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U.S. Fish and Wildlife Service

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MAY 08 2015

Memorandum

To: Jerrold D. Gregg, Area Manager, Snake River Area Office, Pacific Northwest Region, U.S. Bureau of Reclamation, Boise, Idaho

From: Michael Carrier, State Supervisor, Idaho Fish and Wildlife Office, U.S. Fish and Wildlife Service, Boise, Idaho

Subject: Bureau of Reclamation, Operations and Maintenance in the Snake River Basin above Brownlee Reservoir on the Snake River Physa Snail—Biological Opinion
In Reply Refer to: 01EIFW00-2015-F-0111

Enclosed are the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) and concurrence with the U.S. Bureau of Reclamation's (Reclamation) determinations of effects on species listed under the Endangered Species Act (Act) of 1973, as amended, for the proposed Operations and Maintenance (O&M) in the Snake River Basin above Brownlee Reservoir, Idaho. Based on new species information, in a letter dated November 12, 2014, and received by the Service on November 12, 2014, Reclamation reinitiated formal consultation under section 7 of the Act that the proposed project is likely to adversely affect the Snake River physa (*Haitia* (*Physa*) *natricina*) in the Minidoka spillway and Snake River upstream of Milner Dam. Reclamation also requested concurrence for its determination that future O&M of the remaining 10 projects in the Snake River basin above Brownlee Reservoir may affect but are not likely to adversely affect the Snake River physa from Milner Dam to Brownlee Reservoir. The Service acknowledges these determinations.

The enclosed Opinion and concurrence are based primarily on our review of the proposed action, as described in your November 12, 2014, Biological Assessment (Assessment), and the anticipated effects of the action on the Snake River physa, and were prepared in accordance with section 7 of the Act. Our Opinion concludes that the proposed project will not jeopardize the survival and recovery of the species. A complete record of this consultation is on file at this office.

Clean Water Act Requirement Language:

This Opinion is also intended to address section 7 consultation requirements for the issuance of any project-related permits required under section 404 of the Clean Water Act. Use of this letter to document that the Army Corps of Engineers (Corps) has fulfilled its responsibilities under section 7 of the Act is contingent upon the following conditions:

1. The action considered by the Corps in their 404 permitting process must be consistent with the proposed project as described in the Assessment such that no detectable difference in the effects of the action on listed species will occur.
2. Any terms applied to the 404 permit must also be consistent with conservation measures and terms and conditions as described in the Assessment and addressed in this letter and Opinion.

BIOLOGICAL OPINION
FOR THE
Bureau of Reclamation, Operations and Maintenance in the Snake River Basin above Brownlee Reservoir

01EIFW00-2015-F-0111

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

Supervisor ______________________

MAY 0 8 2015

Date ______________________

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1. BACKGROUND AND INFORMAL CONSULTATION

1.1 Introduction

The U.S. Fish and Wildlife Service (Service) has prepared this Biological Opinion (Opinion) of the effects of the U.S. Bureau of Reclamation's (Reclamation) operations and maintenance in the Snake River Basin above Brownlee Reservoir, including a change in operations at Minidoka Dam, on Snake River physa (*Haitia* (*Physa*) *natricina*). In a letter dated November 12, 2014 and received on November 12, 2014 Reclamation requested formal consultation with the Service under section 7 of the Endangered Species Act (Act) of 1973, as amended, for its proposal to implement the actions. Reclamation determined that the proposed actions upstream of Milner Dam are likely to adversely affect Snake River physa, and that the proposed actions between Milner Dam and Brownlee Reservoir may affect but are unlikely to adversely affect Snake River physa. As described in this Opinion, and based on the Biological Assessment [USBR 2014a (Assessment)] developed by Reclamation for this project, and other information, the Service has concluded that the actions, as proposed, are not likely to jeopardize the continued existence of Snake River physa.

In March 2005, the Service provided Reclamation with our biological opinion (2005 Opinion) (USFWS 2005) concluding that Reclamation's proposed actions in their Biological Assessment [USBR 2004 (2004 Assessment)] for the upper Snake River basin for Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir were not likely to jeopardize the continued existence of bald eagles, Utah Valvata snail, Snake River physa snail, Bliss Rapids snail, bull trout, and Ute ladies'-tresses. The Incidental Take Statement in our 2005 Opinion did not quantify take of Snake River physa because "inadequate information exist[ed] about whether and where the species presently occurs in the Minidoka Reach to accurately predict specific impacts of the action to the Snake River physa" and "[w]ithout that information it is not possible to anticipate whether or what incidental take is reasonably certain to result from the actions" (USFWS 2005, p. 162).

To resolve this uncertainty, Reclamation conducted surveys for Snake River physa below Minidoka Dam from 2006 through 2008 to determine if snails matching the species description (Taylor 1988, 2003) existed within the Minidoka Reach of the Snake River (between Minidoka Dam and the upstream end of Milner Reservoir, river mile [RM] 663 to RM 675); and if found, to determine if the Snake River physa is a distinct species or a phenotypic variant of another species in the family Physidae. The surveys positively identified Snake River physa in the Minidoka Reach as well as the Minidoka Dam spillway area, and determined the species to be distinct. (The spillway area is defined as the series of interconnected channels and pools beginning immediately downstream of both the old and new spillway structures, and south of the tailrace exiting the Minidoka powerplants. In the remainder of this Opinion, mention of the "Minidoka Reach" is understood to include the spillway area and the Snake River from Minidoka Dam downstream to Milner Reservoir; use of the "spillway area" alone does not refer to any other part of the Minidoka Reach).

After completion of the survey effort, Reclamation entered into consultation with the Service in 2010 for the Minidoka Dam spillway replacement project. This latter project proposed to replace the existing spillway structure with one that allowed greater operational flexibility between the spillway operation and power generation facilities of Minidoka Dam. Reclamation recently completed (March 31, 2015) replacement of the spillway portion of Minidoka Dam.

Since the completion of our 2005 Opinion, the presence of Snake River physa has now been confirmed in the Minidoka Dam spillway area, in the Snake River below Minidoka Dam, and in the Snake River below C.J. Strike Dam (Keebaugh 2009). Due to this new information, Reclamation is reinitiating formal consultation to address effects of the long-term operations and maintenance of its facilities located above Brownlee Reservoir on Snake River physa, including proposed new operations at Minidoka Dam and the new spillway.

1.2 Consultation History

The Service and Reclamation have maintained open communication regarding the project since December 10, 2013. During that time, the Service has provided recommendations and forwarded information needs. Reclamation has responded to these requests, and provided needed information in correspondence and telephone calls to the Service.

December 10, 2013	At the annual Minidoka Dam Spillway Technical Team meeting, Reclamation explained that the new spillway completion was scheduled for April 1, 2015; and that they had begun to draft the Biological Assessment (Assessment) for effects of post-construction change in operations on Snake River physa, with expected completion of the Assessment in August of 2014.
January 21, 2014	Meeting with Reclamation personnel to discuss issues regarding the section 7 consultation for the proposed change in spillway operations post-construction: the adaptive management approach toward modifying spillway flows; and the effects of Reclamation's operations downstream of Minidoka Dam on Snake River physa. We emailed Reclamation shape files of Snake River physa locations and copy of a Biological Opinion containing Snake River physa status, distribution, and life history data.
May 20, 2014	Receipt of chapters 1 & 2 of Reclamation' Assessment for review.
June 9, 2014	Provided Reclamation with comments to chapters 1 & 2 of their draft Assessment for this project.
August 11, 2014	Receipt of complete draft Assessment for review.
September 12, 2014	Provided Reclamation with comments on their draft Assessment.
November 12, 2014	Receipt from Reclamation of a formal request for consultation on this project.
December 4, 2014	Via emailed letter, we advised Reclamation that their Assessment

	contained sufficient information for us to proceed with the consultation. We advised that our Opinion would be completed on or before March 27, 2015.
January 21, 2015	Receipt from Reclamation of their 2013 and 2014 section 10 sampling results for Snake River physa at Minidoka, in response to our request for the data on January 20.
February 2, 2015	Receipt from Reclamation of a copy of their 2007 Assessment for NOAA Fisheries for operations on the Snake River upstream of Brownlee Reservoir in response to our request.
February 18, 2015	Forwarded draft sections from our Opinion to Reclamation for early review.
February 26, 2015	Attended Reclamation webinar describing how calculation of flows at Minidoka Dam could result in potential affects to Snake River physa under winter minimum flow conditions.
March 10, 2015	Receipt of email from Reclamation of years in which American Falls Reservoir drops below minimum pool in response to our request for the data.
March 16 & 19, 2015	Email exchange: advising Reclamation of possibility that consultation may extend beyond March 27, 2015, and also beyond April 1, 2015, when Reclamation would need to begin passing irrigation flow past Minidoka Dam. Reclamation advised they would begin irrigation season operations under section 7(d) of the Endangered Species Act.
March 24, 2015	Phone conversation with Ryan Newman of Reclamation, in which we requested clarification of conflicting statements in the Assessment suggesting winter flows in the Minidoka Reach could drop below the proposed minimum of 425 cfs.
March 24, 2015	Memorandum to Reclamation, requesting 30-day extension of consultation period to resolve issues regarding minimum flows.
March 26, 2015	Receipt of Reclamation Memorandum granting the 30-day extension, and stating that proposed minimum winter flow into the Minidoka Reach will be greater than or equal to 425 cfs.
April 13, 2015:	Transmittal of draft Opinion via email to Reclamation for their review.
April 17, 2015:	Receipt of Reclamation's comments to draft Opinion.

April 20 & 21, 2015: Telephone conversations with Reclamation discussing validity of Interrelated, Interdependent actions and Reclamation's legal obligations to the 1984 Swan Falls Agreement.

April 22, 2015: Telephone conversation with Reclamation, with the Service requesting additional data and figures modeling mean monthly flows at Milner Dam without Reclamation operations.

April 24, 2015: We advised Reclamation via email that additional time would be needed to complete the consultation.

April 27, 2015: Receipt from Reclamation via email a memorandum giving notice of a 2-week extension for receipt of our Opinion; receipt via separate email the data and figures requested of Reclamation on April 22, 2015.

May 6-7, 2015: Reclamation suggested, via email, a change to Terms and Conditions (T&C) number 1. We responded with a version of T&C 1 that included their suggestion on May 6. Reclamation confirmed that version was acceptable via email on May 7.

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 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."

2.1.1 Action Area

The action area is defined as all portions of the Upper Snake River basin which drain into the main stem of the Snake River and are affected by Reclamation projects (Figure 1). The Snake River main stem (or upper Snake River) is defined for this Opinion as extending from river mile (RM) 344 at the upstream end of Brownlee Reservoir near Weiser, Idaho, to and including Jackson Lake in Wyoming.

2.1.2 Duration of the Proposed Action

The duration of the proposed action is 20 years (2015 through December 31, 2034). This is the remaining term of the 2004 settlement of the Federal water right claims of the Nez Perce Tribe in the Snake River Basin Adjudication that includes the 2004 Nez Perce Term Sheet (Nez Perce Tribe *et al.* 2004). The Term Sheet applies, in part, to those actions involving the operation of the Reclamation projects located in Idaho.

2.1.3 Proposed Action

The 2004 Assessment described 11 proposed actions involving the operations and maintenance of 12 Reclamation projects in the upper Snake River basin: the Baker, Boise, Burnt River, Little Wood River, Arrowrock, Mann Creek, Michaud Flats, Minidoka, Owyhee, Palisades, Ririe, and Vale Projects. Some of these projects consist of multiple divisions on separate rivers (e.g., the Minidoka Project is comprised of the following impoundments: Minidoka Dam and Lake Walcott; American Falls Dam and Reservoir; Jackson Lake Dam and Jackson Lake on the Snake River in Wyoming; Island Park Dam and Reservoir on the Henry's Fork; Grassy Lake Dam and Reservoir on a tributary to the Henry's Fork). Reclamation does not coordinate operation among all 12 projects, but rather operates divisions, projects, or groups of projects independently of each other. Therefore, some actions reflect the operations of only a single project and other actions encompass the integrated operation of multiple divisions of a project or multiple projects. Reclamation stated in their current Biological Assessment (2014 Assessment) that total system operations will be consistent with the 2004 Assessment and as described in our 2005 Opinion, and that the general descriptions of the proposed actions in Chapter 2 of the 2004 Assessment will also remain the same. The proposed actions from the 2004 Assessment and our 2005 Opinion are herein incorporated by reference.

Because Snake River physa occur in the Snake River at multiple locations, the 2014 Assessment addressed the effects of all 11 proposed actions (hereafter collectively referred to as the Future O&M or O&M of facilities above Brownlee Reservoir), with the proposed actions broken down into the following actions:

- Future O&M in the Snake River system above Milner Dam. This includes the long-term operation of the features and facilities of the Michaud Flats, Minidoka, Palisades, and Ririe Projects; and the proposed change in operations involving the Minidoka spillway.
- Future O&M of all projects above Brownlee Reservoir, including those in the Little Wood river, Owhyee, Boise, Payette, Malheur, Mann Creek, Burnt River, and Powder River systems.
- Future provision of salmon flow augmentation from rental or acquisition of natural flow rights.

The only changes from Reclamation's 2004 Upper Snake BA evaluated in this Opinion are specific to how water will pass through the newly constructed facilities at Minidoka Dam. These changes only affect conditions in the spillway area.

As will be discussed in section 2.3 and subsequent sections, Snake River physa are not typically found in impoundments, and are not known to occur in Brownlee Reservoir. Since the Burnt River and Powder River confluences with the Snake River are well downstream of the upstream extent of Brownlee Reservoir, this Opinion will not consider the effects of Reclamation projects in these two rivers on Snake River physa.

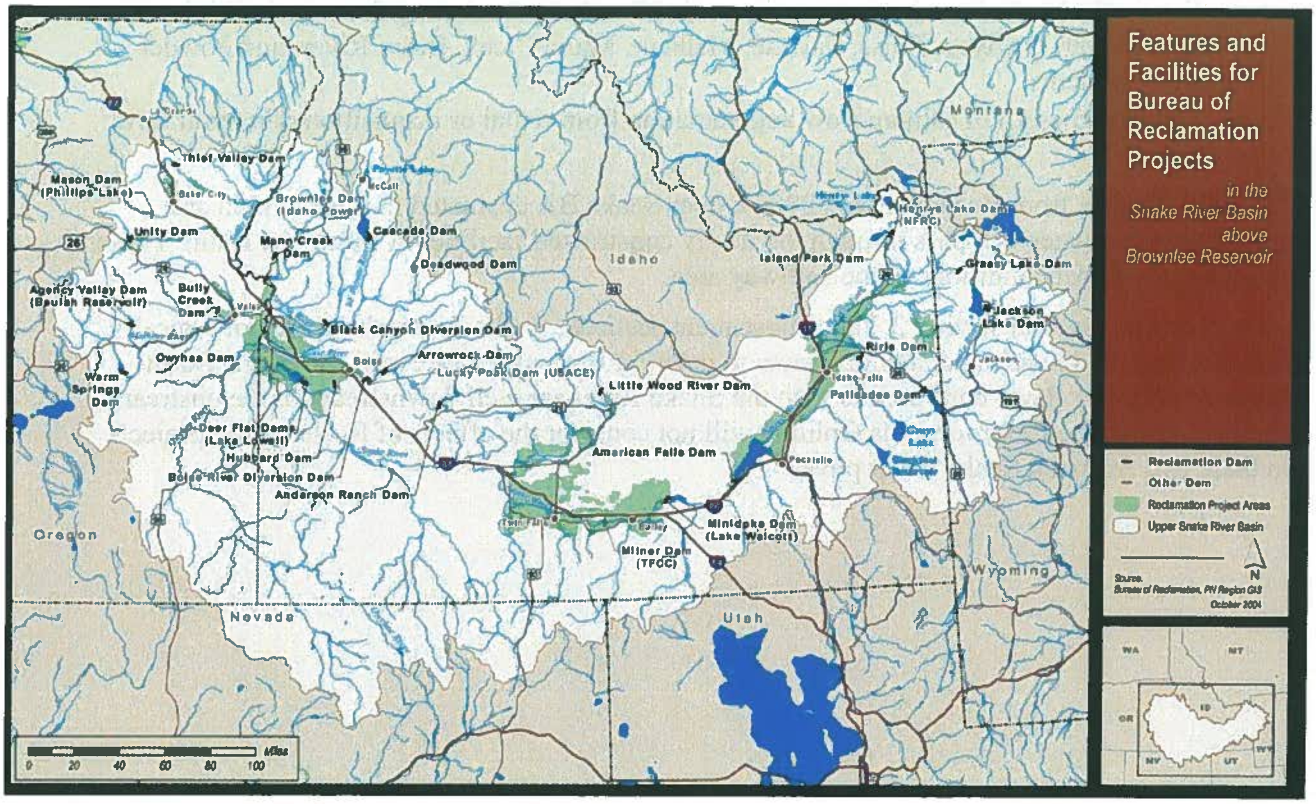

Figure 1. Reclamation facilities located in the upper Snake River basin (USBR 2014a).

2.1.3.1 Future O&M in the Snake River System above Milner Dam

Overall, upper Snake River system management above Milner Dam is anticipated to remain consistent with operations descriptions identified in the 2004 Assessment and our 2005 Opinion. Upstream of Minidoka Dam, the aggregate in-stream effects of natural hydrologic conditions, diversion of water for privately held natural flow water rights, plus in-stream effects of Reclamation projects in this portion of the upper Snake River basin are funneled into American Falls Reservoir. Flow into Lake Walcott (the reservoir behind Minidoka Dam) consists of all the water passed through America Falls Dam plus small reach gains of between 135 to 190 cubic feet per second (cfs). Under Future O&M, flows past Minidoka Dam during the irrigation season will continue to consist of all water that enters Lake Walcott less discharge into the North Side and South Side canals from headgates located on the Minidoka Dam structure. Flows downstream of Minidoka Dam are measured at the U.S. Geological Survey (USGS) Howell's Ferry gage (USGS #13081500) located less than ½ mile downstream of the dam.

As part of the long-term operations of the newly constructed Minidoka spillway, Reclamation proposes to change the way flow is partitioned between the powerplant and spillway at Minidoka Dam. Using the iterative adaptive management approach identified in Reclamation's *Final Environmental Impact Statement (EIS), Minidoka Dam Spillway Replacement, Minidoka Project, Idaho* ([final EIS] USBR 2010), Reclamation will adjust flow partitioning at Minidoka Dam and spillway and identify impacts to the Snake River physa located within the spillway area. These changes only affect conditions in the immediate vicinity of Minidoka Dam, and are not anticipated to change flow volume in the main river channel from the Howell's Ferry gage and downstream to Milner Dam.

2.1.3.1.1 The New Spillway

Reclamation has corrected structural problems in the spillway and canal headworks at Minidoka Dam by:

- Replacing the entire spillway portion of Minidoka Dam with a new spillway structure containing an overflow spillway and new radial gates plus additional smaller release gates for increased flexibility of water release locations;
- Installing a new service road below the spillway;
- Installing new embankments along the South Side Canal;
- Replacing both the North Side and South Side canal headworks.

The new structure is a concrete overflow structure. Flows will be controlled through the use of the existing 3 radial-style gates; 12 newly constructed radial-style gates located on the southern portion of the spillway structure; and five new, smaller water release points (release points) strategically located along the spillway to provide flows to the wetland and pool areas downstream of the spillway (Figure 2). Operation of the new radial gates in the spillway is consistent with the current range of operations and also includes:

- Releases for downstream deliveries beyond the capacity of the powerplants, including flow augmentation for salmon;
- Releases resulting from flood operations;
- Flow passage during load rejection at the power plants if the existing radial gates become disabled or go off-line for maintenance;

- Biological releases, as determined through the adaptive management process (see section 2.1.3.1.3), which may be divided among or singly include both sets of radial-style gates and the five release points, depending on the biological need.

The new overflow structure was completed on March 31, 2015, and will provide Reclamation with greater flexibility in its management of Minidoka Dam and spillway. Future flows past the facility are described below.

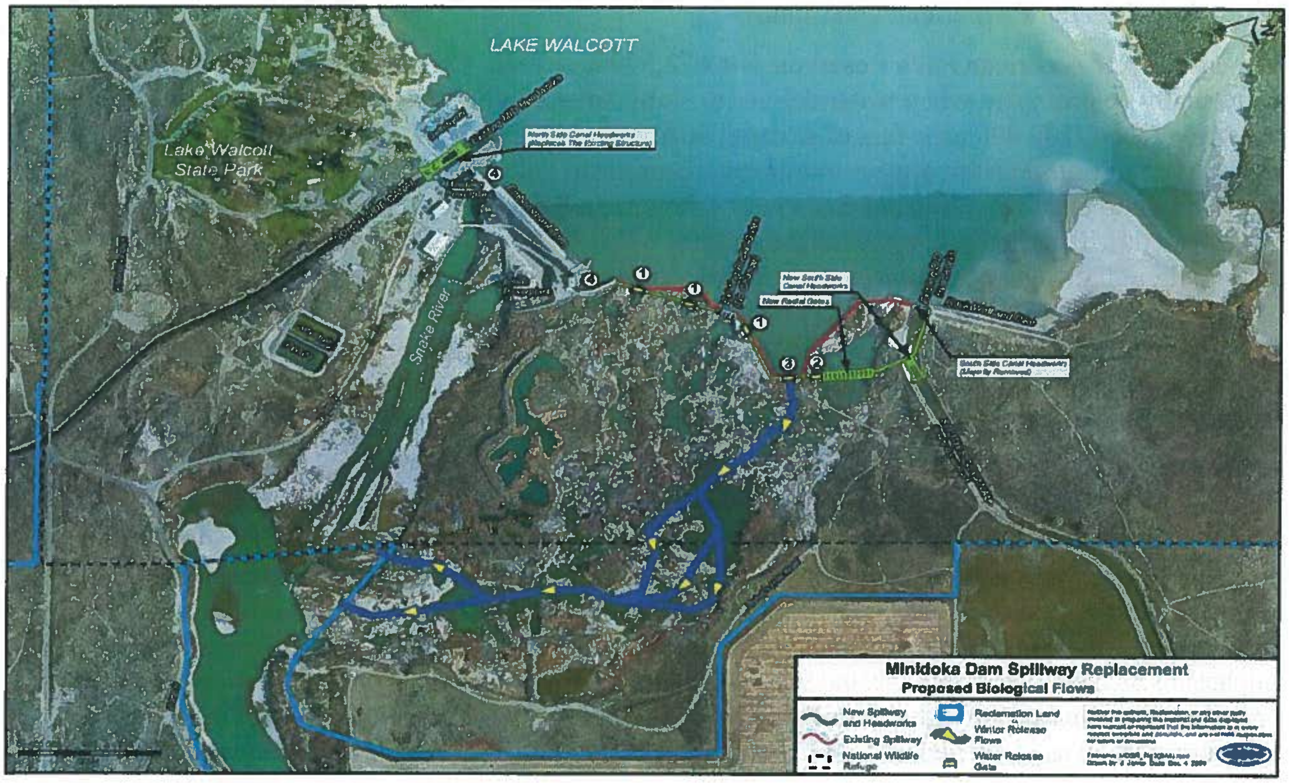

Figure 2. Newly constructed Minidoka Dam spillway and spillway area. Depicts water release points, and direction of proposed spillway flows to benefit Snake River physa and other natural resources in the spillway area (USBR 2014a).

2.1.3.1.2 Operation of the Spillway

With the new spillway structure, current operational constraints necessary to prevent ice damage will be eliminated. Consequently, Reclamation generally intends to maintain Lake Walcott at its full operational elevation of 4245.0 feet throughout the year. However, in 25 to 50 percent of years, it is expected that irrigation demand, facility maintenance needs, and environmental concerns will require that the reservoir be drafted to elevation 4236.0 feet during the winter months. Draft of Lake Walcott to this level would occur in low water years, and would be implemented to reduce to the extent possible the volume of releases from American Falls Reservoir in order to prevent or minimize water quality issues downstream between American Falls Dam and Milner Reservoir (see sections 2.4.1.2.2, 2.4.1.2.3, and 2.5.2.2 for water quality issues downstream of American Falls Dam).

The capacity of American Falls Reservoir is 1,672,590 acre feet. The drafting of Lake Walcott will usually be prompted when water deliveries from American Falls Reservoir create a low pool condition (about 100,000 acre-feet of storage) at American Falls during irrigation season. When low pool conditions exist or appear imminent at American Falls, the Minidoka pool may be drawn down to meet irrigation demands below American Falls. When required, the drafting of Lake Walcott will occur late in the irrigation season (beginning as early as mid-August and lasting through the end of October), making deliveries to Burley Irrigation District (BID) and Minidoka Irrigation District (MID) and other irrigation deliveries below Minidoka Dam. Once Lake Walcott has been drafted, it will typically remain at the reduced level until mid-March, or as soon as upstream flood operations begin. Refill of Lake Walcott will be accomplished by increased releases from American Falls Reservoir.

Except for the storage deliveries described in the previous paragraph, Minidoka Dam will continue to be operated as a run-of-the river project. However, during irrigation season, Reclamation will seek to adjust the existing minimum spillway flow. The intent is to increase power generation through the Inman and Minidoka power plants (labeled 4 at the lower end of the embankment dam in Figure 2), while continuing to meet the intent of mitigation requirements developed for the construction of the Inman Powerplant (see section 2.4.1.2.1) and minimize impacts to Snake River physa located within the spillway area (USBR 2010). Reclamation proposes that releases through the spillway be a minimum of 500 cfs during much of the irrigation season as identified in Table 1 (section 2.1.3.1.3). Releases will be as follows:

- Approximately 50 cfs through each of the four northern-most release points (labeled 1 and 3 on Figure 2).
- At least 300 cfs through one of the radial gates located in the new gated spillway portion of the new structure (Figure 2).

Spillway flows would be increased during the irrigation season when sufficient water is available after powerplant hydraulic capacity is met. It is expected that in most years, Reclamation would have flow greater than 500 cfs in the spillway at some time in the water year due to downstream demand exceeding powerplant hydraulic capacity of 8,850 cfs. Over the last 10 years, all years except 2004 would have had spillway flows exceeding 500 cfs for much of the entire irrigation season due to downstream demands; 2004 would have had the 500 cfs minimum flow for all of the irrigation season.

2.1.3.1.3 Adaptive Management

An adaptive management approach is proposed to adjust the minimum flow down to a consistent 500 cfs through the spillway area during much of the entire irrigation season (Table1). Comments provided to Reclamation during project planning under the Fish and Wildlife Coordination Act and development of the project Environmental Impact Statement highlighted concerns of the Service and the Idaho Department of Fish and Game regarding minimum flow impacts to biological resources in the spillway area, including to Snake River physa recovered from the spillway pool known as the 'snail pool,' where all but one live Snake River physa recovered in the spillway have been found (one live specimen was recovered by Gates and Kerans [2010] in the constructed wetland located just downstream from the Inman Powerplant—see section 2.3.1.4, Status and Distribution). Adjustment to the proposed 500 cfs minimum spillway flow will occur over a period of 4 years following construction. This will allow potential impacts to the biological resources within the spillway area, including Snake River physa, to be assessed over this 4-year period. The proposed incremental reduction in spillway flows is shown in Table 1. Water not being routed through the spillway would be routed through the powerplant. Reclamation will monitor biological resources and collect water quality information at each incremental decrease of flow in order to assess potential impacts associated with the reduction in flow (USBR 2010). While increased power generation is the intent of this change in spillway operations, the new minimum spillway flow will ultimately be established by Reclamation, based on the results of the adaptive management process.

