrgulopsis n. sp. 18 Jim Sage springsnail

Type Localii: None designated as yet; undescribed species.

Description: We are currently working on this taxon with R. Hershler (NMNH). This species is a small, moderately high conic taxon with penile characters characteristic of a small subset of species from the upper snake River tributary drainages.

Ecology: A crenophile found in seeps and small to medium-sized shallow springs. The regolith is basalt; substrate ranges from mud to cobbles, with coarse substrate being characteristic of areas with common springsnails. Macrophytes are limited (mostly ***Rorippa)*** and epiphytic algae may be present in polluted areas, but rather rare in places with wmmon hydrobiids. Few other mollusks (essentially, just ***Physella*** sp. and ***Pisidium insigne)*** are present.

Original distribution: Probably common in the Raft River valley and surrounding ranges (E. side of the Cotterel and Jim Sage Mountains, and possibly Black Pine Mountains and W. side of the Sublett Range, Cassia Co., ID).

Current distribution: A few sites in the Cotterel and Jim Sage Mountains, Cassia Co., ID. Included are sites on BLM lands (including a campground) and State of Idaho lands.

Threats: Most springs in this area have been heavily affected by grazing, and many springs on the appropriate USGS 7.5' maps either are now dry or have uninteresting or no mollusks. Springs have also been extensively capped and/or used for stock water supply. Springs with this species have been grazed and/or dug out, with the result that the species persists in some only in protected situations. Low-elevation springs either no longer exist or appear to have enriched ground water recharge, i.e. are algae-choked and lack interesting mollusks.

Criteria for inclusion: Local endemic; occurrence on public lands; current and ongoing threats to its somewhat specialized habitat.

Recommended status: Thii recently discovered taxon has no special status currently. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to establish that this species should be Federal and State (ID) Endangered.

References: Smithsonian collections, 1993; Deixis collections, 1994.

Pyrgulopsis robusta (Walker, 1908) Jackson Lake springsnail

Type locality: -Jackson Lake, Wyoming. Neither we nor Hershler (1994) were able to locate the UMMZ holotype. We examined specimens from Polecat Creek, collected in 1993.

Description: For comprehensive description and illustration of both shell and soft part morphology see Hershler (1994).

Ecology: Lives in cold springs and also in spring-influenced creeks and large lake. Generally the dominant where found; ***may*** occur with such species ***as Margaritifera falcata***. Areas with this taxon may have dense ***Rorippa*** beds; coarse substrate (sand, gravel, and cobble) is typical. A perilithon feeder (aufwuchs grazer on stone surfaces). Apparently a lithophile. This species is predominantly a crenocole, although sometimes found in other habitats, ***i.e.*** areas suitable for a crenophile.

Original distribution: Sites along the eastern border of Jackson Lake, i.e. Elk Island and vicinity, and Polecat Creek, Teton Co., WY. Most old sites have been inundated by the rise in Jackson Lake; most are on Grand Teton National Park lands.

Current distribution: Uncertain. The species survives in Polecat Creek; but draining and modifications to the Jackson Lake bed in 1993 may have extirpated (and certainly drastically reduced) sites for this taxon. Survey work has been done elsewhere along the WY Snake without finding this taxon; but a few other sites could exist on National Forest, BLM, or National Park lands. Enough is now known about SE ID hydrobiids to eliminate the possibility of its occurrence there (e.g. Frest & Johannes, 1991-1994 surveys; Hershler, 1993-l 994 **surveys).**

Threats: 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.

Criteria for inclusion: Local endemic; occurrence on public lands; loss of historic sites; ongoing threats.

Recommended status: Currently (USFWS, 1994a) a C2 candidate. It minimally should be considered a sensitive species by the National Park Service, Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent work has been done to indicate that this species should be Federal and State (WY) Endangered.

References: Walker (1908); Hershler (1994).

Stagnicola (Stagnicola) elrodi (Baker & Henderson, 1933) Flathead pondsnail

Type locality: Flathead Lake, Lake Co., MT; holotype UI; topotypes in UCM.

Description: See Baker & Henderson (1933) for description and illustrations; the best illustration is in Burch (1989). This is a moderate-sized, rather thin-shelled species with a moderately elevated spire and large, expanded aperture, not closely resembling other western U.S. forms.

Ecology: This species is in part a limnophile, found at shallow to moderate depths in more protected bays and inlets in a large cold, oligotrophic lake. Commonly, the substrate is silt and mud (partly calcareous); macrophytes (*Ceratophyllum, Elodea, Potamogeton crisps, Potamogeton filiformis*) are common to abundant. The snail is not found in areas with dense macrophytes, warm water, or in places subject to hypoxia or anoxia. It also occurs in slower, more lentic portions of the Flathead River.

Original distribution: Probably restricted to Flathead Lake and a few larger lakes and slow-flow riverine situations in the upper Flathead River valley, Lake and Flathead cos. and Flathead Indian Reservation, MT.

Current distribution: Uncertain. We recently visited several of the old sites recollected repeatedly by R. B. Brunson from the 1940s through the 1960s without finding live specimens. We collected live material from 1 site in the upper Flathead River in 1991.

Threats: Increasing shoreline development and agriculture, including grazing, is causing eutropification, accumulation of fine sediment, and other problems throughout the range.

Criteria for inclusion: Local endemic, loss of historic sites; current and ongoing threats.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (MT) Endangered.

References: Baker & Henderson (1933); R. B. Brunson (*pers. comm.*, 1993); Deixis collections, 1993.

Stagnicola (Stagnicola) elrodiana Baker, 1935 largemouth pondsnail

Type locality: McDonald Lake, Flathead Indian Reservation, Mission Mountains Tribal Wilderness, Lake Co., MT; the types of this species have recently been transferred to the USNM; we examined the types, paratypes, and topotypes.

Description: See Baker (1935) for description and illustration; the best illustration is in Burch (1989). Early descriptions and discussion in Elrod (1902) are also helpful. The large shell, acuminate spire and inflated aperture are diagnostic.

Ecology: This species lives in a large oligotrophic subalpine lake;. surrounding bedrock is mostly limestone and schist. The lake substrate ranges from mud to boulders. Macrophytes are limited in numbers and diversity. The snail is seen most often on rocks in water ranging from a few inches to several feet in depth. Snail colonies apparently are rather local and limited in extent. The species is not found in the lake outlet stream. This lake also has an endemic trout species.

Original distribution: High-elevation lakes in the Mission Range (Sin-Yale-a-min and McDonald), Mission Mountains Tribal Wilderness, Lake Co., MT.

Current distribution: Known to survive in McDonald Lake.

Threats: McDonald Lake is regulated and has a spillway; sudden water releases have killed large numbers of this snail in recent years.

Criteria for inclusion: Local endemic; occurrence on public lands; very limited range.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (MT) Endangered.

References: Elrod (1902); Baker (1935); R. B. Brunson (*pers. comm.*, 1993); Deixis collections, 1991, 1993.

Stagnicola (Stagnicola) hinkleyi (Baker, 1906) rustic pondsnail

Type locality: "North fork Snake River, east Idaho"; syntypes CHAS; ANSP; UCM 9778. See Wu & Brandauer (1982) for UCM types.

Description: See Baker (1906) for description and illustration and Burch (1989) for modern illustration. This rather large stagnicolid has a short spire, dark red shell, and relatively few, moderately inflated whorls.

Ecology: This taxon is one of a small group of species with atypical habitat as compared to more widespread lymnaeids. It is a stenothermal amniphile, found mostly in larger, relatively swift, cold, oligotrophic streams with coarse (gravel to boulder) substrate. This species appears to be largely a

perilithon grazer and lithophile (also atypical for the family). Other species with similar habits (and also with limited geographic ranges) *are Stagnicola apicina* (*q.v.*) and *Stagnicola idahoensis* (*q.v.*). We have not found this taxon in the more typical stagnicolid habitats of backwaters, ditches, ponds, small streams, or streams with slow flow and other lotic characters. Common associates are *Fluminicola* sp., *Physella gyrina*, and, in limited areas, such taxa as *Taylorconcha serpenticola* and *Pyrgulopsis idahoensis. See* discussion in Frest & Johannes (1992) for more details.

Original distribution: Taylor (1977, *unpub.*) gives the distribution as Crater Lake, OR; mainstem Snake River from S. ID upstream to Jackson Lake, WY; Birch Creek, Lemhi Co.; Yellowstone Lake and upper Madison and Yellowstone rivers, WY; upper Colorado River drainage, SW WY.

Current distribution: The species survives in Crater Lake and in Birch Creek; almost al of the many S. D middle and upper Snake historic sites (the bulk of the distribution) are now extirpated. We have had no luck in the WY Snake River in recent years in finding this species alive. We have not rechecked the Yellowstone National Park sites as yet. The upper Colorado River sites appear to have been extirpated. The middle Snake system has been extensively surveyed for mollusks in recent years; see USFWS (1992d) and references herein (Frest & Johannes, in part) for details. We have recently surveyed many sites in SE ID (approximately 500) while finding this species in just a few, mostly in springs tributary to Birch, Creek. Sites with (or mostly formerly with) this species are on BLM, Bureau of Reclamation, U.S. Fish & Wildlife Service, ID Department of Fish & Game, and National Park Service lands.

Threats: Many parts of the Snake system have been impounded, which appears inimical to this species. Nutrient enhancement and sedimentation deleteriously affects the great majority of the range; the species is absent from sites with such features. The Snake River in ID has been declared water quality impaired by the EPA and the State of Idaho.

Criteria for inclusion: Local endemic; extensive range and historic site loss; current and ongoing threats.

Recommended status: Currently, this species has no special status. It minimally should be considered a sensitive species by the Forest Service, BLM, Bureau of Reclamation, and other land management and wildlife agencies. Sufficient survey work has been done to show that this species should be Federal and State (ID, OR, WY) Threatened. Status in NV uncertain: and no recommendation is made at present.

References: Baker (1906); Deixis collections, 1988-l 994.

Stagnicola (Stagnicola) idahoensis (Henderson, 1931) shortspire pondsnail

Type locality: Little Salmon River, 16 mi. N. of New Meadows [i.e., near Pinehurst, Adams/Idaho cos., ID]; holotype UCM 17486a; paratypes 17486, 174896b. See Wu & Brandauer (1982) for UCM types.

Description: See Henderson (1931 a) and Burch (1989). The only western species at al like this one in morphology is the lower Columbia River (WA, OR) *Stagnicola apicina.* This species has a shorter spire; and the brown shell color and dark body are also distinctive field characters.

Ecology: This taxon is one of a small group of species with atypical habitat as compared to more widespread lymnaeids. It is a stenothermal amniphile, found in larger, relatively swift, cold, oligotrophic streams with coarse (gravel to boulder) but stable substrate. This species appears to be largely a perilithon grazer and lithophile (also atypical for the family). Other species with similar habits (and also with limited geographic ranges) *are Stagnicola apicina* (*q.v.*) and *Stagnicola hinkleyi* (9.v.). We have not found this taxon in the more typical stagnicolid habitats of backwaters, ditches, ponds, small streams, or streams with slow flow and other lotic characters. Common associates *are Gonidea angulata*, *Fisherola nuttalli* [Salmon River only], and *Fluminicola fuscus* [Salmon River only]. The taxon avoids areas with sand, mud,

or bedrock substrate. Generally, macrophytes or epiphytic algae are rare or absent at sites with this species.

Original distribution: Lower portions of Little Salmon River, Idaho and Adams cos., and lower Salmon River from about French Creek Bridge to White Bird, Idaho Co., ID.

Current distribution: Still survives in parts of the original range. We did not find this species in the lowermost Salmon River, the Salmon River east of the River of No. Return,' uppermost hall of the Little Salmon River, or in Hells Canyon. Sites with this species are on BLM and Payette and Nez Perce National Forest lands.

Threats: Disturbance of the substrate for hydraulic gold mining, dredging for gravel, and changes brought about by bridge and highway construction (e.g. in the vicinity of Riggins and of White Bird) are the primary problems. Jet boating may also be a problem.

Criteria for inclusion: Local endemic; continuing and ongoing threats; loss of much of range to human activities.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient survey work has been done in recent years (e.g., Neitzel & Frest, 1989, 1993) to indicate that this species should be Federal and State (ID) Threatened.

References: Henderson (1931a); Deixis collections, 1990, 1991, 1994.

Taylorconcha serpenticola Hershler *et* a/., 1994 Bliss Rapids springsnail

Type locality: Thousand Springs (N. springs), SW ¼ sec. 8, T 6 S R 14 E, Gooding Co., ID; holotype USNM 860853; paratypes 874558, UF 194616.

Description: This small, generally orange-colored hydrobiid is not easily confused with other taxa in its range, except for juveniles. See Hershler et a/. (1994) for detailed description and illustrations; see also Taylor (19824, *unpub.*).

Ecology: This species is primarily a crenocole, found in springs in various sizes; but does occur in spring-influenced parts of a short stretch of the middle Snake River as well (it is a crenophile, not an amniphile); see Hershler et a/. (1994) for detailed discussion. Mollusk associates include *Pyrgulopsis idahoensis, Physa (Haitia) natricina, Stagnicola hinkleyi, Lanx* n. sp. 1, and *Fluminicola* sp. This species is primarily a lithophile and a perilithon grazer. The Shoshone sculpin also occurs at several sites with this species.

Original distribution: Part of the middle Snake River drainage from about Indian Cove Bridge to Twin. Falls; see Hershler et *a/.* (1994) for detailed discussion.

Current distribution: Survives in limited areas in the original range (Hershler et a/., 1994). Most spring' and river populations have been extirpated or are much reduced.

Threats: Springs have been diverted and/or capped for livestock, industrial, domestic, or piscicuftural water supply. Many springs have had agricultural waste water diverted into them. Ground water pollution from dairy farm runoff and wells is a major concern. Siltation and impoundments are major problems throughout the middle Snake River drainage. The middle Snake River has been declared water quality impaired by the EPA. A recent landslide (1993) may have extirpated many of the remaining river populations.

Criteria for inclusion: Local endemic; occurrence on public lands; current and ongoing threats; reduction in range and loss of historic sites; monotypic genus.

Recommended status: Currently federally listed as Threatened (USFWS, 1990, 1992d). The listing has been challenged in federal court. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent work has been done to demonstrate that this species should be Federal and State (ID) Threatened.

References: Taylor (1982d, *unpub.*); Hershler *et* a/. (1994); Deixis collections, 1988-l 993.

Valvata n. sp. 1 Salmon valvata

Type locality: None as yet; will be designated when the species is formally described.

Description: This small species has a low, glossy shell, with a depressed spire, somewhat as in *Valvata perdepressa*. It is smaller than *Valvata humeralis*, more depressed: and the snout and tentacles are gray. The only taxon at all similar is an undescribed species known from a single NV site.

Ecology: A crenocole species, found in relatively unimpacted to pristine large seeps to medium-sized cold springs. Commonly, the substrate is mud, with minor amounts of sand, gravel, or larger particles; bedrock may be either basalt or limestone. Few other mollusks, other than *Pristinicola hemphilli* and *Pisidium insigne,* co-occur. Springs with this taxon have been noted at low-medium elevations; the only commonly occurring macrophyte is *Rorippa*.

Original distribution: Lower Salmon River drainage, Idaho Co., ID. We have looked for this species in the Snake River canyon elsewhere in ID (Hells Canyon), OR, and WA to the mouth; and also in the upper part of the Salmon River system, ID, without success.

Current distribution: Found at a few sites in the lower Salmon River drainage. See Frest & Johannes (1995a) for discussion. We have collected mollusks in this area since 1988, and heavily since 1990; many other collectors have done likewise since the 1880s. Future large range extensions or finds of sizable numbers of new sites are very unlikely. Known sites are on Nez Perce National Forest, BLM, and private lands.

Threats: There are very few remaining relatively undisturbed low to medium elevation springs in the lower Salmon River drainage. Most springs are subject to heavy gazing; many others have been capped or diverted for stock water supply. Others have been damaged or destroyed by road construction and maintenance. Others have been diverted or capped for domestic water supply, campgrounds, etc.

Criteria for inclusion: Very local endemic; heavy human impact on all of range; continuing and ongoing threats.

Recommended status: This newly discovered taxon currently has no special status. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (ID) Endangered.

References: Frest & Johannes (1995a); Deixis collections, 1994.

Valvata utahensis Call, 1884 desert valvata

Type locality: "Lake Utah, Utah....Utah Lake, near Lehi, not far from the mouth of the River Jordan" (Call, 1884), Utah Co., UT. Types USNM; paratypes MCZ.

Description: See Call (1884) for description and illustrations; see also excellent figure in Burch (1989). This species in basic shell characters is unlike any other U.S. species, except for variant specimens of *Valvata tricarinata*. Shell color and morphological details, as well as anatomy, are unique and not particularly *close* to *tricarinata*.

Ecology: See Taylor (1982 *unpub.*), USFWS (1990, 1992d) and Frest & Johannes (1992a) for discussion. This species is a detritivore, most at home in well-oxygenated, cool water situations; it generally occurs on soft but consistently oxygenated mud substrates, often calcareous. Common plant associates are *Chara*, *Elodea*, *Myriophyllum*, *Ceratophyllum*, and *Potamogeton* spp. Mollusks include sphaeriids, *Physella gyrina*, *Valvata humeralis*, and *Fluminicola* sp. It is generally an amniphile; but has been found in 2 limnocrenes. Generally, some flow is present; it is absent from most impoundment situations, unless sufficient flow and spring influence is present to prevent hypoxic or anoxic bottom conditions.

Original distribution: In the recent past, found live in the middle Snake River from about Weiser through American Falls: in Box Canyon, ID; and also at sites in SE D and Utah Lake, UT. For fossil range and biogeographic significance, see Taylor (1985a).

Current distribution: The SE ID site is extirpated; and we have recently searched over 350 sites in this area without finding this taxon, except as a fossil. The UT site is also extirpated, as are most sites in the middle Snake River. Known to survive currently in the limnocrenes and a couple of Snake River sites.

Threats: Much of the middle Snake River is rapidly becoming eutropified, due to agricultural runoff, trout farms, and urbanization along the river corridor. Much of the river is impounded behind a series of small dams; this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. A recent (1994) landslide impacted some of the historic sites. Introduction of exotic mollusk species (Bowler, 1991) may also be a factor in the species' decline. Springs in this area have been impacted by ground water pollution from agricultural and dairy operations; diverted into irrigation systems; capped and diverted for stock, domestic, industrial, and piscicultural water supply; heavily grazed; and dried due to groundwater drawdown. This taxon is declining, in terms of area occupied and number of sites and individuals. Recent rather extensive survey of much of the middle Snake (see references under Frest & Johannes, e.g.; see also USFWS (1992d)) make it highly unlikely that significant range expansion or increase in the number of sites will occur.

Criteria for inclusion: Local endemic; loss of historic sites and much of range; continuing and ongoing threats.

Recommended status: Currently federally listed as Endangered (USFWS, 1990, 1992d). The listing has been challenged in federal court. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (ID, UT) Endangered.

References: Call (1884); Taylor (1982c, *unpub.*); USFWS (1992d); Deixis collections, 1988-l 993.

Vorticifex effusus dalli (Baker, 1945) Dall rams-horn

Type locality: Klamath Falls, Klamath Co., OR [presumably, head of Link River]; holotype USNM 219747 paratypes USNM 219747.

Description: This is a large form for the genus, with few whorls, a rapidly expanding, thin, yellowish shell, flat spire, prominent regular periostracal fringes, and varices beneath each periostracal fringe. For illustrations of shell and anatomy, see Baker (1945). ***Vorficifex effusa costata*** (Hemphill, 1890) has periodic periostracal fringes; but these are minor; there are no varices, no "pure" populations are known to occur, and the feature is variile, suggesting that synonymy with ***Vorticifex effusus (s.s.)*** is reasonable. ***Vorticifex mailliardi*** (Hanna, **1924),** from Eagle Lake, CA, is simii in appearance and anatomy (from preliminary studies), and also occurs in a Great Basin periphery remnant pluvial lake; if this proves so on further work, then Hanna's name would have priority.

Note that Turgeon ***et a/.*** (1988) use ***Vorticifex effusus*** for the nominate form, while Burch (1989) uses ***Vorticifex effusa.*** Presumably, the former represents a correction to match the masculine gender of ***Vorticifex,*** vs. the feminine ***Parapholyx.*** Burch (1989) notes that ***Vorticifex*** is based on a fossil type, while ***Parapholyx*** has a living type species. Granting that fossil shells can be difficult to relate to living genera, whidh are often anatomically based, at least in part, for the moment there appears to be no conflict, i.e. competing recent genera with different anatomies but vicarious shell morphology. It thus seems reasonable to place all forms in ***Vorticifex,*** as Burch did.

Ecology: A lithophile and perilithon feeder, found mostly on larger cobbles and boulders, in areas with some current, in a large, spring-fed lake. Macrophytes may be present at sites, but the species seems more interested in stable solid surfaces This species also appears to be a limnophile. Remaining sites are in areas with strong spring influence, although this form has not been collected from the springs themselves. It occurs with several other Species of Special Concern, namely ***Lanx klamathensis***, ***Pyrgulopsis*** n. sp. **1,** ***Pyrgulopsis archimedis***, ***Pisidium ultramontanum***, ***Fluminicola*** n. sp. **1,** ***Votiicifex klamathensis klamathensis,*** and ***Lyogyrus*** n. sp. 4.

Original distribution: Upper Klamath Lake drainage; certainly Upper Klamath Lake itself, and possibly Lower Klamath Lake and Tule Lake, Klamath Co., OR, and Siskiiou and Modoc cos., CA.

Current distribution: Survives at a very few sites in Upper Klamath Lake, Klamath Co., OR. The more sensitive species in Tule Lake and Lower Klamath Lake are extirpated, due to "reclamation" of a large part of both and use of the remnants as sumps for irrigation runoff. Existing sites may be in Winema National Forest or other public lands. Sites in Upper Klamath Lake National Wildlife Refuge (W. side of Upper Klamath Lake) are probable. The best remaining site is in the Link River, outlet to Upper Klamath Lake. A comprehensive survey of the Upper Klamath Lake drainage freshwater mollusks is now under way; the first report is nearing completion (Frest & Johannes, 1995b). Substantial range extension or increment of currently known live sites are both very unlikely.

Threats: Much of the lake habitat for this: Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of inigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. The Link River site in Klamath Falls is subject to development and urbanization pressures in its own right.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate. Comprehensive survey of the Upper Klamath drainage is now underway; to date there is little reason to expect that many more sites will be found (Frest & Johannes, **1995b).**

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered. The species lives only in the limited areas of the lake not completely affected by eutropification, as they have considerable spring influx and/or flow. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

References: Baker **(1945);** Frest & Johannes **(1995b);** Deixis Consultants, **1991-I 994.**

Vorticifex effusus diagonalis (Henderson, 1929) lined rams-horn

Type locality: Crater Lake, Crater Lake National Park, Upper Klamath Lake drainage, Klamath Co., OR; holotype UCM 15940a; paratypes UCM 15940; other paratypes in UI (Baker Collection 3926).

