Bliss Rapids Snail
(Taylorconcha serpenticola)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service/
Idaho Fish and Wildlife Office, Boise, Idaho

5-YEAR REVIEW

Species reviewed: Bliss Rapids Snail (*Taylorconcha serpenticola*)

5-YEAR REVIEW
Bliss Rapids Snail/*Taylorconcha serpenticola*

1.0 GENERAL INFORMATION

1.1 Name of Reviewer(s):

Greg Burak, Idaho Fish and Wildlife Office, Fish and Wildlife Biologist
Dave Hopper, Idaho Fish and Wildlife Office, Fish and Wildlife Biologist
Tracy Melbihess, Idaho Fish and Wildlife Office, Chief of Classification and Recovery
Kathleen Hendricks, Idaho Fish and Wildlife Office, Assistant State Supervisor
Christopher Swanson, Idaho Fish and Wildlife Office, Deputy State Supervisor
Gregory M. Hughes, Idaho Fish and Wildlife Office, State Supervisor

1.2 Methodology used to complete the 5-year review:

This review was conducted by staff of the Idaho Fish and Wildlife Office (IFWO) of the U.S. Fish and Wildlife Service (Service), beginning on January 22, 2018. This review was based on a current, available information that has been obtained prior to and since a 2009 12-month finding on a petition to remove the species from the list of endangered and threatened wildlife (74 FR 47536-47545). The evaluation conducted by biologists with the Idaho Fish and Wildlife Office (see above) was reviewed by the IFWO Chief of Classification and Recovery. The document was then reviewed by the Assistant State Supervisor for Endangered Species before submission to the State Supervisor for review and approval.

In conducting this review, we (Service) utilized information obtained since the 2009 12-month finding review for the species that are contained in peer-reviewed literature and numerous technical reports prepared by the Idaho Power Company and various government agencies. These reports include peer reviewed scientific studies related to the species' taxonomy; species monitoring and water quality data collected by the Idaho Power Company and the Service; water quantity and quality reports produced by the U.S. Geological Survey, Idaho Department of Water Resources and Idaho Department of Environmental Quality; regulations and conservation measures produced by the Idaho Department of Fish and Game, Idaho Water Resources Board, and Idaho Department of Water Resources; and, various other scientific literature regarding the species and its habitat requirements.

1.3 Background:

Information regarding the species listing history and other facts is available on the Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species (*https://ecos.fws.gov/ecp/*).

1.3.1 FR Notice citation announcing initiation of this review: February 12, 2016. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 76 Species in Hawaii, Oregon, Washington, Montana, and Idaho. 81 FR 7571.

1.3.2 Listing history

Original Listing
FR notice: 57 FR 59244
Date listed: December 14, 1992 (effective January 13, 1993)
Entity listed: Bliss Rapids Snail (*Taylorconcha serpenticola*)
Classification: Threatened

1.3.3 Associated rulemakings: None

1.3.4 Review History:

90-Day Finding on a Petition to Remove the Bliss Rapids Snail (*Taylorconcha serpenticola*) from the List of Endangered and Threatened Wildlife (72 FR 31250, June 6, 2007).

90-Day Finding on a Petition to Remove the Bliss Rapids Snail (*Taylorconcha serpenticola*) from the List of Endangered and Threatened Wildlife; Notice of Document Availability (73 FR 46867, August 12, 2008).

12-Month Finding on a Petition to Remove the Bliss Rapids Snail (*Taylorconcha serpenticola*) from the List of Endangered and Threatened Wildlife (74 FR 47536, September 16, 2009).

On December 26, 2006, the Governor of Idaho along with the Idaho Power Company, provided a petition providing information on the Bliss Rapids snails' current status, along with a request to the Service that the Bliss Rapids snail be removed from the Federal list of Threatened and Endangered Species. Subsequently, the Service submitted a request to the public for additional information on the species range-wide status and a review of the petition and information by the Service and an expert panel. The 12-Month Finding issued by the Service supported the continued listing of the species as threatened citing factors such as restricted range, specialized habitat requirements, the persistence of threats to those habitats, and without protections afforded by the Endangered Species Act, existing regulations would not be sufficient to conserve the species.

1.3.5 Species' Recovery Priority Number at start of 5-year review: The Service designated a recovery priority number of 7C for the Bliss Rapids snail, indicating that it is a monotypic genus, subject to a moderate degree of threat, rated high in terms of recovery potential, and may be in conflict with construction or other development projects or other forms of economic activity.

1.3.6 Recovery Plan or Outline

Name of plan or outline: Snake River Aquatic Species Recovery Plan.
Date issued: December 26, 1995
Dates of previous revisions, if applicable: NA

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

Not applicable as the DPS policy only applies to vertebrates.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery policy containing objective, measurable criteria?

_*X*___ ***Yes***

____ ***No***

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

____ ***Yes***
_*X*__ ***No***

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information: From: Snake River Aquatic Species Recovery Plan, pp. 29-31. 1)

In 1995 the Service completed the Snake River Aquatic Species Recovery Plan (Plan) (Fish and Wildlife Service (FWS) 1995) that provides the recovery needs and criteria for 5 species of federally listed mollusks in the Snake River, including the Bliss Rapids snail. Since the publication of that Plan, two of the five mollusks have been delisted based on expanded range and increased abundance (75 FR 52272, August 25, 2010) or taxonomic revisions (72 FR 43560, August 6, 2007), but the Plan has not been updated since the original 1995 publication. Two general recovery criteria were identified in the Plan that were needed to achieve recovery of all 5 of those listed species, with specific criteria provided for each. The general recovery criteria are:

- Criteria 1: Recovery will be based on detection of increasing, self-reproducing colonies at pre-selected monitoring sites within each species' recovery area for a 5-year period.

Monitoring sites will be selected in areas of known live snail collections from the past 15 years and will generally represent the outer most boundaries of the recovery area for each species.

  - Specific to the Bliss Rapids snail: three river colonies and three spring colonies were identified in the Plan to serve as reference sites for monitoring population trends. The river colonies/sites include Clover Creek (River Kilometer (RK) 881 (River Mile (RM) 547.5), Bliss Bridge (aka Shoestring Bridge) (RK 909, RM 565), and Bancroft Springs (RK 890, RM 553). These sites were selected in part because they represented the known, down-river extent of the species' range in the Snake River at that time. The three spring populations identified for monitoring in the Plan were Banbury (RK 948, RM 589), Box Canyon (RK 946, RM 588), and Thousand (RK 940, RM 584) Springs.

- Criteria 2: Standards for habitat conditions will be based on State water quality standards for cold-water biota including annual water temperatures that average below 18 °C; dissolved oxygen concentrations greater than 6 parts per million[1]; and pH levels that are within the range of 6.5 to 9.5 mg/l.

Status/Degree to which Criteria have been met

Based on our review, Criteria 1 for the Bliss Rapids snail has not been adequately met. None of the three pre-determined river sites have been monitored regularly and data on the population trends of those colonies has been poorly and insufficiently collected since publication of the recovery plan. We know of no data collected at these river locations since publication of the recovery plan that provide an estimate of density or abundance that might be used as a baseline for the species' status or changes over time. Based on our improved understanding of the species' distribution and biology, those three river sites may no longer represent the best locations for long-term monitoring though they may still "represent the outer most boundaries of the recovery area" within the river as stated in the Plan, and as such provide crucial information on changes in the species' range. Starting in 2010, numerous other river areas were included in annual monitoring and indicate these populations fluctuate greatly between years (section 2.3.1.2 below), likely influenced by environmental factors such as river flow. These colonies are self-reproducing and the 5-year period of 2012 through 2016 show increasing detections. However, other years have shown drastic declines (2011, 2017) which suggest Criteria 1 needs to be more clearly articulated to identify an objective and measurable recovery goal.

Since 2010, the three spring colonies identified in the recovery plan have been regularly monitored. The Banbury Springs population undergoes a more thorough sampling comprised of total counts of individuals from 300 randomly selected cobbles. Both Box Canyon and Thousand Springs are more qualitative, providing an estimate of habitat occupancy (percentage of cobbles occupied), without recording the number of individuals present. While monitoring has confirmed these colonies are self-reproducing, none have demonstrated increasing populations, showing both increases and decreases in numbers of individuals or occupancy between years (section

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[1] Both dissolved oxygen and pH were erroneously presented in the 1995 Plan. Idaho State's water quality criteria for cold-water biota are 6 milligrams per liter (mg/L) for dissolved oxygen (parts per thousand) and pH is reported as a numeric value only and not reported as a concentration (IDEQ in litt., pp. 159-162).

2.3.1.2). While these data do not reveal a steadily increasing trend, neither do they illustrate a steady decline, and are more reflective of naturally fluctuating populations influenced by hydrologic and other environmental parameters. Importantly, not all spring populations being monitored since 2010 show consistent, fluctuating trends, two (Fisher Lake, Hagerman National Fish Hatchery) of nine showing regular declines and a single, up-river colony having become extirpated (sections 2.3.1.2, 2.3.2.1).

Monitoring for Criteria 2 has been less rigorous than that of Criteria 1, indicating that water quality criteria have not been met. We are aware of no data collected at any of the three river locations identified in the recovery plan that have adequately monitored water quality trends to address Criteria 2. The three river-dwelling colonies identified for monitoring all occur downstream of, and are heavily influenced by, springs from the Eastern Snake Plain Aquifer (ESPA). This aquifer system contributes an estimated 5,000 to 6,000 cubic feet per second (cfs) of cold water (14-17 ℃) to the Snake River, which should help ensure river water quality conditions (specifically temperature) do not exceed the State Water Quality Standards for cold-water biota. However from 2001 to 2017[2], these standards have been exceeded in the Snake River (King Hill, USGS gage 13154500) every summer, with the daily mean (19 ℃) exceeding those standards 840 times and the daily maximum (22 ℃) being exceeded 71 times 10 of those years (USGS in litt. 2018). Hence, within the Snake River, recovery Criteria 2 has not been achieved and has been violated in no fewer than 27 days per year over the obtained period of record. Criteria 2 also applies to spring habitats, and since 2010, the Service has collected temperature data at Box Canyon Springs, a spring inhabited by Bliss Rapids snail. These records indicate that past summer highs have exceeded the cold-water temperature criteria by an estimated 0.5 ℃ (Figure 1). However, since 2011, no water temperatures have exceeded 16.7 ℃ at this spring. Data has not been sufficiently collected at other springs to assess if temperatures regularly violate Criteria 2. However as illustrated in Figure 1, temperature exceedance is possible even at these aquifer springs. Other water quality data (e.g., pH) has not been rigorously collected.

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[2] Data for 2003 not accessible through USGS web site.

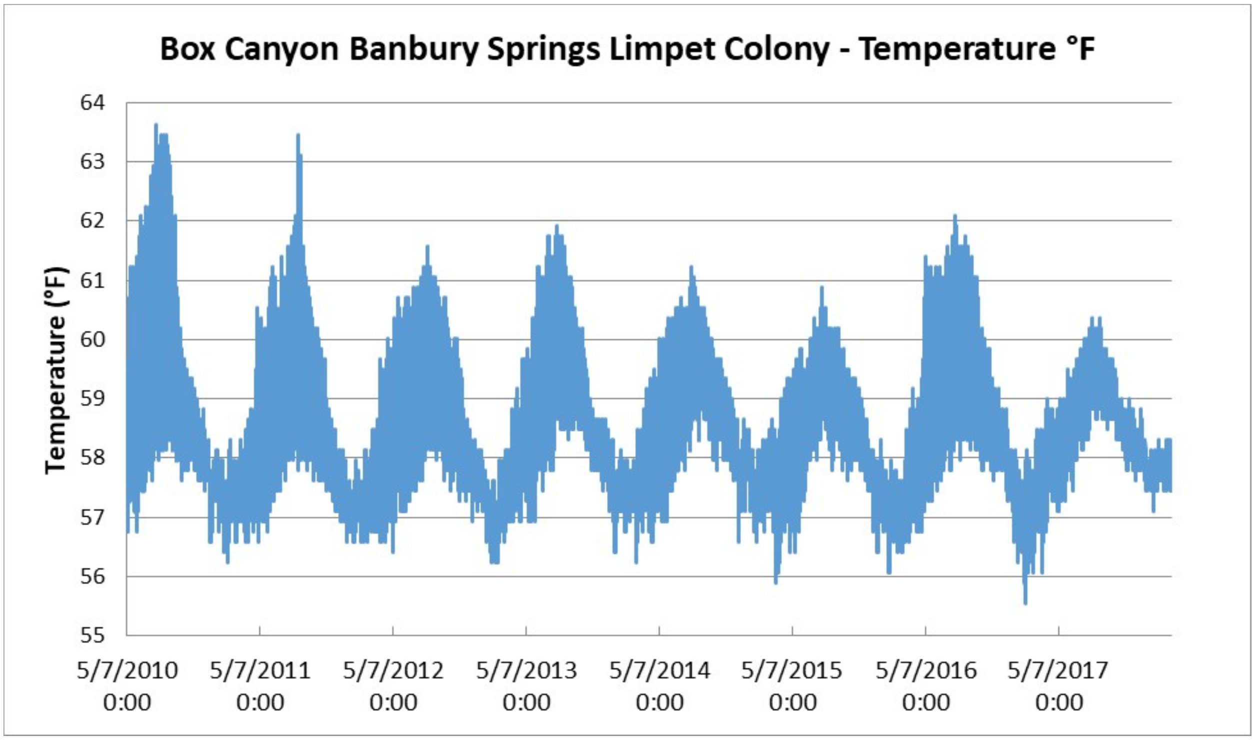

Figure 1. 2010-2017 water temperature (°F) data collected at Box Canyon Springs where it is occupied by the Bliss Rapids snail. The high temperature of 63.5 °F is equivalent to 17.5 ℃, 0.5 ℃ in exceedance of the criteria for cold-water biota. Data collected by the FWS with an Onset® HOBO Pendent® water temperature data loggers.