It is anticipated water velocities will increase throughout the snail pool as a result of the new structure. The previous overflow spillway structure was located approximately 1,300 feet upstream of the snail pool. Water coming over the spillway dropped into a large pool which ultimately flowed into the snail pool. The new structure is located approximately half the distance from the snail pool as the previous structure, thereby decreasing flow time to the snail pool. Additionally, the new structure consists of a radial-style gate which is a bottom release as opposed to surface releases utilized in the old structure. Water releases associated with the new structure will be subject to substantially higher pressure, resulting in much higher velocities at the point of release. There is a possibility that the increased velocity at the point of release coupled with the shortened flow distance will result in higher velocity conditions through the snail pool, possibly creating more usable habitat within this area.

Reclamation may provide non-irrigation season flows into the spillway area to compensate for leakage that occurred along much of the old spillway structure, and which largely drained into the snail pool. (It is thought that such winter leakage may have contributed to conditions that led to the persistence of Snake River physa in the snail pool). These non-irrigation season flows may consist of possible structural leakage from the new structure (anticipated to be minimal) or wave action cresting the overflow spillway, plus a controlled release at one of the new water release points (possibly release point 3, Figure 2) from 1 to 100 cfs, depending on the amount of leakage, if any, from the new spillway. Flows through the spillway would be measured by subtracting powerplant flows from flow data measured at the immediately downstream USGS gage at Howells Ferry (USGS 13081500) as well as by conducting physical measurements.

Table 1. Current operations and proposed incremental reduction schedule at Minidoka Dam.[1]

	Spillway Flow (cfs)					Powerplant Flow (cfs)				
	2013 current[2]	2014	2015	2016	2017	2013	2014	2015	2016	2017
Nov. 01	< 1	< 1	< 1	< 100	< 100	400	400	425	425	425
Dec. 01	< 1	< 1	< 1	< 100	< 100	400	400	425	425	425
Jan. 01	< 1	< 1	< 1	< 100	< 100	400	400	425	425	425
Feb. 01	< 1	< 1	< 1	< 100	< 100	400	400	425	425	425
Mar. 01	< 1	< 1	< 1	< 100	< 100	400	400	425	425	425
Apr. 01	< 1,300	< 1,300	< 1,300	< 1,000	< 500	< 5,035	< 5,035	< 5,035	< 5,335	< 5,835
Apr. 15	1,300	1,300	1,300	1,000	500	< 8,850[3]	< 8,850	< 8,850	< 8,850	< 8,850
May 01	1,300	1,300	1,300	1,000	500	< 8,850	< 8,850	< 8,850	< 8,850	< 8,850
June 01	1,300	1,300	1,300	1,000	500	< 8,850	< 8,850	< 8,850	< 8,850	< 8,850
July 01	1,900	1,900	1,500	1,000	500	< 8,850	< 8,850	< 8,850	< 8,850	< 8,850
Aug. 01	1,900	1,900	1,500	1,000	500	< 8,850	< 8,850	< 8,850	< 8,850	< 8,850
Sep. 01	1,300	1,300	1,300	1,000	500	< 8,850	< 8,850	< 8,850	< 8,850	< 8,850
Sep. 15	< 1,300	< 1,300	< 1,300	< 1,000	< 500	< 5,035	< 5,035	< 5,035	< 5,335	< 5,335
Oct. 01	< 1,300	< 1,300	< 1,300	< 1,000	< 500	400	400	425	425	425

[1] Values in Table 1 have been corrected to match values in Table 1 in Reclamation's Memorandum of March 26, 2015, and differ from the corresponding Table 2-1 in their 2014 Assessment. See Appendix in this Opinion.
[2] See section 2.4.1.2.1 for detailed description of the existing flow schedule.
[3] Irrigation season powerplant flows are highly variable within and among years and are dependent upon several factors. Accurate monthly flows cannot be precisely expressed in a single table. The maximum powerplant capacity at Minidoka Dam is 8,850 cfs.

2.1.3.1.4 Interagency Technical Team

In anticipation of the Minidoka Dam spillway replacement project, Reclamation convened a Natural Resource Working Group in 2004, comprised of various state and federal agencies with jurisdiction and/or interests in the Minidoka Dam and spillway area. The group met at Minidoka Dam on March 25, 2005 to discuss the spillway replacement project and gather input from resource professionals regarding resource needs and concerns related to the project. The group met annually from 2005 through 2008, at which time Reclamation initiated the environmental analysis for the Minidoka Dam Spillway Replacement project (final EIS). Although the group did not formally meet after 2008, members were formally involved in project planning and discussions through the National Environmental Policy Act (NEPA). Reclamation held scoping meetings in December of 2008. In December of 2009, the Draft EIS was provided to 95 individuals, organizations, agencies and congressional delegates for review and comment. Public meetings were again held in January 2010.

Reclamation formally established the interagency Technical Team in early 2011, shortly after the Record of Decision (ROD) for the final EIS was signed, based on commitments made by Reclamation in the EIS. The Technical Team was established to determine monitoring protocols, impact thresholds, and critical minimum-flow criteria for the spillway area for the Snake River physa and other biotic resources in the spillway area. The Technical Team has been collecting baseline information, in varying capacities, since 2011 (USBR 2012, 2013, and 2014b). The team consists of representatives from state and federal agencies as well as academia. All data pertaining to ecological resources associated with this project have been, and will continue to be, provided to this team until final spillway flows have been established.

In the final EIS, Reclamation proposed to reduce irrigation season spillway flows to 500 cfs in order to boost power production for much of the season; however, this flow will be ultimately determined by Reclamation managers utilizing guidance and information provided by the Technical Team. The Technical Team provides a forum so natural resource professionals can evaluate the Minidoka spillway area, determine baseline conditions, and identify indicators or thresholds relative to the respective biotic resources within the area. The Technical Team designed the adaptive management approach to identify the current status of the spillway area and will develop indicators or thresholds, as well as continue collecting information throughout the duration of the incremental flow reduction sequence. The new spillway flow will be established based on flow requirements of the Snake River physa as well consideration for other resources in the spillway area. Reclamation will operate the facility to maximize power production while minimizing impacts to biotic resources within the spillway area.

In the final EIS, Reclamation proposed an adaptive management approach to arrive at the desired target minimum flow of 500 cfs. Based on this approach, Reclamation will gradually reduce irrigation season flows over a 4-year period while monitoring for adverse effects to the biological community in the spillway area. Reclamation proposes the incremental reduction in spillway flows as follows:

- Year 1 – 1,900 cfs
- Year 2 – 1,500 cfs
- Year 3 – 1,000 cfs
- Year 4 – 500 cfs

During the 4-year evaluation period, the Technical Team will have the ability to determine subsequent year spillway flows based upon previous year's data. For example, in the event that unfavorable conditions for the Snake River physa are identified during the 1,000 cfs operation in year 3, the Technical Team could identify a different flow (such as 1,250 cfs) for the year 4 evaluation. This will allow the Technical Team to identify the minimum spillway flow necessary to maintain the biotic resources within the spillway area. If hydrologic events preclude Reclamation from achieving the annual target minimums during one of the four evaluation years, Reclamation will postpone the respective flow evaluation until regular hydrologic conditions occur. Should monitoring data indicate negative impacts to biological communities in the spillway, Reclamation will revert to a higher minimum spillway discharge, up to but not exceeding the highest flow shown for Spillway Flow for 2013-2014 in Table 1.

The technical team would determine if monitoring should continue in order to determine if the increase in flow ameliorated the adverse effect.

The Technical Team was formalized in 2011 and initiated data collection in that year. Data was again collected in 2012, 2013, and 2014. The results from each annual data-collection activity have been discussed each fall at the annual Technical Team meeting. Reclamation proposes to continue this through the duration of the incremental flow-reduction sequence until which time a preferred operation is identified. Data collected by the Technical Team in 2012, 2013, and 2014 as well as data previously collected by Reclamation will provide the baseline for the incremental flow reduction analysis.

There is no planned release of water through the spillway outside of irrigation season. However, due to the presence of Snake River physa inhabiting the spillway area and the unknown potential for reductions in leakage past the new spillway structure, limited releases may be necessary to avoid impacts to Snake River physa. Similar to the adaptive management approach proposed for spillway flows during irrigation season, Reclamation will, in cooperation with the Technical Team, establish monitoring protocols and criteria which will determine what flows, if any, are needed to avoid impacts to the snails in the spillway area outside of irrigation season. If it is determined that non-irrigation season flows are required, Reclamation will provide flows of up to 100 cfs through the new spillway structure, possibly at release point 3, as shown on Figure 2.

2.1.3.1.5 Winter Discharge, Minidoka Reach

Because the Minidoka powerplants require at least 400 cfs minimum outflow in order to heat and light the powerplants to prevent damage to equipment, Reclamation proposes a 425 cfs minimum winter outflow from Minidoka Dam into the Minidoka Reach as measured at the Howell's Ferry gage. This winter outflow consists of releases from the American Falls powerplants (which similarly require a minimum outflow to prevent cavitation in the turbines), plus reach gains of between 135 and 190 cfs between American Falls Dam and Lake Walcott. The 425 cfs minimum includes a 25 cfs buffer. Reclamation monitors the Howell's Ferry Gage in order to calculate and maintain their flow objectives, but the official discharge calibration of the gage according to stage height and river cross section curves is the responsibility of and is conducted by the USGS. Hence, at times there may be discrepancies between the discharge determined by Reclamation and the actual "official" flow calculation determined by the USGS. These discrepancies are usually small (a few cfs), and due to efficient communication between the two agencies, usually exist for short periods of time. However, lag times have occurred and may occur, where the actual flow may be less than that calculated by Reclamation for several days. For this reason Reclamation has included a buffer in their proposed minimum flow. In most years minimum winter flow downstream of Minidoka Dam will exceed the proposed minimum, frequently over 500 cfs, due to outflow from American Falls Reservoir. If non-irrigation season flows into the spillway area are found to be required to protect Snake River physa in the spillway (up to 100 cfs as described at the end of the previous section), this amount would be additive to the minimum 425 cfs outflow of the powerplants, resulting in combined flow of up to 525 cfs into the Minidoka Reach.

On pages 79 and 88 of their 2014 Assessment, Reclamation indicated that non-irrigation season flows in the mainstem of the Snake River downstream of Minidoka Dam could drop below 400 cfs in approximately 5 percent of years. In their 2015 Memorandum to the Service (Appendix, this Opinion), Reclamation clarified that their proposed minimum non-irrigation season flows past Minidoka Dam will range between 425 and 525cfs, and instructed that the references to flows less than 400 cfs in approximately 5 percent of years be deleted from the 2014 Assessment. Our description of the proposed action in this Opinion reflects and includes these changes, and in this Opinion we do not analyze the effects of non-irrigation season flows past Minidoka Dam of less than 400 cfs as part of the proposed action.

2.1.3.1.6 Summary of Proposed Snake River Operations above Milner Dam

Reclamation's operational flexibility is regulated and constrained by Federal water delivery contracts, state water rights law, timing of irrigation demand, facility maintenance needs, flood control operations, and environmental requirements and concerns. Reclamation will have the physical flexibility to adjust the normal reservoir water surface between elevations 4245 feet (full pool) and 4236 feet as conditions warrant. Minimum controlled irrigation season spillway releases at Minidoka Dam will range from 500 cfs to 1,900 cfs. Non-irrigation season spillway flows will range from 0 cfs up to 100 cfs to meet biological requirements, depending on results identified by the technical team.

Following construction, the minimum flow past Minidoka Dam outside of irrigation season will range from approximately 425 to 525 cfs (24-hour average). A minimum flow of 400 cfs with a 25 cfs buffer is necessary to provide power to heat and light the powerplants to prevent damage to equipment. This minimum flow may be increased by up to an additional 100 cfs released through the spillway area to meet biological requirements. These flows are measured downstream at the Howells Ferry gage. It should be noted however, due to fluctuating weather conditions, gage icing, gage error, as well as other factors influencing gage readings, false readings can occur for multiple days, thereby requiring manual data correction to identify actual flow conditions.

2.1.3.2 Future O&M in the Snake River above Brownlee Reservoir

Reclamation's operations within the Snake River basin upstream from Brownlee Reservoir to Milner Dam will remain unchanged from those considered in the 2004 Assessment. Total system operations will be consistent with their 2004 Assessment and as described in our 2005 Opinion. The general descriptions of the proposed actions in Chapter 2 of the 2004 Assessment also remain the same and are herein incorporated by reference (USBR 2004, p 11-28).

2.1.3.3 Future Provision of Salmon flow Augmentation

Reclamation annually provides up to 487,000 acre-feet of water from the Snake River above Brownlee Reservoir, intended to benefit ESA-listed anadromous fish species in the lower Snake and Columbia Rivers. The 2004 Nez Perce Water Rights Settlement reenacted Idaho Code to authorize the rental and protection of up to 427,000 acre feet of Snake River water from traditional sources upstream of Brownlee Reservoir for flow augmentation (prior to the Settlement, state law limited the amount of water that could be protected from all sources to 427,000 acre feet). In addition, the Settlement provided that Reclamation could rent or acquire for protection an additional 60,000 acre feet from holders of Snake River natural (instream flow) water rights, and authorized the release and protection of water from reservoir powerhead space, all to increase Reclamation's ability to provide 427,000 acre feet for flow augmentation (USBR 2007). Reclamation's delivery and timing of flow augmentation water is described in the proposed action in their Biological Assessment [USBR 2007 (2007 Assessment)] submitted to the National Oceanic and Atmospheric Administration (NOAA) and incorporated in the 2008

NOAA Opinion and Incidental Take Statement for O&M of Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir (NOAA 2008). The proposed action description in the 2014 Assessment is consistent with Reclamation's 2007 Assessment and thereby incorporated by reference. The amount of flow augmentation water delivered from various Reclamation projects may vary widely due to availability of water for rental, and to variation in annual precipitation patterns in the upper Snake River subbasin; in some years the larger portion may come from projects upstream of Minidoka Dam, in other years from projects in the Payette River or Boise River.

2.1.3.4 Snake River System Maintenance Activities

In general, all maintenance activities within the Snake River system are handled on a case-by-case basis. Annual maintenance activities typically occur within existing structures and outside of irrigation season, thereby resulting in no affect to ESA-listed species. Maintenance activities are typically scheduled to not coincide with annual water-delivery or flood operations. Reclamation O&M and natural resources personnel coordinate prior to scheduling major maintenance activities to identify timing, sequencing, and other alternatives to avoid or minimize potential impacts to biological resources, including ESA-listed snails. Reclamation will confer with the USFWS to determine the appropriate level of consultation necessary if maintenance activities arise that may affect ESA-listed species.

2.2 Analytical Framework for the Jeopardy and Adverse Modification Determinations

2.2.1 Jeopardy Determination

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

1. The *Status of the Species*, which evaluates the Snake River physa rangewide condition, the factors responsible for that condition, and its survival and recovery needs.
2. The *Environmental Baseline*, which evaluates the condition of the Snake River physa in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the 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.
4. *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the Snake River physa.

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 species' 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 the species in the wild.

The jeopardy analysis in this Opinion places an emphasis on consideration of the rangewide survival and recovery needs of the Snake River physa and the role of the action area in the survival and recovery of the species 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.

2.3 Status of the Species

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.

2.3.1 Species

2.3.1.1 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 (USFWS 1995). The target recovery area for this species is from River Mile (RM) 553 to RM 675 (USFWS 1995, pg. 30). The proposed action includes stretches of the Snake River within and outside of the recovery area.

2.3.1.2 Species Description

The Snake River 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 preputial 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 Reclamation below Minidoka Dam as part of monitoring recommended in our 2005 Opinion (USFWS 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 Reclamation 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 genetic analyses on 15 of 49 live-when-collected specimens recently identified as Snake River physa (Keebaugh 2009), and collected by the Idaho Power Company (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).

2.3.1.3 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 (Pennak 1953). The latter method is assumed to be 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. Dillon (2000, p. 119-121 and156-170) discusses the number of generations pulmonate species may show per year, and indicates that the period of egg-laying is somewhat dependent on snail size and water temperature. McMahon (1975) discussed the range of critical water temperatures in which the onset of egg-laying begins in a number of *Physa* spp., and also stated that breeding frequently ceases when water temperature drops below some critical level. Table 2 provides a summary of McMahon's information.

Table 2. Temperature ranges for onset of egg-laying of some Physa species in the United States and Europe (McMahon 1975).

Location	Temperature Range	*Physa* species
Texas	> 13 ^{0}C	*P. acuta*
Michigan	10-12 ^{0}C	*P. gyrina*
Southern England	7-11 ^{0}C	*P. fontinalis*
Netherlands	7-8 ^{0}C	*P. fontinalis*

P. gyrina and *P. acuta* have both been identified based on shell and internal morphology as having been recovered from the Snake River, with the latter's presence recently confirmed via genetic analysis (Idaho Power Company[Company] unpublished results). It seems reasonable that the temperature range for reproduction among three *Physa* species across a range of latitude on two continents may also include the temperature at which Snake River physa may breed in the Snake River. The Service regards 10 °C as a median water temperature at which *Physa* reproduction might begin. Evaluation of Company and USGS water temperature data from near Marsing, Idaho and Swan Falls Dam (not shown) suggests that Snake River physa might reproduce between late March through early November, depending on the year, with a possibility for more than one generation.

Habitat Characteristics

Water is the primary habitat requirement of Snake River physa. Analysis of Snake River physa substrate preferences (Winslow *et al. in litt.* 2011) indicates the species selects for gravel to pebble, possibly gravel to cobble, substrates where water velocity is sufficient to keep the substrate free of fine sediments and macrophyte plant growth. 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 *in litt.* 1982). While habitats such as rapids over boulder to bedrock substrates 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, and the Minidoka Reach is predominantly made up of run-glide habitats, with rapids making up a small proportion of habitats present (substrate size categories, i.e., gravel, pebble, follow Cummins 1962). More recent analysis of the downstream data collected by the

Company support the findings of Gates and Kerans: Winslow *et al.* (*in litt.* 2011 pg. 6) found that Snake River physa occurred on substrates containing gravel (gravel/pebble and gravel/cobble categories) more than expected by chance alone ($X^2 \geq 55.504$, $P \leq 0.00032$). (Substrate records or data referenced in the format pebble/cobble means the two substrate types were the two dominant types found in the sample, and are not intended to imply one was more common than the other). 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) also evaluated the effect of seasonal flows on the mollusk community, including Snake River physa, in the Minidoka Reach. Flows passed into the Minidoka Reach will typically range well over 5,000 cubic feet per second (cfs) for much or most of the irrigation season (Figure 3) to supply irrigation water to Milner Reservoir, but non-irrigation season flows (a period of about six months) in the Minidoka Reach have been dropped to and varied between 400-600 cfs for approximately a century to provide for annual winter and spring filling of the much larger storage reservoirs upstream at American Falls Dam and Palisades Dam. Low non-irrigation season flows, then, have resulted in consistent de-watering of a large area of river bed for about 100 years. Gates and Kerans' (2010) 2006-2008 surveys of the Minidoka Reach documented that the mean abundance of all mollusk species they recovered, including Snake River physa, was significantly lower in all sample years for areas that are de-watered every year, compared to mean abundance at depths that are always watered. Gates and Kerans' concluded that "the dramatic reduction in winter discharge over the past 100 years has had long term effects on the mollusk community."

Gates and Kerans' (2010, pg. 8-36) detailed study sampled cross sections of the river profile, and characterized Snake River physa habitat as occurring in runs, glides, or pools, with moderate mean water velocity of 0.57 meters/second (m/s). Mean depth of samples containing Snake River physa was 1.74 m, with 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.

In a regulated river, whether fine sediments are present and suspended in the water column or are deposited on the river bed may be a function of water velocity, or of dams that act as sediment traps. Chambers *et al.* (1991) demonstrated how the interaction between sediment and water velocity affected the establishment of macrophyte beds. Low current velocities resulted in sediment deposition and macrophyte establishment in deposited sediment, with macrophyte biomass significantly and inversely correlated with velocity within the macrophyte bed over the range of 0.01-1.0 m/s. Once established, the nutrient concentrations (primarily phosphorous and nitrogen) in the sediments determined macrophyte abundance and density. At velocities greater than 1 m/s, macrophytes were either absent or present in negligible quantities. American Falls Dam and Minidoka Dam both act as highly effective sediment traps, with the result that water in the Minidoka Reach is relatively free of fine sediment (USBR 2014a). Although the mean water velocity of 0.57 m/s in Snake River physa occupied habitat in the Minidoka Reach is roughly half of the velocity (1.0 m/s) for which Chambers *et al.* (1991) reported that macrophytes are absent or present in negligible quantities, macrophytes are nearly absent in the permanently watered river sections of the Minidoka Reach; minimal fine sediments passing Minidoka Dam are a plausible cause. Company biologists surveying for Snake River physa downstream in the Marsing reach of the Snake River (~ RM 424), which typically carries a high sediment load, reported few or no macrophytes and gravel to pebble-sized substrates when water velocities approached 1 m/s. This suggests that the presence of Snake River physa in the Minidoka Reach may be, at least in part, a function of sediment trapped behind Minidoka and American Falls dams; and, that under some river conditions water velocities greater than the mean of 0.57 m/s may be required to maintain Snake River physa potential habitat in suitable condition where sediment loads are higher.

Water temperature requirements and tolerances of Snake River physa have 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 the Snake 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, the range of water temperatures encountered by Snake River physa in its occupied range and habitat do not appear to be limiting.

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.

We do not know which Snake River physa life history characteristics are impacted by habitat conditions differing from those which the species seems to require. For example, with suitable substrates present, depth less than 1.5 m and water velocity less than 0.57 m/s may not inhibit relatively dense occupation by the species if the river is exceptionally free of fine sediments (sand, mud, and silt), no macrophytes are present, and dissolved oxygen concentration is sufficient. The duration of exposure to conditions differing from preferred habitat characteristics that is needed to result in impacts to the species are also unknown. For example, adult Snake River physa may be able move and forage on sand or mud that has temporarily accumulated onto preferred substrates (i.e., the fines may be swept away in a week or two by an additional 1,000 cfs increase in flow), whereas juveniles may not. Egg masses laid on gravel and pebble may die under thin, temporary layers of fines on which adults may be able to move and feed. Egg masses laid on fines may be disintegrated or swept away if an increase in flow from, for example, load following from a hydroelectric dam sweeps the underlying gravel and pebble free of fines. If the species can be reared in the laboratory, experiments may help answer some of these questions. In absence of information, we have to assume that Snake River physa colonies require the presence of all preferred (selected for) habitat conditions in order to reproduce, grow, and persist. If this is indeed the case, it is possible that the species requires locations in the river channel where the presence of all known habitat characteristics are present year around. The Minidoka Reach may be such a location, having the known, largest contiguous area of Snake River physa preferred substrates, and is where the species can consistently be found.

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; and benthic diatoms (diatom films that primarily grow on rock surfaces), bacterial films, and detritus (collectively termed periphyton) (Dillon 2000, pg. 66-70). *P. gyrina* consumes dead and decaying vegetation, algae, water molds, and detritus (DeWitt 1955, pg. 43; Dillon 2000, p. 67).

2.3.1.4 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 (approximately RM 553-572), and the Minidoka Reach (approximately RM 669-675). Its historic range was believed to extend as far downstream as Grandview (RM 487) (USFWS 1995, pg. 8-9). Fossil evidence indicates this species existed in the Pleistocene-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 prehistorically connected to these water bodies (Frest *et al. in litt.* 1991, pg. 8; Link *et al.* 1999). 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 2.3.1.2 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 Reclamation from 2006 through 2008 (Gates and Kerans 2010), confirmed with genetic identification, place the species' 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 a biological assessment for the re-licensing of the Swan Falls Hydroelectric Project in 2011. Surveys for this project were conducted from RMs

441.9-469.4 and collected sixty 0.25 square meter (m^2) benthic samples. These survey efforts did not recover any living Snake River physa or shells (Bean and Stephenson 2011, pg. 7). In combination with the survey result provided by Keebaugh (2009, entire document) and Frest and Johannes (*in litt.* 2004, see section 2.4.1.1.2 this Opinion), 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 and abundance in the upstream-most population which is roughly delineated as occurring immediately below Minidoka Dam (RM 675), downstream to Milner Reservoir (RM 663). Snake River physa have been sporadically recovered from the snail pool located about 250 meters downstream of the spillway (the area below the spillway was originally dry ground before the dam was built, and now may be referred to as the spillway area or the spillway wetlands; it is not part of the original Snake River channel). Although low numbers of individuals have been recovered in the pool, one sample held the highest number (15) of Snake River physa ever recorded in a single sample (Kerans and Gates *in litt.* 2008). It is plausible, although not known, that the snail pool colony may function from time to time as a source for new individuals for the Snake River physa colonies further downstream in the Minidoka Reach. The spillway area is not large and water transit time through the spillway area can be a matter of minutes, depending on flow. Individual Snake River physa that release or are dislodged from substrates in the snail pool could remain suspended and be carried to the Snake River mainstem fairly quickly.

From their transects located in the Snake River, 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 m^2 (Gates and Kerans 2010, Figure 1.6, pg. 23), though typically samples contain lower densities. In addition, Kerans and Gates (*in litt.* 2008, 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 Snake River physa is considerably less commonly encountered in its downstream range (below C.J. Strike Dam). Only 49 live-when-collected specimens have been recovered in the Snake River between C.J. Strike Dam and Brownlee Reservoir. These specimens were identified in only 4.3 percent of 787 inspected samples containing live animals; the density of live animals typically did not exceed 4 individuals per m^2 in these river reaches (Keebaugh 2009, entire document). The numbers of live-when-collected Snake River physa in these reaches are too few to estimate the species' density or abundance with acceptable confidence. Other portions of the Snake River (*e.g.*, Thousand Springs (RM 584) to Milner Reservoir) have received little to no survey effort.

One live Snake River physa was recovered by Reclamation in 2006 from the spillway wetland constructed as mitigation for the Inman Powerplant. The macrophytes rooted in fine substrates in the wetland are not considered Snake River physa habitat. Snake River physa distribution into the wetland is only possible via avian transport, human transport, or drift from somewhere upstream. Early reports of the collection of two live Snake River physa above American Falls Dam (Pentec Environmental 1991, pg. 8, 16) have never been confirmed. Recent survey efforts by Reclamation failed to locate Snake River physa upstream of Lake Walcott (Newman, pers. comm. 9 Feb. 2012). In addition, a recent review (Keebaugh *in litt.* 2014) of a large gastropod collection conducted in 2004 in the Snake River and tributaries upstream of American Falls Reservoir did not identify any live-when-collected Snake River physa specimens or shells, providing further strong, although not conclusive, evidence that the species may not occur upstream of Lake Walcott.

2.3.1.5 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 (USFWS 1995, pg. 27)." The primary conservation actions outlined for this species are to "Ensure State water quality standards for cold-water biota…" (USFWS 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 (USFWS 1995, pg. 1)).
- Monitoring populations and habitat to further define life history, population dynamics, and habitat requirements (USFWS 1995, pg. 27-28).

Priority 2 tasks consist of:

- Updating and revising recovery plan criteria and objectives as more information becomes available, recovery tasks are completed, or as environmental conditions change (USFWS 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 here are based on the most recent information on the species' distribution in the wild.

As described in Section 2.3.1.3, the Service has concluded that Snake River physa select for substrates in the gravel to pebble range, and possibly in the gravel to cobble range, in water velocity sufficient to keep these substrates free of fines and macrophytes, and that these conditions represent the species' preferred habitat in conditions extant in the Snake River.

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

2.4.1.1 Status of the Species in the Action Area

As implied by sections 2.1.1 and 2.3.1.4, the entire known range of Snake River physa, including its recovery area, is encompassed within the action area, with the exception of the two live specimens recovered from Bruneau River Arm of C.J. Strike Reservoir. Since the species' general status in the action area was presented in section 2.3.1.4, much of that information will not be specifically repeated here. Rather, this section focuses on additional detail of the species' presence in various segments of the action area.