Description: For original description, and illustrations, see Henderson (1929a); see also Baker (1945). This subspecies is large and thin-shelled; the diagonal raised lines of the shell are seen occasionally on indiviiuals of other subspecies, but are not universal, as here.

Ecology: This form lives in spring-fed lakes and limnocrenes, as well as exceptionally large spring-fed creeks. Spring influence; very cold, clear, oligotrophic water; and fair depth are among the common factors; this species is effectively both a crenophile and limnophile. Macrophytes and epiphytic algae are sparse, with *Veronica* and rather scattered *Rorippa* the most frequent. Limy substrate is common, often muddy, but ranging to gravel and cobbles; the snails are restricted to hard substrate. Most sites have abundant large woody debris.

Original distribution: Crater Lake and adjoining parts of the Upper Klamath Lake drainage, Klamath Co., OR.; may have occurred in suitable habitat in other fakes and streams in the same drainage, e.g. Lower Klamath Lake and Tule Lake.

Current distribution: Known from a few sites in Crater Lake [Crater Lake National Park] and Upper Klamath Lake and its major tributaries (including one site in Winema National Forest and one in an Oregon State Park). A comprehensive survey of the Upper Khmath Lake drainage freshwater mollusks is now under way: the first report is nearing completion (Frest & Johannes, 1995b). Substantial range extension or increment of currently known live sites are both very unlikely.

Threats: Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs and spring-fed creeks peripheral to Upper Khmath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified. Others have been capped for water supply or are heavily grazed. No Upper Klamath Lake sites are known to survive. Remaining sites am threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species.

Criteria for inclusion: Riparian associate; local endemic; occurrence on public lands; riparian associate.

Recommended status: Currently, this subspecies has no special status. It minimally should be considered a sensitive species by the National park Service, Forest Service, BLM, Bureau of Reclamation, and other land management and wildlife agencies. Sufficient survey work has been conducted in recent years as to demonstrate that this taxon should be Federal and State (OR) Endangered.

References: Henderson (1929a); Baker (1945); Frest & Johannes (1995b); Deixis Consultants, 1991-92.

Vorticifex klamathensis klamathensis (Baker, 1945) Klamath rams-horn

Type locality: Apparently head of Link River, Klamath Falls, Upper Klamath Lake, Klamath Co., OR (Baker, 1945). holotype USNM 406024; paratypes USNM 406024, 219748.

Description: A large form, with few whorls, a shallow, rapidly expanding, nearly flat spire; reddish, thin shell, and no periostracal fringes or varices. For original description and illustrations of anatomy and shell, see Baker (1945). See also Frest & Johannes (1995b). Cited under the same name in Frest & Johannes (1993c).

Ecology: Lives on cobbles and boulders in flowing water in a spring-influenced streams and a large remnant pluvial lake. It occurs with several other Species of Special Concern, namely ***Lanx klamathensis***, ***Pyrgulopsis*** n. sp. 1, ***Pyrgulopsis archimedis***, ***Pisidium ultramontanum***, ***Fluminicola*** n. sp. 1, ***Vorticifex effusus dalli***, and ***Lyogyrus*** n. sp. 4. A lithophile and perilithon feeder, found mostly on larger cobbles and boulders, in areas with some current. Macrophytes may be present at sites, but the species seems more interested in stable solid surfaces This species also appears to be a limnophile. Remaining sites are in areas with strong spring influence, although this form has not been collected from the springs themselves.

Original distribution: Upper Klamath Lake drainage; certainly Upper Klamath Lake itself, and possibly Lower Klamath Lake and Tule Lake, Klamath Co., OR, and Siskiiou and Modoc cos., CA.

Current distribution: Survives at a very few sites in Upper Klamath Lake, Klamath Co., OR. The more sensitive species in Tule Lake and Lower Klamath Lake are extirpated, due to "reclamation" of a large part of both and use of the remnants as sumps for irrigation runoff. Existing sites may be in Winema National Forest or other public lands. Sites in Upper Klamath Lake National Wildlife Refuge (W. side of Upper Klamath Lake) are probable. The best remaining site is in the Link River, outlet to Upper Klamath Lake. A comprehensive survey of the Upper Klamath Lake drainage freshwater mollusks is now under way; the first report is nearing completion (Frest & Johannes, 1995b). Substantial range extension or increment of currently known live sites are both very unlikely.

Threats: Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species. The Link River site in Klamath Falls is subject to development and urbanization pressures in its own right.

Criteria for inclusion: Local endemic; occurrence on public lands; riparian associate.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR) Endangered. The species lives only in the limited areas of the lake not completely affected by eutropification, as they have considerable spring influx and/or flow. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

References: Baker (1945); Frest & Johannes (1995b); Deixis Consultants, 1991-l 994.

Vorticifex kiamathensis sinitsini **(Baker, 1945) Sinitsin rams-horn**

Type locality: Barclay Springs, Hagelstein Park, Upper Klamath Lake, Klamath Co., OR. Holotype USNM 531029; paratypes USNM 531029; topotypes USNM 531054.

Description: For original description, anatomy, and illustrations, see Baker (1945). This subspecies is smaller, has a thicker and more globose shell, and a higher spire than the nominate form. Cited under the same name in Frest & Johannes (1993c).

Ecology: A crenophile, living in large cold springs with coarse substrate. Macrophytes present commonly may include abundant *Rorippa* and common *Mimulus* and Veronica. Water depth. ranges from a few inches to 2 feet, flow is moderately rapid. Associated mollusks include *Fluminicola* sp. and *Lanx klamathensis*. This taxon is a lithophile and perilithon grazer.

Original distribution: Known at present only from a single site, as above. Likely to occur in other springs in the same region, although large numbers of new sites are precluded by recent surveys.

Current distribution: See above. A comprehensive survey of the Upper Klamath Lake drainage freshwater mollusks is now under way; the first report is nearing completion (Frest & Johannes, 1995b). Substantial range extension or increment of currently known live sites are both very unlikely.

Threats: Most of the large springs peripheral to Upper Klarnath Lake were modiiied for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. The single definite remaining site is threatened by eutropification, urban, agricultural, and industrial pollution, and habitat modification to accommodate Endangered sucker species.

Criteria for inclusion: Local endemic; probable occurrence 'on adjoining public lands (Winema National Forest, Upper Klamath Lake National Wildlife Refuge); riparian associate. The spring is being modified currently to enhance listed fish species' spawning habitat.

Recommended status: This taxon has no special status at present. Minimally, it should be considered a sensitive species by the Forest Service, BLM, Bureau of Reclamation, and other relevant federal and state land management and wildlife agencies. Sufficient recent survey work has been done to show that it should probably be considered Endangered both by the federal government and by OR.

References: Baker (1945); Frest & Johannes (1993c, 1995b); Deixis Consultants, 1991-94.

Vorticifex neritoides (Hemphill in Baker, 1945) nerite rams-horn

Type locality: Lower Columbia River, probably at The Dalles, Wasco Co., OR. Syntypes USNM 36615, 37518; ANSP 21772, 21883 [in part]. Coan & Roth (1987, p. 332), following Taylor (1985, *in litt.*) are perhaps correct in recognizing Baker as the author of this species, albeit for the wrong reason. Mere responsibility for publication does not necessarily establish credit (ICZN, 1985, Article 50, Recommendation 51b). This is relevant in regard to certain Hemphill species which were supposedly validated by later authors and are cited by Coan & Roth (1987), using the format "__, ex Hemphill MS". Were there really a Hemphill MS, rather than a label or catalogue citation only, and were this quoted or substantially quoted by the later author, the name would be credited to Hemphill, albeit with the later date, as has been done traditionally. Coan (1985), in quoting Article 50 uses the 1964 edition of the Code, which omits the very crucial words "other than publication" and is otherwise worded differently. Coan & Roth (1987) also uses this interpretation.

Description: A small species with few whorls; a comparatively thick shell; and reinforced aperture. The spire is lower than in *effusus*.

Ecology: Uncertain; rarely found. Probably unpolluted, rocky bottom, in somewhat swift flow, highly oxygenated water, and stable substrate, in relatively unimpounded stretches; past finds indicate that this species is a lithophile and probable perilithon feeder. Low elevations only.

Original distribution: Lower Columbia River; museum records extend from The Dalles to the river mouth, in the following areas: Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat cos., WA and Clatsop, Columbia, Multnomah, Hood River, and Wasco cos., OR.

Current distribution: Likely extinct at the type localii. Collected by us from one site on the WA side of the Columbia in 1988. Another species heavily impacted by lower Columbia River dams: see comments under ***Physeila coiumbiana.***

Threats: Impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia; water pollution including lumber mill effluent: sewage; harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam: and nutrient enrichment of the lower Columbia due to agricultural run off.

Criteria for inclusion:. Local endemic; possible occurrence on public lands; riparian associate.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (OR and WA) Endangered. Very little unmodified rocky habitat is left in the lower Columbia River, due to siltation, pollution, and habitat modification induced by construction and operation of BPA dams and impoundments (Tetra Tech, 1991-l 993, 1993; Neitzel & Frest, 1989, 1993).

References: Baker (1945); Taylor (1977, unpublished); Deixis Consultants, 1988.

Freshwater Bivalves

Anodonta californiensis Lea, 1852 California floater

Type locality: "'Rio Colorado," actually a former distributary of the river, approximately New River, Imperial County, California. " (Taylor, 1981, p. 142).

Description: For best description and illustrations, see Burch (1973, 1975b). This form does not closely resemble other described western anodontids, except for ***Anodonta wahlametensis*** **[*q.v.*].** That species has a much more conspicuous wing and different beak sculpture. This species has been confused in the literature with ***Anodonta nuttalliana nuttalliana*** and with ***Anodonta nuttalliana idahoensis. The*** best treatment is that of Taylor (1977, ***unpub.;*** 1981), who regards ***Anodonta nuttalliana nuttalliana as*** a synonym of ***Anodonta wahlametensis*** and ***Anodonta nuttalliana idahoensis*** as a synonym of ***Anodonta californiensis.*** It should be noted that the lectotype of ***Anodonta nuttalliana idahoensis was*** fixed by Johnson & Baker (1973), according to ICZN (1985), Article 74 b, c; and treatment of type material by Coan & Roth (1987, p. 324) is thus incorrect. As noted by Taylor (1981), there is some chance that ***Anodonta californiensis*** is a composite species: this needs to be carefully studied. One implication would be that protection is more justified, in that all component taxa would have limited ranges, and the whole group is already known to have been much reduced in range and abundance. This species was cited also in Frest & Johannes (1993c).

Ecology: "Lakes and slow rivers" (Taylor, 1981, p. 142), generally on soft substrates (mud-sand), in fairly large streams and lakes only, in relatively slow current. A bw elevation species, found in both lakes and lake-like stream environments; basically a limnophile. A filter-feeder, as are all unionaceans. The host fish for the glochidial stage of this bivalve is (are?) unknown: note that the fate of the fish larval host(s) also limits and determines the distribution of this species.

Original distribution: Lower Willamette and lower Columbia rivers in OR and WA from The Dalles to the mouth. In larger slow streams of northern CA as far south as the northern San Joaquin Valley. The former range includes Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat cos., WA: Clatsop, Columbia, Multnomah, Hood River, and Wasco cos., OR; and Siskiyou, Shasta, Lassen, Modoc, and Tehama cos., CA.

Current distribution: Taylor (1981) reports that this species is probably eradicated over much of its original range. We have not found living specimens in the Willamette and lower Columbia River in searches from 1988-1990. Still survives in the Fall River and Pit River, Shasta Co., CA (1991); some possible specimens collected by USFWS near The Dalles, 1990. Apparently extinct in the upper Sacramento River Also survives in the Okanogan River, Chelan Co., WA, Parts of Roosevelt Lake, Ferry Co., WA (*pers. comm.*, T. Burke, 1994), and Curlew Lake, Ferry Co., WA. This species was likely heavily impacted by the BPA dams and impoundments; see comments under *Physella columbiana*. Of the nearly 500 Columbia Basin sites surveyed by Frest & Neitzel (in press a, b; see also Neitzel & Frest, 1993), only three had live or recently dead specimens of this species. It is clearly declining in numbers and in area occupied throughout its range. The species appears to be extinct or nearly extinct in UT and NV (see, e.g., Clarke & Hovingh, 1993) and is very limited in distribution in AZ. The middle Snake River populations are much circumscribed,' but may be the best extant (Frest, 1992).

Threats: Extensive'diversion of CA rivers for irrigation, hydroelectric, and water supply projects has much reduced the CA range of this species. This species can tolerate some water pollution; but not heavy nutrient enhancement or similar problems.

Much of the middle Snake River in ID is rapidly becoming eutropified, due to agricultural runoff, trout farms, and urbanization along the river corridor. Much of the river is impounded behind a series of small dams; this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. A recent (1994) landslide impacted some of the historic sites. Introduction of exotic mollusk species (Bowler, 1991) may also be a factor in-the species' decline. Springs in this area have been impacted by ground water pollution from agricultural and dairy operations; diverted into irrigation systems; capped and diverted for stock, domestic, industrial, and piscicultural water supply; heavily grazed; and dried due to groundwater drawdown.

In the lower Columbia River region threats include impoundments; continued sikation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run off. The Lower Granite Resewoir, WA population noted by Frest & Johannes (1992b) appears to have been extirpated by the 1992 drawdown. Declines in numbers and/or distribution of the fish host(s) may also be involved.

This taxon is declining, in terms of -area occupied and number of sites and individuals.

Criteria for inclusion: Current C2 Federal candidate; occurrence on public lands; affected by federal projects; current and ongoing threats.

Recommended status: Currently this species is a C2 candidate (USFWS, 1994a). It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to demonstrate that this species should be Federal and State (OR, ID, WA, AZ, UT, WY, and CA) Threatened.

References: Burch (1973, 1975b); Taylor (1981); Frest (1992); Frest & Johannes, 1992b; 1993a, 1993b; Neitzel & Frest (1993); Frest & Neitzel (in press a, b); Deixis Consultants, 1988-l 994.

Anodonta wahiametensis Lea, 1838 Willamette floater

Type locality: Near the mouth of the Willamette River, Multnomah Co., OR.

Description: The best treatment of this species is in Burch (1973, 1975b). Most closely similar in shell characters is ***Anodonta californiensis***; but that species is much less strongly alate and has very different beak sculpture. Literature treatments of alate western ***Anodonta*** species vary; we prefer to follow Burch (1973, 1975b) and Taylor (1981), which are based on much first-hand field and museum collection experience. See discussion of ***Anodonta californiensis***, above, for further information. Also cited in Frest & Johannes (1993c) under the same name.

Ecology: "Lakes and slow rivers" (Taylor, 1981, p. 142), generally on soft substrates (mud-sand), but also on gravel, in fairly large streams and lakes only, in relatively slow current. A bw elevation filter-feeding species. This species is both an amniphile and a limnophile. The host fish for the glochidial stage of this species is (are?) unknown; note that the fate of the fish larval host(s) also limits and determines the distribution of this species.

Original distribution: Lower Willamette River, and lower Columbia River in OR and WA from The Dalles to the mouth. In larger slow streams of northern CA as far south as the northern San Joaquin Valley. The former range includes Wahkiikum, Cowlii, Clark, Skamania, and Klickitat ws., WA; Clatsop, Columbia, Multnomah, Clackamas, Marion, Hood River, and Wasco cos., OR; and Siskiiou, Shasta, Lassen, Modoc, Tehama, Glenn, Butte, Yuba, Sutter, Yolo, and Sacramento ws., CA. Significance of this bimodal distribution pattern is discussed in Taylor (1985a) and herein.

Current distribution: Taylor (1981) reports that this species is probably eradicated over much of its original range. We have not found living specimens in the Willamette and lower Columbia River in searches from 1988-1990. Not found by Tetra Tech (1991-1993, 1993) either. Still survives in the Fall River, CA (1991); one possible specimen collected by USFWS near The Dalles, 1990. Appears to be extinct in the upper Sacramento River and almost certainly in the lower Sacramento as well (Frest & Johannes, 1993e, 1994, 1995c). The lower Columbia populations were likely essentially extirpated by the construction and continued operation of the BPA dams and impoundments; see further comments under ***Physella columbiana***. Could suwive locally in deep pools with oxygenated substrate.

Threats: Extensive diversion of CA rivers for irrigation, hydroelectric, and water supply projects has much reduced the CA range of this species. In the lower Columbii River region threats include impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run off. Decline in numbers and/or distribution of the glochidial host(s) could also be a factor.

This taxon is declining, in terms of area occupied and number of sites and individuals

Criteria for inclusion: Local endemic; possible occurrence on public lands; considerable reduction in range and loss of historic sites; effects of federal projects on habitat; continued and ongoing threats.

Recommended status: At present, this species has no special status. It minimally should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. Sufficient recent survey work has been done to indicate that this species should be Federal and State (OR, WA, and CA) Endangered.

References: Burch (1973, 1975b); Taylor (1981); Deixis Consultants, 1988-l 992.

Margaritifera n. sp. Taylor, 1988 Pahsimeroi pearlshell

Type locality: None designated as yet; taxon not yet formally named (but see Taylor, 1988a). Reposited specimens include UCM 29279. See Wu & Brandauer (1982) for this material.

Description: "Anterior cardinal tooth of left valve about ¼ of the size of the posterior; nacre pale orange on ventroanterior surface, pale purple elsewhere..."; "[t]he sinulus is strongly impressed, setting off the

beaks prominently. Thus the dorsal margin is not broadly curved as in most other species of the genus, but has a pronounced concavity anterior to the beaks" (Taylor, 1988a, pp. 563, 564); see also illustrations in same work.

Ecology: Found in gravel-cobble riffle in small *river;* typical *Margaritifera falcata* occurs at the same site. Surrounding ranges are mostly limestone and dolomite. An amniphile, found generally in swift streams, partly buried in coarse substrate; a filter-feeder.

Original distribution: Pahsimeroi River, Pahsimeroi Valley, Lemhi and Custer cos., ID.

Current distribution: Survives at at least one site on the Pahsimeroi River. Most of the land in this area is BLM-owned.

Threats: Much of the Pahsimeroi River and larger tributary fiowage is diverted into irrigation ditches and returns, which have caused most of the system to become nutrient-enriched and sediment- and macrophytschoked (and hence unsuitable habitat). Grazing is heavy through much of the Valley as well.

Criteria for inclusion: Very local endemic; ongoing threats; severe reduction in suitable habitat.

Recommended status: Currently has none. It should be considered a sensitive' species by the Forest Service, BLM, and other land management and wildlife agencies. Should be Federal and State (ID) Endangered.

References: Taylor (1988a); P. Bowler (*pers. comm.*, 1993).

Pisidium (Cyciocaiyx) ultramontanum Prime, 1865 montane peaclam

Type locality: "Canoe Creek (now Hat Creek), probably at Rising River,. Shasta County, California" (Taylor, 1981, p. 146).

Description: See Burch (1972, 1975a) for description and illustrations. No other North American sphaeriid closely resembles this taxon. Cited under the same name in Frest & Johannes (1993c).

Ecology: Generally found on sand-gravel substrate in spring-influenced streams and lakes, and occasionally in limnocrenes; characteristically in areas with high mollusk diversity. Associates often include other Species of Special Concern, such as *Lanx klamathensis*, *Helisoma newberryi*, *Pyrgulopsis archimedis*, *Fluminicola* n. sp. 1, and *Lyogyrus* spp. This species is effectively both a crenophile and limnophile.

Original distribution: Periphery of the Great Basin in OR to Klamath River and Pit River, OR-CA, as well as some of the larger lakes (Upper Klamath Lake, Tule Lake, Eagle Lake, possibly Lower Klamath Lake), Klamath Co., OR and Siskiyou, Lassen, and Modoc cos., CA.

Current distribution: Some populations are extinct, including those in the Tule Lake and Lower Klamath Lake areas. Known to survive in the Upper Klamath Lake area (including sites in Winema National Forest and Upper Klamath National Wildlife Refuge), the middle Pi River (Frest & Johannes, 1993c, 1994, 1995c), and at Eagle Lake (Lassen National Forest). Sites may exist in Shasta National Forest also, although old sites there appear to be extinct. The species is definitely declining in number of sites, range, and numbers.

Threats: Best remaining populations are in the Upper Kiamath.Lake area. Much of the lake habiiat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Kiamath Lake were modified for log transport and are now part of irrigation projects: the species is absent from most areas so modified, as

spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habiiat modification to accommodate Endangered sucker species. The Link River site in Klamath Falls is subject to development and urbanization pressures in its own right. Klamath River sites may now be extinct, due to impoundment and water pollution. Great Basin populations in general occur(ed) in large spring pools (limnocrenes). Overpumping of ground water; grazing; diversion and capping of springs for stock, industrial, and domestic water supply; and geothermal development are problems for these populations.

Criteria for inclusion: Local endemic; federal listing candidate; occurrence on public lands; riparian associate.

Recommended status: Currently a C2 candidate (USFWS, 1994a). Otherwise, has no special protected status; minimally, the Forest Service, BLM, and other appropriate land and wildlife agencies should consider this a sensitive species. It should be considered Endangered in CA, OR, and federally.

References: Taylor (1981, 1985a); Frest & Johannes (1993c, 1994, 1995c); Deixis Consultants, 1991-92.

Pisidium n. sp. 1 Modoc peaclam

Type locality: None designated as yet; undescribed taxon.

Description: None available at present. The only literature reference is Taylor & Bright (1987), as "Modoc Plateau *Pisidium*"

Ecology: Found only in relatively large, spring-influenced streams and lakes, characteristically in areas with high mollusk diversity. Associates may include other Species of Special Concern, such as ***Lanx klamathensis***, ***Helisoma newberryi***, ***Pyrgulopsis archimedis***, ***Fluminicola*** n. sp. 1, and ***Lyogyrus*** spp. This species is effectively both an amniphile and limnophiie, with spring influence apparently also a ***desideratum.***

Original distribution: Upper Klamath Lake drainage in OR to Klamath River and middle-upper Pit River, OR-CA, Klamath Co., OR and Siskiiou, Shasta, and Modoc cos., CA. The fossil record extends across southern OR (OR Interipr Basins) to SE ID (Taylor & Bright, 1987, fig. 6).

Current distribution: There are six historic populations, mostly on the Modoc Plateau (Taylor & Bright, 1987, fig. 6). Some populations are extinct, including some or all of those in the Klamath River and Pit River. Known to survive in the Upper Klamath Lake area (possibly including sites in Winema National Forest and Upper Klamath National Wildlife Refuge) and possibly in the middle or upper Pit River. The species is definitely declining in number of sites, range, and numbers.

