Banbury Springs Lanx
(*Lanx* n sp.) (undescribed)

5-Year Review:
Summary and Evaluation

Photo by Bill Mullins; Boise, Idaho

U.S. Fish and Wildlife Service
Snake River Fish and Wildlife Office
Boise, Idaho

5-YEAR REVIEW

Species reviewed: Banbury Spring lanx

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I. GENERAL INFORMATION

I.A. Methodology used to complete this review

In conducting this review, we (the U.S. Fish and Wildlife Service (Service)) utilized available commercial and scientific information regarding the Banbury Springs lanx (*Lanx* n sp.) (undescribed), its habitat, and factors affecting the species' continued existence. This information was acquired by various means. We began by searching files in the Snake River Fish and Wildlife Office (SRFWO) file system (i.e., office files). The office file system contains decades of reports from various consultants, private industries, and government agencies that worked with or for the Service in some capacity, and shared with or reported to the Service on their actions with regard to threatened and endangered species. These reports vary greatly in utility and cover a wide range of topics from general reports on species of concern solicited by the Service, to environmental reports in conjunction with the re-licensing of hydroelectric power generating facilities, to consultations under section 7 of the Endangered Species Act (Act).

Additional files were searched for all forms of information and data on the Banbury Springs lanx, which included conference notes, emails, and phone records. For example, we often receive useful information on a species occurrence or extirpation, biology, and life history traits while attending meetings (e.g., The Snail Conservation Plan Technical Committee). Meeting notes reflect the experience and direct observations of biologists, which might not be reported in technical reports or published literature. Similarly, biologists often create field notes from surveys conducted on various species. Such field notes are of use and objective but rarely appear in a technical report or publication. The Service considers this information when conducting status reviews of listed species, especially those species, such as the Banbury Springs lanx, that have not been widely studied.

We also searched scientific databases on the Internet for published literature on the Banbury Springs lanx, life history, habitat, and the effects of spring regulation, water pollution, and invasive species on freshwater invertebrates. These databases included Boise State University's GEOREFS, ART ABSTRACTS, BIOAG INDEX, ARTICLE FIRST, and WORLDCAT. While no specific primary journal articles on the Banbury Springs lanx have been published, much information exists on river regulation, water pollution, and invasive species impacts in the middle Snake River area.

From the relatively few technical reports regarding the Banbury Springs lanx, we have extracted the relevant references cited, acquired the papers, and considered those scientific findings, which are incorporated into this 5-year review. We met with several interested parties that possess large databases of useful information related to the species or its habitat for our review. This effort included meetings with Idaho Power Company (IPC), the Idaho Department of Fish and Game, the Idaho Conservation Data Center, the U.S. Bureau of Reclamation, and the U.S. Geological Survey (USGS). Numerous other interested parties were contacted by the Service by telephone and/or letter to solicit information including Idaho Office of Species

Conservation, Idaho Department of Environmental Quality, Idaho Department of Water Resources, and Idaho Native American Tribes (Nez Perce, Shoshone-Bannock, and Shoshone-Paiute).

All of the information that was gathered or provided to us by any of the means discussed above was assimilated into a status review report for the Banbury Springs lanx (Myler et al. 2006). The draft status review was sent out for peer review to five academic professionals with expertise in general snail biology and/or familiarity with Banbury Springs lanx habitat. Peer reviewers were given a list of questions to consider during the review process. Comments received from peer reviewers were incorporated into the status review document. A meeting of SRFWO managers and biologists was held to review information summarized in the status review as well as peer review comments.

I.B. Reviewers

Lead Regional Office -- Region 1, Portland, Oregon

Lead Field Office – Snake River Fish and Wildlife Office, Boise, Idaho, Cary Myler

I.C. Background

I.C.1. Federal Register (FR) Notice citation announcing initiation of this review: April 11, 2006. Endangered and Threatened Wildlife and Plants: Initiation of 5-Year Reviews of 70 Species in Idaho, Oregon, Washington, and Hawaii, and Guam. 71 FR 18345–18348.

I.C.2. Species status: unknown, as reported in the 2005 Annual Recovery Data Call.

I.C.3. Recovery achieved: 1, meaning 0-25 percent of the identified recovery objectives for the Banbury Springs lanx have been achieved, as reported in the 2005 Recovery Data call

I.C.4. Listing history:
<u>Original Listing</u>
FR notice: FR 57: 59244-59256
Date listed: December 14, 1992
Entity listed: Banbury Springs lanx (*Lanx* n sp.) (undescribed)
Classification: Endangered

<u>Revised Listing, if applicable</u>
FR notice: NA
Date listed: NA
Entity listed: NA
Classification: NA

I.C.5. Associated rulemakings: NA

I.C.6. Review History: No other reviews have been performed.

I.C.7. Species' Recovery Priority Number at start of review*:* The Banbury Springs lanx was assigned a recovery priority number of 8 because although it is taxonomically undescribed, it is believed to be a species, it is subject to a moderate degree of threat, and is rated high in terms of recovery potential.

I.C.8. Recovery Plan or Outline: Recovery Plan

Name of plan: Snake River Aquatic Species Recovery Plan
Date issued: December 1995
Dates of previous revisions: NA

II. REVIEW ANALYSIS

II.A. Application of the 1996 Distinct Population Segment (DPS) policy

Not applicable as the DPS policy only applies to vertebrates.

II.B. Recovery Criteria

II.B.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

____ ***Yes***

_X_ ***No***

The Banbury Springs lanx is covered in the Snake River Aquatic Species Recovery Plan, which was finalized in 1995. Since the completion of this plan, we have learned more about this species, including where it is found, and more about its habitat requirements. We recommend that the recovery criteria be updated to include our current knowledge for the Banbury Springs lanx.

II.C. Updated Information and Current Species Status

II.C.1. Biology and Habitat:

II.C.1.a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate), or demographic trends:

The Banbury Springs lanx, first discovered in 1988 by Terrence Frest (Frest in litt. 2006, page 1), is distinguished by a conical shell of uniform red-cinnamon color with a sub central apex or point (USFWS 1995, p. 12). Length ranges from 2.4 to 7.1 millimeters (mm) (0.09 to 0.28 inch (in)), height ranges from 1.0 to 4.3 mm (0.03 to 0.17 in), and width ranges from 1.9 to

6.0 mm (0.07 to 0.24 in) (USFWS 1995, p. 12). The population size, abundance, and trends of the Banbury Springs lanx are largely uncertain as little density and trend information exists. Very few density estimates have been made and methods have not been consistent between studies. The Banbury Springs lanx is currently known to only exist in four coldwater spring complexes along 10 river kilometers (rkm*)* 6 river miles (rm) of the middle Snake River: Thousand Springs, Box Canyon Springs, Banbury Springs, and Briggs Springs (Figure 1). No information on demographics or demographic trend data was found for the Banbury Springs lanx.

Figure 1. Aerial photo of the four spring locations where the Banbury Springs lanx is currently found along the Snake River. Survey points were generated by visiting each site, zooming into the aerial photographs, consulting the 7.5 minute USGS topomaps, and drawing a survey point.

Thousand Springs [rkm 939.7 (rm 583.9)]

Information for the status review regarding Banbury Springs lanx at Thousand Springs was developed from at least two surveys conducted by private contractors and Federal agencies (Myler et al. 2006). In the Thousand Springs Preserve near Minnie Milner Springs, Frest and Johannes (1992a, p. 27) described the lanx colony as "sporadically distributed and cryptic." Average population density in this area was between 16 to 48 individuals per square meter (m^2) and the total number of individuals in this area was estimated between 600 to 1,200 (Frest and Johannes 1992a, p. 27). Service personnel found 9 individuals while visually inspecting 40 cobbles in January of 2006 (Hopper in litt. 2006b, pp. 1 to 3).

Box Canyon [rkm 947.6 (rm 588.8)]

In Box Canyon at least seven surveys have been conducted by industry, private contractors, Federal agencies, and academicians, which have contributed to our knowledge base of Banbury Springs lanx at this location (Myler et al. 2006). The Banbury Springs lanx was found in 1 out of 17 sites surveyed in Box Canyon (Beak Consultants 1989, p. 6). One hundred and ten individuals were found on 23 out of 50 cobbles (Beak 1989, page 6). A cursory survey performed by Service personnel found the Banbury Springs lanx in the area described by Beak Consultants (1989), just upstream of Sculpin Pool. Thirty-two individuals were observed while 82 cobbles were visually inspected (Hopper in litt. 2006a, pp. 1 to 3). The USGS (in litt. 1994, page 3) also found Banbury Springs lanx in Box Canyon and described it as "rare" in occurrence.

Banbury Springs [rkm 947.9 (rm 589.0)]

Information regarding Banbury Springs lanx at Banbury Springs was developed from at least nine survey efforts conducted by IPC, private contractors, and Federal agencies (Myler et al. 2006). At Banbury Springs, *Lanx* n sp. has only been found in the eastern-most spring flowing into Morgan Lake and only in the lower portion of this spring (Hopper in litt. 2006a, pp. 1 to 3; Richards in litt. 2006, p. 1). Life history data (density) was collected by the IPC at the Banbury Springs site in 1995, 1996, 2000, 2001, 2002, and 2003 (Finni 2003a, p. 34; Finni 2003c, p. 24; Finni 2003f, p. 15; Finni 2003g, p. 13; Stephenson and Bean 2003, p. 26; Stephenson et al. 2004, p. 23). However, the results are difficult to compare across years, because the methods have not been applied consistently (Figure 2). Generally, average density between years is comparable across the 6 years of surveys, with the exception of 2002 and 2003, where one or two outliers per year resulted in skewed averages and standard deviations (Figure 2).