2.4.1.1.1 Minidoka Reach

The results of Gates and Kerans (2010) substrate sampling in this reach suggests that sand, gravel, and pebble substrates have formed most of the Snake River bed in the Minidoka Reach post-Bonneville Flood. There are a number of long, narrow islands in the reach consisting largely of gravel, pebble, and sand. The presence of at least some of these islands may have resulted from dredge spoils deposited in a large scale attempt to extract fine "flour" gold from this section of the river for several years beginning in 1894 or possibly earlier (Idaho Daily Statesman *in litt.* circa 1899, Dee 1987). Assuming Snake River physa were present at the time, the dredged channels and island deposits certainly impacted the species. The existing configuration of islands and channels may represent a benefit to the species under existing regulated flow conditions in that the presence of the islands has resulted in a narrowing and deepening of some sections of the river in this reach, which may contribute to areas of higher water velocity where preferred habitat is maintained in a suitable condition. However, deposition of the islands may have resulted in an overall reduction in habitat compared to pre-dredging.

Gates and Kerans (2010) found that sampling using the 0.25 m^2 plot method was not feasible in boulder and bedrock habitat (largely encountered in the spillway area, the powerplant tailrace, and between the tailrace and the Howell's Ferry gage) due to confined areas; instead divers collected 60 second timed samples in such locations (Gates and Kerans 2010). From sampling using only the 0.25 m^2 plot method, Gates and Kerans (2010) reported the following recovery of live Snake River physa from their 3-year study:

- 2006 Minidoka Reach, 95 specimens from 115 samples; 17 specimens from 8 samples in the spillway area (snail pool);
- 2007 Minidoka Reach, 140 specimens from 143 samples; 1 specimen from 17 samples in the spillway area (snail pool);
- 2008 Minidoka Reach, 18 live Snake River physa from 113 samples. The spillway area was not sampled in 2008.

Only 3 live-when-collected Snake River physa were recovered using timed samples (Gates and Kerans 2010).

Reclamation, in preparation for their evaluation of the effects of the 4-year incremental reduction in spillway flows (sections 2.1.3.1.3 and 2.1.3.1.4) on Snake River physa in the spillway area (the snail pool), began collecting data on Snake River physa under existing conditions in 2012, with surveys continuing in 2013 and 2014. One permanent and three random transects are surveyed each in the snail pool and in the vicinity of the old Jackson Bridge about 4.6 miles downstream from Minidoka Dam, with 10 randomly selected plots sampled per transect. The Jackson Bridge site was chosen as a control site because: A) live Snake River physa can be recovered there with some degree of dependability, facilitating B) comparisons with monitoring of the species in the spillway area where future total flow is expected to be reduced compared to existing operations. Sampling techniques were identical to those described by Gates and Kerans (2010), allowing comparison with their 2006 and 2007 data. Concomitantly with Reclamation sampling, the USGS samples each sample plot for hydrology and water quality data, including water velocity (measured ~ 10 centimeters above the substrate) depth, temperature, dissolved oxygen, turbidity. In addition, acoustic Doppler profiles are measured to aid in estimating the distribution of velocities across the river bed profile.

Sampling in 2012 was conducted in late August, with 45 live Snake River physa recovered. Analysis of the data (USBR 2013) found no detectable differences in Snake River physa abundance or diversity at the Jackson Bridge site compared to Gates and Kerans (2010) data, suggesting that the colonies in this area of the Minidoka Reach are relatively stable. No live Snake River physa were recovered from the snail pool.

Sampling in 2013 and 2014 recovered 92 and 13 live Snake River physa, respectively, at the Jackson Bridge site, and 2 and 0 individuals in the snail pool, respectively. Reclamation attributes the locations of the random transects and sample plots in 2014 for the low numbers of Snake River physa recovered at the Jackson Bridge site; a higher number of plots were located in depths less than 5.5 feet, and the species is less abundant at those depths in the Minidoka Reach (Newman pers. comm., 2015a).

Fifteen of the 17 live Snake River physa specimens recovered from the spillway area (snail pool) in 2006 were recovered from one 0.25 m^2 plot (Kerans and Gates *in litt.* 2008). Fifteen is the largest number of live Snake River physa recovered from any sampling event from all known collectors, and was equivalent to 60 specimens per m^2, the highest recorded density of Snake River physa. Because of the large number of live specimens recovered from this sample, the snail pool was initially thought to represent a significant portion of the Minidoka Snake River physa population. Recovery of this large number of Snake River physa from the snail pool has never been repeated: Gates and Kerans (2010) recovered one live specimen from the snail pool in 2007. Reclamation has since recovered only 2 specimens from the pool in one of 3 sampling years, suggesting that the pool remains occupied, but there is as yet insufficient data to indicate the area of the snail pool that may be suitable habitat or to estimate Snake River physa abundance in the pool.

2.4.1.1.2 Lower Salmon Falls Reach to Brownlee Reservoir

Downstream of the Minidoka Reach, a total of 13 live-when-recovered Snake River physa were collected but not preserved in 1959 by Taylor (1988, 11 specimens) and in 1988 by Frest (Frest *et al. in litt.* 1991, 2 specimens) between the Malad River-Snake River confluence and Bliss Reservoir (Lower Salmon Falls Reach). Taylor's collection site became the type locality for the species. No shells or live specimens have since been reported from this area, despite considerable survey effort by the Company between 1995 and 2001, and additional surveys in this area conducted in 2004 by Frest and Johannes (*in litt.* 2004). A single live specimen recovered from about a mile below Bliss Dam by the Company in 2002 was identified as a probable Snake River physa, the uncertainty due to a missing portion of the shell.

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 considered the distribution of pebble-gravel habitats within the Lower Salmon Falls Reach and Bliss Reach 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, the lower half of the Bliss Reach (RM 522-546) has a reduced gradient and is more meandering in its character. Gravel and sand represented 51 percent and 59 percent of dominant and co-dominant substrates, respectively, with pebble present as only 3 percent of co-dominant substrates. The high percentage of gravel and sand suggests that roughly half of the substrates sampled in the lower Bliss Reach consisted of gravel embedded in sand. Snake River physa have been recovered from such substrates in low numbers but did not prefer (select for) such substrates. The 63 samples collected by the Company in this reach (Keebaugh 2009, entire documents) and a day's intensive survey effort in and near one of the type localities for this species, recovered no Snake River physa (Frest and Johannes 2004, *in litt.* pg. 11; EcoAnalysts *in litt.* 2011). Considering Gates and Kerans' (2010) conclusion that Snake River physa seems to exist in diffusely distributed populations even in what is apparently preferred habitat (the Minidoka Reach), the rarity of preferred habitat in the Bliss and Lower Salmon Falls reaches suggests a) that the probability of encountering this diffusely dispersed species here is likely quite low; and b) that habitat may be the factor most limiting to the species in these reaches of the river.

The next impoundment downstream of Bliss Dam (RM 560.3) is C.J. Strike Dam (RM 494) and Reservoir. Taylor (1988) reported collection (sometime prior to 1988) of about 200 empty Snake River physa shells from somewhere above Indian Cove Bridge (RM 525.25), a few miles above the upstream end of C.J. Strike Reservoir, suggesting a population somewhere upstream in the ~ 40 mile reach (Bliss Reach) between C.J. Strike Reservoir and Bliss Dam. The single probable specimen recovered from below Bliss Dam in 2002 is the only live specimen other than those identified in 1988 by Taylor and Frest *et al.* (*in litt.*1991) that have been recovered between the Minidoka Reach and C.J. Strike Dam.

Eleven live-when-collected Snake River physa were recovered by the Company in 2001 and 2002 in the 24.6 mile reach between C.J. Strike Dam and the upstream end (RM 469.4) of Swan Falls Reservoir (the C.J. Strike Reach), and one additional specimen was recovered 1.7 miles into Swan Falls Reservoir.

Thirty-six live-when-collected Snake River physa were recovered by the Company between 1998 and 2001 between Swan Falls Dam (RM 457.75) and the upstream end of Brownlee Reservoir (RM 344). Over 44 percent (16 of 36) of the live specimens in the Swan Falls Reach were recovered in a relatively small area (5.8 miles) between RM 420.5 and 426.3 near Marsing, Idaho; seven of these individuals were recovered from one 0.25 square meter (m^2) sample. Eleven live specimens were recovered in the 49 mile reach between RM 417 and RM 367.9, the latter being the downstream-most location where live Snake River physa have been recovered. The remaining nine live specimens were recovered between RM 428.3 and 445.8 (the latter location about 12 miles downstream of Swan Falls Dam).

It is important to note that the difference in numbers of live Snake River physa recovered by Gates and Kerans (2010) in the Minidoka area and by the Company downstream of the Malad-Snake river confluence is likely not a function of sampling effort, i.e., the differences in habitat availability and quality between the two areas are more plausible explanations (see sections 2.4.1.2.1 and 2.4.1.2.2): Gates and Kerans (2010) survey was about double the sampling effort conducted by the Company, but Gates and Kerans recovered 4.8 times more live individuals (Winslow *et al. in litt.* 2011) than did the Company.

There has been no recovery of live specimens below Bliss Dam and downstream of C.J. Strike Dam since 2002. In 2014, the Company began surveying for the presence of Snake River physa in the Swan Falls Reach in compliance with Article 405 of the Federal Energy Regulatory Commission's (FERC) license renewal for the Swan Falls Hydroelectric Project. The Company targeted the sample sites in the Marsing area where Snake River physa had previously been recovered in the highest densities outside of the Minidoka Reach. Based on shell structure and internal morphology, no whole Physa shells or live-when-collected adult Physa specimens from this survey effort were identified as Snake River physa (EcoAnalysts, Inc. *in litt.* 2014). In 2015 the Company submitted live-when-collected juvenile Physa specimens from this sampling effort for DNA analysis to species, with results pending. Also in 2014, the Company conducted surveys for Snake River physa in support of a proposed channel improvement project in the Swan Falls Reach. Based on examination of shell structure, internal morphology, and DNA analysis, all Physa shells and live specimens from these surveys were identified as *P. acuta*.

Company divers confirmed the presence, at the time of the surveys, of suitable Snake River physa habitat at some of the sample plots for both the Swan Falls sites and channel improvement sites (Company unpublished data): presence of gravel to cobble-sized substrates; water velocity sufficient to keep substrates free of fines; and few or no macrophytes present. At some of the plots last sampled in 2002 or earlier, Company divers reported the presence of suitable substrates (gravel to cobble) beneath a shallow layer of sand in 2014, suggesting that in some years water velocity in some previously occupied areas is insufficient to keep those areas free of fines.

2.4.1.2 Factors Affecting the Species in the Action Area

Hydrology affects every physical or biological feature essential to the conservation of the Snake River physa. The hydrologic information in the remainder of this Opinion, including the section on Future Hydrologic Conditions (section 2.4.1.2.3) either uses or comes primarily from current data generated by Reclamation from observed records. Reclamation acquired the simulated records from MODSIM hydrologic model outputs that generate monthly data.

MODSIM is a general purpose river and reservoir operation computer simulations model that includes the river system features of storage, irrigation demand, operational flow objectives, and reservoir content. The 2010 MODSIM model simulates current hydrologic conditions and future hydrologic conditions and analyzes both the naturalized and the modified flows on the mainstem Snake River to Brownlee Reservoir as well as the Boise and Payette River systems. The historical data utilized in the model consist of modified flows from 1928 to 2008. Future simulations are provided for the time period of 2010 to 2039, referred to as the "2020s" because the period of record analyzed is generally centered on that future window. This model has also been used to generate results for the River Management Joint Operating Committee (RMJOC) Climate Change Study (see section 2.4.1.2.3 Future Hydrologic Conditions). Current flow conditions are consistent with those modeled for the 2004 Assessment and are extensively discussed in Chapter 3 of that document.

The model output data for the 2014 Assessment were sorted and categorized into wet (10 percent exceedance), average (50 percent exceedance), and dry (90 percent exceedance) water year types based on the modeled total annual volume into Brownlee Reservoir for the MODSIM proposed action scenario. The wet and dry water year types each constitute 10 percent of the years, whereas the average group of water year types comprises the remaining 80 percent. For each of these categories, the data were averaged for use in the analyses within the action area considered in the 2014 Assessment.

The USGS river gages provide the hydrologic data with the exception of the Snake River at Milner gage, which combines data from Company and Reclamation gages. The period of record used for the Milner gage in this analysis and subsequent discussion is the 1981 through 2010 water years for all gages, using a daily time step. All gages had complete periods of record with the exception of the Snake River at Nyssa gage, which has missing data in water years 1987 through 1989. Summary hydrographs displayed in this section illustrate the maximum, 10 percent, 50 percent, 90 percent, and minimum daily exceedance values for the respective water year.

2.4.1.2.1 Water Quantity and Timing, Current Operations

Minidoka Reach, Minidoka Dam, spillway, and Lake Walcott

Minidoka Dam has been operated with a minimum flow in the winter months (non-irrigation season) of approximately 400 cfs. During the irrigation season, Reclamation uses the downstream diversion demands at Milner Dam and Minidoka Dam to determine American Falls Dam irrigation releases. As diversion demands change, the releases at American Falls Dam are adjusted to maintain Lake Walcott at a constant elevation of 4,245 feet. In 80 percent of years, irrigation releases from American Falls Dam will be at least 11,000 cfs (USFWS 2005). (These releases will more or less match the irrigation diversion capacity at Minidoka and Milner dams).

Minidoka Dam is operated as a run-of-the-river dam to meet downstream demands, primarily irrigation demands but also to deliver storage water leased or rented for use below Milner Dam. A summary hydrograph of the current river flow below Minidoka Dam at RM 674.5 is shown in Figure 3, based on data from the Howell's Ferry gage and taken from the 2014 Assessment. The summary hydrograph shows that the maximum and 10 percent exceedance years are typically reflective of flood control operations. The minimum, 50 percent, and 90 percent exceedance flows display little variation because they reflect dry and average conditions which are highly influenced by irrigation diversions and therefore consistent. Only in the larger runoff years will releases typically exceed irrigation demand, therefore, in the majority of years releases are made for irrigation only and do not vary much despite the water year type. In 50 percent of the years, Minidoka outflow is above 5,000 cfs throughout most of the irrigation season (April 1 through September 30).

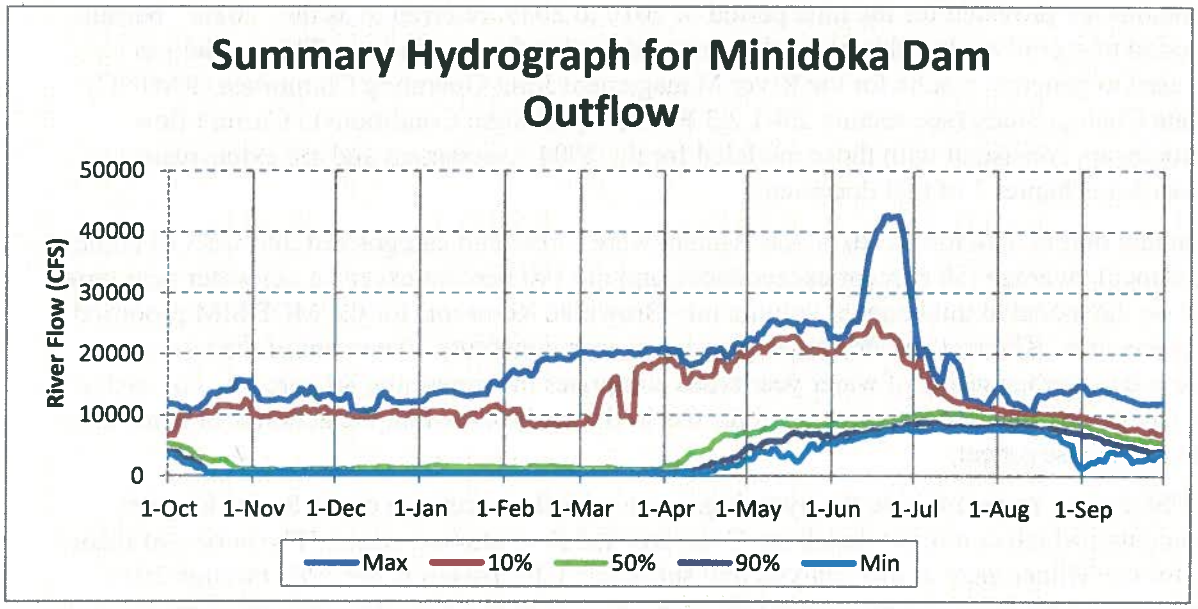

Figure 3. Summary hydrograph for flows below Minidoka Dam. Maximum and 10% exceedance are typical of flood control operations. Minimum, 50% and 90% exceedance are typical of dry and average conditions. Winter flows (which are greater than zero for all scenarios) do not register well on this graph due to the scale (USBR 2014a).

The Minidoka Project was established by Reclamation in 1904, with construction on the dam beginning the same year. Minidoka Dam and the first powerplant were completed in 1906. The spillway was originally designed as an overflow structure without means of regulation of surplus discharge to the river. Due to difficulties experienced in the 1908 water year, the spillway was raised 5 feet in 1909. This new spillway structure consisted of piers on 7-foot centers which were grooved to receive flashboards. The new spillway was very successful but considerable labor was required to operate the flashboards to control river flow. In 1912, Reclamation constructed 4 radial gates to allow operators to regulate the river below the dam without having to manipulate the flashboards. The gates were fully operational in 1913. In 1989, the radial gates were replaced since they had largely surpassed their design life and showed visible damage resulting from regular operations.

Reclamation has recently completed replacement of the spillway portion of Minidoka Dam (March 31, 2015). The new spillway structure will provide greater operational flexibility at the Minidoka Dam site.

Minidoka Dam is operated as a run-of-the-river dam, passing inflow from American Falls to facilitate irrigation deliveries and other downstream demands to Milner Dam. The dam forms Lake Walcott, with a capacity greater than 210,200 acre-feet, which includes an unidentified quantity of dead pool, 115,000 acre-feet of inactive storage and 95,200 acre-feet of active storage. The Minidoka Powerplant was completed in 1906. The Inman Powerplant, a two-unit powerplant, was added in 1997, making the total power generation capacity 28.5 MW, with a combined turbine capacity of approximately 8,850 cfs. Water can be routed through turbines in the two powerplants, through the existing and new spillway radial gates, and over the spillway.

The partitioning of flows between the powerplant and spillway depends on the time of year, total inflow, and associated demands.

As a result of adding the Inman Powerplant in 1997, Reclamation entered into several environmental commitments to benefit biotic resources in the spillway area, including meeting the following minimum spillway flows during the irrigation season:

- April 15 through June 30: 1,300 cfs
- July 1 through August 31, flow increased to: 1,900 cfs
- September 1 through September 15: 1,300 cfs
- April 1 through April 14 and September 16 through October 31:
  - First 5,023 cfs through the powerplant
  - Next available 1,300 cfs over the existing spillway
  - Flows in excess of 6,335 cfs (5,035 + 1,300 cfs) routed through the powerplant up to plant capacity
  - Additional flow above plant capacity is discharged over the existing spillway

A portion of the spillway flow also originated from seepage through the old spillway structure. Additionally, a pipeline from the Inman Powerplant headworks feeds a wetland that was constructed as part of mitigation for the powerplant.

Prior to construction of the new spillway, after irrigation season Lake Walcott was held between elevation 4239.5 feet and 4240.0 feet because of the deteriorated structural condition of the old spillway, thus bringing the water surface elevation below the overflow structure. Prior to the onset of irrigation season each year, Lake Walcott was returned to full-pool elevation. No controlled releases have been provided through the spillway structure outside of irrigation season, although water did seep through cracks in the structure year-around, as well as through the flashboards during irrigation season. Reclamation attempted to quantify flows as a result of structural leakage from the old spillway structure in 2010 and 2011 by visually observing, tracking, and measuring flows through the spillway area during the winter months outside of irrigation season. Flows did not appear to seep into the spillway area from any location with the exception of cracks in the structure, and total cumulative recorded flows were always less than 1 cfs.

The physical condition of the old spillway structure constrained winter operations because the spillway crest was not capable of resisting the loads imposed by ice on the reservoir surface. Additionally, if water was stored above the crest, leakage through the joints of hundreds of boards would have caused an unmanageable accumulation of ice immediately below the structure. In the winter, the radial gates are the only path for water releases from the old structure because the reservoir was drawn down 5 feet to an elevation below the base of the flashboards. In dry winters, no water was spilled through the radial gates. Occasionally, during wet winters, powerplants alone cannot accommodate all of the flow, thereby requiring the use of the radial gates.

Figure 4 shows a summary hydrograph of Reclamation operations at Minidoka Dam and Lake Walcott (USBR 2014a). The target refill date for Lake Walcott is April 1 or the beginning of the irrigation season. Lake Walcott is filled by moving water from American Falls to prepare Lake Walcott for irrigation deliveries to the Minidoka North and South Side canals. The lake is filled to an elevation of 4245 feet and is held throughout the irrigation season at this level by passing inflows from American Falls into the Minidoka North and South side canals and downstream into the river to meet Milner demands. This 4245 foot elevation corresponds to holding the full 95,200 acre-feet of active storage in the reservoir during the irrigation season. At the end of the irrigation season, Reclamation has been lowering the level of Lake Walcott to 4240 feet elevation to avoid ice damage to the structure. This drawdown occurred every year under historical conditions. When the winter level is reached, the irrigation season has ended and flows over the Minidoka spillway are shut off. During dry years, Reclamation may draw down Minidoka Reservoir early to use the storage for irrigation deliveries to the Milner canals, but otherwise will keep Lake Walcott at full pool (see Proposed Action).

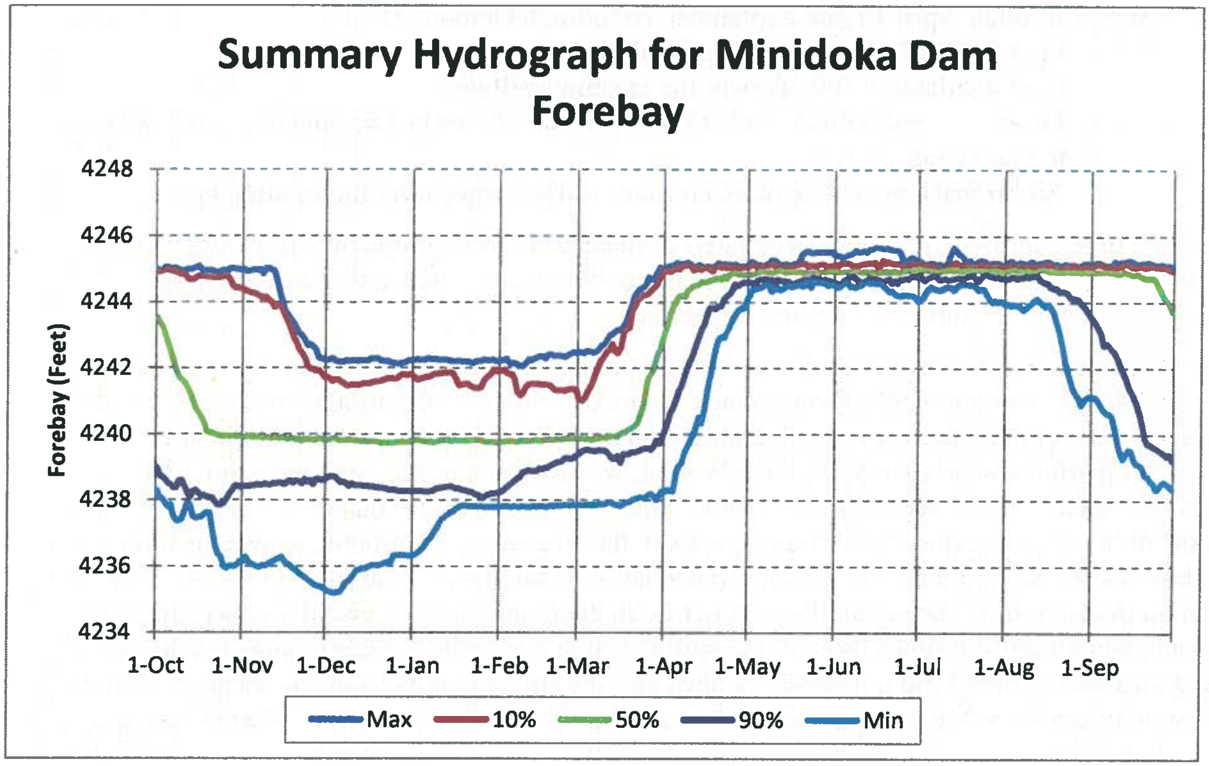

Figure 4. Summary hydrograph for Lake Walcott operations. Maximum and 10% exceedance are typical of flood control operations. Minimum, 50% and 90% exceedance are typical of dry and average conditions (USBR 2014a).

As displayed in Figure 3, June through September releases from Minidoka Dam to the river exceed 7,000 cfs in about 80 percent of the years. During the winter months, Reclamation passes inflow from American Falls. The winter flow out of American Falls Reservoir (established at a minimum of 350 cfs) is reduced to allow for winter and spring filling of the American Falls Reservoir and the other large reservoirs upstream in the Snake River Basin. In addition to the 350 cfs minimum, the typical winter reach gain from American Falls to Lake Walcott is 135 to 190 cfs, resulting in a typical winter release through (usually) the Minidoka Dam powerplant of at least 500 cfs. However, releases from Minidoka Dam have historically been as low as 400 cfs in 10 percent of the years. This recorded minimum flow is comprised of both powerplant and spillway flows as well as subsurface seepage. The minimum flow of 425 cfs through Minidoka Dam is required to provide for the electrical requirements within the Minidoka Dam facility.

As previously described in section 2.3.1.3, Gates and Kerans (2010) determined that the seasonal (winter, or non-irrigation season) de-watering of the Minidoka Reach had long term effects on the mollusk community, with few specimens or species recovered from the de-watered area of the river bed. Gates and Kerans found the following results (derived from data and analyses from Gates and Kerans [2010 and 2014]) specific to Snake River physa presence in permanently wetted and seasonally de-watered habitat:

- 243 0.25 m^2 plot samples were taken in permanently wetted habitat, and 153 were taken in seasonally de-watered habitat;
- 261 live Snake River physa were recovered from 28.4 percent (69 of 243) of samples taken in permanently wetted habitat, and 10 live Snake River physa were recovered from 5.9 percent (9 of 153) of samples taken in seasonally de-watered habitat;
- Only 3.7 percent (10 of 271) of live Snake River physa recovered in the Minidoka Reach (not including the spillway area) came from seasonally de-watered habitat.

While proposed minimum flows will result in an annual reduction of Snake River physa habitat, the data suggests that the potential for actual number of Snake River physa individuals to be directly impacted by the decrease to the proposed minimum flow may be low.

The partitioning of annual flows between the powerplant and the spillway as described in this section has resulted in the establishment of a variety of habitat types within the spillway area, including narrow wetlands and pools separated by elevation breaks through which water empties from one pool into the next at higher velocity, which together support a wide variety of terrestrial and aquatic life. The variety of habitat types is in part a function of the geology of the immediate area that includes the dam and spillway. The immediate vicinity of the spillway area consists of a broad, relatively undissected plain formed by Quaternary fluid basalt lava flows. Interlayed within the basalt flows are discontinuous inter-flow zones comprised of both naturally occurring sediments resulting from deposition at the time of the lava flow as well as sediments transported via current system operations. The consolidated basalt substrate of the spillway area does not possess the physical attributes typically associated with Snake River physa colonization. Unconsolidated materials located within the discontinuous interflow zones provide the appropriate substrate of gravels with intermittent cobbles and pebbles. This substrate, however, only provides suitable habitat in the presence of flows sufficient to provide the conditions necessary for Snake River physa colonization as described in section 2.3.1.3. Much of the higher water velocity areas occur over the solid basalt substrate. The portions of the spillway area where higher velocities intersect the unconsolidated materials (small gravels to medium cobbles) within the inter-flow zones produce the habitat requirements thought to be necessary for Snake River physa colonization, largely located in the snail pool. Topography and elevation changes result in turbulent flow upstream of and in the upper portions of the snail pool, which leads to increased dissolved oxygen in the pool and over suitable Snake River physa habitat in the pool.