Richards (2004, pp. 25-27) conducted controlled experiments to assess optimal water temperatures for the growth of Bliss Rapids snail, finding optimal growth rates occurred from 15 to 20 ℃. Richards also found that growth approached zero at 6 ℃ and 26 ℃, with substantial reductions observed at 22 ℃. Richards also noted increasing rates of mortality (10-20%) at the lowest (6 ℃) and highest (26 ℃) temperatures tested. These studies did not address long-term effects on factors such as reproduction or food (diatom) production. These studies clearly illustrate the importance of maintaining water quality standards within the species' distribution and that failing to meet the standards of recovery Criteria 2 has the potential to result in adverse effects to Bliss Rapids snail. While Richards' findings suggest that Bliss Rapids snails may have a higher temperature range than outlined in Criteria 2, his experiments did not extend beyond 2 months and did not include a measurement of fitness (reproduction), other than to note that no egg laying was observed during the 15 days after termination of the experiment.

As our understanding of water quality changes in the ESPA have improved, there has become an obvious need to consider water quality standards not identified in Criteria 2. As an example, nitrate concentrations in groundwater springs throughout the species' range have increased in recent years (see 2.3.2.1). Nitrates are documented to cause mortality and alter behavior of aquatic insects (caddisflies) and amphipods at relatively low concentrations, especially for younger life stages, but was less toxic to the New Zealand mudsnail, a species recognized as being tolerant of poor water quality conditions (Camargo et al. 2005, p. 1257-1260). We do know that efforts to rear Bliss Rapids snails at a rearing facility in clean spring water sources elsewhere in the country met with poor success (Warbritton in litt. 2009), indicating specialized needs and sensitivities of this species. Knowing that nitrates are an emergent contaminant in the ESPA, that they are documented to adversely affect aquatic invertebrates, and that the Bliss Rapids snail is sensitive to changes in water quality, supports the need to assess the effects of nitrates on Bliss Rapids snail in future studies. Future revisions to Criteria 2 should include the results of those studies and provide objective criteria that adequately protect water quality for the species' conservation.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

There have been new findings on the species' biology and distribution since the last 5-year review of 2009. Monitoring conducted as part of projects conducted by Idaho Power Company have shown that populations of Bliss Rapids snail can rebound if the disturbed habitat is returned to pre-project conditions within certain timeframes. In one well documented case a tributary population was greatly reduced after an extended exposure to high water flows, greatly reducing local densities. Two years after stream discharges had stabilized to pre-project conditions the population had rebounded to healthy levels (e.g., Bean 2014, pp. 1-2). This understanding has enabled certain construction projects to go forward so long as habitat quality is restored and water quality is not overly impaired by the activity. In addition, annual monitoring conducted in the Snake River since 2010 has revealed that while the species' range includes an estimated 23 miles in the river (Figure 2), the snails are not evenly distributed throughout that area. Monitoring indicates that while the species may reach moderate densities in some river areas, they have not been detected in others or may be present only at very low densities (section 2.3.1.2). Lastly, ongoing monitoring has documented the extirpation of one upstream, spring-dwelling population since 2010. This last observation illustrates the vulnerability of small, isolated populations, further supports the need to consider water quality, which is reduced in upstream aquifer springs (Schorzman et al. 2009, pp. 9-15), as an important consideration in the species conservation.

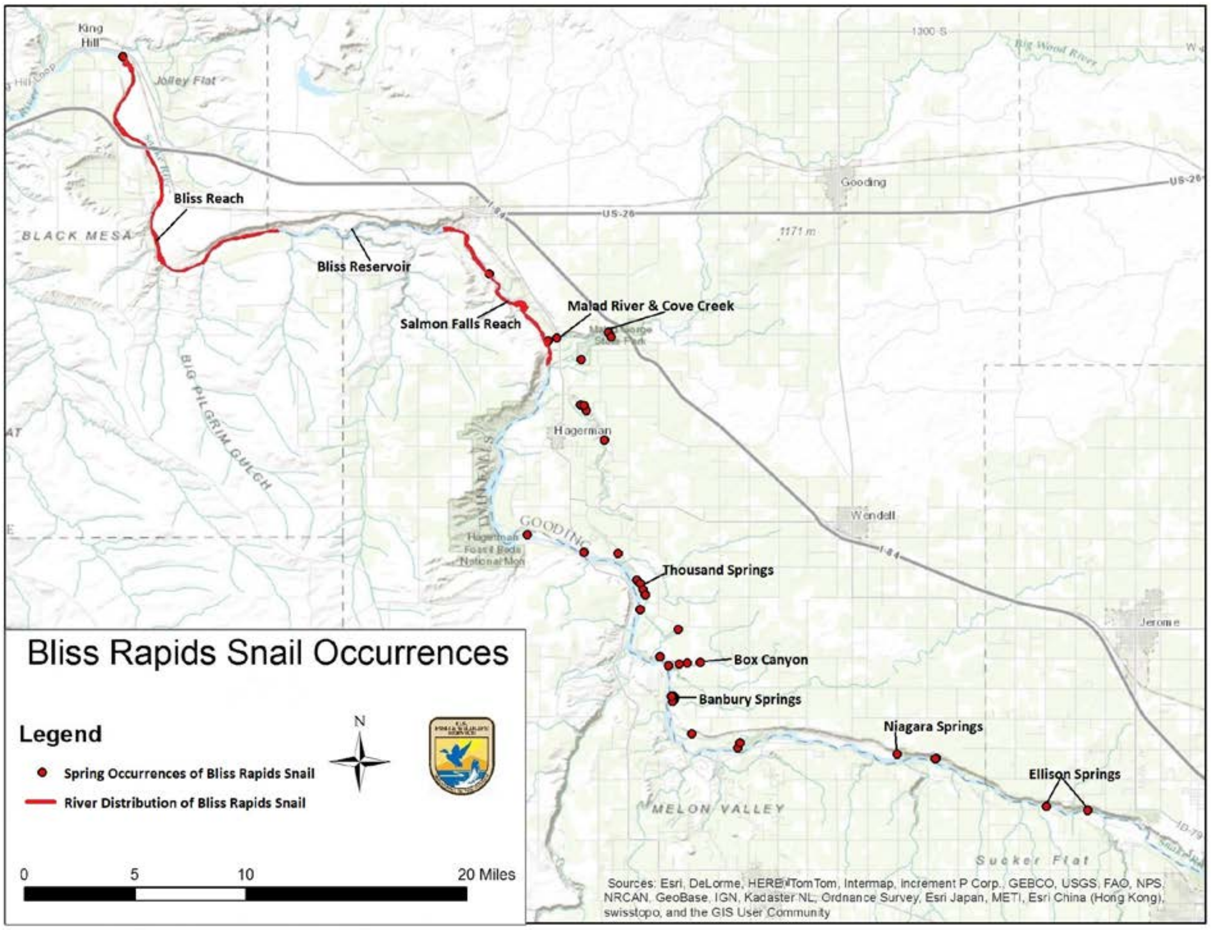

Figure 2. The Bliss Rapids snail is documented to occur in an estimated 35 kilometers (km) (22 miles (mi)) of the middle Snake River as well as numerous isolated springs along the north bank from RK 877, (RM 545) to RK 974 (RM 606).

2.3.1.2 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, etc.), or demographic trends:

Unlike many other snail families which are hermaphroditic, the Bliss Rapids snail has separate sexes. Determination of gender can only be reliably detected by sacrificing and dissecting specimens (Richards 2004, p. 20). No effort has been carried out to determine the sex ratio of the species in the wild. Based on research conducted by Richards (2004, pp. 128-133), population densities undergo seasonal fluctuations with population numbers being at their lowest during the winter months, and typically reaching peaks, a three to six-time increase in density over the observed winter lows, during the summer-fall months.

Although Bliss Rapids snail was listed in the early 1990's, the first regular monitoring of Bliss Rapids snail began in 2005 as part of the Idaho Power Company's relicensing requirements for their Malad Hydropower Project. The Malad River derives most of its flow from the Big and Little Wood Rivers, both of which are sourced from montane snow packs, but is also heavily influenced by spring contributions from the ESPA. The Malad is prone to periodic flooding both from big run-off events as well as from periodic hydropower shut-downs. These shut-downs divert flows from conveyance flumes into the river channel, greatly and instantaneously increasing river flow volume and velocity above the required minimum flows (100 cfs) maintained in the river. Monitoring for Bliss Rapids snail is conducted annually in Cove Creek, a tributary to the river, and semi-annually in the Malad River. This steep, inherently flashy system may, in part, explain the large amount of variability in Bliss Rapids snail numbers (Figure 3), since high discharge events scour and move sediments and snails, altering snail habitat and snail abundance. As an example, the Malad received up to 25 times (4,260 cfs) its normal base flow (approx. 170 cfs) for a period of eight months in 2017, and Idaho Power Company biologists recorded only 37 snails in the river in 2017, a two magnitude decline from previous efforts (Bean 2018a, pp. 3). Similar sharp declines have been documented following similar disturbance events at other sites, but in such cases (Bean 2014, pp. 1-3) populations have rebounded once habitat conditions returned to normal. However, even Cove Creek, a more stable, spring-fed system, shows high levels of variability (Figure 3) which is typical for this species at other locations (see below).

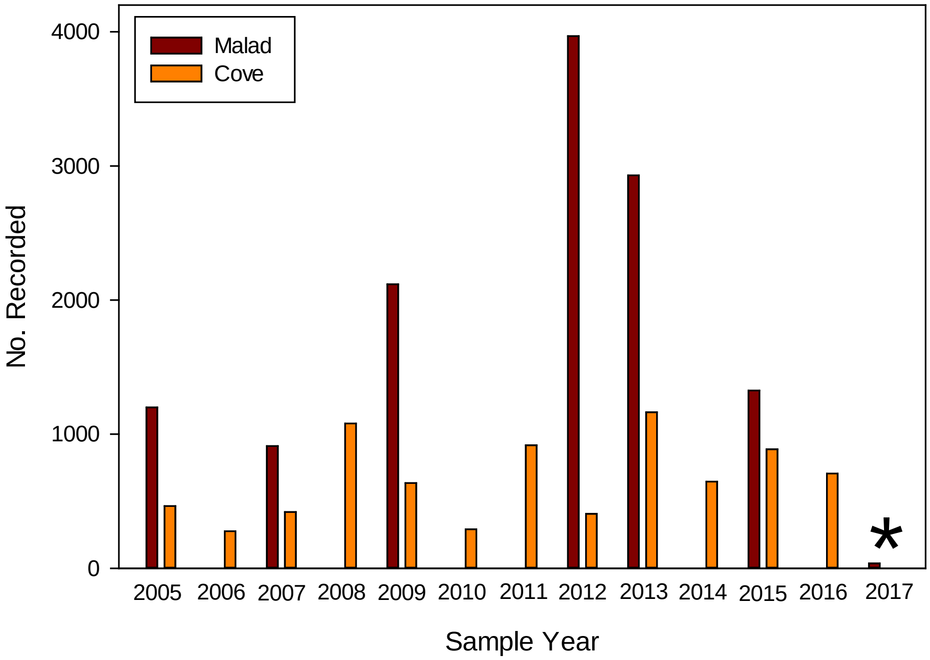

Figure 3. Recorded Bliss Rapids snail in the Malad River system. The Malad River is monitored semi-annually while its' tributary Cove Creek, is monitored annually (except 2017). The Malad River experiences periodic flash flood events due to upstream discharge and hydroelectric operations, while Cove Creek is a spring-fed system not influenced by flash flood events. Counts of Bliss Rapids snails in 2017 (*) dropped to a record low (37 individuals) following an 8-month "flood" attributable to power plant repairs and a record snow-year which increased river discharge up to 25-times its base flow. Idaho Power data (Bean 2018a, pp. 3-4).