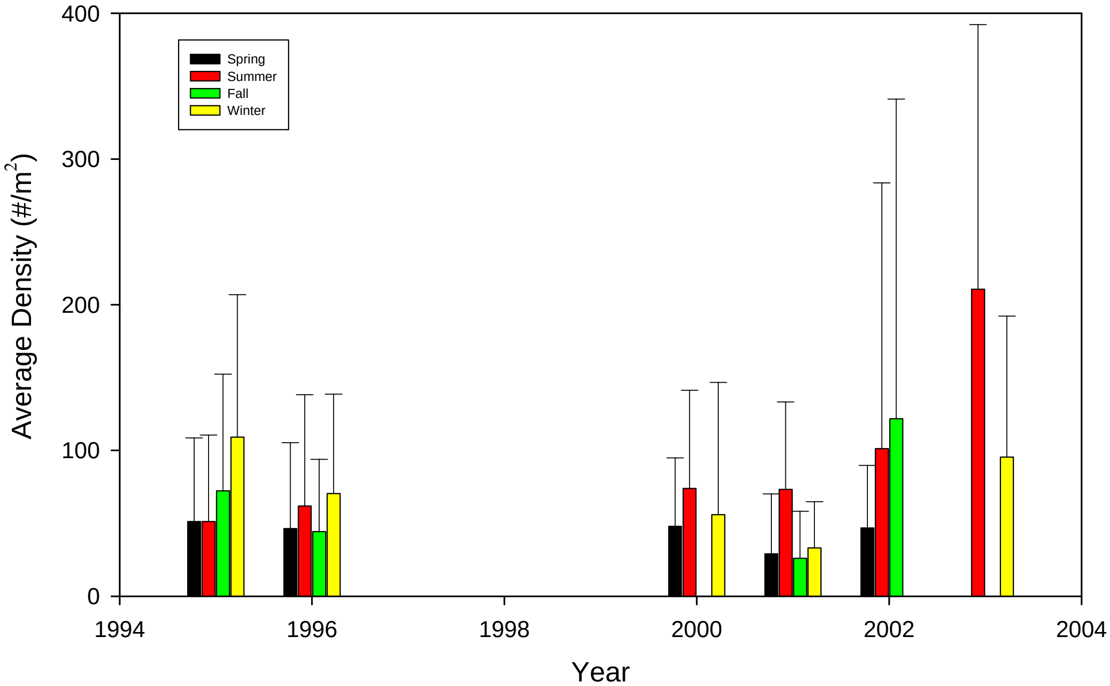


Figure 2. Average estimated density for Banbury Springs lanx collected at Banbury Springs, Idaho, by season. IPC data (Finni 2003a, p. 34; Finni 2003c, p. 24; Finni 2003f, p. 15; Finni 2003g, p. 13; Stephenson and Bean 2003, p. 26; Stephenson et al. 2004, p. 23).

Briggs Springs [rkm 950.2 (rm 590.4)]

Only two surveys, completed by Federal agencies, have been conducted for the Banbury Springs lanx at Briggs Springs (Myler et al. 2006, Appendix 1). Surveys conducted by the USGS (in litt. 1994, pp. 3 and 4) describe the Banbury Springs lanx as common with six or more individuals per cobble. A cursory survey performed by Service personnel found Banbury Springs lanx in the area described by USGS (in litt. 1994, pp. 3 to 4) just upstream and downstream of the USGS gauging station at Briggs Springs Creek. We visually inspected 20 cobbles and found an average of 4.7 individuals per cobble (Hopper in litt. 2006b, pp. 1 to 3).

II.C.1.b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding):

Currently, genetic work is being conducted for this species at the University of Alabama by Dr. Chuck Lydeard's laboratory (Frest in litt. 2006, pp. 3 and 4; S. Clark in litt. 2006, p. 1). Preliminary results indicate that the Banbury Springs lanx is a distinct taxon; however, genetically it more closely resembles the genus *Fisherola* than *Lanx* (Frest in litt. 2006, pp. 3 and 4; S. Clark in litt. 2006, p. 1).

II.C.1.c. Taxonomic classification or changes in nomenclature:

The taxonomic classification of the Banbury Springs lanx, at the time of this report, remains as difficult to understand as it was when it was first discovered. The interrupted mantle muscle scar (breathing apparatus) is consistent with the genus *Fisherola*; however, the shell apex is central, consistent with all described *Lanx* species (Frest in litt. 2006, p. 2). Inconsistencies in identifications between the Banbury Springs lanx and *Fisherola nutalli* are believed to have occurred (Pentec 1991, p. 9). Frest (in litt. 2006, p. 1) described the Banbury Springs lanx as smaller than *F. nutalli,* with a black body color (*F. nutalli* is light to medium gray), and dwelling in spring outflows (*F. nutalli* has not been found in spring flows). Prior to 1988, when Frest first collected taxonomically distinct Banbury Springs lanx (Reed et al. 1989, p. A1-2; Frest in litt. 2006, pp. 1 and 2), Taylor and others (Taylor 1985a, p. 11; Beak 1987, pp. 3 and 4; Beak 1989, p. 6) collected specimens which were described as *F. nutalli*; however, Frest has identified specimens from the Taylor and Beak collections as Banbury Springs lanx (Frest in litt. 2006, p. 1).

Kingdom:	Animalia
Phylum:	Mollusca
Class:	Gastropoda
Subclass:	Pulmonata
Order:	Basommatophora
Family:	Lymnaeidae
Subfamily:	Lancinae
Genus:	*Lanx*
Species:	Undescribed species

II.C.1.d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range):

Each of the four known colonies (Figure 1) remain isolated from each other as they did at the time of listing in 1992. At Thousand Springs, the lanx is found sporadically in an outflow of only one of the springs, which discharges into the North Channel, near the Minnie Milner Diversion (Frest and Johannes 1992a, pp. 26 and 27; Hopper in litt. 2006b, pp. 1 and 2). In Box Canyon, the lanx is found in a rapid upstream of "Sculpin Pool" (Taylor 1985a, p. 11; Beak 1987, pp. 2 and 3; Beak 1989, p. 6; Reed et al. 1989, pp. A3-3 to A3-6; USGS in litt. 1994, pp. 1 and 2; Maret in litt. 2002, p. 3; Hopper in litt. 2006a, pp. 1 and 2). In Banbury Springs, the lanx is found in one of five springs that discharge into Morgan Lake (Finni 2003a, p. 34; Finni 2003c, p. 24; Finni 2003f, p. 15; Finni 2003g, p. 13; Stephenson and Bean 2003, p. 26; Stephenson et al. 2004, p. 23; Richards in litt. 2006, p. 1; Hopper in litt. 2006a, pp. 1 and 2). The lanx is also found in Briggs Springs about 1.1 km (0.7 mi) from the Snake River, upstream and downstream of the uppermost road crossing on Briggs Springs Creek (USGS in litt. 1994, p. 2; Hopper in litt. 2006b, pp. 1 and 2). This is the same area where the USGS gauges the spring's discharge at Briggs Springs.

II.C.1.e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Since the listing of the five Snake River snails in 1992 (USFWS 1992), the number of element occurrences (colonies or documented occurrences where the species have been found) for three of the species [Idaho springsnail (*Pyrgulopsis idahoensis*), Bliss Rapids snail (*Taylorconcha serpenticola*), and Desert valvata (*Valvata utahensis*)] has significantly increased because of intensified survey efforts in the middle Snake River. However, with the Banbury Springs lanx, only one additional site has been located since the time of listing (USGS in litt. 1994, p. 4), in spite of several survey efforts led by Federal agencies, private industry, contractors, and academicians, which have occurred in the middle reaches of the Snake River as well as coldwater spring complexes and tributaries from Twin Falls to the Malad River (Appendix 1 in Myler et al. 2006). Prior to the 1992 listing decision, only four surveys had been conducted (Taylor 1985a; Beak 1987; Beak 1989; and Frest and Johannes 1992a) (Appendix 1 Myler et al. 2006), of which three surveyed particular geographic areas (i.e., not specifically for *Lanx*). In addition to surveys listed in Myler et al. (2006, Appendix 1), the IPC and others have conducted surveys which primarily targeted the Bliss Rapids snail in other coldwater springs and tributaries that could provide suitable habitat for Banbury Springs lanx; these surveys have only resulted in the location/detection of one additional occurrence at Briggs Springs.

II.C.1.f. Other: Not Applicable.

II.C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

II.C.2.a. Present or threatened destruction, modification or curtailment of its habitat or range:

Banbury Springs lanx habitat in Thousand Springs, Box Canyon, Banbury Springs, and Briggs Springs has been impacted by habitat modification and curtailment. The free-flowing, coldwater environments where the Banbury Springs lanx evolved have been affected by, and continue to be vulnerable to, adverse habitat modification and deteriorating water quality from one or more of the following human activities: hydroelectric development, water withdrawal and diversion, water pollution (point and non-point sources), and aquaculture.

Habitat Modification

Thousand Springs [rkm 939.7 (rm 583.9)]

At Thousand Springs, much of the spring water that originally cascaded down the basalt cliffs (Figure 3) is now diverted into a concrete flume (Figure 4) for delivery into the Thousand Springs hydroelectric project (Stephenson et al. 2004, p. 4). The Thousand Springs hydroelectric project is located on private land and was constructed in 1912. We do not have information regarding the historical or current discharge of water from the Thousand Springs complex but the diversion of much of the springflow into a power generating facility likely destroyed and/or modified suitable Banbury Springs lanx habitat. It is not known how the diversion has affected historical population density and/or spatial distribution of the species. However, at present the

Banbury Springs lanx is only known to exist in one section of the North Channel near Minnie Milner Springs (Hopper in litt. 2006b, pp. 1 and 2).

Figure 3. The Thousand Springs complex circa 1900.