The availability of this habitat type is very limited within the spillway area, but it remains watered year-round. USGS acoustic Doppler profiles taken in the snail pool along the transect where live Snake River physa were recovered in 2013 indicate that the sample plots where Snake River physa were found were associated with water velocities greater than 0.5 m/s and depth greater than 1.3 m (USBR 2014a). The small size of the snail pool, approximately 1 acre, likely with even less area of suitable habitat, apparently supports low numbers of this diffusely dispersed species, which makes detection difficult and inconsistent.

As stated on page 26, Reclamation determined that winter flow into the spillway area seemed to always be less than 1 cfs, and apparently resulted from seepage through cracks in the spillway structure. Snake River physa appear to persist in the snail pool in the absence of high water velocities during winter. Plausible explanations for their persistence through winter is that a) the spillway and dam are effective sediment traps, limiting the amount of fines that might accumulate in the pool inter-flow zones, and b) typical non-winter flows into the spillway area and the velocity of water feeding into the snail pool are sufficient to remove fines that might accumulate in Snake River physa habitat. Dissolved oxygen would be expected to drop in winter, but as a poikilotherm the species' metabolic needs would also be diminished due to the colder water, reducing the potential for impacts from lower dissolved oxygen.
Winter operations do not completely dewater the spillway area. Pools within the spillway area remain filled outside of irrigation season. Although no controlled releases are provided outside of irrigation season, structural leakage (<1 cfs) provides flows through the spillway area, including the snail pool. Once irrigation deliveries cease, spillway pool water surface elevations drop to the point where the pools no longer spill, and remain at this level until the next irrigation season. This suggests flows are not lost from the spillway area via seepage and the small flows into the spillway area are sufficient to maintain pool elevation outside of irrigation season.

The actual wetted footprint of the spillway area, including the snail pool, does change, however, under existing operations. Figure 5 depicts the wetted footprint of the spillway area as determined by Reclamation using aerial photos taken under five different flows through the spillway area. The spillway area encompasses roughly 60 acres, depending on how the area is delineated. A reduction in flow from 1,900 to 500 cfs results in a loss of 8 acres of wetland in the spillway area, 6.25 acres of which are rock. A cessation of winter flows, as occurs under current operations, will de-water an additional but unknown amount of habitat. Visual inspection of Figure 5 indicates that wetted habitat loss in the snail pool will be minimal. However, it is possible that during the irrigation season Snake River physa individuals may disperse into those areas in the spillway that are dewatered at the end of irrigation season.

As stated in section 2.1.3.1, upstream of Minidoka Dam the aggregate of in-stream natural hydrologic conditions plus in-stream effects of Reclamation's operations in this portion of the Snake River are funneled into American Falls Reservoir. Reclamation calculated a general comparison between the effect of their current operations on flows passing Minidoka Dam and estimated natural flows, that is, flows without human influence (Figure 6), using monthly averages from 1988 to 2013 derived from the Howell's Ferry gage. As is apparent in Figure 6, current operations upstream of Minidoka Dam (which includes water diverted into the North Side and South Side canals at Minidoka Dam) result in reduced flows in the Minidoka Reach in all months compared to the estimated unregulated flows, representing some probable reduction in Snake River physa habitat. The reduction from irrigation season flows down to winter season flows of between 400 and 600 cfs also results in a probable reduction in Snake River physa habitat. Gates and Kerans (2010) reported that the majority of mollusk species (8 of 10), including Snake River physa, recovered during their study periods (August [during irrigation season] of 2006-2008; and October [non-irrigation season] of 2006-2007) were found less frequently in the area of river bed that is annually dewatered, even though this portion of the channel is available to them during the warmest part of the year when reproduction (and associated increases in numbers) would be expected to occur. This large reduction in flows between irrigation and non-irrigation seasons has been occurring relatively consistently for approximately a century. One hypothesis explaining the infrequent use of the annually dewatered areas by 8 of the 10 species present is that this behavior is an adaptation to the consistent change in flow conditions over time. Gates and Kerans also reported differences in substrates and water velocity between annually watered and de-watered areas of the channel, with dewatered areas containing more fines and experiencing lower water velocities. A second hypothesis explaining the behavior may be simply that most of the mollusk species that happen to inhabit that section of the Snake River prefer gravel to pebble-sized substrates occurring in areas of higher water velocity.

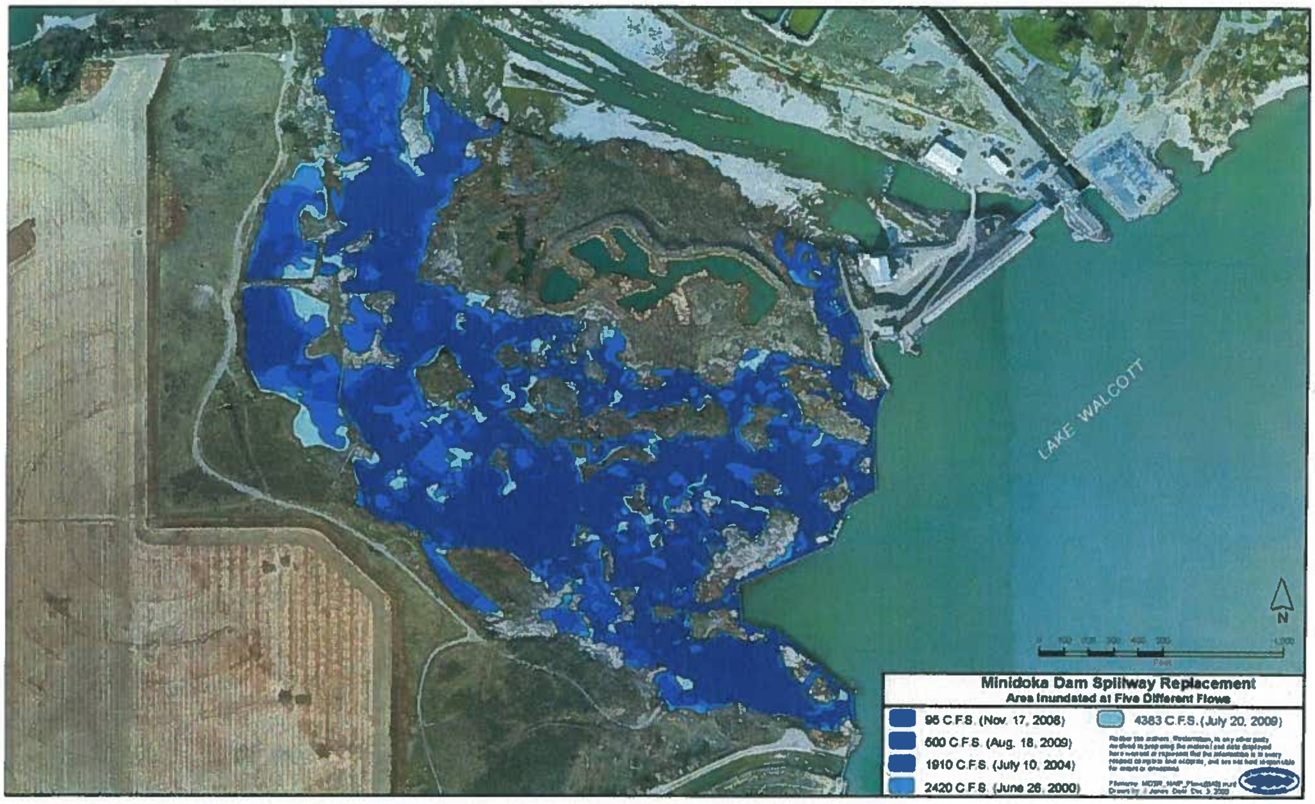

Figure 5. Minidoka Dam spillway area inundated at five different flow levels (USBR 2014a).

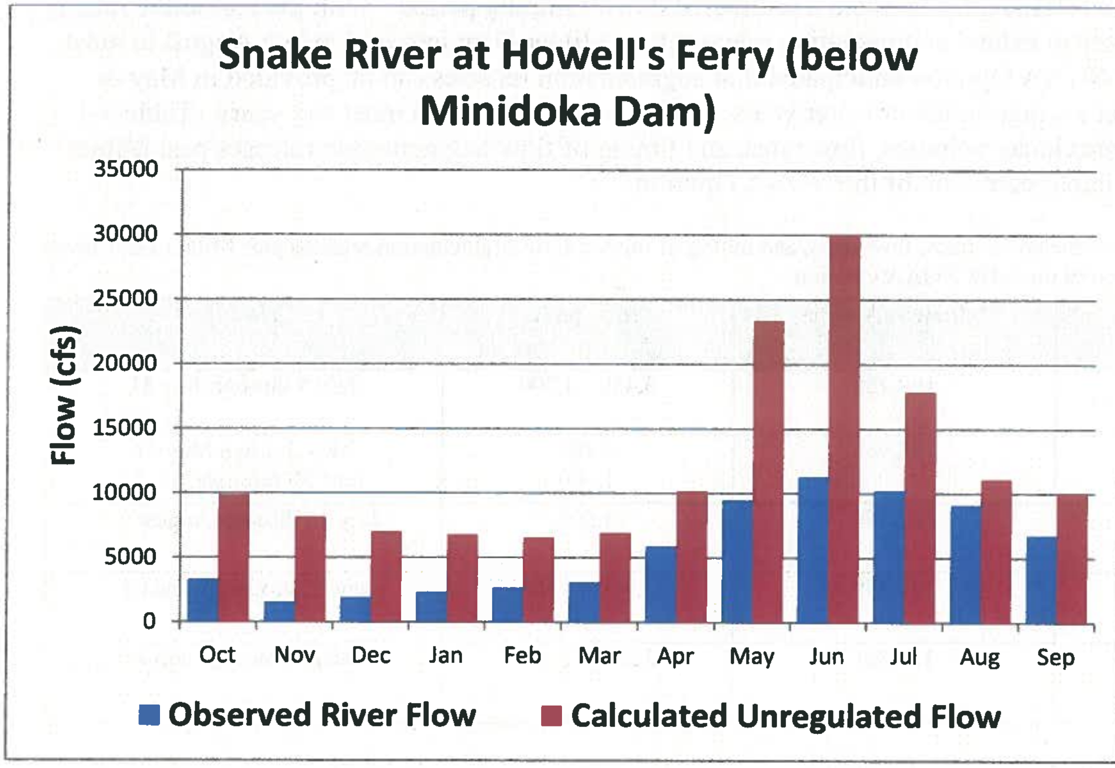

Figure 6. A comparison of observed and calculated unregulated flow in the Snake River at Howell's Ferry gage, using flow data from 1988-2013 (USBR 2014a).

Salmon Flow Augmentation

Reclamation annually provides up to 487,000 acre-feet of water from the Snake River above Brownlee Reservoir, intended to benefit ESA-listed anadromous fish species in the lower Snake and Columbia Rivers. The amount that is provided from above Milner Dam is variable each year depending on water year type, amounts available from the Water District 1 rental pool, and hydrologic conditions in other source basins. Reclamation's delivery and timing of flow augmentation water is described in their 2007 Assessment (USBR 2007) and is incorporated in the 2008 NOAA Fisheries Biological Opinion [NOAA 2008 (NOAA Opinion)] and Incidental Take Statement for O&M of Bureau of Reclamation Projects in the Snake River basin above Brownlee Reservoir (NOAA 2008).

In its 2007 Assessment, Reclamation committed to shifting releases to earlier in the migration season when Snake River flows are more beneficial to listed fish. The primary goals of the earlier releases are to more closely coincide with fish migration and to minimize the amount of warmer water provided in August, shifting releases to July or earlier. The opportunity and ability to shift the releases varies depending on the water year type, total augmentation volume available, and the basin the augmentation originates from.

The primary strategy for shifting augmentation releases in the upper Snake River basin above Milner involves higher release rates and a relaxation of down-ramping criteria at the conclusion of augmentation. Formerly, the down-ramping rate of 100 cfs per day was very restrictive and forced lower release rates to avoid a protracted down-ramping period. With the restrictive rate, it was necessary to extend augmentation releases past Milner Dam into mid to late August in most years. The NOAA Opinion anticipated that augmentation releases can be provided in May or June in most average or lower water years, and by the end of July in most wet years. Table 3-1 lists the approximate volumes, flow rates, and timing of flow augmentation releases past Milner Dam since implementation of the NOAA Opinion.

Table 3. Approximate volumes, flow rates, and timing of salmon flow augmentation releases past Milner Dam since implementation of the 2008 NOAA Opinion.

Year	Volume (acre-feet)	Rate (cfs)	Timing
2009	199,758	3,450 - 4,200	July 5 through July 31
2010	198,966	3,200 1,600	May through May 31 June 30 through July 14
2011	207,500	3,500	July 28 through August 26
2012	190,179	3,500 - 4,500	June 9 through August 26
2013	154,885	2,250 – 2,400	May 1 through Jun 4

Snake River above Brownlee Reservoir

In addition to Reclamation's impoundments in the Upper Snake River basin upstream of American Falls Reservoir, there are a large number of privately held natural flow water rights in the Snake River mainstem and tributaries that divert a substantial volume of water before streamflow released from Reclamation's upper impoundments reaches American Falls Reservoir. Releases from American Falls Dam are controlled to fulfill irrigation demands at the North Side and South Side canals at Minidoka Dam, and to provide sufficient flow to meet irrigation demands at Milner Dam.

Reclamation regulation of the Snake River upstream of Milner Reservoir is primarily to satisfy irrigation demands in the Snake River plain, with a control point at Milner Dam where system storage and flood control operations are balanced to maximize storage in the system above this point. Milner Dam is owned and operated by Milner Dam, Inc., for the benefit of water users receiving their natural instream or storage water rights via the diversions at Milner Dam. Four canals and three pump stations at Milner Dam provide a total diversion capacity exceeding 11,000 cfs. Reclamation owns and operates the headgate at the Milner-Gooding Canal (1,600 cfs capacity) at Milner Dam. In 1976 the Idaho Water Resource Board (IDWRB) adopted the concept of zero minimum flow at Milner Dam as a means of "formalizing the management of the Snake River as 'two rivers'. This policy provides for the optimum development of the surface and ground water resources tributary above Milner Dam, and protects water users above Milner Dam from administration stemming from surface and ground water uses from sources tributary to the Snake River below Milner Dam" (IDWRB 2012). When Milner Dam is operated for irrigation demand only, zero flow is delivered to the river below the dam. Hydrographs of mean daily discharge by year from 1990 through 2013 (not shown) derived from the USGS gage # 1308000 (Milner Gage) data show that outflows from Milner Dam can vary widely during a given irrigation season, ranging from zero to well over 10,000 cfs, as a result of salmon flow augmentation, wet or dry water years, and due to manipulation of the canal intakes above Milner Dam to meet various irrigation and storage needs.

The summary hydrograph in Figure 7 shows flows in the river below Milner Dam at RM 638.7 (USBR 2014a). This flow is a combination of releases through the Idaho Power Hydropower Facility and releases to the river in the canyon directly below the dam. The flows are represented together because they combine approximately 1-mile downstream from the dam and form the total discharge in the downstream section of the Snake River. As suggested by Figure 7, with increasing precipitation (≥ 50 percent exceedance), some of the effects of hydrologic conditions and from Reclamation's upstream operations (separate from salmon augmentation flows) are passed downstream through Milner Dam.

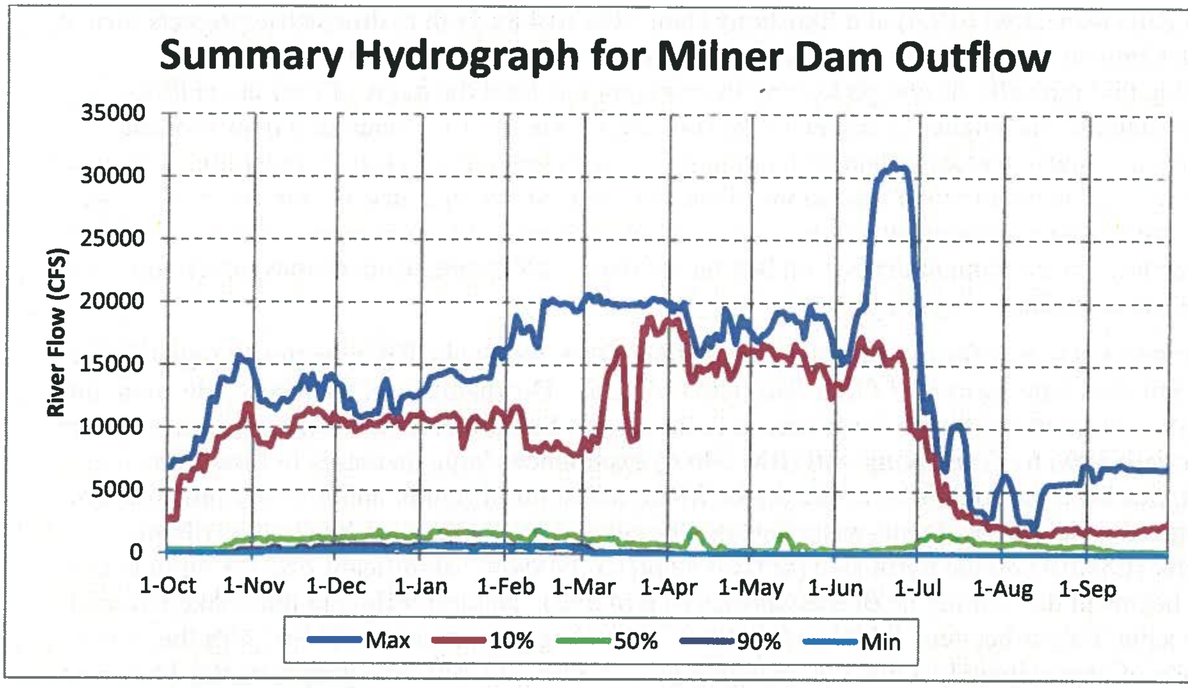

Figure 7. Summary hydrograph for flows below Milner Dam (USBR 2014a). Maximum and 10% exceedance are typical of flood control operations. Minimum, 50% and 90% exceedance are typical of dry and average conditions. Diversion of most—or the entire—flow of the Snake River into irrigation canals at Milner dam April 1 to November 1 accounts for the difference between Milner outflow and Minidoka outflow for those months. Summer flows for minimum and 90% exceedance frequently are 300 cfs or less, and may approach zero, although the scale prevents that degree of resolution in the graph.

The 22 mile reach of the Snake River downstream between Milner Dam (RM 639) and the Twin Falls (RM 617.3) (*the Twin Falls* refers to the geographic feature on the Snake River named the Twin Falls, not the city of Twin Falls) is called the Murtaugh Reach. The Murtaugh Reach has been heavily impacted by operations at Milner Dam since completion of the dam in 1905, experiencing long periods of low flow (including zero flow in areas nearer Milner Dam) and abrupt changes in flow (Milner Gage mean daily discharge data). The USGS gage #1309000 (Kimberly Gage), located about 0.25 miles downstream of the Twin Falls, records gains from agricultural returns and springs estimated between 200 and 250 cfs in the Murtaugh Reach, i.e., when flows at the USGS Gage #13088000 (Milner Gage) are zero, the Kimberly Gage records flows of ~ 200-250 cfs. The lowest flows in the reach would be nearest Milner Dam, with flow increasing from reach gains as the river approaches the Twin Falls. Mapping efforts to locate tributary, agricultural, and industrial return flows, reported in 1993, located 243 springs and 105 agricultural points of return flow to the Snake River between Milner Dam and Buhl, Idaho, with most of the agricultural returns located between Milner Dam and the city of Twin Falls (Maupin 1995). Irrigation water returned to the Snake River has been nutrient enriched (nitrogen and phosphorus) from agriculture and usually contains elevated sediment loads (Clark *et al.* 1998, p. 3).

Snail surveys in the Murtaugh Reach have been sporadic and have found no live Snake River physa. One possible Snake River physa shell has been reported from within the reach, but it is assumed to have been washed downstream from the Minidoka Reach.

Twin Falls Dam (RM 617.4) and Shoshone Dam (RM 614.8), both hydroelectric projects owned by the Company downstream of the Murtaugh Reach, are operated in run-of-river mode, meaning that typically discharge leaving the powerplants (and the dams, if they are spilling water) matches instantaneous inflow to the reservoirs. Run-of-river operation does not lead impacts to aquatic species or habitat from large fluctuations in river stage or reservoir level as do hydroelectric load-following operations. However, during average, dry, or minimum flow years run-of-river impoundments do reduce water velocity, which leads to increased water temperatures and sediment deposition behind the dams, which create conditions not conducive to the presence of Snake River physa.

In periods when zero flow is released from Milner Dam, the Snake River begins to regain large river function downstream of Pillar Falls (RM 613.25). Downstream of the Twin Falls area, the 66 mile section of the Snake River (includes the Lower Salmon Falls and Bliss reaches) between Pillar Falls (RM 613) and King Hill (RM 546.6) experiences large increases in flow from tributaries from the south side of the Snake River, agricultural return, and inflow from cold-water spring-fed tributaries and cold-water springs emerging from the Eastern Snake River Plain Aquifer (ESRPA) on the north side (or river right) of the river. Significant ESRPA input to the river begins in the vicinity of Briggs Springs (~ RM 592). Natural inflow to the Snake River in this section ranges between 5,000 and 6,000 cfs (Bowling pers. comm., 2015a), with the largest fraction of approximately 4,500 cfs (Bowling pers. comm., 2015a) emerging from the Thousand Springs area and consisting of spring water of generally high quality, although many springs have elevated nitrate levels (Clark *et al.* 1998).

As described in section 2.4.1.1.2, low abundance of Snake River physa in the Lower Salmon and upper Bliss reach may be attributed to the low occurrence of preferred habitat. Hydropower operations may also affect the species in these reaches. The Company-owned Upper Salmon Falls Dam is also operated in run-of-river mode, but the two Company dams downstream (Lower Salmon Falls Dam and Bliss Dam) are operated in load-following mode in order to meet peak hydropower demands and to store water in the reservoirs when demand is low. Lower Salmon Falls and Bliss dams are designed to work together as well as in conjunction with the Company's C.J. Strike Dam to respond to short-term fluctuations (typically 24 hours) in power demand. This flexibility in power generation leads to fluctuations in river stage and reservoir levels which may be rapid and do not reflect ambient river flows to which Snake River physa have evolved or adapted. Rapid river and reservoir fluctuations affect both riparian and shallow-water benthic habitats, and may have effects throughout the river and riparian food webs. The work of Gates and Kerans suggests that if Snake River physa are indeed present in these reaches, they would be more abundant at depths below the fluctuation zones, but similar to what occurs in the Minidoka Reach, some individuals could be impacted if they venture into fluctuation zones that would be de-watered by load-following.

Load-following does occur in the King Hill area but is of a lower magnitude compared to upstream. Because flows at King Hill are largely comprised of aquifer discharges with some irrigation returns, which are relatively consistent, the lower magnitude of load-following, as measured at the USGS gage # 13154500 (King Hill gage), results in more stable flows throughout the year, with the exception of flood conditions (maximum exceedance), wet years (10 percent exceedance), or salmon flow augmentation. A comparison of the Milner Dam and King Hill hydrographs (Figure 7 and Figure 8) show that for 50 percent of the years, the effects flow releases at Milner Dam are relatively small compared to the Snake River flows at King Hill and do not have a major impact on the flow in the lower section of the Snake River, due largely to the frequency of zero flow past Milner Dam.

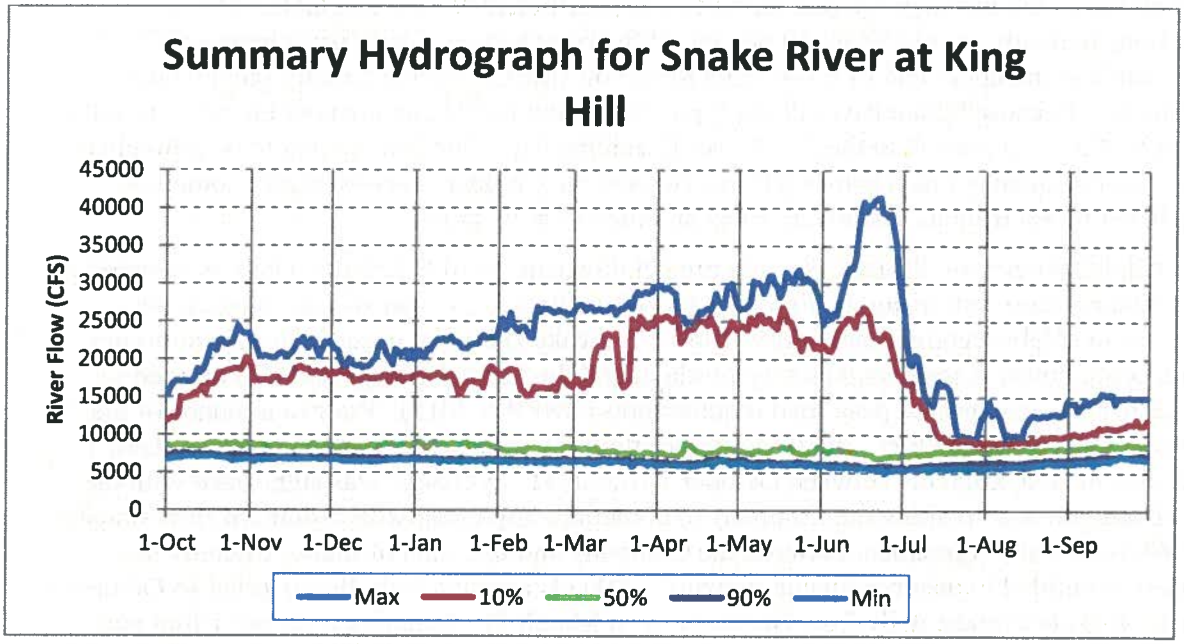

Figure 8. Summary hydrograph for flows at King Hill. Maximum and 10% exceedance are typical of flood control operations. Minimum, 50% and 90% exceedance are typical of dry and average conditions (USBR 2014a).

As described in section 2.4.1.1.2, based on Company survey data from 2002 and earlier the lower Bliss Reach downstream of King Hill likely contains little habitat preferred by Snake River physa. This also includes the area (upstream of the Indian Cove Bridge) where Taylor (1988) collected 200 empty shells he identified as Snake River physa, but given the distance empty shells can be transported, their place of origin cannot be determined. Google Earth images show a more limited amount of agriculture bordering this area of the Snake River and presumably less irrigation return to the river (and hence less nutrient enrichment and less sediment input) compared to the area between Bliss Dam and Milner Dam. Irrigation in this area relies on groundwater pumping and/or water drawn from the Snake River between King Hill and C.J.

Strike Dam. Irrigators relying on the latter in any given year will have available to them the difference between the 5,000-6,000 cfs recharge to the river between Pillar Falls and King Hill, and the Company's 3,900 cfs water right (affirmed as unsubordinated under the 1984 Swan Falls Agreement with the State of Idaho); water users in this area cannot call for water from above Milner dam (Bowling pers. comm., 2015a, b). We were unable to determine the amount of irrigation return water entering this section of the Snake River. Other than Taylor's 1988 report and the Company's survey data between 1997 and 2002, the Service has little information regarding Snake River physa and factors affecting the species between King Hill and C.J. Strike Reservoir.

