BIOLOGICAL OPINION

REGARDING THE EFFECTS OF THE

FEDERAL ENERGY REGULATORY COMMISSION'S PROPOSED LICENSE AMENDMENTS FOR THE LOWER SALMON FALLS AND BLISS HYDROELECTRIC PROJECTS ON THE BLISS RAPIDS SNAIL AND SNAKE RIVER PHYSA

TAILS: 01EIFW00-2012-F-0361

FERC Nos. 2061 and 1975

November 9, 2012

U.S. FISH AND WILDLIFE SERVICE
IDAHO FISH AND WILDLIFE OFFICE
BOISE, IDAHO

Supervisor Russell R. Holden for Brian T. Kelly

Date NOV 09 2012

Table of Contents

List of Figures

1. BACKGROUND

1.1 Introduction

This document transmits the Fish and Wildlife Service's (Service) biological opinion (Opinion) regarding the effects of the Federal Energy Regulatory Commission's (Commission) proposed license amendments for the Lower Salmon Falls and Bliss hydroelectric projects (Projects) in Idaho on the threatened Bliss Rapids snail (*Taylorconcha serpenticola* Hershler) and the endangered Snake River physa (*Haitia* (*Physa*) *natricina* Taylor). This document was prepared in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.). Your June 26, 2012 request for formal consultation was received by our office on June 28, 2012, which was accompanied by a Draft Environmental Assessment (Assessment) on the proposed action.

This Opinion is based primarily on information provided by the following studies that were conducted in response to a settlement agreement (Agreement) between the Service and the license applicant, the Idaho Power Company (Company); a Snail Protection Plan (Snail Plan) prepared by the Company; the license amendments for the two projects; the Final Environmental Impact Statement (FEIS) for the four mid-Snake River projects (Commission 2002); and other sources of information cited herein. A complete decision record of this consultation is on file at the Service's Idaho Fish and Wildlife Office in Boise, Idaho.

1.2 Consultation History

February 9, 2004	The Agreement concerning the Commission's relicensing of the Company's mid-Snake and C.J. Strike hydroelectric projects goes into effect.
June 28, 2004	The Service receives a petition, dated June 25, 2004, from the State of Idaho to remove the Idaho springsnail (*Pyrgulopsis idahoensis*) from the Federal Endangered Species List. The petition includes a recently published scientific re-evaluation of the species' taxonomic status (see

	References Cited for published paper). This species was included in the studies outlined in the Agreement between the Company and the Service.
August 4, 2004	The Commission issues licenses to the Company for the continued operation of the Bliss, Lower Salmon Falls, Upper Salmon Falls, and C.J. Strike hydroelectric projects with restrictions on load-following operations, with restrictions as described in the Agreement.
December 21, 2006	The State of Idaho and the Company petition the Service to remove the Bliss Rapids snail (*Taylorconcha serpenticola*) from the Federal Endangered Species List.
August 6, 2007	The Idaho springsnail is delisted, effective September 5, 2007, based on a taxonomic revision. Studies developed for this species in the Agreement are terminated.
November 14, 2007	The Service provides a letter to the Commission describing the continuing obligations of the Agreement pertaining to the Bliss Rapids snail, given the recent delisting of the Idaho springsnail.
March 7, 2008	The Service releases a draft status review (Service 2008) for the Bliss Rapids snail for use by science and management panels to assess the species' status.
March 6, 2009	The Company submits a letter to the Commission requesting that they be provided a 2-month extension for submission of the final study findings as required under the settlement agreement.
June 2, 2009	The Company submits the final results of the Agreement-related studies to the Commission in fulfillment of Article 402 of the licenses for the Lower Salmon Falls and Bliss projects, and Article 410 of the license for the C.J. Strike project (see References Cited for study documents).
September 16, 2009	The Service publishes a Federal Register notice stating the Bliss Rapids snail is found to warrant protection under the Act and retains its Federal listing status as threatened.

March 12, 2010	The Company provides a letter to the Commission requesting that they reinitiate section 7 consultation with the Service pertaining to the license amendment requests for the Upper Salmon Falls and Bliss projects. This letter also included a request that the Company be designated as the non-Federal representative for the formal section 7 consultation process.
March 18, 2010	The Service sends a letter to the Commission recommending that they reinitiate formal section 7 consultation, based on availability of new information on the Bliss Rapids snail, as well as the Company's proposal to change operations at the Lower Salmon Falls and Bliss projects and implement the Snail Plan.
March 30, 2010	The Company submits the Snail Plan to the Commission for review and approval.
May 5, 2010	The Company submits an application to the Commission to amend the current license to operate the Lower Salmon Falls Project (FERC 2061), requesting that they be allowed to operate the facility in a load-following mode for the remainder of the 30-year license.
May 11, 2010	The Company submits an application to the Commission to amend the current license to operate the Bliss Project (FERC 1975), requesting that they be allowed to operate the facility in a load-following mode for the remainder of the 30-year license.
June 15, 2010	The Commission designates the Company as the non-Federal representative to conduct section 7 consultation with the Service for the proposed Upper Salmon Falls project and Bliss project license amendments.
August 30, 2010	The Idaho Department of Environmental Quality provides a letter to the Company stating that the proposed, amended operations of the Lower Salmon Falls and Bliss projects are not different than the historic mode of operation, and thus do not require a new Clean Water Act 401 certification.

September 13, 2010	The Company submits license amendments for Lower Salmon Falls and Bliss projects to conduct load-following operations at these facilities, as outlined in the 2004 license, for the remainder of the 30-year license.
January 13, 2011	The Service sends a letter to the Commission informing them that a draft biological opinion has been prepared and inquiring if they are planning on entering into formal section 7 consultation.
March 30, 2011	An conference call is conducted with the Commission, Company, and Service attending, to assess the state of the Commission's progress in preparation of the Draft Environmental Assessment (Assessment). Commission stated that it was assessing the need for a full NEPA analysis.
June 26, 2012	The Commission issued a Notice of Availability for the Draft Assessment for Non-capacity Related Amendments to Licenses for the Bliss and Lower Salmon Falls Projects.
June 28, 2012	The Service received a letter from the Commission dated June 26, 2012, requesting initiation of formal Section 7 Consultation under the Act for the proposed license amendments. In this initiation letter, the Commission provided a likely to adversely affect determination for the threatened Bliss Rapids snail and the endangered Snake River physa snail. The Commission also noted that some of the mitigative elements in the proposed action were not within its authority to oversee or implement.
July 23, 2012	The Service sent a letter to the Commission acknowledging receipt of the Assessment as well as their request for formal consultation. The Service noted that consultation would be initiated utilizing the Assessment as representative of the proposed action and that a draft biological opinion would be provided for their review prior to issuance of a final biological opinion.
July 24, 2012	The Service sent a letter to the Commission stating that it was in the process of developing a dispute resolution clause with the Company for inclusion in the proposed action (Bliss Rapids Snail Protection Plan) to

	absolve the Commission of this responsibility for issues they perceive to be outside of their authority.
October 11, 2012	The Service sends an e-mail to the Commission requesting a response regarding their acceptance of the Company and Service's proposed Dispute Resolution clause, and asking if the Commission desired to review a draft Opinion for review prior to receiving a final. This e-mail transmission was accompanied by a phone call.
October 12, 2012	The Commission provides an e-mail regarding the Dispute Resolution clause and receipt of a draft Opinion, stating that the Commission needed to discuss these issues internally.
October 15, 2012	The Commission (representatives) provided an e-mail stating the current consultation process was a contested proceeding until the Commission took action on the proposed operational amendments. It also reiterated the Commission's previous statements that they possessed no authority outside of the project's boundaries, or agreements or actions to be required of a third party(ies). The Commission expressed its interest in receiving a draft Opinion prior to submission of a final.
November 5, 2012	The Service provides a draft biological opinion to the Commission for their review and comment.
November 8, 2012	The Commission provides an e-mail stating they have no comment on the Draft Opinion.

2. BIOLOGICAL OPINION

2.1 Description of the Proposed Action

This section describes the proposed Federal action, including any measures that may avoid, minimize, or mitigate adverse effects to listed species or critical habitat, and the extent of the geographic area affected by the action (i.e., the action area). The term "action" is defined in the implementing regulations for section 7 as "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas."

The Company is requesting the Commission to amend its licenses to allow operation of the Lower Salmon Falls and Bliss hydroelectric projects in a load-following mode, as proposed in the 2002 FEIS (Commission 2002), for the remainder of the 30-year license. Both Projects currently operate in a run-of-river mode as provided in their 2004 licenses and as stipulated in the 2004 Settlement Agreement (Agreement 2004).

2.1.1 Action Area

The term "action area" is defined in the regulations as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." Lower Salmon Falls Dam is located on the Snake River at river mile (RM) 573 (river kilometer (RK) 922) and its reservoir extends upstream to approximately RM 580 (RK 933), where it ends immediately below the infrastructure of the Upper Salmon Falls Project. Water released from Lower Salmon Falls Dam then flows unimpeded for approximately 8 miles (12.9 kilometers (km)) until it enters Bliss Reservoir at approximate RM 565 (RK 909). Bliss Dam lies 5 miles (8 km) downstream from that point at RM 560 (RK 901). Water released from this dam flows unimpeded for approximately 37 miles (60 km) to the headwaters of C.J. Strike Reservoir (est. RM 523 (RK 841)). Collectively, this 57 mile (92 km) river reach comprises the project area (Figure 1). For the purposes of this consultation, the action area includes the project area as well as isolated spring habitats that occur an additional 24 miles (39 km) upstream of the project area

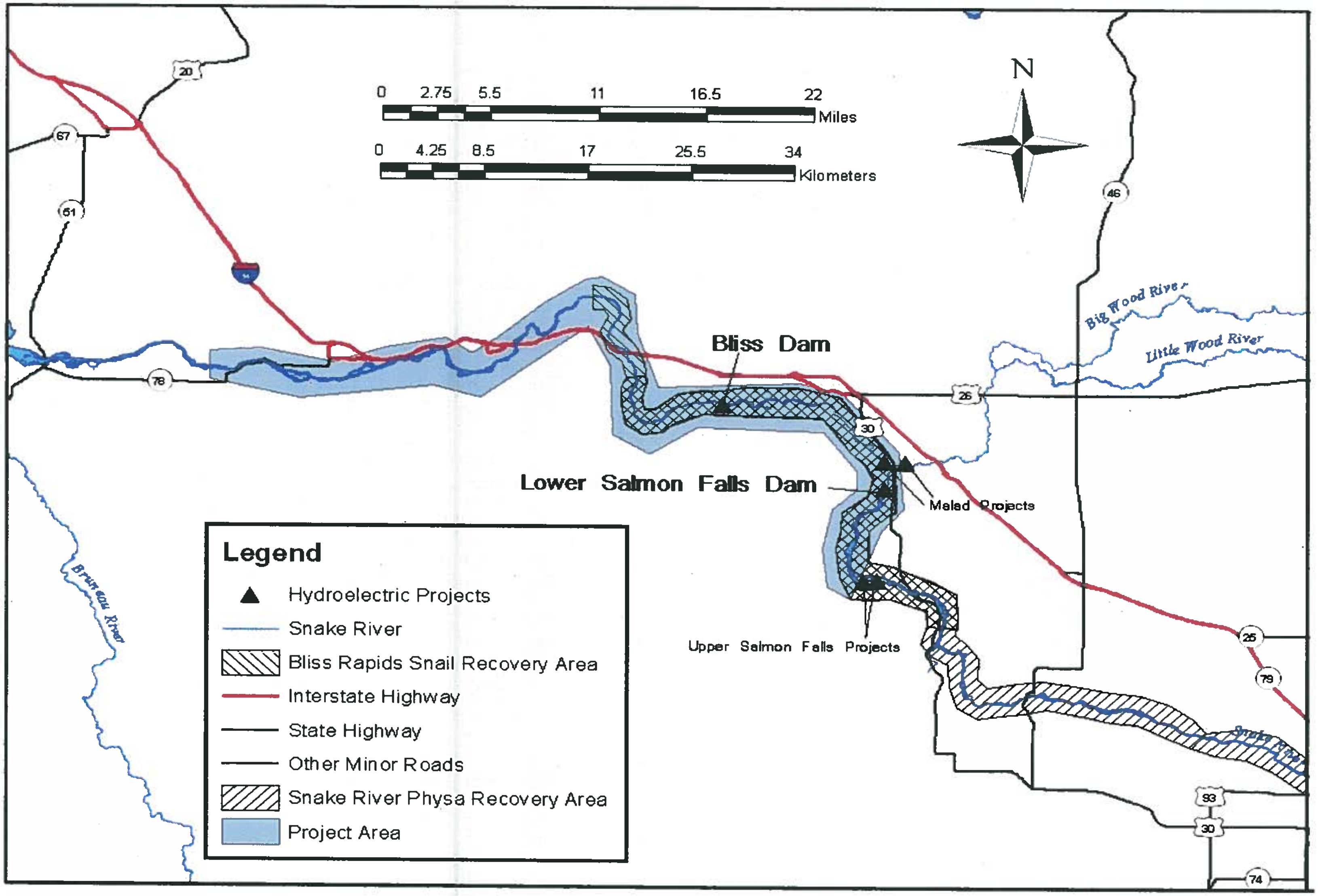


Figure 1. Project area of the Bliss and the Lower Salmon Falls projects and the recovery area of the two species of the federally listed snails being considered in this Opinion.

(to RM 604 (RK 972)). Several of these spring habitats will be monitored as part of the Snail Plan, also included as part of the Action. Hence, the action area includes the known distribution of the Bliss Rapids snail both within the project area as well as upstream of the projects addressed in this Opinion.

As noted by numerous researchers (Hershler *et al.* 1994, pg. 237; Richards 2004, pg. 8), the Bliss Rapids snail is absent from reservoirs such as those within the action area and those habitats are covered in the analysis provided in sections 2.5.3 of this Opinion. Within the Snake River, the Bliss Rapids snail is restricted to the unimpounded river reaches downstream of both the Lower Salmon Falls Project (Lower Salmon Falls or Hagerman Reach) and the Bliss Project (Bliss Reach). In addition to stage and flow fluctuations due to load-following, these river reaches are subject to flow fluctuations from seasonal changes in river flow or other water use and management operations (e.g., irrigation use and return, salmon augmentation flows) that occur upstream of the projects, and that are not the result of Company operations of these projects.

2.1.2 Proposed Action

The proposed action includes both the operational changes proposed by the Company, as well as mitigation actions to off-set impacts of those operations. The proposed operational changes are to. increase the Company's operational flexibility to allow load following to better track power demand during peak demand periods and store water in the reservoir when demand is low (2.1.2.1). Given the relatively small size of these facilities, storage and release of water is limited and seldom exceeds a 24-hour cycle. Minimum flows from the dam are ensured under the license and those are provided below. This flexibility in power generation leads to fluctuations in river and reservoir stage which may be rapid and do not reflect ambient river flows to which native aquatic species have evolved, and that would occur in the absence of these dams and the water management practices conducted upstream. Rapid river and reservoir fluctuations will affect both riparian and shallow-water benthic habitats and may have effects throughout the river and riparian food webs. Mitigation for the proposed operational changes are also provided and analyzed in the Draft Assessment and this Opinion and include the Bliss Rapids Snail Protection Plan (2.1.2.2) as well as the Riparian Mitigation Plan (2.1.2.3).

2.1.2.1 Proposed Operational Changes

As described in the Agreement (2004), both the Lower Salmon Falls and Bliss projects are currently constrained to operate in a run-of-river mode for the remainder of the 30-year license. The Agreement describes run-of-river operations for these projects as "… holding Lower Salmon Falls and Bliss project reservoirs full while passing inflows." This mode of operation ensures that, within the control of the Company, stage fluctuations below these dams would not be altered suddenly, thus maintaining river stage and not resulting in the sudden stranding of Bliss Rapids snails in shallow benthic habitats.

The proposed action for the new licenses is described in the 2002 FEIS (Commission 2002, pg. 12-17). The Lower Salmon Falls and Bliss projects have been designed to work in conjunction with one another as well as C.J. Strike Dam to fulfill short-term (typically 24-hour) fluctuations in power demand ('load-following' operations).

Under the proposed 2010 license amendment, and as described in the 2002 FEIS and Attachment 2 of the Agreement, the Lower Salmon Falls Project will operate under the following constraints:

- Minimum flows leaving the Project are not to fall below 3,500 cubic feet per second (cfs)
- Hourly tailwater ramp rate is not to exceed 2.5 feet (ft) per hour
- Daily tailwater ramp rate is not to exceed 5 ft per day
- Reservoir headwater elevations are not to fluctuate by more than 2 ft from full pool.

For the Bliss Project the 2010 license amendment proposes the operation of the Project as described in the 2002 FEIS and Attachment 2 of the Agreement, under the following constraints:

- Minimum flows leaving the Project are not to fall below 4,500 cfs
- Hourly tailwater ramp rate is not to exceed 3.0 ft per hour
- Daily tailwater ramp rate is not to exceed 6 ft per day

Reservoir headwater elevations are not to fluctuate by more than 2 ft from full pool.

2.1.2.2 Bliss Rapids Snail Protection Plan

The action also proposes to implement the Snail Plan, which includes monitoring the Bliss Rapids snail throughout its range (fully encompassed by the action area under consideration, as well as area outside of the action area, specifically spring habitats upstream of Lower Salmon Falls Reservoir), establishes thresholds of decline used to trigger an assessment of the decline, as well as consideration and implementation of appropriate conservation or mitigation actions. The

Snail Plan also establishes a forum (technical team) for investigating causes of declines and for implementing appropriate protection and mitigation actions. The Plan utilizes an adaptive management approach to consider data on the species' abundance and distribution as it becomes available, and to respond to any future declines in population parameters, should they occur, in the most efficient and beneficial manner deemed appropriate. Using this adaptive management approach, the Plan is intended to provide flexibility to respond to the uncertainty in the selected abundance thresholds (see discussion below) and the protection and/or mitigation responses that could be implemented should the need arise.

At the time of the development of the Agreement (2004) and the implementation of the Snail Plan, the Snake River physa was not regarded as common to the action area and its taxonomic status was in question (see sections 2.3.2.2 and 2.3.2.4 below). In addition, adverse effects had been regarded as minor since the species was believed to be restricted to deeper portions of the river and outside of the influence of load-following operations. For these reasons, studies to assess the effects of operations on this species and its habitat were not included in the Agreement or the Snail Plan and no effort to study the Snake River physa within the action area was undertaken. Currently, this species is known to reach its highest densities and to be found with some frequency in the Minidoka Reach (RM 663-675 (1066.7-1086.1 km)), where long-term monitoring is being planned by the Bureau of Reclamation and Service.

The Snail Plan outlines a series of Bliss Rapids snail distribution and abundance thresholds (referred to as Evaluation Criteria in the Snail Plan), which include reductions in snail distribution and/or abundance that will initiate analysis and potential management responses by a technical team made up of members of both the Company and the Service. Abundance estimates considered in the Snail Plan are developed from data collected annually from both river- and spring-dwelling populations of the Bliss Rapids snail. Data from the first 3 to 5 years of monitoring will be used to identify low or minimum abundance values as well as the extent of the species' distribution; these values will be used as thresholds below which snail declines will be assessed to determine if further protection and/or mitigation actions need to be implemented. These minimum abundance values may be adjusted (lowered) after the initial 3 to 5 years of monitoring if, during following years, the species' populations have dropped to low numbers but have recovered to previous abundance estimates in subsequent years, providing evidence that natural population variability is greater than determined during the initial 3 to 5 year study period. Such population declines and rebounds would depend on the nature of species' decline and rebound (e.g., natural or anthropogenic factors) and the species' prospects for recovering to previous abundance numbers.

Development of the Snail Plan was a collaborative effort between the Company and the Service and incorporates findings from studies set forth in the Agreement (Clark 2009, entire document). The Snail Plan outlines and describes four actions which comprise its major components: (1) describing and implementing protection measures to address current threats to the species; (2) detailing the types and methodology of monitoring that will be conducted on Bliss Rapids snail (Appendices 1 and 2 of the Snail Plan); (3) defining the level of decline (relative to snail abundance and distribution) at which point conservation actions will be planned and implemented; and (4) detailing how the above decisions will be made, including a dispute resolution process designed to resolve decision-making conflicts, including issues outside of the Commission's jurisdiction (Randolph *in litt.* July 20, 2012).

The following are protection measures outlined in the Snail Plan:

1. Measures to address habitat destruction and modification specific to water diversion and groundwater withdrawals include:

- The Company shall continue to defend and protect, in a manner consistent with State law, all water rights it holds relative to spring or river flows;
- The Company shall implement water-management practices on all Company-owned property in a manner that is consistent with the protection and conservation of the Bliss Rapids snail;
- The Company shall not support actions or initiatives that can reasonably be expected to result in the loss or reduction of surface water or groundwater sources that support known or potential Bliss Rapids snail habitat.

2. Measures to address degraded water quality include:

- The Company shall fully implement all requirements related to its responsibilities as identified in Total Maximum Daily Loads (TMDLs) within and upstream of Bliss Rapids snail habitat;
- The Company shall prioritize water-quality enhancement measures that improve conditions in Bliss Rapids snail habitat when implementing watershed enhancement programs;

- The Company shall not support any future activity that is identified as substantively degrading water quality within Bliss Rapids snail habitat.

3. Measures to address physical alteration of spring habitat include:

- The Company shall manage all Company-owned spring habitat consistent with the protection and conservation of the Bliss Rapids snail that occur, or may occur, on its property;
- The Company shall not support or fund any activities that are known to degrade existing or potential Bliss Rapids snail habitat where those activities could be avoided or properly mitigated.

4. Measures to control invasive species, such as the New Zealand mudsnail (*Potamopyrgus antipodarum*), and quagga (*Dreissena rostriformis bugensis*) and zebra mussels (*D. polymorpha*) include:

- The Company shall support and participate in state and regional efforts to control the introduction of the New Zealand mudsnail, and quagga and/or zebra mussels into Bliss Rapids snail habitat where they do not currently exist;
- The Company shall support and participate in state and regional efforts to control the introduction of other, as yet unidentified, non-native invasive plant or animal species (e.g., the diatom alga, *Didymosphenia geminata*).

5. A measure to monitor Bliss Rapids snail populations and to adaptively manage the impacts of load-following operations at the Lower Salmon Falls and Bliss projects includes:

- The Company shall monitor the species as described in Appendices 1 and 2 of this Plan and shall implement an adaptive management plan as defined below.

2.1.2.3 Riparian and Wetland Mitigation Plan

Based on the Commission's analysis of the middle Snake River projects in their 2002 Final Environmental Assessment (Commission 2002), they estimated an average of 245 acres of riparian and wetland habitats would be needed to offset the impacts of the projects, including habitat impacts due to load following operations. In the absence of load following operations under the current license, in which the projects operated in a run-of-river mode, the Company has mitigated an estimated 180.5 ac for project effects. This leaves the remaining 64.5 ac of riparian/wetland habitat to be acquired and appropriately managed, as determined by the Commission, for the Company to mitigate for these projects to operate a load following mode.

As provided in the Riparian Plan (Holthuijzen and Huck 2011, pg. 2-3, 13-14), the Company will purchase a minimum of 64.5 ac of Commission-approved parcels for mitigation. Parcels would fulfill their mitigation value by falling within the following criteria: 1) including lands with riparian values including springs and wetlands; 2) to the extent possible, be adjacent to other protected areas to create larger blocks of protected riparian habitat; 3) acquire and manage riparian lands for their protection and enhancement; 4) when possible including the inclusion of parcels containing federally listed species such as the snails addressed in this Opinion; and 5) potential acquisition of non-riparian parcels that would effectively lead to the protection and enhancement of important riparian or wetland habitats.