Since completion of the last 5-year status review for the Bliss Rapids snail in 2009, Idaho Power Company has conducted annual monitoring at established locations throughout its range. The Idaho Power Company initiated this monitoring as part of a larger agreement (Idaho Power Company (IPC) 2010, entire) helping to mitigate for the relicensing of numerous hydroelectric projects located within the species’ range along the Snake River. This agreement assures that monitoring is conducted to ensure populations do not decline to levels that would leave the species vulnerable to hydroelectric operations or other threats. Monitoring is conducted in both river and spring habitats and is designed to locally assess the species’ local abundance and distribution. While insufficient to estimate population size[3], these data can be used to provide some estimate of population trends as well as contractions in the distribution of the species.

Initial monitoring in the Snake River included 60 bank transects (100 m each), randomly selected within each river kilometer, across 23 river miles below the Lower Salmon Falls and Bliss dams. Since monitoring began in 2010, 20 bank transects (33%) have been discontinued from monitoring due to absence or repeated low detections of Bliss Rapids snail, making these transects of little monitoring value. The discontinued use of these transects help illustrate the patchy distribution of Bliss Rapids snails within the Snake River. Those sites selected for this long-term monitoring did not include those river sites identified under Criteria 1 of the Plan.

Over the past 8 years of monitoring, the river population of Bliss Rapids snail appears to have generally shown an increase from a low of 350 recorded individuals in 2011 (both reaches combined), to a high of 2,500 in 2016, with a median of just over 1,100 over that period (Figure 4). Both of these river reaches are heavily influenced by springs derived from the ESPA, which contribute between 5,000 to 6,000 cfs of clear cold water to the Snake River (Clark et al. 1998, p. 18). The observed fluctuations in the river populations are likely influenced by water year type (high vs. low precipitation years and subsequent discharge through the system), in which high discharge years flush accumulated sediments from benthic habitats downstream of these dams. These flushing events likely benefit the species by flushing fine sediments and exposing and cleaning the preferred cobble substrates. High water years may also limit Bliss Rapids snail populations, at least temporarily, due to the flushing and scouring effects to the snails themselves.

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[3] Data collected by the Idaho Power Company include density estimates and cobble occupancy, but do not include information on habitat conditions or mark-recapture studies that would provide information necessary for robust populations estimates.

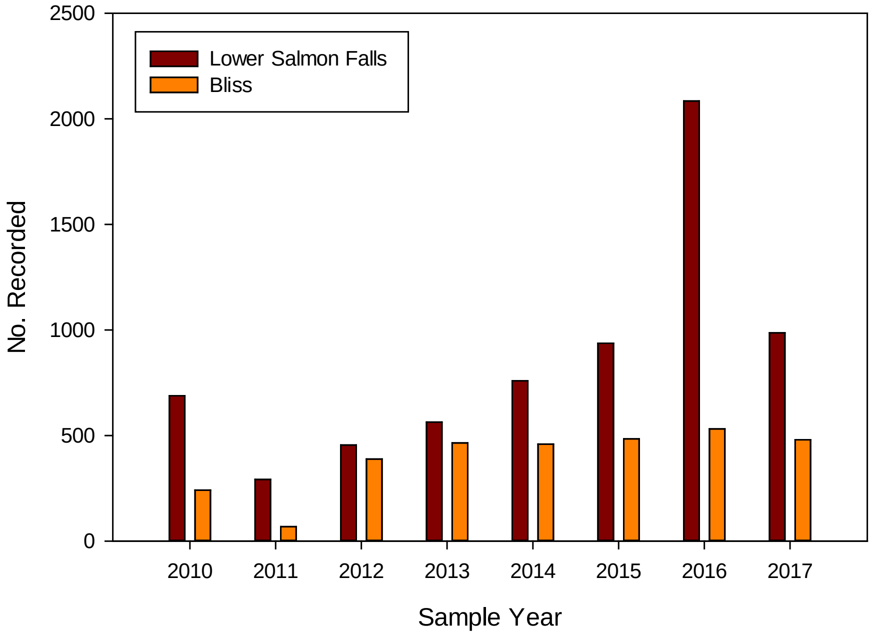

Figure 4. Total annual counts of Bliss Rapids snails from 2 reaches (Lower Salmon Falls and Bliss) within the Snake River. The annual median count is 723 and 462 for the two reaches respectively. Idaho Power Company data (Bean 2018b, pp. 3-9).

Since 2010, the Idaho Power Company has conducted monitoring at nine springs. Two of these, Banbury and Niagara include a total count of all Bliss Rapids snails observed on each randomly selected cobble (300 per spring), providing an estimate of site occupancy (percent of samples occupied) as well as density (individuals/m^2). Five of the nine springs are monitored for occupancy only (percent of cobbles occupied). These include: Fisher Lake, Box Canyon, Thousand Springs, Crystal Springs, and Hagerman National Fish Hatchery. The last 2 springs contain small and isolated populations, and are located at the most upstream (Snake River) extent of the species' distribution. Because they contain limited habitat and low snail densities these springs, Ellison Springs 1 and 2, are treated as sentinel springs and only used to assess presence or absence; there is no measurement of percent occupancy. The populations at the two springs from which individual snails are counted (Niagara and Banbury) have varied over time (Figure 5); the slight declining trend recorded at Niagara Springs (2012-2014) was due to recurring human disturbance.

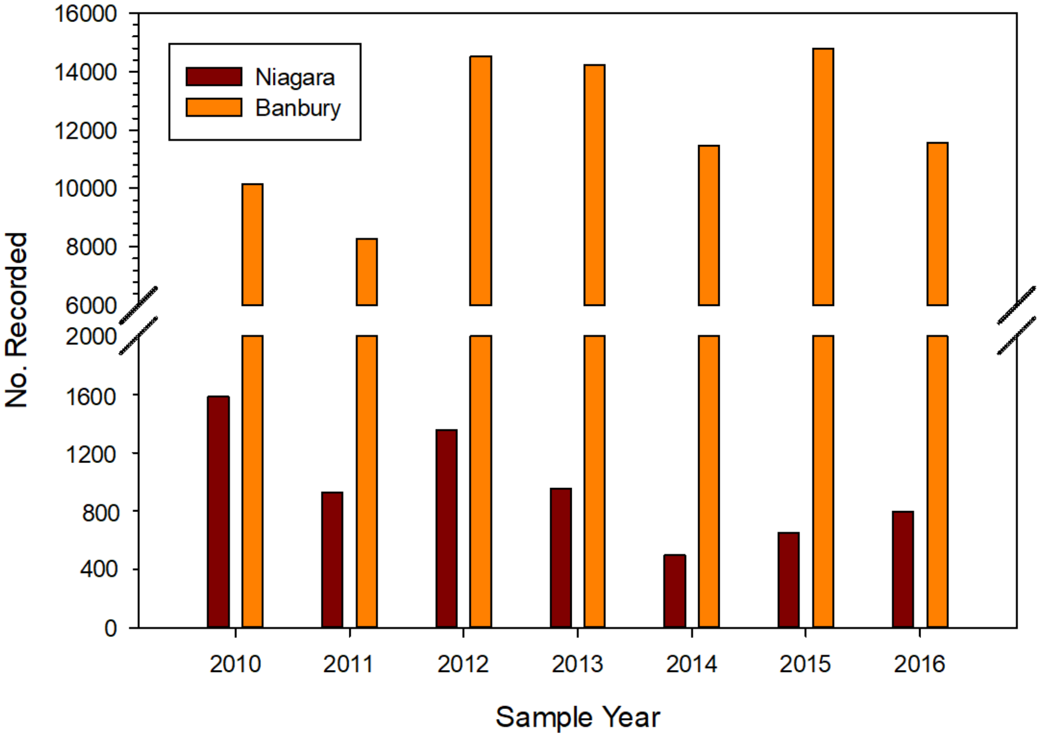

Figure 5. Total counts of Bliss Rapids snails at Niagara and Banbury Springs, where random cobbles are collected and snails on each cobble are counted. Sample sizes at the 2 springs are 200 to 300 cobbles, respectively, at each spring annually. Idaho Power Company data (Bates 2017, pp. 5-6).

The 5 occupancy monitoring sites utilize inspection of ≥110 cobbles per site. Two of those have shown a slight declining trend since 2010 while the other three appear to have remained constant (Figure 6). The two sentinel springs (Ellison Springs 1 & 2), representing the most up-river known distribution of the species, are small and highly isolated populations. Since monitoring began in 2010, one of these appears to have become extirpated (Bates 2017, pp. 12-14).

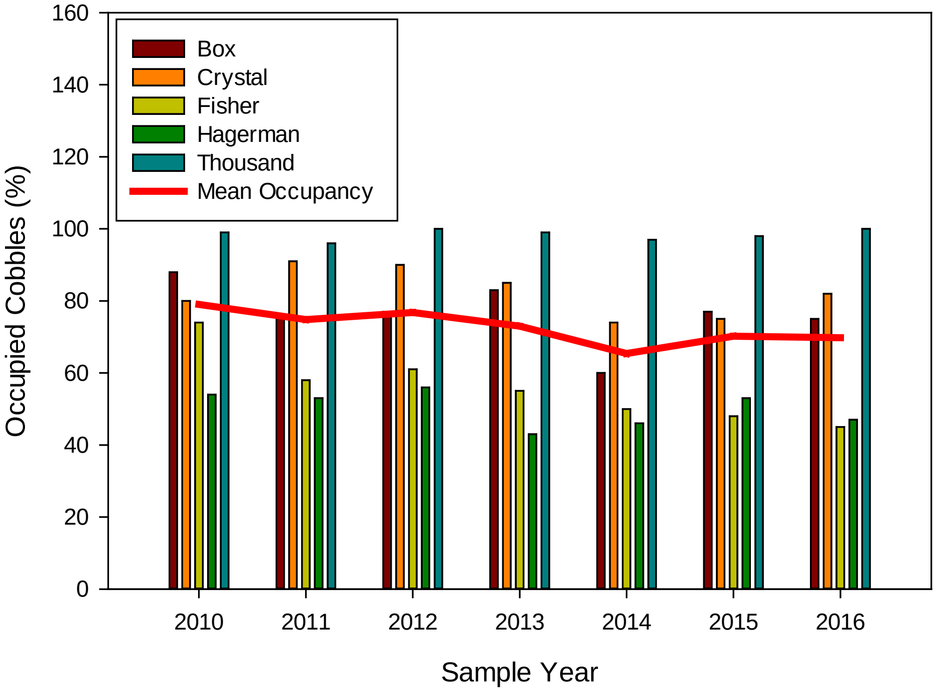

Figure 6. Percent Bliss Rapids snail occupancy of randomly selected samples (cobbles) in five aquifer springs along the middle Snake River, Idaho. Two of the five springs have shown a declining trend since monitoring began in 2010 while the others appear stable. The mean occupancy line illustrates the slight decline in the number of occupied samples in all five populations combined, most of those declines occurring at two of the populations. Idaho Power Company data (Bates 2017, pp. 10-12).