C.J. Strike Dam (RM 494) is also operated for load-following. Ramping rates for load-following are constrained by the FERC license to changes in stage height of 2.5 feet per hour and 4 feet per day. The total hydraulic capacity of the three C.J. Strike turbines is 15,500 cfs. Due to loss of efficiency at discharge less than full capacity, the turbines are usually run at full capacity for longer periods. The range of flows from C.J. Strike dam may vary nearly three-fold over 24 hours in low and median water years (approximately 5,000 to 15,000 cfs). In high-water years, two or all three turbines may run continuously when sufficient flow is available. The fluctuations typically expose about 10 percent of the river bed on a daily basis between C.J. Strike Dam and the upper end of Swan Falls Reservoir (the C.J. Strike Reach), the next dam downstream. Because Snake River physa typically inhabit the deeper areas of the river, usually ≥ 1.5 m (4.9 feet), if present in the C.J. Strike Reach the daily fluctuations would be unlikely to expose most (though not necessarily all) individuals; the Company has recovered some live Snake River physa from as shallow as 1 foot in other areas of the river.

Swan Falls Hydroelectric Project, the next project downstream of C.J. Strike Dam, is operated as a re-regulating reservoir, using the limited 3 feet of available reservoir storage capacity on a daily basis to safely accommodate inflow from C.J. Strike Dam that exceeds license minimums. Hydroelectric power is generated as a by-product, and the limited storage can also be used to meet short-term, unexpected peak load requirements (USFWS 2012). Prior to issuance of the new Swan Falls license (FERC 2012), minimum flow releases were 5,000 cfs between April 1-September 30, and 4,000 cfs between October 1-March 31. A change was authorized with the 2012 license renewal to allow the Company to come into alignment with minimum flow stated in the 1984 Swan Falls Agreement between the Company and the State of Idaho, whereby the Company is entitled to unsubordinated rights of 3,900 cfs average daily flow April 1 to October 31, and 5,600 cfs average daily flow November 1 to March 31. Ramping rates are 1 foot per hour and 3 feet per day. The Service considers it likely that the difference in water velocity between the license minimums of 5,600 cfs and 3,900 cfs in the Swan Falls reach will result in water velocities at the substrate level in depths preferred by Snake River physa that may be insufficient to keep potentially suitable habitat free of fines on a sufficiently regular basis to prevent macrophyte establishment (see expanded discussion under section 2.4.1.2.2 Water Quality).

In our 2012 Opinion for relicensing of the Swan Falls hydroelectric project, we used mountain whitefish (*Prosopium williamsoni*) spawning habitat as a surrogate for estimates of Snake River physa habitat downstream of Swan Falls Dam, based on the work of Anglin *et al.* (1992) and Brink (2008), due to similarities between the two species' use of habitat parameters related to depth, water velocity and substrate size. Anglin *et al.* (1992) conducted in-stream flow studies in the Snake River to develop habitat suitability criteria indices for life stages of six fish species occurring downstream of Swan Falls Dam, including mountain whitefish. The index for mountain whitefish spawning habitat has considerable overlap with Snake River physa habitat in terms of water velocity, depth, and substrate size as described in section 2.3.1.3 of this Opinion. The mountain whitefish index ratings (**bold**) for these factors are (Anglin *et al.* 1992):

- Mean water column velocity: **1.0** at approximately 0.55 m/s (index is **0.0** at both 0.0 m/s and 1.0 m/s, with the shape of the curve symmetrical)
- Depth: **0.0** from 0.0 to 0.1 m, **1.0** at 0.25 m up to 3.0 m
- Substrate size: **0.9** for cobble, **1.0** for gravel (Anglin *et al.* did not have a substrate category between gravel and cobble, so one or both of these categories likely includes pebble-sized substrates as delineated by Cummins (1962).

Using the habitat suitability criteria indices, Anglin *et al.* (1992) then estimated area of useable habitat in hectares (ha) in the river between Swan Falls Dam and Brownlee Reservoir for life stages of the six species, including mountain whitefish spawning habitat, and modeled useable habitat against flow ranging between 3,000 to 15,000 cfs. Brink (2008) used Anglin *et al.*'s (1992) data, substituting substrates present for macro-habitat area used by Anglin *et al.*, to model the effects of different water years on useable habitat for two of the species studied by Anglin *et al.*, including mountain whitefish and its spawning habitat. Results from Anglin *et al.* (1992) and Brink (2008), together with discharge and stage height data from the Murphy gage, are in Table 4.

Table 4. Total useable habitat area (ha) for mountain whitefish (MWF) spawning habitat at a range of discharges modeled for the area between Swan Falls Dam and the Boise River confluence with the SnakeRiver. Modified from USFWS (2012).

	Swan Falls Dam to Walter's Ferry Bridge[1] RM 457.7-441.9		Walter's Ferry Bridge to the Boise River[2] RM 441.9-395.5		
Discharge cfs	Stage Height (ft), Murphy Gage	MWF spawning habitat (ha)	Stage Height (ft), Murphy Gage	MWF spawning habitat (ha)	Total habitat (ha)
3000	--[4]	2.0	--	708.1	710.1
3900[3]	2.4	2.7	2.4	724.2	726.9
4000	2.5	2.7	2.5	727.3	730.0
5000	2.80-2.92	3.1	2.80-2.92	735.9	739.0
5600	3.0	3.4	3.0	739.3	742.7
6000	3.31-3.34	3.7	3.31-3.34	790.4	794.2
7000	3.6	4.4	3.6	932.2	936.6
8000	3.85-4.03	5.1	3.85-4.03	976.3	981.3
9000	4.1	5.7	4.1	933.8	939.5
10000	4.49-4.5	6.3	4.49-4.5	864.9	871.2
11000	4.83-4.85	7.1	4.83-4.85	787.3	794.4
12000	5.18-5.2	7.9	5.18-5.2	722.5	730.4
13000	5.52-5.55	8.7	5.52-5.55	646.5	655.2
14000	5.9	9.6	5.9	580.0	589.6
15000	6.21-6.24	10.5	6.21-6.24	520.4	530.8

[1] From Brink (2008)
[2] From Anglin *et al.* (1992)
[3] Minimum flow from the 1984 Swan Falls Agreement
[4] No data available

As indicated in Table 4, the amount of potential Snake River physa habitat (using mountain whitefish habitat as a surrogate) is limited between Swan Falls Dam and the Walter's Ferry Bridge, with only 10.5 ha available at 15,000 cfs. The limited habitat is likely due to the high gradient and confined nature of this reach. The canyon in this reach is steep-walled and lined with large boulders and cobble banks, and the channel is narrow and incised, and connects numerous turbulent runs and rapids mixed with intermittent deep pools (Brink 2008). This description is similar to the river character in the Lower Salmon Falls and Bliss reaches, where gravel and pebble substrates are also limited. Hectares of Snake River physa habitat in this reach increase linearly with flow. The estimated amount of potential Snake River physa habitat between Walter's Ferry Bridge and the Boise River is much greater, and peaks at 976.3 ha (about 3.8 square miles) at 8,000 cfs. This reach of the Snake River includes the 5.8 river miles where 16 of the 36 live Snake River physa collected between Swan Falls Dam and Brownlee Reservoir were recovered.

In wet years, when excess flow is passed downstream of Milner Dam, available habitat may decrease as flows rise above 8,000 cfs. In dry years or in periods when flow downstream of Milner Dam is zero, habitat will decrease as flow decreases toward the Swan Falls Agreement minimum of 3,900 cfs downstream of Swan Falls Dam. Since water velocity affects river bed stability, and changes in flow may change the location of wetted area of habitat available, habitat that is lost as flow rises above 8,000 cfs may not be the same habitat lost as when flow drops below 8,000 cfs. Hence, the amount of estimated habitat available indicates little about how connectivity of habitat patches may change with flow. Because mountain whitefish are far more mobile than Snake River physa, they can forego patches of spawning habitat that have become unsuitable due to increased water velocity or to sediment deposition as water velocity decreases, and seek out new areas in which to spawn made available by changes in water velocity. Far less mobile, Snake River physa may not easily move to habitat, made newly available by changes in water velocity, which is not connected to where they already are. Hence, due to the difference in mobility between the two species, estimates of mountain whitefish spawning habitat may overestimate the amount of habitat that may actually be available to Snake River physa over the range of flows in Table 4. Differences in use of shallow habitat between the two species may also lead to an overestimate of habitat available for Snake River physa. The depth criteria index for mountain whitefish spawning habitat is 1.0 between depths of 0.25 m and 3.0 m, but Snake River physa in large numbers are typically found deeper than 1.5 m. Some loss of spawning habitat might result from shallow gravel-pebble beds being exposed as water levels drop, but few Snake River physa would be expected to inhabit the shallower areas. However, decrease in discharge and water level is accompanied by decrease in water velocity, which may affect the suitability of deeper habitat for Snake River physa.

Despite that overlap in habitat requirements between the two species is not one to one, these estimates of mountain whitefish habitat are the best available surrogate for Snake River physa habitat in the Snake River between Swan Falls Dam and the Owyhee-Boise Rivers' confluence with the Snake River (the two rivers join the Snake River within a half mile of each other). In addition, as is further discussed in the following section (2.4.1.2.2), historical (pre-dam/pre-diversion conditions on the river) minimum flows between the Bruneau River confluence (about RM 495.3) and the Owyhee-Boise Rivers' confluence may have ranged at least between 8,120 and 9,320 cfs, and as is suggested by Figure 9, runoff would have produced flows in this reach well above the 15,000 cfs modeled by Anglin *et al.* and Brink. Reasonable conclusions are that Snake River physa would historically seldom have experienced flow 8,000 cfs or less downstream of the Bruneau River confluence; flushing flows scouring fines from Snake River physa preferred substrates would have occurred in most years; and the existing irrigation season flow regimes lower than 8,000 cfs impact the availability of Snake River physa habitat in this area of the river.

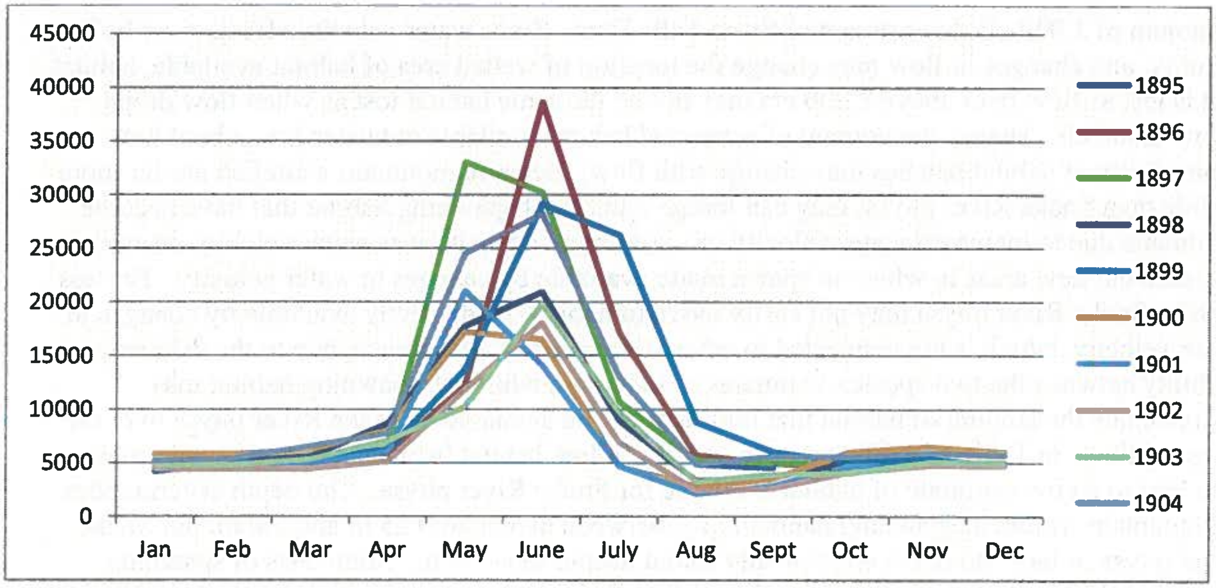

Figure 9. Snake River hydrographs from the U.S. Geological Survey gage at Montgomery Ferry near Minidoka, Idaho, 1895 to 1904, prior to Reclamation dam construction on the Snake River (USDOI 1956, p. 146). Flow is mean monthly flow in cfs. Lowest flow was 2,120 cfs for August of 1901. The source indicates diversions for irrigation upstream of about 174,000 acres in 1895 and 700,000 acres by 1910. Private upstream diversions included the Great Feeder Canal (constructed in 1895), which diverted about 2,000 cfs (Carter 1955). There were many other private diversions, so these values underestimate actual unregulated flow.

Downstream of Swan Falls Dam, inflow to the Snake River upstream of Brownlee Reservoir consists mainly of small creeks, irrigation returns, and several rivers: the Owyhee River and Malheur River from Oregon; and the Boise River, Payette River, and Weiser River from Idaho. All five rivers are heavily regulated for irrigation, and carry their associated irrigation returns into the Snake River. Reclamation constructed summary hydrographs (not shown) for this section of the river using data from USGS gages located between gage #13172500 (Murphy gage) and Brownlee Reservoir. Average (50 percent exceedance), dry (90 percent exceedance) and minimum flows at the Nyssa gage (# 13213100, RM 385.6) and the Weiser gage (#13269000, RM 351.3), reflective of base flows and consumptive uses (mostly irrigation), continue to remain relatively flat as in the Murphy hydrograph, but with a general increase over these the base flows at Murphy. The wet (10 percent exceedance) and maximum flows at the Weiser gage, however, reflect the cumulative flows from multiple tributary basins emptying into the Snake River downstream of Swan Falls Dam, and resulting in very large flows into Brownlee Reservoir.

The Nyssa gage reflects the input of the Owyhee and Boise rivers. These two rivers join the Snake River within a half mile of each other with the latter providing a much larger flow, and account for most of the difference in flow recorded at the Nyssa gage compared to the Murphy gage. For the most part the shape of flows recorded at the two gages is similar. Comparisons of flows between the Milner and Nyssa gages (1990-2013) show that in wet years the shape of flows spilled past Milner Dam can be tracked at the Nyssa gage. In part this may reflect similar precipitation and snowmelt patterns in the mountains of central and eastern Idaho and the western Wyoming ranges feeding the Snake River, but also likely reflects similar use and timing of irrigation withdrawals at Milner Dam and from Reclamation dams on the Boise River. In dry years the shape of flows at the two gages looks quite different when Milner outflow drops to near zero.

From the Owyhee-Boise Rivers' confluence on down to Brownlee Reservoir, effects of Reclamation projects located in the Owyhee, Boise, Malheur, and Payette rivers on Snake River physa in the Snake River become more difficult to describe other than in general terms. Anglin *et al.* (1992) and Brink (2008) conducted their work to inform the effects of flows released past Swan Falls Dam on aquatic vertebrates downstream of Swan Falls Dam, and it is not clear if they accounted for timing and flow from the major tributaries entering the river downstream of the dam. For this reason, even though Anglin *et al.* (1992) extended their habitat estimates downstream to Brownlee Reservoir, we did not present estimates of mountain whitefish spawning habitat (a surrogate for Snake River physa habitat) downstream of the Owyhee-Boise Rivers' confluence in Table 4. No hydrograph similar to Figure 6 has been modeled for pre-dam, unregulated flows in this section of the Snake River, so there is nothing to which we can compare existing conditions. The Owyhee, Boise, Malheur, and Payette rivers are all regulated for flood control and diverted for irrigation. Comparisons can be made between flows upstream of Reclamation reservoirs on the Owyhee, Boise, and Payette rivers and flows at their confluence with the Snake River using USGS gage data. Flow data from 2000 to 2015 (not shown) indicates a decrease in flows at the confluences compared to upstream of the reservoirs that is probably largely due to irrigation diversion, so we can state that discharge from these rivers into the Snake River are likely less than historic, but we cannot state by how much. As discussed in the next section, it is clear that three of these rivers contribute to the sediment load in the Snake River.

Downstream of Swan Falls Dam, only 2 live Snake River physa have been collected downstream of the Owyhee-Boise Rivers' confluence with the Snake River (RM 395.5); both from the sample site at RM 367.9 (about 2 miles upstream of the Payette River confluence), the downstream-most recovery site of live Snake River physa. Reasons for the scarcity of Snake River physa collection in this section of the river may involve gradient and sediment input. The available substrate data (Company unpublished data) indicate the presence of suitable substrates in this reach at varying depths, which can be subjected to widely varying water velocities at different times of the year. The Company sampled this section of the river in late June and early July of 1998 when flow varied from 14,400 to 19,100 cfs, and in late August of 2001 with flows between 6,040 and 7,150 cfs. Sites sampled at 3 to 4 feet in depth in 2001 (when the live specimens at RM 367.9 were collected) would likely have been more than 5 feet deep in 1998. Most sites sampled in 1998 were between 3 to 5 feet deep, but some sites sampled at 1 to 2 feet may have been above water in 2001. High flushing flows may occur during runoff in many years. However, Google Earth images of the Owyhee-Boise Rivers' confluence and the Malheur River's confluence with the Snake River, taken during irrigation season after runoff in 2005, 2006, and 2010 through 2014 (images were not available for irrigation season for missing years) show substantial sediment plumes from all three rivers, though more so from the Boise River, entering the Snake River. The river in this section and downstream is braided and has a low gradient, dropping 87 feet in 44 miles from the Owyhee-Boise Rivers' confluence to the Weiser River confluence, or about two feet per mile. Water velocity at base flows at this gradient during the irrigation season may not be sufficient to keep Snake River physa preferred substrates at depth free of fines in most years. The Payette River enters the Snake River about 2.5 miles downstream of the Malheur River, and it seems to be the exception in this section regarding sediment load: Google Earth images of the Payette River's confluence with the Snake River consistently show comparatively clearer water.

2.4.1.2.2 Water Quality, Current Operations

Section 303(d) of the Clean Water Act (CWA) requires that states and tribes must adopt water quality standards that restore and protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. States and tribes are required to identify and prioritize water bodies that are water quality limited (i.e., do not meet established water quality standards).

States and tribes must periodically publish a priority list of impaired waters every 2 years. For waters identified on this list, states and tribes must develop water quality improvement plans known as TMDLs that establish thresholds for pollutant loads set at levels to achieve water quality standards. The most recent approved Section 303 (d) list for the State of Idaho is the 2010 Integrated Report (IDEQ 2011). Snake River water quality problems identified in the action area include water temperature, sediment, excess total phosphorus, low dissolved oxygen, and unknown pollutants (IDEQ 2011). The TMDLs developed for the Snake River sections in the action area beginning at Minidoka Dam-Lake Walcott and downstream are listed in Table 5, along with the TMDL pollutant targets. Average pollutant concentrations for the Lake Walcott Subbasin TMDL are also listed.

Table 5. Snake River Subbasin TMDLs and listed pollutant targets from American Falls downstream to Brownlee Reservoir, along with pollutant concentrations recorded in the Minidoka Dam/Lake Walcott area. Only pollutant target values established for a given TMDL are listed for that TMDL.

	TMDL Contaminants					
Snake River TMDL section, downstream order	**Total Suspended Sediment (mg/L)**	**Oil or Grease (mg/L)**	**Total Phosphorous (mg/L)**	**Fecal Coliform Bacteria (colony forming unit/100 ml)**	**Temperature**	**Mercury**
Lake Walcott Subbasin (IDEQ 2000a) (Lake Walcott to Milner Dam)	4.2-14.3 (target 25)	5 (target)	0.06 (targets: 0.08 annual; 0.128 daily)			
Upper Snake-Rock Subbasin (IDEQ 2000b) (Milner Dam to King Hill)	52 (target)		0.075 (target)	406 (target)		
Snake River King Hill C.J. Strike Subbasin (IDEQ 2006) (King Hill to C.J. Strike Dam)	50 (geometric mean 60 days, target)		0.075 (target)			
Mid-Snake Succor Subbasin (IDEQ 2003a) (C.J. Strike Dam to Boise R.)			0.07 (target)		No target yet set	
Snake River Hells Canyon (IDEQ 2004) (Adrian, OR to Salmon R.)			0.07 (target)			No target yet set

Minidoka Reach, Minidoka Dam, Spillway, and Lake Walcott

As discussed in Chapter 2, flows into Lake Walcott are controlled by American Falls Dam to meet the downstream demands of irrigation and other water rights. Sediment carried into Lake Walcott by the Snake River and other tributary streams generally deposits in the upstream portions of the reservoir where it transitions from lotic to lentic. This transitional area begins approximately 4 river miles downstream from the confluence with Raft River. Sediment deposited in this area may be redistributed to lower areas of Lake Walcott each year when the reservoir is drawn down in the winter for spillway protection. In addition, Lake Walcott also retains much of the nutrient load passing through from American Falls Reservoir as well as the nutrient loads from tributary streams and other point and nonpoint sources located upstream from the reservoir.

As a result, water quality conditions in the spillway area and the river segment below the dam can be quite different from the water quality seen below American Falls Dam and even through much of Lake Walcott. Furthermore, Lake Walcott currently supports the designated and existing beneficial uses. These beneficial uses are domestic water supply, cold water aquatic life, and primary contact recreation. As part of an ongoing reservoir monitoring program for operating projects, Reclamation collects water quality data every 3 years from Lake Walcott. These samples are analyzed for chemical, physical, biological, and trace metal parameters. Reclamation also collects data from temperature recording loggers throughout the spillway area. These data have been collected in 2005 and 2010. In other years, the temperature loggers were placed mainly in the snail pool to assess the local temperature of that feature. In addition, the State of Idaho collected water quality data from the reservoir in 2007 to review the status of the Lake Walcott Subbasin Assessment and TMDL.

Due to the sediment and nutrient retention in Lake Walcott, the water passing Minidoka Dam is typically of excellent quality. This water quality is maintained in the Minidoka Reach (between Minidoka Dam and the Milner pool—the reach in which most Snake River physa are recovered and where it is most abundant)—and then begins to degrade in the Milner pool due to several large point sources as well as many smaller agricultural drains and tributaries carrying nonpoint source loads of nutrients. Because the TMDLs are applied to the entire Lake Walcott Subbasin, however, the entire reach between Lake Walcott and Milner Dam is listed as not currently supporting the designated and existing beneficial uses.

Waste load and load allocations for total phosphorus were developed by the State and are prescribed in the Lake Walcott Subbasin Assessment and TMDL. This segment of the Snake River was also assigned load allocations for sediment as well as oil and grease in anti-degradation TMDLs (IDEQ 2000). Total phosphorus (TP) targets for the Snake River downstream from Minidoka Dam were set at an average annual concentration of 0.08 mg/L of TP and a 0.128 mg/L TP daily maximum concentration to allow for natural variability. TP concentrations passing Minidoka Dam typically average 0.06 mg/L; this data is collected at the old Jackson Bridge site, approximately 5 miles downstream from Minidoka Dam and located just upstream of the pool created by Milner Dam.

Lake Walcott effectively retains most sediment delivered to the reservoir from upstream locations. Monthly annual TSS concentrations below Lake Walcott range from 4.2 to 14.3 mg/L (Table 5). These values are well below the 25 mg/l concentration target used in the Lake Walcott TMDL to develop load and waste load allocations for Milner Pool.

Under current conditions, a slight seasonal effect can be seen in the TSS data below Minidoka Dam. In March and April, sediment transport from the reservoir increases slightly, which corresponds with the annual spring freshet and flood control releases from upstream storage reservoirs. Additionally, in the months of September, October, and November, TSS also increases above the annual average of 9.2 mg/L. Also, in these months there are occasional spikes in TSS above the water quality targets. These spikes and monthly average concentration increases may be the result of the reservoir level changes, or they may simply be a reflection of the natural increase in TSS due to the die-off of aquatic plants or wind events mixing bottom sediments, leading to higher export of sediment coinciding with reservoir drawdown. In general, these spikes account for less than 10 percent of the overall TSS concentration in the Snake River on an annual basis (USBR 2014a).

Historically, however, there have been periods when sediment releases from American Falls Reservoir exceeded concentrations (i.e., the turbidity standard and the Lake Walcott sediment target). As presented in the Proposed Action, Reclamation normally maintains Lake Walcott at full pool during the irrigation season, but in 25 to 50 percent of years may draft the reservoir down to as low as 4,236 feet elevation to meet irrigation demands, maintenance needs, or environmental concerns. Drafting of Lake Walcott will usually be prompted when water deliveries from American Falls Reservoir create a low pool condition, i.e., ≤ 100,000 acre feet of storage. Since 1980, American Falls has been drafted below 100,000 acre feet in 12 of 35 years, below 50,000 acre feet in 8 of 35 years, and below 5,000 acre feet in 1 of 35 years (Newman and Hildreth pers. comm., 2015). In the 2004 Assessment, Reclamation indicated that sediment begins to be mobilized and exported from American Falls Reservoir at higher rates as the reservoir water level is drawn down. Higher rates of sediment export typically begin to appear in the range of 2 to 4 percent of water storage levels (approximately 33,000 to 67,000 acre feet remaining in the reservoir), depending on the year (USBR 2004, p. 81), but sediment export may sometimes occur during drawdown as storage decreases past 80,000 acre feet (Newman pers. comm., 2015b). Drawdowns to these levels in American Falls Reservoir tend to occur late in the irrigation season in low water years.

Reclamation modeled maximum water temperatures in the spillway, and found spillway temperatures were nearly uniform. Data from the 2005 and 2010 data logger placements were used to model summer temperatures throughout the spillway area. Seasonal temperature variation occurs as expected. At any given time certain areas within the spillway may be as much as 1 °F warmer or cooler than the rest of the spillway area, but the areas of such temperature variation move about the spillway area during a summer, with no apparent correlation to spillway features (USBR 2014a).

Lake Walcott only weakly stratifies and is prone to wind events that can mix the reservoir throughout the water column. As a result, there is little or no vertical temperature gradient in the reservoir, and reservoir temperatures routinely reach 22 to 25°C during the summer months. Because of this, the background temperatures of Lake Walcott are the driving factor of temperatures in the spillway area and in the river down to Milner Pool.

There is insufficient information to conclude that Snake River habitat occupied by Snake River physa in the Minidoka Reach represents optimal habitat; this quandary is not uncommon when there is little information on a listed species' historical or pre-disturbance range. However, the species has persisted and has been consistently found in numbers in the Minidoka Reach since 2006, suggesting that low sediment and nutrient concentrations and temperature ranges typical of the Reach, including the spillway area, do not seem to be inhibiting this colony's stability.

Snake River above Brownlee Reservoir

The Upper Snake-Rock Subbasin TMDL has been developed for the Snake River between Milner Dam and King Hill and associated streams. This section of the river includes the Murtaugh Reach, the Company's Twin Falls, Shoshone, Upper and Lower Salmon Falls, and Bliss hydroelectric projects, and the ESRPA influenced section between Briggs Springs and King Hill. It also includes the Snake River physa type locality. As indicated in Table 5, pollutants contributing to degradation of water quality in this reach are total suspended sediments, phosphorous, and bacteria. As described in section 2.4.1.2.1, natural flow regimes are no long present, which allows sediment to accumulate. As IDEQ (2000b) describes in this TMDL: "In general, the middle Snake River . . . [is] impacted by runoff from irrigated crop production, rangeland, pastureland, animal holding areas, feedlots, dredging, hydro-modification, and urban runoff. Natural springs have exhibited hydro-modification and streambank modification from activities relating to sedimentation, aquaculture, hydropower, irrigated crop production, and land development."

Anecdotal reports of flow, substrate, and water quality conditions in the reach suggest that during summer much of the Murtaugh Reach is frequently characterized by a series of pools with low water velocity, mud and silt substrates, algal blooms, and high water temperatures exceeding Idaho's cold water aquatic life standards (19 °C daily average and/or 22 °C daily maximum), separated by narrow spills over basalt outcrops; all conditions considered not conducive to Snake River physa presence. High flows from salmon augmentation or due to wet years may flush live Snake River physa from the Minidoka Reach through Milner Dam and Reservoir to be deposited in the Murtaugh Reach. However, given the water quality conditions most years in the Murtaugh Reach the Service would not expect the species to persist there. Flows released from Milner Dam sufficient to flush and transport sediment through the Murtaugh Reach may temporarily improve water quality in the Murtaugh Reach, but can also transport the degraded water downstream.