Based on the current Riparian Mitigation Plan (Riparian Plan) (Holthuijzen and Huck 2011, pg. 3-12), eight properties (parcels) have been proposed for acquisition and management for riparian and wetland mitigation. Some of these parcels are already owned by the Company, but are not protected or credited as mitigation lands, are not under Commission jurisdiction from previous licenses and/or are managed for purposes other than conservation (e.g., Niagara Springs, Clear Lakes Number 1 and 2, Briggs Creek, and selected parcels at Thousand Springs). The remaining proposed parcels are owned by other entities such as Idaho Department of Fish and Game (Billingsley Creek) or other private owners (Sand Springs, Simplot East and West). Based on more recent communications with the Company (August 21, 2012) the Simplot parcels were not available for purchase, but additional parcels may be investigated for their availability. The Company is still in the process of determining available parcels for acquisition and has not yet made a complete selection of properties for the Commission's approval.

2.2 Analytical Framework for the Jeopardy and Adverse Modification Determinations

2.2.1 Jeopardy Determination

In accordance with policy and regulation of section 7 of the Act, the jeopardy analysis in this Opinion relies on four components:

1. The *Status of the Species*, which evaluates the range-wide condition of the Snake River physa and Bliss Rapids snail and the factors responsible for their condition, and for their survival and recovery needs.
2. The *Environmental Baseline*, which evaluates the condition of the Snake River physa and Bliss Rapids snail in the action area, the factors responsible for their condition, and the relationship of the action area to the survival and recovery of these species.

3. The *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the Snake River physa and Bliss Rapids snail.
4. *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the Snake River physa and Bliss Rapids snail.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the Snake River physas' and Bliss Rapids snails' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of these species in the wild.

The jeopardy analysis in this Opinion places an emphasis on consideration of the range-wide survival and recovery needs of these two species and the role of the action area in their survival and recovery as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Critical habitat has not been designated for the Snake River physa nor the Bliss Rapids snail, so there are no discussions regarding critical habitat or adverse modification in this Opinion.

2.3 Status of the Species and Critical Habitat

This section presents information about the regulatory, biological and ecological status of the Bliss Rapids snail and Snake River physa that provides context for evaluating the significance of probable effects caused by the proposed action.

2.3.1 Species 1: Bliss Rapids Snail

This section presents information about the regulatory, biological and ecological status of the Bliss Rapids snail that provides context for evaluating the significance of probable effects caused by the proposed action.

2.3.1.1 Listing Status

The Bliss Rapids snail was listed as a threatened species on December 14, 1992 (57 FR 59244). Critical habitat for this species has not been designated. The recovery area for this species is designated as the Snake River and tributary cold-water spring complexes between RM 547 (RK 880) and RM 585 (RK 941) (Fish and Wildlife Service 1995, pg. 31). On December 26, 2006, the State of Idaho and the Idaho Power Company petitioned the Service to delist the Bliss Rapids snail from the Federal list of threatened and endangered species, based on new information that the species was more widespread and abundant than determined at the time of its listing. The Service reviewed the information provided in the petition and initiated a 12-month review of the species' status. After compilation and review of new information, the Service hosted an expert panel of scientists and a panel of Service managers to reevaluate the species' status. On September 16, 2009, based on the findings of these expert panels, the Service posted a notice in the Federal Register stating the Bliss Rapids snail still warranted protection as a Threatened species given its restricted range and the persistence of threats (Service 2008, pg. 19-37).

2.3.1.2 Species Description

The shells of adult Bliss Rapids snails are 0.08 to 0.16 inches long with 3.5 to 4.5 whorls, and are clear to white in color when empty (Hershler *et al.* 1994, pg. 235). The species is known to occur in at least two different color morphs, a white or pale form, and a red form (*ibid.*, pg. 240). It is not known what controls these color forms, but some populations contain both.

2.3.1.3 Life History

The Bliss Rapids snail is dioeceous (has separate sexes). Fertilization is internal and eggs are laid within capsules on rock or other hard substrates (Hershler *et al.* 1994, pg. 239). Individual, life-time fecundity is not known, but deposition of 5 to 12 eggs per cluster have been observed in laboratory conditions (Richards *et al.* 2009c, pg. 26). Reproductive phenology probably differs between habitats and has not been rigorously studied in the wild. Hershler *et al.* (1994, pg. 239) stated that reproduction occurred from December through March. However, a more thorough investigation by Richards (2004, pg. 135) suggested a bimodal phenology with spring and fall reproductive peaks, but with some recruitment occurring throughout the year.

The seasonal and inter-annual population densities of Bliss Rapids snails can be highly variable. The greatest abundance values for Bliss Rapids snails are in spring habitats, where they frequently reach localized densities in the tens to thousands per square meter (Richard 2004, pg. 129; Richards and Arrington 2009, Figures 1-6, pg. 23-24). This is most likely due to the stable environmental conditions of these aquifer springs, which provide steady flows of consistent temperatures and relatively good water quality throughout the year. Despite the high densities reached within springs, Bliss Rapids snails may be absent from springs or absent from portions of springs with otherwise uniform water quality conditions. The reasons for this patchy distribution are uncertain but may be attributable to factors such as habitat quality (Service 2008, pg. 11-13), competition from species such as the New Zealand mudsnail (Richards 2004, 89-91), elevated water velocity, or historical events that had eliminated Bliss Rapids snails in the past (*e.g.*, construction of fish farms at spring sources, spring diversion, *etc.*).

By contrast, river-dwelling populations are subjected to highly variable river dynamics where flows and temperatures can vary greatly over the course of the year. Compared to springs in which water temperatures range between 14° to 17° C, river temperatures typically fluctuate between 5° to 23° C, (Figure 4) and river flows within the species' range can range from less than 4,000 cfs to greater than 30,000 cfs throughout the course of a year (Figure 3). These river processes likely play a major role in structuring and/or limiting snail populations within the Snake River (Dodds 2002, pg. 418-425; EPA 2002, pg. 9-10–9-12). While Bliss Rapids snails may reach moderate densities (10s to 100s per m^2) at some river locations, they are more frequently found at low densities ($\leq$10 per m^2) (Richards and Arrington 2009, Figures 1-6, pg. 23-24; Richards *et al.* 2009b, pg. 35-39) if they are present (Figure 2). It is likely that annual river processes play a major role in the distribution and abundance of the Bliss Rapids snail throughout its range within the Snake River by killing or relocating snails, and by greatly altering the benthic habitat (Palmer and Poff 1997, pg. 171; Dodds 2002, pg. 418-425; Liu and Hershler 2009, pg. 1296). While declines in river volume due to a natural hydrograph are typically less abrupt than load-following (see Section 2.5.1.1), they are of much greater magnitude, and hence it is logical to assume these natural events play an important role in limiting snail populations within the river.

A genetic analysis of the Bliss Rapids snail based on specimens collected from throughout its range (Liu and Hershler 2009, pg. 1294) indicated that spring populations were largely or entirely sedentary, with little to no movement between springs or between springs and river populations. Most spring populations were highly differentiated from one another as determined by DNA microsatellite groupings. By contrast, river populations exhibited no clear groupings, suggesting that they are genetically mixed (Liu and Hershler 2009, pg. 1295) and without genetic barriers, or they have not been isolated long enough to establish unique genetic differentiation. This pattern supports the suggestion made by other biologists that the river-dwelling population(s) of the Bliss Rapids snail exist in either a continuous river population (Liu and Hershler 2009, pg. 1295-1297) or as a metapopulation(s) (Richards *et al.* 2009b, entire document) in which small, semi-isolated populations (within the river) provide and/or receive recruits from one another to maintain a loosely connected population.

Habitat Characteristics

The Bliss Rapids snail is typically found on the lateral and undersides of clean cobbles in pools, eddies, runs, and riffles, though it may occasionally be found on submerged woody debris (Hershler *et al.* 1994, pg. 239) where it grazes on periphyton (benthic diatom mats) (Richards *et al.* 2006, pg. 59). This species appears to be restricted to aquifer spring-influenced bodies of water within and associated with the Snake River from King Hill (RM 546 (RK 879)) to Elison Springs (RM 604 (RK 972)). The snails' distribution in the Snake River is, with rare exception, within reaches that are not impounded and receive significant quantities (current est. 5,000 cfs) of recharge from the Snake River Plain Aquifer (Clark and Ott 1996, pg. 555; Clark *et al.* 1998, pg. 9). It has not been found within impounded reaches of the Snake River (Richards *et al.* 2006, Table II.1.5, pg. 37), but can be found in spring pools or pools with evidence of spring influence (Hopper *in litt.* 2006). With few exceptions, the Bliss Rapids snail has not been found in sediment-laden habitats. It is typically found on, and reaches its highest densities on, clean gravel-to-boulder substrates in habitats with low-to-moderately swift currents, but it is typically absent from whitewater habitats (Hershler *et al.* 1994, pg. 237). Difficulties in rearing this species in a laboratory setting (Warbritton, *in litt.*, 2009), along with its natural distribution within spring-influenced waters, suggest it requires cool water of relatively high or specific quality.

Previous observations have suggested that the Bliss Rapids snail is more abundant in shallower habitats, but most sampling has been in shallow habitat since deeper river habitat is more difficult to access. Clark *et al.* (2009, pg. 24-25) used a quantile regression model that modeled a 50 percent decline in snail abundance for each 3 meters of depth (*e.g.*, snail density at 3 meters was approximately 50 percent less than that at shoreline (pg. 24). Richards *et al.* (2009a, pg. 6-7) used an analysis of variance (ANOVA) to assess snail densities at 1-meter intervals and only found a statistical difference (increase) in densities in the first meter of depth, with no declining trends with increasing depth. Nonetheless, these authors suggest that greater than 50 percent of the river population could reside in the first 1.5 meter depth zone of the Snake River (Richards *et al.* 2009a, Appendix 1).

Diet

Richards (2004, pgs. 112-120) looked at periphyton (benthic diatoms) consumption by the Bliss Rapids snail and the New Zealand mudsnail (*Potamopyrgus antipodarum*) in competition experiments. He described the Bliss Rapids snail as a "bulldozer" type grazer, moving slowly over substrates and consuming most, if not all, available diatoms. The dominant diatoms identified in his controlled field experiments consisted of the bacilliariophyt genera *Achananthus* sp., *Cocconeis* sp., *Navicula* sp., *Gomphonema* sp., and *Rhoicosphenia* sp., although the species composition of these and others varied greatly between seasons and location. At least one species of periphytic green algae was also present (*Oocystis* sp.). Richards (2004, pg. 121) suggested that the Bliss Rapids snail appeared to be a better competitor (relative to the New Zealand mudsnail) in late successional diatom communities, such as the stable spring habitats where they are often found in greater abundance than the mudsnail.

2.3.1.4 Status and Distribution

The Fish and Wildlife Service (1995, pg. 10) reported that the Bliss Rapids snails' "modern" range extends along the Snake River from Indian Cove Bridge (RM 525.4 (RK 845.4)) to Twin Falls (RM 610.5 (RK 982.3)) and that it likely occurred upstream of American Falls in a disjunct population where it had been reported from springs (RM 750 (RK 1207)). The current documented range of extant populations is more restricted; this species has been identified from the Snake River near King Hill (RM 546 (RK 878.5)) to below Lower Salmon Falls Dam (RM

573 (RK 922)), and from spring tributaries as far upstream as Ellison Springs (RM 604 (RK 972)) (Bates *et al.* 2009, pg. 100). The "American Falls" occurrence was later discounted after multiple surveys failed to relocate the species (Fish and Wildlife Service 2008, pg. 5-6). There is an isolated river population that occupies a limited bypass reach (Dolman Rapids) between the Upper and Lower Salmon Falls reservoirs (Stephenson 2006, pg. 6).

Recently completed studies by the Company found the species to be more common and abundant within the Snake River (RM 546-572 (RK 879-920)) than previously thought, although typically in a patchy distribution with highly variable abundance (Bean 2006, pg. 2-3; Richards and Arrington 2009, Figures 1-6, pg. 23-24). Most, if not all, of the river range of the species is in reaches (Lower Salmon Falls and Bliss) where recent records show an estimated 5,000 cfs of water entering the Snake River from numerous cold springs from the Snake River Plain Aquifer (Clark and Ott 1996, pg. 555; Clark *et al.* 1998, pg. 9). This large spring influence, along with the steep, unimpounded character of the river in these reaches, improves water quality (temperature, dissolved oxygen, and other parameters) and helps maintain suitable habitat (low-sediment cobble) for the snail that likely contributes to the species' presence in these reaches (Hershler *et al.* 1994, pg. 237). It is noteworthy that the species becomes absent below King Hill, where the river loses gradient, begins to meander, and becomes more sediment-laden and lake-like. Although Bliss Rapids snail numbers are typically lower within the Snake River than in adjacent spring habitats, the large amount of potential habitat within the river suggests that the population(s) within the river is/are low-density but large compared to the smaller, isolated, typically high-density spring populations (Richards and Arrington 2009, Figures 1-6, pg. 23-24). These river reaches comprise the majority of the species designated recovery area as well as the action area (see Section 2.4.1.1 below).

The species' range upstream of Upper Salmon Falls Reservoir (RMs 585-604 (RKs 941-972)) is restricted to aquifer-fed spring tributaries where water quality is relatively high and human disturbance is less direct. Within these springs, populations of snails may occupy substantial portions of a tributary (*e.g.*, Box Canyon Springs Creek, where they are scattered throughout the 1.1 miles (1.8 km) of stream habitat) or may be restricted to habitats of only several square meters (*e.g.*, Crystal Springs). Spring development for domestic and agricultural use has altered or degraded a large amount of these habitats in this portion of the species' range (Hershler *et al.*

1994, pg. 241; Clark *et al.* 1998, pg. 7), often restricting populations of the Bliss Rapids snail to spring source areas (Hershler *et al.* 1994, pg. 241). Within the Snake River (and with the exception of the small, isolated population in the Dolman Rapids bypass reach), the Bliss Rapids snail only occurs in the unimpounded reaches from below Lower Salmon Falls Dam (RM 573 (RK 922)) to near the town of King Hill (est. RM 546 (RK 879)), a total of approximately 19 river miles (31 km). In the King Hill area the gradient and velocity of the Snake River declines and the benthic habitats begin to become more sediment laden; a habitat from which the species is absent. Although the species is typically less abundant within river habitats than within springs, it is far more widespread and genetically similar within the river where it probably is distributed via river transport mechanisms during high-flow events (see Life History section).

2.3.1.5 Conservation Needs

Survival and recovery of the federally listed snails in and adjacent to the Snake River, Idaho, is considered contingent on "conserving and restoring essential main-stem Snake River and cold-water spring tributary habitats" (Fish and Wildlife Service 1995, p. 27). Given the Bliss Rapids snail's habit of utilizing both river and spring habitats, the above stated recovery goal is critical. The generalized priority tasks for all of the listed Snake River snails, including the Bliss Rapids snail, consist of the following.

Priority 1

- Securing, restoring, and maintaining free-flowing main-stem habitats between the C.J. Strike Reservoir and American Falls Dam, and securing, restoring, and maintaining existing cold-water spring habitats.
- Rehabilitating, restoring, and maintaining watershed conditions (specifically: cold, unpolluted, well-oxygenated flowing water with low turbidity. (*ibid.*, pg. 1)).
- Monitoring populations and habitat to further define life history, population dynamics, and habitat requirements (Fish and Wildlife Service 1995, pg. 27-28).

Priority 2

- Updating and revising recovery plan criteria and objectives as more information becomes available, recovery tasks are completed, or as environmental conditions change (Fish and Wildlife Service 1995, pg. 28).

Given the known limited distribution of the Bliss Rapids snail and its specific habitat requirements, maintaining or improving spring and river habitat conditions within its range is the primary need for this species' survival and recovery. The Bliss Rapids snail reaches its highest densities in cold-water springs dominated by cobble substrates and free, or relatively free, of fine sediments, and with good water quality. Protecting these habitats that contain Bliss Rapids snail populations is critical to their survival and recovery.

Ensuring that water quality within the Snake River is not degraded is important for sustaining the species' river-dwelling populations. Since water quality appears to be of crucial importance to the species, protection of the Snake River Plain Aquifer is a priority. The aquifer is the source of water for the springs occupied by the snail and serves a major role in maintaining river water quality within the species' range.

2.3.2 Species 2: Snake River Physa

This section presents information about the regulatory, biological and ecological status of the Snake River physa that provides context for evaluating the significance of probable effects caused by the proposed action.

2.3.2.1 Listing Status

The Service listed the Snake River physa as threatened effective January 13, 1993 (57 FR 59244). No critical habitat has been designated for this species. A recovery plan for the Snake River physa was published by the Service as part of the Snake River Aquatic Species Recovery Plan (Fish and Wildlife Service 1995). The target recovery area for this species is from River Mile (RM) 553 to RM 675 (Fish and Wildlife Service 1995, pg. 30), which includes the river reach downstream of Minidoka Dam and includes most of the project area.

2.3.2.2 Species Description

The Snake River physa (or Physa) was formally described by Taylor (Taylor 1988, pg. 67-74; Taylor 2003, 147-148), from which the following characteristics are taken. The shells of adult Snake River physa may reach 7 mm in length with 3 to 3.5 whorls, and are amber to brown in color and ovoid in overall shape. The aperture whorl is inflated compared to other Physidae in the Snake River, the aperture whorl being ≥ 1/2 of the entire shell width. The growth rings are oblique to the axis of coil at about 40° and relatively course, appearing as raised threads. The soft tissues have been described from limited specimens and greater variation in these characteristics may be present upon detailed inspection of more specimens. The body is nearly colorless, but tentacles have a dense black core of melanin in the distal half. Penal complex lacks pigmentation although the penal sheath may be opaque. Tip of the penis is simple (not ornamented). The preputal gland is nearly as long as the penal sheath.

The Snake River physa, is a pulmonate species, in the family Physidae, order Basommatophora (Taylor 1988, 2003). The rarity of Snake River physa collections, combined with difficulties associated with distinguishing this species from other physids, has resulted in some uncertainties over its status as a separate species. Taylor (2003, pg. 135-137) presented a systematic and taxonomic review of the family, with Snake River physa being recognized as a distinct species (*Haitia* (*Physa*) *natricina*) based on morphological characters he originally used to differentiate the species in 1988. Later authors concluded that the characters described by Taylor (1988) were within the range of variability observed in the widely distributed *Physa acuta*, and placed Snake River physa as a junior synonym of *P. acuta* (Rogers and Wethington 2007, entire document). Genetic material from early Snake River physa collections was not available when Rogers and Wethington published and their work included no analysis or discussion on the species' genetics.

More recent collections of specimens resembling Taylor's (1988, 2003) descriptions of Snake River physa have been used to assess morphological, anatomical, and molecular uniqueness. Live snails resembling Snake River physa collected by the Bureau of Reclamation (Reclamation) below Minidoka Dam as part of monitoring recommended in a 2005 Biological Opinion (Fish and Wildlife Service 2005, pg 162-163) began to be recovered in numbers sufficient to provide specimens for morphological review and genetic analysis. Burch (*in litt.* 2008) and Gates and Kerans (2010, pg. 41-61) identified snails collected by BOR as Snake River physa using Taylor's

(1988, 2003) shell and soft tissue characters. Their genetic analysis also found these specimens to be a species distinct from *P. acuta*.

Gates and Kerans (2011, entire document) also performed similar analyses on 15 of 51 live-when-collected specimens recently identified as Snake River physa (Keebaugh 2009), and collected by the Company between 1998 and 2003 in the Snake River from Bliss Dam (RM 560) downstream to near Ontario, Oregon (RM 368). Gates and Kerans (2011) found that these specimens were not genetically distinct from Snake River physa collected below Minidoka Dam (but were genetically distinct from *P. acuta*), and provided additional support that Taylor's (1988) shell description of Snake River physa is diagnostic (Gates and Kerans 2011, pg. 6).

2.3.2.3 Life History

Freshwater pulmonate snail species such as Snake River physa do not have gills, but absorb oxygen across the inner surface of the mantle via a "lung" or pulmonary cavity (Pennak, 1953, pg. 675-676). Some freshwater pulmonates may carry an air bubble within the mantle as a source of oxygen, which may be replenished via occasional trips to the surface, though this is not a required mode of respiration and many diffuse oxygen directly from the water into their tissues across the surface of the mantle (*Ibid.*). The later method is the likely respiratory mode for the Snake River physa. Since they live in moderately swift current, individuals that release from substrates to replenish air at the surface would mean they would likely be transported some distance downstream away from their cohort and habitat of choice, and thus away from potential mates and known food sources. The lung-like mantle cavity may also permit at least some physa species to survive for short periods out of water. *Physa virgata*, a junior synonym of *P. acuta* (Dillon *et al.* 2005, pg. 415), have been observed to move and remain out of the water for up to 2 hours in reaction to chemical cues given off by crayfish foraging on nearby conspecifics (Alexander and Covich 1991, pg. 435). Whether or not Snake River physa can survive under such conditions of desiccation is not known.

As far as is known, all freshwater pulmonates, which include Snake River physa, are able to reproduce successfully by self-fertilization (Dillon 2000, pg. 83). While self-fertilization (selfing) in pulmonates can be forced under laboratory conditions by isolating individual snails, there is considerable variation within and among pulmonate genera and species in the degree of selfing that occurs in natural populations. Of the many *Physa* species in North America and world-wide, studies of self-fertilization effects on population genetics seem to have been conducted only on *P. acuta*. Selfing and its implications for genetic variation and survival are unknown for Snake River physa.

Snake River physa have yet to be reared and studied in the laboratory, and the species' reproductive biology has not been studied under natural conditions. Dillon *et al.* (2004, pg. 65) reported mean fecundity of 39.1 hatchlings per pair per week for *P. acuta*, but whether the Snake River physa exhibits similar reproductive output is not known. *Physa gyrina* began mating and laying eggs when water temperatures reached 10° to 12° C (DeWitt 1955, pg. 43), with eggs hatching in eight to ten days (*ibid.*, pg. 41), and Dillon (2000, pg. 119-121) presents evidence that the period of egg-laying in gastropods is somewhat dependent on snail size and water temperature. The reproductive period for Snake River physa is not known, but might be expected to generally follow that of other Snake River gastropods, with juveniles appearing in mid- to late-spring and numbers peaking in mid- to late-summer as river temperatures increase. Most members of the genus and family are not believed to live longer than one year (Dillon 2000, pg. 156-162). DeWitt (1955, pg. 42) stated that the lifespan of *P. gyrina* in southern Michigan populations was 12 to 13 months. It is reasonable to assume that Snake River physa lifespan would be similar.

Habitat Characteristics

The earliest descriptions of the species state that it was predominantly found in deep, fast flowing habitats such as rapids, and on boulder to bedrock substrates (Taylor 1982, pg. 2). While such habitats may be utilized by the Snake River physa, the large amounts of collection data currently available have allowed for a more rigorous analysis of occupied habitat within the Snake River. Gates and Kerans (2010, pg. 33-36) found the species to be most associated with pebble to gravel sized substrate, but note that these substrate types made up 67 percent of the river sampled (Table 1.11, pg. 36) and the Minidoka Reach is predominantly made up of run-glide habitats, rapids making up a small proportion of habitats present. More recent analysis of the downstream data collected by the Company, support the findings of Gates and Kerans. Winslow and others (*in litt.* 2011, pg. 6) found that Snake River physa occurred on substrates containing gravel (Pebble-gravel and Cobble-gravel categories) more than expected by chance alone ($X^2 \geq 55.504$, P_0.00032). In addition, such gravel substrates are more prevalent where typical river velocities are great enough to transport finer sediments, but not so high as to readily transport pebble-gravel sized sediments, representing water velocities typically encountered in runs and glides. Although these data cannot provide us with certainty of the habitat preference of the species, nor provide assurance that the species will not occur in other habitat types, they do provide the most supported analysis of such a preference currently available.