Threats: Best remaining populations may be in the Upper Klamath Lake area. Much of the lake habitat for this Upper Klamath Lake endemic is considerably eutropified, has soft substrate, or both; the species is absent from such areas. Most of the large springs peripheral to Upper Klamath Lake were modified for log transport and are now part of irrigation projects; the species is absent from most areas so modified, as spring influence no longer compensates for the lake's general condition. Even in the lake areas adjacent to best remaining spring pools and spring-fed creeks feeding into the lake, the species seems to be confined to limited areas with the best water quality. Remaining sites are threatened by eutropification, urban, agricultural, and industrial pollution, and habiiat modification to accommodate Endangered sucker species. The Link River site in Klamath Falls is subject to development and urbanization pressures in its own right. Klamath River and some or all Pit River sites may now be extinct, due to impoundment and water pollution. Great Basin populations in general presumably occurred in large river environments. Overpumping of ground water; grazing; diversion and capping of springs for stock, industrial, and

domestic water supply; and geothermal development are problems for populations in this area, if any remain.

Criteria for inclusion: Local endemic; occurrence on public lands; continued threats to very specialized habitat.

Recommended status: Currently this undescribed form has no status. Minimally, it should be considered sensitive by the Forest Service, BLM, and other appropriate federal and state wildlife and land management agencies. Sufficient recent survey work has been done in the species' known current and fossil range (e.g. Frest & Johannes, 1993c, 1994, 1995c; see also various Snake River surveys by Frest & Johannes and others, summarized in USFWS, 1993) to establish that this taxon should be considered Endangered in CA, -OR, and federally.

References: Taylor & Bright (1987); Deixis Consultants, 1991-94.

WATCH LIST: SENSITIVE, BUT NOT CRITICALLY

Under this heading are discussed taxa which are known or have been reported to occur in the Interior Columbii Basin; are known to have lost much of their range; and are regarded as sensitive species, ie. especially associated with mature, relatively undisturbed forests; riparian areas; springs; and/or some combination of specialized or especially impacted habitat. However, these taxa may have had a comparatively broad range originally; or may be species which currently known or thought to be common outside the area of assessment elsewhere in the U.S. or in adjacent countries. These taxa are not regarded as in imminent danger of extinction without protection currently (although this may change rapidly, depending upon the management strategy adapted for public lands, and upon the effectiveness of its implementation).

These taxa should be regarded as sensitive by land management and wildlife planners, and their status should be carefully and periodically reviewed. Complacency in regard to their status and needs is not suggested.

Land Snails

Cryptomastix (Cryptomastix) devia **(Gould, 1846)** **Puget oregonian**

Type locality: Puget Sound (no specific site); holotype MCZ 189124 (see Johnson, 1984).

Description: The best description and illustrations are those of Pilsbry (1940), *q.v.* This species was cited similarly in Frest & Johannes (1993c).

Ecology: Low to middle elevations; old growth and riparian associate; habitat includes leaf litter along streams, under logs, seeps and springy areas. Moist valley, ravine, gorge, or talus sites are preferred, i.e. low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a ***desideratum.*** Relatively intact and florally diverse forests are preferred, with diverse forbs and deciduous shrubs. A mesophile-notophile species.

Original distribution: Scattered sites from southern Vancouver Island, B.C. to the west end of the Columbia Gorge, including the following counties: King, Clark, Skamania, and Thurston (WA), Multnomah (OR). Probably originally very widely distributed in western WA. There is one record from the eastern Cascades (Lake Chelan State Park, Chelan Co., WA; Branson, 1980).

Current distribution: Known to survive at a few scattered sites in King and Thurston cos., WA. The species is likely to survive on Ft. Lewis (no recent collections) and near Carson, WA. The record from the Lake Chelan area needs confirmation.

Threats: See Frest & Johannes (1993c) for discussion. Logging and clearing of relatively intact forest and grazing of logged areas; and impacts to riparian zones and their borders are the primary concerns.

Criteria for inclusion: Old growth associate, riparian associate, regional endemic. Most of habitat has been logged or is in heavily urbanized areas now rapidly expanding, e.g. the central and southern Puget Sound area. This species is in strong decline throughout its range, and many historic sites are extirpated. Numbers found at surviving colonies are limited, and no examples of large numbers at a single site, such as observed as single lots in museum collections, have been seen for some time. The trends for population (number of sites, number of individuals) are downward.

Recommended status: Currently, this species has no special status. It minimally should be considered a sensitive species by the Forest Service and BLM. Sufficient information is available to indicate that it should be Endangered in WA, OR, and Federally, due to loss of habitat, continuing threats to remaining habitat, and loss of historic sites, and rarity at extant sites. This species was also recommended for listing in the Spotted Owl report (Frest & Johannes, 1993c). If it occurs on the east side, it should be regarded as quite rare. We have not collected it in eastern WA, nor has T. Burke (*pers. comm.*, 1994); so the validity of Branson (1980) should perhaps be rechecked.

References: Pilsbty (1940); Branson (1980); Frest & Johannes (1993c); Deixis Consultants, 1987-94.

Oreohelix jugalis (Hemphill, 1890) boulder pile mountainsnail

Type locality: "Salmon River Mountains, Idaho"; lectotype ANSP 62372a; for possible paralectotypes, see Coan & Roth (1987) and Frest & Johannes (1995a). Hemphill's lots often contained specimens. of what we here term *Oreohelix* n. sp. 23.

Description: The best previous description and illustrations are those of Pilsbry (1939); but see also Solem (1975) for anatomy and Frest & Johannes (1995a).

Ecology: This species occurs at low elevations in rock taluses (schist; basalt; metasediments; limestone) and boulder piles (mixed lithologies). This is a rather tolerant species, occupying the range from slightly mesophile to moderately-strongly xerophile. Sites are open, vary in exposure, and can be seasonally dry. Plant associates include *Celtus*, *Rhus*, *Salix*, *Sorbus*, and *Cornus stolonifera*, as well as grasses and a few bryophytes. Common associates include *Allogona ptychophora ptychophora, Allogona pfychophora solida, Cryptomastk harfordiana*, and such *Oreohelix* species as *Oreohelix* vortex. The species is found occasionally with such species as *Oreohelix waltoni* and several of the new taxa described above.

Original distribution: Limited to the area along the lower Salmon River from Riggins to about RM 20, mostly in Idaho Co., ID.

Current distribution: Still survives at a fair number of sites in the original range, including some on BLM lands. See Frest & Johannes(1995a) for a recent assessment.

Threats: Nearly all known sites are impacted by grazing; sheep, horses, and cattle have considerably reduced or even extirpated sites. Road construction and maintenance have considerably reduced sites along US 95, and probably extirpated the species from much of the corridor, judging by still-common dead shells. Talus mining, especially for basalt gravel, has affected taluses in the immediate vicinity of al sites. Large sites near Whiie Bird have been completely eliminated (in 1991 and 1994) from talus mining and road improvements. Road corridors are selectively located in preferred habit of this species. Gold mining and prospecting impacts sites in schist lithologies. Boulder piles along the Salmon River are mostly disturbed by gold mining, and there is little indication that this species has reoccupied mining discard heaps and similar sites, even though some are quite old. Population trends (number of sites, number of individuals) are very clearly downward.

Criteria for inclusion: Local endemic; occurrence on public lands; habitat decline; loss of historic sites.

Recommended status: At present, this species is a C2 federal candidate (USFWS, 1994a). With thorough survey, it has been noted as more common than originally expected, even though quite limited and though it has suffered considerable range and site loss (Frest & Johannes, 1995a). Assuming that sites for other, more rare species in the same corridor can be protected, it is possible that this species will be included on enough as to not warrant listing. The species should minimally be considered sensitive by the Forest Service, BLM, and other appropriate land management and wildlife agencies. If other species are not protected then this taxon should be federally listed as Threatened.

References: Hemphill (1890a); Pilsbry (1939); Solem (1975); USFWS (1994a); Deixis collections, 1988-1994.

Polygyrella polygyrella (Bland & Cooper, 1861) humped coin

Type locality: Eastern slope of the Coeur d'Alene Mountains, Sanders Co., MT (likely in Lolo National Forest currently). Location of holotype uncertain; Bland specimens in USNM.

Description: For best descriptions and illustrations, see Pilsbry (1939); see also illustration in Burch & Pearce (1990).

Ecology: Found generally in moist Douglas fir and spruce forests, often in association with rock outcrops. Substrate is quite variile, and can include basalt, schist, and limestone. Partly open forest with a rich understory, including diverse forbs, mosses, and deciduous shrubs, is common; the best colonies occur in forested taluses. Moist valley, ravine, gorge, or talus sites are preferred, i.e. low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a *desideratum.* Land snail associates include such forms as *Allogona ptychophora ptychophora*; *Allogona lombardii*; mesophile-slight xerophile *Oreohelix* species; mesophile *Cryptomastix* species, including *mullani mullani*; *Zacoleus idahoensis,* and *Hemphillia camelus.* This species is a mesophile, but can tolerate moderately xerophilic conditions in rock taluses. This species often occurs with quite rare and endemic mesophile-weakly xerophile taxa, such as *Anguispira nimapuna* and *Ctyptomastix magnidentata.*

Original distribution: In MT, generally in the Clark Fork River drainage, Bitterroot Range and Coeur d'Alene Mountains; in ID, in the Coeur d'Alene River drainage (Kootenai Co.); the Cleat-water, Lochsa, and

Selway drainages (Nez Perce, Idaho cos.); and also in the Blue Mountains (Walla Walla Co., WA; Umatilla Co., OR).

Current distribution: T. Burke (*pers. comm.*, 1994) has not found this species in NE WA; nor have we. Recent attempts to recollect the Blue Mountain localities were also unsuccessful. This species is known from very few MT sites (R. B. Brunson, *pers. comm.*, 1993). Old sites were in Clearwater National Forest, Nez Perce National Forest, Nez Perce Tribe lands, Lolo National Forest, possibly Kaniksu National Forest; and the Panhandle National Forests. For extant lower Salmon River sites, see Frest & Johannes (1995a). We have (1991, 1994) unsuccessfully tried the old sites in the vicinity of Coeur d' Alene, Cataldo, and Old Mission. The Mission Creek site is still viable, though threatened by quarry expansion (see discussion under ***Cryptomastix magnidentata*** above). For another old site, see Branson, Sisk, & McCoy (1966).

Threats: Logging and grazing over most of known and potential range; the species is restricted to rather moist sites, generally in exceptionally botanically diverse and intact forests. Logging' of relatively intact moderate-elevation Douglas fir forest: grazing of much of the logged terrain;. highway construction and other river right-of-way impacts; severe forest fires. This species was probably once very common and widespread. It has lost most of its habiiat and most historic sites; but a fair number of other sites probably remain viable. We have found it only very locally abundant.

Criteria for inclusion: This species is definitely declining in terms of remaining habitat and population size. Some old sites are known to be extirpated. Most historic sites are on federal lands, including Nez Perce National Forest, Clearwater National Forest, the Idaho Panhandle National Forests, and Umatilla National Forest. Sites occur on Nez Perce Tribe and BLM lands as well. See Frest & Johannes (1995a) for lower Salmon River occurrences. Because this taxon originally had a rather extensive range, and because we have not had the opportunity to recheck all old sites, we are not recommending listing at present. One should note, however, that the whole family or subfamily to which it belongs (Ammonitellinae) is rare and thought to have a relict distribution. Several members of this group are either federal listing candidates or have been suggested for listing, including members of all other ammonitellinid genera (***Megomphix, Ammonitella***, *Polygyroidea*, and *Glyptostoma*).

Recommended status: We do not recommend federal or State (WA, OR, ID, MT) listing at this juncture; however, it should be regarded as a sensitive species by Forest Service, BLM, and other land management and wildlife agencies.

References: Pilsbry (1939); Frest & Johannes (1995a); Deixis collections, 1988-l 994.

Radiodiscus (Radiodomus) abietum Baker, 1930 fir pinwheel

Type locality: Near the mouth of the East Fork of the Weiser River, on Stevens Ranch, Adams Co., ID. Holotype ANSP 149979a; paratypes 149979.

Description: See Baker (1930) and Pilsbry (1948) for description and illustrations. This species is much larger and has a comparatively smaller umbilicus than the Southwestern ***Radiodiscus millicostatus***. Anatomy of the two nominal subgenera is rather different, and each is monotypic.

Ecology: Generally found in rather moist, rocky forested terrain, at medium-high elevations. Most often, the dominant vegetation ***is Pseudotsuga menziesii*** forest, with a rich understory including many forbs, deciduous shrubs, and bryophytes. The species has also been found in *Thuja* stands. Moist 'valley, ravine, gorge, or talus sites are preferred, ***i.e.*** low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture ***is*** a ***desideratum.*** The regolith is variable, ranging from basalt to schist to limestone. Common associates include ***Allogona ptychophora ptychophora***, *Cryptomastix mullani* subspp. and other *Cryptomastix* spp., larger mesophile

Oreohelix spp., *Polygyrella polygyrella*, and slugs such as *Hemphillia camelus* and *Zacoleus idahoensis.* A mesophile species, apparently feeding on partly decayed leaves and organic debris in soil.

Original distributIon: Old sites for this species included the Blue Mountains, WA and OR; a string of western ID and ID Panhandle counties (Bonner, Kootenai, Shoshone, Clearwater, Nez Perce, Idaho, and Adams); extreme NE WA (Ferry Co.: T. Burke, *pers. comm.*, 1994); and part of NW MT (Lincoln, Sanders, Lake, Mineral, Ravalli, & Missoula cos.; Brunson & Russell, 1967). River valleys involved included the upper Weiser, Liile Salmon, Salmon, Hells Canyon, Coeur d'Alene, St. Joe, Clearwater, Lochsa, Selway [all Snake tributaries), Flathead, Kootenai, Clark Fork, and Bitterroot. Sites on public lands include ones in Payette, Nez Perce, Clearwater, and the Panhandle National Forests.

Current distribution: Known to survive at several sites in NE WA (T. Burke, *pers. comm.*, 1994); we have unsuccessfully rechecked most of the old ID sites, finding it extirpated in all but one. On the other hand, we have collected this species in several sites recently; mostly remnant moist forest patches at moderate elevations. Some notion of relative rarity can be gauged from the Lower Salmon River study (Frest & Johannes, 1995a); we found this species at very few sites.

Threats: Logging of relatively intact moderate-elevation Douglas fir forest; grazing of much of the logged terrain; highway construction and other river right-of-way impacts; severe forest fires. This species was probabty once very common and widespread. It has lost most of its habitat and most historic sites; but a fair number of other sites probably remain viable. We have found it nowhere abundant.

Criteria for inclusion: Regional endemic; mature forest species; occurrence on public lands; riparian associate.

Recommended status: Formal Federal or State (WA, OR, ID, MT) listing is probably unnecessary at this point. However, this species should be considered sensitive by Forest Service, BLM, and other appropriate federal and state land management and wildlife agencies.

References: Baker (1930); Pilsbry (1948); Brunson & Russell (1967); Frest & Johannes (1995a); Deixis collections, 1988-l 994.

Slugs

Zacoleus idahoensis Pilsbry, 1903 sheathed slug

Type locality: Meadows, Washington Co., Idaho; holotype ANSP 87493a.

Description: See Pilsbry (1903, 1948) for best description and illustrations; see also illustration in Burch & Pearce (1990).

Ecology: This species is a moderate mesophile-notophile, which can sometimes be found also in somewhat more xeric sites. Most sites are in relatively intact and florally diverse forests, generally Douglas fir, spruce, or Ponderosa pine, with a rich understory including many forbs and bryophytes. It most often occurs at moderate-high elevations. At high elevation sites, forests may be more open, and nonvascular plants a more significant component of the flora. Moist valley, ravine, gorge, or talus sites are preferred, *i.e.* low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistence of moisture is a *desideratum.* It has been noted with many other land snail and slug species, including *Hemphillia camelus, Magnipelta mycophaga, Allogona ptychophora ptychophora, Allogona lombardii*, *Polygyrella polygyrella*, various *Cryptomasfix* species, including *mullani mullani*; *Anguispira kochi occidentalis;* and *Anguispira nimapuna.*

Original distribution: Lower Salmon-Little Salmon River drainage, Clearwater (including Lochsa and Selway) River drainage, Coeur d'Alene (including St. Joe) River drainage, Washington, Adams, Idaho, Bonner, Kootenai, Shoshone, and Clearwater cos., ID; Clark Fork River drainage, Sanders Co., MT. Old sites are in the Idaho Panhandle National Forests, Clearwater National Forest, Nez Perce National Forest, Payette National Forest, and Lolo National Forest, as well as on BLM and other lands in this same region.

Current distribution: Still occurs at scattered sites in the original distribution. For lower Salmon River sites, see Frest & Johannes (1995a). Collected recently (1988-l 994) also at a few sites in the Lolo Pass area; Coeur d'Alene drainage; and Clearwater drainage.

Threats: Logging and grazing over most of known and potential range; the species is restricted to rather moist sites, generally in exceptionally botanically diverse and intact forests. Logging of relatively intact moderate-elevation Douglas fir forest; grazing of much of the logged terrain; highway construction and other river right-of-way impacts; severe forest fires. This species was probably once very common and widespread. It has lost most of its habitat and most historic sites; but a fair number of other sites probably remain viable. We have found it only very locally abundant. It is less sensitive than the more clearly notophile slug genera, such as *Prophysaon* and *Hemphillia*.

Criteria for inclusion: Local endemic; occurrence on public lands; loss of historic sites; loss of most habitat.

Recommended status: This slug has none at present. It should be considered a sensitive species by the Forest Service, BLM, and other federal and state land management and wildlife agencies, *e.g.* in ID and MT. However, enough sites are likely to exist as to not require federal listing at this time.

References: Pilsbry (1903, 1948); Frest & Johannes (1995a); Deixis collections, 1990-1994.

Freshwater Snails

Fluminicola n. sp. 10 vagrant pebblesnail [in part]

Type locality: None designated as yet; several species involved. We are currently working on these taxa with R. Hershler (NMNH).

Description: Under this rubric are included several species related to *Fluminicola fuscus* and *Fluminicola coloradensis*. Many of these snails have been recorded in the literature *as Fluminicola hindsi, sensu* Taylor (1966b; 1977 *unpub.*; 1985a: see map therein). With the recent revision of the nominate *Fluminicola* species by Hershler & Frest (in press), *hindsi* is a synonym of *fuscus,* and *coloradensis is* a valid full species. These species are as yet insufficiently characterized in regard to morphology and distribution as to permit separate entries. We are working on these currently with R. Hershler (NMNH), however, and such information is likely to be available within the next 2-3 years. It is quite likely that all or many will be very limited in distribution and in some danger of extinction, so that protection will be warranted.

Ecology: Most of these taxa are cold-water stenotherms and crenocole, limnocrene, or spring-influenced (crenophile) stream species. Generally, these prefer cold, clear, water with near-saturation amounts of dissolved oxygen, no or minor nutrient enhancement (oligotrophic waters); and coarse but stable substrate. Almost all are lithophiles and perilithon feeders. Common mollusk associates are other hydrobiids, such *as Pyrgulopsis* and *Lyogyrus* species, and other cold-water taxa, such *as Vorticifex effusus*. Preferred habitats generally have abundant *Rorippa,* and common *Veronica* and *Chara*; but relatively minor amounts or coverage by epiphytic algae and such tolerant macrophytes *as Ceratophyllum* and *Potamogeton crispus* and *filiformis*.

Original distribution: Taxa reported as *hindsi* from the following areas will have to be reassigned; Salmon River upstream from River of No Return, i.e. eastern ID; middle and Upper Snake River, Blackfoot River, Teton River, and Salt River, southern ID and WY; springs tributary to the middle and upper Snake and the large tributaries just listed; Bear River drainage (including springs), SE ID and NE UT; John Day River, OR.

Current distribution: See above; most survive at scattered sites within the range specified above; and all have lost most of their original distribution and many historic sites represented in museum collections and the literature.

Threats: Specifics of former sites can be given in many cases, based on Taylor's (1966a) map, museum collections, and on field notes. This will be deferred until species are better characterized.

Much of the middle Snake River in ID is rapidly becoming eutropified, due to agricultural runoff, trout farms, and urbanization along the river corridor. Much of the river is impounded behind a series of small dams; this is also detrimental for coldwater species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. A recent (1994) landslide impacted some of the historic sites. Introduction of exotic mollusk species (Bowler, 1991) may also be a factor in the species' decline. Springs in this area have been impacted by ground water pollution from agricultural and dairy operations; diverted into irrigation systems: capped and diverted for stock, domestic, industrial, and piscicultural water supply; heavily grazed; and dried due to groundwater drawdown.

Similar statements apply to the Salmon and other riier drainages mentioned. Conditions in the various tributary riiers and springs are noted in the discussions of other taxa (notably the numerous Snake River *Pyrgulopsis* and *Lyogyrus* species with individual entries above). ***Fluminicola* sites** are threatened by being in and impacted negatively by public campgrounds, with human usage and grazing causing some impacts are common. Grazing has negatively impacted nearly all springs in the region of occurrence, with many formerly mapped and named now dry. Many mapped springs are now grazed to the point that none of the native mollusk fauna remains. Many springs have been diverted or capped for stock, domestic, or industrial water supply. As we are currently surveying SE D for springsnails (1991-l 994), along with R. Hershler *et al.* (1993-1994), significant range extension or discovery of sizable numbers of new sites for individual taxa are not to be expected from future work.

Criteria for inclusion: Local endemics; loss of historic sites; specialized habitat; modification and loss of that habitat; occurrence on public lands. Many of the species occur in part or wholly on National Forest (e.g. Targhee, Sawtooth; Challis; Cache) or BLM or State (ID) lands.

Recommended status: None at present; recent discoveries needing to be explored further. As noted above, most or al are likely to warrant Federal or State (OR, ID, MT) listing; and ***Fluminicola*** in general should be regarded as a sensitive species by Forest Service, BLM, state, and other land management and wildlife agencies.

References: Taylor (1966b; 1977, *unpub.;* 1985a); Hershler & Frest (in press); Deixis collections, 1988-1994.

Fluminicola n. sp. 11 [other large *Fluminicola* species; no common names]

Type locality: None designated as yet; several species involved. We are currently working on these taxa with R. Hershler (NMNH).

Description: Here discussed are several undescribed species related to ***Numinicola virens.*** Many of these snails have been recorded in the literature ***as Numinicola nuttalliana*** or ***virens, sensu*** Taylor (1966a; 1977, *unpub.*; 1985a); Clarke (1981); Burch (1989); and many other authors. With the recent revision of the nominate ***Fluminicola*** species by Hershler & Frest (in press), ***nuttalliana*** is a species likely originally restricted to part of the lower Willamette River, and probably now extinct. ***Numinicola virens*** may

occur only in parts of the Willamette system and the lower Columbia River. The undescribed, *virens*-like species are as yet insufficiently characterized in regard to morphology and distribution as to permit separate entries. We are working on these currently with R. Hershler (NMNH), however, and such information is likely to be available within the next 2-3 years. It is quite likely that all or many will be very limited in distribution and in some danger of extinction, so that protection will be warranted.