Figure 4. The Thousand Springs hydroelectric project as it appears today.

Box Canyon [rkm 947.6 (rm 588.8)]

Box Canyon Creek is fed by Box Canyon Spring. It is approximately 1.75 km (1.1 mi) in length and joins the Snake River just upstream of the Thousand Springs complex at rkm 939.7 (rm 588) (Figure 1). Box Canyon Creek current discharge is the lowest in 50 years (USGS 2006a, p. 1). Beginning in 2004, flows in Box Canyon Creek dropped below 300 cubic feet per second (cfs) for the first time in its recorded history (USGS 2006a, p. 1). The majority of the water originating from Box Canyon Creek is diverted upstream of the existing Banbury Springs lanx colony into a flume for delivery to a commercial aquaculture facility (Taylor 1985a, p. 2;

Langenstein and Bowler 1991, p. 185). The Banbury Springs lanx is currently known from Box Canyon Creek between Sculpin Pool and the diversion (Taylor 1985a, p. 11; USGS in litt. 1994, pp. 1 and 2; Maret in litt. 2002, p. 3; Hopper in litt. 2006a, pp. 1 and 2). The diversion of approximately 86 percent of this creek's water (Langenstein and Bowler 1991, p. 185) constitutes a significant modification of potential and possibly historical Banbury Springs lanx habitat.

Banbury Springs [rkm 947.9 (rm 589.0)]

The Banbury Springs complex is the type locality, or the physical location from which the Banbury Springs lanx was originally collected and identified as a unique species (Reed et al. 1989, p. 2; Frest in litt. 2006, p. 1; Figure 1). The actual springs of Banbury Springs originate from basalt cliffs and talus slopes about 50 m (164 feet (ft)) above the Snake River. The entire flow of these springs is captured in Morgan Lake, a man-made lake with a levee separating the lake from the Snake River. This lake creates lentic (still water) habitat and inundates the riffle/rapids habitat that likely existed previously at the confluence of Banbury Springs Creek and the Snake River. Currently, the Banbury Springs lanx is only found in the lower riffle complex in one of five spring outflows that enter into Morgan Lake (Hopper in litt. 2006a, pp. 1 to 3).

Additional impacts to Banbury Springs lanx habitat occurred when the Boy Scouts of America previously used Morgan Lake for recreational activities such as canoeing and swimming (Wood in litt. 1998, p. 1). This use of Banbury Springs was discontinued by 1998 but dilapidated bridges and remnant trails that crossed the riffle complex just upstream of where the lanx occur are still evident (Hopper in litt. 2006a, pp. 1 to 3). Current recreational use of Banbury Springs is evidenced by relatively recent shotgun hulls, discarded by waterfowl hunters, observed in the streambed on top of a Banbury Springs lanx colony (Hopper in litt. 2006a, pp. 1 to 3). Recreational users at Banbury Springs could potentially trample individual lanx at the lower section of the spring outflow.

Briggs Springs [rkm 950.2 (rm 590.4)]

Briggs Springs Creek supplies water used for commercial fish production at Clear Springs Fish Hatchery. The Banbury Springs lanx was discovered at Briggs Springs in 1994 in the headwaters of the main channel of the Creek upstream of the upper-most diversion approximately 1.1 km (0.7 mi) from the Snake River (Figure 1). The lanx is also found just downstream of this diversion and in a diversion canal about 50 m (164 ft) from this location (Hopper in litt. 2006b, pp. 1 and 2). The confluence of Briggs Springs Creek and the Snake River was also searched, but no lanx were found (Hopper in litt. 2006b, pp. 1 and 2). The diversion of water for hatchery operations diverts water from the original streambed and thus limits suitable habitat for the lanx.

Potential Snake River Habitat

The Banbury Springs lanx currently is known to occur only in coldwater spring complexes and tributaries, in riffles and along the margins of rapids where water quality is considered relatively good. Prior to anthropogenic (human caused) alterations between Briggs Springs and Thousand Springs, the Snake River at least seasonally may have provided a conduit where the Banbury Springs lanx could move between coldwater springs. We hypothesize that dams constructed in the middle Snake River contributed to the restricted range of the Banbury Springs lanx and precluded immigration, emigration, and genetic exchange between the four extant colonies by inundation of habitat, reduction of flow, and sediment accumulation. As a result, the Banbury Springs lanx is now restricted to four isolated colonies with no possible conduit for dispersal or range expansion.

At least three dams on the middle Snake River (Milner, Upper Salmon Falls, and Lower Salmon Falls) could potentially affect Banbury Springs lanx dispersal and potential habitat in the Snake River. Milner [rkm 1030 (rm 640)] is an irrigation dam, which in many years can deplete the Snake River of flow at that location on a seasonal basis. Even though this dam is 80 rkm (50 rm) upstream from the closest Banbury Springs lanx location, a reduction of flow of that magnitude could potentially have negative ramifications on downstream habitat. The Upper Salmon Falls [rkm 937 (rm 582.5)] and Lower Salmon Falls [rkm 933 (rm 572.9)] hydroelectric projects have replace free-flowing river habitat with slow moving water storage reservoirs. The reservoir created by the Upper Salmon Falls Dam extends in the Snake River upstream of Thousand Springs [rkm 937.7 (rm 583.9)]. The drop in water velocity in a reservoir often results in elevated surface water temperatures and subsequent reductions in dissolved oxygen concentrations (Hynes 1970, pp. 444 to 448). In addition, water-transported sediments, that would under free-flowing river flows be flushed downstream and deposited in pools, eddies, and other still-water environments, are now settled out in slower moving reservoir waters (Hynes 1970, pp. 448 to 449; Simons 1979, p. 95).

Since the four colonies of Banbury Springs lanx biologically represent a single species, we hypothesize that they were likely at one time part of a larger, continuous interbreeding population. The knowledge of events that isolated these colonies from one another are speculative since we do not have a detailed understanding of the species' historic distribution. It is possible, like other Snake River gastropods, that they are a relict population of a lake-dwelling species formerly of Pleistocene Lake Idaho. However, the species' morphology and current habitat preference (groundwater dependence) do not suggest it was a strict lacustrine (lake) species. Given this species' morphology and observed habitat preferences, it is more likely that the Banbury Springs lanx is a riverine species and that its historic distribution probably included appropriate habitats within the Snake River prior to anthropogenic activities, which altered flows and reduced water quality. Detailed genetic studies would be required to better assess the degree of genetic differentiation between the four isolated colonies.

Groundwater Quality

In addition to the destruction and/or modification of the Banbury Springs lanx habitat discussed above (i.e., modification of Thousand Springs, Box Canyon, Banbury Springs, and Briggs Springs), poor groundwater quality is an anthropogenic factor which likely impacts this species and limits its geographic distribution. Springflow diversions and irrigation return flows are believed to degrade water quality and are detrimental to the Banbury Springs lanx due to the resulting flow reduction, increased water temperature, decreased dissolved oxygen, elevated nutrient concentrations, and the accumulation of pollutants and sediment, as described below.

Springflow reduction

USGS records show that the average spring outflows in the Hagerman reach of the Snake River have declined over the past 50 years (Clark and Ott 1996, pp. 553 to 555). These declines have been observed at locations occupied by Banbury Springs lanx [e.g., Box Canyon (Figure 5) and Briggs Springs (Figure 6)]. In part, these declines are due to groundwater pumping of the Snake River Plain aquifer for agricultural and urban use, as well as a gradual replacement of flood irrigation practices with the use of center-pivot sprinkler systems, which contribute to little or no aquifer recharge. Furthermore, as groundwater pumping continues in the Snake River Plain, aquifer levels have shown a declining trend over the last 50 years in Gooding County (Figure 7). Groundwater pumping continues today and the potential exists for severe aquifer depletion in the future with continuing and new demands from water users such as municipalities and irrigators. Senior water right holders (e.g., fish hatcheries and irrigators) are expected to maintain the same quantities of water withdrawal from the springs, thereby continuing to reduce flow in the natural spring channel. The cumulative effects of these actions translate into a continued decline in the coldwater springflows upon which the Banbury Springs lanx depends.

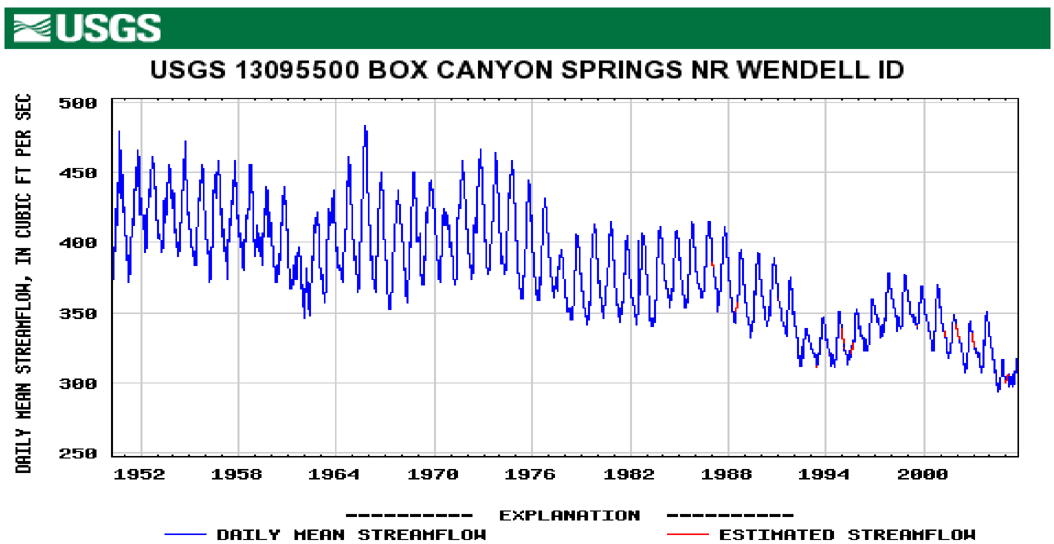


Figure 5. Spring Discharge of at Box Canyon (USGS 2006a).