Gates and Kerans' (2010, pg. 8-36) detailed study, sampled cross sections of the river profile, and characterized habitat as run, glide, or pool. Mean depth of samples containing Snake River physa was 1.74 m, live specimens most frequently recovered from depths of 1.5 to 2.5 m. Depths in which all specimens were recovered ranged from less than 0.5 m to over 3.0 m, and abundances of three or more Snake River physa per sample were found at depths > 1.5 m. Eighty percent of samples containing live Snake River physa were located in the middle 50 percent of the river channel (Gates and Kerans 2010, pg. 20). This evidence may be suggestive of habitat requirements related primarily to velocity and depth as they influence substrate deposition, and possibly other factors.

Possibly of significance may be the fact that, despite intense and extensive surveys and monitoring for the Bliss Rapids snail in cold water spring habitats of high water quality, Snake River physa have never been noted in such habitats, including those with a clear connection to the Snake River such as the Thousand Springs area. Relatively cool water of a consistent temperature might represent an outside boundary to Snake River physa's habitat requirements. Water temperatures below 10° C are known to inhibit reproduction in *P. gyrina* (DeWitt 1955, pg. 43), a widespread physid species that co-occurs with Snake River physa in the Snake River. Summer water temperatures of spring flow from the Snake River Plain Aquifer, including Thousand Springs, typically ranges from 14° to 16° C.

Water temperature requirements and tolerances of Snake River physa are not been specifically researched. Gates and Kerans (2010, pg. 21) reported a mean water temperature of 22.6° C for sites occupied by the species at the time of sampling (in August and October), but it is not known if this represents an optimal range or if it happens to be the temperature range in which the species has been able to persist following anthropogenic changes to the Snake River system. Winter water temperatures in this river have historically reached freezing, though records are patchy (USGS 2003) Water temperatures for samples collected by the Company in the Bruneau Arm of C.J. Strike Reservoir and in the Snake River between RM 559 and RM 367 in late July to mid-August between 1998 and 2002 that contained live-when-collected Snake River physa averaged 23.4° C. The maximum temperature for cold water biota established in the Clean Water Act is 22° C. Based on available information, Snake River physa appear to be able to tolerate water temperatures slightly above the cold water standard of 22° C.

Diet

Diet preferences of Snake River physa are not known. Species within the family Physidae live in a wide variety of habitats and exhibit a variety of dietary preferences to match this. Physidae from numerous studies consumed materials as diverse as macrophytes, benthic diatoms (diatom films that primarily grow on rock surfaces), bacterial films, and detritus (Dillon 2000, pg. 66-70). *P. gyrina*, which co-occurs with Snake River physa in the Snake River, consumes dead and decaying vegetation, algae, water molds, and detritus (DeWitt 1955, pg. 43; Dillon 2000, p. 67).

2.3.2.4 Status and Distribution

At the time of its listing in 1992, the Snake River physa was presumed to occur in two disjunct populations, one in the Lower Salmon Falls and Bliss Reaches (approx. RM 553-572), and the Minidoka Reach (approx. RM 669-675). Its historic range was believed to extend as far downstream as Grandview (RM 487) (Fish and Wildlife Service 1995, pg. 8-9). Fossil evidence indicates this species existed in the Pliocene-Holocene lakes and rivers of northern Utah and southeastern Idaho, and as such, is a relict species from Lake Bonneville, Lake Thatcher, the Bear River, and other lakes and watersheds connected to these water bodies (Frest *et al.* 1991, pg. 8). The species' cryptic morphology (resembling more common species within the genus), the difficulty of sampling a large river, and the species' rarity, all made determining its distribution and abundance challenging and ambiguous.

Much of the resolution on the species' distribution has come from recent advances in the use of genetic tools, which have provided a greater degree of certainty in identification, and hence confirmation of the species' abundance and distribution (see Section 2.3.2.2 above). Subsequent work conducted by a number of agencies, private entities, and academics has greatly increased our understanding of the species' distribution and preferred habitat, though numerous questions on the factors limiting its distribution and abundance remain. Surveys conducted by the Company between 1995 and 2003 (Keebaugh 2009) and the BOR from 2006 through 2008 (Gates and Kerans 2010), confirmed with genetic identification place its current distribution from RM 368 near Ontario, Oregon (some 128 miles downstream from its previously recognized downstream range), upstream to Minidoka Dam (RM 675). Gates and Kerans (2011, pg. 10) confirmed that shell morphology, diagnostic of Snake River physa, from one of the specimens collected in the Bruneau River arm of C.J. Strike Reservoir matches that of specimens with similar morphology also confirmed as Snake River physa by DNA analysis.

More recently, the Company conducted surveys targeting the Snake River physa in the lower portion of its range for their preparation of biological assessments for the Swan Falls license (FERC No. 503) in 2011. Surveys for this project were conducted from RMs 441.9-469.4 and collected sixty 0.25 m^2 benthic samples. These survey efforts failed to recover any living Snake River physa and no empty shells were recovered (Bean and Stephenson 2011, pg. 7). In combination with the survey result provided by Keebaugh (2009, entire document), these results further support the conclusion that the species is rare outside of its core range in the river reach below Minidoka Dam.

As discussed above, while the full extent of the species' range is considerably greater than originally thought, the snail is not uniformly distributed throughout that range and there remain extensive portions of the Snake River that have not received adequate survey. The Snake River physa is known to reach it highest densities in the upstream-most population which is roughly delineated as occurring immediately below Minidoka Dam (RM 675), downstream to Milner Reservoir (RM 663). Gates and Kerans (2010, pg. 23) report Snake River physa from 19.7 percent of their samples with high density samples ranging from 30 to 64 individuals per square meter (m^2) (Gates and Kerans 2010, Figure 1.6, pg. 23). In addition, Kerans and Gates (*in litt.* 2006, p. 8) also reported finding 7,540 empty Physa shells during their 2006 sampling effort in the Minidoka Reach, by far the largest number of Snake River physa shells reported from any surveys. The frequency of occurrence and densities both decline in this reach downstream toward Milner Reservoir where the river transitions from a lotic to more lentic and sediment-laden environment (Gates and Kerans 2010, Table 1.2, pg. 21, 39). In contrast to the Minidoka Reach, the Physa is considerably less commonly encountered in its downstream range (below C.J. Strike), with only 4.3 percent of 787 inspected samples containing live animals and those positive plots most typically not exceeding 4 individuals per m^2 (Keebaugh 2009, entire document). Other portions of the Snake River (*e.g.*, Thousand Springs (RM 584) to Milner Reservoir) have received little to no survey effort. The action area has received limited surveys targeting Physa, but has received considerable effort for Bliss Rapids snail. However, based on these observations, the species does not appear to be a common inhabitant of this river reach and those results are reported in Section 2.3.2.1.

Lastly, early reports of the collection of two live Snake River physa above American Falls Dam (Pentec Environmental, *in litt.* 1991, pg. 8, 16) have never been confirmed. Recent survey efforts by the Bureau of Reclamation failed to locate Snake River physa upstream of Lake Walcott (Newman, pers. comm. 9 Feb. 2012), and as such the Service considers the colonies below Minidoka Dam and spillway as the upstream-most extent of the species' current range.

2.3.2.5 Conservation Needs

Survival and recovery of the Snake River physa is considered contingent on "conserving and restoring essential mainstem Snake River and cold-water spring tributary habitats (Service 1995, pg. 27)." The primary conservation actions outlined for this species are to "Ensure State water quality standards for cold-water biota…" (Fish and Wildlife Service 1995, pg. 31).

Priority 1 tasks consist of:

- Securing, restoring, and maintaining free-flowing mainstem habitats between the C.J. Strike Reservoir and American Falls Dam; and securing, restoring, and maintaining existing cold-water spring habitats.
- Rehabilitating, restoring, and maintaining watershed conditions (specifically: cold, unpolluted, well-oxygenated flowing water with low turbidity. (*ibid.*, pg. 1)).
- Monitoring populations and habitat to further define life history, population dynamics, and habitat requirements (Fish and Wildlife Service 1995, pg. 27-28).

Priority 2 tasks consist of:

1. Updating and revising recovery plan criteria and objectives as more information becomes available, recovery tasks are completed, or as environmental conditions change (Fish and Wildlife Service 1995, pg. 28).

The conservation needs of listed species are based on the species' habitat requirements. Habitat requirements of the Snake River physa are based on habitat where the species has been found, which may inject substantial uncertainty for a rare species. Recorded habitat may not necessarily represent optimum habitat, but until more definitive data on optimal habitat can be obtained, we must accept habitat where the species has been found as representing what we know of its habitat requirements. Information and conclusions below are based on the most recent information on the species' distribution in the wild.

As described in Section 2.3.3.1, the Service has concluded that Snake River physa select for substrates in the pebble to gravel range, and possibly in the cobble to gravel range, and that these substrates represent the species' preferred habitat under current conditions. In general terms, most Physa have been found in unimpounded reaches of run-glide habitats with pebble-gravel substrates, and this is currently regarded as the species' preferred habitat.

2.4 Environmental Baseline of the Action Area

This section assesses the effects of past and ongoing human and natural factors that have led to the current status of the species, its habitat and ecosystem in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have already undergone section 7 consultations, and the impacts of state and private actions which are contemporaneous with this consultation.

2.4.1 Species 1: Bliss Rapids Snail

2.4.1.1 Status of the Bliss Rapids snail in the Action Area

Eighty-seven percent of the Bliss Rapids snails' recovery area occurs within the proposed action area, the remaining 5 miles of which is in reservoir habitat (Upper Salmon Falls Project) which does not provide habitat for the species (Figure 1). An additional 12 miles of recovery area are hydroelectric reservoirs associated with the proposed action. This leaves an estimated 55 percent of the species' recovery area that is unimpounded river in which the species may occur in appropriate habitats; it is absent from an estimated 45 percent due to the presence of reservoirs or diversion structures (Upper Salmon Falls Project). Additional habitat areas are occupied upstream and along the river corridor of the recovery area in the form of emergent springs or spring complexes and most of these are not directly affected by project operations. The river upstream of Lower Salmon Falls Reservoir is largely altered by the presence of the Upper Salmon Falls Project as well as relatively poor water quality from upstream sources, both agricultural and domestic. Most of the populations upstream of the action area are restricted to aquifer springs which are isolated from one another and which lie outside of the species' recovery area. Nonetheless, a large proportion of the Bliss Rapids snails' occupied range occurs within or adjacent to the action area in habitats that will be affected by project operations as described in the proposed action. There are a number of occupied springs and tributaries in both of the river reaches within the action area. However, with few exceptions, these are outside of the influences of project operations.

Bean *et al.* (2009a, pg. 62-79) provided estimates of river occupancy by Bliss Rapids snail utilizing cobble count surveys carried out over 100 m transects of river bank and sampling an estimated 80 cobbles per transect. These surveys detected snail presence in 67 to 81 percent of transects in the Lower Salmon Falls Reach and 64 to 86 percent in the Bliss Reach (2005-2007). Within the remaining transects the species was recorded as absent or at densities too low to be detected. While the incidence of detection is common utilizing a sample size of 80 cobbles, it is considerably less when cobbles are considered independently. Figure 2 illustrates the relatively large number of cobbles sampled from which no Bliss Rapids snails were detected, with considerably fewer cobbles containing large numbers of snails (from Bean *et al.* 2009a, pg. 66). Nonetheless, the large amount of potential habitat provided within the river is substantial and hence contains a large, though dispersed and patchy, population.

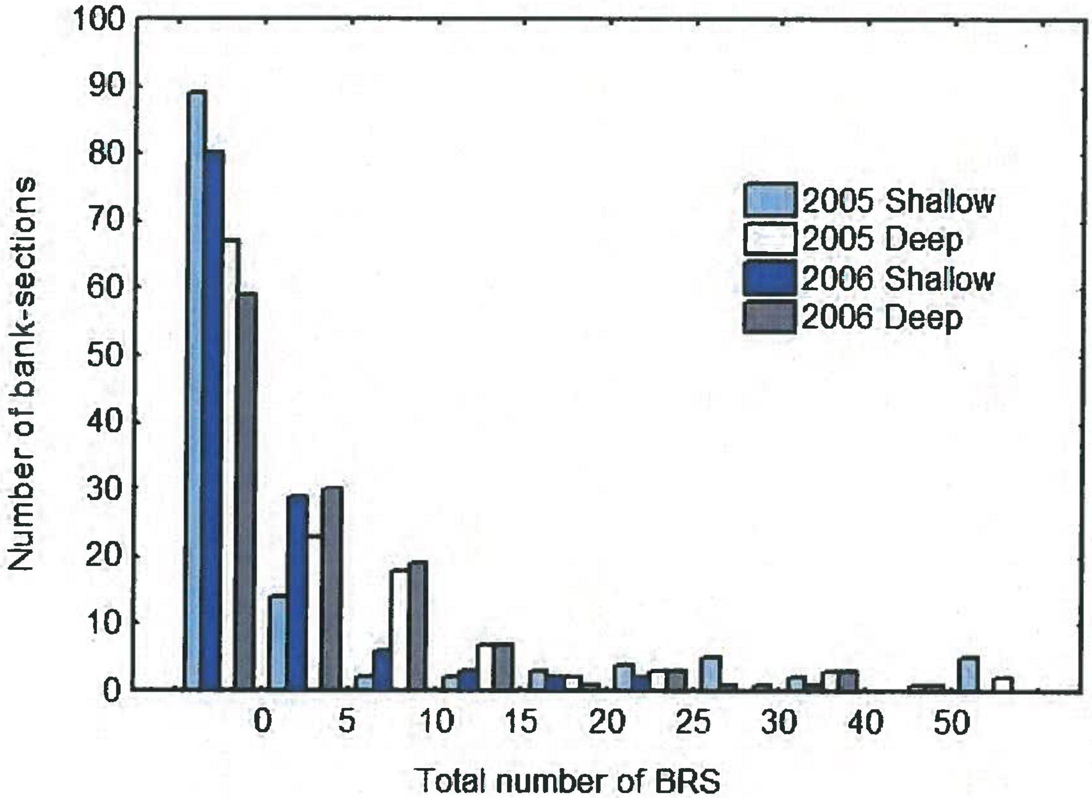


Figure 2. Comparison of the numeric frequency of Bliss Rapids snails on individual cobbles for shallow transects (0.0-0.5 meters) and deep transects (0.5-1.5 m) in the Lower Salmon Falls and Bliss river reaches of the Mid-Snake River in 2005 and 2006. This illustrates the patchy distribution of the species within the river portion of the action area. From Bean *et al.* 2009a, pg. 66.

The area affected by the Lower Salmon Falls Project is defined as the Lower Salmon Falls Reservoir (est. RM 580 (RK 933)), where it terminates adjacent to infrastructure associated with the Upper Salmon Falls Project, to below the Lower Salmon Falls Dam where the unimpounded reach empties into Bliss Reservoir (est. RM 565 (RK 909)). While all of this area falls within the geographic range of the Bliss Rapids snail, the snail is absent (or occurs at undetectable densities) from portions of this area (Bean *et al.* 2009a, pg. 62-64). The area affected by the Bliss Project is defined as the upper reservoir (est. RM 565 (RK 909)), where it is fed by waters from the terminal end of the Lower Salmon Falls Reach, to the headwaters of C.J. Strike Reservoir (est. RM 523 (RK 842)). The Bliss Rapids snail only occurs within this area from below Bliss Dam (RM 560 (RK 901)) to near the town of King Hill (est. RM 546 (RK 879)), an estimated 14 miles (22.5 km). It is in the King Hill area that the gradient and velocity of the Snake River declines and the benthic habitats begin to become more sediment laden. The last large documented aquifer spring enters the river at RM 553 (RK 890) (Bancroft Springs), just several miles upstream of the species' downstream geographic limit. Within this river reach, Bean *et al.* (2009a, pg. 62) encountered the snail in 64 to 86 percent of the surveyed river segments they surveyed from 2005 through 2007. Detection is defined as at least one individual per 80 cobbles in a 50 m river segment.

Studies conducted as part of the Agreement quantified the available snail habitat within the Lower Salmon Falls Reach and the river reach below Bliss Dam (Bliss Reach) (Borden and Conner 2009a, b, entire document; Welker *et al.* 2009a, b, entire document). Company biologists used that information to develop estimates of the Bliss Rapids snail populations within the river (Bean and Van Winkle, 2009, pg. 7). Given the species' patchy distribution and the high degree of variation in abundance and other habitat parameters, these population estimates are quite variable. Their estimates for the Lower Salmon Falls Reach ranged from a low of 1.1 million to a high of 14.3 million snails, with a best estimate of 3.8 to 3.9 million individuals. Richards *et al.* (2009a, pg. 18-19) conducted a similar analysis that incorporated estimates of Bliss Rapids snail depth distributions and estimated available habitat, and developed population estimates under different river flow volumes. They reported an estimate of between 4.2 million to 13.7 million individuals of the Bliss Rapids snail within the Lower Salmon Falls Reach.

Bliss Rapids snail densities within the Bliss Reach are lower than those encountered in the Lower Salmon Falls Reach (est. at 7.6 per m^2 in the Lower Salmon Falls Reach compared to 4.8/m^2 in the Bliss Reach) (Bean and VanWinkle 2009, pg. 6, and Appendix 1). With these lower densities within the longer Bliss Reach (est. 14 RM (RK 22.5) they reported a population range of between 900,000 to 12.5 million Bliss Rapids snails, with a best estimate of between 2.9 and 3.2 million individuals, while Richards and others (2009a, pg. 18) estimated between 1.8 to 12.0 million individuals.

2.4.1.2 Factors Affecting the Bliss Rapids snail in the Action Area

The predominant factor affecting the distribution and abundance of the Bliss Rapids snail within the action area is water quality. As reviewed in Section 2.3.1.3, the species reaches its highest densities in cold water springs derived from the Eastern Snake River Aquifer. The highest densities occur in habitats where spring water has not been significantly impaired by human uses and is free of fine sediment.

An estimated 12 miles of river habitat within the action area are reservoirs created by the Company's projects. Reduced water velocities in these reservoirs make them serve as sediment traps, covering gravel, cobble, and boulder substrates with fine sediments; habitat not occupied by Bliss Rapids snail. While these reservoirs (primarily Bliss Reservoir) may reduce gene flow between the large river populations of Bliss Rapids snail, there is no evidence that these populations are genetically isolated or otherwise at risk due to this (these) barrier(s) (Liu and Hershler 2009, pg. 1290-1295). It is plausible that these reservoirs improve river habitat below Lower Salmon Falls and Bliss Dams, since they help remove sediment from the system during low flows, however river gradient and velocity might effectively keep these areas free of fine sediments even in the absence of these dams. It is clear that the presence of these reservoirs have altered this river habitat to such a degree that the 12 reservoir miles are no longer suitable to the Bliss Rapids snail, and hence this resulting effect has been negative.

The action area is a region of major aquifer discharge into the Snake River. Section 2.3.1.4 discusses the prevalence of the Bliss Rapids snail in springs derived from the ESRPA and notes the large volumes of water from that aquifer that recharge the Snake River within the action area. This recharge plays a critical role in improving water quality in the unimpounded reaches within this area and is likely the most essential factor in controlling the species' range and distribution.

Whereas the spring habitats are relatively constant, with limited changes in flow and water temperatures, river habitats are far more variable. River flow can vary by as much as an order of magnitude depending on precipitation, timing of snow-melt, and upstream water management (Figure 3). High flows can mobilize bed sediments and deposits of considerable size and volume, and has been implicated in the localized extirpations and/or movement of Bliss Rapids snail populations (Stephenson and Bean 2003, pg. 12; and as cited in Fish and Wildlife Service 2008, pg. 13, 17). These periods of elevated river flow also tend to transport fine sediments away from higher gradient areas, creating cobble habitat more useful to the species. By contrast, sequential low water years (droughts) may result in the deposition of fine sediments, embedding the cobble substrate, and eliminating preferred habitat. Similarly, river temperatures undergo substantial seasonal variation, typically in excess of 20° C (68° F) (Figure 4). By contrast, spring habitats rarely if ever experience increases in stream flow that will mobilize substrates utilized as habitat by Bliss Rapids snails and temperatures seldom range by more than 3° C (7° F) annually (Richards 2004, pg. 17). While aquifer discharge into the Snake River likely is the most important factor explaining the Bliss Rapids snails' distribution in this portion of the river, the highly variable river conditions likely alter substrate conditions and move snails into and out of preferred habitat, thus influencing the species' distribution and abundance in the river within the project area. By contrast, the relatively stable conditions found within occupied springs may help explain the higher densities and more predictable distributions of the species in those habitats.

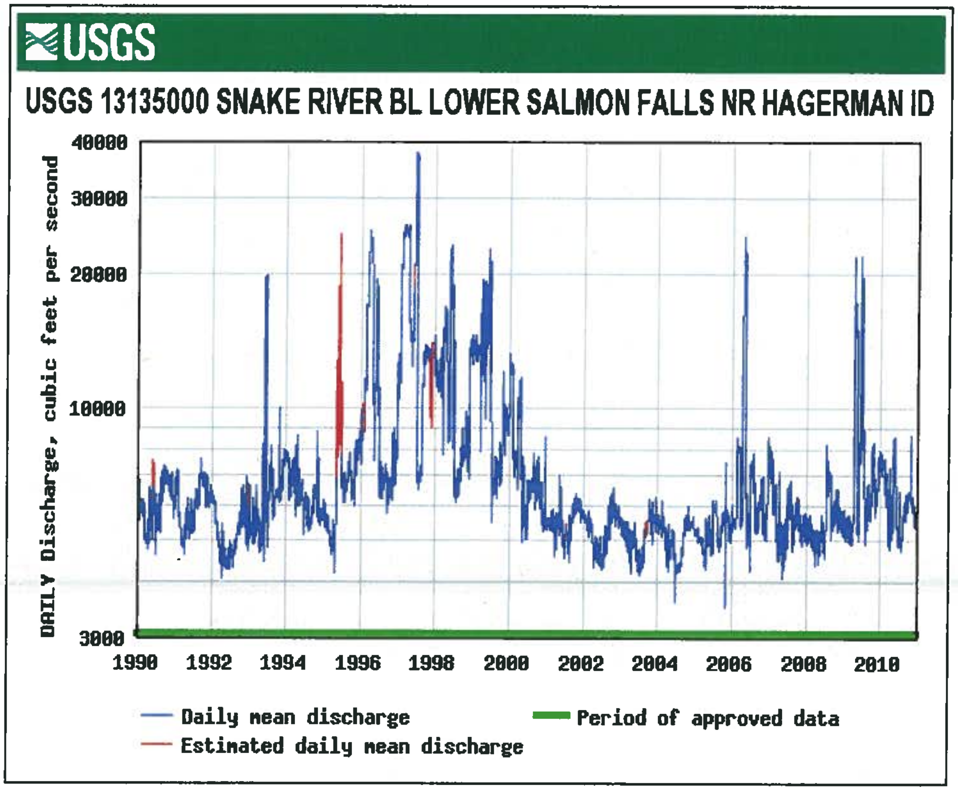


Figure 3. Water volume, velocity, and river stage can vary widely throughout the course of a year. High river flow can greatly modify the river channel, moving large cobble and boulders, and scouring benthic habitats with finer sediments, while low water years can lead to deposition of finer sediments. These dynamics greatly affect the benthic fauna of a river system and likely plays a key role in affecting the distribution and abundance of the Bliss Rapids snails within the Snake River. Data from USGS 2011a.