Collectively, monitoring conducted at the five springs to date has shown slight declines of most known populations, although the rate of decline is probably not significant for most. Reasons for the more pronounced of these declines are known at Niagara Springs and efforts have been made to discourage these causative factors (2.3.2.1). For the other population (Fisher Lake) the decline has been slow and steady, but the reasons for those declines have not been identified. Since the species' listing in 1992, at least two upstream populations have become extirpated, Blue Lakes (Grotheer, pers. comm. 2008) and an additional small spring identified by the Idaho Power Company (Ellison No. 2). In addition to the extirpation of the population at Ellison Springs No. 2, a spring population in the Hagerman Valley, Birch Creek, identified by Hershler and others (Hershler et al. 1994, p. 242) as occupied, has also been noted as no longer being present (Richards and Arrington 2009, p. 38). While these data do not point to rapid or catastrophic declines, the continued and/or growing threats to snails and their habitat require continued monitoring and protections.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

At the time of the species' listing in 1992, the Bliss Rapids snail was not formally described. Formal description of the species was completed in 1994 (Hershler et al. 1994, entire) and created a new monotypic Genus, *Taylorconcha*. A second species was added to the genus in

2006 with the description of *T. insperata*, which was collected from both the Owyhee River of southeastern Oregon and the Hells Canyon reach of the Snake River along the Idaho-Oregon border (Hershler et al. 2006, entire). This second species was both geographically separated from *T. serpenticola* in the middle Snake River and helped support the divergence of the two species both morphologically and genetically. Liu and Hershler (2009, entire) completed a detailed population-level analysis of Bliss Rapids snail based on specimens collected from 29 locations throughout its range, including both river and spring-dwelling populations. They documented a highly diverse population structure based on microsatellite variation, ranging from well-mixed and diverse assemblages to isolated populations with low diversity. Their study was supportive of a species that is frequently sedentary, isolated within most spring populations, but with a more well-mixed river-dwelling population that has not suffered notable isolating effects from the recent construction of hydroelectric dams.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Since the species description in 1994 (Hershler et al. 1994, entire), there have been no changes in the taxonomy of the Bliss Rapids snail. The genus *Taylorconcha* is now recognized to contain two species (Hershler et al. 2006), both of which are restricted to the Snake River and a limited number of its tributaries. The range of these species is not believed to overlap.

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

The Bliss Rapids snail is documented to occur in an estimated 35 kilometers (km) (22 miles (mi)) of the middle Snake River as well as numerous isolated springs along the north bank from the towns of King Hill (river kilometer (RK) 877, river mile (RM) 545) to Jerome (RK 974, RM 606) in south central Idaho (Figure 2). Although named after a series of rapids within the Snake River, the species reaches its highest densities in springs and creeks derived from the Eastern Snake Plain Aquifer (ESPA) that emerge over 100 km (62 mi) of the middle Snake River from RK 882 to 975 (RM 548-606). Populations located in the upstream area of this distribution are typically restricted to springs and spring creeks and do not occur in the Snake River, this river reach being water quality limited. Downstream of Lower Salmon Falls Dam, the species becomes a periodic occupant of the river, though typically at lower densities than found in many springs. The two reaches of the Snake River containing Bliss Rapids snail are not only highly influenced by ESPA spring discharge, but lie outside of the influence of reservoirs where fine sediments dominate benthic substrates. The genetic analysis of Liu and Hershler (2009, pp. 1288-1297) illustrated a greater level of well mixed genetic diversity of snails occurring within the Snake River relative to those collected from springs, the latter of which typically showed reduced diversity and less mixing. This supported the notion that many of these springs are genetically isolated from one another, whereas the river-dwelling populations are genetically mixed.

The distribution of the species has changed little since its listing. Early reports of populations located as far upstream as American Falls have not been substantiated. While the species has been documented occurring in additional springs since its listing and formal description, those springs have all been within the originally described range of the species. The only observed changes in the species' distribution is that of a reduction in range from the most upstream springs where isolated spring populations have become extirpated. Early collections of the species at Blue Lakes Springs, near the town of Twin Falls (RK 981, RM 610) by USGS in 1992 (Garabedian 1992), could not be repeated in 1994 (Grotheer pers. comm. 2008). More recently, the Idaho Power Company reported the apparent extirpation of a spring-dwelling population at RK 975 (RM 606).

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

The distribution of the Bliss Rapids snail is fundamentally tied to the waters of the ESPA, being found in springs and spring-fed creeks or spring-influenced portions of the Snake River. The ESPA underlies an area of the Eastern Snake River Plain, Idaho and is approximately 274 km (170 mi) long and 97 km (60 mi) wide (Garabedian 1992, entire). Most groundwater moves horizontally through interflow zones in Quaternary basalt, while moving vertically in recharge and discharge areas along joints and inter-fingering edges of basalt flows (Garabedian 1992, p. F1). Studies indicate the basalt may exceed several thousand feet in thickness, though along the margins of the plain, sand and gravel several hundred feet thick transmit large volumes of water (Garabedian 1992, p. F1). Water can move quickly through portions of the ESPA, up to 1,767 meters/day (5,800 feet/day) in certain areas (Idaho Department of Water Resources (IDWR) 2014, p. 56). Most of the ESPA is derived from older water that entered the aquifer from sources such as the south central mountains (e.g., Pioneer, Lost River), but local contributions from irrigation canals as well as aquifer recharge efforts (section 2.3.2.1) also contribute to aquifer levels.

In its upstream (Snake River) distribution (RM 573-606), Bliss Rapids snails are restricted to spring-sourced creeks with substrates composed of clean gravel, pebble, and cobble. Springs provide stable flows and temperatures that are typically free of fine sediments, providing Bliss Rapids snails with preferred habitat. Given the stable conditions in these aquifer springs, spring-dwelling populations can reach high densities (>5,000/m^2; Richards 2004, pp. 128-133), but may be restricted to areas of only a few square meters or less. The species is absent from slower tributary streams dominated by fine sediments such as Billingsley Creek. Many habitats that appear suitable, may lack Bliss Rapids snail as a result of past management practices (see below). In other areas (e.g., Malad River) the species may be absent from seemingly suitable habitat in some areas, yet common in others (Bean and Stephenson 2009, pp. 4-5). Bliss Rapids snails are documented from no fewer than 17 springs or spring complexes in this upstream area (Richards and Arrington 2009, pp. 29-42), but the habitat area and snail densities vary greatly between springs.

In contrast to spring-dwelling Bliss Rapids snails, river-dwelling populations (Snake RMs 545-572) are subjected to highly variable conditions that fluctuate seasonally and by water-year type. River temperatures vary from 5 to 23 °C seasonally (as measured at King Hill, Idaho, 2000-2017, USGS gage No. 13154500), exceeding the temperature preferences of the species (Richards 2004, pp. 25-27) and likely limiting its distribution within the Snake River to those associated with spring discharge. While the Snake River is heavily regulated with dams, high flow years frequently exceed the storage capacity of dams in the system and flows can vary from as low as 5,000 cfs (summer 2004) to greater than 30,000 cfs during high discharge events (spring 2017) (King Hill, Idaho, 2000-2017, USGS gage No. 13154500). During years of low discharge, river velocities slow and allow for the accumulation of fine sediments and the establishment and/or spread of rooted macrophytes. This can bury the gravel-cobble habitat utilized by Bliss Rapids snail, reducing habitat availability and snail abundance throughout the river. High discharge years typically flush fine sediment from the system and re-establish preferred habitat, though these events may also scour and flush snails, temporarily reducing populations or causing localized extirpations. Extreme events, high discharge years or successive drought years, are likely responsible for the lower observed densities and numeric fluctuations observed in river-dwelling Bliss Rapids snails (Fig. 4). Downstream of approximate RM 545, spring influences from the ESPA cease, and the river gradient declines as it moves toward C.J. Strike Reservoir. The loss of temperature refugia (springs) along with the drop in water velocity and corresponding accumulation of fine sediments, imposes the down-stream limit to the species' range.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms) -

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Habitat Modification

Many of the spring habitats typically occupied by the Bliss Rapids snail underwent considerable destruction and modification prior to its listing. While such direct habitat loss is no longer as prevalent (e.g., no proposed dams, spring sources either developed or protected), reduced water quality from the aquifer may play a greater role in habitat modification in the future. In addition, as spring discharges decline as a result of groundwater use in the area, demands for spring water for consumptive use can generally be expected to conflict with the needs of aquatic species in the future. These and additional factors affecting habitat availability are described below.

A significant portion of the springs of the ESPA have been diverted or modified for their use in fish production. Based on a review of National Pollution Discharge Elimination System (NPDES) applications as well as Google imagery, there are at least 36 aquaculture facilities[4] that are likely utilizing springs from the ESPA as their source for fish culture. Many of these facilities are large and/or may capture multiple springs or entire spring complexes. Many of these facilities are located at or near the spring source and have permanently altered habitats that would have likely been occupied by Bliss Rapids snails prior to development. Fish farms located along spring creeks have permanently altered stream habitat and now impose barriers to habitat connectivity that may have existed prior to development. Habitat fragmentation results from facility infrastructure as well as downstream discharge of waste products, residual disinfectants and disease-control drugs (EPA 2002, pp. 19-20), which typically impairs the aquatic habitat to a level that will not support Bliss Rapids snails. These spring modifications are only known from

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[4] The U.E. Environmental Protection Agency reported 80 such facilities in their Ecological Risk Assessment for the Middle Snake River (EPA 2002, p. 19).

facilities that require NPDES permits or are clearly modified for fish production, but do not capture other spring modifications which include most private or municipal water rights, or infrastructure that captures spring flows for hydropower production or other beneficial use. Not all of these spring modifications have resulted in the extirpation of Bliss Rapids snail populations from those sites, but most have likely resulted in the decline and or isolation of any populations present prior to those modifications. We know of numerous locations adjacent to spring modifications or downstream of them, which contain populations of Bliss Rapids snail. However, most such modified sites do not support the species or have left populations isolated above such developments. While such populations may persist into the future, if groundwater continues to be depleted (see below), snail habitat may be further modified or dewatered in order to maintain existing human water uses.

More recent habitat loss, though infrequent and localized, has occurred through alteration of stream habitats that have resulted in adverse effects to populations of Bliss Rapids snail. The Idaho Power Company documented sharp population declines at Niagara Springs in 2013 and 2014 when stream cobbles were moved and stacked for recreational activities. This resulted in estimated population declines of 29% and 48% (Figure 5) for those years respectively (Bates 2017, pp. 5-6). A similar alteration of a spring four miles downstream of Blue Lakes (see section 2.3.1.2) likely lead to the extirpation of a small, declining population at Ellison Springs (Bates 2017, pp. 12-14).

Habitat loss has also occurred due to development of water resources. Recent purchase of spring water rights by groundwater users is an example of the growing and future water conflicts likely to affect the species. The Fisher Lake (Big Springs) complex, which feed Billingsley Creek, was previously managed as part of the Idaho State Parks system. The Fisher Lake springs have long been known to support a number of Bliss Rapids snail populations in the headwater springs and along the length of the complex's creeks entering Fisher Lake. A water right of 54.68 cfs was recently (January 12, 2018) ceded to Evaqua Farms (IDWR, in litt. 2018) for the purpose of fish propagation. It is unknown whether or how this water right transfer will affect Big Springs or Bliss Rapids snail habitat, but prior water use plans at this location included capture and diversion of springs that would have adversely affected occupied habitat (SPF Water Engineers, in litt. 2014). As groundwater in the ESPA continues to be drawn down (see below) water conflicts between human consumptive use and aquatic species reliant on these springs is likely to increase.

Groundwater

The groundwater storage in the ESPA has been declining since the 1950's due to more efficient water delivery through canals (thus decreasing seepage into the ground), increased groundwater pumping, drought, and climate change (IDWR 2016, p. 7; Idaho Water Resources Board (IWRB) 2013, p. 2). These issues have resulted in declines in the average spring outflows in the Thousand Springs area over the past 60 years (IDWR 2016, p. 7). Given the Bliss Rapids snails' reliance on these springs derived from the ESPA, adequate water quantity and quality of these springs is critical to the long-term persistence of the species.

Groundwater Quantity

Current estimates of surface and groundwater use for Idaho are approximately 17.2 billion gallons per day, with irrigation for agricultural and horticultural uses accounting for about 80 percent of this total (Maupin et al. 2014, pp. 10, 25-26). Idaho ranks second in the country (below California) in total irrigation water withdrawals, which includes both surface and groundwater (Maupin et al. 2014, p. 10). Over a 95-year period of recordkeeping, spring flows from the ESPA contributed between 30-85 percent of year-round flow in the Snake River at King Hill (Richards et al. 2006, pp. 84, 85). Prior to the 1950's, irrigation water was moved from rivers and streams with the use of surface conveyance canals. Seepage from these canals into the fractured basalt resulted in recharge of the ESPA and corresponding increases in spring discharge (Kjelstrom 1992, entire). Based on analyses reported by Richards and others (2006, p. 84), and Ondrechen (in litt. 2004), spring discharges in the early 2000's may have been 15 percent greater than they were in the early 1900's. However, spring discharges began a sharp decline with the increased use of groundwater for irrigation, and a corresponding decrease in flood irrigation due to the use of central pivot sprinklers, which draw from groundwater but contribute little to groundwater recharge (Ondrechen in litt. 2004; University of Idaho in litt. 2007). Current estimates of groundwater use for Idaho are >34 billion liters (9 billion gallons) per day, with agricultural uses accounting for about 60 percent of this total (IDEQ in litt. 2013a). These large withdrawals, along with a decrease in incidental recharge, drought, and changes in cropping patterns, have been documented to be contributing to the depletion of the overall ground water storage in the ESPA (IDWR 2016, p. 7; University of Idaho in litt. 2007).