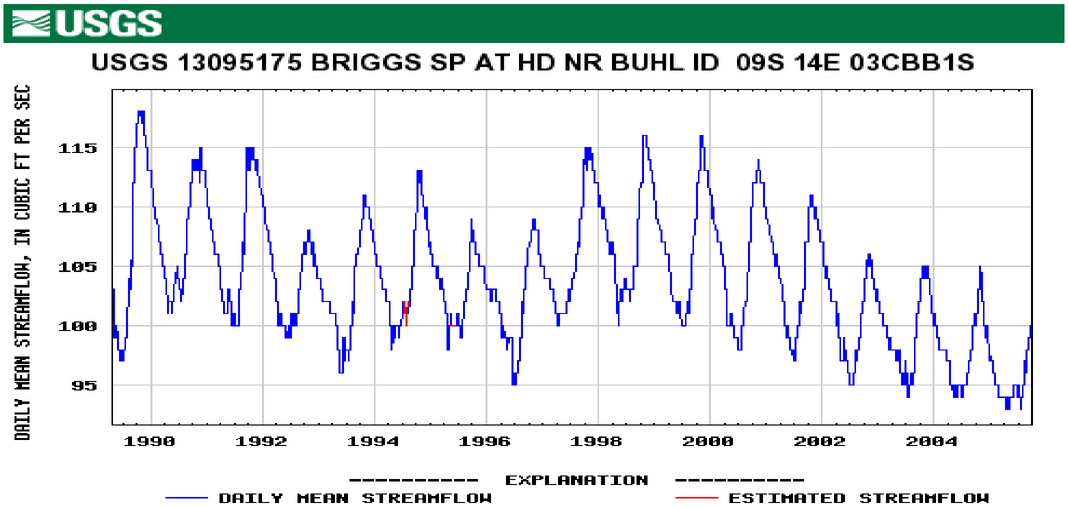
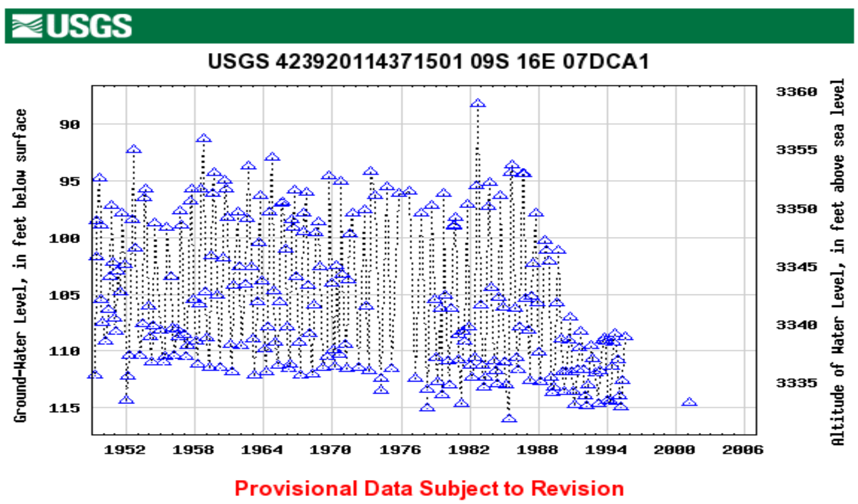
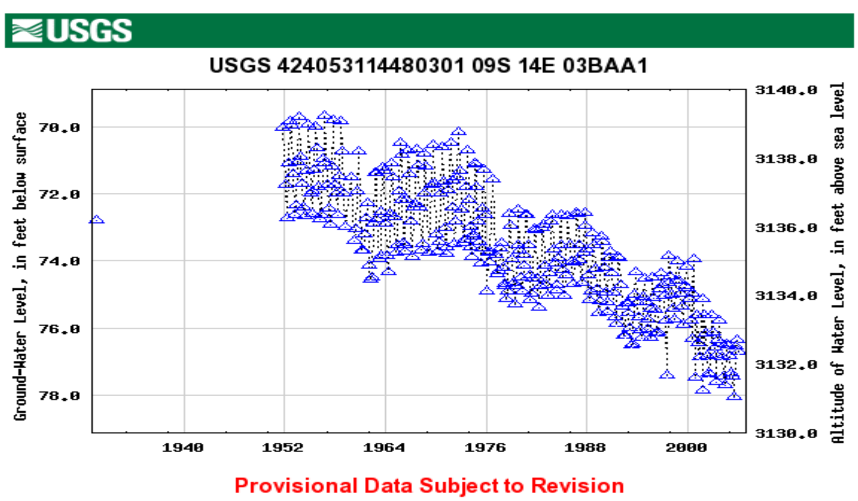


Figure 6. Spring Discharge of at Briggs Springs (USGS 2006b).





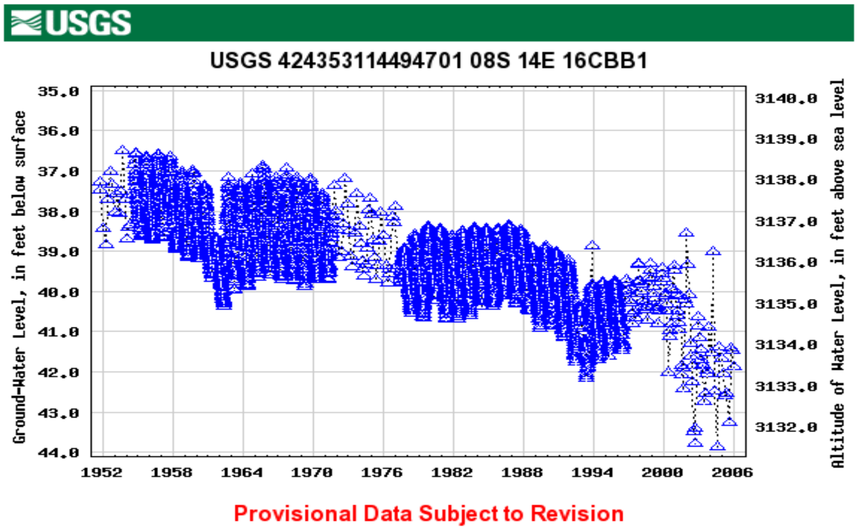


Figure 7. Groundwater well data, as feet below the surface and as feet above sea level, for three locations in Gooding County, Idaho, that have over 50 years of nearly continuous data. **http://nwis.waterdata.usgs.gov/id/nwis/gwlevels**

Water Temperature and Dissolved Oxygen

Water temperature is considered one of the most influential environmental factors controlling the occurrence and distribution of macroinvertebrates (Ward and Stanford 1979, p. 35). Although water temperature may not be a major issue of concern for the Banbury Springs lanx in the four coldwater spring complexes where it resides, anthropogenic activities in the springs such as impoundments and/or diversions can alter natural thermal characteristics of water bodies (Ward and Stanford 1979, p. 42). This is problematic because the capacity of water to hold dissolved oxygen decreases with increasing water temperatures (Mason 1996, p. 34). As specialized respiratory organs are lacking, the Banbury Springs lanx are particularly sensitive to dissolved oxygen fluctuations (Baker 1925, p. 148) and have stringent dissolved oxygen requirements. It has been suggested that any factor that reduces dissolved oxygen concentrations in the water column (e.g., siltation, flow reduction, removal of riparian vegetation, and increased water temperature) for even a few days is likely to prove fatal to all or the majority of the population (Reed et al. 1989, pp. A1-4 to A1-5).

Accumulation of Nutrients, Sediments, and other Pollutants

The two primary nutrients associated with plant growth, and of interest in freshwater systems, are nitrogen and phosphorus (Smith 1996, p. 300). Excessive additions of nitrogen and phosphorus constitute pollutants in water (Clark et al. 1998, p. 12) and can limit the ability of streams to support the beneficial uses (coldwater biota) (Hardy et al. 2005, p. 12). The main sources of excessive nutrient and sediment loads are agriculture in the form of crop production, cattle grazing, confined animal feeding operations, aquaculture facilities, and municipal wastewater treatment facilities (Bowler et al. 1992, pp. 45 to 47; USEPA 2002, pp. 4.22 to 4.24).

Nitrogen and phosphorus are also introduced to the environment from numerous natural and anthropogenic sources (Smith 1996, pp. 206, and 212; Clark et al. 1998, p. 12; Hardy et al. 2005, p. 12), including atmospheric deposition and the weathering of bedrock material, but also from sewage disposal, urban runoff, crop production, and fish production. Excess nutrients enter groundwater by way of infiltration, percolation, and lateral flow through alluvial deposits and bedrock material. There it can be sequestered and accumulate in groundwater aquifers which eventually flow into spring habitats. Nutrient levels in springs may be linked to seasonal fertilizer application and irrigation practices. Data collected by the USGS from 1985 to 1990 on nutrient concentrations in springs within the Hagerman reach and their contribution to nutrient loading into the Snake River show that concentrations of nitrite+nitrate fluctuate seasonally and coincide with higher spring discharges during and following irrigation season (Clark 1994, pp. 19 and 24). Of this amount only 20 percent was derived from leguminous plants (e.g., alfalfa) while 29 percent was from cattle manure and 45 percent was from synthetic fertilizers (Clark 1994, p. 8). Similarly, the Idaho Department of Environmental Quality (IDEQ) reported that the majority of nitrogen concentrations in their study originated from agricultural fertilizers and livestock sources (Baldwin et al. 2000, p. 21). The report also stated that nitrate+nitrite concentrations increased significantly during the 1990s at spring sites along the north bank of the Snake River (Baldwin et al. 2000, p. 25), including the springs identified to be within the Banbury Springs lanx recovery area.