Beginning in 2013 in response to modified license requirements for their Shoshone Falls, Upper Salmon Falls, and Lower Salmon Falls hydroelectric projects, the Company began collecting water quality data every two weeks at three locations on the Snake River that are contained within the Upper Snake-Rock Subbasin TMDL reach (Younk and Hoelscher 2014):

- Below the [Company's] Milner hydroelectric project Main Powerhouse (Milner site) at River Mile (RM) 637;
- At the Clear Lakes Road Bridge near Buhl, Idaho, (Buhl site) at RM 594.4; and,
- At the bridge at King Hill, Idaho, (King Hill site) at RM 546.

The Company's Milner site is just downstream of Milner Dam, and so does not capture water quality conditions in the Murtaugh Reach. The Buhl site (RM 594.4) would capture water quality exiting the Murtaugh Reach (when flow from Milner Dam is greater than zero), but this water quality would also be influenced by intermediate inflow from Niagara Springs and Crystal Springs (both springs support fish hatcheries, which contribute nutrients to the river), Blue Lakes Springs, and input from small tributaries and agricultural returns, all located between the Buhl collection site and the Twin Falls Dam. Data from the King Hill site will reflect all of the above, plus water quality influenced by spring-fed inflow of over 5,000 cfs from Box Canyon Creek, the Malad River, the Thousand Springs area, numerous smaller springs and spring-fed tributaries, and nutrient input from a number of fish hatcheries.

Each of these locations is co-located with a USGS stream gage. The data collection time frame coincides with the October 1 through September 30 water year (rather than follow a calendar year, in Idaho a water year follows the irrigation period from October 1 to September 30, where irrigation diversion ceases on October 1). Results from the Company's 2013 data collection (from March 28 through September 25—14 collection dates) follow.

Total suspended solids at all three collection sites were below the Upper Snake-Rock Subbasin TMDL on all collection dates. The total phosphorous TMDL was exceeded at least once at all three sites, and was exceeded four and six times at Milner and Buhl, respectively. The Company's 2013 data suggest that the total phosphorous TMDL may be close to being met. There is yet insufficient data to indicate whether or not reduced total phosphorous is reducing nuisance macrophyte growth in the mid-Snake River, which is a main focus of the phosphorous TMDL.

The Malad River/Snake River confluence occurs within the Upper Snake-Rock Subbasin TMDL reach, and during part of the year water from the Snake River is directed into the Malad River. Reclamation owns and operates the headgate at the Milner-Gooding Canal (1,600-cfs capacity) and holds natural flow water rights for irrigation delivery for 850 cfs and 1,700 cfs. When sufficient water is available at Milner Dam, the Milner-Gooding Canal delivers Snake River water from Milner Reservoir to irrigators across over 60 miles to the northwest, and then empties into the Big Wood River north of Shoshone, Idaho. A number of diversions and irrigation returns are located on the Big Wood River downstream of the Milner-Gooding Canal confluence. Reclamation also owns the Little Wood River Project, which includes the Little Wood River Dam and Reservoir. The Little Wood River Irrigation District operates and maintains the dam and reservoir. There is no minimum flow at the dam outlet. Irrigation releases in average years are between 200 and 400 cfs, and in dry years may be as low as 100 cfs. Outflow is shut off following the irrigation season to allow for refill. The Big Wood River and the Little Wood River combine to form the Malad River about nine miles upstream of the Malad River Gorge at I-84, which empties into the Snake River at RM 571.4. The Company collected water quality data over a six month period in 2014 at their Upper Malad project site (receives water from the Wood Rivers system with little spring input) and Lower Malad River project site (receives water largely from the Malad Springs). Results for total phosphorous were well under the TMDL at both sites.

Despite the Upper Snake-Rock Subbasin TMDLs not being met consistently, as discussed in section 2.3.1.3 (Habitat Characteristics), the available evidence suggests that the low availability of suitable habitat in the mid-Snake River may be limiting to Snake River physa, with limited or no evidence of impact from water quality.

The Snake River King Hill C.J. Strike Subbasin TMDL covers the area from King Hill to C.J. Strike Dam (RM 494). Notably less agricultural use borders this reach (entirely within Elmore County) compared to the area covered by the Upper Snake-Rock TMDL. The total suspended solids TMDL target is a geometric mean, which allows for considerable variation in daily measurement without exceeding the target. Total phosphorous TMDL is the same as for the Upper Snake-Rock TMDL. This reach includes the area upstream of Indian Cove Bridge, within which Taylor collected approximately 200 Snake River physa shells. The Company's 2013 data from the King Hill collection site suggests that Snake River water entering the Snake River King Hill C.J. Strike Subbasin is meeting or close to meeting the TMDLs for both subbasins. Anecdotal evidence indicates, however, that extensive macrophyte beds form in C.J. Strike Reservoir every summer.

The Mid-Snake Succor Subbasin TMDL in 2003 listed the Snake River from C.J. Strike Dam to the Oregon border for nutrients (primarily phosphorous), dissolved oxygen (too low) and pH. The TMDL for phosphorous (0.07 mg/L) was set as a means to address the pH and dissolved oxygen issues in this river segment and downstream in Hells Canyon.

This TMDL does not have a load allocation for sediment, i.e., sediment was not determined to be impairing beneficial uses. Due to the placement of turbine intakes and the spill gates midway in the reservoir depth (between 40 to 50 feet above the reservoir bottom) at C.J. Strike Dam, turbine and spill gate operations mobilize little bottom sediments. The dam itself functions as an effective sediment (and nutrient) trap, i.e., most of the sediment load entering C.J. Strike reservoir settles out of the water column upstream of the dam. However, unpublished Company data collected in 1995, 2007, and 2013 indicates considerable sediment load during the irrigation season accumulating in a downstream direction from agricultural returns beginning just downstream of C.J. Strike Dam (TFT *in litt.* 2014). About 12,000 pounds of sediment per day enters the river beginning about six miles downstream of the dam, with a spike up to about 150,000 pounds per day entering the river near RM 480 (TFT *in litt.* 2014).

The narrow character of the Snake River in the Swan Falls Reservoir plus the reservoir's small storage capacity frequently leads to relatively rapid transit times (Naymik and Hoovestol 2008), with water velocity sufficient to carry fine sediment to the area (the forebay) behind Swan Falls Dam. The design and placement of Swan Falls Dam (RM 457.75) results in sediment passage conditions differing from most dams upstream. The dam itself will trap some sediment, particularly in low water years (Naymik and Hoovestol 2008, p. 15), but otherwise the placement of the turbine intakes and spillway gates near the reservoir bottom result in sediment being passed through the dam. Hence, a large fraction of the cumulative sediment load (and accompanying nutrient load) at RM 480 passes Swan Falls Dam. (Groves and Chandler (2005, p. 479-480), studying historical chinook salmon spawning sites, attributed proliferation of macrophytes on the cobble/gravel beds in their study areas below Swan Falls Dam to high sediment loads, sediment deposition, and nutrient loading passing Swan Falls Dam). From Swan Falls Dam to about RM 420, during the irrigation season sediment load from agricultural drains gradually increases to about 200,000 pounds per day, and over the next five river miles (from RM 420 to 415), there is a second spike to over 375,000 pounds per day. The cumulative sediment load approaches 400,000 pounds per day near the Boise River confluence (TFT, *in litt.* 2014).

The Service's (USFWS 2012) indirect effects analysis in our Opinion for the Swan Falls hydroelectric project relicensing concluded that sediment and nutrient load is likely to significantly impact Snake River physa habitat in the Swan Falls Reach (defined in that Opinion as Swan Falls Dam to Weiser, Idaho) under low flow conditions. Low flow conditions (reduced water velocity) result in sediment deposition. As discussed in Section 2.3.1.3, Chambers *et al.* (1991) found that macrophyte biomass was significantly and inversely correlated with current velocity within the macrophyte bed over the range of 0.01-1.0 m/s. In *in situ* experiments of macrophytes growing in varying sediment textures (sand, and sand/silt mixtures), they demonstrated that increase of velocity over a range of 0.2–0.7 m/s resulted in a decrease in plant biomass irrespective of sediment texture. They also noted that nutrient uptake by macrophytes was negatively affected by increased velocity (see also Biggs 1996, p. 137-138 for description of relationship between velocity and nutrient uptake). Their results indicated that low water velocities result in macrophyte establishment and growth, and once established the nutrient concentrations in the sediments determine macrophyte abundance and density. In addition, once established, macrophytes further reduce velocity within the macrophyte bed (p. 254), which may lead to additional sediment deposition over the macrophyte bed with the potential to maintain or increase nutrient concentrations. At velocities greater than 1 m/s macrophytes were either absent or present in negligible quantities. At velocities less than 1 m/s, even small velocity increases resulted in a decrease in macrophyte biomass.

As discussed in the previous section (2.4.1.2.1), historic flows of 8,000 or less may have been uncommon between the Bruneau River and Boise River confluences with the Snake River. Table 4 indicates that a quarter of the habitat available at 8,000 cfs in this reach is lost when flows drop to the 3,900 cfs set by the Swan Falls Agreement. Although habitat estimated in Table 4 may overestimate Snake River physa habitat, it makes clear that some Snake River physa habitat will likely be unavailable at low flows. Some of that loss will occur as water level drops and reduces wetted area, and some will occur when water velocity decreases as flows decrease. The latter loss will be compounded by sediment deposition over Snake River physa suitable habitat, which may lead to macrophyte establishment and further reduction in water velocity.

The Snake River Hells Canyon TMDLs are set for the reach between around Adrian, Oregon (about RM 409), to the Salmon River confluence (about RM 188). The TMDL of 0.07 mg/L for phosphorous was set to alleviate the issues for nutrients, nuisance algae, and dissolved oxygen. By one estimate, achievement of the TMDL phosphorous target for the Snake River Hells Canyon TMDL may span 50-70 years (IDEQ 2003b, p. 448). However, water quality will consistently improve as treatments are applied to point and nonpoint discharges (IDEQ 2003b, p. 448).

Major inflow to the Snake River between RM 409 and Brownlee Reservoir are the Owyhee, Boise, Malheur, Payette, and Weiser rivers. The Boise, Malheur, and to a lesser extent the Payette, rivers are bordered by a large percentage of flood irrigated fields, which contribute considerable sediment and nutrient loads to the Snake River. Although the Snake River can receive substantial spring runoff from these tributaries, post-runoff flow frequently drops to ~ 6,000-7,000 cfs (Nyssa Gage data). As discussed in the last paragraph under Section 2.4.1.2.1, only 2 live Snake River physa at one sample site have been collected downstream of the Owyhee/Boise confluence, which may be related to sediment load and water velocity in the low gradient reach from the Owyhee/Boise confluence to Weiser.

In the Snake River downstream of Milner Dam, spring runoff and salmon flow augmentation can produce flushing flows that redistribute sediment, especially in high water years. We could not locate estimates of discharge or water velocity needed to flush and maintain suspension of fine sediments (defined here as sand, fine sand, very find sand, mud, and silt) in the Snake River. However, due to exercise of water rights and a more or less stable amount of irrigated land under cultivation each year, the amount of agricultural water return to the Snake River, with its accompanying sediment and nutrient load, is relatively consistent throughout the irrigation season and from year to year. Hence, after spring runoff or after salmon flow augmentation passes and discharge has decreased to contemporary base flows, much of the consistent sediment input will drop out of the water column, and accompanied by optimum growth conditions (nutrient load, warm water temperatures, and long periods of daylight with high insolation) will lead to macrophyte establishment in sediment beds, which in turn further impedes water velocity. These are conditions which lead to degradation of Snake River physa suitable habitat (as described in Section 2.3.1.3, Habitat Characteristics). Under these conditions there may remain deep areas in the thalweg or patches at the downstream end of pools where water velocity is sufficient to keep Snake River physa preferred substrates free of fines, but experience suggests such habitat patches in large segments of the river downstream of Swan Falls Dam are discontinuous and not large under current river conditions. In early August of 2013, Service and Company biologists conducted a qualitative Snake River physa habitat suitability survey at nine sites between Walter's Ferry Bridge and the Marsing area (about 18 river miles) in support of a river-function restoration project. Only an estimated 10 percent of one site rated above medium suitability (defined as preferred substrates embedded in but not covered by fines, and present in patches > 2 m^2) [Winslow *et al. in litt.* 2012]). Due to unusual and extraordinary water clarity, visibility extended to about three meters, with discharge at 6,340 cfs. Macrophyte beds unexpectedly covered a far more extensive area of the river bottom, even at the limit of visibility, than would have been apparent under normal (visibility to about ≤ 1.25 m) conditions.

The ability of pre-settlement Snake River minimum flows to move sediment in the reaches downstream of Milner Dam can be derived from historic USGS Montgomery Ferry gage data (not shown) used in Figure 9, and estimates of total discharge from the ESRPA between Milner Dam and King Hill (Kjelstrom 1992). The lowest mean monthly flow depicted in Figure 9 is 2,120 cfs (USDOI 1956), to which can be added about 2,000 cfs diverted from the Snake River upstream into the Great Feeder Canal (Carter 1955), for a total minimum pre-settlement flow of 4,120 cfs at the Montgomery Ferry gage. This flow value is an underestimate, but is the best that can be derived from the available information underestimate (there were other private diversions upstream of the Montgomery Ferry gage, but there is no data on how much additional flow was diverted). The best available estimate of minimum pre-settlement ESRPA discharge into the Snake River between Milner Dam and King Hill comes from near the beginning of the era of extensive irrigation on the Snake River Plain (when irrigation using Snake River water began to increase aquifer volume and spring discharge), and is about 4,100 cfs, occurring between 1900 and 1910 (Kjelstrom 1992). Thus, minimum total flow at King Hill would be about 8,220 cfs (4,120 cfs at Montgomery Ferry, plus 4,100 at King Hill). Figure 9 also depicts minimum flows approaching 5,000 cfs in other years at the Montgomery Ferry gage, suggesting that total, estimable pre-settlement flow passing King Hill and entering the reaches downstream of C.J. Strike Dam in some years could have been in excess of 10,000 cfs, to which can be added unknown pre-settlement flows from the Big Wood River, Salmon Falls Creek, and the Bruneau River, all joining the Snake River downstream of Milner Dam. Based on the pre-settlement flows that are known or can be estimated, it is a reasonable conclusion that prior to irrigation on the Snake River plain, minimum Snake River flow downstream of C.J. Strike Dam would have kept Snake River physa preferred substrates free of fines and macrophytes in patches larger than now exist.

Review of daily flow data from the Murphy gage from 1990 through 2014 clearly shows periods during some years when irrigation season flows downstream of Swan Falls Dam match or exceed estimated minimum pre-settlement flows (e.g., ≥ 8,000 cfs). That this occurs is not at issue. Our concern rests with the potential impacts to Snake River physa resulting from the timing and duration of minimum flows less than historic. Due to exercise of water rights and a more or less stable amount of irrigated land under cultivation each year, the amount of agricultural water return to the Snake River, with its accompanying sediment and nutrient load, is assumed to be relatively consistent throughout the irrigation season and from year to year. Assuming that flows ≥ 8,000 cfs occurring during a given irrigation season or for an entire irrigation season flush Snake River physa preferred substrates free of fines does not address the question of what happens to Snake River physa habitat, individuals or eggs when, with a similar sediment and nutrient load still present in the river, flows drop below 8,000 cfs during the remainder of an irrigation season or for the whole of the following irrigation season. We do not yet know how Snake River physa or their eggs respond to sediment deposition and macrophyte establishment in occupied habitat, only that the species can be consistently found in habitat where sediment deposition and macrophytes are absent or at worst minimal (i.e., in the Minidoka Reach). Hence, to err on the side of the species, we assume that impacts resulting from sediment deposition and macrophyte establishment in occupied habitat under low flow conditions will be severe and may include extirpation of individual colonies. Sporadic flushing flows that occur later in an irrigation season or in the following irrigation season may temporarily restore habitat conditions, which may allow re-colonization from an upstream source. However, the pattern of repeated low flow conditions over time evident in gage data downstream of C.J. Strike Dam, combined with consistent sediment and nutrient loads in the river, suggests re-colonization events are likely to be subjected to the same conditions that may have impacted or extirpated the previous colony.

Given that Snake River physa have not been identified as occurring downstream of C.J. Strike Dam since 2002, it is plausible that the nearest upstream Snake River physa colony able to function as a source of re-colonization might be at Minidoka. In order for Minidoka to serve as a re-colonization source, individuals flushed from the Minidoka Reach during high flows would need to remain suspended in the water column and be passed through seven reservoirs and over seven dams for 180 river miles in order to arrive downstream of C.J. Strike Dam, and then drop out of the water column onto preferred substrates in condition suitable to support a new colony. We do not know that this could not occur, nor do we know that Snake River physa cannot survive sediment deposition events. However, given the available evidence, the Service considers it probable that repeated low flow conditions downstream of C.J. Strike Dam, over time, could lead to extirpation of Snake River physa colonies, due both to direct impacts from sediment deposition, and to a diminishing number of colonies able to function as re-colonization sources. This would provide one explanation why Snake River physa have not been identified in this section of the Snake River since 2002.

2.4.1.2.3 Future Hydrologic Conditions

Reclamation evaluated the potential impacts of climate change for this project (USBR 2011a) using climate change and hydrology datasets that were adopted by Reclamation, the U.S. Army Corps of Engineers (Corps), and Bonneville Power Administration in 2011 (USBR *et al.* 2011b). These agencies collaborated to develop climate change and hydrology datasets to be used in their longer-term planning activities in the Columbia-Snake River Basin. Development of the datasets was coordinated through the RMJOC (River Management Joint Operating Committee), a sub-committee of the Joint Operating Committee which was established through direct funding Memorandums of Agreement between BPA, Reclamation, and the Corps. The RMJOC is specifically dedicated to reviewing the practices, procedures, and processes of the three agencies to identify changes that could improve the overall efficiency of the operation and management of the Federal Columbia River Power system projects.

In the Climate and Hydrology Datasets for Use in the RMJOC Agencies' Longer-Term Planning Studies (RMJOC Climate Change Study; USBR *et al.* 2011b), climate change simulations were conducted using global climate (circulation) models (GCMs) selected in collaboration with the RMJOC. During this process, future climate change and hydrologic datasets were selected based on GCM type, emission forcing scenario, area of interest, and timescale. In addition, both Hybrid-Delta (step change) and Transient (time evolving) techniques were used. The data were downscaled from a large coarse-scale GCM resolution to a finer resolution scale that was better representative of the geographic area of study (i.e., the Columbia Basin) and was bias-corrected (a process in which each GCM's tendencies to simulate past conditions that are statistically different from historical observations {e.g., too wet, too warm} are adjusted). This process is referred to as Bias Correction Spatial Disaggregation.

For the RMJOC Climate Change Study, future climate change Hybrid-Delta datasets were selected for two future periods, from 2010 through 2039 and 2030 to 2059. These 30-year periods are also referred to as "centered around" the 2020s and 2040s, respectively. Only results for the Hybrid-Delta 2020s period are reviewed here, since the period extends to 2039, which includes the time frame—to 2034—considered in the 2014 Assessment and this Opinion. Six scenarios of future temperature and precipitation conditions were selected to be evaluated relative to a simulated historical period from 1950 to 1999 for the Columbia River Basin. The scenarios were built from a collective of nine underlying climate projections developed by the University of Washington's Climate Impacts Group (Climate Impacts Group) (USBR *et al.* 2011c, p. xv, Part I). The scenarios selected included:

- Less warm, wetter (LW/W), or the future projection closest to the 10th percentile temperature and 90th percentile precipitation;
- More warm, wetter (MW/W), or the future projection closest to the 90th percentile temperature and 90th percentile precipitation;
- Minimal change (MC), roughly targeting less warming and the 50th percentile precipitation;
- Central change (C), or the future projection closest to the 50th percentile temperature and 50th percentile precipitation;
- Less warm, drier (LW/D), or the future projection closest to the 10th percentile temperature and 10th percentile precipitation; and,
- More warm, drier (MW/D), or the future projection closest to the 90th percentile temperature and 10th percentile precipitation.

The 90th, 50th, and 10th percentile coordinates for change in mean annual temperature and mean annual precipitation were chosen to enable an analysis of a broad range of future projections over the Columbia River Basin.

These ranges of temperature and precipitation were generated using two of several future greenhouse gas emission forcings available. Emission forcings make assumptions about future greenhouse gas emissions based on different economic, technical, environmental, and social developments. The selected emission forcings included A1B, which assumes an average or medium emissions future and B1, which assumes a low emissions future (IPCC 2000).

Streamflow generated using the six Hybrid-Delta model scenarios were uses as input to MODSIM, a general purpose river and reservoir operation computer simulations model that includes the river system features of storage, irrigation demand, operational flow objectives, and reservoir content (see pages 26-27 this Opinion). The baseline MODSIM model was updated in 2010 to more accurately model modified and natural flow in the Snake River subbasin upstream of Brownlee Reservoir. The update incorporated the current level of irrigation development, which reflects the effects of groundwater pumping in the system. Meeting environmental objectives such as water quality pools, minimum flows for resident fish, and objectives for listed snails and bull trout were factored into the modeling constraints. The frequency of meeting environmental objectives and subsequent impact to other parts of the river system was evaluated. Flow from the Hybrid-Delta scenarios were then compared to the historical flow record developed by the Climate Impacts Group.

(Note: The six Hybrid-Delta scenario selections were chosen among those available to represent a range of climate change projections compared to historical conditions averaged over the Columbia River Basin as a whole. The RMJOC Climate Change Study evaluated the results for three subbasins within the Columbia River Basins—the Yakima River, Deschutes River, and the

Snake River—and stated the following: "The [Columbia River] basin-wide Hybrid-Delta scenario selections qualitatively describe similar types of climate changes [with]in the Yakima and Deschutes River subbasins (e.g., basin-wide LW/W and MW/W scenarios are generally also "wetter" over the subbasin, or basin-wide LW/D and MW/D are generally also "drier" over the subbasin). This is not the case for the Snake River subbasin, where four of the six selected Hybrid-Delta scenarios for both 2020s and 2040s happen to be "wetter than historical" over the Snake River subbasin. In particular, the MC and C scenarios are wetter over the Snake River subbasin than they are when averaged over the Columbia-Snake River Basin. This appears to be a geographic artifact of the selected mix of Hybrid-Delta scenarios. These findings are not interpreted to suggest that the Snake River subbasin should be relatively wetter than the remainder of the Columbia River Basin. In fact, the consensus view of changes from a larger collection of projections suggests the Snake River subbasin precipitation changes should be comparable to those in . . . the Columbia River Basin [i.e., *not* wetter than historical] and possibl[y] slightly less . . ." (USBR *et al.* 2011c, p. 89, Part I). The driest scenario (MW/D) used in the analyses was minimally dry compared to historical conditions (USBR *et al.* 2011a, p. 189, Part II). The Summary for Part II of the RMJOC Climate Change Study recommended that future climate change analyses at the Snake River subbasin level consider additional dry climate change projections in order to provide better understanding of the potential impacts that drier climate outcomes may have on overall Reclamation operations).

Results of meteorology modeling project a warming climate for the Snake River subbasin through 2039. Mean annual temperature is projected to increase by 1 to 3 °F (0.5 to less than 2 °C). Projected changes in mean annual precipitation in the six scenarios ranged from a 5 percent decrease to > 10 percent increase (USBR 2011a, Part II). (However, annual precipitation averaged over all models increased only 1 to 2 percent through 2039 over the Columbia River Basin as a whole—see Note). The projected warming led to increased winter rainfall, reduced snowpacks, and increased rate of snowmelt. MW/W was the wettest scenario, and resulted in a shift in peak runoff to one month earlier (May), measured as the sum of inflow to reservoirs above Brownlee Reservoir ("reservoirs above Brownlee Reservoir" refers to reservoirs on the mainstem Snake River or the Henry's Fork; flow and volume on the Boise and Payette rivers were analyzed separately), but all scenarios resulted in earlier peak runoff. Inflow to reservoirs increased over historical conditions for all scenarios from October to May, and the overall annual reservoir inflow volume above Brownlee Reservoir was greater under all scenarios. For all but the LW/D and MW/D scenarios, causes of the increased October-May inflow included a component of increased precipitation. However, despite that annual reservoir inflow above Brownlee Reservoir increased compared to historical conditions, the projected magnitude of inflow *during a portion of the irrigation season was less in all scenarios compared to historical*, particularly from June through September. This latter is a function of change in timing of runoff and existing finite reservoir storage space, as follows:

- Increased winter precipitation that falls as rain will drain to the streams and rivers during winter; it will not become part of the snowpack, but will contribute to increased winter reservoir inflow greater than historical conditions as described above.
- With warmer temperatures, snowpacks have less water volume (because more winter precipitation fell as rain), and will melt and run off earlier in the year compared to historical conditions.

However, Reclamation's reservoirs in their current form and configuration can capture and store only the same amount of water they always have. Reservoir operators will need to continue to balance storing the earlier inflow versus drafting the reservoir to make room for snowpack or high precipitation events. Because precipitation events in the form of rain cannot be forecasted as accurately as snowpack runoff, decisions about whether to store incoming flow or release it to make room for more inflow (that may never come) will become far more difficult in the future. Because snowpack is less (thus less infiltration and groundwater) and precipitation (either in the form of rain or snow) is projected to continue dropping during the summer months, natural instream flow will be less by the late summer and fall. Thus, deeper drafts will be required from the reservoirs during mid to late irrigation season to meet irrigation demand as natural flows drop (USBR *et al.* 2011a, Part II p. 147). This will lead to less carry-over of stored water into the next season, which will result in reservoir storage reaching full capacity later in the following season. Less natural instream flow will also have a negative effective on water users who rely solely on that water for their irrigation. Less natural instream flows in the Snake River during mid to late irrigation season (as a result of early runoff and irrigation demand) also may have negative effects to native aquatic species in the river, including Snake River physa.

Minidoka Reach, Minidoka Dam, Spillway, and Lake Walcott

The Snake River reservoirs above Brownlee Reservoir (includes Milner Reservoir) refilled consistently in all but the driest scenarios; in the driest scenario (MW/D) end-of-month storage volume was less than historical at the end of the water year (October 1) and reservoirs did not reach complete refill until January or February of the following year (USBR *et al.* 2011a, Part II). The minimum flow of 900 cfs at Palisades Dam was projected to be met between October and March for all climate change projections, but meeting minimum pool at American Falls Reservoir will be more difficult in the driest future climate projections (USBR *et al.* 2011a, Part II, p. x). However, projections for all scenarios indicated that irrigation demands would be met, although there would be a decrease in use of natural flows and an increase in use of storage water for irrigation for reasons explained in the previous paragraph. Whether originating from natural flows or from storage, flows would be released past Minidoka Dam to fill the four irrigation canals at Milner Dam, as occurs under existing conditions. Of relevance to Snake River physa, this means that future summer flows in the Minidoka Reach may fall in the range of existing conditions (see Section 2.4.1.2.1), with effects to Snake River physa (with regard to discharge levels) similar to those under existing conditions, as depicted in Figure 3 (Summary hydrograph, Minidoka outflow).