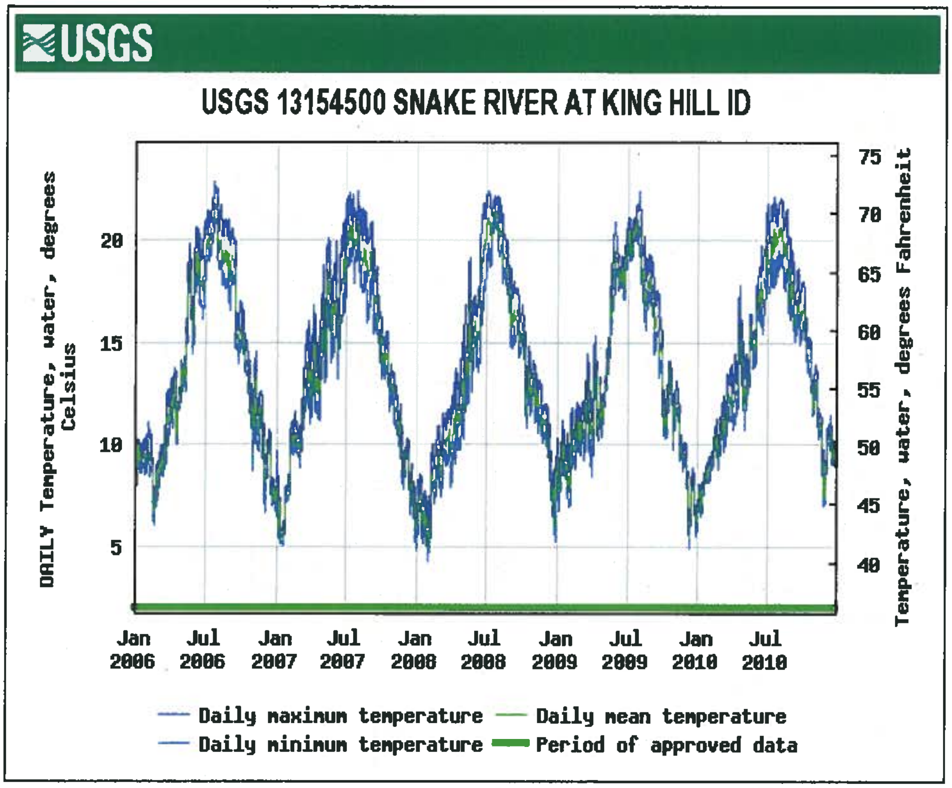


Figure 4. Seasonal fluctuations in river temperature in the Snake River at the lower end of the action area. Springs that emerge from the Eastern Snake River Plain Aquifer have far less variable temperatures, ranging from 14° to 17° C year round. The highly variable temperatures in the river may play a role in limiting the distribution of Bliss Rapids snails found in that habitat. Data from USGS 2011b.

River management and hydroelectric operations have affected river populations of Bliss Rapids snails. Upstream River management, not controlled by the Company, greatly affects river volume and stage within the action area. The Bureau of Reclamation (Reclamation) is responsible for using their projects to store water for irrigation and conducting flood control. Various local government and private irrigation entities also exercise their water rights to withhold or move water through the Snake River or water conveyance canals. This water management is documented to have major influences in river flow that are outside the control of downstream water users, including the Company (Figure 5).

Load-following operations by the Company have influenced Bliss Rapids snail populations and distributions but these effects are addressed in Section 2.5 below.

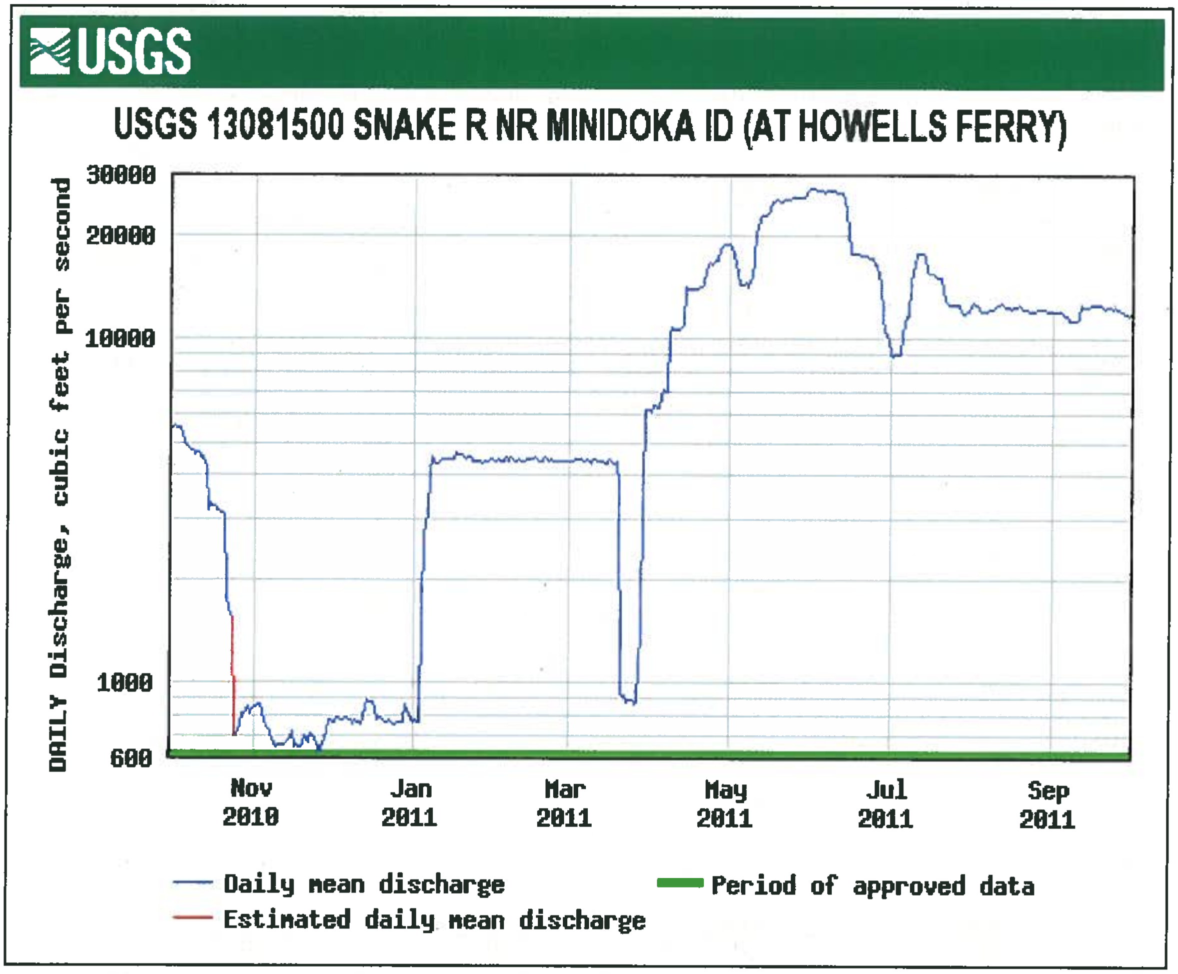


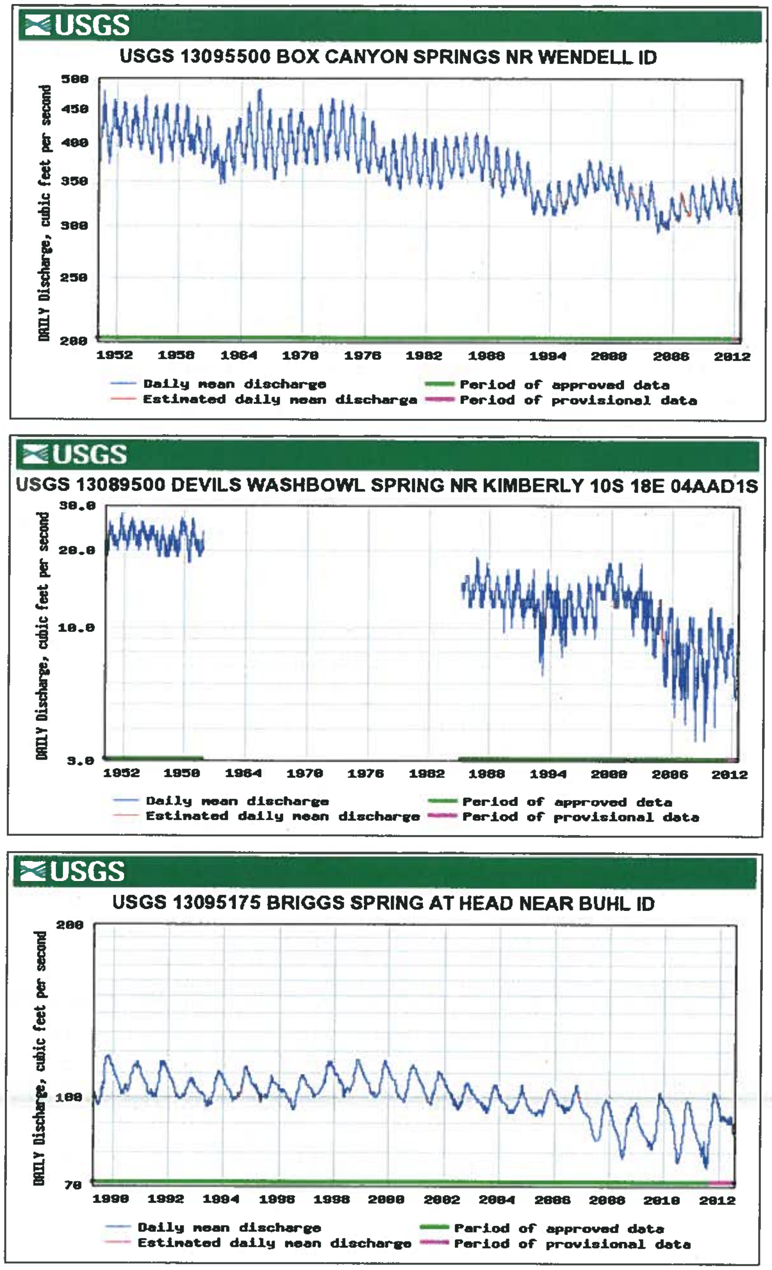
Figure 5. This graph illustrates the periodic erratic water management of the Snake River. Abrupt releases and withholding of river flows will affect river stage downstream and can have significant impacts on benthic and riparian habitats as well as on species that may rely on more consistent flows to complete life history functions (e.g., elevated flows for sturgeon spawning). Data from USGS 2011c.

Given the Bliss Rapids snails' great reliance on aquifer spring waters, the status of Eastern Snake River Plain Aquifer's (ESRPA) water quantity and quality are paramount to the species continued existence. Aquifers are under threat globally both from depletion (Foster and Chilton 2003, entire document) as well as contamination (Loague and Corwin 2005, entire document), and the ESRA is no exception.

Over the past century, spring discharges from the ESRPA initially increased and more recently decreased (Kjelstrom 1992, entire document). The initial increase in spring discharge was due to the expansion of irrigation canals and flood irrigation which contributed substantial amounts of water (primarily derived from the Snake River) to groundwater recharge. Since the 1950s, the aquifer spring discharge has undergone a gradual decline (Figures 6a, b, and c) as the amount irrigated farmland has increased along with a corresponding use in groundwater for irrigation and other agricultural uses (confined animal feeding operations, CAFOs). While groundwater pumping has increased, a significant amount of irrigation is now done using sprinkler systems which conserve water relative to flood irrigation, but makes far less water available for groundwater recharge (Kjelstrom 1992, entire document).

The potential for aquifer contamination has increased with human population growth, increases in agricultural lands, development of new agricultural practices (USGS 2010a, entire document), and use of new synthetic compounds for agricultural and other uses (e.g., fertilizers, pesticides, household, industrials) that become environmental contaminants. While the undesirable effects of some of these are well recognized and have been restricted (e.g., DDT, PCBs), the negative effects of others are unknown or have only recently been confirmed and regulations not yet determined or implemented (e.g., Bisphenol-A, PBDEs). Numerous environmental contaminants have been detected in the ESRPA, and the largest number and concentrations of such compounds were found in ground wells with high concentrations of nitrate in agricultural areas (Clark *et al.* 1998, pg. 17) such as those adjacent to habitats occupied by the Bliss Rapids snail. Nitrate is the most ubiquitous of contaminants detected in ground water and springs of the ESRPA and is predominantly derived from fertilizer, cattle manure, and legume crops, and at the time of their study (Clark *et al.* 1998, pg. 12-13) groundwater contributions accounted for 70-80 percent of the nitrate in the Snake River at King Hill (RM 487). Numerous studies investigating groundwater and spring nitrates indicate that some ESRPA wells are greatly compromised from groundwater nitrates (Neely 2005, pg. 3-6), and both Clark *et al.* (1998, pg. 12-13) and Schorzman *et al.* (2009, pg. 9-12) provide data to show increasing trends in groundwater and spring nitrate levels. Water quality data collected by the Service has shown some springs contain traces of pesticides, most notably Alchlor and Atrazine, two widely used agricultural herbicides (Fish and Wildlife Service, unpublished data).

River populations will be affected by the proposed load-following operations. In 2004, the Company and the Service entered into a settlement agreement designed to study operational



Figures 6a, b, c. Illustrate the over-all decline in spring discharge adjacent to the action area (confluences located at RM 588, 590, and 617, respectively). The 3 springs depicted are all derived, in part or fully, from the ESRPA. The seasonal lows in these figures have dropped by approximately 21%, 82%, and 25%, respectively, but the period of record is different for each spring. The above data were obtained from the U.S. Geological Survey (2012).

effects of the Lower Salmon Falls and Bliss projects. The primary objective of these studies was to determine the zonal (depth) distribution of Bliss Rapids snails under differing hydroelectric operations (load-following and run-of-river). However other studies complemented this by assessing the species' sensitivity to dewatering, providing estimates of potential available habitat, estimating the species' current distribution and abundance (spring and river habitats), as well as conducting population models to assess population dynamics (Clark 2009, entire document).

2.4.2 Species 2: Snake River Physa

2.4.2.1 Status of the Snake River Physa in the Action Area

Due to the aforementioned difficulties in species identification and taxonomic uncertainties surrounding this species (Section 2.3.2.2), information on the distribution and status of the Snake River physa has been plagued with uncertainty. While some experts have the ability to discern this species in the field, it has only been through the use of new molecular tools that identification of specimens can be reliably confirmed, and these methods are of limited use to field monitoring and rapid assessment studies. From 1995 through 2005, the Company collected 78 benthic samples from unimpounded river reaches within the action area (Keebaugh 2009, entire document). At the time of these collections, the subtle characteristics of the Snake River physa distinguishing it from the more common *Physa gyrina* were not understood by local biologists and these specimens were merely noted as "Physidae" and taxonomic resolution beyond this level was not pursued. These collections were reassessed after clarification of the species' taxonomic identification and morphological characteristics (Burch *in litt.* 2008). This second assessment, carried out by J. Keebaugh of the Orma J. Smith Museum of Natural History, identified 587 *Physa gyrina*, from within the project area, with a single live specimen of Snake River physa (*Haitia* (*Physa*) *natricina*) (Taylor 2003, pg. 147-148) recovered from river mile 559.3, an estimated 0.7 miles downstream of Bliss Dam. Confirmation of the Snake River physa identified by Keebaugh (2009, entire document) was conducted by Gates and Kerans (2011, pg. 3-6), but the small size and damaged shell of this Physa did not allow for full confidence in the species' identification nor could sufficient DNA be extracted for molecular sequencing. Given the confirmation of most of those specimens positively identified by Keebaugh, the Service regards this snail as likely being Snake River physa, though we acknowledge that this identification is uncertain and cannot be reliable confirmed. This suspect individual of Snake River physa was collected in 2002 from a recorded depth of 1 ft.

In 2003, more focused surveys were conducted for the Snake River physa with a taxonomic expert (Dr. T. Frest), during which the Company provided logistic support for collections at locations where the species had been collected by D. Taylor, the original describer of the species (Taylor 1988, pg. 67-74), all of these locations being within the action area. While collections were only from 7 river locations (11 samples), these included the type locality and sampling was intensive, utilizing divers and suction dredges, and included a number of deep water habitats within swift water eddies, habitats described as preferred by Taylor (1988, pg. 67). No living Snake River physa, nor empty shells of the species, were reported by Frest and Johannes (2004, pg. 4) from these surveys. In 2011, the remaining, unsorted samples of these 2003 surveys were inspected by EcoAnalysts who also reported the lack of Snake River physa from these collections (EcoAnalysts *in litt.* 2011).

Based on the habitat analyses conducted by Gates and Kerans (2010, pg. 7-37) and Winslow *et al.* (*in litt* 2011, pg. 1-10), Snake River physa appear to be predominantly associated with gravel and pebble-sized substrates. Winslow *et al.* (2011, pg. 10-15) also consider the distribution of pebble-gravel habitats within the Lower Salmon Falls and Bliss project action areas by utilizing Company data. Both the Lower Salmon Falls Reach (RM 566-573) and upper Bliss Reach (RM 546-560) are of relatively steep gradient and contained relatively little pebble-gravel habitats, 5.8 percent and 14 percent respectively (by dominant substrate category; 18 and 17 percent by co-dominant) (Winslow *et al. in litt.* 2011, pg. 11-14). By comparison, these habitats were reported to comprise an estimated 75 percent of the substrate in the Minidoka Reach where Gates and Kerans reported comparatively high frequency and density of Snake River physa (2010, pg. 20-24, Figure 1.5).

In contrast to the two action area reaches described above, the lower half of the Bliss Reach (RM 522-546 (RK 840-879)) has a reduced gradient, is more meandering in its character, and was estimated to contain 51 percent of gravel as a dominant habitat. By contrast, pebble substrates only represented 3 percent as a co-dominant substrate in that reach. Surveys in this reach, 63 samples collected by the Company (Keebaugh 2009, entire documents) and a day's intensive survey effort in and near one of the type localities for this species (Taylor 1998, pg. 72), recovered no Snake River physa (Frest and Johannes 2004, pg. 11; EcoAnalysts *in litt.* 2011).

No vouchered river samples have been collected in the action area since the 2003 surveys (Frest and Johannes 2004, entire document; Keebaugh 2009, entire document), but even this sampling suggest the Snake River physa is not a common component of the fauna within the action area, being recorded in only 1[1] of 126 samples (0.8 percent) collected from 1995-2002, and absent from the 11 intensive samples[2] collected in 2004 (Frest and Johannes 2004, pg. 8-11; EcoAnalysts *in litt.* 2011). The above analysis does not include samples from reservoir habitats which have also been documented to provide habitat for Snake River physa, though at low frequency; 2 of 149 samples (1.3 percent), all of which were from C.J. Strike Reservoir (Keebaugh 2009, entire document). More systematic surveys and monitoring would be useful in assessing the species' presence, but based on the available information, the Snake River physa is not commonly encountered nor locally abundant in the action area.

2.4.2.2 Factors Affecting the Snake River physa in the Action Area

Based on our current understanding of the habitat preference of the Snake River physa, the factors affecting the distribution of this species in the action area includes both good water quality and the presence of pebble-gravel substrates that are relatively free of fines. As discussed in Section 2.4.2.1 above, the distribution of the Snake River physa may be largely controlled by the distribution of fine-free pebble and gravel habitat, and some level of good water quality. In the analysis of Winslow *et al.* (2011, pg. 8-9; Figure 2), they showed the species to be predominantly associated with pebble habitat, which has a low occurrence in most of the action area (see 2.4.2.1 above). Given the higher gradients of the Snake River in this area, most pebble-

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[1] Keebaugh (2009, p. 80) identified a single specimen collected below Bliss Dam by the Company in 2002 as Snake River physa, but because Gates and Kerans (2011, p. 11) could not extract DNA from this small specimen, and part of the shell was missing, they could not confirm its identity. Thus Taylor's early collections (1956-1980; Taylor 1988, pg. 72) are the only confirmed live specimens collected between C.J. Strike Reservoir and the reach below Minidoka Dam.

[2] Samples between these two studies are not comparable. The 126 samples collected by the Company were suction dredge samples taken from $0.25m^2$ plots, whereas the intensive searches conducted in Frest and Johannes (2004) were suction dredge samples from much larger areas, frequently in excess of square meters, and hence of greater intensity, but more localized in effort.

sized sediments are likely transported into the intervening reservoirs along with finer sediments. While the ESRPA springs in this reach do provide relatively good water quality, the high-gradient unimpounded reaches are largely free of preferred sediments and the reservoirs are dominated by fines. While some pebble habitats may be found intermittently throughout the action area, their low frequency may explain the over-all low frequency and abundance of Snake River physa in this area.

Fine sediments have also been identified as a negative correlate with the presence of Snake River physa (Gates and Kerans 2010, pg. 24, 34-36). Human activities in the mid-Snake contribute substantial quantities of fines to the river in the form of suspended solids, predominantly from agricultural returns and effluent draining agricultural lands (Brockway and Robison 1992, pg. 45-68; Clark *et al.* 1998, pg. 18-19). While speculative, sequential drought (low precipitation) years may result in increased deposition of fines smothering potential habitat and contributing to the creation of macrophyte beds which in turn reduces water velocity and captures more suspended sediments (EPA 2002, pg. 4-29 to 4-31, 9-14). Years with high precipitation and run-off events may remove buildup of such fines from throughout the drainage system. Hence different hydrologic years may play an important role in controlling the distribution of the species both by creating and destroying habitat via the dynamic movement and deposition of sediments, as well as disturbance-induced mortality, as occurs for other river-dwelling mollusks and arthropods (Vannote and Minshall 1982, pg. 4104-4106; Di Maio and Corkum 1995, pg. 663-670; Wallace and Anderson 1996, pg. 42-43; Holomuzki and Biggs 1999, pg. 41-45;Stone *et al.* 2004, 341-349).

Load-following operations by the Company are anticipated to affect the Snake River physa within the action area, but these effects are addressed in Section 2.5 below.

Gates and Kerans (2010, pg. 20) made an effort to assess the impacts of seasonal dewatering on the zonal/depth distribution of the Snake River physa in the Minidoka Reach, where spring run-off is stored in upstream reservoirs for irrigation. They found that habitats seasonally dewatered (winter flood control and water storage) were 80 percent less likely to contain the species than deeper habitats that remained watered year-round. In addition, abundance (density) increased substantially in deeper, permanently watered habitats. As with the Minidoka Reach where they conducted their studies, the action area is subjected to similar water management regimes as illustrated in Figures 3 and 5. However, as noted in Section 2.4.1.2 above, the action area is greatly supplemented by spring contributions that are largely independent of upstream river management[3].

In the above study Gates and Kerans (2010, pg. 24-40) also provided data showing an over-all selection of deeper, constantly watered habitat, by the majority of the river's molluscan fauna. The river reach studied by these authors is seasonally dewatered rather than "daily" as can happen under a load-following mode of hydroelectric generation. Nonetheless, it illustrates that dewatering of habitats will limit the habitat quality for some subset of the benthic community. This effect appears to reduce the amount of quality habitat for many organisms and reduces their occupation of these dewatered zones. This in essence manifests itself as an indirect effect more than a direct effect, since fewer species of the benthic assemblage will occupy this habitat/zone, and hence be less prone to the direct effect of becoming stranded and dewatered under hydroelectric operations.

2.5 Effects of the Proposed Action

Effects of the action considers the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered along with the environmental baseline and the predicted cumulative effects to determine the overall effects to the species. Direct effects are defined as those that result from the proposed action and directly or immediately impact the species or its habitat. Indirect effects are those that are caused by, or will result from, the proposed action and are later in time, but still reasonably certain to occur. An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation.

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[3] Spring flows are influenced by human-induced water management regimes. During irrigation season, irrigation water provides aquifer recharge which is illustrated in the seasonal increases in spring discharges (Figure 6a-c).