The total contribution of nitrogen and phosphorous entering the middle Snake River from agricultural lands via groundwater springs has been estimated to be 27,000 kilograms (kg) of nitrogen daily (USEPA 2002, pp. 4.22 to 4.24). This accounts for 64 percent of the detected total nitrogen in the system (MacMillan 1992 and Clark 1994, in USEPA 2002, p. 4.22). Recent reports developed by the Idaho Department of Agriculture (IDA) stated that groundwater aquifers within the middle Snake River region continue to be impacted by nitrates and pesticides (Bahr and Carlson 2000, pp. 10; Carlson and Bahr 2000, pp. 3; Baldwin et al. 2000, pp. 22 and 23; Fox and Carlson, 2003, p. 7). One report stated that 53 percent of wells tested had levels of nitrates greater than 5 milligrams per liter (mg/L) and one well had concentrations greater than the Environmental Protection Agency's (EPA) drinking water standard of 10 mg/L (Carlson and Bahr 2000, p. 3). Another showed that 19 percent of wells tested approached the EPA's established drinking water limit of 10 mg/L, and 6 percent of the 761 tested wells surpassed the EPA standard (Bahr and Carlson 2000, p. 10). The reports concluded that agricultural practices are likely a contributor of nitrates and pesticides to groundwater sources. Similarly, a review of springflow effects on chemical loads in the Snake River demonstrated that 36 percent of nitrogen in the system at King Hill, Idaho, was derived proximately from springflows and ultimately from irrigated agriculture (Clark and Ott 1996, pp. 556 to 560). More recently, Rattray and others reported elevated levels of nutrients from groundwater samples collected from the Eastern Snake River Plain aquifer (Rattray et al. 2005, p. 8). They reported that at all sites, concentrations of nitrite+nitrate were greater than the laboratory reporting level (LRL), and at one site near Jerome, Idaho, the concentration of nitrite+nitrate exceeded the EPA's maximum contaminant level (MCL) for drinking water (Rattray 2005, p. 8).

Approximately 80 aquaculture facilities are located in the Hagerman Valley (Bowler et al. 1992, p. 46; USEPA 2002, p. 4.19), of which at least 3 utilize or divert coldwater spring and tributary flows where the Banbury Springs lanx resides. These facilities have directly affected spring habitats that are or may have been occupied by the Banbury Springs lanx and other coldwater spring adapted fauna. The two hatcheries that occur on the tributary springs where the lanx is found belong to a private facility which grows rainbow trout for human consumption, and does not have any mitigation responsibilities to the government or Tribes. Hatchery operations contribute significant quantities of nutrients and sediment to lower sections of coldwater springs as well as the Snake River (Bowler et al. 1992, pp. 45 to 47). Most of these nutrients are derived from metabolic wastes of the fish and unconsumed fish food. A number of aquaculture facilities also include fish-processing facilities and some of the processing wastes make their way into the Snake River (USEPA 2002, p. 4.20). Other wastes and residues from fish farms include disinfectants, bacteria, and residual quantities of drugs used to control disease outbreaks. Of the standard contaminants, aquaculture facilities contribute a sizable proportion of the total measured nutrients (e.g., greater than 5,000 kilograms per day (kg/day) nitrogen, and greater than 700 kg/day phosphorus) as well as an estimated 13,500 kg/day of suspended sediment in the mid-Snake River area (USEPA 2002, p. 4.22). Recent research found elevated levels of nitrogen and phosphorous, as well as elevated levels of trace elements, including zinc, copper, cadmium, lead, and chromium in sediments from the Snake River (Falter and Hinson 2003, page 26 to 27). Benthic (occurring on the bottom of a stream) macroinvertebrate densities and biomass in Snake River studies have been shown to generally increase downstream of aquaculture discharges with a concomitant decrease in species richness, indicating an overall decline in habitat quality immediately downstream of aquaculture facilities (Falter and Hinson 2003, page 13). The cumulative effects of these alterations (e.g., increased sediment, nutrients, and contaminants) are undesirable consequences with regard to benthic species habitats (Bowler et al. 1992, page 45). In addition, the recent discovery of antibiotics originating from fish farms in streams of the United States is of concern (USGS in litt. 2003b, page 1 to 4). Researchers from the USGS collected 189 water samples from 14 fish farms across the Nation and found antibiotics in 27 of those samples from 5 fish farms (USGS in litt. 2003b, pp. 1 to 4). Although no information exists that directly links these pollutants to the Banbury Springs lanx, there are studies (Bowler et al. 1992, page 45; USGS in litt. 2003b, pp. 1 to 4; Falter and Hinson 2003, page 13) that show a decrease in species richness below aquaculture facilities and the lanx has not been found in these locations.

Another pollutant of concern to the Banbury Springs lanx is sediment. Past construction of the diversion structures in Box Canyon and Briggs Springs for aquaculture facilities likely impounded lanx habitat that is now inundated with fines (fine sediment). Similar habitat modifications occurred at Banbury Springs with the impoundment of what is now Morgan Lake, which restricts the current distribution of that colony of lanx. Dr. Terrence Frest in an affidavit (Reed et al. 1989, page A2-3) indicated that “immediate and irreparable harm” to lanx could occur with even a few hours of siltation because members of the subfamily Lancinae breathe through a heavily vascularized mantle and excessive siltation could compromise the animal’s oxygen exchange capacity.

The return of diverted irrigation water to the coldwater springs and tributaries plays a major role in degrading water quality (Frest and Johannes 1992a, pp. 16 and 17; Bowler et al. 1992, pp. 45 to 47; Clark et al. 1998, page 2; USEPA 2002, page 4.21), which may impact benthic organisms in the Snake River. Irrigation return flow returns to coldwater springs within the range of the Banbury Springs lanx (Frest and Johannes 1992a, pp. 16 and 17; Clark and Ott 1996, pp. 553 to 555). Irrigation water generally has increased temperatures (with a subsequent decrease in dissolved oxygen), contains pesticide residues, has been enriched with nutrients from agriculture (nitrogen and phosphorous), and frequently contains elevated sediment loads (Frest and Johannes 1992a, pp. 16 and 17; Bowler et al. 1992, page 45; Clark et al. 1998, pp. 2 to 3;

USEPA 2002, page 4.22). In Sand Springs and the Thousand Springs complex Frest and Johannes (1992a, pp. 16 and 17) observed certain areas at the base of talus slopes discharging relatively warm, silty water that contained agricultural contaminants. Clark et al. (1998, pp. 2 to 3) found pesticides in animal tissues, streams, irrigation canals, and irrigation returns in the Snake River Basin in concentrations exceeding the aquatic-life criteria established by EPA. Similarly, Falter and Hinson (2003, pp. 68 to 69) found that sediments, nitrogen, phosphorous, and trace elements were generally higher downstream from irrigation returns while species richness was generally higher upstream.

Industrial wastes in groundwater are also a potential threat to the Banbury Springs lanx. Beginning in the 1950s, the Idaho National Laboratory (INL), a Department of Energy facility, pumped mixed waste and wastewater from nuclear industrial processing into the ground for disposal (Rattray et al. 2005, page 1). This practice continued until 1984; currently waste and wastewater from the facility are handled differently and not pumped into the aquifer. These contaminants include tritium, strontium-90, cesium-137, gross alpha-particle radioactivity, and gross beta-particle radioactivity (Rattray et al. 2005, pp. 6 and 7). The presence of contaminants from nuclear industrial processes in the Snake River Plain aquifer is of concern because they someday will likely reach the coldwater springs upon which the Banbury Springs lanx depends. It is not currently known how these contaminants from the nuclear industrial process will impact the Banbury Springs lanx. However, Clark and Ott (1996, pp. 556 to 559) reported tritium in several of the coldwater springs in the mid Snake River area in extremely minute quantities. The source of this nuclear contaminant remains unknown.

Presently, there are other environmental pollutants affecting coldwater springs complexes where the Banbury Springs lanx occurs. Box Canyon Springs has concentrations of cadmium and lead that exceed the State of Idaho’s acute criteria for aquatic life (Hardy et al. 2005, p. 65). Recent research at Montana State University revealed elevated concentrations of lead, cadmium, and arsenic in *Fluminicola* tissues collected from Banbury Springs (Richards in litt. 2002, p. 4). Rattray and others detected trace elements including barium, chromium, lithium, manganese, and zinc in water sources that supply the major springs on the north side of the Snake River (Rattray et al. 2005, pp. 7 and 8), including the Thousand Springs complex and Box Canyon Springs. The effects of metal bioaccumulation in stream organisms are widely documented in the primary literature (Eisler 1998, pp. 16 to 20; Brumbaugh et al. 2001, p. 19; Maret et al. 2003, pp. 1 to 2). Pollutants such as mercury, other trace elements, and pesticides can enter tributaries and springs (and eventually the Snake River) from atmospheric deposition, agriculture, and industrial inputs (Maret and Ott 1997, p. 2; Rattray et al. 2005, p. 4). Although the direct and long-term effects of these pollutants upon Banbury Springs lanx colonies are not known, the pollutants are present in the spring system in which the lanx resides.

II.C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes:

The data indicate that overutilization of this species is not a threat to the continued existence of the Banbury Springs lanx. There is no known commercial or recreational use of the species, and collection for scientific or educational purposes is subject to permitting by the Service and therefore highly controlled. Future permits for collecting the Banbury Springs lanx will likely be contingent upon more detailed collection and reporting requirements to facilitate improved species occurrence and distribution information.