Ecology: Most of these taxa are cold-water stenotherms and spring-influenced amniphile species. Generally, these prefer cold, clear, streams with near-saturation amounts of dissolved oxygen, no or minor nutrient enhancement (oligotrophic waters); continual current; and coarse but stable substrate. Almost all are lithophiles and periliihon feeders. Common mollusk associates are other cold-water taxa, such as *Vorticifex effusus,* and species such as *Physella gyrina, Margaritifera falcata*, and *Gonidea angulata.* Preferred habiits generally have few rooted aquatic macrophytes and relatively minor amounts or coverage by epiphytic algae and such tolerant macrophytes as *Ceratophyllum* and *Potamogeton crispus* and *filiformis*; such may occur in finer-substrate areas nearby.

Original distribution: Taxa reported *as nuttalliana* or *virens* from the following areas will have to be reassigned: Okanogan, Methow, and possibly Wenatchee rivers, WA; Deschutes River, OR; portions of the Columbia River, from the Hanford Reach to The Dalles, and possibly to the mouth, WA and OR; and from the Clearwater River, ID

Current distribution: See above; most survive at scattered sites within the range specified above; and all have lost most of their original distribution and many historic sites represented in museum collections and the literature. For sites for many of these forms, see Neitzel & Frest (1993); these were recorded as *Fluminicola* species other than *columbiana* [=*fuscus*; *q.v.*] and *hindsi [see* above].

Threats: Specifics of former sites can be given in many cases, based on Taylor's (1966a) map, museum collections, and on field notes. This will be deferred until the individual species are better characterized. Problems in the Columbia River proper and many of its larger tributaries include impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions. Harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam; nutrient enrichment due to agricultural run off. For more details on threats for some specific rivers with these species, see Frest & Neitzel (in press), especially on the Okanogan, Methow, and lower Clearwater; see also Hershler & Frest (in press).

Similar statements apply to the Deschutes River and other river drainages mentioned. Conditions in the various tributary rivers and springs are noted in the discussions of other taxa (notably *Juga (Oreobasis) bulbosa; Juga (Juga) hemphilli maupinensis*; *Fluminicola fuscus*; *Physella columbiana, Fisherola nuttalli*; and *Anodonta californiensis*, all of which see).

Criteria for inclusion: Local endemics; loss of historic sites; specialized habitat; modification and loss of that habitat; occurrence on public lands. Many of the species occur in part or wholly on National Forest (e.g. Clear-water, Wenatchee; Okanogan; Cache). or BLM or State (WA, OR, ID) lands.

Recommended status: None at present: recent discoveries need to be examined further. As noted above, most or al are likely to warrant Federal or State (WA, OR, ID) listing; and *Fluminicola* in general should be regarded as a sensitive species by Forest Service, BLM, state, and other land management and wildlife agencies.

References: Taylor (1966a; 1977, *unpub.;* 1985a); Neitzel & Frest (1993); Hershler & Frest (in press a, b); Frest & Neitzel (in press); Deixis collections, 1988-l 994.

Lyogyrus greggi Pilsbry, 1935 — Rocky Mountain duskysnail

Type locality: Spring in Cliff Creek Canyon, Teton Co., WY; holotype ANSP 163812a.

Description: This hydrobiid is small, moderately high conic with convex whorls; and has a dark gray body, black mantle, and dark male external genitalia. The most closely related forms are such eastern species as ***Lyogyrus walker*** and some western endemics such as Lyogyrus n. sp. 1, ***Lyogyrus*** n. sp. 6, and ***Lyogyrus*** n. sp. 7.

Ecology: A crenocole species, found mostly in small to medium-sized springs. Substrate is generally coarse, the species, like many western Lyogyrus, is a lithophile and periliihon feeder. Common macrophytes include ***Rorippa, Veronica,*** and ***Mimulus.*** This species is less wmmon in deeper springs and spring pools; and is either rare in or absent from nutrient-enriched settings (generally absent). Often, this is the only hydrobiid and most common mollusk present.

Original distribution: Taylor (1966a) cites localities in SW MT, SE ID, and western WY (Snake River, Bear River, and Clark Fork River drainages).

Current distribution: Uncertain. We are currently working on this species (with R. Hershler). The species is quite rare in WY and MT. SE ID sites may be relatively more common, but confusion with other undescribed Lyogyrus species (as discussed above) has to be resolved. We are currently (together with R. Hershler) systematically surveying SE ID and adjacent areas for this and other mollusk taxa. It is quite possible that this is a complex of several similar-appearing species, each of which is rather circumscribed in its distribution and in need of protection.

Threats: Much of the middle and upper Snake River in ID and WY is rapidly becoming eutropified, due to agricultural runoff, fish farms, and urbanization along the river corridor. Much of the river is impounded behind a series of small dams; this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. Springs in this area have been impacted by ground water pollution from agricultural and dairy operations; diverted into irrigation systems; capped and diverted for stock, domestic, industrial, and piscicultural water supply; heavily grazed; and dried due to groundwater drawdown.

Similar statements apply to the Bear River and other river drainages mentioned. Conditions in the various tributary rivers and springs are noted in the discussions of other taxa (notably the numerous Snake River ***Pyrgulopsis*** and ***Lyogyrus*** species with individual entries above). ***Lyogyrus*** sites are threatened by being in and impacted negatively by public campgrounds, e.g. the type locality for this species, with human usage and grazing causing some impacts are common. Grazing has negatively impacted nearly all springs in the region of occurrence, with many formerly mapped and named now dry. Many mapped springs are now grazed to the point that none of the native mollusk fauna remains. Many springs have been diverted or capped for stock, domestic, or industrial water supply. As we are currently surveying SE ID for springsnails (1991-l 994), along with R. Hershler ***et a/.*** (1993-l 994), significant range extension or discovery of sizable numbers of new sites for individual taxa are not to be expected from future work.

Criteria for inclusion: Local endemics; loss of historic sites; specialized habitat; modification and loss of that habitat; occurrence on public lands. Many of the species occur in part or wholly on National Forest (e.g. Targhee, Sawtooth; Challis; Cache; Bridger-Teton). or BLM or State (ID, WY) lands. Mountain ranges involved include the Teton Range, Salt River Range, Gros Ventre Range, Big Hole Mountains, Caribou Range, Blackfoot Range, Bear River Range, Portneuf Range, Bannock Range.

Recommended status: None at present; recent discoveries need to be explored further. As noted above, some or all of the species involved may warrant Federal or State (ID, MT, WY) listing; and ***Lyogyrus*** in general should be regarded as a sensitive genus by Forest Service, BLM, state, and other land management and wildlife agencies.

References: Pilsbry (1935); Taylor (1966a, b); Deixis collections, 1988-l 994.

Pristinicola hemphilli (Pilsbry, 1907) pristine springsnail

Type locality: Uncertain, and probably extinct in any case; Kentucky Ferry ***[sic],*** Snake River, WA; for information on the likely location of this Hemphill site, see Henderson (1936) and Hershler ***et al.*** (1994). Lectotype ANSP 31176; paralectotypes ANSP 368405.

Description: See Hershler ***et al.*** (1994) for detailed anatomy and shell description and illustrations. The small, elongate, ***Bythinella*-like conch** is unique in western North America. As presently construed, the **taxon** embraces a wide range of shell morphology. **With** further study, ***Pristinicola*** **may** prove to be a species group, rather than a monospecific genus. This lithoglyphinid does not appear to be closely related to typical western North American **taxa,** such as ***Fluminicola* (*s.l.*).**

Ecology: Occurs mostly in very small springs and seeps; sometimes in larger springs, spring runs, or strongly spring-influenced small streams. A crenophile **taxon,** generally a perilithon grazer and lithophile. Substrate is usually coarse; ***Rorippa*, *Mimulus*,** and bryophytes are the commonly associated plants. Most sites are in semiarid areas, in low-medium elevation sage scrub; but Cascades sites are in **fairly** dense Douglas fir forests at low-medium elevations. Often this is the only wmmon mollusk: the most frequent associates are ***Pisidium insigne*** and ***Fossaria*** spp. At some sites, this **taxon** occurs with ***Lyogyrus*** spp., ***Juga*** spp., ***or Fluminicola*** spp. Sites are generally very shallow; very cold, clear: have slow-moderate flow; and are relatively undisturbed.

Original distribution: Scattered sites in -part of the Columbia Basin, including a few large tributaries; and S. in the Willamette and possibly coastal OR. Absent from northern WA; interior OR except for the Blue Mountains and Deschutes River drainage; and from all except western ID (not in the Snake system above the Weiser area).

Current distribution: See Hershler ***et al.*** (1994) for detailed site descriptions. Surviving sites are often on public lands, including BLM (Baker District); Hells Canyon National Scenic Area; the Grand Coulee area (Bureau of Reclamation); Gifford Pinchot National Forest; state and federal fish hatcheries in the Columbia Gorge, etc.

Threats: The small semiarid springs and seeps preferred by this species **are** very readily subject to modification and destruction from a variety of causes. Recently extinct sites of which we are **aware** were extirpated by road building and maintenance (WA 14; **I-84),** grazing (Baker District BLM), dam construction **and** maintenance (Hells Canyon Dam, John Day Dam); and diversion and capping for campground, hatchery, stock, and domestic water supply (Columbia Gorge area). in the range as a whole, grazing is probably **the biggest** single problem. In some areas, nutrient-enriched groundwater is a problem also, e.g. Grant Co.. WA.

Criteria for inclusion: Local endemic; occurrence on public lands; loss of historic sites and habitat loss and threats to the remaining localities.

Recommended status: None at present; there are about 50 sites presently known, some of which could be secure. The species should be regarded **as** sensitive by the BLM, Forest **Service,** and other appropriate land management and wildlife agencies. **With** further study, there is some possibility that this **taxon** will be divided into several species, each of which would then possibly require protection. At present, this **taxon** should not be listed in WA or OR; but as there **are** few sites in ID, state listing as Threatened may be appropriate.

References: Henderson **(1929a, 1936b);** Hershler ***et*** al. (1994); Deixis collections, 1987-l 994.

Promenetus exacuous megas **(Dall, 1905) prairie sprite**

Type locality: Birtle, Manitoba; types in USNM.

Description: See Dall (1910) and Clarke (1973, '1981) for description and illustrations. Much like the nominate form (small, lenticular; with peripheral keel); but much larger and with conspicuous periostracal fringe.

Ecology: Especially common in slightly eutrophic to oligotrophic lakes and kettle lakes; to N. in Canada, in smaller bodies of water. Sites are often cold; have macrophyte beds (including *Ceratophyllum, Elodea, Potamogeton* spp.) and have some epiphytic algae. This species does not prefer vernal water bodies and is most abundant in larger perennial lakes. Substrate is often mixed, but with mud and silt a major part. Associated mollusks include a variety of freshwater taxa in the genera *Gyraulus, Planorbella, Valvata,* Lymnaea, *Stagnicola, Fossaria,.* and sphaerfids: more *rarely* but characteristically, *Amnicola, Lyogyrus,* and *Bithynia* may occur at the same sites. See Clarke (1973) for details of Canadian occurrences. This taxon seems much less tolerant in its habitat requirements than the nominate subspecies.

Original distribution: For range in Canada (portions of the prairie provinces), see Clarke (1973, 1981). Range in the U.S. is poorly known. Originally, portions of northern WA, northern ID, and western MT and WY(?).

Current distribution: Rare in undisturbed or relatively undisturbed. kettle lakes within the original range. There are several sites in WA and MT.

Threats: This species is not found in strongly eutropified kettle lakes, nor in streams. Lakes used as part of irrigation systems, with untreated sewage, or having other sources of nutrient enrichment, seem to lack the species. Lakes with extensive treatment to kill out aquatic macrophytes or to stock or modify the native fish fauna also seem to lack this species. The great majority of northern WA, ID, and NW MT lakes have such problems. The species is definitely declining in terms of populations and number of individuals. We have noted a number of WA kettle lakes in which dead specimens may still be dredged from bottom sediments but live specimens no longer occur.

Criteria for inclusion: Local endemic; occurrence on public lands; ongoing major threats: very substantial reduction in habitat. Habitat and range for this taxon are unlikely to be substantially expanded by future work.

Recommended status: This species has no special status at present. It should be considered a sensitive species by the Forest Service, BLM, and other land management and wildlife agencies. When the range is better understood, it is possible that Federal and State (WA, ID. MT) listing will be appropriate: but this species may still be fairly wmmon and in no immediate danger of extinction.

References: Dall (1910); Clarke (1973, 1981); Deixis collections, 1991-1993.

Stagnicola (Hinkleyia) montanensis (Baker, 1913) mountain marshsnail

Type locality: Hayes Creek, Bitterroot Mountains, near Ward, MT; types in UMMZ (76196); see Taylor, Walter, & Burch (1963) for discussion of both types and type locality.

Description: The best description is Taylor, Walter, &.Burch (1963); see this and Burch (1989) for illustrations. See also Baker (1913).

Ecology: Found mostly in small, perennial, very cold streams and spring outflows; unlike many *Stagnicola,* never found in seasonal ponds, stagnant or muddy water bodies, or (unlike many *Lymnaea)* in larger clear-water bodies, such as large perennial rivers and lakes. Substrate varies from mud to cobbles; aquatic macrophytes are generally rather uncommon or absent: *Rorippa* and bryophytes are most common. Most site with this species have flow, but minor volume and shallow depth. Elevation vanes: but moderate to higher-elevation sites are either more common or more likely to have survived to the present.

Original distribution: Eastern Columbia Basin and western Great Plains; about 21 sites in NV, ID, MT, WY, and UT, with most sites in SE ID and adjacent parts of WY and UT; see Taylor, Walter, & Burch (1963) for map and discussion.

Current distribution: Survives at some of the original sites; some of the ID and UT sites are now extirpated. As we are currently surveying SE ID for springsnails (1991-l 994), along with R. Hershler *et al.* (1993-1994), significant range extension or discovery of sizable numbers of new sites for individual taxa are not to be,expected from future work in this area. Some portions of the range, i.e. in WY and MT, need much additional suwey work.

Threats: The small drainages and spring outflows preferred by this species are particularly vulnerable to grazing. Small semiarid springs and seeps preferred by this species are very readily subject to modification and destruction from a variety of causes. Among these are road building and maintenance; dam construction and maintenance; location of housing and industrial buildings; and diversion and capping for campground, hatchery, stock, and domestic water supply. In the range as a whole, grazing is probably the biggest single problem. In some areas, nutrient-enriched groundwater is a problem also.

Criteria for inclusion: Local endemic; loss of historic sites and range; very specialized habitat.

Recommended status: No formal status at present, although the species should be regarded as sensitive by the BLM, Forest Service, and other appropriate land management and wildlife agencies. Further exploration in its limited habitat may show that this species is in need of Federal ESA or equivalent State (ID, MT, WY, NV, UT) protection.

References: Taylor, Walter, & Burch (1963); Burch (1989); Deixis collections, 1988-l 994.

Valvata tricarinata (Say, 1817) threeridge valvata

Type locality: Delaware River: holotype ANSP 58151 a.

Description: See Burch (1989) for best short description and illustration.

Ecology: Occurs in a variety of permanent lacustrine or perennial lake-like habitats, including portions of larger rivers. Generally found in cool-cold clear waters, on soft substrate, in areas with macrophytes (*Chara*, *Myriophyllum*, *Ceratophyllum*, etc.). Very abundant on marl substrates in kettle lakes, often to a considerable depth.

Original distribution: "Quebec and New Brunswick west to Alberta and south to Wyoming, Arkansas, and Virginia" (Burch, 1989). As emphasized by Taylor & Bright (1987), western occurrences are strongly disjunct, as this species does not now occur in the Missouri headwaters. Specimens from the WA and MT populations need to be compared in detail with more easterly occurrences, in view of the fact that speciation has occurred in several other genera with disjunct species swarms with both eastern and western representation, e.g. ***Pyrgulopsis, Tryonia, Amnicola,*** and ***Lyogyrus.*** For ***Pyrgulopsis, see*** Hershler (1994); for ***Amnicola*** and ***Lyogyrus, see*** discussion herein.

Current distribution: In the western U.S., this species is quite rare, similar environments being occupied by ***Valvata humeralis***. Through the efforts of R. B. Brunson, this basically Mississippi drainage and Atlantic species is now known from several lakes in the Clark Fork and Flathead drainages. T. Burke (***pers. comm.***, 1994) has found this species in Lake Roosevelt, WA as well. Taylor & Bright (1987) show this taxon from 3 Ferry Co., WA sites. Some known sites are on Flathead Indian Reservation, Bureau of Reclamation reservoirs, and other public owned or regulated lands. The species is certainly very rare in WA; and recent (1994) searches in ID turned up no sites.

Threats: Modification, poisoning, and eutropification of kettle lakes. In particular, nutrient enhancement due to farm animal wastes, sewage, or to irrigation runoff may so eutropify lakes as to exclude this species. Most kettle lakes in its western U. S. range have been so affected, or have been made part of irrigation systems.

Criteria for inclusion: Rare in this region; occurrence on public lands; substantial range loss; occurrence in specialized habitat.

Recommended status: No formal status is recommended at present. More work is necessary to determine the species' current status in WA, ID and MT. It should minimally be regarded as a sensitive species by the Forest Service, BLM, and other appropriate land management and wildlife agencies. Listing in the western U.S. is likely to prove necessary, even though the species' status in the eastern U. S. is much better. Note that there is some possibility that western populations are morphologically distinct.

References: Taylor & Bright (1987); Burch (1989); Deixis collections, 1994.

Freshwater Bivalves

Gonidea angulata (Lea, 1636) western ridgemussel

Type locality: "Lewis's River" [Snake River], Idaho; types not seen.

Description: See Butch (1973, 1975b) for best short description and illustration. This taxon is very distinctive.

Ecology: Found mostly in creeks and rivers of all sizes; rarely in lakes or resewoirs unless with substantial flow. This amniphile, filter-feeding taxon can live on firm mud substrate as well as on more warse materials (which are more typical). More pollution-tolerant than some unionids; but still absent from highly polluted areas and places with unstable or very soft substrate. The host fiih for the glochidia of this species is (are?) unknown.

Original distribution: "Southern British Columbia to southern California, eastward to southern Idaho and northern Nevada" (Taylor, 1981). It should be noted that the species had a limited distribution W. of the Cascades, particularly in WA and OR, where most sites N. of SW OR are doubtful.

Current distribution: Uncertain. Known to be extirpated from many of the old sites, including much of the Snake system; but still wmmon in some areas. Still occurs sporadically in some major tributaries to the Columbia and Snake, such as the Okanogan River (WA) and Clearwater River, Hells Canyon, and middle Snake River (ID). Formerly in Liile Granite Reservoir (Frest & Johannes, 1992b); but this population is believed to have been extirpated by the 1993 drawdown..

Threats: Extensive diversion of CA rivers for irrigation, hydroelectric, and water supply projects has much reduced the CA range of this species. This species can tolerate some water pollution; but not heavy nutrient enhancement or similar problems. For some recent records, see Taylor (1981), Frest & Johannes (1991a, 1992b, 1993e, 1994, 1995c).

Much of the middle Snake River in ID is rapidly becoming eutropified, due to agricultural runoff, fish farms, and urbanization, along the river corridor. Much of the river is impounded behind a series of small dams; this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also

a major problem. A recent (1994) landslide impacted some of the historic sites. For some recent ID sites for this species, see references under Frest & Johannes (in part).

In the lower Columbia River region threats include impoundments; continued siltation and other impacts on the few remaining sites with habitat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of Portland, The Dalles, and John Day Dam: nutrient enrichment of the lower Columbia due to agricultural run-off.

This taxon is declining, in terms of area occupied and number of sites and individuals. Note that the fate of the fish larval host(s) also limits and determines the distribution of this species.

Criteria for inclusion: Regional endemic; loss of historic sites; human modification throughout range; concentration of human activities within preferred habitat; occurrence on public owned or regulated lands.

Recommended status: We do not recommend Federal or State (WA, OR, ID) listing as this point, although the species minimally should be considered sensitive by the BLM, Forest Service, and other appropriate land management and wildlife agencies. More survey work needs to be done on this species, particularly in OR.

References: Burch (1973, 1975b); Taylor (1981); Deixis collections, 1987-l 994.

Margaritifera falcata (Gould, 1850) western pearlshell

Type locality: "Puget Sound, Oregon" *[sic* now Washington]; holotype USNM 5893, according to Johnson (1964).

Description: For best short description and illustration see Burch (1973, 1975b). The generally purple nacre and hermaphroditic condition are distinctive as compared to ***Margaritifera margarififera,*** the most closely related species. See also discussion in Taylor (1988b).

Ecology: Primarily an amniphile species; medium-sized streams are preferable, although sometimes found in streams considerably narrower than 1 m *(contra* Clarke, 1981); rarely, in lakes with stream-like conditions. Generally in fast, clear, very cold areas with coarse substrate. In undisturbed streams, this species may cover the bottom. Host fish for the glochidia include chinook salmon, rainbow trout, brown trout, brook trout, speckled dace, Lahontan redside, and Tahoe sucker (Clarke, 1981).

Original distribution: "Southern Alaska to central California, eastward to western Montana, western Wyoming, and northern Utah" (Taylor, 1981).

Current distribution: Extinct in most of the Snake system (except for upper tributaries, including the Blackfoot River (ID) and some major creeks in ID and WY); extinct from many of the coastal streams, in which it was once ubiquitous. Status of interior populations needs further work: extinct in the Okanogan River, e.g. many populations do not appear to have reproduced for many years. Populations persist locally in parts of the Coeur d'Alene system, including the Coeur d'Alene River and St. Maries River.

Threats: Extensive diversion of rivers for irrigation, hydroelectric, and water supply projects has much reduced the WA, OR, ID, and CA range of this species. This species is not as tolerant of water pollution as ***Gonidea angulata*** and ***Anodonta kennerlyi***; heavy nutrient enhancement, siltation, unstable substrate, or similar problems extirpate populations. For some recent records, see Taybr (1981), and Frest & Johannes (1991 a, 1992b, 1993e, 1994, 1995c).

Much of the middle Snake River in ID is rapidly becoming eutropified, due to agricultural runoff, fish farms, and urbanization along the river corridor. Much of the river is impounded behind a series of small dams; this is also detrimental for cold-water species such as this taxon. The area has been declared water-quality limited by EPA and the State of Idaho. Fine sediment influx, generally from the same causes, is also a major problem. A recent (1994) landslide impacted some of the historic sites. For some recent ID sites for this species, see references under Frest & Johannes (in part). Conditions in the Snake are typical for

many of the rivers in this species' range. We have seen no live specimens from the mainstem Snake recently.

In the lower Columbia River region threats include impoundments: continued siltation and other impacts on the few remaining sites with habiiat characteristics approximating pre-impoundment conditions on the lower Columbia. Harbor and channel "improvements" in the vicinity of The Dalles and John Day Dam; nutrient enrichment of the lower Columbia due to agricultural run-off. We have seen no live specimens from the mainstem Columbia recently.