For the purposes of this Opinion, we are evaluating the effects of the proposed hydroelectric operations as well as the effects of implementing the Bliss Rapids Snail Protection Plan (Snail Plan) and the Riparian and Wetland Mitigation Plan (Riparian Plan). The Snail Plan is included as part of the action in the license amendment application, and was prepared in partial fulfillment of the 2004 Agreement to incorporate snail conservation and/or mitigation into the license action. Hence, the Snail Plan includes a set of collaboratively developed conservations actions, articulating measures to avoid or minimize the potential for negative effects to the Bliss Rapids snail from project operations, as well as a monitoring component to assess the species' range-wide status, over the remainder of the amended license.

The Riparian Plan outlines the purchase and/or management of riparian and/or wetland habitats for the purpose of off-setting the near-shore impacts of the proposed load following operations. The Riparian Plan is provided as a general concept by the Commission in the Assessment, but details of this plan will be reliant on availability of properties for purchase by the Company.

2.5.1 Effects of Proposed Hydroelectric Operations on Bliss Rapids Snails

The direct effects of load-following operations on adult Bliss Rapids snails were the focus of 6 years of study conducted as part of the Agreement between the Service and the Company. Among other related topics, these studies collected new information on the depth distribution and range of the Bliss Rapids snail in the river reaches below the Bliss and Lower Salmon Falls dams, the amount of habitat dewatered by load following operations, and the effects of dewatering on adult snails. The Service is primarily relying on this information as cited below to inform the analysis of effects of the proposed action on the Bliss Rapids snail.

The effects of load following operations on the eggs and food supply of the Bliss Rapids snail are regarded as indirect and were not addressed by the completed studies due to field sampling logistical difficulties and analytical limitations. However, we address indirect effects below, using other sources of information.

2.5.1.1 Direct Effects of Operations

Information obtained from the above and other studies was also used to model the effects of load following and other factors on the population dynamics of the Bliss Rapids snail. Details of all of these studies and their findings are provided in the documents referenced in Clark (2009). Both field and laboratory studies carried out by Richards and Arrington (2006, 2008, entire documents) and Richards and Kerans (2008, entire doc.), and summarized by Stephenson (2009, entire doc.), provide documentation that Bliss Rapids snails occurring within the dewatered zone would be subject to adverse effects during periods of extreme, seasonal air temperatures, and/or over prolonged durations under dry conditions. Under tightly controlled laboratory conditions, moderate exposure conditions resulted in mortality typically ranging from 5 to 25 percent and as high as 90 percent under more severe conditions, whereas field trials typically provided lower levels of mortality (Stephenson 2009, pg. 48-52). While some of the scenarios of experimental exposure (*e.g.*, duration of exposure) were outside of those expected under normal hydroelectric operations of the projects considered herein, some of the exposures to extremely hot and cold temperatures could be encountered by Bliss Rapids snails living in zones prone to dewatering caused by the proposed action during seasonal temperature extremes. Although relatively fast rates of desiccation in the drier climate of the middle Snake River region are reasonably expected to occur, spring/groundwater influences and/or hyporheic and bank discharge in some operations-induced dewatered areas below the Lower Salmon Falls and Bliss projects can be expected to reduce those desiccation rates (Hopper *in litt.* 2009a, b). In addition, most of the extended dewatering periods occur at night when desiccation brought on by dewatering may be moderated during summer months. We anticipate greater desiccation impacts will occur during winter operations, when load-following operations will dewater benthic habitats at night, exposing them to subfreezing temperatures, although this effect will also be dampened by hyporheic or spring influences (Hopper *in litt.* 2009a, b).

Bean *et al.* (2009a, pg. 62-82) utilized their river-wide abundance (density) data from load following and run-of-river years to assess if there were changes in Bliss Rapids snail abundance, and by extrapolation, population size. Within the Lower Salmon Falls Reach three sample locations exhibited relatively high densities during run-of-river years relative to load-following (estimated in excess of 100 per m^2). However, at all remaining locations within that reach (total n=18) densities were similar between operational years (*ibid.*, Figure 3.5, pg. 63). Within the Bliss Reach, Bliss Rapids snails showed no notable density changes between operational years (n= 43) (*ibid.*, Figure 3.6, pg. 64). These authors found no statistically significant difference in densities between years ($P<0.05$; Wilcoxon Signed Rank Test, pg. 77). No statistical differences in snail densities were observed between operational years that would suggest more stable flows (run-of-river) had resulted in conditions significantly favorable to Bliss Rapids snail populations. While other studies carried out by the Company and others suggested an observable degree of impact (Stephenson 2009, pg. 48-52), direct comparisons in snail abundance between operational years within the Snake River suggest that other factors may ameliorate the effects of dewatering. The Service anticipates that snail mortality brought on by habitat dewatering will have a negative impact on Bliss Rapids snail populations residing in the Snake River, but these negative impacts are not statistically evident when comparing abundance data between operational modes and are small compared to the variability of Bliss Rapids snail populations observed outside of the effects of hydropower load-following operations.

Under the Agreement studies, the Company developed numerous parameters by which to estimate the effects of dewatering on Bliss Rapids snails. Welcker *et al.* (2009a, b, entire documents) provided estimates on the amount of suitable benthic habitat that was available within the action area, while Wilson and Conner (2009, entire document) and Conner *et al.* (2009, entire document) provided information on the duration and extent of dewatering in those habitats during both load-following and run-of-river operations. Bean *et al.* (2009a, pg. 57) then used their data on Bliss Rapids snail distribution and abundance during run-of-river and load-following operational years to develop a model to describe how snail densities varied with recent dewatering history (i.e., duration of dewatering periods) under these different dewatering scenarios. Using the above cited benthic habitat and dewatering studies, Bean *et al.* (2009b, pg. 6-13) developed estimates of habitat units (HU) affected and developed differences between run-of-river and load-following operations. An estimation of run-of-river impacts was calculated since fluctuations in river stage still occurred irrespective of the Company's operations due to upstream water use and flow management. The values of run-of-river dewatering were subtracted from the load-following values of stage change to arrive at estimates of the Company's impacts. Utilizing uncertainty distributions of observed snail densities in each river reach (Lower Salmon Falls and Bliss), they calculated an estimate of snail densities at different depths under the differing river flows and operational scenarios.

The Company (Bean *et al.* 2009b, Appendix 1: pg. 33-42) provided "best estimate" population numbers as well as the number of Bliss Rapids snails affected by load-following operations, calculated at different river flow volumes. The "best estimates" used in the Company's conclusions exclude the substantial amount of variation reported in their calculated confidence intervals for snail populations in each reach, and the Service regards the "best estimates" as a more conservative and reliable estimate. Bean *et al.* (*ibid.*, pg. 10) reported a best estimate of 79,000 to 158,000 Bliss Rapid snails affected by dewatering caused by load-following operations in the Lower Salmon Falls Reach, with between 18 and 37 percent of the dewatering impacts attributable to stage fluctuations occurring during run-of-river operations. For the Bliss Reach, these authors provided estimates of 127,000 to 159,000 with 19 to 25 percent attributable to run-of-river stage fluctuations. However, Bean and others (*ibid.*, pg. 2) regarded snails recorded or estimated to occur within dewatered zones as being unaffected. While the presence of these snails further indicates that dewatering will not necessarily result in mortality to all individuals, the Service recognizes dewatering as an adverse effect, whether or not it results in mortality or physical injury. For this reason, we include all individuals estimated to occur within dewatered zones, not just those estimated as absent, to provide our estimate of animals potentially adversely affected. This method is also provided by Bean *et al.* (*ibid.*, pg. 11) as a means of estimating all Bliss Rapids snails dewatered. Based on the Service's definition of adverse effects, our estimates of Bliss Rapids snails affected is substantially higher than that of the Company's. Within the Lower Salmon Falls Reach, the Service estimates that from 171,000 to 453,000 snails, 4.5 to 11.9 percent of that river population may be dewatered, while those in the Bliss Reach may be upwards of 266,000 to 651,000, representing 7.4 to 22.4 percent of that population (Fish and Wildlife Service *in litt.* 2012).

The estimates of the number of Bliss Rapids snails adversely affected by dewatering as provided in Bean *et al.* (2009b, Appendix 1) are not based on estimates of depth, but rather on the duration of dewatering (*ibid.*, pg. 5-11) which is the appropriate parameter of concern. The average or baseline river stage and flows change from year to year depending on precipitation, snow pack, and the rate of snow melt and water release from upstream dams. Given the heterogeneous bathymetry of the river, differences in river volume and subsequent changes in river stage will result in different quantities of habitat being available at different depths between years. Hence, while Bean *et al.* (2009b) could measure the duration of dewatering they could not assign the duration value to a corresponding value of depth since dewatering of specific depths changes with river profile which in turn is reliant on river volume and stage which typically varies between years.

Multiple factors make arriving at a reliable estimate of adverse effects to Bliss Rapids snail difficult. Factors that could elevate the estimates of adverse effects above that provided by the Company include but are not limited to the following: 1) snails migrating to zones not dewatered; 2) dead or injured snails dropping from occupied cobbles into the underlying substrates and missing detection; and 3) indirect effects such as reduced food production or reduced reproductive output due to mortality of eggs laid in the dewatered zone, etc. These types of negative impacts, which could not be quantified in the Agreement studies, are considered in the Service's effects and jeopardy analysis, but given the lack of information no precise estimates of snails harmed, harassed, or killed, relative to those displaced but not significantly harmed can be reliably reported. While it is reasonable and logical to assume that all snails dewatered will undergo some level of physiological stress and behavioral alteration (inhibition of feeding, mating, oviposition, *etc.*), especially in times of temperature extremes (Brown *et al.* 1998, pg. 92), there are factors that likely make the Service's estimate of adverse effects elevated. These include but are not limited to: 1) snails not colonizing or utilizing periodically dewatered habitats due to their impaired quality (see discussions in Sections 5.2.1.2 and 5.2.2.2, with examples in Gislason 1980, pg. 64-78, and Gates and Kerans 2010, pg. 23-39); and 2) mediation of dewatering exposure due to the influence of local springs, hyporheic effects, and bank discharge (see discussion above and Hopper *in litt.* 2009a, b).

It is critical to restate that the above numbers and percentages are not an estimate of mortality, but rather of snails that could potentially be subjected to adverse effects due to dewatering. The Service estimates provided above likely represent an over-estimate since Bliss Rapids snails are not likely to colonize areas that are subjected to more frequent episodes of dewatering or dewatering of greater duration, since such dewatering regimes greatly impair habitat quality. In this regard, the Company's work illustrating increasing snail density with declining durations of dewatering (Bean *et al.* 2009b, Appx. 1) has substantial merit and should be regarded as a strong qualitative assessment of the Bliss Rapids snails' ability to persist in viable populations when exposed to short-duration dewatering events, and is supported by snail survival rates under controlled and experimental conditions (see review and references in Stephenson 2009 above). The Service suggests the true adverse effects of dewatering due to load-following affects more than the 2 to 4 percent estimated by the Company, but is below the high estimates of 11.9 to 22.4 percent obtained in our simplified estimates. With the available data, developing a reliable estimate within the bounds of the above range of percentages is not readily achievable or practical.

A key consideration in the models developed by Richards *et al.* (2009c) is inclusion of an appropriate amount of natural variation in the species' population. Most invertebrate populations are highly variable, frequently undergoing fluctuations in numbers on a scale of orders of magnitude; such a pattern has been observed with the Bliss Rapids snail (Richards 2004, pg. 128-131). The problem of collecting data on a very small snail is compounded by its patchy distribution within a large and dynamic river system (see 2.3.1.3) such that it results in a substantial amount of uncertainty in both collecting data that adequately capture actual population variation and developing population models. The population intensively studied by Richards (2004, entire document) resided at a spring-river confluence and hence was influenced by both habitat types. This population underwent annual mean declines of 80 to 85 percent (as measured in densities, *ibid.*, pg. 129). However, while the population was exposed to changes in river stage due to seasonal river flow and upstream uses, it was not subjected to load-following operations and water quality and temperature were moderated by spring influences. Hence, population numbers underwent substantial annual variation, reaching seasonal (annual) highs of between 2800 to 5600 snails per m^2 each year and then undergoing seasonal declines to numbers below 1000 snails per m^2. Given the spring influence at Richard's study site (*ibid.*, pg. 124) snail habitat was always inundated, hence declines in snail density were not influenced by habitat dewatering. The natural inter-annual variation in snail density reported here greatly exceeds the estimated adverse effects attributable to load-following operations (see above) and occurs throughout the population. It is logical that in areas subjected to hydroelectric operations, dewatered habitats might have some additive mortality (see estimates of operational mortality above), but the study population rebounded seasonally and Richards (*ibid.*, pg. 130) provided evidence that the population's growth was positive throughout his period of study. Based on this, mortality due to hydroelectric dewatering maybe somewhat additive to the other factors influencing demography, but portions of any snail population not subjected to dewatering are able to rebound to seasonal highs. Those Bliss Rapids snails that occur within the zonal refugia (not subject to dewatering) rapidly increase seasonally and readily rebound to high levels seasonally.

Richards *et al.* (2009 b, c, entire docs.) developed a number of population viability models to assess how populations and metapopulations of the Bliss Rapids snail might be expected to fluctuate over time. One of these analyses (Richards *et al.* 2009c, pg. 49-50, 53-56) specifically incorporated mortality from hydroelectric load-following operations. This model artificially increased and decreased the estimated population size to assess sensitivity of larger and smaller populations to variability associated with load-following. Richards found little difference in the probability of extinction risk for Bliss Rapids snail under the estimated effects of load-following, and this probability was little influenced with initial population size. Although the accuracy of model results is limited due to their reliance on multiple assumptions that may or may not be an accurate reflection of the real world and limitations in available information, they are useful in shedding light on potential variation that will be observed in the real world over time.

Seasonal variation in river and spring populations of the Bliss Rapids snail is known to vary by up to two orders of magnitude (Richards *et al.* 2009c, pgs. 32-33). Richards *et al.* (2009c) used the coefficient of variation (CV: Standard Deviation N/Mean N) for modeled spring and river populations of the Bliss Rapids snail to incorporate observed variation within these models. The CV considers mortality effects from multiple causes (environmental stochasticity), and includes the effects of load-following operations and other indirect effects of hydroelectric operations (*ibid.*, pg. 29-31). While both the river and spring snail populations exhibited substantial variation, the river CV was larger (*ibid.*, pg. 29-36) and when combined with the lower density of river-dwelling snail populations, it suggests that the river-dwelling snail populations are more prone to local extinction. While these estimates of variation are based on limited data, they do reflect the variability of their respective habitats. Springs proved to be more stable (*e.g.*, flow volume, temperature, water quality) relative to the seasonal variation observed in these environmental variables within the river. Ultimately the CVs utilized in Richard's models were 0.4 for the spring-dwelling populations of Bliss Rapids snail, 0.5 for tributary-dwelling populations, and 0.6 for the river-dwelling populations (*ibid.*, pg. 35).

The findings of Liu and Hershler (2009, pg. 1294) state that the Bliss Rapids snail is largely sedentary, which suggests there may be relatively little-to-no snail immigration from springs (active or passive) and tributaries to the Snake River population(s) or that this occurs at undetectable frequencies. This suggests that a strict metapopulation analysis may not accurately represent the population dynamics of the species, especially for the many isolated spring populations. The metapopulation modeling conducted by Richards *et al.* (2009c) found that dispersal was not a large contributing factor except within the Lower Salmon Falls Reach (pg. 57). This modeling is instructive since it incorporates our best estimates of population size along with observed population variations of river and spring-dwelling Bliss Rapids snail populations and may aptly describe the dynamics of one or more river populations or metapopulations.

The model analysis did point to a greater risk of extinction of river metapopulations compared to the spring populations (*ibid.*, pg. 51-52). However, given the large population sizes and the amount of variation observed in the river, the mortality anticipated to occur from exposure to dewatering was small relative to the variation observed and the estimated population size. As a modeling exercise, Richards *et al.* (2009c, pg. 53-55, 63-64) decreased Bliss Rapids snail abundances by a factor of 10 in an attempt to analyze a scenario in which load-following killed a significant portion of the river-dwelling Bliss Rapids snails. Given the estimated and modeled population sizes and variation, this did not significantly increase the species' estimated time to extinction (extinction risk) using a 100-year timeframe. These authors state that such a scenario is unlikely and hence they conclude that load following impacts are extremely unlikely to result in declines of river populations of the Bliss Rapids snail to levels that would pose a serious extinction risk (*ibid.*, pg. 64-68). These authors could not quantify indirect effects on snails occupying habitats below the dewatered zone, but these effects were assumed to be represented in their CV and hence accounted for in their model (*ibid.*, pg. 64-65).

Richards *et al.* (2009c, pg. 66-67) point out that their models only include observed variation over a relatively short time frame (<10 years) and do not include other parameters that could greatly influence changes in snail abundance, nor do they include catastrophic events (*ibid.*, pg. 48, 63, 66). Their population viability models relied on recent recorded and estimated population or abundance estimates and do not include plausible declines due to other known threats (*e.g.*, anthropogenic impacts to the aquifer, habitat destruction). Based on the limitations of their data and the projected 100-year model duration, Richards *et al.* (2009c, pg. 66-67) stated that extinction risk is probably greater than they conclude based on their modeling effort. The Snail Plan recognizes that the status of the species may change over time and attempts to monitor and plan for such contingencies (see discussion below).

Although a relatively large portion of the Bliss Rapids snail population is estimated to occur in the upper 1.5 meters of river depth, most of this depth zone along the length of the river is not dewatered in the usual course of load-following hydroelectric operations. Snails inhabiting these zones will not suffer from direct effects of dewatering. The most dramatic hydroelectric stage fluctuations occur in closer proximity to the dams and locations with open and flat canyon profiles. Generally, the rate and amount of stage change becomes attenuated or dampened as one observes these effects downstream from the dam. Based on data from the Lower Salmon Falls Project provided and modeled by the Company (Bowling *in litt.* 2010, Figure 2), the actual change in river stage (water depth) 3 miles (4.8 km) downstream of the dam was 60 percent of that at the dam, and 30 percent 6 miles (9.7 km) downstream. Some of these stage differences are due to the river profile (*e.g.*, deep and confined versus shallow and broad canyon areas), which is apparent when viewing stage change profiles for the Bliss Project (*ibid.*, Figure 3). The effect of attenuation on benthic habitat exposure was factored into the Mike II models prepared by the Company (Borden and Conner 2009a, b, entire document) and incorporated into the habitat accounting tables provided by Bean *et al.* (2009b, Appendix 1).

Attenuation also results in time delays of the stage change as it is observed downstream. This is more apparent for the data reported for the Bliss Project (Bowling *in litt.* 2010, Figure 3), and the maximum stage change occurs for a longer duration (estimated at 3 hours compared to 1 hour at the dam) some 14 miles (22.5 km) downstream from the dam. This is also true for the Lower Salmon Falls project, but is less pronounced graphically (*ibid.*, Figure 2). While the peak dewatering durations are longer downstream, the amount of dewatered habitat corresponding to those episodes is considerably less than those areas closer to the dams as discussed above.

Lastly, the moderating effects of river temperature along with spring and hyporeic bank discharge (Hopper *in litt.* 2009a, b) probably reduce rates of snail mortality by moderating microscale humidity and temperature in periodically dewatered habitats occupied by Bliss Rapids snails. The documented number of snails still living within zones of recent dewatering suggest that the influence of the above discussed factors may be reducing snail mortality in these zones as illustrated in the depth analysis provided by Bean *et al.* (2009b, Appendix 1).

Summary of Direct Effects of Operations

The direct effect of dewatering on Bliss Rapids snail cannot be provided with great precision. The "biological accounting" as provided in the Company's studies (Bean *et al.* 2009b, 8-42) conclude that, on average, we would expect no more than 5.5 percent of the river population to be directly exposed (and in some way affected) due to dewatering resulting from load following operations. By comparison, Richards' monitoring data (2004, pg. 128-136) suggests that annual population fluctuations in a hybrid river-spring habitat not affected by load following can result in local declines in density (and by extrapolation population size) that are typically in excess of 50 percent seasonally.

Based on Bliss Rapids snail abundance estimates provided by the Company, the Service anticipates that operations-related habitat dewatering can be expected to adversely impact as much as 452,000 individual Bliss Rapids snails in the Lower Salmon Falls Reach (approx. 11.9% of that population) and 651,000 in the Bliss Reach (22.4%) annually. These numbers, and the controlled studies conducted by Richards and Arrington (2006, 2008) and Richards and Kerans (2008), suggest that while adverse effects can be estimated at the population level, given the species' current status and under current conditions, snail losses due directly to load-following are not significant relative to the inter-annual variation in population size attributable to other sources of normal demograhphic and environmental variation. As with the population declines and rebounds observed by Richards (2004, pg. 129), the lower levels of declines attributed to load-following are not anticipated to cause river populations to decline significantly nor to result in cumulative declines that could threaten the species over time, given its current range-wide status. Direct comparisons of Bliss Rapids snail abundances within the Snake River between load-following and run-of-river operational years showed no notable differences that could be attributed to load following, suggesting other factors may moderate the impacts of habitat

habitat dewatering. In addition, inter-annual variation in Bliss Rapids snail populations indicate that other factors not attributable to hydroelectric operations have a greater annual effect than those numbers estimated lost due to load-following and that those populations rebound to "high" levels each year.

Lastly, the two projects have been operating for periods of 71 (Bliss) and 102 years (Lower Salmon Falls), and prior to the current license, with less restrictive minimum flow requirements. Despite this history, the Bliss Rapids snail is distributed throughout large portions, though often sparsely, of the unimpounded river within the action area where habitats are appropriate (*e.g.*, upstream of King Hill). This in part may be due to a substantial portion of the river-dwelling population occurring well below those depths directly affected by load-following (zonal refugia), but probably also includes snails not significantly affected due to other discussed factors (*e.g.*, short dewatering durations, spring and hyporheic influences; see other discussions in this section). Given this operational history and current distribution of the species, including the species' distribution during years of run-of-river and load-following operations, it seems unlikely that sudden extinctions or local extirpations are of concern given the more generous minimum flows now being practiced. This assessment does not take into account possible changes in water distribution and use due to modeled climate change scenarios, the outcomes of which are highly uncertain.

2.5.1.2 Indirect Effects of Operations

The above referenced studies conducted by the Company show that load-following hydroelectric operations will dewater shallow, river habitats that contain Bliss Rapids snail and their algal food. While less is known about the egg-laying habits of the species, we are not certain how dewatering affects deposited eggs, but it is reasonable to assume that this does have a negative effect given the obligate aquatic habits of this snail. Neither the desiccation of food or eggs were studied under the Agreement, but pertinent studies on these impacts are discussed below.

Although we know of no studies that have assessed the effects of dewatering on hydrobiid snail eggs, it is reasonable to assume that when the eggs of a strictly aquatic snail are dewatered and subjected to subfreezing or elevated air temperatures they are likely to freeze or become desiccated, respectively, and die. Based on our understanding of the reproductive phenology of the Bliss Rapids snail, there is likely to be less oviposition during the winter months (Richards 2004, pg. 135), which will reduce the extent of such impacts on snail eggs when temperatures reach their most extreme lows. However, subfreezing conditions can occur in southern Idaho well into the month of May (NOAA *in litt.* 2012) which greatly overlaps with the primary oviposition period for the Bliss Rapids snail. Some level of mortality is certain to occur to dewatered eggs (see review in Stephenson 2009), although it is also likely to be 'buffered' by hyporheic and bank discharge/spring influences that partially ameliorate temperature extremes. While mortality to exposed eggs cannot be quantified, this factor was included in the CV relative to consideration of environmental stochasticity in the population viability models reported by Richards *et al.* (2009c, pg. 29-31).