As discussed in sections 2.1.3.1.2 and 2.4.1.2.2, Reclamation may draft Lake Walcott when water deliveries from American Falls Reservoir create a low pool condition in the latter reservoir, i.e., $\leq$ 100,000 acre feet of storage, resulting in water quality issues involving increased sediment load downstream of Minidoka Dam. A decrease in natural flows and increased use of storage water under the projected climate scenarios may result in significant drawdowns in American Falls Reservoir more frequently than now occurs. Some amount of sediment thus exported will be transported into Lake Walcott and delivered past Minidoka Dam as drafting of Lake Walcott also occurs under these conditions. The RMJOC Climate Change Study indicated that meeting minimum pool in American Falls Reservoir will be more difficult in the driest years modeled. If in fact future conditions in the Snake River subbasin become drier than the range of projections used in the RMJOC analyses (see Note above), the likelihood and frequency of significant drawdowns in American Falls Reservoir that result in sediment mobilization may increase.

Snake River above Brownlee Reservoir

As developed in sections 2.4.1.2.1 and 2.4.1.2.2, contemporary minimum flows less than minimum pre-settlement flows downstream of C.J. Strike Dam have substantial impacts on Snake River physa via the pathway of reduced water velocity, sediment deposition, and macrophyte establishment and growth. Management of the Snake River for irrigation and hydropower under existing policy and agreements is expected to sustain conditions leading to low flow conditions downstream of C.J. Strike Dam for the foreseeable future. The frequency and duration of low flow conditions may be increased under future hydrologic conditions.

The 1984 Swan Falls Agreement between the Company and the State of Idaho granted the Company unsubordinated water rights of 3,900 cfs from April 1 to October 31 (summer flow or irrigation season flow) and 5,600 cfs from November 1 to March 31 as measured at the Murphy Gage downstream of Swan Falls Dam. This Agreement was reaffirmed in 2009, and relevant to Snake River physa, provides the only guarantee of summer flows in excess of input from irrigation returns and small creeks between C.J. Strike Dam and the Owhyee/Boise rivers confluence. The renewed license for the Swan Falls Hydroelectric Project (2012) ordered a change in minimum flows that match the Swan Falls Agreement, and which brought minimum flows at Swan Falls Dam for the April 1-October 31 period in line with FERC-ordered year around minimum flows of 3,900 cfs at the C.J. Strike Hydroelectric Project. As stated in section 2.4.1.2.1 (Water Quantity and Timing) on page 37, total natural river recharge from Milner Dam to King Hill ranges between 5,000-6,000 cfs, with most of that volume entering downstream of Pillar Falls. The difference between the Company's 3,900 cfs unsubordinated water right and the 5,000-6,000 cfs total recharge is held by other water-right holders, and is all used for irrigation downstream of King Hill (Bowling pers. comm., 2015a). The Swan Falls Agreement and its 2009 Reaffirmation both confirmed State policy that minimum flow at the Milner Gage is zero. When zero flow is released at Milner Dam, by necessity the Company's 3,900 cfs water right is derived almost entirely from ESRPA discharge downstream of Milner Dam.

The Company attempts to maintain summer flows of ≥ 3,900 cfs at Swan Falls Dam in order to comply with the FERC license and to avoid the need for a water call that would result in curtailing uses of other water right holders below King Hill. Minimum summer flow recorded at the Murphy Gage downstream of Swan Falls Dam has once approached (dropped below 4,000 cfs) 3,900 cfs in the period between 2000 and 2010 (Bean and Stephenson 2011), though summer flows have dropped below 5,000 cfs in nine years between 2000 and 2010 (USFWS 2012). When the Company foresees that periods of low flow are approaching downstream of Milner Dam, they begin shaping flow from Lower Salmon Falls Reservoir downstream through Swan Falls Reservoir such that flows above 3,900 cfs are maintained. In all low water years since 1984 this strategy has worked to avoid dropping flow to 3,900 cfs at the Murphy Gage (Bowling pers. comm., 2015a). On May 6, 2015, the Company contacted the Service's Idaho Fish and Wildlife Office (IFWO) to advise that Snake River flow may drop below the 3,900 cfs minimum during the 2015 irrigation season (Tucker *in litt.* 2015) and to discuss the implications for snail (Snake River physa) habitat. The Company contacted the IFWO in 2014 for the same reason, but discharge from Swan Falls Dam did not drop to the minimum flow in that year. Issuance of a water call by the IDWRB requires some processing time, and the Company would need to make the request with enough lead time to avoid hitting or dropping below the minimum.

Forecasting the exact week or day that less than minimum flow would be released from Swan Falls may be difficult, however. Since a water call would entail reduction or stoppage of water to some irrigated fields, the IDWRB may need information showing that high probability of discharge from Swan Falls Dam less than the minimum is imminent before acting to maintain 3,900 cfs. This means that, due to processing time, the curtailment order to water users and their subsequent compliance could occur after discharge at Swan Falls Dam has decreased to less than 3,900 cfs.

The Service's Swan Falls Opinion (USFWS 2012) concluded that degradation of Snake River physa habitat downstream of Swan Falls Dam due to conditions stemming from low flows was part of the environmental baseline (i.e., degradation was already occurring prior to relicensing). Our indirect effects analysis from that Opinion assumed that nutrient input to the Snake River from agricultural and municipal sources will remain relatively constant for at least the near future. Chambers *et al.* (1991) implied that even small decreases in water velocity will increase macrophyte growth (section 2.4.1.2.2), in part by increasing nutrient uptake. We concluded that the decrease in the Company's minimum summer flows from 5,000 to 3,900 cfs would indirectly affect Snake River physa by further contributing to macrophyte growth due to decreased current velocity in the Swan Falls action area during the part of the year when macrophytes would typically exhibit the highest rate of primary production under warm water temperatures and high insolation. Reduction to flow of less than 3,900 cfs would have the same effects. We also stated that we considered the impacts of low summer flows, nutrient load, and sediment deposition in the Swan Falls action area, particularly in the Walter's Ferry Reach (RM 441.9-395.5), to be the most significant threat to the persistence of Snake River physa downstream of Swan Falls Dam.

In large part it is the existence and operation of the Reclamation projects upstream of Milner Reservoir which, by storing and slowly releasing runoff, has lowered peak flows and delayed runoff volume, and which led to the ability to fully allocate and fulfill water rights for consumptive use of Snake River flows roughly equal to average and dry conditions (minimum, 50% and 90% exceedance in Figure 7) upstream of Milner Dam. This in turn, combined with the substantial amount of flows diverted upstream of American Falls Reservoir by privately held water rights, has led to the demand in many years to divert at Milner Dam, for irrigation purposes, most or all remaining runoff and available summer flow derived from upstream of American Falls and released past Minidoka Dam. This has resulted in the two-river system, whereby river recharge and flow downstream of Milner Dam (particularly downstream of C.J. Strike Dam), is typically far less than historic flows and insufficient to ameliorate the negative effects of high sediment and nutrient load on native aquatic species, including Snake River physa.

RMJOC future conditions analysis suggests that zero flow at Milner Dam may become more frequent and of longer duration compared to historic conditions as a result of less natural instream flow available during the irrigation season. Frequently, under existing and historic conditions, when irrigation demand can be met via use of natural instream flow, flow in excess of irrigation needs is passed downstream of Milner Dam and there is less drawdown of the upstream reservoirs to meet irrigation demand. However, under future projected conditions, with more of the annual precipitation having runoff prior to the beginning of irrigation season compared to historical conditions, natural instream flow during irrigation season will be less, and more of irrigation demand will of necessity be met from stored reservoir water. This will more frequently result in less natural instream flow, leading to a higher frequency of zero flow past

Milner Dam. Less natural instream flow was projected even under the four "wetter" scenarios due to timing of runoff and finite reservoir storage space. If future conditions drier than the minimally driest scenario prevail, the likelihood of zero flow at Milner Dam throughout the irrigation season may become the norm except for salmon flow augmentation. Thus, the RMJOC's future hydrologic conditions analyses suggest the possibility that low summer flows approaching 3,900 cfs may become more frequent downstream of C.J. Strike Dam, with resultant impacts to Snake River physa habitat as described above.

Effects to the ESRPA were not modeled by RMJOC, and this inserts additional uncertainty into our evaluation involving the Company's minimum flow. Discharge of springs emerging from the ESRPA have been decreasing since the 1950s, due to more efficient delivery and application of irrigation water; development of groundwater pumping; periods of drought; and climate change (IDWRB 2013, *in litt.*). The effects of future irrigation and municipal water demands, how increased precipitation as fall and winter rain will affect volume and timing of groundwater infiltration, and of longer and warmer growing seasons on aquifer recharge are all uncertain, and will also affect the availability of instream flow in excess of 3,900 cfs downstream of C.J. Strike Dam.

2.4.1.2.4 Habitat Connectivity

Assuming that Snake River physa existed throughout its known range at the time, the completion of Swan Falls Dam in 1901 erected the first man-made barrier to divide Snake River physa populations into upstream and downstream segments. The importance of movement between Snake River physa colonies for the species reproduction and population viability is not known, but a reasonable assumption is that at least active movement (crawling upstream and downstream) and passive transport (carried downstream by current) would play important roles.

Working with Bliss Rapids snails, Liu and Hershler (2009, p. 1295-1296) found no evidence that fragmentation of the Snake River by large dams in the river section inhabited by Bliss Rapids snails has resulted in reduced genetic diversity in riverine populations separated by the dams. The authors noted that passive transport of Bliss Rapids snails downstream in the Snake River mainstem, with individuals occasionally passing through the reservoirs and over the dams, would account for similar levels of genetic diversity and elevated gene flow among the mainstem populations separated by dams.

The known range of Snake River physa in the Snake River, however, covers more than five times the range of the Bliss Rapids snail and is divided by eight dams compared to three dams in the range of the latter. Besides the dams functioning as possible physical barriers to snail passage, decreased water velocity and accompanying sediment deposition that occurs upstream of dams creates habitat unsuitable for Snake River physa, typically for many miles upstream of a given dam. Such long stretches of unsuitable habitat created by dams are also almost certainly barriers to connectivity of Snake River physa habitat, and thus function to restrict recruitment and the genetic diversity of the species in the Snake River, with possible impacts to population viability downstream of the Minidoka Reach.

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.

2.5.1 Review of Relevant Life History Factors and Factors Affecting the Species in the Action Area

In section 2.3.1.3 (Life History) we describe Snake River physa habitat requirements that include water velocity sufficient to preclude the presence of fines and macrophytes on the species' preferred substrates. In section 2.4.1.2.1 (Water Quantity, Current Operations), we introduced mountain white fish spawning habitat as a surrogate for Snake River physa habitat in Table 4. In sections 2.4.1.2.2 (Water Quality, Current Operations), we noted that despite that mountain white fish spawning habitat may overestimate Snake River physa habitat, Table 4 still indicates a loss of Snake River physa habitat as flow drops to the 3,900 cfs minimum flow set by the Swan Falls Agreement. This unsubordinated water right of the Company is the guarantee of summer flows in excess of input from irrigation returns and small creeks between C.J. Strike Dam and the Owyhee/Boise rivers confluence, outside of salmon flow augmentation. In sections 2.4.1.2.2 (Water Quality, Current Operations) and 2.4.1.2.3 (Future Hydrologic Conditions) we reference the conclusion of our analysis in the Swan Falls Opinion (USFWS 2012) that low flow conditions (reduced water velocity) and nutrient input lead to sediment deposition and macrophyte establishment and growth over Snake River physa habitat in the Swan Falls Reach and that these factors were leading to Snake River physa habitat degradation under environmental baseline conditions. Also in section 2.4.1.2.2 we describe the sediment input to the Snake River beginning downstream of C.J. Strike Dam. In these latter two sections we also reference the research (Chambers *et al.* 1991, Biggs 1996) linking low water velocity conditions to sediment deposition and macrophyte establishment (with macrophyte density as a function of nutrient levels). In Future Hydrologic Conditions we describe the Swan Falls Agreement and its affirmation that state policy remains that Snake River minimum flow at the Milner gage is zero. The information and analyses in these and other sections establish that a physical loss of habitat occurs at low flows less than historical, and establishes the link between low flows (low water velocity less than 0.57 meters per second) and the impact of sediment deposition and or nutrient levels on Snake River physa habitat in the action area.

Under Future Hydrologic Conditions, we also described the interconnection between the existence and operation of Reclamation projects upstream of Milner Dam and the ability for and demand to divert all available runoff and summer flows at Milner Dam for irrigation purposes in average to low water years.

2.5.2 Direct and Indirect Effects of the Proposed Action

2.5.2.1 Spillway Area and Minidoka Reach

Adaptive Management Surveys

Impacts to Snake River physa from the adaptive management surveys may result from suction dredging, handling (includes time in a sorting tray), and return to the spillway area. These surveys will allow for monitoring of Snake River physa as operations change in an effort to assess the effects of these changes on the species' abundance and distribution within the spillway reach (see below). Monitoring of the species downstream and outside of this area is being conducted to provide a level of scientific control, monitoring the species abundance in habitats not affected by the proposed action. The Service issued Reclamation Recovery Permit #TE-056557-5, with Terms and Conditions, for Reclamation's adaptive management surveys. Effects to Snake River physa from the adaptive management surveys were analyzed in an intra-Service section 7 consultation (USFWS 2012, *in litt.*) as part of the permitting process.

Spillway Area

Proposed Minimum Spillway Flows

As presented in the Proposed Action, Reclamation will implement an adaptive management approach to determine the level of minimum flows into the spillway area during irrigation season. The goal of the adaptive management process, regarding Snake River physa, is to determine or estimate the minimum summer flows that can be achieved and that will minimize or avoid impacts to Snake River physa in the snail pool, or elsewhere in the spillway area if they exist there. The reduction in spillway flow from 1,900 cfs will begin July 1in the first adaptive management year (2015 in Table 1). Monitoring of Snake River physa in the snail pool will not begin until sometime in mid to late August of a given year, with monitoring results evaluated later that autumn. If a reduction in flow resulted in impacts to Snake River physa, the effect may not be known until sometime after the fact, meaning individuals in the snail pool could be exposed to impacts until irrigation season is finished or until monitoring data is evaluated. Such impacts might result from but not be limited to deposition of fines in the pool onto Snake River physa suitable habitat due to decreased water velocity; stranding of individuals that ventured onto or laid eggs on pool substrate that is subsequently de-watered at the lower flow; or reductions in dissolved oxygen due to reduced flow upstream of and in the snail pool during summer when water temperatures are high and result in less overall dissolved oxygen in Lake Walcott and in the spillway area.

Direct effects to Snake River physa from sediment deposition may include loss of foraging habitat due to covering of periphyton, resulting in loss of fitness or mortality from starvation; or suffocation or crushing of individuals or eggs. If individuals release from the substrate to evade sediment deposition, indirect effects may occur if they are carried downstream out of the pool into unsuitable habitat and later perish from starvation, or are unable to reproduce. Direct effects may occur if individuals or eggs that are stranded above decreasing water levels when flows are reduced desiccate and die. Within the temperature ranges in which freshwater snails live and reproduce, metabolic activity would typically increase with temperature increases, with an associated increased demand for oxygen. In addition, dissolved oxygen decreases as water temperatures rise. Hence, elevated summer temperature along with associated thermally-induced anoxic conditions can be expected to lead to physiological stress and mortality. The probability of such effects would be expected to increase as dissolved oxygen levels decrease to anoxic levels and remain below the 6.0 mg/L Idaho state standard for cold water aquatic life (IDAPA 58.01.02, section 250) during summer water temperature conditions.

Summer water release into the spillway will come from the new radial gates located in closer proximity to the snail pool. Further, the pressure of water released from the bottom of the radial gates will result in higher water velocity at the point of release compared to the surface releases from the old structure. Combined with shortened flow distance to the snail pool, the increased velocity of released water, even under whatever minimum summer flows are agreed to, may ameliorate some or all of potential impacts to the species that might otherwise result from decreased spillway flows.

Given the relatively low and inconsistent detection of Snake River physa in the snail pool historically, it may be difficult to associate the species' abundance with the proposed changes in operation. Assuming that existing conditions have sustained a small Snake River physa colony in the snail pool (sporadic recoveries of individuals in the pool in small numbers staggered over a period of several years suggests this is the case), the effects of attempts to change those conditions may not be measurable by detectable numbers of Snake River physa alone. Conservation of known and assumed Snake River physa habitat requirements in the snail pool consistent with measurements of those requirements where the species can be consistently recovered may be the final determinant of minimum spillway flows for Snake River physa.

In the 25 to 50 percent of years when water deliveries from American Falls result in a low pool (≤ 100,000 acre feet) in American Falls Reservoir and Lake Walcott is subsequently drafted in order to meet downstream irrigation demands (section 2.4.1.2.3, p. 61), impacts to Snake River physa may result from sediment mobilization and transport from American Falls Reservoir and/or Lake Walcott over the Minidoka Dam spillway area. These conditions could occur in low water years when spillway area flows may have already been reduced to whatever minimum the technical team has determined. If this is the case, sediment deposition in the pool may lead to direct effects to Snake River physa similar to those described earlier in this section, including suffocation or crushing of individuals or eggs. Indirect effects to individuals may occur if they release from the pool substrate to avoid sediment deposition and be carried downstream into unsuitable habitat. If in fact future conditions in the Snake River subbasin become drier than the range of projections used in the RMJOC analyses, the likelihood and frequency of significant drawdowns in American Falls Reservoir may increase, leading to higher frequency of these direct and indirect effects. Again, the likelihood of increased water velocity through the snail pool resulting from the location of and bottom release from the new radial gates might ameliorate the effects of increased sediment load in the spillway during drafting of American Falls Reservoir.

In summary: the adaptive management reduction in spillway flows may result in impacts to Snake River physa individuals or eggs from sediment deposition, stranding, or reduction in dissolved oxygen, leading to loss of forage, suffocation, or crushing, desiccation if stranded, or transport away from suitable habitat while avoiding sediment deposition. These impacts may be ameliorated by increased water velocity into the snail pool. A delay in assessing such impacts may occur due to the time lag between reduction in spillway flow and the monitoring period. Sediment transported from American Falls Reservoir in low water years under existing or future hydrologic conditions when American Falls is drafted below minimum pool may be carried over Minidoka Dam to be deposited in the snail pool, particularly if spillway flows are already at the minimum chosen by the technical team. Potential direct and indirect effects and possible amelioration are the same as described for sediment deposition incurred from the adaptive management process. Given that the snail pool may have experienced sediment deposition when American Falls Reservoir has been previously drafted below minimum pool (section 2.4.1.2.3, p. 61) and Snake River physa has since been recovered from the snail pool, such effects are considered to be short term. However, due to the small size of the pool—about one acre—with even less Snake River physa suitable habitat present (a portion of the pool bottom is consolidated bedrock [USBR 2014a]), combined with the species' characteristic of diffuse populations, it should be noted that changes in conditions affecting Snake River physa in the snail pool may rise to the level of affecting all individuals in the pool.

Minidoka Reach

As discussed in section 2.4.1.2.3 (Future Hydrologic Conditions), projections for all scenarios indicated that irrigation demands would be met upstream of Milner Dam. Thus, whether originating largely from natural flows or from reservoir storage, flows would be released past Minidoka Dam to fill the four irrigation canals at Milner Dam, as occurs under existing conditions. This suggests that future summer flows in the Minidoka Reach may fall in the range of existing conditions experienced by Snake River physa, although the frequency of some impacts may increase.

Summer Flows

The spillway area discussion above regarding the impacts to Snake River physa from sediment deposition resulting from low water deliveries from American Falls also applies in the Minidoka Reach. In years with low pool conditions in American Falls Reservoir, sediment mobilization and transport from American Falls Reservoir to the Minidoka Reach may occur. Sediment may fall out of the water column leading to direct impacts to Snake River physa, including suffocation or crushing of individuals or eggs. Sediment deposition is more likely to occur in areas where water velocity is less than 0.57 m/s (Gates and Kerans 2010). Indirect effects to individuals may occur if they release from Reach substrates to avoid sediment deposition and be carried downstream into unsuitable habitat. If in fact future conditions in the Snake River subbasin become drier than the range of projections used in the RMJOC analyses, the likelihood of significant drawdowns in American Falls Reservoir may increase, leading to higher frequency of these direct and indirect effects in the Minidoka Reach. Drawdowns of American Falls Reservoir likely leading to sediment transport into the Minidoka Reach have occurred before and during Reclamation sampling periods in the Reach. While sediment deposition over Snake River physa habitat in the Reach may have occurred during past drafts of American Falls Reservoir, with possible direct and indirect effects to the species, based on their ability to consistently recover in the Minidoka Reach such effects do not appear to have affected the stability of Snake River physa colonies in this section of the river. This conclusion appears to be supported for at least the year 2007: American Falls Reservoir was drafted to below 50,000 acre feet in 2007 (Newman and Hildreth pers. comm., 2015), and Gates and Kerans (2010), sampling in August and October of 2007 increased the total number of Snake River physa recovered and the number of specimens recovered per sample that year compared to their results from 2006 (section 2.4.1.1.1) when American Falls was not drafted below 100,000 acre feet. Hence, while past drawdowns may have affected directly or indirectly Snake River physa in the Minidoka Reach, and possibly may have affected the population, the effects are considered short term under historic conditions, though their frequency may increase under drier climate change projections.

Proposed Winter Flows

The proposed minimum winter flow of 425 cfs is consistent with the range of flows experienced by Snake River physa in the Minidoka Reach for many decades (Gates and Kerans 2010). Gates and Kerans (2010) recorded that substrates suitable for Snake River physa habitat are found above this low water level, in areas inundated during runoff and higher irrigation season flows. Reclamation's estimates of unregulated flows at Minidoka indicate historical winter flows in the range between 6,500 cfs to just under 10,000 cfs. Reice *et al.* (1990) argued that lotic species' behavior and life history stages may evolve to minimize losses to the species exposed to predictable disturbance regimes, such as annual discharge events. Gates and Kerans' (2010) finding that Snake River physa were rarely recovered in winter de-watered habitat even when this habitat was inundated and available during the irrigation season may suggest a species adaptation to this predictable absence of habitat. If correct, the species' adaptive response (avoid dispersion into areas de-watered every year) may have been a trade-off between minimizing losses to the predictable winter disturbance (low flows) and giving up some reproductive capability in additional habitat made available during the assumed Snake River physa reproductive period when summer flows are higher. If so, the proposed continuation of minimum winter flow is expected to lead to the indirect effect of diminished reproductive capacity, due to avoidance of summer habitat potentially suitable for reproduction.

Gates and Kerans (2010) did recover a few live Snake River physa in areas that are de-watered in winter. Thus there is potential for individuals to be stranded above the winter de-watered areas when flows are decreased at the end of the irrigation season, leading to the direct effects of desiccation and death. Out of 271 live Snake River physa recovered in 3 sample years, Gates and Kerans (2010) recovered only 10 (3.7 percent) in seasonally de-watered areas (section 2.4.1.2.1), which suggests that numbers of individuals so stranded in any given year can be expected to be few. There is no evidence to suggest that this small percentage of Snake River physa found in the seasonally de-watered areas is other than normal. Therefore, we expect that loss of comparative percentages due to the direct effects of reducing flows at the end of the irrigation season to the proposed minimum flows would not rise to the level of population effects in the Minidoka Reach.

Salmon Flow Augmentation

If the range of flows in future discharge of salmon flow augmentation remain similar to those in Table 3, in most years salmon flow augmentation will impose a direct beneficial effect in the Minidoka Reach by increasing water velocity, which will aid in keeping fine sediment suspended, possibly ameliorating some effects of sediment transport into the Reach during years when American Falls is drafted below 100,000 acre feet. Since Snake River physa seldom inhabit the areas of the river bottom that are inundated during the irrigation season, additional habitat watered by salmon flow augmentation is considered to be insignificant to the species. The extent of the beneficial effect will vary by water year. In some years the largest fraction of augmentation flow has come from the Boise and Payette Rivers, in other years from the Snake River above Minidoka Dam. In addition, the RMJOC climate change analysis indicated that future hydrologic conditions may lead to the ability to meet the 427,000 acre feet delivery more frequently compared to existing conditions, but the full 487,000 acre feet may become more difficult to meet (USBR *et al.* 2011a). To the extent that flow from above Minidoka Dam contributes to the total salmon augmentation flow, this will also provide a direct beneficial effect to Snake River physa habitat downstream of Milner Dam during the critical summer period when nutrient input and insolation are high and water velocity has otherwise decreased due to irrigation demands at Milner Dam. During the period of augmentation flow, the increased discharge passed downstream of C.J. Strike and Swan Falls dams will contribute, even if by small amounts, to increased water velocity, and possibly reducing sediment deposition over areas of potential Snake River physa habitat. Since augmentation flow released past Minidoka Dam will take several days to reach C.J. Strike Dam, increased water velocity leading to less sediment deposition in that area would be a beneficial indirect effect (resulting from the action of releasing augmentation flow, occurring later in time from the release, and reasonably certain to occur) to the species.

2.5.2.2 Milner Dam to Brownlee Reservoir

As indicated in sections 2.4.1.2.1 and 2.4.1.2.3, Reclamation's O&M upstream of Milner Dam contribute to de-watering the Snake River downstream of Milner Dam, via the storage and diversion of water from Reclamation projects. Since there are no changes proposed for Reclamation's future O&M that would change flows released from Minidoka Dam, impacts from Reclamation's contribution to zero flows at Milner Dam are expected to continue for the effective duration of this Opinion.

As indicated in section 2.4.1.2.3, zero flow at Milner Dam may mean that flow passing C.J. Strike Dam may be derived solely from river recharge beginning downstream of Pillar Falls. In average or dry water years, for some period during the irrigation season flow passing C.J. Strike Dam may be reduced to the Company's unsubordinated water right of 3,900 cfs. These low flow conditions may occur gradually or abruptly, depending on how operations are conducted at Milner Dam, but will result in de-watering some portion of the river channel, which could include suitable or occupied Snake River physa habitat, and will result in reduced water velocity. With reduced water velocity, the cumulative sediment load (and accompanying nutrient load) entering this section of the Snake River is likely to result in sediment deposition over potential or occupied Snake River physa habitat. Direct effects of de-watering and sediment deposition may include:

- Injury or mortality of individuals or eggs to desiccation as habitat is de-watered;
- Injury or mortality of individuals or eggs due to suffocation or crushing during sediment deposition;

Indirect effects of de-watering of habitat, and sediment and nutrient deposition, may include:

- Loss of habitat for foraging and reproduction, leading to reduced individual or colony fitness;
- Establishment and proliferation of macrophyte beds, in turn leading to reduced water velocity and additional sediment and nutrient deposition, with further effects to the species of injury or mortality due to suffocation or crushing during sediment deposition; loss of habitat for foraging and reproduction, leading to reduced individual or colony fitness.

In addition, the frequency of low or zero flow at Milner Dam during irrigation season may increase under projected future hydrologic conditions, leading to longer and more frequent periods of low summer flows approaching or reaching 3,900 cfs downstream of C.J. Strike Dam, with effects as described above.

2.5.3 Effects of Interrelated or Interdependent Actions

There were no effects of interrelated or interdependent actions identified for this project.

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 Operations at Milner Dam

In section 2.4.1.2.1 we stated that during the irrigation season the Snake River upstream of Milner Reservoir is regulated by Reclamation projects primarily to satisfy irrigation demands in the Snake River plain, with a control point at Milner Dam where system storage and flood control operations are balanced to maximize storage in the system above this point. Due to the exercise of water rights and a more or less stable amount of irrigated land under cultivation each year, we expect the water user demands for instream or storage water rights received via the diversions at Milner Dam to remain relatively consistent for the foreseeable future. For this reason we expect that the owners/operators of the privately-owned Milner Dam will continue to control water releases from Milner Dam in a manner consistent with their operations prior to this consultation. Such operations are expected to lead to periods of low or zero flow past Milner Dam during future irrigation seasons. Low or zero flow at Milner Dam will contribute or lead to low flow conditions downstream of C.J. Strike Dam (i.e., approaching or reaching 3,900 cfs). The effects of low flows on the Snake River physa and/or its habitat downstream of C.J. Strike Dam may include:

- De-watering, which may result in a loss of Snake River physa wetted habitat, reducing habitat available for foraging or reproduction; and may injure or kill individuals or eggs due to desiccation;
- Reduction in water velocity, which leads to deposition of sediment and nutrients (derived from agricultural returns to the Snake River) onto Snake River physa suitable habitat, rendering habitat unavailable or unsuitable for foraging or reproduction by the species, and which may injure or kill individuals or eggs due to crushing or suffocation;
- Reduction in water velocity which leads to macrophyte establishment, which in turn reduces water velocity resulting in further sediment deposition, with effects to the species similar to the previous bullet.