II.C.2.c. Disease or predation:

There is currently no known information regarding the threat of disease or predation to the continued existence of the Banbury Springs lanx. We believe that disease is not likely to affect the species unless an unknown pathogen is transmitted to the Banbury Springs lanx via a non-native disease vector. The effects of predation on the species' continued existence are unknown. Predation on snails by native crayfish and fish is well documented (Lodge et al. 1994, pp. 1276 to 1277; Martin et al. 1992, pp. 450 and 479; Merrick et al. 1992, pp. 230 to 232; McCarthy and Fisher 2000, pp. 390 to 393), and predation effects of non-native species on snails may also be detrimental (Strayer 1999, pp. 87 to 88). We have no information that documents interactions between Banbury Springs lanx and native or non-native predators.

II.C.2.d. Inadequacy of existing regulatory mechanisms:

The Idaho Department of Water Resources (IDWR) regulates water development in the Snake River Basin. At present, there are maintenance flow requirements for fish and wildlife on several tributary streams to the Snake River; however, coldwater springs used for aquaculture can be completely appropriated for hatchery operations if it falls within their water right. At Box Canyon, the Banbury Springs lanx occurs downstream of the aquaculture diversion and further reduction or diversion of this coldwater springflow would reduce suitable, available habitat and potentially harm this species. Present management regulations may be inadequate, and water withdrawals from groundwater aquifers, spring outflows, or tributary streams may be at a level that affects the sustainability of Banbury Springs lanx.

In Idaho, the EPA retains authority for the issuance of permits through the National Pollutant Discharge Elimination System (NPDES), which is designed to manage point-source discharges. There are approximately 80 private or public-owned aquaculture facilities on the middle Snake River now permitted under the NPDES and over 20 additional facilities have applied for permits (USEPA 2002, pp. 4.19 and 4.20; Meitl 2002, pp. 23 to 25). Briggs Springs and Box Canyon have active NPDES permits for point-source discharges downstream of existing Banbury Springs lanx colonies. Given the increase in permit applications and the record of Clean Water Act violations in Idaho and the Pacific Northwest (Meitl 2002, pp. 23 to 25), threats to aquatic species, including the Banbury Springs lanx, from unexpected point-source discharges are not likely to be eliminated in the immediate future.

The IDEQ is responsible for managing point and non-point sources of pollution to waterbodies of the State. These sources contribute to a stream's inclusion in the EPA's list of impaired water bodies pursuant to section 303(d) of the Clean Water Act. Additionally, IDEQ under authority of the State Nutrient Management Act coordinates efforts to identify and quantify contributing sources of pollutants (including nutrient and sediment loading) to the middle Snake River and other Idaho watershed areas using a Total Maximum Daily Load (TMDL) approach (Baldwin et al. 2000, pp. 14 to 21). The TMDL approach is used to develop pollution control strategies in waterbodies that are currently not meeting water quality standards through several of the following programs: State Agricultural Water Quality Program, Clean Water Act section 401 Certification, Bureau of Land Management land management plans, the State Water Plan, and local ordinances. Factors addressed under TMDLs are mostly limited to phosphorus, total suspended solids, dissolved oxygen, flow, temperature, pesticides, metals, and petroleum compounds. National TMDL allocations were approved by USEPA in August of 2000. In 2001, over 700 river or stream segments in Idaho that have been formally recognized by USEPA as water quality-impaired were reported to have exceeded TMDL limits; 23 of those segments are located on the Snake River and many more in its tributaries (USEPA 2002, pp. 5.6 to 5.9). Improvements have been made in several reaches of the Snake River (Buhidar in litt. 2005, p. 1). TMDLs do not address groundwater, although protection of surface water may improve/conserve groundwater quality.

II.C.2.e. Other natural or manmade factors affecting its continued existence:

Invasive species may affect the continued existence of the Banbury Springs lanx in Idaho. The most notable example in the range of Banbury Springs lanx is the New Zealand mudsnail (mudsnail) (*Potamopyrgus antipodarum*) which was discovered in North America in the Snake River in 1987 and has since spread rapidly throughout Idaho and to other western states (Bowler 1991, pp. 175 and 176; Richards et al. 2004, p. 114). Frest and Johannes (1992a, pp. 45 and 46) found the mudsnail in 43 sites on the Thousand Springs Preserve. Currently, the mudsnail occurs in all four coldwater spring tributaries where the Banbury Springs lanx is found but in very low densities at occupied Banbury Spring lanx sites (Hopper in litt. 2006a, pp. 1 and 2; Hopper in litt. 2006b, pp. 1 and 2). However, near habitat margins where Banbury Springs lanx disappear, observed mudsnail densities increase.

The mudsnail appears to flourish in watercourses with relatively low dissolved oxygen and with substrates of mud or silt, but has also been recorded at high densities within some of the cold-water spring complexes of the middle Snake River (e.g., up to 500,000/m^2 at Banbury Springs; Richards et al. 2001, p. 375). Although the mudsnail may be able to withstand high water velocities (Lysne and Koetsier 2006a, pp. 81 to 83), they appear to reach the greatest densities in slower moving waters (Richards et al. 2001, p. 378). The New Zealand mudsnail's physiological tolerances (e.g., temperature and water velocity; Winterbourne 1969, p. 454; Lysne and Koetsier 2006a, pp. 81 to 83), life history attributes (e.g., high fecundity, growth, and dispersal rates; Winterbourne 1970, p. 147; Richards 2004, pp. 25 to 34), and habitat uses (e.g., springs, rivers, reservoirs, and ditches; Cada 2004, p. 27; Hall et al. 2003, p. 407; Clark et al. 2005b, p. 10; Richards 2004, pp. 47 to 67) may confer to the mudsnail a competitive advantage over the Banbury Springs lanx. Given the potential for an ecosystem-wide impact given the species' specific habitat requirements (Hall et al. 2003, p. 407), the New Zealand mudsnail seems likely to continue to present a threat to native populations of aquatic species by occupying marginal habitats where native species may have been found.

II.D. Synthesis

The primary factors that threaten the existence of the Banbury Springs lanx in its four remaining coldwater spring complexes and tributaries of the middle Snake River include the effects from habitat modification, spring flow reduction, reduced groundwater quality, the invasive New Zealand mudsnail, and inadequate regulatory mechanisms. The respiratory requirements and life history attributes of the Banbury Springs lanx make this species susceptible to small fluctuations in water temperature, dissolved oxygen, sediment, or the effects of pollutants. This species appears to prefer deep, cold water springflows of high quality and stable substrate. Habitat modification has affected this species by reducing the availability of suitable coldwater spring habitats. Examples of habitat modification at the four known locations include: hydroelectric development in the Thousand Springs Preserve; aquaculture diversions in Box Canyon and Briggs Springs; and past impoundments of the springflows at Banbury Springs. Coldwater springflows from the Snake River aquifer at the four Banbury Springs lanx sites are also declining. As spring flows continue to decline throughout the range of this species, flows appropriated for hydroelectric power generating facilities and coldwater springflows diverted for aquaculture facilities and other uses will continue to compete for and likely reduce the available water for the Banbury Springs lanx. Degraded groundwater quality of the Snake River aquifer from agricultural and aquaculture practices will continue to affect the coldwater spring outflows upon which this species exists. The non-native New Zealand mudsnail has invaded the coldwater springflows where the Banbury Springs lanx colonies occur, and occupation of nearby coldwater spring habitat could alter the trophic dynamics of these tributary springs. Further, expansion of the mudsnail likely limits the ability of the Banbury Springs lanx to migrate and disperse to other suitable nearby locations. Because this species is currently restricted to four isolated colonies, future stochastic as well as anthropogenic disturbances could negatively impact this species. Existing regulatory mechanisms that oversee groundwater management of the Snake River Plain Aquifer may not be adequate to reverse the declining coldwater spring outflows upon which the Banbury Springs lanx depends. For these reasons we feel that the Banbury Springs lanx remains in danger of extinction in a significant portion of its range.

III. RESULTS

III.A. Recommended Classification*:*

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist*:*
  ____ *Extinction*
  ____ *Recovery*
  ____ *Original data for classification in error*
__X__ No change is needed

III.B. New Recovery Priority Number __6__

In 1995, the Banbury Springs lanx was assigned a recovery priority number of 8, indicating a moderate degree of threat, and rated high in terms of recovery potential. At the completion of the 5-year review process, we believe that although taxonomically undescribed, the Banbury Springs lanx is believed to be a species, it is subjected to a high degree of threat, and it rated low in terms of recovery potential. This species only lives in four spring complexes, each of which are isolated from each other. Coldwater springflows from the Snake River Plain

Aquifer continue to decline and current regulatory management may not be adequate to stop the decline. The isolation of the four remaining colonies makes each colony susceptible to genetic inbreeding as well as at risk from natural or manmade disturbances. It seems unlikely that the Banbury Springs lanx will be able to increase in distribution or abundance because of the effects of past habitat modification, reduced water quality, declining springflows, and the invasive New Zealand mudsnail.

III.C. If a reclassification is recommended, indicate the Listing and Reclassification Priority Number: Not applicable

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

Update the Recovery Plan

We recommend that the Snake River Aquatic Species Recovery Plan be updated to include new information that we have learned since the listing of this species in 1992. The existing recovery plan was finalized in 1995 and does not contain measurable recovery criteria specific to the Banbury Springs lanx; the existing criteria were written to encompass all species covered by the recovery plan. We recommend that the formulation of new recovery criteria include monitoring components as we have listed below that will enable us to know whether each colony of Banbury Springs lanx is stable, declining, or increasing in trend information and show an increasing or stable trend across at least a 5-year period.