Gislason (1980, entire doc.) studied the effects of hydroelectric operations on periphyton communities in three rivers in Washington State. In most cases, he found a direct, linear decline in chlorophyll *a* (used as a measure of periphyton abundance) with increasing air exposure time. While there were differences between rivers, river stations, and seasons, at a few sites Gislason (1980, pg. 64-78) recorded a complete loss of chlorophyll *a* from artificial substrates with as little as 25 percent exposure time, and in most cases all chlorophyll *a* was gone with ≥60 percent exposure time. During typical load following operations at Lower Salmon Falls and Bliss, water is withheld for approximately 32 percent of the time in each 24-hour period (Bean *et al.* 2009b, pg. 21), but the hydrologic fluctuations can vary greatly depending on the operational scenario (*ibid.*, pg. 21-30). Such dewatering durations will likely have an impact on the shallow periphyton community in the middle Snake River and can be expected to have a significant indirect impact on the benthic grazing community, including on the Bliss Rapids snail. It is plausible that periphyton declines associated with dewatering may explain or be partially responsible for the distribution of Bliss Rapids snails within dewatered zones. Rather than attributing snail absence to mortality from dewatering alone, the reduced habitat quality (due to retarded periphyton growth) may discourage snails from colonizing suboptimal habitats. However these potential effects cannot be separated based on the study results. The zonation documented by Gates and Kerans (2010, pg. 23-39) in their study of Snake River physa and other river mollusks in the Minidoka Reach, may be attributed to these or other effects.

Although relatively fast rates of desiccation in the drier climate of the middle Snake River region are reasonably expected to occur, spring/groundwater influences and/or hyporheic and bank discharge in some dewatered areas below the Lower Salmon Falls and Bliss projects are also likely to occur and may reduce those desiccation rates (Hopper *in litt.* 2009a, b). In addition, most of the extended dewatering periods occur at night when desiccation brought on by dewatering may be moderated during summer months. We anticipate greater desiccation impacts to occur during winter operations, when load following operations will dewater benthic habitats at night, exposing them to extreme cold temperatures. However, even during winter freezing, influences of warmer temperatures from ground water discharge and the river will dampen the effects of low air temperatures (Hopper *in litt.* 2009a, b).

In his dissertation research, Richards (2004) provides several lines of evidence that the introduced New Zealand mudsnail (*Potamopyrgus antipodarum*) occupies overlapping and/or adjacent habitats and compete, to some degree, with the Bliss Rapids snail for food resources (Richards 2004, pg. 89-122). In general, Richards (2004, pg. 89-91) provided strong evidence of competition between these two species, with declines in Bliss Rapids snails when mudsnails reached higher densities, but his studies were restricted to laboratory and spring or spring-influenced study sites. These interspecific interactions were more notable in habitats where the species were strongly density dependent (springs), and much less important when they were weakly density dependent (as modeled in the Snake River) (Richards *et al.* 2009c, Appendix 4, pg. 107-112). Within the Snake River, it has been speculated that mudsnails are better able to withstand the effects of rapid and/or frequent dewatering brought on by load-following operations than are the native Bliss Rapids snails (Bowler 1991, pg. 176-177; Hershler *et al.* 1994, pg. 241) and that this confers an added competitive advantage to the mudsnail in habitats that are frequently dewatered.

Other physical parameters of the Snake River, such as varying temperature extremes, might also confer an advantage to the mudsnail over the Bliss Rapids snail (Richards 2004, pg. 25-27). However, the influences of the mudsnail would have been captured, to some extent, by the data used in Richards *et al.* (2009c, pg. 29-31, Appendix 5, pg. 122-123) in the CV utilized in their population viability studies. Although it appears that load following operations may be better tolerated by the New Zealand mudsnail, and hence confer a competitive advantage to it, the Bliss

Rapids snail still occupies the Snake River and co-occurs with the mudsnail in river habitats. While Richards *et al.* (2006, pg. 6) stated that no Bliss Rapids snail population extirpations could be attributed to the New Zealand mudsnail, the Service notes that extirpations have not been studied in sufficient detail to determine the causes, which are likely to be numerous and possibly complex.

A number of studies have documented adverse impacts to aquatic gastropod populations due to hydroelectric operations (Fisher and LaVoy 1972, pg. 1473-1476; Christman *et al.* 1996, pg. 38-42) and similarly, others have shown improvements to the benthic community when hydroelectric operations are moderated and/or minimum flows increased (Morgan *et al.* 1991, pg. 422-427; Weisberg and Burton 1993, pg. 104-107; Bednarek and Hart 2005, pg. 1001-1005). From the information provided in the above and other papers (*e.g.*, Osmondson *et al.* 2002), as well as the results provided in Clark (2009, entire document) as part of the Agreement, it is reasonable to conclude that load-following operations adversely affect Bliss Rapids snail populations within the Snake River, both directly and indirectly. The research findings obtained by the Company comparing Bliss Rapids snail abundance between load following and run-of-river years do not reveal significant differences between these operational modes. Bean *et al.* (2009a, pg. 62-82) compared Bliss rapids snail densities in the river between load following and run-of-river years. While there were three sample locations in the Lower Salmon Falls Reach that exhibited elevated densities during run-of-river sampling, the remaining locations (total n=21) were similar to densities observed during load following years (*ibid.*, Figure 3.5, pg. 63). Within the Bliss Reach snails showed no notable density changes between operational years ($P<0.05$; Wilcoxon Signed Rank Test, n=39; *ibid.*, pg. 77, Figure 3.6, pg. 64). While the above discussed studies have shown negative impacts to Bliss Rapids snails due to habitat dewatering, no statistically significant differences in snail densities were observed between years to suggest that more stable flows (run-of-river) had resulted in conditions that would substantially increase snail populations. While the Service acknowledges that the factors controlling food production and fecundity (survivorship of eggs) are not limited to more stable river flow (*i.e.*, absence of load-following operations), we would expect to see an increase in snail abundance had load following operations been a significant factor in controlling Bliss Rapids snail populations. The Service anticipates that both elevated egg mortality and reduced food availability brought on by habitat dewatering, will have an indirect, negative impact on Bliss Rapids snail populations residing in the Snake River, but these negative impacts are not statistically evident when comparing snail abundance data between operational modes/years. The apparent disparity in the above published and cited studies and the findings of the Company provided here are likely due in part to the complicated life history parameters of the species that result in highly variable population estimates, such as large demographic variation (Richards 2004, pg. 129), patchy distribution (Section 2.4.1.1), and river-habitat dynamics (Section 2.3.1.3).

Although the best available information derived from the study results developed under the Agreement (Bean *et al.* 2009b) indicate that load following operations do structure/influence the depth distribution of the Bliss Rapids snail in shallow zones in these reaches, such impacts are not readily quantified in snail distributions throughout the river based on current sampling information and the studies conducted to date. As discussed in the Status of the Species section, the range-wide distribution (in linear river miles) of the Bliss Rapids snail is likely controlled by other factors such as the influence of aquifer inputs (water quality) and river hydrologic and hydrogeologic processes rather than by hydroelectric operations (see Status of the Species section above).

Summary of Indirect Effects of Operations

The Service anticipates that habitat dewatering of shallow benthic habitats resulting from hydroelectric load-following operations will adversely affect Bliss Rapids snails by reducing survivorship of eggs and reduction of food resources. We lack information or sampling procedures that would allow us to quantify the indirect effects of dewatering occurring from hydroelectric operations. However, comparative studies between years with load following and run-of-river operations did not reveal substantial or statistically significant differences in snail abundance, suggesting that population-scale impacts were not statistically detectible. In addition, inter-annual variation in Bliss Rapids snail populations indicate that other sources of population variation are greater than those numbers estimated lost due to load following and that river populations rebound to comparable levels, though variable, observed during corresponding months each year (Richards 2004, pg.129). While the Service anticipates that habitat dewatering will result in indirect adverse impacts to Bliss Rapids snail, given the results and limitations of the research conducted to date, these impacts do not rise to a level that is significant at the population scale.

2.5.2 Effects of Proposed Hydroelectric Operations on Snake River Physa

Unlike the Bliss Rapids snail, there have been no studies on the effects of load following operations on Snake River physa (Physa) within the action area. Studies conducted by Montana State University (Gates and Kerans 2010, pg. 8-37) and funded by the Bureau of Reclamation did provide useful information on this species' distribution in river habitats that were seasonally dewatered, but do not provide specifics on the effects of a daily dewatering regime such as hydroelectric load following. Nonetheless, information on the Physa's zonation/depth distribution within a river reach that undergoes seasonal dewatering, along with information on the species' range and abundance within the action area and elsewhere in the Snake River provide the foundation for our analysis on operational effects on the species within the project area. The effects of load-following operations on the eggs and food supply of the Snake River physa are regarded as indirect and while we currently lack information on these factors, we nonetheless deduce negative impacts based on this species' obligate aquatic life history.

As discussed in section 2.4.2.1 above, a single individual of Snake River physa was likely collected in the project area in the past decade (2002) (Keebaugh 2009, entire doc.) which was collected less than a mile below Bliss Dam and from a depth of around 1 ft. This was the only positive sample of 126 collected from 1995 to 2003 within the action area. Subsequent sampling conducted in 2003 by Frest and Johannes (2004, pg. 3-5) targeted locations where the species had been collected by the original describing biologist, Dwight Taylor, but this sampling effort found no Snake River physa to be present. While this sampling is not extensive, it provides supporting evidence that the species is not currently abundant in the habitats found within the project area.

2.5.2.1 Direct Effects of the Proposed Action on the Snake River Physa

Although the species does not appear to be common in the project area, it is logical to assume that the species is present at low or very low numbers, and will occur in waters shallow enough to be adversely affected by load following operations. This could include dewatering and stranding of individuals or their eggs and their exposure to hot or freezing desiccating conditions. Unlike the Hydrobiidae (which includes the Bliss Rapids snail), the Physidae is a relatively mobile group of snails, and being members of the "lung-breathing" Class Pulmonata, are typically capable of some limited respiration out of aquatic habitats. Under certain conditions, members of the aquatic pulmonates, and notably the Physidae, may actively leave the water as in the case of predator avoidance (Dillon 2000, pg. 307-309). Covich *et al.* (1994, pg. 287) observed *Physa virgata* (*P. acuta*) remain out of the water for hours and days to avoid predation by crayfish, and while a number of these snails died from desiccation, some 87 percent survived. Similarly, it is plausible that unlike the slower-moving Bliss Rapids snail, the more mobile physids may be able to re-enter water should their habitats suddenly be dewatered. Alexander and Covich (1991, pg. 392) state that *P. virgata* may be highly adapted to exiting water for durations of time to avoid predation. While the Snake River physa may be less adept at being dewatered than other species in the family, its apparent trend to live in deeper habitats may also keep it outside of the regularly dewatered zone (see below).

The work of Gates and Kerans strongly suggests that the Snake River physa prefers habitats within deeper river zones that are not subjected to seasonal dewatering. As stated previously, 80 percent of samples containing live Snake River physa were located in the middle 50 percent of the river channel, most from depths of 1.5 to 2.5 m (Gates and Kerans 2010, pg. 20). More specifically, the species was more commonly recorded from zones that remained watered (28.4 percent of samples being occupied) as opposed to habitats that underwent seasonal dewatering (5.8 percent occupied). This same trend was observed for most other aquatic mollusks sampled by these authors (Gates and Kerans 2010, pg. 24-25), suggesting that the watered zones provided more preferred habitats throughout the year and that habitats subjected to dewatering are less frequently and less densely occupied. Such a zonal distribution in the project area would place a larger proportion of that Snake River physa habitat deeper than most operational dewatering events.

The actual linear portion of the Snake River currently occupied by the Snake River physa is data limited and uncertain (see section 2.3.2.4 above). While the species has been recorded at varying frequencies and densities from RM 368 to 675, large portions of this area have not been surveyed (e.g., RM 586-662) and many lentic areas likely do not provide suitable habitat (e.g., RM 573-580, 639-662). The action area (RM 523-580) comprises 18 percent of the species' known range and 22 percent of its designated recovery area. Taken as a linear measurement alone, these would likely represent a significant portion of the species' range. However, as provided in the studies of Gates and Kerans (2010, pg. 23-36), the predominance of this species' occurrence in deeper zones indicates that it is not excluded from this linear reach of river. Hence while operational effects can be expected to adversely affect some portion of that river reach, it would not be excluded from nor jeopardized within that portion of its distribution within this range.

While the full extent of the species' range is considerably greater than originally thought, the snail is not uniformly distributed throughout that range and there remain extensive portions of the Snake River that have not received adequate survey. The Snake River physa is known to reach it highest densities in the upstream-most population which is roughly delineated as occurring immediately below Minidoka Dam (RM 675), downstream to Milner Reservoir (RM 663). Gates and Kerans (2010, pg. 23) report Snake River physa from 19.7 percent of their samples with high density samples ranging from 30 to 64 individuals per square meter (m2) (Gates and Kerans 2010, Figure 1.6, pg. 23). In addition, Kerans and Gates (in litt. 2006, p. 8) also reported finding 7,540 empty Snake River physa shells during their 2006 sampling effort in the Minidoka Reach, by far the largest number of Snake River physa shells reported from any surveys. The frequency of occurrence and densities both decline in this reach downstream toward Milner Reservoir where the river transitions from a lotic to more lentic and sediment-laden environment (Gates and Kerans 2010, Table 1.2, pg. 21, 39). In contrast to the Minidoka Reach, the Physa is considerably less commonly encountered in its downstream range (below C.J. Strike), with only 4.3 percent of 787 inspected samples containing live animals and densities most typically not exceeding 4 individuals per m^2 (Keebaugh 2009, entire doc.). Other portions of the Snake River (e.g., Thousand Springs (RM 584) to Milner Reservoir) have received little to no survey effort. The action area has received limited surveys targeting the Physa, but has received considerable effort for Bliss Rapids snail. However, based on these observations, the species does not appear to be a common inhabitant of this river reach and those results are reported in Section 2.3.2.1.

2.5.2.2 Indirect Effects of the Proposed Action

As with the Bliss Rapids snail, the effects of habitat dewatering on the eggs and food source of the Snake River physa are not known. However, it is logical to assume that a mollusk that is aquatic in its habitat requirements will be impacted indirectly by river stage fluctuations and/or habitat dewatering.

Based on our understanding of seasonality of reproduction, egg mortality of Snake River physa in the Minidoka Reach is likely not hampered by daily fluctuations in river stage since this reach of river is maintained at a relatively constant flow throughout the irrigation and reproductive season. This would not be the case in the project area where, under the proposed action, load following would likely occur during the Physa's peak reproductive season as demand for electricity peaks (irrigation pumping and air conditioning demands). While this might adversely affect reproduction, the general zonal distribution of Physa as documented by Gates and Kerans (2010 pg. 20) suggests that most individuals likely spend most of their life cycle in deeper zones that remain permanently watered, and by extension it is a logical assumption that eggs are deposited in these habitats, keeping them safe from periodic dewatering of shallower zones.

Periodic dewatering will have a negative effect on habitat suitability. This may largely be due to the detrimental effect dewatering has on periphyton (diatoms, bacteria, and other *aufwich*), the primary food of the species, as discussed in section 2.5.1.2 above. The Service anticipates that dewatering of shallow habitats will greatly reduce periphyton in this zone, helping to ensure that the Physa will spend more time in the deeper, continuously wetted river zones where habitat and food are maintained.

2.5.3 Effects of Interrelated or Interdependent Actions

2.5.3.1 Bliss Rapids Snail

The proposed hydroelectric operations are contingent on the presence of the two existing dams, which are interrelated and interdependent to the proposed action. Bliss Dam creates a reservoir approximately 5 miles (8 km) in length, while the Lower Salmon Falls Dam creates a reservoir of 7 miles (11 km). These reservoirs create lentic conditions and serve as sediment traps, covering benthic substrates with fines which in turn can result in the seasonal creation of macrophyte beds. Prior survey and monitoring efforts by the Company have failed to locate Bliss Rapids snails in reservoirs (Richards *et al.* 2006, pg. 35) and in all but a few instances the species has never been found in habitats with depositions of fine sediments; most typically only being associated with clean, hard substrates (gravels-boulders). Bliss Rapids snail populations are known to occur within the river on either side of these reservoirs (Bliss Reach, Lower Salmon Falls/Hagerman Reach, and Dolman Rapids) where cobble and boulder habitats are present. Hence, it is likely that the project reservoirs have eliminated potential river habitat for the Bliss Rapids snail. Indeed, the combined 12 miles (19 km) of reservoir habitat account for an estimated 31.6 percent of the species linear recovery area (which does not include numerous spring habitats outside of the recovery area), and this does not include an additional 5 miles of reservoir formed by the Upper Salmon Falls Project. Reservoirs within the species' designated recovery area account for 44.7 percent of river habitat, but the value or quality of those river reaches, as actual habitat, if unimpounded, cannot be assessed. However, as described here, it is logical to assume that river habitat lost to reservoirs likely represents a significant amount of the species potential range.

The effects of the project reservoirs were not addressed in the studies defined under the Agreement because the Bliss Rapids snail does not occupy reservoir habitats, and removal of these reservoirs was not recommended under the relicensing proposal at that time (Commission 2002, pg. 32-34). The Snake River Aquatic Species Recovery Plan (Fish and Wildlife Service 1995, pg. 32) called for securing and protecting free-flowing mainstem Snake River habitats between C.J. Strike Reservoir and American Falls Dam as a recovery action along with monitoring of three mainstem Bliss Rapids snail "colonies". While the recovery plan does discuss habitat and water quality improvements within the recovery area, it does not discuss or advocate removal of the middle Snake River dams within the recovery area (*ibid.*, pg. 32-53). The recovery plan does emphasize that the future loss of unimpounded ("free-flowing") river habitat would be detrimental, and that such river habitat be protected to help ensure the recovery of the Snake River aquatic species, including the Bliss Rapids snail, however the current existence of the Bliss and Lower Salmon Falls reservoirs are not regarded as precluding recovery (see below).

Analyses of river-dwelling snails in the Bliss and Lower Salmon Falls reaches suggest that there is little genetic difference between these populations despite the presence of an intervening reservoir (Bliss) (Liu and Hershler 2009, pg. 1290-1297). Nonetheless, it is reasonable to assume that the intervening dam and reservoir may reduce gene flow between these river reaches. In addition, given the likely large size of the river-dwelling populations, genetic differences that might arise from the founder effect and/or genetic drift are not likely to become apparent over the period in which the projects have been in place (71 and 102 years respectively).

2.5.3.2 Snake River Physa

The effects of reservoir and lentic habitats on the Snake River physa are less well understood than for the Bliss Rapids snail. All of the formal data collected to date suggest that the species reaches higher densities in gravel-pebble substrates, in unimpounded reaches with sustained water velocities that are largely free of fine sediments. However, surveys conducted by the Company have recovered the Physa from the Bruneau Arm of C.J. Strike Reservoir, from fine sand (primary substrate) as well as other river habitats from which the primary substrate was fine silt (IPC, *in litt.* 2010), though most collections of the species were from gravel substrates or larger. For this reason, the interrelated and interdependent effects of the project reservoirs are less certain regarding their influence on the species' distribution within the action area. Based on the information provided by Gates and Kerans (2010, pg. 20-40) and Keebaugh (2009, as summarized in IPC *in litt.* 2010), the reservoir habitat are expected to provide less than ideal habitat for the Snake River physa, but given their recorded occurrence from the C.J. Strike, can be assumed to be less detrimental than observed for the Bliss Rapids snail. Overall, given the apparent infrequency of occurrence of this species in the unimpounded reaches of the action area or downstream of C.J. Strike Dam, the Snake River physa is not anticipated to be a common occupant of the action area and as such the interrelated and interdependent effects of the reservoirs are regarded as not significant to the species at the population level.

<u>Summary of Effects of Interrelated and Interdependent Actions</u>

Under current conditions, the presence and operation of the Lower Salmon Falls and Bliss Reservoirs are not anticipated to result in the future declines of the Bliss Rapids snail or Snake River physa. These reservoirs were in existence prior to listing of these species and were noted as one reason for their decline. At the time of listing, the construction of additional dams was discussed as a potential future threat and the existing reservoirs were noted as having reduced both species' range (Fish and Wildlife Service 1995, pg. 17). In addition, the Recovery Plan (*ibid.*, pg. 27) states that allocated surface and ground water could continue to be used for beneficial use, which includes hydroelectric operations of the two dams under consideration, as well as other uses of their reservoirs. That plan further states (*ibid.*, pg. 27), "Recovery will require that remaining free-flowing mainstem habitats between C.J. Strike Reservoir and American Falls Dam are protected and preserved…" While restoration of the river through removal of these dams and their reservoirs would likely create more suitable habitat for the species and could result in an increase in their population size and distribution, it is not stated as a recovery goal and was not regarded as a viable recovery action given the pre-existing water rights and uses at the time of species listing. The continued existence of the Lower Salmon Falls and Bliss reservoirs, in their current form and with their current mode of operation, is not anticipated to result in the future decline of either the Bliss Rapids snail or Snake River physa.

2.5.4 Effects of Implementing the Bliss Rapids Snail Protection Plan

Each of the proposed protection measures under the Snail Plan are described below, followed by an analysis of the effects of their implementation on the Bliss Rapids snail and Snake River physa. The Service could not identify any interrelated or interdependent effects related to implementation of the Snail Plan and none are addressed in this section.

Measure 1: Addressing habitat destruction and modification specific to water diversion and groundwater withdrawals.

Analysis of Effects: Water from the Snake River Plain Aquifer is likely the most important physical parameter for the continued existence of the Bliss Rapids snail (Frest and Johannes 1992, pg. 23-24; Hershler *et al.* 1994, pg. 237). This species reaches its highest densities in springs derived from this aquifer and only occurs in portions of the Snake River that are highly influenced by aquifer accretion, with an estimated 5,000 cfs of spring water currently entering the river (Clark *et al.* 1998, pg. 9) that largely corresponds to this species' known range. With the advent of agricultural development in southern Idaho, irrigation canals brought water throughout this arid, sagebrush region, where it artificially elevated groundwater levels (Kjelstrom 1992, entire document). However, since the 1950s, the area has seen increasing agricultural development which has been accompanied with increased groundwater pumping for agriculture (Kjelstrom 1992, entire document). As a result, spring discharges in habitats occupied by the Bliss Rapids snail have declined steadily (see Figure 6).

The Company's first stated protection measure and specific actions will be of benefit to the Bliss Rapids snail in that it will help to ensure that surface and groundwater volumes, held within the Company's water rights, will be unaltered. The Company holds water rights within the Snake River to help ensure adequate flow for hydroelectricity production and these flows help ensure improved water volume and quality for Bliss Rapids snails occupying river habitat below Lower Salmon Falls and Bliss Dams. The Service anticipates that water sources in southern Idaho will continue to suffer declines as demand from agricultural and urban development increases consumption of both surface and groundwater sources (see the "Cumulative Effects" section below). The Company's stated goals of protecting their water rights for nonconsumptive uses by keeping water in springs and the Snake River will help off-set the plausible impacts of water withdrawal from these competing sources. These efforts are anticipated to be beneficial to the Bliss Rapids snail.

Unlike the Bliss Rapids snail, the Snake River physa does not reside in spring habitats within the action area. Although the Physa has not been recently documented from the area, the Service expects that any measures that protect habitat through measures that prevent water diversion and groundwater withdrawals will have an overall beneficial effect to the Snake River in which the Physa has been documented to occur. For this reason, Measure 1 of the Snail Plan is expected to be of benefit to the conservation of the Snake River physa.

Measure 2: Addressing degraded water quality.