This taxon is declining, in terms of area occupied and number of sites and individuals. Note that the fate of the fish larval host(s) also limits and determines the distribution of this species.

Criteria for inclusion: Regional endemic; loss of most historic sites; human modification of habitat throughout the range; occurrence on public lands.

Recommended status: We do not recommend formal Federal or State (WA, OR, ID, MT, WY, NV, & UT) listing at this point, although the species should be considered sensitive by the ELM, Forest Service, National Park Service, and other land management, wildlife, and water regulatory agencies. Further work needs to be dome to document range changes. it should be noted, however, that populations showing repeated reproduction (at least several age classes) are now the exception rather than the rule.

References: Burch (1973, 1975b); Taylor (1981); Deixis collections, 1987-1994.

EXTRALIMITAL SENSITIVE TAXA WHICH MAY OCCUR IN THE PLANNING AREA

Under this heading a few species are discussed which are known to be sensitive and in need of protection; are not known at present to occur in the Interior Columbia Basin planning area: but which occur so nearby as to make it likely that they will be found in this area in the future. Because the total number of such taxa is small, they are simply listed alphabetically, rather than in taxonomic groupings.

Acroloxus coloradensis (Henderson, 1939) Rocky Mountain capshell

Type locality: Peterson Lake, 3.4 mi. WSW of Nederland, Boulder Co., Colorado; types not examined.

Description: See Clarke (1981) for a good short description and illustration.

Ecology: Western North American sites are generally in high mountain lakes, on cobble-gravel substrate. Macrophytes are generally rare; and the species appears to be a stenothermal lithophile and perilithon grazer. Reports from Ontario and Quebec (Clarke, 1970) suggest a very different ecology, and recall that of the European *Acroloxus lacustris* (which may be what they are). The Beaver River, Alberta site (Paul & Clifford, 1991) is somewhat similar to the Quebec and Ontario localities, and needs reexamination. For comprehensive discussion, see Clarke (1973) and Clarke & Hovingh (1993).

Original distribution: Rocky Mountain lakes in CO (Walker, 1925); Alberta (Mozley, 1936); MT (Russell & Brunson, 1967), and British Columbia (Clarke, 1981); Beaver River, Alberta; and three ponds in Ontario and Quebec (Clarke, 1970); see Clarke & Hovingh (1993) for full details.

Current distribution: Known to survive in CO and MT; some of the other sites need rechecking. The MT site is in Glacier National Park, and very near the Columbia drainage.

Threats: Eutropification and siltation in lake habitats (see, e.g. Bryce, 1970).

Criteria for inclusion: Local endemic; occurrence on public lands; threats to the very few known sites.

Recommended status: At present, the Rocky Mountain capshell is a Federal C2 candidate (USFWS, 1994). Minimally, this species should be considered sensitive by the Forest Service, BLM, and other relevant land management and wildlife agencies. This species should be listed Federally and State (CO, MT) Endangered. Enough survey work has been done in CO and MT to demonstrate that this is a rare species, with declining numbers and, likely, populations.

References: Walker (1925); Mozley (1930); Henderson (1939); Russell & Brunson (1967); Bryce (1970); Clarke (1970); Clarke & Hovingh (1993).

Fluminicola modoci Hannibal, 1912 Modoc pebblesnail

Type locality: Fletcher Spring, near SW end of Goose Lake, Modoc Co., CA. The figured type may be the specimen illustrated as *Amnicola* micrococcus in Hannibal in Keep (1911 [1910]); this may be the specimen (former SU 5777, now in CAS) designated as type by Taylor and Smith (1971); other material (paratypes) CAS 60798, 60799, 66545. The specimen illustrated by Hannibal (1912) as this species appears to be the same one illustrated as *Paludestrina longinqua* in Hannibal (1911).

Description: See Hershler & Frest (in press) for comprehensive discussion and illustration. Taylor (1966b, 1985a) regarded this species as a synonym of *Fluminicola turbiniformis*; with comprehensive revision of the named *Fluminicola* species, this is not tenable. Problems remain with this taxon, in that the description and some of the type lot indicating a tall conical species, probably a *Pyrgulopsis*. The Fletcher Spring lot may contain *two* species of *Fluminicola,* the other of which is certainly undescribed. The revision by Hershler & Frest (in press) for the time being accepts this taxon as a valid species of *Fluminicola* with a small, moderately tall-low conical decollate spire, somewhat as in the specimen regarded by Taylor & Smith (1971) as the holotype. This is by no means certain, although such a taxon does indeed exist; and the Taylor & Smith specimen may not be the holotype.

Ecology: Found in medium-large springs; a crenocole. Sites with this species have slow-swift flow; clear, very cold water; and common *Rorippa* and *Mimulus*. Substrate varies from sand and mud to basalt cobble and boulder, with most specimens occurring in areas with coarse substrate. Other small *Fluminicola* species, *Pyrgulopsis*; *Physella*; and sphaeriids co-occur, although this species is the usual dominant.

Original distribution: Known with certainty only from springs on the W. side of Goose Lake, Modoc Co., CA. The species is included here because Goose Lake and its associated drainages extend into Lake Co., OR. We have recently collected small *Fluminicola* spp. there, which may represent this or other taxa. Such taxa have been known to occur in the OR portion of the drainage since the 1970s (D. W. Taylor, *unpub.*).

Current distribution: Currently (Hershler & Frest, in press) known to persist only in a few springs on the SW end of Goose Lake. Some of the springs in this area are on Modoc National Forest lands.

Threats: Springs in this area are heavily grazed, including the type locality. Many mapped springs are now dry, due to grazing, diversion, and capping for stock and domestic usage. Others have become heavily eutropified, due to integration into irrigation systems.

Criteria for inclusion: Very local endemic; occurrence on public lands; loss of populations and threats to the specialized habitat of this species.

Recommended status: This species has no special status at present. Minimally, it should be considered asensitive species by the Forest Service, BLM, and other appropriate land management and wildlife agencies. We recommend listing as Endangered Federally and in CA (and possibly in OR as well). We are currently doing a comprehensive survey of this drainage (Frest & Johannes, 1993e, 1994, 1995b); much of NE CA has recently been surveyed for springsnails by R. Hershler *et al.* (1990-1994).

References: Hannibal (1911, 1912); Taylor & Smith (1971); Hershler & Frest (in press); Deixis collections, 1993-1994.

Oreohelix strigosa berryi (Pilsbry, 1915) Big Snowy mountainsnail

Type locality: East wall of Swimming Woman Creek Canyon, Big Snowy Mountains, Musselshell Co., MT. Holotype ANSP 112489.

Description: The best illustration and description are those of Pilsbry (1940); see also Pilsbry (1915) and Frest & Johannes (1993d) for further details.

Ecology: Generally in rather open and dry rocky sage scrub. At the type locality, the dominant lithology and regolith is Lodgepole Limestone. This species occurs mostly in monospecific colonies.

Original distribution: The best documented sites are in the Mississippi drainage, Big Snowy Mountains, Musselshell and Fergus cos., MT. Specimens from Wyoming have also been ascribed to this species (Pilsbry, 1939; Frest & Johannes, 1993d). The Bear Lodge Mountains material is also from the Mississippi drainage and need not be further considered here. Material from Clematis Gulch, Yellowstone National Park, and material recently (1994) collected by us near Montanopolis suggests the possibility that this taxon may occur within the Columbia drainage in SW MT. Beetle [Pilmore) (1987, 1989) ascribes the Clematis Gulch specimens to the Big Horn Mountains, WY endemic *Oreohelix pygmaea.* We have not seen enough good Yellowstone material to evaluate this plausible suggestion: but that which we have seen does not appear to be pygmaea.

Current distribution: Known to survive in the Big Snowy Mountains (R. B. Brunson, *pers comm.*, 1993) and in the vicinity of Montanopolis, MT. The status of the Yellowstone National Park material needs to be reassessed, following the severe fires of recent years.

Threats: Grazing and overgrazing in most of the known range; logging at sites outside of Yellowstone National Park; mining and quarrying activities in part of the range.

Criteria for inclusion: Local endemic; occurrence on public lands; threats to historic range.

Recommended status: This species has no special status at present. Minimally, it should be considered a sensitive species by the Forest Service, BLM, and other appropriate land management and wildlife agencies. We recommend listing as Endangered Federally and in MT (and possibly in WY as well).

References: Pilsbry (1915, 1939); Frest & Johannes (1993d); Deixis collections, 1992-l 994.

Oreohelix yavapai mariae Bartsch, 1916 Gallatin mountainsnail

Type locality: Holotype USNM 215132; paratype ANSP 113374; Squaw Creek near the mouth of Gallatin Canyon, Gallatin Range, Gallatin Co., MT; elev. 5600'. Topotypes collected later by Berry are widely distributed in public and private collections, including our own.

Description: See Bartsch (1916) and Pilsbry (1939) for details. Pilsbry (1939) compares this form with Wyoming specimens referred to 0. y. *extremitatis*. Aside from the unlikelihood of the WY specimens really being referable to a taxon with an AZ type locality, we have compared available material of the MT form with numerous specimens of *WY "extremitatis"* from all 3 Bighorn Mountain sites. Aside from the consistently greater size of the MT specimens (emphasized by Pilsbry), WY material commonly has a strongly deflected aperture, much stronger carination, and is often a bandless, dirty white in color. MT specimens consistently have the typical 2 bands well-developed and are usually pigmented above and below, often with minor banding.

Ecology: Dry, rather open limestone talus and outcrops.

Original distribution: Known only from the type locality, which is in Gallatin National Forest. This is in the Mississippi River drainage; but close to the Columbia drainage divide. As noted by Taylor (1985a) and Taylor & Bright (1987), much of this area may have been a part of the Columbia drainage in the relatively recent past. Sites may occur in the Columbia drainage in MT or WY.

Current distribution: Presumably survives at the type locality (not revisited in recent years. No other sites are known; but likely to occur elsewhere in the limestone portions of this range (which is largely composed of igneous lithologies) in Gallatin National Forest.

Threats: Logging and road building along the Gallatin Road (US 191) and Squaw Creek Road (FS 132) in the upper portion of Gallatin Canyon and adjacent Squaw Creek.

Criteria for inclusion: Very local endemic; occurrence on public lands.

Recommended status: Federal and State (MT) listing as Endangered; due to past and continuing threats, reduction in potential habitat. This taxon should be considered sensitive by Forest Service and BLM and other appropriate land management and wildlife agencies. R. B. Brunson collected western Montana extensively for this and other mollusks from 1947 through the 1960s without finding additional sites.

References: Bartsch (1916); Pilsbry (1939).

TAXA OF UNCERTAIN STATUS

Under this heading are discussed various forms reported previously from the Interior Columbia Basin planning area which may be taxonomically valii and have been mentioned in the literature, but whose status has not been resolved. Some may prove to be synonyms or atypical specimens of described forms or of forms recognized as new species herein. These are included 1) because some are known or likely to occur on public lands; 2) to prevent confusion with better-known forms; 3) to stimulate (hopefully) investigation of their status and occurrence; and 4) to better approach complete coverage of possibly sensitive taxa. As the number of taxa is relatively small, all are listed alphabetically regardless of affinities.

Juga (Juga?) bairdiana (Lea, 1882) [no common name]

Type locality: Columbia River at Ft. George [Astoria], OR; holotype USNM.

Description: A moderate-sized, rather flat-sided *Juga* with distinct brown, pinkish brown, and yellow color bands; early whorls decollate. As noted above, the lack of early whorls makes assignment of this species difficult. The banding could be suggestive of *Juga* (*Juga*) n. sp.; but that taxon generally has more definitely yellow and brown bands, and is often slightly more slender. the overall appearance

Ecology: Unknown.

Original distribution:, Reported only from the type locality.

Current distribution: Uncertain.

Threats: Unknown.

Criteria for inclusion: Could be a valid species with limited distribution.

Recommended status: None at present.

Reference& Lea (1862).

Juga (Juga) rubiginosa (Lea, 1882) rusty juga

Type locality: "Oregon", which at the time included part or all of what is now OR, WA, ID, and MT; types in USNM. Two lots of WA specimens referred to this taxon are in UCM.

Description: See Lea (1862) and Henderson (1929a) for description and rather poor illustrations. This species is included here because of the Yakima area material referred to it by Henderson (1929a, 1936b); otherwise it appears to be a lost species. WA material could represent another taxon; but the poor quality of the type material, and the inability of anyone thus far to find identical material elsewhere, makes the point difficult to resolve; and Henderson's material is best left in this taxon, pending further study.

Ecology: Unknown.

Original distribution: Uncertain. See discussion in Henderson (1929a, 1936b). The WA specimens were from Ahtanum Creek or a nearby spring, near Union Gap, Yakima Co.

Current distribution: We have made several unsuccessful attempts to find this or other live *Juga* in the Ahtanum Creek drainage.

Threats: The Yakima Valley is heavily farmed, with a complex irrigation system. Water quality is correspondingly poor for mollusks in general and *Juga* in particular, due to siltation, diversion and capping of springs, agricultural runoff, and groundwater pollution.

Criteria for inclusion: Local endemic; very substantial recent modification of known and potential habitat.

Recommended status: Currently has none. It should be considered a sensitive species by the Forest Service, BLM, Yakama Tribe, and other hnd management and wildlife agencies. Should be Federal and State (WA) Endangered.

References: Lea (1862); Henderson (1929a, 1936b).

Juga (Oreobasis?) draytonii (Lea, 1862)

Type locality: Ft. George [Astoria], Oregon; types in USNM.

Description: A small, evenly dark brown *Juga* with convex whorls; all specimens in type suite decollate. We were unable to locate specimens from the Astoria area which have this morphology. Unfortunately, all specimens from the original collection by Drayton seem to be decollate; and there are now known both *Juga (Juga)* and *Juga (Oreobasis)* with this basic shell morphology, distinguished most readily by the initial whorls. Unless similar material from the type locality becomes available, the subgeneric status of the species cannot be determined, and we consider it unrecognizable. Perhaps technological advances, e.g. ability to extract diagnostic DNA from long-dead shells, will allow settlement of this problem in the future. Barring this it is better to redescribe similar-appearing Columbia Gorge or Lower Columbia River drainage taxa from better material. Many literature references to this taxon pertain to species occurring in N. CA or S. OR; some of these *am Juga (Oreobasis) nigrina* or other *Oreobasis* species. Drayton traveled from the vicinity of Astoria as far as Walla Walla and thence up the Columbia River, at least as far as Entiat, WA (Smith, 1937). His specimens likely are from the Columbia Gorge area.

Ecology: Uncertain.

Original distribution: Uncertain; the type locality may not be correct, and similar-appearing taxa occur in the Columbia Gorge, WA-OR.

Current distribution: Uncertain; see above.

Threats: Uncertain.

Criteria for inclusion: Local endemic (all similar-appearing taxa have short ranges, and *Juga occurs* in only part of the area of Drayton's travels at best); probable occurrence on public lands. Much of the best Juga habitat in the Columbia Gorge-lower Columbia River area has been destroyed or is subject to various threats; see earlier entries for *Juga (Juga)* n. sp. 1 [*q.v.*] and other Columbia Gorge taxa for details.

Recommended status: None; status of this taxon is uncertain.

References: Lea (1862); Henderson (1929a, 1936b).

Pristiloma (Priscovitrea) sp.

Type locality: None at present. No types can be designated, or need be, until status is resolved. Specimens are in ANSP and SBMNH collections.

Description: See Pilsbry (1946, p. 415) for description and comparisons with *Pristiloma (Priscovitrea) chersinella*, the closest described form. Anatomy unknown.

Ecology: No information available.

Original distribution: Reported by Pilsbry (1946) from Glacier National Park, MT; collected by S. S. Berry.

Current distribution: Uncertain. This species apparently was not recollected by R. B. Brunson.

Threats: Cannot be determined on present information.

Criteria for inclusion: As pointed out by Beny (quoted by Pilsbry, 1946), valid *chersinella occurs* in eastern and northern CA; and morphologic differences seem too great to allow ascription to that species, nor to ***wascoense,*** the geographically nearest species with any close resemblance. Existence of a MT endemic Pristiloma is quite possible, given that this is the edge of the genus' range, and given analogous occurrences in several other land snail genera ***(e.g., Discus brunsoni)***.

Recommended status: None at present. This taxon needs reinvestigation.

References: Pilsbry (1946).

Oreohelix haydeni bruneri (Ancey, 1881)

Type locality: Montana (no other information available); Pilsbry (1939) was uncertain of the location of Ancey's type, and we have not run across it.

Description: See Pilsbry (1939) for best description: see also Ancey (1887). There is no available illustration. Pilsbry (1939, p. 472) characterized it is apparently 'with a shell shaped like ***Oreohelix hemphilli,*** has weak sculpture of the ***haydeni*** type, and thus must be quite similar to some examples of *Oreohelix haydeni oquirrhensis* form *gabbiana*". He may have had in mind the form from Byrne's Resort, discussed under *Oreohelix* n. sp. above. Another possibility would be the Bearmouth mountainsnail, *Oreohelix* n. sp. 2 (9.v.).

Ecology: Unknown.

Original distribution: Unknown.

Current distribution: Unknown. We collected a single specimen in 1994 from Medicine Tree Hill, Granite Co., MT, that could be referable to this taxon; but could just as well represent another taxon.

Threats: Unknown.

Criteria for inclusion: Likely to be a narrow endemic.

Recommended status: None at present; needs investigation.

References: Ancey (1887); Pilsbry (1939).

Oreohelix hemphilli (Newcomb, 1889) White Pine mountainsnail

Type locality: White Pine mining district, elevation 8000', near Hamilton, White Pine Co., Nevada; holotype ANSP 23060a.

Description: See Pilsbry (1939) for discussion and illustrations. Specimens from the Nevada localities, which are outside the scope of this work, are being investigated by M. Ports (University of Nevada). Of concern here are specimens in the ANSP collections ascribed to this species by Pilsbry (1939) from Lost River Range, Needle Park, elev. 10,000-11,000', Custer & Butte cos., ID (Challis National Forest). These likely belong to another species; but this possibility needs to be substantiated.

Ecology: Unknown. This possibly may be one of the few hypsiphile ***Oreohelix*** species.

Orlglnal distribution: See above. We **have** not been able to relocate this site: and have not collected this species as yet in the Lost River Range.

Current distribution: Uncertain; see above.

Threats: Grazing. Phosphate mining is extensive in other SE Idaho Great Basin limestone mountain ranges, though not yet here.

Criteria for inclusion: Local endemic; grazing.

Recommended status: None at present; needs investigation. Likely a sensitive species.

References: Pilsbry (1939).

Oreohelix strigosa **n. subsp. 2**

Type locality: None designated as yet; undescribed taxon of uncertain status.

Description: Pilsbry (1939, p. 425) "The last whorl is well rounded throughout, as in ***cooperi*** and ***subrudis***. Shell solid. The surface is dull and eroded but shows irregular striae and minute spiral lines in the best preserved. There are two brown bands. These shells can hardly be referred to ***Oreohelix strigosa cooperi*** as they are separated from the range of that race by the whole Rocky Mountain system [for a redescription of this species, see Frest & Johannes, 1993d]. They are apparently an undefined subspecies or race of ***strigosa***, distinguished by the more amply rounded whorls: but material in better condition is wanted". This material is in the ANSP collections.

Ecology: No information available with specimens; see below.

Original distribution: A single site along Cottonwood Creek, "from Cottonwood Canyon in the Blue Mountains east of Walla Walla" (Pilsbry, 1939, p. 424). This area is southeast of Walla Walla in Umatilla Co., OR.

Current distribution: Uncertain. We attempted unsuccessfully to recollect the area in 1991.

Threats: The valley has mostly been logged, except for a few areas at higher elevations (Umatilla National Forest). Lower reaches are privately owned and are mostly heavily grazed. The Blue Mountains have been heavily logged and grazed; and much of the original vegetation (Ponderosa pine) has been replaced by monoclonal stands of Douglas fir. Much of the area that has not been recently cut has been affected by severe forest fires and by insect infestations.

Criteria for inclusion: Probable local endemic; likely occurrence on public lands; past and ongoing modifications to much of the Blue Mountains.

Recommended status: None at present. the status of this taxon needs to be investigated.

References: Pilsbry (1939).

Oreohelix sp.

Type locality: Inappropriate at this time. Specimen in UCM; we were unable to locate this in a brief search in 1991.

Description: Pilsbry (1939, p. 471): "A single worn specimen of a peculiar snail from Gold Creek, between Drummond and Garrison, Montana, is contained in the University of Colorado Museum. It has weak spirals and a carinate periphery, and does not seem referable to any of the known *races* of *haydeni* or *hemphilli*. The rather spare description could fit *Oreohelix* n. sp. 3 (9. v.).

Ecology: "Found under shrubbery on a dry slope" (Pilsbry, 1939, p. 471): The area was originally Ponderosa pine forest; most trees are long gone, and current vegetation is mostly grasses and sage. Soil is dry and rocky, with small rock outcrops and talus piles (some old prospects or small-scale mine dumps) common.

Original distribution: A single site in Powell Co., MT: as above.

Current distribution: Uncertain: R. B. Brunson does not seem to have collected this taxon. We made one try in 1991 but found no *Oreohelix* in the Gold Creek area.

Threats: The Gold Creek valley is now very dry and open. Extensive portions were mined or prospected in the past and the effects of those activities persist to the present. Much of the area is now heavily grazed.

Criteria for inclusion: This area has several better-known endemic species. The taxon could persist on nearby BLM or Deerlodge National Forest lands.

Recommended status: None; this occurrence of *Oreohelix* needs further investigation.

References: Pilsbry (1939).

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REFERENCES

AFS. 1991. The Effects of Livestock Grazing on Riparian and Stream Ecosystems. Fisheries 16: 7-11. [AFS position statement drafted by C. L. Armour, D. A. Duff, & W. Elmore]

Agee, J. K. *1993. Fire Ecology of Pacific* Northwest *Forests.* Island Press, Washington, D. C. 493 pp.

Allison, I. S. 1966. Fossil Lake, Oregon; its geology and fossil faunas. Oregon State University Monographs, Studies in Geology, no. 9: l-48.

Ancey, 1887. Description of North American shells. The Conchologists' Exchange [The Nautilus] 2: 64.

Araujo, R., J. M. Remonl, D. Moreno, & M. A. Ramos. 1995. Relaxing Techniques for Freshwater Molluscs: Trials for Evaluation of Different Methods. Malacologia 36: 29-42.

Baker, F. C. 1966. *Lymnaea hinkleyi* n. sp. The Nautilus 18: 62-63.