In addition, the frequency of low or zero flow at Milner Dam during irrigation season may increase under projected future hydrologic conditions, leading to longer and more frequent periods of low summer flows approaching or reaching 3,900 cfs downstream of C.J. Strike Dam, with effects as described above.

2.6.2 Changes in Water Use Resulting from Climate Change

Cumulative effects from climate change that may affect future hydrologic conditions in the action area have already been discussed. The RMJOC did not model how activities related to industrial and residential development, agricultural, and grazing may change in response to climate change. Large scale changes in livestock choice or crop choice (e.g., from dairy to beef cattle; from high to lower water consumption, or vice versa) in response to changes in water availability may affect water quantity, timing, and quality in the Snake River upstream of Minidoka Dam, and thus affect Snake River physa stability and habitat in the Minidoka area.

2.6.3 Aquifer Recharge

The state of Idaho declared a moratorium on new groundwater pumping permits in the ESRPA beginning in 1992, but periods of drought combined with continued exercising of the existing groundwater water rights have resulted in persistent mining of the aquifer. Idaho has embarked on a Comprehensive Aquifer Management Plan that employs several strategies designed to stabilize the aquifer: managed aquifer recharge; conversion of irrigation via groundwater to surface water; demand reductions (increasing water use efficiencies); and weather modification (IDWRB) 2013, *in litt.*, p. 3). In 2014, the Idaho legislature passed House Bill 547, which in part appropriated 5 million dollars annually to be utilized by the IDWRB for aquifer stabilization. Managed aquifer recharge will essentially utilize Snake River flows in excess of existing water rights, when such excess water is available, and may be funded by private entities, the state, or both. Excess flows will be delivered to several recharge sites via existing canal systems. An analysis of the potential effectiveness of recharge at several recharge sites proposed by the IDWRB suggests there is a likelihood of significant increases to flow in the western end of the ESRPA (Johnson 2012, p. 67-84), and hence to springs emerging from the ESRPA downstream of the Twin Falls. To date, most aquifer recharge has been accomplished utilizing water stored upstream of American Falls Dam (Tuthill *et al.* 2014).

Since enhanced spring flow emerging from the ESRPA would provide habitat for Snake River physa in the Snake River downstream of Pillar Falls, the quality of water used for managed aquifer recharge is of concern to the Service; there is potential that some types of contaminants may resist filtration and be carried through the ESRPA into spring discharge. Water quality of aquifer recharge water is managed by the State of Idaho through the IDEQ and the Idaho Department of Water Resources (IDWR). Managed aquifer recharge "occurs when surface water or treated wastewater is intentionally added to an aquifer . . . either through injection wells or by applying water to the land surface (land application), allowing the water to infiltrate down" (IDEQ *in litt.* 2015). Idaho Wastewater Rules (IDAPA 58.01.16.600) require that water intended for recharge via land application "must be restricted to the premises of the application site." No permit is required under the Wastewater Rules to apply recharge water via land application, but the applicant must develop a ground water monitoring program, subject to approval by IDEQ, to monitor ground water quality in proximity to the recharge application site. Land application of certain types of wastewater does require a permit under Idaho Recycled Water Rules (IDAPA 58.01.17). Managed aquifer recharge via injection wells is managed by the IDWR. Injection wells are permitted by the IDWR under the Underground Injection Control (UIC) program, delegated to IDWR by the Environmental Protection Agency in 1985 under the U.S. Safe Drinking Water Act (SDWA). Most injection wells regulated by the IDWR UIC (under IDAPA

37.03.03) are storm water, agricultural return flow, and heat exchange systems (IDWR *in litt.* 2015). Subsurface contamination can readily occur via injection wells, and IDWR can require mitigation, cleanup, fines, and legal fees if a well owner or operator is deemed liable for contamination (IDWR *in litt.* 2015). The burden of proof that a proposed injection of water or fluid will *not* lead to groundwater contamination under the SDWA is on the permit applicant. If an applicant fails to show that a proposed injection is safe, the SDWA requires that the IDWR deny the permit (U.S. Court of Appeals, 9th Circuit 2011).

RMJOC projections indicate increased inflow to Snake River reservoirs upstream of Brownlee Reservoir from October to May. Hence, the timing of aquifer recharge will likely default to winter, when excess water is available. However, if future conditions drier than projected prevail, use of winter/spring precipitation and runoff for aquifer recharge may further reduce the amount of late irrigation season Snake River reservoir inflow and increase use of stored water for irrigation, with potential to affect the amount of water available in the Minidoka Reach. We assume that aquifer recharge water that is discharged back into the Snake River downstream of the Twin Falls will be allocated to existing water right holders for irrigation purposes downstream of King Hill, and in low water years will not likely pass C.J. Strike Dam.

2.7 Conclusion

2.7.1 Upstream of Milner Reservoir

The Service has reviewed the current status of Snake River physa, the environmental baseline in the action area, including future hydrologic conditions, effects of the proposed and interrelated and interdependent actions, and cumulative effects, and it is our conclusion that the proposed action involving Reclamation's future O&M upstream of Milner Dam is not likely to jeopardize the species' continued existence in the Minidoka spillway and in the Snake River between Minidoka Dam and Milner Dam. No critical habitat has been designated for the species, therefore none will be affected. Our conclusion is based on the following rationales.

In our 2012 Swan Falls Opinion (USFWS 2012) we stated:

> "Due to conditions prevailing in the Minidoka Reach (low sediment deposition, current velocities that keep Snake River physa preferred habitat relatively free of fines, very low occurrence of macrophytes, and relatively large and contiguous areas of preferred substrates), the Service considers the Snake River physa population in this reach to be relatively stable."

The process of jeopardy determination involves the assessment of the effects of the proposed action in combination with any cumulative effects to determine if the proposed action will appreciably reduce the likelihood of both the survival and recovery of the species. Survival is the condition in which a species continues to exist into the future while retaining the potential for recovery (USFWS and NMFS 1998, p. 4-35). We further stated that if the Minidoka populations remained stable, the species would persist for the length of the Swan Falls license (30 years) and retain the potential for recovery even if the populations in the Swan Falls action area were measurably reduced. Our analysis in this Opinion supports this conclusion. In so far as we can assess the effects of future Reclamation operations and maintenance upstream of Milner Dam based on the proposed action and projected future hydrologic conditions derived from the

RMJOC climate change projections, we anticipate the Snake River physa population in the Minidoka Reach to remain relatively stable, under the proposed action, through 2034.

The existing Snake River Aquatic Species Recovery Plan (USFWS 1995) does not contain recovery criteria specific to Snake River physa. The existing criteria were written to encompass all five aquatic snail species listed within the Recovery Plan and we no longer consider them to be objective or measurable (USFWS 2014). The known habitat requirements of Snake River physa have been described in this Opinion, and differ from those stated in the recovery plan. For example, while Snake River physa may occasionally be found on rock and boulder substrates in cold water averaging below 18 °C (two of the habitat requirements given for all five snail species listed in the recovery plan), more recent evidence indicates the species selects for gravel to pebble substrates, and water temperatures above 22 °C do not appear to be limiting to the species.

In keeping with the intent of the existing recovery criteria, we conclude that the proposed action upstream of Milner Reservoir does not preclude the survival or recovery of Snake River physa as follows. The recovery plan (for all five snail species) states that recovery will be based on detection of increasing, self-reproducing colonies at pre-selected monitoring sites within each species recovery area for a 5-year period. While there is as yet insufficient information to determine population trends in the Minidoka colonies with acceptable confidence, the species has been predictably recovered from the same locations in six different years over an 8-year time span. There are no known colonies upstream or downstream which could be contributing to the Minidoka colonies, which argues that these colonies are most likely self-sustaining. Should Snake River physa colonies be found elsewhere in the species' range, or should suitable habitat be found or restored within its range, the stability of the Minidoka colonies (described in this section) may allow, for example, recovery efforts such as translocation of Snake River physa from Minidoka to attempt colonization of such habitat.

These conclusions should not be construed to mean that future hydrologic conditions, future climate change projections, changes in irrigation or other water demands, or other factors not listed here that may affect water volume, timing, and delivery in the Snake River upstream of Milner Dam should not be monitored and evaluated with respect to effects to Snake River physa.

It is important to emphasize that the preponderance of factors affecting Snake River physa in the Minidoka Reach result and will continue to result from existing and future Reclamation O&M, and the conservation and stability of the Minidoka Snake River physa colonies will largely depend on Reclamation's future actions upstream of Milner Reservoir.

2.7.2 Downstream of Milner Dam

In our Swan Falls Opinion (USFWS 2012) we stated that we considered the impacts of low summer flows, nutrient load, and sediment deposition in the Swan Falls action area to be the most significant threats to the persistence of Snake River physa downstream of Swan Falls Dam. In this Opinion, we extend that conclusion to the C.J. Strike Reach. Projected climate and hydrologic conditions to 2039 suggest an increased probability of more frequent zero flow past Milner Dam, subsequently leading to a higher probability and frequency of flows downstream of C.J. Strike Dam to the Owyhee-Boise River's confluence approaching or meeting 3,900 cfs with probable subsequent impacts to Snake River physa habitat as described in previous sections.

Based on our review and analysis, we conclude that the operations of Reclamation projects upstream of American Falls Reservoir, through impoundment and regulation of the Snake River that substantially enhances the capability for use of Snake River water derived from upstream of Milner Reservoir for irrigation purposes, contributes to de-watering of the Snake River at Milner Dam. The frequency with which de-watering occurs concurrently may lead to flows between C.J. Strike Dam and the Owyhee-Boise Rivers' confluence, and possibly to Brownlee Reservoir, that may be insufficient (due to decreased water velocity) to maintain much of the potential Snake River physa habitat in condition suitable for occupancy by the species in that section of the river. It is important to note that, except for renting or shaping water for salmon flow augmentation or entering into voluntary or other agreements affecting flow or water releases, Reclamation does not control the timing and demand for, use of, or hold water rights for the water that is stored in or released through its projects.

It is difficult to quantify the effects of Reclamation's contribution, through de-watering of the river at Milner Dam, to direct and indirect effects to Snake River physa downstream of C.J. Strike Dam due to a number of uncertainties. Variation in effects deriving from natural hydrology aside, low flow conditions downstream of C.J. Strike Dam are also a function of private diversions occurring both upstream and downstream of Milner Dam, and determining the fraction of Reclamation's contribution would be difficult. In addition, the amount of mountain whitefish habitat (a surrogate for Snake River physa habitat) has not been quantified between C.J. Strike Dam and Swan Falls Reservoir. Also, it is not clear if Anglin *et al.* (1992) and Brink (2008) considered effects of sediment deposition and nutrient input in their modeling of changes in mountain whitefish spawning habitat with decreasing flows, or how/if these factors would affect their results. The overlap between mountain whitefish spawning habitat and Snake River physa habitat, while quite good, is not one to one. The nature of river channels in large rivers such as the Snake River results in water velocity often varying considerably with channel shape within a given reach, and so velocity becomes less correlated with discharge. We know that Snake River physa can be consistently found in habitat where sediment deposition and macrophyte establishment are absent or at worst minimal (i.e., in the Minidoka Reach), but we do not know the discharge and water velocity needed to keep the existing irrigation sediment and nutrient load downstream of C.J. Strike suspended (and thus minimize or prevent degradation of Snake River physa habitat during the irrigation season), and we do not know what affect that water velocity itself might have on Snake River physa or aspects of its habitat in this area. Lastly, there have been no confirmed collections of Snake River physa downstream of C.J. Strike Dam since 2002.

While we can state that future Reclamation O&M operations may contribute to affects to the species by diminishing flows in the Snake River, due to the uncertainties stated above there is as yet insufficient information to conclude that the portion of effects resulting from Reclamation's actions would rise to the level of an adverse effect to the species. Therefore, we conclude that Reclamation's future O&M in the Snake River basin between Milner Dam and Brownlee Reservoir may affect but are not likely to adversely affect the Snake River physa.

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.

Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation 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, Reclamation 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 Form and Amount or Extent of Take Anticipated

Take will result from the proposed action by two main pathways:

- Reduction in water velocity:
    - Sufficient to allow sediment deposition, at times or in certain action area locations accompanied by macrophyte establishment and growth, onto Snake River physa suitable habitat;
    - That reduces water depth;
    - That leads to decreases in dissolved oxygen;
- Summer drafting of American Falls Reservoir below low pool (< 100,000 acre feet) accompanied by drafting of Lake Walcott that results in mobilization of sediment from American Falls Reservoir and Lake Walcott to be carried over Minidoka Dam.

Spillway Area, Snail Pool

Take of Snake River physa may occur in the snail pool as Reclamation begins its adaptive management process of reducing summer spillway flows, with a minimum target of 500 cfs. Take may be in the form of:

- Mortality to individuals or eggs from crushing or suffocation due to sediment falling out of the water column at lower velocities. This may occur as a result of decreasing spillway area flows during the adaptive management process, or from sediment mobilized from American Falls Reservoir in excess (amount or size) of the ability of the minimum spillway flow determined by the technical team to keep suspended. The latter may happen more frequently under some climate change projections compared to historical conditions.

- Stranding and desiccation of individuals or eggs as water levels are lowered during the adaptive management process or to the minimum eventually determined by the technical team.
- Sublethal effects or mortality due to reduced dissolved oxygen resulting from decreased water velocity into the snail pool.

There is as yet insufficient data from which to estimate Snake River physa numbers in the snail pool. The design and placement of the new radial gates in relation to the snail pool (located half the distance from the placement of the old spillway structure) are expected to result in an increase of water velocity into the snail pool, which may ameliorate some, possibly all, take resulting from these pathways. However, as stated in section 2.5.2.1, given the small size of the pool, changes in some conditions impacting Snake River physa in the snail pool (e.g., reduction in water velocity), even if short term, may rise to the level of affecting all individuals in the pool. For this reason, take is provided for all Snake River physa in the snail pool through the year 2034.

Minidoka Reach

Take of Snake River physa in the Minidoka Reach may occur as a result of summer drafting of American Falls Reservoir and Lake Walcott; and from reduction of flow from Minidoka Dam at the end of irrigation season. Take may be in the form of:

- Mortality to individuals or eggs from crushing or suffocation due to sediment falling out of the water column at lower velocities. This may result as flows are decreased at the end of the irrigation season, or from sediment mobilized from summer drafting of American Falls Reservoir and Lake Walcott.
- Stranding and desiccation of individuals or eggs as water levels are lowered at the end of the irrigation season.

The ability to estimate the numbers of Snake River physa that may be impacted by Reclamation O&M in the Minidoka Reach is tied to the ability to estimate the area of benthic habitat in the Minidoka Reach that is suitable for Snake River physa, and which lies deeper than the annually de-watered area. The USGS is gathering such data for the control monitoring area near the old Jackson Bridge in conjunction with Reclamation's monitoring of the Snake River physa colonies at that location as part of their adaptive management process. The USGS benthic modeling is incomplete at this time, however, and there are no plans to estimate total habitat available in the entire Minidoka Reach. Without such data, there is no means to estimate Snake River physa abundance in the Minidoka Reach with acceptable confidence, and therefore no means to estimate numbers for incidental take. For this reason, incidental take is assigned based on the following reasoning.

Based on Gates and Kerans (2010) work as described in section 2.4.1.2.1, the numbers of Snake River physa that may inhabit the de-watered zone and be directly and indirectly affected by flow reduction to the winter minimum of 425 cfs are likely to be a small percentage of the population, and effects of proposed winter flows are not expected to rise to the level of population affects. Therefore, incidental take is provided for all Snake River physa in the Minidoka Reach that may be killed, harmed, or harassed when Snake River flows are reduced post-irrigation season to the proposed winter discharge of 425 cfs through the year 2034.

Since Snake River physa presence in the Minidoka Reach appears to be stable, we extrapolate from this that past incidents of sediment mobilization from American Falls Reservoir into the Reach have had short term effects, and likely directly or indirectly affected a limited number of Snake River physa or eggs in the Reach. Under projected hydrologic conditions, the annual frequency of future sediment mobilization events may increase, but there is as yet no evidence that the severity of sediment mobilization may change. Therefore, incidental take is provided for all Snake River physa or eggs occupying benthic habitat in the Minidoka Reach that may be killed, harmed, or harassed due to sediment deposition from sediment mobilized from American Falls Reservoir through the year 2034.

2.8.2 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.

2.8.3 Reasonable and Prudent Measures

The Service concludes that the following reasonable and prudent measures are necessary and appropriate to minimize the take of Snake River physa caused by the proposed action.

1) Minimize the possibility of sediment deposition into the snail pool during in the 25 to 50 percent of years when water deliveries from American Falls result in a low pool (≤ 100,000 acre feet) in American Falls Reservoir and Lake Walcott is subsequently drafted in order to meet downstream irrigation demands.

2) The relatively low and inconsistent detection of Snake River physa in the snail pool may make association of changes in the species' abundance in the pool with proposed changes in spillway flows under the adaptive management process difficult. Reclamation should consider alternate methods by which to measure or monitor the effects of proposed changes in spillway flows on Snake River physa in the snail pool.

2.8.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1) In the 25 to 50 percent of years when water deliveries from American Falls result in a low pool (≤ 100,000 acre feet) in American Falls Reservoir and Lake Walcott is subsequently drafted, Reclamation shall monitor sediment transport and deposition in the snail pool at whatever minimum spillway area flow was determined by the Technical Team. If sediment deposition into the snail pool is found to occur under these conditions (low pool and drafting of the reservoirs), Reclamation shall, while continuing to monitor sediment deposition in the snail pool, manage spillway area flows in such a way so as to increase water velocity to and through the snail pool, until sediment deposition in the snail pool ceases. The increased water velocity in the snail pool shall be maintained until sediment transport from Lake Walcott into the pool ceases in that irrigation season.

2) If during sampling of the snail pool for the adaptive management process, Snake River physa cannot be recovered from the pool in abundance or frequency sufficient to determine effects of reduction in spillway area flows to the snail pool colony, Reclamation shall instead adjust spillway area flows to conserve known and assumed Snake River physa habitat requirements in the snail pool consistent with measurements of those requirements where the species can be consistently recovered.

2.8.5 Reporting and Monitoring Requirements

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)].

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.

1) We recommend that Reclamation work with the USGS or another entity with the appropriate expertise, in order to develop a means to increase the precision of Reclamation's flow calculations based on flow data from the Howell's Ferry gage when compared to the official discharge calculations provided by the USGS (also based on the Howell's Ferry gage), such that the disparity between the two calculations will not result in Reclamation overestimating discharge past Minidoka Dam that leads to winter (non-irrigation) season flows of less than 400 cfs entering the Minidoka Reach. Reclamation should keep the Service apprised of the progress and outcome of this process. If developing a means to achieve this precision is deemed to be unfeasible, then we recommend that Reclamation consider, in consultation with the Service, increasing minimum winter (non-irrigation) flows to a level to include a buffer, based on historical disparities between the two calculations, such that discharge of less than 400 cfs into the Minidoka Reach is considered unlikely within an agreed upon confidence level.

2) Together, the Company (Idaho Power Company) and Reclamation, are the two main entities that conduct the majority of operations and maintenance of projects in the Snake River that affect Snake River physa throughout its known range. Some effects are adverse, and some effects cannot yet be determined if they rise to the level of adverse effects due to lack of data. Analyses in this Opinion should make clear that what happens upstream can have dramatic effects on aquatic life downstream. Decreased river volume and velocity, sediment transport, and nutrient input are the trifecta that results from regulation and diversion of the river that impact aquatic life, including Snake River physa. Therefore, we recommend that Reclamation approach the Company to discuss collaboration and potentials for combining knowledge, expertise, and resources toward designing and conducting studies that may include but not be limited to:

- Determining flow conditions (water velocities, depth, and location) of habitat occupied by Snake River physa in the Minidoka Reach in winter, with the intent to describe the habitat and conditions under which they persist during winter.

- Increase sampling for Snake River physa in the Snake River downstream of C.J. Strike Dam to increase the chance of determining if the species persists in that area of the river;
- Develop models of the benthic habitat downstream of C.J. Strike Dam to locate, if possible, areas of the river where suitable substrates and water velocity are present under minimum flows prescribed under the Swan Falls Agreement;
- Attempt to more precisely model river flow and tributary input in order to determine if a means exists to consistently provide additional flow downstream of C.J. Strike Dam, sufficient to restore Snake River physa habitat or to conserve any existing Snake River physa habitat;
- Attempt to rear Snake River physa in the laboratory in order to study its responses to varying habitat conditions, including but not limited to water quality and contaminants, sediment deposition, and changing water velocity, with the intent to determine the range of habitat conditions under which the species may survive and recover.

Foreseen outcomes of such collaboration may include or lead to:

- The ability to make an informed conclusion as to the presence of Snake River physa downstream of C.J. Strike Dam;
- The range of habitat conditions under which Snake River physa life history needs may be met;
- The extent of suitable Snake River physa habitat, or of restorable Snake River physa habitat;
- Increased flow downstream of C.J. Strike Dam timed to ameliorate or minimize effects of sediment and nutrients on Snake River physa habitat;
- Means to conserve or restore Snake River physa habitat downstream of CJ. Strike Dam.

3) Since a basis for determining future survival and recovery of Snake River physa cannot be assessed without appropriate data, we recommend that after the adaptive management process is concluded, Reclamation develop and implement, in discussions with the Service, monitoring protocols sufficient for determining and tracking Snake River physa population or colony trends in the Minidoka Reach. Such protocols might include but not be limited to: an agreed upon sampling interval; acceptable confidence limits; and lower limits of population or duration of continuous downward trend that indicate conservation measures or changes in Reclamation's O&M may be needed.

2.10 Reinitiation Notice

This concludes formal consultation on Snake River physa for the Bureau of Reclamation's Operations and Maintenance in the Snake River Basin above Brownlee Reservoir. 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.
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.

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4. APPENDICES

4.1 Appendix

U.S. Bureau of Reclamation Memorandum: Amendment to the Bureau of Reclamation's Biological Assessment for Reclamation's Operations and Maintenance in the Snake River Basin above Brownlee Reservoir on Snake River Snail (*Haitia* [*Physa*] *natricina*).

United States Department of the Interior

BUREAU OF RECLAMATION
Pacific Northwest Region
Snake River Area Office
230 Collins Road
Boise, ID 83702-4520

IN REPLY REFER TO:

MAR 2 6 2015

SRA-1207
ENV-1.00

VIA ELECTRONIC MAIL ONLY

MEMORANDUM

To: State Supervisor, U.S. Fish and Wildlife Service, 1387 South Vinnell Way, Suite 368, Boise, ID 83709
Attention: Mr. Michael Carrier (michael_carrier@fws.gov)

From: Jerrold D. Gregg
Area Manager

Subject: Amendment to the Bureau of Reclamation's Biological Assessment for Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir on Snake River Physa Snail (*Haitia [Physa] Natricina*)

In September 2014, Reclamation submitted a Biological Assessment (BA) to the U.S. Fish and Wildlife Service to initiate formal consultation on Reclamation's operation and maintenance activities in the Snake River Basin above Brownlee Reservoir on the Snake River physa snail. It has come to our attention through discussions with your staff that portions of the document are not as clear as intended. Accordingly, we are correcting these inconsistencies and submitting an erratum to the BA.

The inconsistencies are associated with minimum flows past Minidoka Dam, outside of irrigation season (i.e., winter flows). To be clear, Reclamation's proposed minimum flow past Minidoka Dam, outside of irrigation season, will range from 425 to 525 cfs. These flows are the sum of releases through the powerplant, non-volitional releases to the spillway (leakage) and volitional winter spillway flows recommended by the Technical Team. We are also correcting discussions of observed historic flows that are not likely to occur under the proposed action. Specifically, Reclamation has made following changes to the BA:

- **Chapter 2, Page 23: Replace Table 2-1 with Table 1 below.** This table illustrates the flow partitioning between the powerplant and spillway at Minidoka Dam. The previous table incorrectly identified 525 cfs as the post construction powerplant flow, when in fact 425 cfs is the correct powerplant flow. As identified in the BA, spillway flow alterations are a function of the adaptive management process and respective Technical Team operational recommendations. Flow through the powerplant will remain consistent with Table 1 through the duration of the proposed action, identified on page 9 of the BA.

	Spillway Flow (cfs)					Powerplant Flow (cfs)				
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
Nov. 01	<1	<1	<1	<100	<100	400	400	425	425	425
Dec. 01	<1	<1	<1	<100	<100	400	400	425	425	425
Jan. 01	<1	<1	<1	<100	<100	400	400	425	425	425
Feb. 01	<1	<1	<1	<100	<100	400	400	425	425	425
Mar. 01	<1	<1	<1	<100	<100	400	400	425	425	425
Apr. 01	<1,300	<1,300	<1,300	<1,000	<500	<5,035	<5,035	<5,035	<5,335	<5,835
Apr. 15	1,300	1,300	1,300	1,000	500	<8,850*	<8,850	<8,850	<8,850	<8,850
May 01	1,300	1,300	1,300	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
June 01	1,300	1,300	1,300	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
July 01	1,900	1,900	1,500	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
Aug. 01	1,900	1,900	1,500	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
Sep. 01	1,300	1,300	1,300	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
Sep. 15	<1,300	<1,300	<1,300	<1,000	<500	<5,035	<5,035	<5,035	<5,335	<5,835
Oct. 01	<1,300	<1,300	<1,300	<1,000	<500	400	400	425	425	425

*Irrigation season powerplant flows are highly variable within and among years and are dependent upon several factors. Accurate monthly flows cannot be precisely expressed in a single table. The maximum powerplant capacity at Minidoka Dam is 8,850 cfs.

Table 1. Current and proposed Minidoka Dam Powerplant and spillway operations.

- **Chapter 2, Page 26**: In 2.3.5, second paragraph, replace the first sentence with "Following construction, the minimum flow past Minidoka Dam outside of irrigation season will be range from approximately 425 to 525 cfs (24-hour average)."
- **Chapter 3, Page 31**: In 3.1.2, third sentence, replace "525" with "400."
- **Chapter 4, Page 78**: In the last sentence on the page in the parenthesis, replace "approximately 525" with "approximately 425 to 525 cfs."
- **Chapter 4, Page 79**: In the first paragraph, delete the second sentence, which reads, "Reclamation predicts flows below 400 cfs approximately 5 percent of the time."
- **Chapter 4, Page 88**: In the first sentence, delete "and stranding and mortality when flows in the mainstem Snake River are less than 400 cfs, approximately 5 percent of the time."

Because our BA contemplated effects associated with flows ranging to less than 400 cfs, these changes to the BA do not alter Reclamation's analysis or affect determinations. Reclamation recognizes additional time is necessary to incorporate these changes into your draft Biological Opinion (BO) and therefore grants your March 24, 2015, request for an additional 30 days to complete the BO. Consistent with the BA, post-construction operations (Table 1) of the new spillway are scheduled to begin April 1, 2015. These operations will be consistent with previous operations identified in Reclamation's 2005 and 2007 BA's and resultant biological opinions. While operating the facility, Reclamation will not make any irreversible or irretrievable commitment of resources or changes with respect to the proposed action identified in the current (2014) operations BA.

If you have any questions, please contact Mr. Ryan Newman, Natural Resource Specialist, at 208-678-0461, extension 17, or via email at rnewman@usbr.gov.

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