At this time we lack direct evidence that reduced spring discharge has led to mortality of Bliss Rapids snail, however this is due in part to the small size of the snail (≈2 mm) which makes detection and documentation of such mortality difficult. By contrast, large numbers of dead Banbury Springs limpet (*Idaholanx fresti*) have been found after human-caused dewatering events (Burak and Hopper 2014, pp. 18-21; 2016, pp. 13-14) (Fig. 7). Given the co-occurrence of these species and their strict aquatic nature, it is reasonable to conclude that Bliss Rapids snails have also been affected by dewatering events. Such mortality events are certain to occur as spring discharges decline and/or human water use, via groundwater pumping or spring diversion, increases or claims an increasing share of spring discharge.

At this point in time, the Service has not documented the loss of springs due to groundwater depletion, however, ongoing reductions in spring discharge are well documented within the system (Figs. 8, 9) which may likely lead to conflict between water users and the conservation of aquatic resources. In Box Canyon, both Bliss Rapids snails and Banbury Springs limpets are present below a water diversion that delivers 300 cfs to an aquaculture facility across the Snake River. As measured at the USGS gauge upstream, spring discharge from the Box Canyon source has dropped below 300 cfs a number of times since 2004 (Figure 7) and in one case did impact the Banbury Springs limpet population downstream of the diversion (Burak and Hopper 2016, pp. 11-14) (Figure 7). Numerous spring systems are captured and diverted for uses such as fish farming or power generation and have adversely affected snail habitat during low seasonal discharges (Burak and Hopper 2014, pp. 18-22). Dewatering events such as these will inevitably increase as springs in these areas continue to decline.

Figure 7. A dewatering event at Briggs Springs. The photo on the left was taken (January 3, 2012) when spring discharge was elevated, while the photo on the right (April 23, 2014) was taken when spring discharge was lower. This location occurs below a diversion that can also vary in how much water is removed from the spring. The marked cobbles (red circles) are the same in each photo and are visual marker to illustrate the difference in stream stage. The event resulted in significant mortality of the federally endangered Banbury Springs limpet, a species that shares habitat with the Bliss Rapids snail.

Aquifer Recharge

The State of Idaho is attempting to stabilize ESPA levels by implementing water conservation measures, including aquifer recharge, identified in the 2010 Comprehensive Aquifer Management Plan (CAMP; IWRB 2009, entire). The long-term aquifer recharge target identified in the CAMP is 150,000 to 250,000 acre feet (acft) per year (Idaho Water Resource Board (IWRB) 2009, p. 4; IDWR in litt. 2017). Due to the high water year during the 2016/2017 recharge season (October 25, 2016 to July 7, 2017), the Idaho Water Resource Board was able recharge over 310,000 acft, surpassing their annual goal of 250,000 acft (IDWR in litt. 2017).

If aquifer recharge actions, coupled with other conservation measures being concurrently undertaken, are successful at stabilizing ESPA levels, this will likely provide some positive outcomes for the Bliss Rapids snail in areas where declining groundwater volume will lead to water conflicts. However, if groundwater quality is compromised due to aquifer recharge efforts, impacts could be negative (see below). It is too early at this time to determine if aquifer recharge will affect groundwater quantity or quality for the Bliss Rapids snail. Successful recharge efforts will depend on numerous factors such as water year type, amount of water allotted to recharge efforts, and groundwater withdrawal, all of which are highly uncertain and currently unregulated. During average flow years, all water in the Snake River is allocated for beneficial use. Successful recharge of the ESPA will require excess/surplus water (high water years), which may become more limited under current climate change projections (Mote et al. 2013, pp. 54-75).

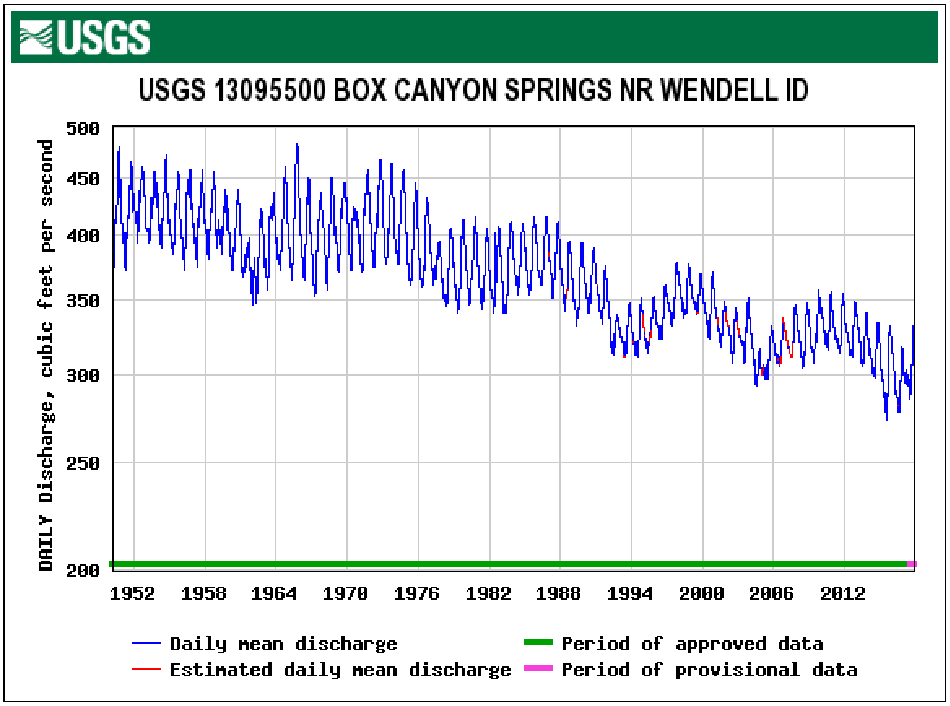

Figure 8. Spring discharge record for Box Canyon Spring, a tributary to the Snake River that provides habitat for Bliss Rapids snail and other federally listed species, illustrating a 29% decline in mean discharge over a 60-year period of record (USGS 2017). Since the time of listing (1992) spring discharge has declined by approximately 15 cfs.

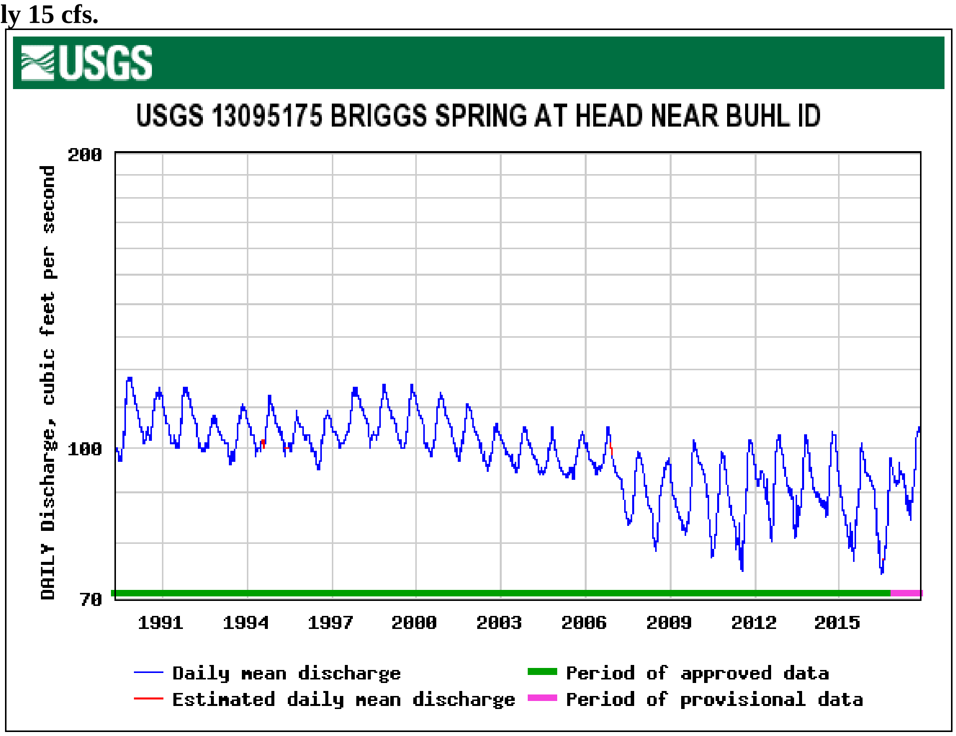

Figure 9. Spring discharge record for Briggs Spring, a tributary to the Snake River that provides habitat for Bliss Rapids snail and other federally listed species, illustrating a 20% decline in mean discharge over a 27-year period of record (USGS 2017). Since the time of listing (1992) spring discharge has declined by approximately 10 cfs.

Groundwater Quality

In addition to groundwater quantity, groundwater quality is important to the long-term persistence of the Bliss Rapids snail. Bliss Rapids snails restricted to springs can be affected by both the local aquifer and/or regional aquifers that contribute to the Snake River within the species' range (Baldwin et al. 2006, p. 20). Bliss Rapids snails in springs that predominantly originate from the regional aquifer system, are located from approximate RK 949 (RM 590) downstream (left) (denoted as *Flow Division* in Figure 10). Conductivity, as well as various contaminant and other chemical constituents, are typically found to be lower in these downstream reaches, whereas springs derived from the local aquifer (right of *Flow Division* line, Figure 10) tend to have high values for measured constituents (Figure 10, Schorzman et al. 2009, pp. 5-19). In general, the regional aquifer is characterized by low specific conductance, along with low total dissolved solids and nitrate concentrations compared to water quality in the local aquifer system upstream of RK 949 (RM 590) (Baldwin et al. 2006, p. 66, Schorzman et al. 2009, pp. 5-7). While the majority of Bliss Rapids snail populations and individuals are located in waters most influenced by the regional aquifer, a number are located in waters influenced by local aquifers (e.g., Niagara, Clear Lake, Crystal, and smaller un-named springs), which are subjected to more compromised water sources. Some springs derived from the local aquifer have been documented to periodically exceed human health standards in nitrates, but the effects of these constituents on Bliss Rapids snails are not known (see below).