Monitoring Program

We recommend that a non-intrusive annual monitoring program be performed at each of the four colonies (Thousand Springs, Box Canyon, Banbury Springs, and Briggs Springs) on a recurring basis. Comparisons can be made across years to determine whether Banbury Springs lanx colonies are declining, stable, or increasing. We recommend that measurements be performed in January when vegetation will be stunted allowing for more efficient detection; this time of year is the period when body sizes are largest and predates egg-laying. The Banbury Springs lanx occurs in low densities in some areas and we recognize that monitoring should be halted if it is believed that the population is being reduced as a result of the monitoring effort.

Life History Experiments

We recommend that life history experiments with live Banbury Springs lanx be performed in a laboratory setting to better understand the life history of this species in a controlled environment. Life history parameters of interest would include but not be limited to: growth rate, size at reproduction, number of egg capsules/individual, location of egg capsules, self-fertilization or fertilization from another individual, dispersal, feeding, temperature preference/maximums and minimums, and dissolved oxygen preference/maximum/minimum.

Translocation

As the Banbury Springs lanx are currently found at only four, isolated locations over 6 rm of the Snake River, we recommend translocation of Banbury Springs lanx to other suitable and protected coldwater spring habitats to ensure the continued existence of this species. Possible locations for translocation of the Banbury Springs lanx would be upstream of the waterfall at

Box Canyon and the adjacent four spring locations at Banbury Springs. At Box Canyon, upstream of the falls, the New Zealand mudsnail does not occur; therefore, caution should be exercised while transporting Banbury Springs lanx upstream of the falls to avoid contaminating this habitat with the mudsnail. As genetic studies are not yet available that show how colonies are related, we suggest that Banbury Springs lanx from Box Canyon be used to introduce Banbury Springs lanx upstream of the waterfall at Box Canyon, and that Banbury Springs lanx from Banbury Springs be used to introduce snails to the adjacent springs at Banbury Springs. At Box Canyon, Banbury Springs lanx should be introduced near the spring origin to facilitate natural colonization of habitat downstream of the introduction site.

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Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Banbury Springs lanx

Current Classification __Endangered__

Pre-1996 DPS listing still considered a listable entity? __Not Applicable__

Recommendation resulting from the 5-Year Review;

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
_X_ **No change is needed**

Appropriate Listing/Reclassification Priority Number, if applicable __Not Applicable__

Review Conducted By __Cary Myler, Steve Lysne, and Dave Hopper__

________________________ Date 8-25-06
Jeffery L. Foss, Field Supervisor, Snake River Fish and Wildlife Office, Region 1

Acting
Approve ________________________ Date 9/15/06
Regional Director, Region 1, Fish and Wildlife Service

APPENDIX A: Summary of peer review for the 5-year review of Banbury Springs lanx/*Lanx* n sp. (undescribed)

A. Peer Review Method:

We first generated a document, the Banbury Springs lanx status review, which represented the best information regarding the status of the species. This document underwent intense internal SRFWO review to insure that the document that we presented to the peer reviewers was of high quality and utility. A list of experts in general snail ecology and Snake River snail habitat was developed by performing library searches for pertinent snail related topics and keywords from primary scientific journal articles. A short list of potential peer reviewers was created by using scientific articles authored specifically about the Banbury Springs lanx or its habitat. After we identified individuals that were qualified to conduct a critical review of the Banbury Springs lanx draft status review, we generated a candidate list and asked for their interest and availability via a phone call. We selected six peer reviewers that were interested and available. Peer reviewers were given a cover letter, the Banbury Springs lanx draft status review, PDF files of all cited literature, and a list of questions to consider during their review. We provided over 30 days for the actual peer review of the Banbury Springs lanx draft status review. We received comments from five out of the six peer reviewers. Peer review comments were incorporated into the Banbury Springs lanx status review. The updated Banbury Springs lanx status review document, and peer review comments were provided to manager panel members 2 weeks prior to the briefing.

B. Peer Review Charge:

Peer reviewers were given the following list of questions to consider on the draft status review:

- Does the information contained in the draft status review clearly describe the life history, ecology and habitat needs of the Banbury Springs lanx?
- Are there areas of uncertainty or significant information gaps or omissions that should be discussed in the draft status review?
- Is the discussion regarding the Banbury Springs lanx's population status and trends clear, reasonable, and supported by the best scientific and commercial information available?
- Is the discussion regarding the relationship between the Banbury Springs lanx's known distribution and life history requirements, and the threat factors, as identified within the document, accurate?
- How do the basic life history traits of the Banbury Springs lanx contribute to population resiliency, resistance, or vulnerability to threat factors potentially affecting the species?
- Are you aware of other threat factors not discussed in the status review that are of importance to the continued growth, survival, and/or reproduction of the Banbury Springs lanx?
- Are you aware of other documents (journal articles or unpublished information) relevant to the Banbury Springs lanx or potential threat factors that we have not considered? If so, please provide citations and a brief summary of the relevant information.

- Is the discussion of regulatory mechanisms complete?
- Are you aware of additional regulatory mechanisms directly pertaining to the conservation and recovery of the species?
- Are you aware of additional conservation measures, either implemented or planned, that are not considered in this document but may contribute to the conservation and recovery of the species?

C. Summary of Independent Peer Review Comments/Report:

Generally, all five peer reviewers concurred that the Banbury Springs lanx status review document was an accurate description of what we know about this species' life history, biology, ecology, threats, and regulatory mechanisms. All five peer reviewers agreed that the Banbury Springs lanx still faces the same threats it did at the time of listing. All peer reviewers provided ideas where research could benefit our understanding of this species (e.g., propagation, introductions, life history studies). Terry Frest provided additional life history observations on the Banbury Springs lanx (e.g., egg capsules, hermaphroditic, no self fertilization, hatchlings reach full size in a few months). Terry Frest and Peter Bowler commented on the paleoecology of the Banbury Springs lanx (e.g., how the species evolved through geologic time) and provided pertinent literature. David Richards commented that the New Zealand mudsnail lives in areas of high stream productivity and that Banbury Springs lanx lives in areas of low productivity. Richards still believes that the mudsnail may out-compete the Banbury Springs lanx in fringe habitat where both species occur. Richards commented that the Banbury Springs lanx should remain endangered because it only occurs across a small geographic range, it has a limited distribution, has low densities, and only lives in 4 spring complexes that do not have potential for migration. Terry Frest and Stephanie Clark commented on ongoing anatomical and genetics studies that they are performing on Banbury Springs lanx specimens collected from Idaho. Preliminary results suggest that this species may be more closely related to the genus *Fisherola* than *Lanx*, but it is still believed to be a distinct species. They expect to formally describe this species by the end of 2006. Peter Bowler and Stephanie Clark suggested that more life history information be added to the status review but did not provide any new information.

D. Response to Peer Review:

<u>Peter Bowler (University of California, Irvine)</u>

Comment: Photographs and/or line drawing of the shells of the Banbury Springs lanx, *Fisherola nuttalli*, and *Ferrisia rivularis* should be presented so that the clear morphological differences between them can be demonstrated.
Response: Terry Maret provided an excellent photograph of the Banbury Springs lanx that was incorporated into the status review. The Service feels that further explanation between *Lanx*, *Fisherola*, and *Ferrisia* is beyond the scope of this 5-year review process.

Comment: It would be useful to discuss the relationship between the Banbury Springs Lanx, and the *Lanx* that Dwight Taylor reported from the Glenns Ferry formation.
Response: The Service acknowledges that the paleoecology of the Banbury Springs lanx is interesting, but this topic is beyond the scope of the 5-year review for this species.

Comment: While the Banbury Springs lanx is a narrowly restricted endemic, it would be useful to briefly mention reviews of other species in that genus and of *Fisherola nuttali*. The ecology and autecology of related taxa could be useful in better understanding various aspects of the life history of this species.
Response: The Shoshone sculpin and *Fisherola nuttali* are mentioned in the status review. However, *Fisherola nuttali* has not been found in springs (only in the Snake River). Although the Service acknowledges that these species may occupy similar habitat, we do not have documentation needed for our records that shows a clear connection with the Banbury Springs lanx.

Comment: I think that the life history could be better elaborated so that non-technical reviewers could understand this species more readily. Are there male and female animals, or do they self-fertilize (what kind of reproductive system is used and what would be that rate of sexual recombination)? How many eggs are laid by each snail? Are these produced at one time or is the deposition of eggs stretched over a period of days, weeks, or months? How long does it take each egg to hatch, and what are the critical nursery characteristics needed by hatchlings? Presumably they reach maturity relatively rapidly; does an individual reproduce more than once in its life cycle? Better describing this kind of information, if known, would also aid in strengthening and making more specific the discussions of population fragmentation and genetic isolation later in the document.
Response: In the peer review comments provided by Terry Frest, more life history observations were provided and have been incorporated into the status review document. At this point there are still many things that we do not understand about the Banbury Springs lanx, and we will add these information needs as recommendations for future recovery actions.

Comment: Is the Banbury Springs lanx restricted to basalt cobbles, or has it been observed on cobble of other lithic sources as well (I realize that most of the available cobbles would be basaltic in origin)?
Response: The Service acknowledges that the Banbury Springs lanx may be present on cobbles other than basalt. All available information has shown that Banbury Springs lanx is found on basalt cobbles most likely as stated in the comment as basalt is the most available substrate available. The main point to convey is that the Banbury Springs lanx has been found only on large, stable substrate, and has not been found on wood, macrophytes, silt or sand.

Stephanie Clark (University of Alabama)

Comment: The draft status review document does not address issues such as the presence or not of either discrete management units or evolutionary significant units.
Response: Management units are determined by recovery actions and are beyond the scope of the 5-year review process. Evolutionary significant units are used by the National Oceanographic and Atmospheric Administration for the recovery of species and are not applicable to species administered by the Service.

Comment: There is no mention of determining the levels of genetic variation present within and between the four colonies.
Response: The need for determining the genetic variation among the four colonies of Banbury Springs lanx was mentioned in the draft status review document. We continue to stress the importance of this information for recovery actions such as reintroductions and propagation.