Analysis of Effects: The Company has provided assurances that its future activities will not degrade water quality in areas of its influence. The Company has agreed to implement all requirements related to its responsibilities under Clean Water Act-related Total Maximum Daily Loads (TMDLs) and it will prioritize water quality enhancement measures within its control. These assurances will benefit surface water quality in which the Company plays a role in the middle Snake River region and, by extension be assumed to benefit Bliss Rapids snail. Water quality from the aquifer is a critical parameter for which the Company has little direct or indirect influence. However, the Snail Plan does involve the Company in monitoring efforts of Bliss Rapids snails and water quality in occupied springs, and considers the species' status in these spring habitats in guiding their future conservation and mitigation actions (see Measure 5 below). Similarly, since the Snake River physa evolved in a pre-developed Snake River habitat, any provisions that the Company takes to protect water quality within the action area, are expected to be neutral at worst and otherwise beneficial to the conservation of the Physa.

Measure 3: Addressing physical alteration of spring habitat.

Analysis of Effects: Spring habitat in the middle Snake River region has been greatly modified and developed throughout this century, with springs being diverted for household and agricultural (*e.g.*, aquaculture, irrigation) uses. Most of these modifications occurred before the description and/or Federal listing of the Bliss Rapids snail, and therefore before the species' predevelopment distribution and status was known. Nonetheless, the amount of development at spring sources that has occurred probably contributed substantially to the destruction of Bliss Rapids snail habitat. Some of these developments have come from hydropower projects (*e.g.*, the Thousand Springs and Malad projects). The Company controls numerous other undeveloped springs in the region, many of which contain substantial populations of the Bliss Rapids snail and are regarded as critical to the species' survival and recovery (*e.g.*, Briggs, Banbury, Thousand springs, and others). In the Snail Plan the Company provides assurances that spring habitats under their control will not be physically altered, nor will the Company fund such activities, and that their future management of these springs will be done in a way that is consistent with the protection and conservation of the Bliss Rapids snail. These assurances should serve to provide a beneficial effect to the species.

While the physical protection of spring habitats is not expected to have any direct positive or negative impact on the Snake River physa, any efforts that help to ensure that adjacent spring habitats are protected are expected to be neutral (at worst) or may provide some benefits to adjacent river habitats and water quality. For this reason, Measure 3 of the Snail Plan is not expected to result in adverse effects to the Physa.

Measure 4: Controlling invasive species, such as the New Zealand mudsnail, quagga, and the zebra mussel.

Analysis of Effects: Invasive, aquatic species are responsible for massive financial losses (Pimentel *et al.* 2000, entire document) and the decline of native species including mollusks (Strayer 1999, entire document). The New Zealand mudsnail modifies aquatic systems where it has become established (Hall *et al.* 2003, entire document) and has likely played a role in the competitive exclusion and population declines of the Bliss Rapids snail (Richards 2004, pg. 117-122). Although the New Zealand mudsnail is already well established in the action area, the threats from other, as yet unestablished, non-native, aquatic invasive species is substantial. The efforts of State and Federal agencies to prevent the spread and establishment of such species is crucial. However, the Company also plays a visible and influential role in southwestern and south-central Idaho and is a valuable partner in impeding the establishment of invasive aquatic species. While the introduction and establishment of additional aquatic invasive species is uncertain, the Company's assurances, as put forth in the Snail Plan, to continue with efforts in helping to control this threat will likely be of importance to the conservation of both the Bliss Rapids snail and Snake River physa.

Measure 5: Monitoring Bliss Rapids snail populations and adaptively managing the impacts of load following operations at the Lower Salmon Falls and Bliss hydroelectric projects on the snail.

Analysis of Effects: The monitoring component of the Plan is provided in detail in Appendices 1 and 2 of the Plan. Impacts to Bliss Rapids snails from this monitoring effort are covered in the Company's Endangered Species Act Section 10 Permit and are not covered in this Opinion. Nonetheless, since most of the sampling for this monitoring effort will be with the approved cobble count method, relatively little direct mortality is anticipated to occur. While trampling of Bliss Rapids snails by researchers is likely to occur, the infrequency of sampling (annually) and the snails' habit of occupying crevices and gas vesicles on cobbles tend to reduce these impacts. In most spring habitats, snail densities are relatively high and mortality associated with monitoring is anticipated to be insignificant with regard to the viability of such populations. A small number of Bliss Rapids snails may also be killed as a result of the collection of voucher specimens.

The monitoring is designed to establish a baseline level of Bliss Rapids snail abundance and distribution within the species' range in the unimpounded reaches of the Snake River, as well as a number of occupied springs. In this regard, the Snail Plan provides extensive protection to the species since it considers their status throughout the species' range (action area), and not just within the project area. The baseline levels will be established based on observed abundance and distribution trends over the first 3 to 5 years of monitoring, starting in 2010. The lowest abundance and distribution levels observed during the initial 3 to 5 year period will be used to establish a lower index threshold ("evaluation criteria" in the Plan). After the 3 to 5 year baseline period, should either the abundance and/or distribution of the Bliss Rapids snail fall below the established index threshold, representatives from the Company and the Service will assess the causes of the decline, investigate appropriate conservation or mitigation efforts directed at off-setting the observed declines or impacts, and implement those actions if deemed appropriate.

The adaptive nature of the Snail Plan allows for a reassessment of the lower index threshold should causative environmental parameters be evident (*e.g.*, extreme water years) and/or snail populations be observed to rebound during subsequent years. The adaptive management approach also allows for the resumption of load-following operations if they previously became restricted due to significant or concerning snail declines.

The adaptive management component of the Snail Plan provides substantial flexibility in responses to observed declines of the Bliss Rapids snails should they occur. As discussed in the Snail Plan, being able to assess the cause of future declines will allow for a more directed and effective conservation or mitigation response. While this flexibility in responsiveness may be viewed as providing a loophole to avoid timely management actions, the combination of Company commitment, as provided in the Snail Plan, along with the collaborative and adaptive decision-making process between the Company and the Service, should provide greater assurances that the most appropriate and efficient conservation actions are implemented when needed. The Snail Plan goes on to list a number of plausible conservation actions that include, but are not limited to:

- Reintroduction/re-establishment of Bliss Rapids snails to appropriate habitats;
- Habitat improvements at protected spring sites;
- Pollution abatement efforts adjacent to, or in, aquifer recharge areas that could effect springs;
- The purchase of spring habitats and/or surface or ground water rights, should they become available, that would provide water quality and quantity improvements to Bliss Rapids snail habitat;
- Modification of hydroelectric operations to reduce or eliminate Bliss Rapids snail habitat exposure.

Monitoring of Bliss Rapids snail will result in the disturbance of benthic habitats that may negatively impact Snake River physa. As previously stated, the abundance of the Physa within the action area is believed to be low and if present a substantial portion of these animals could be expected to be in deeper zones that would not be disturbed during the course of standard cobble surveys used for monitoring Bliss Rapids snails. Given the small size of these snails, such incidental adverse effects are not readily quantified, but the over-all low numbers of Physa believed to occupy the area suggest that impacts to the species as a whole would be inconsequential. For this reason, while there may be adverse effects to Physa from these monitoring efforts, they are not anticipated to be significant at the population level and cannot be readily quantified.

The Company has played a significant role in monitoring and conserving listed Snake River snails in the past. Monitoring of listed snails has been conducted since the mid-1990s as part of the Project license obligations and has been reported in annual Section 10 Reports as well as collaborative surveys and monitoring carried out with the Service (*e.g.*, monitoring and surveys of Banbury Springs limpet and Snake River physa). In addition, post license conservation and mitigation measures have been carried out by the Company as part of their Settlement Agreement license requirements as stated in the Snail Plan (pg. 1, 3), but they have also taken part in other conservation activities that are not part of a legally binding agreement. As part of operations and management of its projects, the Company owns several major spring complexes (*e.g.*, Banbury, Bancroft, Briggs Springs) and it has managed these springs in such a way as to protect Bliss Rapids snail and other species. Given this history, as well as pertinent license obligations and assurances provided in the Plan, the Service anticipates continuing cooperation and collaboration in the future conservation of the Bliss Rapids snail.

2.5.5 Effects of Implementing the Riparian and Wetland Mitigation Plan

While the details of the acquired parcels and their management are not provided in the Commission's assessment or the Riparian Plan, the proposed criteria and goals of these acquisitions and resulting management are expected to be beneficial, or at least neutral, to the protection and conservation of the Bliss Rapids snail and Snake River physa. Acquisition and protection of spring habitats may protect habitat currently occupied by the Bliss Rapids snail, or could potentially be used for purposes of restoration and (re)introduction of the species. Protection of river-edge wetlands and riparian habitats would either be neutral (*e.g.*, occur downstream of the Bliss Rapids snails' range) or could help improve water quality for populations of Bliss Rapids snail and Snake River physa that reside within the Snake River, and such efforts were identified in the Recovery Plan for these species (Fish and Wildlife Service 1995, pg. 27-28). Should purchases of these mitigation parcels occur outside of the project area, their value to federally listed mollusks could still be realized as well as their value to migratory birds and/or in improving water quality. The Service could not identify any interrelated or interdependent effects related to implementation of the Riparian Plan and none are addressed in this section.

2.6 Cumulative Effects

The implementing regulations for section 7 define cumulative effects to include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

2.6.1 Bliss Rapids Snail

While the project area of the two projects considered herein is restricted to the river corridor from Crane Rock to the Lower Salmon Falls Dam, some of the most pertinent cumulative impacts lie on adjacent lands, outside of the river corridor, but affect the water resources that are critical to the continued survival of the Bliss Rapids snail. As discussed above, the Eastern Snake River Plain Aquifer (ESRPA) probably represents the most important single resource for the conservation of the Bliss Rapids snail, but it is heavily influenced by human use. Aquifer depletion and contamination are global problems (Foster and Chilton 2003, entire document; Loague and Corwin 2005, entire document) that threaten human welfare as well as biological diversity (Deacon *et al.* 2007, entire document). Most of these impacts to the ESRPA do not occur within the action area or project area, however, the resulting impacts affect water resources in the action and project area via a direct pathway. As illustrated in Figure 2 and Kjelstrom (1992, entire document), groundwater pumping has resulted in declines of ESRPA spring discharges over the past 60 years. While aquifer recharge has been suggested as a partial solution to over-pumping (IWRB 2009, pg. 10-11), this may be overstated and may also increase the level of risk of aquifer contamination (Foster and Chilton 2003, pg. 1959-1961, 1967-1970).

Clark *et al.* (1998, pg. 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. These locations occur in the uplands adjacent to the recovery area of the Bliss Rapids snail. Nitrate concentrations showed significant increases at several major springs, most with populations of the Bliss Rapids snail, from 1994 through 1999 (Baldwin *et al.* 2000, Figure 18, pg. 22-23), and these elevated concentrations are linked to heavy agricultural use (Holloway *et al.* 2004, pg. 4-6). Both fertilizers and animal wastes contribute to groundwater nitrates and these contaminants have been documented to reach toxic levels in the ESRPA (Tesch *et al.* 2003, pg. 3-7; Neely 2005, 3-9). Such threats have not diminished as the number of cattle in Gooding County (one county of several that overlay the Snake River Plain Aquifer) have increased by 180 percent between 1992 and 2011 (Figure 7), and poultry/egg producing facilities are expected to increase in the coming years (Welch *in litt.* 2010), bringing yet another source of potential contamination. The effects of these contaminants on the Bliss Rapids snail are not known, but in numerous wells in the region nitrate values have been recorded to exceed human health standards (Neely 2005, pg. 2-7; Schorzman *et al.* 2009, pg. 9-19). The presence of nitrates and other agrochemical contaminants in the groundwater (Holloway *et al.* 2004, pg. 4-6; Carlson and Atlakson 2006, pg.

3-5; Schorzman *et al.* 2009, pg. 9-19) illustrate the pathway through which these agricultural contaminants can reach the habitats of the Bliss Rapids snail and other sensitive species living within the aquifer springs as well as the Snake River.

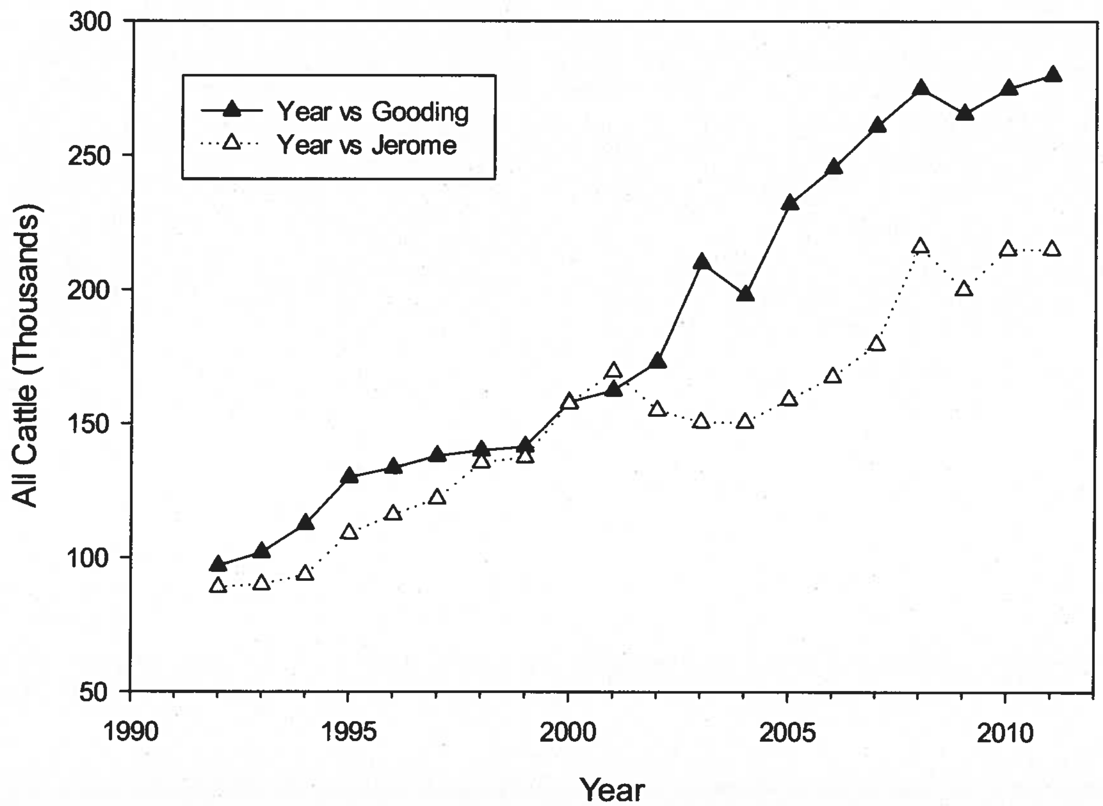

Figure 7. Gooding and Jerome County annual cattle statistics presented for all cattle (beef and dairy) since the Federal listing of the Bliss Rapids snail. Data are from the Idaho Agricultural Statistics Service, 1992-2009.

Spring discharge from the ESRPA plays a significant role in both improving as well as degrading water quality within the Snake River in this reach. It is estimated that on average 42 percent of the Snake River's volume at King Hill is contributed by springs derived from the ESRPA (Clark *et al.* 1998, pg. 18), and the near constant spring temperatures (14°-17° C) will have a moderating effect on over-all river temperature, which in the summer will provide a significant influence both in reducing water temperatures and helping to maintain healthy levels of dissolved oxygen. However, Clark *et al.* (1988, pg. 19) also report that most of the total nitrogen that occurs in this reach is derived from aquifer water, contributed from the sources discussed above. While total phosphorous may be the most important limiting factor in controlling macrophyte and algal growth within this reach, elevated nitrogen levels are a concern and as stated above, may be accompanied by other groundwater-derived contaminants.

Agriculture water quality issues within the action area are not restricted to aquifer-spring sources, but are widespread in surface water sources and conveyances (*e.g.*, streams, irrigation return canals) (Clark *et al.* 1998, pg. 17). For that reason, the effects of water quality degradation within the Snake River and some tributaries must be considered on the river-dwelling populations of the Bliss Rapids snail. State programs to attain Total Maximum Daily Load (TMDL) requirements have met with some success, but some portions of the Snake River, including those adjacent to and most dramatically upstream of known Bliss Rapids snail populations, have not met TMDL standards. In addition, TMDL criteria for the middle Snake River have only been established for a limited number of contaminants (total phosphorous, total suspended solids). The criteria also do not include other nutrients or pesticides, or consider the synergistic effects of these contaminants with one another (*e.g.*, Hoagland and Drenner 1991, entire document). In addition, such agricultural contaminants, either through groundwater or surface irrigation returns, are regarded as nonpoint source pollutants and are not subject to regulation under the Clean Water Act.

Lastly, aquaculture facilities make up a significant amount of non-consumptive water use in the middle Snake River region, and use an estimated 2,500 cfs of groundwater, derived primarily from the ESRPA, before releasing that water into the Snake River. This use contributes wastes from fish food, fish metabolism, and processing (Clark *et al.* 1998, pg. 9) as well residual antibiotic and antiseptic compounds to the Snake River (EPA 2002, pg. 4-19). While many of these facilities are permitted (80 in 2002; EPA 2002, pg. 4-19) by the U.S. Environmental Protection Agency under the National Pollutant Discharge Elimination System (NPDES), those facilities producing less than 20,000 pounds of fish (dry weight) per year are exempt from NPDES requirements and are not federally regulated (EPA 2007, pg. 9). Clark and other (1998, pg. 7) state that those unregulated facilities may account for an estimated 95 percent of the point-source pollutants within the Snake River Basin. While this sounds (and may be) substantial, they also point out that unregulated non-point sources are responsible for 98 to 99 percent of total nitrogen and phosphorous discharge (*ibid.*, pg. 2). Nonetheless, smaller aquaculture facilities, not restricted by Clean Water Act provisions, are an additional source of pollutants not regulated or monitored by Federal or State agencies.

At present, the above noted cumulative effects likely pose the greatest threats to the Bliss Rapids snails' future survival and may undermine other conservation actions that would otherwise benefit the species and its habitats. The lethal limits of these threats (e.g., aquifer depletion and spring discharge, increasing contaminant risks from growing agricultural industries) on the species are not known, but it is likely that continuing degradation and over-consumption of water resources (due to increasing human use) will degrade snail habitat and place the Bliss Rapids snail at greater risk over time. Many of the above discussed issues or programs (e.g., aquifer recharge) are derived from private, local, or State initiatives and currently have little to no Federal oversight. As such, aquifer management and nonpoint source pollutant issues will likely continue to provide challenges into the future.

2.6.2 Snake River Physa

The Snake River physa is not known to occupy spring habitats, but its apparent preference for high-flow environments with low levels of fine sediments is, in part, tied to water management and land use outside of the action area. Springs derived from the ESRPA provide an important contribution in maintaining/improving water quality in the Snake River within the action area and as such, impacts from over-pumping of the aquifer or groundwater contamination can be expected to adversely affect habitats occupied by the Physa, however the point at which such adverse effects can be expected to exhibit acute toxic effects to the species is not known at this time. In this regard, all of the specifics regarding impacts to the ESRPA in section 2.6.1 above can be regarded as cumulative effect to the Snake River physa as well.

Low stream gradient and reservoir reaches both within and outside of the action area accumulate finer sediments which likely eliminates more preferred habitat for the species. Most of these fine sediments are derived from off-site sources, many of which are agriculturally derived, and most enter the Snake River via irrigation return canals and or during high-precipitation events, and hence are a non-point source and not regulated. Such sediments are not the result of the proposed action nor the project itself, and are independent of the action. Within the action area, sediment deposition occurs within both Bliss and Lower Salmon Falls reservoirs and in the unimpounded reach between King Hill and C.J. Strike Reservoir. Hence, both of these project reservoirs may play a role in limiting the Physa's distribution within the action area (see Inter-related and Interdependent Effects above). The accumulation of fine sediments downstream of King Hill occur as the river gradient declines and, as is the case with sediments within the projects' reservoirs, is not due to operations carried out by the Company.

Accumulation of fine sediments in the Snake River will, in part, be dependent on water-year type which controls river volume, flow, and velocity, which redistributes sediments. During low water years fine sediments can be expected to be more widely distributed in unimpounded reaches, whereas during high water years such sediments will be moved to reservoirs or carried farther downstream.

Sources of sediments from in-water construction activities are typically reviewed by the Army Corps of Engineers and subject to Federal permitting under the Clean Water Act and may undergo consultation with the Service. Hence, these sources are not regarded as cumulative. Similarly, numerous other point-source pollutants fall under Federal permit jurisdiction (e.g., NPDES), but see exceptions in 2.6.1 above.

Both the Snake River physa and Bliss Rapids snail may be threatened by future introduction of invasive species. The severity of such introductions cannot be quantified since we do not know what species will become established, or how they will respond to their new habitats, but given suffient time we are reasonably certain they will occur. Based on documented aquatic invasions elsewhere in North America, we do know the impacts can be severe, drastically changing ecosystems and costing millions of dollars in economic losses (Pimentel *et al.* 2000, entire document). While some such introductions could be the result of Federal activities, they are more likely to come from private individuals or local industries and hence not be subject to Federal or other government review, and hence conducted without oversight or regulation. These uncertainties make assessing the risks posed from this threat within the context of the action area impossible at this time.

Rieman and Isaak (2010) synthesized much of the existing literature on effects of climate change on aquatic ecosystems in the Rocky Mountains, including the Pacific Northwest; and Isaak *et al.*

(2011) analyzed the effects of climate change on stream and river temperatures in the northwestern U.S. and discussed the implications to salmonid fish species. If their climate change projections are reasonably accurate for the Snake River Basin, areas in central and southern Idaho may experience moderate to extreme drought over the next 50 years (Rieman and Isaak 2010, p. 5).

Mean annual air temperatures have been warming more rapidly over the Rocky Mountain West compared to other areas of the coterminous U.S., by about 0.4° C during the twentieth century (Rieman and Isaak 2010, p. 3). Precipitation appears to be increasing in extreme western and southeastern Idaho. Precipitation data is lacking for southern and central Idaho. However, data from stream flow gages in the Snake River watershed in western Wyoming, and southeast and southwest Idaho indicate that spring runoff is occurring between one to three weeks earlier compared to the early twentieth century (Rieman and Isaak 2010, p. 7). These altered hydrographs have been attributed to interactions between increasing temperatures (earlier spring snowmelt) and decreasing precipitation (declining snowpacks). Global Climate Models (GCM) project air temperatures in the western U.S. to further increase by 1-3° C by mid-twenty first century (Rieman and Isaak 2010, p. 5). Global Climate Models are in closest agreement in their prediction of significant decreases in precipitation for the interior west. Areas in central and southern Idaho within the Snake River watershed are projected to experience moderate to extreme drought (Rieman and Isaak 2010, p. 5).

Richards (2004, pg. 25) provides data on optimal water temperatures for the Bliss Rapids snail, showing they have an optimum of 17° C (for growth, comparing differences of 15°, 17°, and 20° C) As such, any resulting increases in river temperature may negatively impact river-dwelling populations, more narrowly restricting them to spring-influenced sites (thermal refugia) (but see discussion on Snake River physa below). As previously discussed, the Bliss Rapids snail are largely restricted to springs and/or spring-influenced habitats and springs from the ESRPA have historically provided water of fairly consistent temperatures (14° to 17° C). Precluding possible human influences that might elevate the temperatures of the ESRPA (e.g., surface water injection for aquifer recharge), the aquifer springs utilized by the species should not see significant warming. A more important consideration in this regard would be increased aquifer pumping to offset late-season declines in river flows and/or reservoir declines brought on by drought. It has already been pointed out that aquifer depletion is an on-going, and possibly increasing, threat to the Bliss Rapids snail and other spring-reliant species. While it is impossible to accurately predict the magnitude of climate change and how society will respond to these changes, some of the predicted changes are likely to have a negative effect on populations of the Bliss Rapids snail.