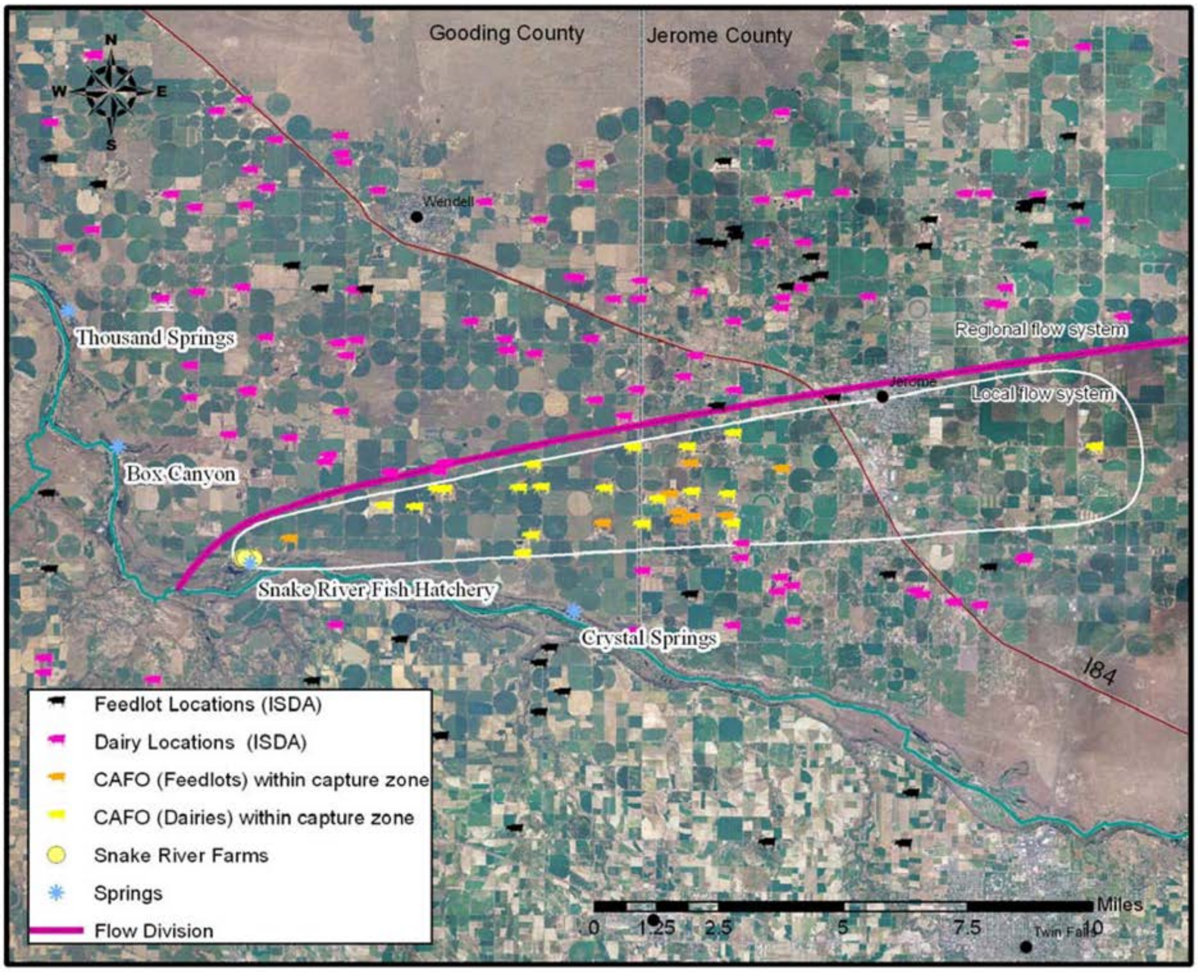

Figure 10. Land use east and hydraulically up-gradient of Snake River Farms using calculated one-year TOT capture zone.

Figure 10: Cattle feedlot and dairy locations within the range of the Bliss Rapids snail, which are located over the ESPA and in close association with springs occupied by the Bliss Rapids snail. Map from Schorzman et al. (2009, p. 18, Fig. 10).

Sources of nutrients and contaminants

Over 23,310 square kilometers (9,000 square miles (mi^2)) of irrigated land are located within the Snake River drainage or that of its tributaries (Johnson, unpub. 2013). Most of the crops grown in this area are subject to modern agricultural practices which include the use of herbicides (some of which include copper, a known toxicant (Besser et al., 2016, pp. 324-327)), insecticides, fungicides, and fertilizers; a proportion of which make their way into the Snake River via irrigation return flows and through ground water recharge (Clark et al. 1998, p. 2). Clark et al. (1998, p. 17) found the largest amounts of pesticides to be present in wells adjacent to agricultural areas around the Snake River between Burley and Hagerman, which are also the locations with the highest frequencies and concentrations of nitrates in ground water. The presence of nitrates and other agrochemical contaminants in the groundwater (Holloway et al. 2004, pp. 4-6; Carlson and Atlakson 2006, pp. 3-5; Schorzman et al. 2009, pp. 9-19) illustrates the pathway through which these agricultural contaminants can reach the habitats of the Bliss Rapids snails and other sensitive species living within the aquifer springs and the Snake River.

Cattle production and confinement has increased substantially in south central Idaho (Gooding, Jerome, and Lincoln Counties) overlaying the ESPA and in close proximity to springs occupied by Bliss Rapids snail. From 2006 through 2016, total cattle numbers in these counties increased from an estimated 456,500 to 579,000 head (both dairy and beef combined; US Department of Agriculture in litt. 2017); since listing in 1992 the number of cattle in these counties has increased by 170 percent. The close proximity of Concentrated Animal Feeding Operations (CAFOs) and other intensive agricultural practices on the adjacent canyon rim (Figure 10) illustrate the proximity of potential agricultural-related influences on spring habitats. Wastewater from confined animal feeding operations has been identified as a major contributor to water quality degradation in surface waters, groundwater, and springs in southern Idaho (Clark et al. 1998, p. 19; Bahr and Carlson 2000, p. 2; Schorzman et al. 2009, p. 19). Nitrate values from monitored wells in southern Idaho between 1990 and 2003 indicate an increasing trend in concentrations overall, although there were decreases at some wells (Neely 2005, pp. 5-11). Clark et al. (1998, p. 3) report that 10 percent of the wells sampled between Burley and Hagerman contained nitrate concentrations in excess of 10 mg/L, quantities regarded as harmful to human health and identified as well in the range to harm aquatic invertebrates (Camargo et al. 2005, p. 1257-1260). Both fertilizers and animal wastes contribute to groundwater nitrates and these contaminants have been documented to reach toxic levels in the ESPA (Neely 2005, pp. 3-9; Schorzman et al. 2009, pp. 9-12).

The human population has also grown within southern Idaho. For example, from 2006 through 2011, the human population in Gooding, Jerome, and Lincoln Counties in southern Idaho grew 15 percent (U.S. Census Bureau in litt. 2013), with the city of Twin Falls growing by 20 percent from 2000 to 2010 (City of Twin Falls in litt. 2013). Sewage treatment facilities from these municipalities have permitted NPDES discharges of nutrients, ammonia, suspended solids, organic matter, and industrial wastes into the Snake River (Clark et al. 1998, p. 7; EPA 2002, pp. 4-19). Other nonpoint discharges from urban areas, such as parking lot run-off and urban-use pesticides (Clark et al. 1998, p. 7), do not undergo treatment but can be reasonably expected to make their way into the Snake River and/or its tributaries. Although urban run-off likely contributes to declines in water quality in the Snake River, it has not been considered to be a major source of pollutants relative to agricultural inputs (Clark et al. 1998, p. 19). Nonetheless, toxicity from urban run-off has been documented to negatively affect aquatic invertebrates (Whiting and Clifford, 1983, entire; Weston et al. 2015, pp. 653-655) and should be monitored as a potentially growing issue.

Schorzman et al. (2009; pp. 13-15,19) detected personal care products and pharmaceuticals, all of which were below levels that create a human health concern, within certain springs originating from the local aquifer in southern Gooding County. Such personal care and pharmaceutical products detected in groundwater include sulfamethoxazole (animal and human antimicrobial compound), caffeine, DEET (insect repellent), and carbamazepine (anti-seizure medication). While the detection of these PCPPs does not identify a point source of pollution, it does indicate that they are detectable in southern Gooding County spring discharge throughout the year and that a pathway exists for these and other constituents to enter habitats occupied by Bliss Rapids snails and other federally listed species (Schorzman et al. 2009, p. 15).

Nutrient Trends

More recent reports and data indicate that nitrate concentrations continue to increase in springs originating from both the local and regional aquifer (Schorzman et al. 2009, p. 10; Frans et al. 2012, pp. 35-38; Skinner and Rupert 2012, p. 2). While a trend analysis performed by IDWR between 2 time periods (2002 to 2006, and 2007 to 2011) showed decreasing groundwater nitrate trends in the Twin Falls Nitrate Priority Area (NPA; IDWR 2013, p. 30), nitrate data collected at springs occupied by Bliss Rapids snail indicate an upward trend (Figure 11; Bates 2017, p. 22; Frans et al. 2012, pp. 35-38; FWS unpublished data), with increases of 21% to 48% from 2014 through 2017. While nitrate concentrations in springs have been increasing over the longer-term, there are also within year concentration variations (Baldwin et al. 2006, pp. 59-60; Schorzman et al. 2009, p. 10). The highest nitrate concentrations within the local and regional aquifers occur in the fall from September to December, with the lowest nitrate concentrations occurring in the spring and early summer from April to June (Figure 11). It is believed that the peak nitrate concentrations coincide with the lag time between summer irrigation and travel time to the springs, and that any nitrogen remaining in the soil after the growing season is transported to the aquifer in the same year if sufficient soil moisture is available (Baldwin et al. 2006, p. 59; Schorzman et al. 2009, p. 10; Skinner and Rupert 2012, p. 4).

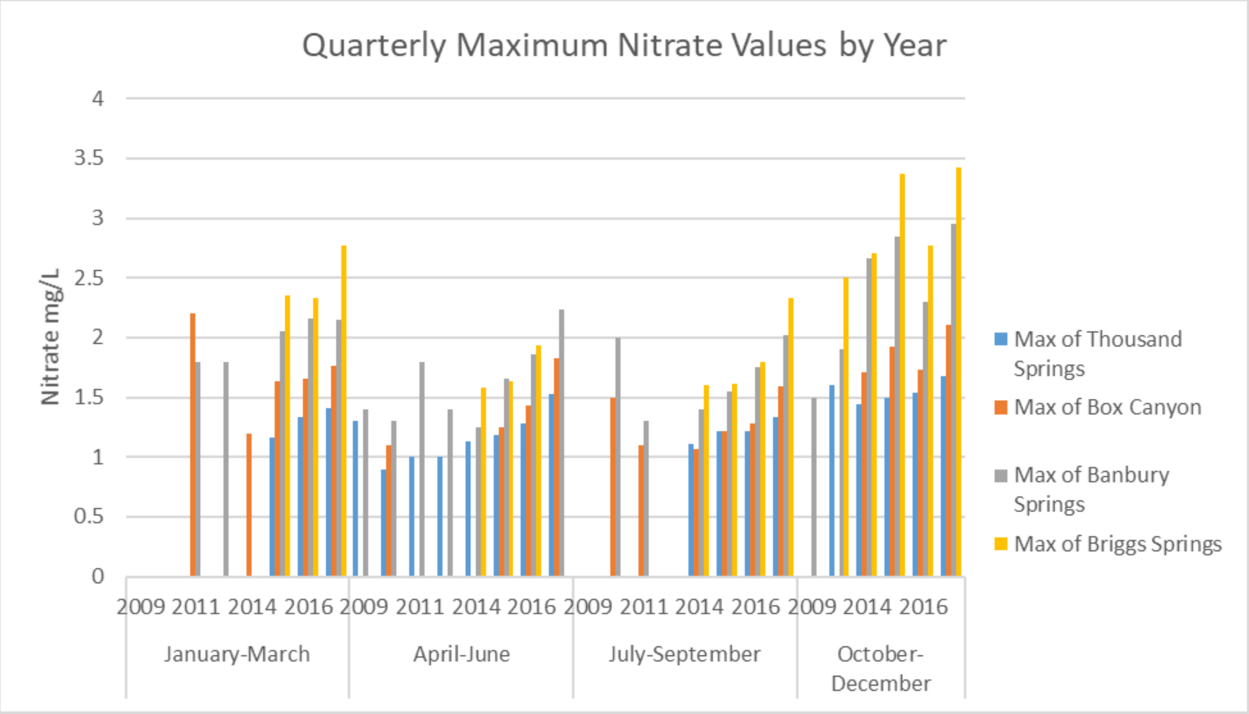

Figure 11: Quarterly (winter, spring, summer, fall) maximum nitrate (mg/L) values from 2009-2017 at four occupied Bliss Rapids snail populations. Springs are listed in ascending order of their location along the Snake River, with Thousand Springs being located at river mile 584 and Briggs Springs at 590. Data collected by FWS and the Idaho Power Company.

As previously discussed, the upstream distribution of the Bliss Rapids snail (RK 922-975, RM 573-606) is more water quality limited since springs along this portion of the river are more greatly influenced by a local aquifer which contains higher concentrations of nitrates and possibly other nutrients (Baldwin et al. 2006, p. 66). Nitrate concentrations decrease in ESPA springs downstream along the Snake River as illustrated in Figure 11.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Currently there is no information that leads us to believe that overutilization of the Bliss Rapids snail for commercial or recreational purposes is a threat. Collections for scientific or educational purposes is regulated by the Service through issuance of Section 10(a)(1)(A) recovery permits. Existing permits are limited, and we do not anticipate an increased demand in future requests to collect this species.