_____.1913. A new *Lymnaea* from Montana. The Nautilus 26: 115-l 16.

_____. 1935. *Stagnicola elrodiana*, new name for *Limnaea montana* Elrod. The Nautilus 49: 64.

_____. 1945. *The Molluscan Family Planorbidae*. University of Illinois Press, Urbana, Illinois, 530 pp.

_____, & J. Henderson. 1933. A new *Stagnicola* from Montana. The Nautilus 47: 30-32.

Baker, H. B. 1925. Anatomy of *Lanx*, a limpet-like lymnaeid mollusk. Proceedings, California Academy of Sciences 14: 143-l 69

_____. 1930. New and problematic west American land-snails. The Nautilus 43: 95-128.

_____. 1931. Nearctic vitreine 'land snails. Proceedings, Academy of Natural Sciences of Philadelphia 73: 85-117.

_____. 1932. New land snails from Idaho and eastern Oregon. The Nautilus 45: 82-87.

_____ 1964. Type land Snails in the Academy of Natural Sciences of Philadelphia. Part Ill. Limnophile and Thalassophile Pulmonata. Part IV. Land and Fresh-water Prosobranchia. Proceedings, Academy of Natural Sciences of Philadelphia 116: 149-193.

Baker, R. G., R. S. Sanders Rhodes II, D. P. Schwert, A. C. Ashworth, T. J. Frest, G. R. Hallberg, & J. A. Janssens. 1986. A full-glacial biota from southeastern Iowa, USA. Journal of Quatemary Science 1: 91-107.

Bartsch. P. 1916. Two new land shells from the Western States. Proceedings, U. S. National Museum 51: 331-333.

Beetle (Pilmore], D. E. 1987. The genus *Oreohelix* (Pulmonata: Oreohelicidae) in two western Canyons of the Bighorn Mountains, Wyoming. The Festivus 19: 66-72.

_____. 1989. Checklist of Recent Mollusca of Wyoming. Great Basin Naturalist 49: 637-645.

Benke, A. C. 1990. A Perspective on America's Vanishing Streams. North American Benthological Society 9: 77-88.

Bequaert, J. C. & W. B. Miller. 1973. ***The Mollusks of the Arid Southwest.*** University of Arizona Press. 271 pp.

Berry, S. S. 1932. Three New Mountain Snails from Idaho and Nevada. Journal of Entomology & Zoology 24: 5763.

_____. 1947. A new *Pyrgulopsis* from Oregon. The Nautilus 60: 76-78.

_____ 1955. An important new land-snail from the Mission Range, Montana. Bulletin, Southern California Academy of Sciences, 54: 17-l 9.

Bieler, R. 1993. Gastropod phylogeny and systematics. Annual Review of Ecology and Systematics 23: 31 l-338.

BLM. 1993a. Lower Deschutes River Management Plan and Environmental Impact Statement [Final]. BLM-OR-ES-92-45-1792, 2 vols. 160 pp., 74 pp.

BLM. 1993b. Lower Deschutes River Management Plan. Record of Decision. BLM-OR-ES-93-10-1792, 52 pp.

Boag, D. A. 1982. Overcoming sampling bias in studies of terrestrial gastropods. Canadian Journal of Zoology 60: 1289-l 292.

_____ 1985. Microdistribution of three genera of small terrestrial snails (Stylommatophora: Pulmdnata). Canadian Journal of Zoology 63: 1o89-1095.

_____ 1990. On the effectiveness of artificial shelters in the study of population attributes of small terrestrial gastropods. Canadian Journal of Zoology 68: 254-262.'

_____ & W. D. Wishart. 1982. Distribution and abundance of terrestrial gastropods on a winter range of bighorn sheep in southwestern Alberta. Canadian Journal of Zoology 67: 2633-2640.

Bowler, P. A. 1991. The Rapid Spread of the Freshwater Hydrobiid Snail *Potamopyrgus antipodarum* and its Impacts on the Native Snail Fauna in the Middle Snake River, Southern Idaho. Proceedings Desert Fishes Council, 21: 173-l 82.

Branson, B. A. 1972. *Hemphillia dromedarius*, a new arionid slug from Washington. The Nautilus 85: 1 00-106.

_____ 1977. Freshwater and Terrestrial Mollusca of the Olympic Peninsula, Washington. The Veliger 19: 31 O-330.

_____. 1980. Collections of gastropods from the Cascade Mountains of Washington. The Veliger 23: 171-176.

_____, & D. H. Barrett. 1981. Analysis of some Characteristics in Twenty-four Populations of western U. S. pleurocerid snails. The Nautilus 95: 14-19.

_____ & R. M. Branson. 1984. Distributional Records for Terrestrial and Freshwater Mollusca of the Cascade and Coast Ranges, Oregon. The Veliger 26: 248-257.

_____ M. E. Sisk, & C. J. McCoy. 1966. Observations on and Distribution of Some Western and Southwestern Mollusks. The Veliger 9: 145-151.

Bonnichsen, B. & R. M. Breckenridge *(eds.).* 1982. ***Cenozoic Geology of Idaho.*** Idaho Bureau of Mines and Geology Bulletin 26. xi + 725 pp.

Bronmark, C. 1985. Interactions between macrophytes, epiphytes, and herbivores: an experimental approach. Oikos 45: 26-30.

_____ 1989. Interactions between epiphytes, macrophytes, and freshwater snails: a review. Journal'of Molluscan Studies 55: 299-311.

Brown, D. S. ***1980. Freshwater Snails of Africa and their Medical Importance.*** Taylor & Francis, Ltd., London. 487 pp.

Brown, J. H. & A. C. Gibson. ***1983. Biogeography.*** C.V. Mosby, St. Louis. 643 pp.

Brown, K. M. 1991. Mollusca: Gastropoda, pp. 285-314. In Thorp, J. & A. Covich (*eds.*). 1991. Ecology ***and Classification of North American Freshwater Invertebrates.*** Academic Press. 911 pp.

Brunson, R. B. 1967. Zoogeography of Mollusca of western Montana [abstract]. Annual Reports, American Malacological Union 33: 43.

_____, & R. H. Russell. 1967. Radiodiscus, new to molluscan fauna of Montana. The Nautilus 81: 18-22.

Bryce, G. W. 1970. Rediscovery of the limpet Acroloxus coloradensis (Basomatophora: Acroloxidae) in Colorado. The Nautilus 83: 105-108.

Burch, J. B. 1962. How to ***Know the Eastern Land Snails.*** W. C. Brown, Dubuque, Iowa. 214 pp.

_____ 1972. Freshwater Sphaeriacean Clams (Mollusca: Pelecypoda) of North America. [Biota of Freshwater Ecosystems Identification Manual 3]. U. S. EPA EP1.16:18050 ELD03/72/no. 3, 31 pp.

_____ 1973. Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America. [Biota of Freshwater Ecosystems Identification Manual 11]. U. S. EPA EP1.16:18050 ELD03/73/no. 11, 176 pp.

_____ 1975a. Freshwater Sphaeriacean Clams (Mollusca: Pelecypoda) of North America. Malacological Publications, Hamburg, MI. xi + 96 pp.

_____ 1975b. Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America. Malacological Publications, Hamburg, Ml. xviii + 206 pp.

----------. ***1989. North American Freshwater Snails.*** Malacological Publications, Hamburg, Ml. 365 pp.

_____, & T. A. Pearce. 1990. Terrestrial Gastropoda, pp. 201-309, in D. L. Dindal ***(ed.), Soil Biology Guide.*** J. Wiley, NY. 1359 pp.

Call, R. E. 1884. On the Quaternary and Recent Mollusca of Great Basin with Descriptions of new forms. U. S. Geological Survey Bulletins 11: 358-421.

Calow, P. 1.978. The evolution of life-cycle strategies in fresh-water gastropods. Malacologia 17: 351-364.

_____. 1983. Life-cycle patterns and evolution, pp. 649-680. *In* W. D. Russell-Hunter (ed.), The

Mollusca. Volume 6: ***Ecology.*** Academic Press, Orlando, Florida.

Carlton, J. T., G. J. Vermeij, D. R. Lindberg, D. A. **Carlton, &** E. C. Dudley. 1991. The first historical extinction of a marine invertebrate in an ocean basin: the demise of the **eelgrass** limpet ***Lottia alveus.*** Marine Biology 180: **72-80.**

Cattaneo, A. 1983. Grazing on epiphytes. Limnology and Oceanography 28: 124-l 32.

Chace, E. P. 1951. California land snails and how some of them **live.** American Malacological Union Bulletin, 1951: 7-8.

Chamberlin, R. V. **&** D. T. Jones. 1929. A descriptive illustrated catalog of the Mollusca of Utah. University of Utah Bulletins **19(4)** [biological series 1 **(1)],** ix + 203 pp.

Clarke, A. H. 1970. On ***Acroloxus coloradensis*** (Henderson) (Gastropoda, Bassomatophora) in Eastern Canada. National Museums of Canada, Publications in Zoology 2.13 pp.

_____. 1973. ***The Freshwater Molluscs of the Canadian Interior Basin.*** Malacologia 13: l-509.

_____. **1976a.** Endangered freshwater mollusks of northwestern North America. American **Malacological** Union Bulletins, 1976: 18-19.

_____ 1976b. Report to the Office of Endangered Species on the Endangered Freshwater Mollusks of Northwestern North America. **Office** of Endangered Species, Washington, D. C. 37 pp.

_____. **1979a.** Gastropods as indicators of trophic lake stages. The Nautilus: 94: 138-142.

_____. 1979b. Sphaeriidae as indicators of trophic lake stages. The Nautilus: 94: 178-184.

_____ 1981. ***The Freshwater Molluscs of Canada.*** **National Museum** of Natural History, National Museums of Canada. 446 pp.

_____ **&** P. Hovingh. 1991. Status **Survey** of 'Selected Land and Freshwater Gastropods in Utah Draft Report, Contract **#14-16-0006-89-021, USDI** Fish **&** Wildlife Service. Ecosearch, Inc., Portland Texas. 70 pp. + appendices.

_____ 1993. Status **Survey** of Fifteen Species and Subspecies of Aquatic and Terrestrial Mollusks from Utah, Colorado, and Montana. Final Report, Contract **#14-16-0006-91-046, USDI** Fish **&** Wildlife Service. Ecosearch, Inc., Portland Texas. 77 **pp.** + appendices.

Clench, W. J. 1940. ***Pyrgulopsis nevadensis*** Steams in Oregon. The Nautilus 53: 137.

Coan, E. 1985. A bibliography and list of molluscan names of Josiah Keep. The **Veliger** 28: 211-215.

Coan, E. **&** B. Roth 1987. The malacological **taxa** of Henry Hemphill. The Veliger 29: 322-339.

Cockerell, T. D. A. 1890. New Western Slugs. The Nautilus 3: 11 l-1 13.

Coutant, C. C. **&** C. D. Becker. 1970. Growth of the Columbia **River** limpet, Fisherola nuttalli (Haldeman), in normal and reactor-warmed water. Battelle Pacific Northwest Laboratories BNWL-1537.34 pp.

Crowl, T. A.., **&** A. P. Covich. 1990. Predator-induced life history shifts in a freshwater snail. Science 247: 949-951.

Dall, W. H. **1877.[*Hyalina subrupicola,*** n. s.], pp. 163-164, in A. S. Packard, On a new cave fauna from Utah. Bulletin, U. S. Geological and Geographical Suwey of the Territories, 3: 157-l 69.

_____. 1910. Land and Freshwater Mollusks of Alaska and Adjoining Regions. Smithsonian Institution,

Harriman Alaska Series, 13: l-l 71.

Davis, G. M. 1982. Historical and Ecological Factors in the Evolution, Adaptive Radiation, and Biogeography of Freshwater Mollusks. American Zoologist 22: 375-395.

Debiche, M., G., A. Cox, & D. Engebretson. 1987. ***The Motion of Allochthonous Terranes Across the North Pacific Basin.*** Geological Society of America Special Paper 207. v + 49 pp.

EFS. 1993. Interim protection for late-successional forests, fisheries, and watersheds. Executive summary. Eastside Forests Scientific Society Panel.

Elrod, M. J. 1901. Montana shells. Rocky Mountain Magazine 2: 691697.

_____ 1902. A biological reconnaissance in the vicinity of Flathead Lake. Bulletins, University of Montana, Biological Series 3: 89-182.

Emberton, K. C. 1988. The Genitalic,. Allozymic, and Conchological Evolution of the Eastern North American (Pulmonata: Stylommatophora: Polygyridae). Malacologia 28: 159-273.

_____. 1991. The Genitalic, Allozymic, and Conchological Evolution of the Tribe Mesodontini Triodopsinae (Gastropoda: Pulmonata: Polygyridae). Malacologia 33: 71-l 78.

---------- 1995. Land-Snail Community Morphologies of the Highest Diversity Sites of Madagascar, North America, and New Zealand, with Recommended Alternatives to Height-Diameter Plots. Malacologia 36: 67-78.

_____, G. S. Kuncio, G. M. Davis, S. M. Philips, K. M. Monderewicz, & Y. H. Guo. 1990. Comparison of recent Classifications of Stylommatophoran Land-Snail Families, and Evaluation of Large-Ribosomal-RNA Sequencing for their Phylogenetics. Malacologia 31: 327-352.

EPA. 1990. Livestock grazing on western riparian areas. U. S. Environmental Protection Agency, Denver, Colorado.

Fairbanks, H. L. 1980. Morphological Notes ***on Oreohelix amariradix*** Pilsbry, 1934 (Pulmonata: Oreohelicidae). The Nautilus 94: 27-30.

_____ 1984. A new Species of ***Oreohelix*** (Gastropoda: Pulmonata: Oreohelicidae) from the Seven Devils Mountains, Idaho. Proceedings, Biological Society of Washington 97: 179- 185.

FEMAT, 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. U. S. Department of Agriculture, Forest Service, Portland, Oregon. xi + 729 pp. appendices.

Fleischner, T. L. 1994. Ecological Costs of Livestock Grazing in Western North America. Conservation Biology 8: 629644.

Frest, T. J. 1984. National Recovery Plan for Iowa Pleistocene Snail (Discus macclintocki (Baker)). USDI Fish & Wildlife Service. 24 pp. + appendix.

_____ 1990. Field Survey of Iowa Spring Fens. Final Report to Iowa Preserves and Ecological Services Bureau, Iowa DNR. 84 pp.

_____ 1991. Summary Status Reports on Eight Species of Candidate Land Snails from the Driftless Area (Paleozoic Plateau), Upper Midwest. Final Report, Contract #30181-01366, USDI Fish & Wildlife Service. Deixis Consultants, Seattle, Washington. iii + 54 pp.

_____ 1992. Mollusc Fauna in the Vicinity of Three Proposed Hydroelectric Projects on the Middle Snake River, Central Idaho. Supplemental Report on the California floater ***Anocfonta californiensis*** Lea, 1852. Final Report to Don Chapman Consultants, Inc., Boise, Idaho. Deixis Consultants, Seattle,

Washington. 4 pp.

_____. 1995. A Review of the North American Freshwater Snail Genus *Pyrgulopsis* (Hydrobiidae), by R. Hershler [review]. The Veliger 38: 77-78.

_____, & E. J. Johannes. 1991a. Mollusc Fauna in the Vicinity of Three Proposed Hydroelectric Projects on the Middle Snake River, Central Idaho. Final Report to Don Chapman Consultants, Inc., Boise, Idaho. Deixis Consultants, Seattle, Washington. 60 pp.

_____. 1991b. Present and Potential Candidate Molluscs Occurring Within the Range of the Northern Spotted Owl. Final Report to Northern Spotted Owl Recovery Team, Portland, Oregon. Deixis Consultants, Seattle, Washington. 30 pp.

1991 c. Survey of Spearfish Canyon and Vicinity, Black Hills, South Dakota and Wyoming, for Oreohelix striaosa cooperi (Binney, 1858) and Associated Land Snails. Final Report to USDA Forest Service and USDI Fish & Wildlife Service. Deixis Consultants, Seattle, Washington. ii + 59 pp.

_____ 1992a. Distribution and Ecology of the Endemic and Relict Mollusc Fauna of Idaho TNC's Thousand Springs Preserve. Final Report to Idaho TNC, Sun Valley, Idaho. Deixis Consultants, Seattle, Washington. ii + 291 pp.

_____ 1992b. Effects of the March, 1992 Drawdown on the Freshwater Molluscs of the Lower Granite Lake area, Snake River, SE WA and W. ID. Final Report to US Army Corps of Engineers, Walla Walla District. Deixis Consultants, Seattle, Washington. i + 11 pp.

_____ 1993a. Mollusc Survey of the Auger Falls Project (FERC #4794) Reach of the Middle Snake River, Idaho. Final Report to Idaho DEQ and EPA Region 10. Deixis Consultants, Seattle, Washington. ii + 35 pp.

_____. 1993b. Mollusc Survey of the Minidoka Dam area, upper Snake River, Idaho. Final Report to USDI Bureau of Reclamation. Deixis Consultants, Seattle, WA. ii + 36 pp.

_____ 1993c. Mollusc Species of Special Concern Within the Range of the Northern Spotted Owl. Final Report to Forest Ecosystem Management Working Group, USDA Forest Service. Deixis Consultants, Seattle, Washington. 98 pp.

_____. 19934. Land Snail Suwey of the Black Hills National Forest, South Dakota and Wyoming. Final Report to USDA Forest Service and USDI Fish & Wildlife Service. Deixis Consultants, Seattle, Washington. 156 pp. + appendix.

_____ 1993e. Freshwater Molluscs of the Upper Sacramento System, California, with Particular Reference to the Cantara Spill. 1992 yearly report to California Department of Fish & Game. Deixis Consultants, Seattle, Washington. iv + 101 pp., appendices.

_____ 1998. Mollusc Survey of the Hanford Site, Benton and Franklin Counties, Washington. Battelle Pacific Northwest Laboratories PNL-8653. viii + 39 pp.

_____ 1993g. Freshwater Mollusks in the Vicinity of Three Proposed ITD Projects, Middle and Upper Snake River, Idaho. Final Report to Idaho Transportation Department. Deixis Consultants, Seattle, Washington. 40 pp.

_____ 1994. Freshwater Molluscs of the Upper Sacramento System, California, with Particular Reference to the Cantara Spill. 1993 yearly report to California Department of Fish & Game. Deixis Consultants, Seattle, Washington, ii + 58 pp., appendices.

_____. 1995a. Land Snail Survey of the Lower Salmon River Drainage, Idaho. Final

Report to USDI Bureau of Land Management. Deixis Consultants, Seattle, Washington.

_____ 1995b. Fresh Water Mollusks of the Upper Klamath Lake Drainage, Oregon. 1994 yearly report to bregon Natural Heriiage Program. Deixis Consultants, Seattle, Washington.

_____ 1995c. Freshwater Mollusks of the Upper Sacramento System, California, with Particular Reference to the Cantara Spill. 1995 final report to California Department of Fish & Game. Deixis Consultants, Seattle, Washington.

_____, & D. Neitzel. [in press, a]. Notes on the distribution and biology of *Fisherola nuttalli* (Haldeman, 1843), the shortface lanx (Gastropoda: Pulmonata: Lancidae). The Veliger.

_____, & D. Neitzel. [in press, b]. Notes on the distribution and biology of *Fluminicola fuscus* (Haldeman, 1841), the Columbia pebblesnail (Gastropoda: Prosobranchia: Hydrobiidae). The Veliger.

Fretter, V. & A. Graham. ***1994. British Prosobranch Molluscs. Their Functional Anatomy and Ecology.*** Ray Society, London. xix + 820 pp. [revised edition].

FSEIS, 1994a. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. U. S. Department of Agriculture, Forest Service, Portland, Oregon. Vol. 1, xvi + 532 pp.; vol. 2, 521 pp.[appendices].

FSEIS, 1994b. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. Appendix J2. Results of Additional Species Analysis. U. S. Department of Agriculture, Forest Service, Portland, Oregon. 476 pp.

Fuller, S. L. H. 1974. Clams and Mussels (Mollusca: Bivalvia), pp. 215-273. ***In C.*** W. Hart, jr. & S. L. H. Fuller ***(eds.), Pollution ecology of freshwater invertebrates.*** Academic Press, New York.

Fullington, R. W. 1979. The Land and Freshwater Mollusca of the Guadelupe Mountains National Park, Texas. National Park Service Transactions and Proceedings 4: 91-111.

Furnish, J. L. 1990. Factors affecting the growth, production and distribution of the stream snail ***Juga silicula*** (Gould). Unpublished PhD thesis, Oregon State University, 173 pp.

_____, J. Mclver, & M. Teiser. 1993. A Survey of Algae and Invertebrates Associated with Borax Lake, Hamey County, Oregon. USDI Bureau of Land Management, Salem, Oregon. 53 pp.

GAO. 1979. Endangered Species - A Controversial Issue Needing Resolution. GAO/CED-79-65, 123 pp.

1986. Public Lands: Interior Should Ensure Against Abuses Form Hardrock Mining. GAO/RCED-***86-48, 50*** pp.

1987. Parks and Recreation: Limited Progress Made in Documenting and Mitigating Threats to the Parks. GAO/RCED-87-36, 71 pp.

1988a. Rangeland Management: More Emphasis Needed on Declining and Overstocked Grazing Allotments. GAO/RCED-88-80, 71 pp.

____. 1988b. Public Rangelands: Some Riparian Areas Restores but Widespread Improvement Will Be Slow. GAO/RCED-88-105, 85 pp.

1989a. Federal Land Management: The Mining Law of 1872 Needs Revision. GAO/RCED-89-72. ***47*** pp.

____. 1989b. National Wildlife Refuges: Continuing Problems Wiih Incompatible Uses Call for Bold

Action. GAO/RCED-89-196. 84 pp.

____. 1989c. Wilderness Preservation: Problems in Some National Forests Should Be Addressed. GAO/RCED-89-202. 91 pp.

____. 1990a. Rangeland Management: BLM Efforts to Prevent Unauthorized Livestock Grazing Need Strengthening. GAO/RCED-91-17, 16 pp.

____. 1990b. Public Lands: Limited Progress in Resource Management Planning. GAO/RCED-90-225, 35 pp.

____. 1991a. Public Land Management: Attention to Wildlife is Limited. General Accounting Office, GAO/RCED-91-64, 52 pp.

1991 b. Wildlife Protection: Enforcement of Federal Laws Could Be Strengthened. General Accounting Office, GAO/RCED-91-44, 48 pp.

1991 c. Wildlife Management: Problems Being Experienced With Current Monitoring Approach. General Accounting Office, GAO/RCED-91-123, 8 pp.

1991d. Rangeland Management: Forest Service Not Performing Needed Monitoring of Grazing Allotments. GAO/RCED-91-148, 8 pp.

____. 1992. Rangeland Management: Interior's Monitoring Has Fallen Short of Agency Requirements. GAO/RCED-92-51, 53 pp.

1993a. Endangered Species: Factors Associated with Delayed Listing Decisions, GAO/RCED-93-152, 41 pp.

1993b. Rangeland Management: BLM's Range Improvement Project Data Base Is Incomplete and Inaccurate. GAO/RCED-93-92, 18 pp.