Comment: The draft status review document does not make mention of possible effects of parasitism, which appears to be prevalent in some populations of related species of *Lanx* from the Northwest.
Response: The Service acknowledges that parasitism could possibly affect the Banbury Spring lanx population, but we are not aware of information that indicates this is an issue. New information regarding parasitism as a threat was not submitted during the Status Review process.

Comment: The draft status review does not address issues related to the possibility of developing a captive rearing program to supplement/enhance the currently known population or to possibly establish additional colonies within the known range of the species.
Response: Propagation and transplantation are recovery actions that are beyond the purpose of the draft status review. However, the Service is currently exploring the feasibility of using these tools to strengthen existing Banbury Spring lanx colonies.

Comment: Recent anatomical studies have confirmed that the Banbury Spring lanx should be transferred from the genus *Lanx* to the genus *Fisherola*. In addition, the anatomical data suggests that the Banbury Spring lanx is a separate and as yet unnamed species distinguishable from, and closely related to *Fisherola nuttalli*. The anatomy also indicates that the four known colonies are closely related and belong to a single species.
Response: This information is already recorded in the Banbury Spring lanx status review. When this information is finalized and the Banbury Spring lanx is formally described the Service will update our files and naming.

<u>Terry Frest (Deixis Consultants)</u>

Comment: There are a few other considerations that need to be looked at more seriously. The fossil record is admittedly rather incomplete, so that the absence of Lake Idaho fossils is not decisive. This is especially so if this taxon is a complete limnocrene form, as the record seems to indicate. The absence of Middle Snake mainstem colonies, historic or surviving, is possibly significant. One should keep in mind here that Lake Idaho spring deposits are small in area as compared to other habitats. Nevertheless, over half of Taylor's 90-species fauna seems to be confined to the few spring deposits: and the fluvial and fluvial-lacustrine Lake Idaho fauna is very distinct. Note that western US freshwater springsnail faunas are characteristically diverse, endemic, and very distinct from stream forms (Frest & Johannes, 2002). For that matter, so is the transitional Pliocene-Pleistocene "Lake Idaho" mollusk fauna. Further, we have covered the range of *Fisherola*

nuttalli fairly completely, *e.g.* in Neitzel & Frest (1993), finding *Fisherola* in a wider range than previously supposed. But despite rather extensive investigations into Columbia Basin freshwater habitats of many sorts, including springs of various sorts, we have found no indication of spring-specialized *Fisherola* populations. On the other hand, there do appear to be spring-specialist *Lanx* in California, which may well be new taxa. In any case, we've found nothing in the range of *Fisherola* diverging much from the standard stream habitat and morphology of *F. nuttalli*. It would seem especially remarkable if *Fisherola* gave rise to a spring taxon only in the core Lake Idaho, although this is not impossible.
Response: The Service acknowledges the importance of paleoecology to the Banbury Spring lanx. However, this information is beyond the scope of the 5-year review process. When this species is formally described we will incorporate that information and/or name changes into our files and documents.

Comment: p. 4. Perhaps better characterization of Banbury sites would be useful. What species occur with the lancid? Note how many are coldwater forms; similar endemics; listed or specialized forms, etc. Perhaps show photo of typical site? Do associated species share life history or other features?
Response: The Shoshone sculpin and *Fisherola nuttali* are mentioned in the status review. However, *Fisherola nuttali* has not been found in springs (only in the Snake River). Although the Service acknowledges that these species may occupy similar habitat, we do not have documentation needed for our records that shows a clear connection with the Banbury Spring lanx.

Comment: pp. 7-8. Life history possibly deserves more discussion. In general, both steam and spring lancids seem to have a near-annual life cycle; and turnover is extensive. Many seem to breed in early spring; lay egg capsules about a month later; and die shortly after laying eggs. The capsules develop quickly and hatch within 1 to 2 months. Generally, they are small, hemispherical, clear, and may contain 6 to 12 eggs. Each egg-layer appears to lay several capsules, over a period of a few days. The yolk may be pigmented (pink, blue, and white have been seen) and the yolk color may be a species characteristic, as may the number of eggs per capsule. Many *Lanx* stream populations are very obviously seasonal; but spring populations seem less so, perhaps indicating that only a portion of the population breeds in any given month. Banbury Springs lanx and *Fisherola* populations are less obviously age-structured than many *Lanx*. Perhaps consequently, few egg masses are seen at any special time. Still, the death after breeding and seeming semelparous condition are atypical for pulmonates and more like co-occurring hydrobiids. The life span, though, seems to seldom exceed 1 year, unless an individual does not reproduce. Like many pulmonates, *Lanx* and *Fisherola* are hermaphrodites but do not appear to be self-fertilized. The annual life cycle, small number of eggs per capsule, and semelparous breeding are rather unusual for pulmonates. Hatchlings appear to grow rapidly and reach nearly full size in a few months. Capsules seem to be laid only on hard substrate, generally undersides or sides of cobbles in especially protected areas where the adults occur. The same areas seem to be preferred repeatedly, from year to year. In many areas, rather smooth cobbles, often of basalt, seem to be preferred. Recesses in more complex liths may be areas of capsule concentration.

Egg-layers seem to place a single capsule before moving on to another location. In *Lanx*, several capsules are deposited by each egg-layer; but the total number possible is not known.
Response: Comment incorporated. This information was added to the Banbury Spring lanx status review document and was used to develop a recommendation in the 5-year review process.

Comment: p. 11. It is unlikely that too many more sites will be found. What is notable is that at least three of the four sites would have been readily subject to Bonneville floods if that made a difference. The association with Lake Idaho seems especially likely to hold. We did about 200 spring sites in southeast Idaho in a variety of situations without finding this taxon.
Response: The Service also feels confident that we have a good understanding on the distribution of the Banbury Spring lanx. The list of studies and springs that were sampled is included in the status review and was used to develop a recommendation in the 5-year review process.

Comment: One thing that does concern me overall is that water quality and quantity problems may be underemphasized. The review of available information is good; but perhaps too sanguine re. nutrient loading, interactions with point recharge wells, etc. Moreover, it appears to me that there is an obvious decline in spring volume at sites overall. If this continues, it could become critical. How has ground water withdrawal volume changed in the area: and are we looking at atypical, e.g. drought conditions or average withdrawal in the ranges covered? How much ground water can legally be extracted from the aquifer? Given population increases throughout southern Idaho, is there any chance of long-term drawdown, as occurs at, say, Burns OR?
Response: The Service acknowledges the concerns of poor water quality and reduction of spring discharge. These are the highest ranking threats that still may harm the Banbury Spring lanx. However, we can only include the best information available in the status review process and this comment did not provide any new information.

<u>Terry Maret (US Geological Survey)</u>

Comment: I disagree with the statements on page 1 under Listing Status section "… it is subject to a moderate degree of threat, and is rated high in terms of recovery potential." The evidence provided in the status review shows that the Banbury Spring lanx is subject to a high degree of threat, and its recovery potential would be low.
Response: The comment refers to the recovery priority number which was assigned at the time of the recovery plan. The Service agrees with the comment. The 5-year review is a venue to change a recovery priority number and this will be addressed with the new information present in the status review. This recommended recovery priority number resulting from the 5-year review agrees with the assessment of threats and recovery potential in this comment.

Comment: On the map, the symbol indicating the known locations of Banbury Spring lanx is not easily visible, suggesting using a different color and enlarging the symbol.

Response: Comment incorporated.

Comment: The Description section begs for a photo of the Banbury Spring lanx. The USGS has some nice photos if you would like to borrow them.
Response: Comment incorporated. The USGS provided our office with a photo of the lanx which was incorporated into the status review.

Comment: Pg 11, last sentence of second paragraph. Suggest changing pollution to chemical constituents. Total dissolved solids and nitrogen aren't necessarily considered pollution. These constituents occur naturally in the springs and only are considered pollutants when in excess.
Response: The Service agrees with the comment, but we feel that the context is provided in the paragraph that shows that these constituents are pollutants in the current context.

Comment: Pg. 16. In your discussion about water temperature you might want to consider adding a graph of continuous water temperature from either Briggs or Box Canyon to illustrate the thermal characteristics of the spring habitats where BSL are found. The USGS can provide this information if you would like to use.
Response: The Service obtained this information from the USGS and incorporated this information of the final recommendation in the 5-year review.

Comment: The statement about finding tritium in several springs leads the reader to believe the source might be Idaho National laboratories. Clark and Ott (1996) were using tritium analysis as a tracer to determine water sources of the springs. The levels they detected were characteristic of natural background levels. Tritium sources found in the springs are likely a result of atmospheric deposition from natural fallout and a variety of nuclear testing began in the early 1950s.
Response: Comment incorporated into the status review.

David Richards (EcoAnalysts)

Comment: In the draft status review there were several assumptions made about life history and behavior of the Banbury Spring lanx. I do not feel that we have adequate data to support many of these assumptions. (1) We do not know that the life cycle of the Banbury Spring lanx is similar to *Fluminicola*, (2) We do not know the food habits of the Banbury Spring lanx, (3) The Banbury Spring lanx is found at depth in Banbury Springs, and (4) We do not know that the Banbury Spring lanx's steep conical shell makes it more adapted to fast water.
Response: The Service fully acknowledges that life history information is lacking for the Banbury Spring lanx, however, these assumptions come from papers from Terry Frest who has observed this species, other limpets, and many other snail species across the western U.S. at over 200 sites. Frest is a recognized expert on the Banbury Spring lanx and we have qualified these life history attributes as observations in the status review. In addition, we acknowledge that the Banbury Spring lanx is not found at depth at Banbury Springs, but it is at the other three colonies. The status review clearly makes that distinction.