2.3.2.3 Disease or predation:

Currently there is no new information regarding the threat of disease or predation to the continued existence of the Bliss Rapids snail. We believe that disease is not likely to affect the species unless an unknown pathogen is transmitted via a non-native vector. The effect of predation is unknown on the species, though crayfish and fish, which are known predators of snails (FWS 2006, p. 18), continue to co-occur with the Bliss Rapids snail. We have no information which leads us to believe that native or non-native predators are affecting the Bliss Rapids snail.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Surface and Groundwater Management

Water Quantity Regulations

The Idaho Department of Water Resources (IDWR) manages water in the state of Idaho. Among the IDWR's responsibilities is the development of the state Water Plan (Water Plan) (IWRB 2012, entire). The Water Plan outlines objectives for the conservation, development, management, and optimum use of all unappropriated waters in the state. One of these objectives is to ''maintain, and where possible enhance water quality and water-related habitats'' (IWRB 2012, p. 6). It is the intent of the Water Plan that any water savings realized by conservation or improved efficiencies is appropriated to other beneficial uses (e.g., agriculture, hydropower, or fish and wildlife).

The Water Plan also states that the capacity of water storage, flood control, and flow regulation on the Snake River is insufficient for future beneficial uses (IWRB 2012, p. 55) and further states that construction of new reservoirs, enlargement of existing reservoirs, and development of off-stream storage sites may be necessary to meet future demands (IWRB 2012, p. 19). Given the non-protected status of the Snake River where springs occupied by Bliss Rapids snail enter the river, there exists no assurances that future development of water resource projects will not further inundate occupied springs, deplete groundwater, or negatively impact habitat or water quality upon which the species depends.

The IDWR and other state agencies have created additional regulatory mechanisms that limit future surface and ground water development in the ESPA, including the continuation of various moratoria on new consumptive water rights, and the designation of Water Management Districts (Caswell in litt. 2007). The state is attempting to stabilize aquifer levels and enhance cold water spring outflows from the ESPA by implementing water conservation measures identified in the

Comprehensive Aquifer Management Plan (CAMP) for this area (IWRB 2009, entire). The long-term objective of the CAMP is to incrementally achieve a net ESPA water budget of 600,000 acre feet annually by the year 2030 through a mix of management strategies, including aquifer recharge, ground-to-surface water conversions, demand reduction strategies, and weather modification (IWRB 2013, p. 3).

Overall, since adoption of the CAMP, progress is being made towards strategy implementation (IWRB 2013, p. 3; CH2M 2016, p. 1; IDWR in litt. 2017), although it is too early to determine if these strategies will be effective at reducing and reversing the rate of groundwater depletion in the ESPA especially in the face of climate change (see 2.3.2.5 below). Ongoing monitoring of CAMP efforts (IDWR in litt. 2017), along with spring discharges data at existing USGS stream gages, should provide the information needed for future assessments of whether implementing the CAMP water conservation measures stabilize and increase ESPA spring outflows.

The state of Idaho signed an order on November 4, 2016 creating a Ground Water Management Area (GWMA) for the ESPA region (IDWR 2016, entire). A designated GWMA is "a ground water basin or part thereof that the Director (IDWR) determines may be approaching the condition of not having sufficient ground water to provide a reasonably safe supply for irrigation and other uses in the basin under current or projected rates of withdrawal" (IDWR 2016, pp. 18-19). Idaho Code § 42-233b authorizes the Director of the IDWR to designate GWMAs and approve associated ground water management plans that provides "for managing effects of ground water withdrawals on the aquifer… and on any other hydraulically connected sources of water" (IDWR 2016, p. 18). Ground water users that comply with an approved GWMA plan, which has not been developed for the ESPA region, "shall not be subject to administration on a time priority basis" if the Director determines the ground water supply is insufficient to meet demands within the GWMA (IDWR 2016, p. 18). Given the recent GWMA designation for the ESPA, it is too soon to determine if it will address the long-term goal of addressing the decline in ESPA spring flows that the Bliss Rapids snail is reliant upon, although this designation is a positive step towards that goal.

Water Quality Regulations

State and federal laws are responsible for safeguarding the water quality criteria required by the Bliss Rapids snail and its habitat. In Idaho, ground water is protected by state laws regulating activities that either directly or indirectly affect ground water quality (IDEQ 2014, in litt.). Important ground water quality protection legislation in Idaho includes: Environmental Protection and Health Act (Title 39, Chapter 1, Sections 102, 120, 126); Health and Safety: Aquifer Protection Districts (Title 39, Chapter 5); Local Land Use Planning Act (Title 67, Chapter 65, Section 37); and, Ground Water Quality Protection Act of 1989 (Title 39, Chapter 1). Three Idaho agencies have specific statutory responsibilities regarding ground water quality: the IDEQ coordinates and administers ground water quality protection programs for the state, the IDWR maintains the natural resource Geographic Information System (GIS) for the state and collecting baseline data for the state's water resources, and the Idaho State Department of Agriculture regulates the use of pesticides and fertilizers and licenses operators (IDEQ in litt. 2014).

In accordance with the Environmental Protection and Health Act, the Idaho Ground Water Quality Rule (IDAPA 58.01.11) was promulgated in 1996 and requires for protection of ground water quality through water quality standards and an aquifer categorization process (IDEQ 2014, in litt.). The Primary Constituent Standards (numerical ground water quality standards) are based on protection of human health. Nonetheless, nitrate toxicity to aquatic invertebrates have also been documented (Camargo et al. 2005, p. 1257-1260), and future studies on nitrate toxicity need to be conducted on the Bliss Rapids snail to determine the risk elevated nitrates may pose to the species.

Various state-managed water quality programs are being implemented within the range of the Bliss Rapids snail. These programs are tiered off the CWA, which requires states to establish water-quality standards that provide for (1) the protection and propagation of fish, shellfish, and wildlife, and (2) recreation in and on the water. As required by the CWA, Idaho has established water-quality standards (e.g., for water temperature and dissolved oxygen) for the protection of cold-water biota (e.g., salmonids) in many reaches of the Snake River. The CWA also specifies that states must include an anti-degradation policy in their water quality regulations that protects water-body uses and high quality waters. Idaho's anti-degradation policy, updated in the state's 1993 triennial review, is detailed in their Water Quality Standards (IDEQ in litt. 2012, pp. 15-16).

While point source pollution regulations are enforceable through the CWA, non-point source water pollution is primarily addressed through non-regulatory means under the CWA (EPA in litt. 2013a,). While not quantified, a substantial portion of the water quality degradants likely to adversely affect the Bliss Rapids snail are derived from non-point sources (e.g., agricultural return to the Snake River and its tributaries, elevated nitrates in groundwater). The IDEQ works closely with the USEPA to manage point and non-point sources of pollution to water bodies of the state through the NPDES program under the CWA, but has begun the process of transferring authority for the issuance of these permits through the to the state of Idaho (EPA in litt. 2018). IDEQ expects to phase in full implementation of the Idaho Pollutant Discharge System Program by 2021. There are approximately 115 permitted aquaculture facilities in the Idaho, with nearly 70% of those operating in the Magic Valley and discharging into the Snake River or its tributaries (IDEQ in litt. 2018). Additional smaller facilities, not requiring NPDES permits, may also be operating in the area and discharging waste into the Snake River.

Under Section 303(d) of the 1972 Clean Water Act, states are required to develop lists of impaired waters not meeting state water quality standards (EPA in litt. 2013b). Waters that do not meet water-quality standards due to point and non-point sources of pollution are listed on EPA's 303(d) list of impaired water bodies. In water bodies that are currently not meeting water quality standards, the TMDL approach applies pollution-control strategies through several of the following programs: State Agricultural Water Quality Program, Clean Water Act section 401 Certification, USBLM Resource Management plans, the State Water Plan, and local ordinances. While TMDLs do not directly address groundwater, protection of surface water may improve and/or conserve groundwater quality that the Bliss Rapids snail is dependent upon.

State Invertebrate Species Regulations

There has been no change in state regulations regarding the protection of invertebrates since the time of the 1992 listing. The IDFG, under Idaho Code section 36-103, is mandated to preserve, protect, perpetuate, and manage all wildlife. However, these regulations do not extend protection to invertebrate species. The only regulations provided for Bliss Rapids snail are provided by the Endangered Species Act. In 2017, Idaho finalized the 2015 Idaho State Wildlife Action Plan (SWAP; IDFG 2017, entire), which is a conservation strategy for the state's species of greatest conservation need (SGCN). As part of the SWAP, the Bliss Rapids snail is a Tier 1 species in the state's list of SGCN (IDFG 2017, p. xvi), though there is no regulatory authority associated with this designation. In summary, there are no state regulations in place that are specific to the Bliss Rapids snail; therefore state invertebrate species regulations for the Bliss Rapids snail continue to be inadequate.

There are no assurances that current regulations and policies will protect the Bliss Rapids snail and its habitat from effects to declines in groundwater quantity and quality. While there are no known water development projects within the range of the Bliss Rapids snail, future development projects would be a concern if they impacted the remaining occupied springs or river sections within the species' range. Conservation measures in the ESPA CAMP have been developed and implemented, but it will likely take many years to decades to determine if they can effectively stabilize ESPA water levels and/or if they will adversely affect groundwater quality. The same can be said of the newly formed ESPA GWMA – it is too soon to determine if this effort will stabilize and reverse declining spring flows the Bliss Rapids snail is reliant upon. While federal and state regulations exist regarding groundwater and surface water quality, it is unknown if they are protective enough for the Bliss Rapids snail given its requirements of cold, clear, and well oxygenated water with clean gravel to boulder substrates. Lastly, there continues to be no state regulations in place providing protection to invertebrate species such as the Bliss Rapids snail.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Invasive Species

Certain researchers have suggested that the New Zealand mudsnail competes with native species for food and/or space (Kerans et al. 2005, pp. 135, 136; Hinson 2006, p. 41) and can dominate ecosystem nutrient and energy flow (Hall et al. 2003, p. 411). Research has shown that New Zealand mudsnails influence the growth of sympatric freshwater snails (Richards 2004, entire) and can displace native species (Hall et al. 2006, entire). Competition from the New Zealand mudsnail was shown to negatively impact growth rates of the Bliss Rapids snail (*Taylorconcha serpenticola*) under experimental conditions (Richards 2004, pp. 117-118). In enclosure experiments, increasing New Zealand mudsnail densities also resulted in lower Bliss Rapids snail densities (Richards 2004, pp. 117-118).

Although the New Zealand mudsnail can tolerate various water velocities, they appear to reach their highest densities in slower moving waters (Richards et al. 2001, pp. 378, 389), unlike the Bliss Rapids snail, which thrives in higher velocity waters. In addition, the New Zealand mudsnail appears to flourish in Snake River reaches under a variety of environmental conditions, including low dissolved oxygen and on substrates of mud or silt, but it is also found at high densities in some cold-water spring tributaries to the Snake River (e.g. up to 500,000 snails/m^2 (46,500/ ft^2 at Banbury Springs; Richards et al. 2001, p. 375). The Bliss Rapids snail is found on gravel to boulder habitat in areas of flowing water, and not found in areas of non-flowing systems composed of mud or silt. Regardless, these species overlap in resource use (diatoms) and co-occur in some habitats. While there are impacts from the New Zealand mudsnail on the Bliss Rapids snail, those impacts are subtle and indirect, and there have been no documented cases in which the extirpation of the latter has occurred due to invasion by the former.

Climate Change

Changes in temperature, precipitation, and streamflow patterns from a changing climate could be detrimental to the Bliss Rapids snail. Global warming is changing and will continue to change the climate of the Columbia River and Upper Snake River Basins. The average mean-annual air temperature in the Columbia River Basin has increased by approximately 1.1 °C since the late 1800s (U.S. Bureau of Reclamation (USBR) 2016, p. 24). By 2039, mean annual air temperatures in the Columbia River Basin are projected to increase by between 1.1 °C (Brekke et al. 2010, p. 25) and 1.3 °C (Rupp et al. 2017, Table 1 on p. 1788) compared to the historical baseline of 1970-1999. The largest temperature increases throughout the Columbia River Basin are projected to occur in the Upper Snake River Basins (USBR 2016: pp. 34-35 main report). Snow and rain that falls on the Upper Snake River Basins, including parts of Wyoming, Utah and Nevada, supply the Snake River and the ESPA. For an area encompassing the USRB minus the central Idaho mountains, Petersen et al. (2017, pp. 10, and 15-17) projected an annual mean temperature increase between 2.5 °C to 2.94 °C, and a mean summer temperature increase of approximately 3.3 °C, for the period 2040-2069 compared to a historical period of 1950-2005. In addition, models project an increase in the frequency and intensity of extreme weather events such as heat waves and heavy precipitation (Mote et al. 2013, p. 37 and 46), both of which could lead to elevated water temperature, reduced snow pack, and more frequent drought.