Gould, S. J., & D. S. Woodruff. 1986. Evolution and Systematics of *Cerion* (Mollusca: Pulmonata) on New Providence Island: a radical revision. Bulletin, American Museum of Natural History 182: 389-490.

Gray, J. 1985. Interpretation of co-occurring megafossils and pollen: a comparative study with Clarkia as an example, pp. 185-244. *In* Smiley, *C.* J. (ed.), ***Late Cenozoic History of the Pacific Northwest.*** Pacific Division AAAS and California Academy of Science, San Francisco. 417 pp.

_____. 1988. Evolution of the freshwater ecosystem: the fossil record. Palaeogeography, Palaeoclimatology, Palaeoecology 62: l-214.

Green, R. H., & R. C. Young. 1993. Sampling to detect rare species. Ecological Applications 3: 351-356.

Gregg, W. O., & D. W Taylor. 1965. Fontelicella (Prosobranchia: Hydrobiidae), a New Genus of West American Freshwater Shells. Malacologia 3: 103-l 10.

Grimm, F. W. 1974. Status survey of land snails of the St. Joe, Salmon, Coeur d'Alene, Snake, and Clearwater systems. Office of Endangered Species, Washington, DC. 16 pp. [unpub. letter dated 28 November, 1974]

Hanna, *G.* D. 1930. ***Pyrgulopsis nevadensis*** (Stearns) in Oregon. The Nautilus 43: 1643-l 04.

_____ & A. G. Smith. 1939. Notes on some forms of Oreohelix strigosa. Proceedings, California Academy of Sciences 23: 381-392.

Hannibal, H. 1911 [1910]. Shells of lakes and streams, pp. 299-318, in J. Keep, West Coast Shells. Whitaker and Ray-Wiggin Co., San Francisco. 346 pp.

_____ 1912. A Synopsis of the Recent and Tertiary Freshwater Mollusca of the Californian Province, based upon an Ontogenetic Classification. Proceedings of the Malacological Society of London 10: 112-166.

Harman, W. N. 1972. Benthic substrates: their effect on fresh-water Mollusca. Ecology 53: 271-277.

_____ 1974. Snails (Mollusca: Gastropoda), pp. 275-312. *In* C. W. Hart & S. L. H. Fuller (eds.) ***Pollution' Ecology of Freshwater Invertebrates.*** Academic Press, NY.

Harmon, M. E., J. F. Franklin, F. J. Swanson, P. Sollins, S. V. Gregory, J. D. Lattin, N. H. Anderson, S. P. Cline, N. G. Aumen, J. R. Sedell, G. W. Lienkaemper, K. Cromack, jr., & K. W. Cummins. 1986. Ecology of coarse woody debris in temperate ecosystems. Advances in Ecological Research 15: 133-302.

Harris, L. D. 1984. ***The Fragmented Forest. /s/and Biogeography Theory and the Preservation of Biotic Diversity.*** University of Chicago Press, Chicago. 211 pp.

Hawkins, C. P. & J. L. Furnish. 1987. Are snails important competitors in stream ecosystems? Oikos 49: 209-220.

Hemphill, H. 1881. New catalogue of the shells of California and adjacent states. San Diego, California; privately published. 12 pp.

_____. 1890a. Descriptions of new varieties of North American land shells. The Nautilus 3: 133-135.

_____. 1890b. New forms of western limniades. The Nautilus 4: 25-27.

_____ 1911. Description of some varieties of shells, with short notes on the geographical range and means of distribution of land shells. Transactions, San Diego Society of Natural History 1 : 99-108.

Henderson, J. 1924. Mollusca of Colorado, Utah, Montana, Idaho and Wyoming.-University of Colorado Studies 13: 65-223.

_____. 1929a. The Non-marine Mollusca of Oregon and Washington. University of Colorado Studies 17: 47-190.

_____. 1929b. Some notes on Oreohelix. Proceedings, California Academy of Sciences (4th series) 18: 221-227.

_____. 1931a. A new lymnaeid from Idaho. The Nautilus 44: 75-77.

_____ 1931.b. Molluscan provinces in the western United States, University of Colorado Studies 18 : 177-186.

_____. 1932. ***Carinifex jacksonensis***, new species, from Wyoming. The Nautilus 45: 133- 134.

_____ 1933. Mollusca of the Yellowstone Park, Teton Park and Jackson Hole region. The Nautilus 47: 1-3. .

_____. 1935. West American species of ***Goniobasis,*** with a description of new forms. The Nautilus: 48: 94-99, 130-134.

_____ 1936a. The Mollusca of Colorado, Utah, Montana, Idaho and Wyoming. Supplement. University of Colorado Studies 23: 81--145.

_____ 1936b. The Non-marine Mollusca of Oregon and Washington. Supplement. University of Colorado Studies 23: 251--280.

_____ 1939. New name for ***A. hendersoni*** Walker, 1928, preoccupied by ***A. hendersoni*** Walker, 1908. The Nautilus **44:31.**

_____ **&** L. E. Daniels. 1916. Hunting Mollusca in Utah and Idaho. Proceedings, Academy of Natural Sciences of Philadelphia 68: 315-339.

_____ 1917. Hunting Mollusca in Utah and Idaho in 1916. Proceedings, Academy of Natural Sciences of Philadelphia 69: 48-81.

Hershey, A. E. 1990. Snail populations in arctic lakes: competition mediated by predation? Oecologia 82: ***26-32.***

Hershler, R. ***1990. Pyrgulopsis bruneauensis,*** A new springsnail (Gastropoda: Hydrobiidae) from the Snake River Plain, southern Idaho. Proceedings, Biological Society of Washington, 103: 803-814.

_____ 1994. A Review of the North American Freshwater Snail Genus ***Pyrgulopsis*** (Hydrobiidae). Smithsonian Contributions to Zoology no. 554, iv + 121 pp.

_____. [in press]. New Freshwater Snails of the Genus ***Pyrgulopsis*** (Rissooidea: Hydrobiidae) from California. The Veliger.

_____ **&** T. J. Frest. (in press). A Review of the North American Freshwater Snail Genus ***Fluminicola*** (Hydrobiidae). Smithsonian Contributions to Zoology.

_____, T. J. Frest, E. J. Johannes, P. A. Bowler, **&** F. G. Thompson. 1994. Two New Genera of Hydrobiid Snails (Prosobranchia: Rissooidea) from the Northwestern United States. The Veliger 37: 221-243.

_____, **&** J. R. Holsinger. 1990. Zoogeography of North American hydrobiid cavesnails. Stygologia 5: 5-16.

_____, **&** J. J. **Landeye.** 1988. Arizona Hydrobiidae (Prosobranchia: Rissoacea). Smithsonian Contributions to Zoology, no. 459, iii + 63 pp.

_____, **&** F. Thompson. 1988. Notes on morphology of ***Amnicola limosa*** (Say, 1817) **(Gastropoda:** Hydrobiidae) with comments on status of the Subfamily Amnicolinae. Malacological Review 21: 81-92.

Horning, J. 1994. Grazing to Extinction: Endangered, Threatened and Candidate Species Imperiled by Livestock Grazing on Western Public Lands. National Wildlife federation, Washington, DC. 68 pp.

Hubricht, L. 1985. ***The Distributions of the Native Land Mollusks of the Eastern United States.*** Fieldiana: Zoology, new series 24 (pub. **1359),** 191 pp.

Hunter, R. D. 1980. Effects of grazing on the quantity and quality of freshwater aufwuchs. Hydrobiologia 69: **251-259.**

ICZN. ***1964. International Code of Zoological Nomenclature.*** 176 pp. International Trust for Zoological Nomenclature, London.

1985. ***International Code of Zoological Nomenclature.*** 338 pp. International Trust for Zoological Nomenclature, London.

Imlay, M. J. 1982. Use of shells of freshwater mussels in monitoring heavy metals and environmental stresses: a review. Malacological Review 15: l-1 4.

Irwin, L. L., J. G. Cook, R. A. Riggs, **&** J. M. Skovlin. 1994. Effects of Long-Term Grazing by Big Game and

Livestock in the Blue Mountains Forest Ecosystems. From Vol. III: Assessment. U. S. Dept. of Agriculture, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-335. 59 pp.

Jacoby, J. M. 1985. Grazing effects on periphyton by *Theodoxus fluviatilis* (Gastropoda) in a lowland stream. Journal of Freshwater Ecology 3: 265-274.

Johnson, K. N., J. F. Franklin, J. W. Thomas, & J. Gordon. 1991. Alternatives for Management of Late-Successional Forests of the Pacific Northwest. U. S. Dept. of Agriculture, Forest Service, Portland, OR. 59 pp.

Johnson, R. I. 1964. The Recent Mollusca of Augustus Addison Gould. U. S. National Museum Bull. 239, 182 pp.

_____. 1970. The systematics and zoogeography of the Unionidae (Mollusca: Bivalvia) of the southern Atlantic Slope region. Harvard University, Museum of Comparative Zoology, Bulletins, 140: 263-450.

_____ 1972. The Unionidae (Mollusca: Bivalvia) of Peninsular Florida. Florida State Museum, Bulletins; Biological Science, 16: 181-249.

_____ & H. B. Baker. 1973. The types of Unionacea (Mollusca: Bivalvia) in the Academy of Natural Sciences of Philadelphia. Proceedings, Academy of Natural Sciences of Philadelphia 125: 145-186.

Kabat, A. R. & R. H. Hershler. 1993. The Prosobranch Snail Family Hydrobiiiae (Gastropoda: Rissooidea): Review of Classification and Supraspecific Taxa. Smithsonian Contributions to Zoology, no. 547, iii + 94 pp.

Kairesalo, T., & I. Koskimies. 1987. Grazing by oligochaetes and snails on epiphytes. Freshwater Biology 17: 317-324.

Karlin, E. J. 1961. Ecological Relationships Between Vegetation and the Distribution of Land Snails in Montana, Colorado, and New Mexico. American Midland Naturalist 65: 60-66.

Keep, J. 1887. *West coast she//s, A familiar description of the marine, fresh* water, *and land mollusks of the United* States, *found west of the Rocky Mountains.* Bancroft Bros., San Francisco, California. *230* pp.

Kerney, M. P. & R. A. D. Cameron. 1979.A *Field Guide to the Land Snails of Britain and North-west Europe.* Collins, London. 288 pp.

Kopp R. S. & R. E. Cohenour *(eds.).* 1987. *Cenozoic Geology of Western Utah. Sites for Precious Metal and Hydrocarbon Accumulations.* Utah Geological Association Publication 16. 684 pp.

Kozloff, E. N. & J. Vance. 1958. Systematic status of *Hemphillia malonei.* The Nautilus 72: 42-49.

Kralka, A. A. 1986. Population characteristics of terrestrial gastropods in boreal forest habitats. American Midland Naturalist 115: 156-164.

LaRocque, A.- 1960. Molluscan faunas of the Flagstaff Formation. Geological Society of America, Memoir *78,* 100 pp.

Lea, I. 1862. Description of a new genus *(Goniobasis)* of the family Melanidae and eighty-two'new species. Proceedings, Academy of Natural Sciences of Philadelphia 14: 262-272.

Leviton, A. E., R. H. Gibbs, jr., Heal, E., & C. E. Dawson. 1985. Standards in Herpetology and Ichthyology: Part I. Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology. Copeia 1985: 802-832.

Link, P. K., M. A. Kuntz, & L. B. Platt ***(eds.). 1992. Regional Geology of eastern Idaho & western Wyoming.*** Geological Society of America Memoir 179. ix + 312 pp.

Locasciulli, O., & D. A. Boag. 1987. Microdistribution of terrestrial snails (Stylommatophora) in forest litter. Canadian Field-Naturalist 101: 76-81.

Losos, E., J. Hayes, A. Phillips, C. Alkire, & D. Wilcove. 1993. ***Taxpayers' Double Burden. Federal Resource Subsidies and Endangered Species.*** The Wilderness Society, Washington, DC. viii + 66 pp., appendices.

Malde, H. E. 1991. Quaternary geology and structural history of the Snake River Plain, Idaho and Oregon. pp. 251-281, in ***The Geology of North America,*** vol. K-2. ***Quaternary Nonglacial Geology: Conterminous U.*** S. Geological Society of America, Boulder, Colorado. 529 pp.

_____, & H. A. Powers. 1960. Upper Cenozoic stratigraphy of western Snake River Plain Idaho. Geol. Soc. American Bull. 73. 1197-1219.

Malek, E. A. ***1985. Snail Hosts of Schistosomiasis and Other Snail-transmitted Diseases in Tropical America: A Manual.*** Pan American Health Organization, Scientific Publications 478. 325 pp.

Mason, W. T., Jr., J. B. Anderson, R. D. Kreis, & W. C. Johnson. 1970. Artificial Substrate Sampling, Macroinvertebrates in a Polluted Reach of the Klamath River, Oregon. Journal Water Pollution Control Federation, Research Supplement, part 2, 42: R315-R328.

McCormick, P. U., & R. J. Stevenson. 1989. Effect of snail grazing on benthic algal community structure in different nutrient environments. Journal of the North American Benthological Society 8: 162-172.

McMahon, R. F. 1991. Mollusca: Bivalvia, pp. 315-399. In Thorp, J. & A. Covich ***(eds.).*** 1991. ***Ecology and Classification of North American Freshwater Invertebrates.*** Academic Press. 911 pp.

Miller, W. B., R. L. Reeder, N. Babrakzai, & H. L. Fairbanks. 1984. List of new and revised Recent taxa in the North American terrestrial Mollusca (north of Mexico) published since 19 March 1948. Part 1. Tryonia 11. I + 14 pp.

Mladenka, G. C. 1992. The Ecological Life History of the Bruneau Hot Springs Snail (***Pyrgulopsis bruneauensis).*** Idaho State University, Stream Ecology Center. Pocatello, Idaho. 116 pp.

Morrison, J. P. E. 1954. The relationships of Old and New World melanians. Proceedings, U. S. National Museum 103: 357-394.

Morton, J. E. 1979. ***Molluscs*** [fifth ed.]. Hutchinson & Co., London. 264 pp.

Moseley, R. K. 1992. Ecological and Floristic Inventory of Birch Creek Fen, Lemhi and Clark counties, Idaho. 50 pp. Conservation Data Center, Idaho Department of Fish & Game, Boise, Idaho.

Mozley, A. 1930. Reports of the Jasper Park Lakes investigations, 1925-26. The Mollusca of Jasper National Park. Transactions, Royal Society of Edinburgh 56: 647-669.

Neitzel, D. & T. Frest. 1989. Survey of Columbia River Basin for Giant Columbia River Spire Snail ***Fluminicola columbiana*** and Great Columbia River Limpet ***Fisherola nuttalli.*** Battelle Pacific Northwest Laboratory PNL-7103. xix + 34 pp.

_____ 1990. Suwey of Columbia River Basin Streams for Columbia Pebblesnail and Shortface Lanx. 'Fisheries 15: 2-3.

_____. 1992. Survey of Columbia River Basin Streams for Columbia Pebblesnail ***Fluminicola columbiana*** and Shortface Lanx ***Fisherola nuttalli.*** Battelle Pacific Northwest

Laboratory PNL-8229. ix + 29 pp., appendices. [draft]

_____. 1993. Survey of Columbia River Basin Streams for Columbia Pebblesnail *Fluminicola columbiana* and Shortface Lanx *Fisherola nuttalli*. Battelle Pacific Northwest Laboratory PNL-8229. ix + 29 pp., appendices.

Newell, P. F. 1971. Molluscs, pp. 128-149. In J. Phillipson (ed.), ***Methods of study in quantitative soil ecology: population, production and energy flow.*** Blackwell Scientific Publications, Oxford.

Newman *G.* W. & H. D. *Goode (eds.).* 1979. 7979 ***Basin and Range Symposium.*** Rocky Mountain Association of Geologists and Utah Geological Association, Boulder, Colorado and Salt Lake City, Utah. xii + 662 pp.

NPS. 1994. Hanford Reach of the Columbia River. Comprehensive River Conservation Study and Environmental Impact Statement. FINAL. National Park Service, 2 vols.

Okland, J. 1983. Factors regulating freshwater snails (Gastropoda) in Norway. Malacologia 24: 277-288.

Olson, D. 1992. The Northern Spotted Owl Conservation Strategy: Implications for Pacific Northwest Forest Invertebrates and Associated Ecosystem Processes. The Xerces Society, Portland, Oregon. 50 pp.

ONRC. 1993. Petition for a Rule to list Eighty-three Mollusc Species as Threatened or Endangered under the Endangered Species Act, and to Designate Critical Habitat. Oregon Natural Resources Council, Portland, Oregon, August 16, 1993. 3 pp.

Ostrovsky, I. S. 1981. Ecological-productional characteristics of a population of *Valvata piscinalis* (Ectobranchia: Valvatidae) in Lake Sevan. Zoologichesky Zhurnal 60: 825-834.

Palmer, K, V. W. 1958. Type Specimens of Marine Mollusca described by P. P. Carpenter from the West Coast (San Diego to Briiish Columbia). Geological Society of America, Memoir 76. 376 pp.

Paul, A. J., & H. F. Clifford. 1991 . *Acroloxus coloradensis* (Henderson), a Rare North American Freshwater Limpet. The Nautilus 105: 173-l 74.

Paul, C. R. C. 1971. Revision of the *Holocystites* Fauna (Diploporita) of North America. Fieldiana: Geology 24, 166 pp.

PEER. 1994. ***Public trust betrayed: employee critique of Bureau of Land Management range/and management.*** Public Employees for Environmental Responsibility, Washington, DC. v + 25 pp.

Pennak, R. W. 1958. Some problems of freshwater invertebrate distribution in the western states. Zoogeography, American Association for the Advancement of Science Publication, no. 51: 223-230.

_____. 1989. ***Fresh-water Invertebrates of the United States*** [3rd ed.]. Wiley-Interscience, NY. 628 pp.

Pilsbry, H. A. 1899a. Catalogue of the Amnicolidae of the western United States. The Nautilus 12: 121-127.

_____. 1899b. Mollusks collected by R. C. McGregor in northern California. The Nautilus 13: 64-67.

_____. 1900. Notices of new American snails. The Nautilus 14: 40-41.

_____. 1902a. New American land shells. The Nautilus 16: 30-33.

_____. 1902b. *"Pyramidula" elrodi* and ***Epiphragmophora circumcarinata.*** The Nautilus 16: 62-63.

_____ 1903. A new American genus of Arionidae. Proceedings, Academy of Natural Sciences of Philadelphia 55: 626-629.

_____ 1905. Mollusca of the southwestern States, I: Urocoptidae; Helicidae of Arizona and New Mexico: Proceedings, Academy of Natural Sciences of Philadelphia 57: 21 l-290.

_____. 1907. A new species of Pluminicola. The Nautilus 21: 75-76.

_____. 1912. Two new American land shells collected by Messrs. Hebard and Rehn. The Nautilus *26:* 88-90.

_____. 1915. A new subspecies of ***Oreohelix cooperi.*** The Nautilus 29: 48.

_____ **1917a.** Notes on the anatomy of ***Oreohelix.*** II. Proceedings, Academy of Natural Sciences of Philadelphia 69: 42-46.

_____. **1917b.** A new Hemphillia and other snails from near Mt. Hood, Oregon. The Nautilus 30: 117-119.

_____ 1926. A fresh-water snail, ***Physa zionis,*** living under unusual conditions. Proceedings, Academy of Natural Sciences of Philadelphia 77: 325-328.

_____. 1933. Amnicolidae from Wyoming and Oregon. The Nautilus 47: 9-12.

_____.**1934.** Notes on the anatomy of ***Oreohelix,*** -III, with description of new species and subspecies. Proceedings, Academy of Natural Sciences of Philadelphia 85: 383-410.

_____. 1935. Western and Southern Amnicolidae and a new Humboldtiana. The Nautilus 48: 91-94.

_____ 1939. Land Mollusca of North America (North of Mexico), vol. 1 pt. 1. Academy of Natural Sciences of Philadelphia Monograph 3 (1): l-574.

_____ 1940. Land Mollusca of North America (North of Mexico), vol. 1 pt. 2. Academy of Natural Sciences of Philadelphia Monograph 3 (1): 575-994.

_____ 1946. Land Mollusca of North America (North of Mexico), vol. 2 pt. 1. Academy of Natural Sciences of Philadelphia Monograph 3 (2): l-520.

_____ 1948. Land Mollusca of North America (North of Mexico), vol. 2. pt. 2. Academy of Natural Sciences of Philadelphia Monograph 3 (2): 521-1113.

_____. 1953. Magnipelta, a new genus of Arionidae from Idaho. The Nautilus 67: 37-38.

_____, & R. B. Brunson. 1954. The Idaho-Montana slug Magnipelta (Arionidae). Notulae Naturae, Academy of Natural Sciences of Philadelphia 262. 6 pp.

_____, & J. B. Henderson. 1930. [A new subspecies of Polygyra from Idaho]. The Nautilus 44: pl. 5, figs 8-10.

_____. 1931. A new subspecies of Polygyra from Idaho. The Nautilus 44: 121-122.

_____. 1936. ***Polygyra columbiana depressa,*** new subspecies, from Oregon. The Nautilius 49: 134.

Pilsbry, H. A., & E. G. Vanatta. 1897. A new species of ***Hemphillia.*** The Nautilus 11: 44.

_____1898. Revision of the North American slugs: ***Binneya, Hemphillia,***

Hesperarion, *Ptvphysaon* and *Anadenulus*. Proceedings, Academy of Natural Sciences of Philadelphia 50: 219-261.

Pip, E. 1986. The ecology of freshwater gastropods in the central Canadian region. The Nautilus 100: 56-66.

Ponder, W. F. 1985. ***A review of the genera of the family Rissoidae (Mollusca: Mesogastropoda: Rissoacea).*** Australian Museum, Records (Supplements) 4. 221 pp.

_____ & A. Warén. 1988. Appendix. Classification of the Caenogastropoda and Heterostropha-A list of the Family-group Names and Higher Taxa: Prosobranch Phylogeny. Malacological Review, Supplement 4: 288-326.

Rees, B. B. & S. C. Hand. 1990. Heat Dissipation, Gas Exchange and Acid-Base Status in the Land Snail *Oreohelix* During Short-term Estivation. Journal of experimental Biology 152: 77-92.

_____. 1991. Regulation of glycolysis in the land snail *Oreohelix* during estivation and artificial hypercapnia. Journal of Comparative Physiology B 161: 237-246.

_____ 1993. Biochemical Correlates of Estivation Tolerance in the Mountainsnail *Oreohelix* (Pulmonata: Oreohelicidae). Biological Bulletins 184: 230-242.

_____ D. Malhotra, J. I. Shapiro, & S. C. Hand. 1991. Intracellular pH Decreases During Entry Into Estivation in the Land Snail ***Oreohelix strigosa.*** Journal of experimental Biology 159: 525-530.

Riedel, A. 1980. ***Genera Zonitidarum.*** W. Backhuys, Rotterdam. 197 pp.