While the temperature tolerances for the Snake River physa appear to be broad, reflected in annual river temperatures (Section 2.3.2.3), the nature and timing of climate change impacts to Snake River physa habitat in the Snake River are difficult to predict. Isaak and others (2011, p. 1) demonstrated statistically significant net warming trends at seven sites on unregulated rivers in Montana, Idaho, Washington, and Oregon, including one site on the Snake River at Anatone, Washington. While acknowledging that the Snake River is generally highly regulated, the authors noted (p. 7) that the distance between the site at Anatone and the next reservoir upstream was well in excess of the spatial lag over which stream temperatures are correlated, i.e., it was assumed that river temperatures would have equilibrated to local climatic conditions before reaching the study site. While suggestive that temperatures in the Snake River can be expected to rise with concurrent projected air temperature increases, Isaak *et al.* (2010, p. 1, 11) did not find statistically significant trends at regulated study sites, though temperature trends were qualitatively similar to those at unregulated sites. They attributed this to variation among sites resulting from differences in local management policies and effects of reservoirs. Deep reservoirs can have dampening effects on fluctuations in river water temperatures, but if air and water temperatures consistently increase in the watershed, over time water temperatures in regulated portions of the Snake River must rise as well.

As discussed above, increasing temperatures (earlier spring snowmelt) and decreasing precipitation (declining snowpacks) may ultimately have impacts on flow volume in the Snake River. Should this result in increased human demand of river water (or decreasing availability of that resource), especially for agricultural use, reduced river flows and elevated water temperatures could further impair water quality (*e.g.*, lowering dissolved oxygen concentrations). The multiple contingencies that could be attributable to climate change, forecasts which are variable and uncertain, are difficult to predict with any degree of confidence. However, most scenarios would likely not be beneficial to either the Bliss Rapids snail or the Snake River physa.

2.7 Conclusion

2.7.1 Bliss Rapids Snail

The Service has reviewed the current status of the Bliss Rapids snail, the environmental baseline in the action area, effects of the proposed action, and cumulative effects, and it is our conclusion that the proposed action is not likely to jeopardize the species' continued existence. Data collected by the Company help demonstrate that Bliss Rapids snails will be killed and otherwise harmed as a result of the proposed load following operations, however, these adverse effects will be restricted to river-dwelling populations with the most dramatic effects being on shallow water habitats and those snails inhabiting such habitats. Populations of Bliss Rapids snails that reside in the Snake River undergo large seasonal population fluctuations due to various environmental perturbations, and the estimated mortality to this species due to hydroelectric operational dewatering is regarded as small relative to other environmental factors. Spring-dwelling populations will be unaffected by the proposed operational changes and individuals that occur in deeper portions of the Snake River will not be directly affected. The indirect effects of habitat dewatering on food and eggs (reproduction) may explain some of the species' current zonal distribution, dewatered habitats being of poorer quality and hence more sparsely occupied. For these reasons we anticipate indirect effects will likely result in some level of constricted distribution and lowered population numbers, but not to a point that significantly affects the probability of population persistence. In addition, based on field and laboratory experiments, even those snails that are periodically dewatered have a high probability of survival and some likely contribute to population viability. Lastly, the persistence of river-dwelling populations after decades of hydroelectric load following is a strong indicator that these populations will continue to persist, especially given the increased minimum release flows as provided in the 2004 license requirements.

The interrelated and interdependent effects of the reservoirs may be important factors eliminating the species from large portions of its historic range. Despite this the probability of extinction in the foreseeable future due to this factor is probably not great given the historical operations of these projects and the persistence and current distribution of the Bliss Rapids snail within the unimpounded reaches of the Snake River within the action area.

2.7.2 Snake River Physa

The Service has reviewed the current status of the Snake River physa, the environmental baseline in the action area, effects of the proposed action, and cumulative effects, and it is our conclusion that the proposed action is not likely to jeopardize the species' continued existence. While Snake River physa are likely to be adversely affected and killed due to load following operations, their general low abundance in this portion of the Snake River, along with their apparent preference for deeper habitats not (or minimally) subjected to seasonal or periodic dewatering will probably ensure that large numbers of the species are not adversely affected in the project area under the proposed operational changes. The species' range and distribution, both its preference for deeper water and the river reach, well upstream from project effects, from which the species has been recorded, means that the global population of the species will not be significantly reduced by the proposed action. Neither will these adverse effects eliminate the species from a significant portion of its range since it is anticipated that, if present, the species will predominantly occur in deeper portions of the river, below habitats dewatered during typical hydroelectric load following.

2.8 Incidental Take Statement

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without specific exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm in the definition of take in the Act means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The Commission has a continuing duty to regulate the activity covered by this incidental take statement. If the Commission fails to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Commission must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)].

2.8.1 Bliss Rapids Snail

2.8.1.1 Form and Amount or Extent of Take Anticipated

Lower Salmon Falls Project

On an annual basis, up to 453,000 adult and sub-adult Bliss Rapids snails may be killed or injured in the form of harm as a result of exposure and desiccation caused by dewatering of snail habitat by load-following operations in the Lower Salmon Falls Reach (see section 2.5.1.1). This incidental take is likely to occur in unimpounded portions of the Snake River from RM 565 (RK 909) to RM 573 (RK 922), at river volume levels above the granted 3,500 cfs minimum flow rate and above a stage level of 5.2 ft as measured at the U.S. Geological Survey (USGS) gage (no. 13135000) located below Lower Salmon Falls Dam. The level of incidental take permitted is defined as Bliss Rapids snails occupying benthic habitats from approximate RM 565 (RK 909) (upper limit of Bliss Reservoir) to RM 573 (RK 922) (tailrace of Lower Salmon Falls Dam), as measured in instantaneous[4] flows equal to or greater than 3,500 cfs from Lower Salmon Falls Dam, as measured at USGS gage 13135000. Hence, the proposed operational limits as requested by the Company in their draft amended license application will serve as the measure of incidental take of Bliss Rapids snails in this river reach. Incidental take will be exceeded if instantaneous river flows from Lower Salmon Falls Dam drops below the 3,500 cfs flow volume as recorded at the above referenced stream gage. This level of incidental take is provided for the

[4] Instantaneous flows are used here to distinguish them from average flows. Some hydroelectric flows are measured as daily averages and would not adequately identify periods of high or low flows that might adversely affect the benthic habitats identified in this Opinion.

duration of the remainder of the project license (est. 22 years). Given the impracticality of measuring actual numbers of Bliss Rapids snails impacted by operations, as well as the uncertainties as described in section 2.5.1.2, the operational constraints outlined in this section will be used to identify and quantify the permitted incidental take or exceedence of that permitted incidental take.

On an annual basis, an unquantifiable number of Bliss Rapids snail eggs are also likely to be killed in the form of harm in the same river reach and habitat areas and for the same reasons as described above. Snail habitat below the granted 3,500 cfs minimum instantaneous flow will not be dewatered during load-following operations. For that reason, no incidental take of the Bliss Rapids snail is anticipated to occur below this river volume and associated river stage elevations.

Bliss Project

On an annual basis, up to 651,000 adult and sub-adult Bliss Rapids snails are likely to be killed or injured in the form of harm as a result of exposure and desiccation caused by dewatering of snail habitat by load-following operations within the Bliss Reach (see section 2.5.1.1). This take is likely to occur in unimpounded portions of the Snake River between Bliss Dam and C.J. Strike Reservoir from RM 525 (RK 845) to RM 560 (RK 901), at stage levels above the granted 4,500 cfs minimum flow rate and above a stage level of 7.0 ft as measured at the USGS gage (no. 13153776) located below Bliss Dam. The level of incidental take permitted is defined as Bliss Rapids snails occupying benthic habitats from approximate RM 525 (RK 845) (upper limit of C.J. Strike Reservoir) to RM 560 (RK 901) (tailrace of Bliss Dam), as measured in instantaneous flows equal to or greater than 4,500 cfs from Bliss Dam, as measured at USGS gage 13153776. Hence, the proposed operational limits as requested by the Company in their draft amended license application will serve as the measure of incidental take of Bliss Rapids snails in this river reach. Incidental take will be exceeded if instantaneous river flows from Bliss Dam drops below the 4,500 cfs flow volume as recorded at the above referenced stream gage location. This level of incidental take is provided for the duration of the remainder of the project license (est. 22 years). Given the impracticality of measuring actual numbers of Bliss Rapids snails impacted by operations, as well as the uncertainties as described in section 2.5.1.2, the operational constraints outlined in this section will be used to identify and quantify the permitted incidental take or exceedence of that permitted incidental take.

On an annual basis, an unquantifiable number of Bliss Rapids snail eggs are also likely to be killed in the form of harm in the same river reach and habitat areas and for the same reasons as described above.

Snail habitat below the granted 4,500 cfs minimum instantaneous flow rate will not be dewatered during load-following operations. For that reason, no incidental take of the Bliss Rapids snail is anticipated to occur below this river volume and associated river stage elevations.

2.8.1.2 Effect of the Take

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to jeopardize the continued existence of the Bliss Rapids snail across its range. In summary:

- Spring-inhabiting populations of the Bliss Rapids snail will not be affected by hydropower operations;
- Bliss Rapids snails directly affected by hydropower dewatering, are estimated to be less than 15 percent of the entire river-inhabiting population;
- The ≤15 percent of the river population estimated to be taken due to load-following operations is small relative to the natural population variation exhibited by the species each year due to a variety of biologic and physical factors which are not well understood. Load-following will subject snails residing in the dewatered habitats to additive adverse effects beyond the natural variation, but only on that portion of the population that is exposed to hydroelectric dewatering (outside of the zonal refugia). Seasonal population eruptions within zonal refugia are anticipated to contribute a high level of demographic robustness for these river populations;
- Comparisons of snail abundance data under load-following and run-of-river operational years do not indicate significant population changes attributable to load-following operations;

- Given the robust nature of river-inhabiting populations of Bliss Rapids snails and the less variable fluctuations of spring-inhabiting populations, hydroelectric and other known threats to the species are not anticipated to reduce populations to a point where the species could become endangered in the foreseeable future.

2.8.1.3 Reasonable and Prudent Measures

Since the Commission and the Company have committed to implementing all of the actions set forth in the Plan, and reviewed in this Opinion, as part of the proposed action, the Service concludes that no reasonable and prudent measures are necessary and appropriate to further minimize the impacts of incidental take of the Bliss Rapids snail caused by the proposed action.

2.8.1.4 Terms and Conditions

As no reasonable and prudent measures have been identified, terms and conditions have not been developed to further reduce the amount or extent of take.

2.8.1.5 Reporting and Monitoring Requirement

In order to monitor the impacts of incidental take, the Federal agency or any applicant must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [(50 CFR 402.14 (i)(3)]. In this case, such monitoring shall be conducted annually as described in the Bliss Rapids Snail Protection Plan (Snail Plan) (Appendices 1 and 2) and as amended by the Bliss Rapids Snail Technical Team, a planning and management committee described in the Snail Plan, and approved by the Commission. The results of that monitoring shall be provided to the Service with the Company's annual report on its section 10 permit (no. TE799558) activities. Monitoring summaries shall also be conducted at annual, or as needed, meetings of the Bliss Rapids Snail Technical Team. To document the amount or extent of incidental take as described in this Incidental Take Statement, the Company shall provide a summary of annual operations, including unusual or emergency events, in their annual monitoring report.

The Company shall also report any emergency operations to the Service before they occur, if possible, or within one week after the event(s) if prior notification is not possible. A complete and detailed description of such events, including the amount of flow reduction or increase, and the duration of the event will be provided. Should an emergency event(s) occur that reduces flows below the licensed minimum flows, the event(s) shall be communicated to the Service immediately.

If the actions described in the Snail Plan (e.g., river and spring habitat monitoring) are not implemented as scheduled, this will constitute a failure of the Commission and Company to appropriately carry out the Action as proposed and as evaluated by the Service in this Opinion. Under such an event, the Commission may be required to reinitiate formal consultation as determined by the Service.

2.8.2 Snake River Physa

2.8.2.1 Form and Amount or Extent of Take Anticipated

Lower Salmon Falls Project

As discussed in section 2.4.2.1, there is only a single individual likely to be Snake River physa to be found within the action area in the past 10 years, all other known collections occurring prior to 1986 (Taylor 1988, pg. 72). This single specimen is the result of some 137 samples (see Section 2.4.2.1 and Footnote 2) from the project area collected by both the Company, and Frest and Johannes, the latter of which was a compilation of numerous point samples from type localities. Based on a quick assessment alone, this could be reported as a 0.7 percent occurrence, but in reality, the samples are not comparable, and given the low positive incidence, cannot be extrapolated with any degree of confidence. For these reasons we do not provide estimates of incidental take as was done for the Bliss Rapids snail (above), for which sampling was far more intensive and in which the higher rate of occurrence allows for a much larger degree of confidence in estimating the species distribution and abundance. Unlike the Bliss Rapids snail, the Physa may occur within reservoir habitats, although the data reported to date suggest if it is present in lentic habitats it is less common there than in river habitats. Still the rare nature of this snail within the action area and downstream suggests that it may occur in low numbers. For this reason, incidental take is provided under the following descriptive parameters:

On an annual basis, all Snake River physa present in snail habitat dewatered by load-following operations in the Lower Salmon Falls Reach are likely to be killed, harmed, or harassed as a result of exposure and desiccation. This incidental take is likely to occur in unimpounded portions of the Snake River from RM 565 (RK 909) to RM 573 (RK 922), at river volume levels above the granted 3,500 cfs minimum flow rate and above a stage level of 5.2 ft as measured at the U.S. Geological Survey (USGS) gage (no. 13135000) located below Lower Salmon Falls Dam. The level of incidental take permitted is defined as all Snake River physa occupying benthic habitats from approximate RM 565 (RK 909) (upper limit of Bliss Reservoir) to RM 573 (RK 922) (tailrace of Lower Salmon Falls Dam), as measured in instantaneous flows equal to or greater than 3,500 cfs from Lower Salmon Falls Dam, as measured at USGS gage 13135000. Hence, the proposed operational limits as requested by the Company in their draft amended license application will serve as the measure of incidental take of Snake River physa in this river reach. Incidental take will be exceeded if instantaneous river flows from Lower Salmon Falls Dam drops below the 3,500 cfs flow volume as recorded at the above referenced stream gage. This level of incidental take is provided for the duration of the remainder of the project license (est. 22 years). Given the impracticality of measuring actual numbers of Snake River physa impacted by operations, as well as the uncertainties as described in section 2.4.2.1, the operational constraints outlined in this section will be used to identify and quantify the permitted incidental take or exceedence of that permitted incidental take.

On an annual basis, all Snake River physa present within benthic habitats of Lower Salmon Falls Reservoir, between 2,876.2 ft and 2,878.2 ft mean sea level (msl), as measured at the project's reservoir stage gage, are likely to be killed, harmed, or harassed as a result of exposure and desiccation resultant from the proposed operations. The proposed operational limits as requested by the Company in their draft amended license application will serve as the measure of incidental take of Snake River physa in this river reach (reservoir) since the quantification of actual Snake River physa adversely affected is impractical and unreasonable given the rarity of the species in the action area. This level of incidental take is provided for the duration of the remainder of the project license (est. 22 years). Given the impracticality of measuring actual numbers of Snake River physa impacted by operations, as well as the uncertainties as described in section 2.4.2.1, the proposed operational limits outlined in this section will be used to identify and quantify the permitted incidental take or exceedence of that permitted incidental take.

On an annual basis, an unquantifiable number of Snake River physa eggs are also likely to be killed in the form of harm in the same river reach and habitat areas and for the same reasons as described above. Snail habitat below the granted 3,500 cfs minimum instantaneous flow will not be dewatered during load-following operations. For that reason, no incidental take of the Snake River physa, or their eggs, is anticipated to occur below this river volume and associated river stage elevations.

Bliss Project

On an annual basis, all Snake River physa present in snail habitat dewatered by load-following operations in the Bliss Reach are likely to be killed, harmed, or harassed as a result of exposure and desiccation. This take is likely to occur in unimpounded portions of the Snake River between Bliss Dam and C.J. Strike Reservoir from RM 525 (RK 845) to RM 560 (RK 901), at stage levels above the granted 4,500 cfs minimum flow rate and above a stage level of 7.0 ft as measured at the USGS gage (no. 13153776) located below Bliss Dam. The level of incidental take permitted is defined as Snake River physa occupying benthic habitats from approximate RM 525 (RK 845) (upper limit of C.J. Strike Reservoir) to RM 560 (RK 901) (tailrace of Bliss Dam), as measured in instantaneous flows equal to or greater than 4,500 cfs from Bliss Dam, as measured at USGS gage 13153776. Hence, the proposed operational limits as requested by the Company in their draft amended license application will serve as the measure of incidental take of Snake River physa in this river reach. Incidental take will be exceeded if instantaneous river flows from Bliss Dam drops below the 4,500 cfs flow volume as recorded at the above referenced stream gage location. This level of incidental take is provided for the duration of the remainder of the project license (est. 22 years). Given the impracticality of measuring actual numbers of Snake River physa impacted by operations, as well as the uncertainties as described in section 2.4.2.1, the operational constraints outlined in this section will be used to identify and quantify the permitted incidental take or exceedence of that permitted incidental take.

On an annual basis, all Snake River physa present within benthic habitats of Bliss Reservoir, between 2,796 ft and 2,798 ft msl, as measured at the project's reservoir stage gage, are likely to be killed, harmed, or harassed as a result of exposure and desiccation resultant from the proposed operations. The proposed operational limits as requested by the Company in their draft amended license application will serve as the measure of incidental take of Snake River physa in this river reach (reservoir) since the quantification of actual Snake River physa adversely affected is impractical and unreasonable given the rarity of the species in the action area. This level of incidental take is provided for the duration of the remainder of the project license (est. 22 years).

On an annual basis, an unquantifiable number of Snake River physa eggs are also likely to be killed in the form of harm in the same river reach and habitat areas and for the same reasons as described above.

Snail habitat below the granted 4,500 cfs minimum instantaneous flow rate will not be dewatered during load-following operations. For that reason, no incidental take of the Snake River physa is anticipated to occur below this river volume and associated river stage elevations.

2.8.2.2 Effect of the Take

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to jeopardize the continued existence of the Snake River physa across its range. In summary:

- Based on the most recent sampling, Snake River physa are a relatively rare component of the species assemblage within the action area, with only a single individual likely having been collected in the past 10 years (section 2.4.2.1);
- Based on our understanding of this species' preferred benthic habitat, the action area contains relatively little of this habitat type;
- Based on our understanding of this species' depth distribution in habitats that are seasonally dewatered, the Service does not anticipate that it will occur in these compromised habitats (shallow water zones) at high numbers and hence will not be subjected to high levels of incidental take;
- The action area represents an estimated 18 percent of the linear river miles from which the species has been recorded historically. Taken alone this could be significant, but given that the species has been so infrequently encountered in this reach, and since most of the submerged river habitat (that not subjected to load-following) within this area

could still be regarded as available habitat, the effects of benthic dewatering are not expected to result in severe impacts to the species in a significant portion of its range, and by extrapolation, not anticipated to have a significant impact on the Snake River physa at the population level.

2.8.2.3 Reasonable and Prudent Measures

The Service concludes that the proposed action will not jeopardize the Snake River physa and is unlikely to result in significant adverse impacts to the species at the population level. Given this, no Reasonable and Prudent Measures are required.

2.8.2.4 Terms and Conditions

Based on the analysis in section 2.3.2.4 above, and the apparent rarity of the Snake River physa in the action area, incidental take is not anticipated to be insignificant at the scale of population viability. For this reason, no Terms and Conditions are required for the Snake River physa.

2.8.2.5 Reporting and Monitoring Requirement

In order to monitor the impacts of incidental take, the Federal agency or any applicant must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [(50 CFR 402.14 (i)(3)]. Monitoring of the Bliss Rapids snail is covered in the Snail Plan which is included as part of this action and is also covered under the Company's Section 10 permit. Under this Opinion, there are no monitoring requirements for the Snake River physa, but monitoring for this species is highly recommended and is outlined in Section 2.9 below. Any resulting collection of the species in that effort would be under the authority of Section 10 of the Act, under which the Company is granted limted take of Snake River physa for the purposes of scientific research. If the Company does carry out survey efforts for the Snake River physa, the results of such surveys will be included in their annual Section 10 Report.

As per the reporting requirements for the Bliss Rapids snail, the Company shall also report any emergency operations to the Service before they occur, if possible, or within one week after the event(s) if prior notification is not possible. A complete and detailed description of such events, including the amount of flow reduction or increase, and the duration of the event will be provided. Should an emergency event(s) occur that reduces flows below the licensed minimum flows, the event(s) shall be communicated to the Service immediately. If emergency actions are not reported in a timely fashion, this would constitute a violation of these reporting requirements, and the Commission may be required to reinitiate formal consultation as determined by the Service.

2.9 Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery programs, or to develop new information on listed species.

2.9.1 Bliss Rapids Snail

The Service regards the conservation actions as outlined in the Snail Plan as adequate and proposes no additional conservation recommendations for the Bliss Rapids snail.

2.9.2 Snake River Physa

Based on the information above, the Service concludes that Snake River physa occur in the action area in such low densities as to be little affected at the population level by the proposed actions. Given the species' low abundance in the area, surveys conducted with the purpose of assessing project-related impact are likely to lack detection of the species and as a result be of little value in assessing such impacts. However, given conflicting history of this species' presence within the action area, additional information regarding the species' presence or absence may be valuable both for the Company as well as providing information on its range-wide status. For this reason, the Service strongly recommends that the Company conduct periodic surveys, carried out through the life of the license, that include methods suitable for detecting the presence of Snake River physa. Under the Snail Plan, stringent monitoring and reporting has been developed for the Bliss Rapids snail, but given the rarity and difficulties in distinguishing the Snake River physa from other common species within the genus, monitoring for the latter species was not considered as part of the Snail Plan. The methods by which Bliss

Rapids snails are most efficiently and reliably monitored are substantially different than those methods best suited for the Snake River physa, and hence the monitoring effort developed in the Snail Plan is not suitable for detection of Snake River physa.

Monitoring of the Snake River physa should be conducted within the action area and in habitats most likely to be occupied by the Physa as determined by the Bliss Rapids Snail Technical Team. Due to this species' rarity in the action area, sampling efforts will likely be less intensive than those for Bliss Rapids snail. The locations intensity of said sampling will be collaboratively agreed upon by the Company and the Service. Any resulting collection of Snake River physa will be covered by the Company's section 10 permit (no. TE799558), and the findings of those surveys be reported in the Company's annual section 10 report.

As outlined in the reporting requirements for the Bliss Rapids snail, the Company shall provide a summary of unusual operations or emergency events, in their annual monitoring report as outlined in Section 2.8.2.5 above.

The Company shall also report any emergency operations to the Service before they occur, if possible, or within one week after the event(s) if prior notification is not possible. A complete and detailed description of such events, including the amount of flow reduction or increase, and the duration of the event will be provided. Should an emergency event(s) occur that reduces flows below the licensed minimum flows, the event(s) shall be communicated to the Service immediately.

If the actions described in the Snail Plan (e.g., river and spring habitat monitoring) are not implemented as scheduled, this will constitute a failure of the Commission and Company to appropriately carry out the Action as proposed and as evaluated by the Service in this Opinion. Under such an event, the Commission may be required to reinitiate formal consultation as determined by the Service.

2.10 Reinitiation Notice

This concludes formal consultation on Bliss Rapids snail and Snake River physa, as affected by the proposed operational changes of the Lower Salmon Falls (FERC 2061) and Bliss (FERC 1975) projects. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if:

1. The amount or extent of incidental take is exceeded (based on operational constraints as provided in the Incidental Take Permit included in this Opinion).
2. New information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion.
3. The agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this Opinion.
4. A new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

3. LITERATURE CITED

3.1 Published Literature

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