Precipitation projections vary more widely than temperatures, with most showing increased cool season precipitation (winter and early spring) and decreased warm season precipitation (USBR 2016: pp. 34-35 main report; Mote et al. 2013, pp. 32-36). An annual mean increase in precipitation is projected in the Columbia River Basin of 1% (range -5 to 6%), with seasonal changes showing a winter increase of 3% (range -14 to +13%), and a summer decrease of -5% (range -21 to +7%) (Rupp et al. 2017, p. 1788, Table 1). Projected increases in winter precipitation will likely not be sufficient to offset the effects of strong regional warming that would lead to earlier snowmelt (prior to April 1) or to more winter precipitation falling as rain instead of snow (Mote et al. 2005, p. 47). Compared to baseline (1980-2009) total annual runoff above Brownlee Reservoir will increase (USBR 2016, Appendix A, p. 29), but negative trends in April 1 snow water equivalent (Ashfaq et al. 2013, entire; Hamlet et al. 2013, Figure 7, left panel, p. 404) combined with earlier and higher peak runoff (USBR 2016, pp. 56-58) will affect seasonal flows. For the period 2010-2039, Snake River summer flows above Brownlee Reservoir are projected to be between approximately 6 to 30% lower in July, 6 to 25% lower in August, 2 to 14% lower in September, and 1.5 to 12% lower in October compared to the historical period 1980-2009 (USBR 2016 Appendix A, p. 6; Figure 3.13, p. 31). Projected reduced streamflow in the warm season leads to less natural flow and could negatively affect water rights used for irrigation. Less available surface water will likely increase water users' reliance on stored water contracts and groundwater as opposed to instream flow rights to meet irrigation and other needs (USBR 2016: p. 16 of Appendix B). Compounding the demand for water are the increases in temperature, drought intensity, and growing season projected for the Upper Snake River Basins, which will reduce soil moisture availability and increase evapotranspiration from crops, leading to potential water shortages and increased reliance on groundwater from the ESPA (USBR 2016, pp. 46, 59 and 70).

While responses of the ESPA to climate variability and change have yet to be formally evaluated, projected changes in air temperatures, form and timing of precipitation, and the frequency and intensity of extreme events (droughts and floods) all have the potential to affect groundwater quantity and quality. The direct impact of these changes on aquifer replenishment are unknown, with changes in snowmelt having the potential to reduce the seasonal duration and magnitude of natural recharge (Taylor et al. 2013, p. 323). A substantial portion of ESPA recharge comes from irrigation return flow (Lindholm 1996, p. 44); thus, the potential indirect effects of a warming climate may pose a greater threat than potential direct effects through increased groundwater demand as surface water becomes more limiting. Projected increases in the frequency and intensity of droughts for the Upper Snake River Basins over the latter half of the 21st century (USBR 2016, p. 46) could trigger a shift from agriculture to the expansion of municipal, industrial and commercial uses. Such a shift in land use may serve to further stress groundwater resources by reducing incidental recharge from irrigation return flow. Despite future uncertainties regarding water use and supply in light of climate change, the continued implementation of management actions outlined in the Comprehensive Aquifer Management Plan (IWRB 2009, entire) offers an opportunity to stabilize and improve spring flows, aquifer levels, and river flows across the Eastern Snake Plain. As part of this plan, in 2016/2017, the IWRB artificially recharged over 310,000 acft to the ESPA (IWRB in litt. 2017). The development of additional recharge sites and necessary infrastructure to maximize delivery of recharge water provides a mechanism for taking advantage of future wet years and high flow events when surplus water may be available. It will require years if not decades to determine if and to what degree to which artificial recharge will affect groundwater quantity and quality and how this could affect the Bliss Rapids snail.

If temperature, precipitation, and streamflow patterns change as described in the climate projections above, indirect impacts could be detrimental to the Bliss Rapids snail. Indirect impacts could include spring flow reductions (from reduced recharge and/or increased groundwater pumping), increased flow variability, lower oxygen concentrations due to increased water temperatures, and contaminants in the groundwater becoming more concentrated with less water available during droughts to dilute them (FWS 2006, pp. 11-17; Petersen et al. 2017, p. 38; Norvitch et al. 1969, p. 30). Other potential indirect effects from climate change may include an increasing prevalence of meltwater that is notably colder than winter spring discharge and carrying sediments overtopping the canyon rim and inundating spring complexes, as was evidenced during a heavy rain-on-snow event in 2017 (FWS 2017, pp. 10-11). Further, the spring habitats supporting Bliss Rapids snail could be reduced during low summer flows by macrophyte productivity, which would benefit from nutrient enrichment and spring flow reductions (Mebane et al. 2013, pp. 143, 152; Jones et al. 2012, p. 1006).

Vulnerability to projected changes in snowmelt timing is probably highest in basins with the largest hydrologic response to warming and lowest management flexibility – that is, fully allocated, mid-elevation, temperature-sensitive, mixed rain-snow watersheds with existing conflicts among users of summer water, such as the USRB (Melillo et al. 2014, p. 491). The Snake River is a highly regulated river system that serves multiple uses, including, but not limited to, irrigation, hydropower, and aquaculture. Even though the Snake River is a highly managed riverine system, if summer streamflow decreases within the Snake River as the models and literature forecast, and groundwater flows decline due to continued depletion of the aquifer, there may be less water within the spring complexes themselves, especially as competition for this limited resource increases (Meyer et al. 1999, p. 1373).

With these projected changes, suitable habitat for the Bliss Rapids snail may become limited and the species may disappear from portions of its range. At the same time, in light of the ongoing conservation measures being implemented in the ESPA through the CAMP process (IDWR 2016, p. 17), along with the uncertainty in how such changes will affect future water use practices, it is difficult to determine with certainty how climate change will affect groundwater resources. In short, there are many uncertainties regarding projected climate change and this is compounded by the lack of information on how human consumptive use will change to offset these changes. However, given recent changes in aquifer water quantity and quality, and the growing pressures of human use of the aquifer, growing conflicts of water resources is a likely outcome and this will likely affect habitats occupied by the Bliss Rapids snail.

In summary, of those factors affecting the species, the New Zealand mudsnail continues to be found co-occurring with the Bliss Rapids snail. However, the Bliss Rapids snail’s ability to reside in habitats with swifter current will exclude New Zealand mudsnail from reaching high densities and competing with the Bliss Rapids snail where their habitat use overlap. While there are documented competitive effects of the New Zealand mudsnail on the Bliss Rapids snail, we lack data to document the extirpation of Bliss Rapids snails due to the competitive effects of the New Zealand mudsnail. Projected climate change will affect the water resources utilized by the Bliss Rapids snail. However, these projections have a level of uncertainty and we do not know how water users and managers will respond to future water conditions. Given this, we cannot, with any level of certainty, identify how climate change will directly or indirectly affect the species in the foreseeable future.

2.4 Synthesis

Monitoring to assess the status of the species as prescribed in the recovery plan (Criteria 1), has only partially been carried out, but has been highly informative. River locations identified for monitoring in the recovery plan have not been monitored, but there has been an effort by the Idaho Power Company starting in 2010, to monitor population trends in the two occupied river reaches as well as several springs. All of these monitoring efforts have shown those populations to vary between years, with increasing and decreasing numbers from year to year. With the exception of one river reach, none of these populations have shown a 5-year increase in abundance (as prescribed in the recovery plan). The one population that demonstrated a 5-year increase in abundance underwent a significant decline on its sixth year. Of the nine springs regularly monitored, these also show substantial inter-annual variation, with most showing a slight downward trend. Since the last 5-year review one spring population has been extirpated and since the time of listing (1992), three spring populations have become extirpated. The recorded extirpations to date represent a contraction of the species' range of 4 river miles (6 %). The original 1995 recovery criteria lacked an understanding of the Bliss Rapids snails' distribution and habitat needs and should be updated to better incorporate our understanding of the species' biology and distribution and to better outline informed and measurable objectives.

The water quality criteria identified in the recovery plan (Criteria 2) has not been achieved. Within the Snake River the upper temperature limits identified in the recovery plan have been exceeded most years and we do not have data on standards such as pH or dissolved oxygen. We have less water quality data for springs identified for monitoring. Since completion of the recovery plan, other potential threats to water quality have been identified and some effort to quantify their impact to the species should be undertaken and included in the revised recovery plan. New, emerging toxicants (e.g., nitrates) have been identified in the current range of the Bliss Rapids snails and are documented to harm some aquatic invertebrates. Studies on the toxicological effect of these contaminants/nutrients on the Bliss Rapids snail should be conducted and acceptable limits included in a revised Recovery Criteria 2.

While original threats to the species at the time of listing no longer exist (proposed hydroelectric dams), other threats to the species persist and/or are increasing. Spring discharges from the ESPA continue to decline, with two such springs, Box Canyon and Briggs, having declined by approximately 15 cfs (6%) and 10 cfs (9%) over the observed period of record respectively, and are illustrative of spring discharges throughout the species' range. Spring water quality has also shown signs of deterioration, with nitrate levels showing increases at monitored springs. While regulatory efforts to stabilize the ESPA have been implemented, it will require many years if not decades to determine if these efforts will be effective. Therefore, existing regulatory mechanisms that oversee ESPA groundwater management may not be adequate to reverse the declining cold-water spring quantity and quality upon which the Bliss Rapids snail depends. In addition, activities such as aquifer recharge have the potential to further reduce water quality at occupied springs. While we do not know the critical thresholds of nutrients and most other contaminants for the Bliss Rapids snail, many such contaminants are known to adversely affect other aquatic invertebrates. Degraded water quality could have both acute and chronic toxic effects as well as indirect impacts on habitat, such as increased growth of aquatic macrophytes. Land use changes, most importantly in agriculture, are likely the drivers for both aquifer depletion and water quality degradation. Based on current climate change projections, it is almost certain that associated changes in temperature and precipitation will directly or indirectly affect the water resources required by the Bliss Rapids snail. What is less certain, however, is how state or Federal water managers and/or the public will alter their water use or management to address these changes. This makes predicting how climate change will affect the Bliss Rapids snail highly uncertain. While the Bliss Rapids snail occurs at numerous locations including both river and spring habitats throughout its range, it has disappeared from at least three springs it formerly occupied. Threats to the ESPA, the water source upon which the species depends, have increased since the species listing and spring discharge has decreased while water contaminants (nitrates) are increasing. For these reasons we regard the Bliss Rapids snail's status as threatened to still be warranted.

3.0 RESULTS

3.1 Recommended Classification:

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

3.2 New Recovery Priority Number: 8C

Brief Rationale: The Service recommends the Recovery Priority number for the Bliss Rapids snail be changed from 7C to 8C since the Bliss Rapids snail is no longer regarded as a monotypic genus. In 2006 Hershler and others described a second species within the genus *Taylorconcha*, so the Bliss Rapids snail is no longer the only species represented in the genus.

3.3 Listing and Reclassification Priority Number, if reclassification is recommended

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (Removal from list regardless of current classification) Priority Number: ____

Brief Rationale: N/A

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Update/Revise Recovery Plan

We continue to recommend that the Snake River Aquatic Species Recovery Plan be updated and/or revised to include new information that we have learned since the plan was completed in 1995. We also recommend that the recovery criteria within a revised Recovery Plan be updated in order to make them more objective and measureable.

Monitoring

While monitoring conducted by the Idaho Power Company is the only regular monitoring currently conducted, and has provided invaluable insights into the species distribution and population trends, we recommend the Service initiate a more systematic and rigorous monitoring effort at strategic locations to supplement the Idaho Power Company's effort. This should be accompanied by a regular water quality component. An updated monitoring criteria to assess the species' recovery should be developed and included in an updated recovery plan.

Toxicology

We have only limited data on water quality constituents that adversely affect the Bliss Rapids snail. Additional research is needed to assess how emerging contaminants (Atrazine, Neonicotinoids, pyrethroids) and nutrients (e.g., nitrates) can affect the species. An updated water quality criteria, that includes emerging contaminants such as these, should be developed and included in an updated recovery plan.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Bliss Rapids Snail*

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
[✓ No change needed]

Appropriate Listing/Reclassification Priority Number, if applicable: 8C

Review Conducted By: Dave Hopper and Greg Burak

FIELD OFFICE APPROVAL:

State Supervisor, Idaho Fish and Wildlife Office

Approve ______________________ Date 9/9/18