Riedel, S. P. & P. R. Hooper ***(eds.).*** 1987. ***Volcanism and Tectonism in the Columbia River Flood-Basalt Province.*** Geological Society of America Special Paper 239. xiii + 386 pp.

ROD. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. U.S. Department of Agriculture, Forest Service, Portland, Oregon. ii + 73 pp.; viii,+ 143 pp.

Roth, B. 1972. Rare and endangered land mollusks in California. Sterkiana 48: 4-16.

_____. 1981. Distribution, reproductive anatomy, and variation of ***Monadenia troglodytes*** Hanna and Smith (Gastropoda: Pulmonata) with the proposal of a new subgenus. Proceedings, California Academy of Science 42: 379-407.

_____. 1986. Land Mollusks (Gastropoda: Pulmonata) from early Tertiary Bozeman Group, Montana. Proceedings of the California Academy of Sciences 44: 237-267.

1991. A phylogenetic analysis and revised classification of the North American Haplotrematidae (Gastropoda: Pulmonata). American Malacological Bull. 8: 155-163.

_____. 1993. Critical Review of Terrestrial Mollusks Associated with Late-Successional and Old-Growth Forests in the Range of the Northern Spotted Owl. B. Roth, San Francisco, CA. 42 pp.

_____, & K. C. Emberton. 1994. "Extralimital" Land Mollusks (Gastropoda) from the Deep River Formation, Montana: Evidence for Mesic Medial Tertiary Climate. Proceedings of the Academy of Natural Sciences of Philadelphia 145: 93-106.

_____, & L. Eng. 1980. Distribution, ecology, and reproductive anatomy of a rare land snail, ***Monadenia setosa*** Talmadge. California Fish and Game 66: 4-16.

_____ & P. Pressley. 1983. New range information on two west American slugs (Gastropoda: Pulmonata: Arionidae). Bulletin, Southern California Academy of Sciences 82: 71-78.

_____ & W. Miller. 1992. A new genus and species of polygyrid land snail (Gastropoda: Pulmonata) from Oregon. The Veliger 35: 222-225.

_____ 1993. Polygyrid land snails, ***Vespericola*** (Gastropoda: Pulmonata). 1. Species and populations formerly referred to ***Vespericola columbianus*** (Lea) in California. The Veliger 36: 134-144.

Russell, R. H. 1967. Lymnaeidae of western Montana (abstract). Annual Report of the American Malacological Union, no. 33: 26.

_____. 1972. The type locality of ***Stagnicola montanensis*** (Baker) 1913. The Nautilus 85: 145.

_____, & R. B. Brunson. ***1967. Acroloxus coloradensis*** from Montana. The Nautilus 81: 33.

Russell-Hunter, W. D. 1978. Ecology of freshwater pulmonates, pp. 335-383. ***In*** V. Fretter & J. Peake (eds.), The ***Pulmonates. Volume 2A. Systematics, Evolution and Ecology.*** Academic Press, Orlando, Florida.

Schuster, J. E. ***(ed.).*** 1987. ***Selected Papers on the Geology of Washington.*** Washington Division of Geology and Earth Resources, Bulletin 77. x+395 pp.

Schmidt-Nielsen, K., C. R. Taylor, & A. Shkoinik. 1971. Desert Snails: Problems of Heat, Water and Food. Journal of experimental Biology 55: 385-398.

Sheldon, S. P. 1987. Effects of herbivorous snails on submerged macrophyte communities in Minnesota lakes. Ecology 68: 1920-l 931.

SIT. 1994. Scientific Framework for Ecosystem Management in the Interior Columbia River Basin. Working Draft--Version 2. Eastside Ecosystem Management Project, Walla Walla, Washington. viii + 80 pp.

Smiley, ***C.*** J. ***(ed.). Late Cenozoic History of the Pacific Northwest.*** Pacific Division AAAS and California Academy of Sciences, San Francisco. 417 pp.

Smith, A. ***G.*** 1937. The type locality of ***Oreohelix strigosa*** (Gould). The Nautilus 50: 73-77.

_____ 1943. Mollusks of the Cleat-water Mountains, Idaho. Proceedings, California Academy of Sciences, series 4: 23: 537-554.

_____ 1970. Western Land Snails, pp. 39-46. ***In*** Clarke, A. H. ***(ed.)*** Papers on the Rare and Endangered Mollusks of North America. Malacologia 10: l-56.

Solem, A. ***1974. The Shell Makers. Introducing Mollusks.*** Wiley-Interscience, New York. 289 pp.

_____ 1975. Notes on Salmon River oreohelicid land snails, with description of ***Oreohelix waltoni***. Veliger 18: 16-30.

_____. 1979. Biogeographic Significance of Land Snails, Paleozoic to Recent, pp. 277-287. ***In*** J. Gray & A. J. Boucot ***(eds.) Historical Biogeography, Plate Tectonics, and the Changing Environment.*** Oregon State University Press, Cowallis, Oregon. 767 pp.

_____ 1981. Land-Snail Biogeography: A True Snail's Pace of Change, pp. 197-237. ***In G.*** Nelson & D. E.' Rosen ***(eds.) Vicariance Biogeography: A Critique.*** Columbia University Press, New York. 563 pp.

_____. 1984. A world model of land snail diversity and abundance, pp. 181-213. ***In*** A. Solem & A. C.

Van Bruggen *(eds.) World-wide Land Snails.* E. J. Brill, Leiden. 363 pp.

_____ & A. H. Clarke. 1974. Report on status survey for Salmon River Valley land snails. Office Endangered Species, Washington, DC. 12 pp. [unpub. letter dated August 23, 1974]

_____, & F. M. Climo. 1985. Structure and Habitat Correlations of Sympatric New Zealand Land Snail Species. Malacologia 26: l-30.

_____, & D. J. Roscoe. 1981. Sympatric species diversity of New Zealand land snails. New Zealand Journal of Zoology 8: 453-485.

Spamer, E. E. , & A. E. Bogan. 1993. Mollusca of the Grand Canyon and Vicinity, Arizona: New and Revised Data on Diversity and Distributions, With Notes on Pleistocene-Holocene Mollusks of the Grand Canyon. Proceedings, Philadelphia Academy of Natural Sciences 144: 21-68.

Spies, T. A., J. F. Franklin, & T. B. Thomas. 1988. Coarse woody debris in Douglas-fir forests of western Oregon and Washington. Ecology 69: 1689-1702.

Stacey, P. B., & M. Taper. 1992. Environmental variation and the persistence of small populations. Ecological Applications 2: 18-29.

Stohlgren, T. J. & J. F. Quinn. 1992. An Assessment of Biotic Inventories in Western U.S. National Parks. Natural Areas Journal, 12: 145-154.

Stokes, W. L. 1979. Paleohydrographic history of the Great Basin region, pp. 345-351. *In* G. W. Newman & H. D. *Goode (eds.) 7979 Basin and Range Symposium.* Rocky Mountain Association of Geologists and Utah Geological Association, Boulder, Colorado and Salt Lake City, Utah. 662 pp.

Taylor, D. W. 1966a. A remarkable Snail Fauna from Coahuila, Mexico. The Veliger 9: 152-228.

_____. 1966b. Summary of North American Blancan Nonmarine Mollusks. Malacologia 4: l-1 72.

_____ 1970. Western freshwater mollusks, p. 33. *In* Clarke, A. H. *(ed.)* Papers on the Rare and Endangered Mollusks of North America. Malacologia 10: l-56.

_____. *1975. Index and Bibliography of Late Cenozoic Freshwater Mollusca of Western North America.* University of Michigan Museum of Paleontology Papers on Paleontology 10, 384 pp.

_____. 1977. Rocky Mountain and Intermountain Freshwater Molluscs: an Annotated List. 40 pp. [unpub. ms.]

_____. 1981. Freshwater mollusks of California: a distributional checklist. California Fish & Game 67(3): 1 40-I 63.

_____. 1982a. Status report on the Giant Columbia River Limpet in southwestern Idaho. Unpublished rept. to BLM. 7 pp.

_____ 1982b. Status report on the Great Columbia River Spire Snail in southern Idaho. Unpublished rept. to BLM. 9 pp.

_____. 1982c. Status report on Snake River *Physa* Snail. Unpublished rept. to BLM. 4 pp.

_____. 1982d. Status report on Bliss Rapids Snail. Unpublished rept. to BLM. 4 pp.

_____. 1982e. Status report on the Utah Valvata Snail in southwestern Idaho. Unpublished rept. to BLM. 6 pp.

_____. 1982f. Status report on Homedale springsnail. Unpublished rept. to BLM. 4 pp.

_____. 1985a. Evolution of freshwater drainages and molluscs in western North America, pp. 265-321. *In* Smiley, *C.* J. *(ed.), Late Cenozoic History of the Pacific Northwest.* Pacific Division AAAS and California Academy of Science, San Francisco. 417 pp.

_____ 1985b. Candidate Threatened or Endangered Molluscs in Box Canyon ACEC, Gooding Co., Idaho. Unpublished report to BLM, Shoshone, Idaho. 19 pp.

_____. 1987. Fresh-water molluscs from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116: 50 pp.

_____. 1988a. Aspects of Freshwater Mollusc Ecological Biogeography. Palaeogeography, Palaeoclimatology, Palaeoecology 62: 51 l-576.

_____. 1988b. New species of *Physa* (Gastropoda: Hygrophila) from the western United States. Malacological Review 21: 43-79.

_____ 1988c. Phylum: Mollusca, pp. 33-57. *In* J. Gray, Evolution of the freshwater ecosystem: the fossil record. Palaeogeography, Palaeoclimatology, Palaeoecology 62: l-21 4.

_____, & R. C. Bright. 1987. Drainage History of the Bonneville Basin, pp. 239-256, in R. S. Kopp & R. E. Cohenour *(eds.), Cenozoic Geology of Western Utah. Sites for Precious Metal and Hydrocarbon Accumulations.* Utah Geological Association Publication 16, 684 pp.

_____, & A. G. Smith. 1971. Harold Hannibal (1889-l 965) with a review of his molluscan research. The Veliger 13: 303-315.

_____ & G. Smith. 1981. Pliocene molluscs and fishes from northeastern California and northwestern Nevada. University of Michigan Museum of Zoology Contributions 25: 339-413.

_____, H. J. Walter, & J. B. Burch. 1963. Freshwater snails of the subgenus *Hinkleyia* (Lymnaeidae: *Stagnicola*) from the western United States. Malacologia 1: 237-281.

Te, *G.* 1978. ***The systematics of the Family Physidae (Basommatophora: Pulmonata).*** Unpub. Ph. D. dissertation, University Michigan, Ann Arbor, 325 pp.

Tetra Tech, 1991-l 993. Reconnaissance Survey of the Lower Columbia River. 6 vols. [available from Washington Department of Ecology, Olympia, Washington, and Oregon Department of Environmental Quality, Salem, Oregon]

----------. 1993. Lower Columbia River Backwater Reconnaissance Survey. 3 vols. [available from Washington Department of Ecology, Olympia, Washington, and Oregon Department of Environmental Quality, Salem, Oregon]

Thomas, J. W., E. D. Forsman, J. B. Lint, E. C. Meslow, B. R. Noon, & J. Verner. 1990. A Conservation Strategy for the Northern Spotted Owl. U.S. Dept. of Agriculture, Forest Service, Portland, OR. 427 pp.

_____, M. G. Raphael, R. G. Anthony, E. D. Forsman, A. G. Gunderson, R. S. Holthausen, B. G. Marcot, G. H. Reeves, J. R. Sedell, & D. M. Solis. 1993. Viability Assessments and Management Considerations for Species Associated with Late-Successional and Old-Growth Forests of the Pacific Northwest. U. S. Dept. of Agriculture, Forest Service, Portland, OR. 530 pp.

Thompson, F., & R. Hershler. 1991. Two new hydrobiid snails (Amniwlinae) from Florida and Georgia, with a discussion of the biogeography of freshwater gastropods of south Georgia streams. Malawlogical Review 24: 55-72.

Tryon, G. W. 1865a. Description of new species of *Amnicola, Pomatiopsis, Somatogyrus, Gabbia,*

Hydrobia, and ***Rissoa.*** American Journal of Conchology 1: 219-222.

_____ 1865b. Descriptions of new species of North American Limnaeidae. American Journal of Conchdlogy 1: 223-231.

Turgeon, D. D. ***et al.*** 1988. ***Common and Scientific Names of Aquatic Invertebrates from the United States and Canada. Mollusks.*** American Fisheries Society, Special Publication 16, 277 pp.

Uminski, T. 1963. Taxonomy of ***Anguispira (?) marmorensis*** (H. B. Baker, 1932) with notes on the taxonomy of the genera ***Anguispira*** Morse and ***Discus*** Fiiinger ***(Gastropoda, Endodontidae).*** Polska Akademia Nauk Instytut Zoologiczny Annales Zoologici 21: 81-91.

USFS. 1994. Eastside Ecosystem Management Strategy, Pacific Northwest Region. Federal Register 59: 4680-4681.

USFWS. 1985. Endangered and Threatened Wildlife and Plants: Proposed Endangered Status for the Bruneau Hot Spring Snail, Proposed Rule. Federal Register 50: 33803-33805.

_____.1988. Endangered and Threatened Wildlife and Plants: Animal Notice of Review. (unpub. draft dated 8/8/88. 23 pp.]

.1989. Endangered and Threatened Wildlife and Plants: Animal Notice of Review. Federal Register 54: 554-579.

_____. 1990. Endangered and Threatened Wildlife and Plants: Proposed Endangered Status for Five Idaho Aquatic Snails. Proposed Rule. Federal Register 55: 51931-51936.

1991. Endangered and Threatened Wildlife and Plants: Animal Candidate Review for Listing as Endangered or Threatened Species, Proposed Rule. Federal Register 56: 58804-58836.

_____. 1992a. Recovery Plan for the Northern Spotted Owl-DRAFT. 662 pp.

_____. 1992b. Recovery Plan for the Northern Spotted Owl- FINAL DRAFT. 2 vols.: 332 pp. 490 pp.

_____. 1992c. Endangered and Threatened Wildlife and Plants. U. S. Fish and Wildlife Service. 38 pp.

1992d. Endangered and Threatened Wildlife and Plants: Determination of Endangered or Threatened Status for Five Aquatic Snails in South Central Idaho. Final Rule. Federal Register 57: 59244-59257.

_____. 1993. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Bruneau Hot Springsnail in Southwestern Idaho. Final Rule. Federal Register 58: 5938-5946.

_____. 1994. Endangered and Threatened Wildlife and Plants: Animal Candidate Review for Listing as Endangered or Threatened Species; Proposed Rule. Federal Register 56: 58982-59028.

Vagvolgyi, J. 1968. Systematics and Evolution of the Genus ***Triodopsis*** (Mollusca: Pulmonata: Polygyridae) Harvard University Museum of Comparative Zoology, Bull. 136 (7): 14-254.

Vallier, T. L. & V. C. Miller. 1974. Landslides in the Snake River Canyon along the Oregon and Idaho Boundary. Indiana State University, Department of Geography & Geology, Professional Papers, 5: 3-22.

_____ & H. C. Brooks ***(eds.).*** 1986. ***Geology of the Blue Mountains Region of Oregon, Idaho, and Washington.*** U. S. Geological Survey, Professional Paper 1435. x+93 pp.

Vanatta, E. G. 1914. Montana shells. Proceedings, Academy of Natural Sciences of Philadelphia 66: 367-371.

Van der Schalie, H. & A. Van der Schalie. 1950. The mussels of the Mississippi River. American Midland Naturalist 44: 448-466.

_____ 1924. Descriptions of four new American shells. Proceedings, Academy of Natural Sciences of Philadelphia 76: 25-27.

Vaught, K. C. 1989. ***A Classification of the Living Mollusca.*** American Malacologists, Inc., Melbourne, FL. 189 pp.

Walton, M. L. ***1970.*** Longevity in ***Ashmunella, Monadenia,*** and ***Sonorella.*** The Nautilus 83: 109- 112.

Walker, B. ***1908. Pomatiopsis robusta*** n.spThe Nautilius 21: 97.

_____. 1925. New species of North American Ancylidae and Lancidae. University of Michigan Museum of Zoology, Occasional Papers 165: 13 pp.

Webb, G. F. 1959. Two New Northwestern Slugs, ***Udosarx lyrata,*** and ***Gliabates oregonia.*** Gastropodia l(3): 22-25,28 (figs 37, 39).

_____. ***1968.*** The ***Ashmunellinae:*** Sexological Notes on ***Allogona.*** Gastropodia l(7): 70-72

_____. 1970a. Sexological Notes on ***Cryptomastix mullani*** (Bland and Cooper). Gastropodia l(8): 73-75, 78 (Pl. 35, figs. 13. 14).

_____. 1970b. Fragmentary Observations on Sexology of ***Cryptomastix hendersoni*** Pilsbry and C. ***magnidentata*** Pilsbry and a new subgenus ***(Pulmonata, Polygyridae, Ashmunellinae).*** Gastropodia l(8): 77-78.

_____ 1980. The Slug ***Udosaryx lyrata***: Additional Data on Distribution, Anatomy, and Taxonomy. Gastropodia 2(1): 3 (pl. 1, fig. 7), 6 (pl. 2, figs. 1, 6-8), 8-10, 12 (pl. 5, fig. 1).

_____ 1990. Photographs of the Copulation of ***Cryptomastix (Bupiogona) hendersoni.*** Gastropodia 2(3): 22.

_____, & R. H. Russell. 1977. Anatomical Notes on a ***Magnipelta: Camaenidae?*** Gastropodia 1(10): 107-l 08.

Weber, L. M., & D. M. Lodge. 1990. Periphyton food and crayfish predators: relative roles in determining snail distribution. Oecologia 82: 33-39.

Wheeler, H. E. & E. F. Cook. 1954. Structural and stratigraphic significance of the Snake River capture, Idaho-Oregon. Journal of Geology 62: 525-536.

Williams, J. D., M. L. Warren, jr., K. S. Cummings, J. L. Hams & R. J. Neves. 1992. Conservation Status of Freshwater Mussels of the United States and Canada. Fisheries 18: 6-22.

Wilson, E. 0.1987. The Little Things That Run the World (The Importance and Conservation of Invertebrates). Conservation Biology 1:344-346.

Winslow, M. 1920. Notes on Oreohelix idahoensis baileyi Bartsch. University of Michigan Museum of Zoology, Occasional Papers no. 79: 4 pp.

Wu, Shi-Kuei, & N. E. Brandauer. 1982. Type specimens of Recent Mollusca in the University of Colorado Museum. University of Colorado Museum, Natural History Inventory of Colorado no. 7: 47 pp.

GLOSSARY

amnicole (n.) organism living only in or preferring stream environments; stream dweller.

amniphile (n.) preferring stream environments.; **amniphilic** is the adjective.

aufwuchs (n.) the organic coating on stones or other underwater surfaces in permanent water bodies; consists of diatoms, protozoans, small algal epiphytes; fungi; and bacteria. The major food resource for lithophile **taxa,** and for periliihon and periphyton feeders ***(q.v.)*.**

calciphile (n.) a species requiring relatively large amounts of free calcium ions for its shell or for other physiology- or metabolism-related reasons; used here for certain land snail and slug species; there are calciphile plants as well.

crenocole (n.) organism living only in spring environments; spring dweller.

crenophile (n.) preferring spring environments; crenophilic is the adjective.

detritivore (n.) aqueous **taxon** feeding on organic particles in sediment.

edaphic (adj.) pertaining to soil conditions, such as composition, **pH,** zone, etc.

epiphyte (n.) (small) organism living attached to a (larger) substrate particle or other organism; **epiphytic** is the adjective.

eucrenic (adj.) well-watered; having large numbers of springs and streams.

genotype (n.) formally designated type species of a genus-level **taxon.**

holotype (n.) formally designated type specimen for a species-level **taxon,** as established at the time of the original description or by valid subsequent action.

hypsiphile (n.) **taxon** restricted to or liking high elevations: refers to certain land and freshwater mollusk **taxa; hypsiphilic** is the adjective.

insolation (n.) the amount of sunlight striking the ground.

lectotype (n.) a subsequently designated holotype.

limnetic (adj.) of or pertaining to lakes; living in lakes.

limnocole (n.) organism restricted to or preferring lake environments; lake dweller.

limnocrene (n.) spring pool, with or without outlet: generally used for rather large pools.

limnophile (n.) preferring lake environments; **limnophilic** is the adjective.

mesophile (n.) a species tolerant of or requiring relatively moist [but not extremely moist]

	conditions for at least part of its life, such as occur in forests or other areas shielded from continual insolation. The adjective is **mesophilic.**
metasedimentary (adj.)	rock type of difficult to characterize lithology derived from the metamorphosis of a sedimentary unit.
monospecific (adj.)	single species; used in two senses: 1) a genus with but one species; 2) a species assemblage or community with but one species.
monotypic (adj.)	having a single species-level **taxon;** generally applied to a genus.
nasmode (n.)	spring complex; spring family; area with a number of nearby springs originating from the same source.
nasmodic (adj.)	having large numbers of springs.
neotype (n.)	holotype designated later to replace a lost holotype.
nomen dubium (n.)	a species-level name of questionable validity.
notophile (n.)	a species tolerant of or requiring very moist conditions for at least part of its life, such as occur alongside permanent streams, seeps or springs; used here for certain land snail and slug species. The adjective is **notophilic.**
paralectotype (n.)	a subsequently designated paratype.
paratype (n.)	all members of the type suite for a species-level **taxon,** other than the holotype.
pelophile (n.)	preferring muddy environments; **pelophilic** is the adjective.
perilithon (n.)	those organisms growing on stones; usually refers to the smaller (near to microscopic, and consisting of just one or a few cells per individual) and inconspicuous epiphytic algae, diatoms, protozoans, bacteria and fungi, rather than to larger organisms or plants; **aufwuchs,** in part.
periphyton (n.)	those organisms growing on submerged stems and other parts of aquatic macrophytes; usually refers to the smaller (near to microscopic, and consisting of just one or a few cells per individual) and inconspicuous epiphytic algae, diatoms, protozoans, bacteria and fungi, rather than to larger organisms or plants: **aufwuchs,** in part.
phreatic (adj.)	of or pertaining to groundwater crevices; living in underground waters,
regolith (n.)	the parent rock from which the soil in an area is derived; or that lithology most influencing edaphic conditions.
s.s.	abbreviation for ***sensu stricto*** (Latin), in the strict sense.
s.l.	abbreviation for ***sensu lato*** (Latin), in a loose sense.
species inquirenda (n.)	species whose validity needs further investigation.
syntype (n.)	all members of a type suite for a species-level **taxon** for which a holotype and paratypes have not yet been designated.
thermicole (n.)	organism living only in or preferring warm spring environments.

thetmiphile (n.) preferring warm spring environments; **thermiphilic** is the adjective.

xerophile (n.) a species tolerant of or requiring relatively dry (arid or semiarid) conditions for at least part of its life; used here for certain land snail and slug species. The adjective is **xerophilic.**