APPENDIX A – CONSULTATION RECORD

Mason Dam Entrainment Report

Elizabeth A OsierMoats to: jyencopal 12/10/2012 10:48 AM

Cc: "Gonzalez, Daniel -FS", gary_miller, "Ken Homolka", "Timothy Bailey"

History: This message has been forwarded.

Jason,

Please see ODFW's comments on the Mason Dam Hydro Project (FERC P-12686) Entrainment Report.
Feel free to contact me if you have any questions.

Sincerely,

Elizabeth A. O. Moats
Hydropower Coordinator, Northeast Region
Oregon Dept. of Fish and Wildlife
107 20th Street
La Grande, OR 97850
Office: 541-962-1832
Elizabeth.A.OsierMoats@state.or.us

ODFWcomments-Rev2EntrainmentRpt.pdf

Oregon
John A. Kitzhaber, MD, Governor

Department of Fish and Wildlife
Northeast Region
107 20th Street
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(541) 963-2138
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December 10, 2012

Jason Yencopal
Baker County
1995 Third Street
Baker City, Oregon 97814

Subject: Mason Dam Hydroelectric Project (FERC 12686)
Report on Fish Entrainment and Mortality at Mason Dam

Dear Mr. Yencopal,

Oregon Department of Fish and Wildlife (ODFW) received the Fish Entrainment and Turbine Mortality Preliminary Draft Report on October 18, 2012. ODFW understands that this report is a "work in progress." ODFW, therefore, provides the following comments to inform the development of the Mason Dam Hydro Project Fish Entrainment and Turbine Morality Report.

1. Page 4, 5th paragraph – A description of water level and thermocline in relation to the water surface is presented. A graphic of this relationship would be helpful.

2. Page 5, Fish Species –Please correct then statement regarding the rotenone treatment and restocking. The treatment was conducted in the fall of 1977 and the reservoir was restocked in the spring of 1978.

3. Page 6, 1st Paragraph – The total number of yellow perch netted per year is presented. Effort, timing and location of nets have varied by year. These data cannot be used to demonstrate population trend because there are too many variables. Yellow perch population estimates have been developed for 2011 and 2012, but the difference is not statistically significant.

4. Page 6, 2nd Paragraph – Please make note that Merwin nets used are designed to capture littoral migrating species such as yellow perch. They are particularly effective to capture yellow perch during their spawning activities when they are moving to spawning grounds. Other open water species were not targeted during this netting and therefore, this data does not present an accurate representation of species composition in Philips Reservoir. Gillnet data could provide a better understanding of species composition.

5. Page 10 – Many references are made to anadromous fish and the proportion of anadromous fish that are captured. Please include a discussion of the importance of anadromy in the analysis and interpretation of entrainment data. Further, please explain why each aspect used to

compare Mason Dam to other entrainment studies is important. Also include a discussion of why other aspects are not included for comparison, such as flow range.

6. Table 4 – How did the species composition of these reservoirs compare with the species composition of Philips Reservoir? In our comments dated March 15, 2011, ODFW noted that fish communities at the studies used for comparison could have an influence on the level of entrainment.

7. Page 18-19 – Entrainment of stocked rainbow trout. In addition to the annual stocking of adult rainbow trout in June, 6-inch sub-adult rainbow trout are stocked in September. ODFW disagrees that the potential impact to these fish is “low to moderate”, as is indicated on page 19. As stated in Appendix A, EPRI reports that 90% of all fish entrained at dams are between 4 to 8 inches. Further, the release location of these stocked fish is within the vicinity of the dam and occurs when the water level is generally nearing its lowest point. Additionally, the dissolved oxygen and temperature data presented in Figures 2 and 3 indicate that conditions at the intake are likely to be suitable for sub-adult rainbow trout when they are stocked in September. Therefore, ODFW believes the entrainment risk is at least “moderate.”

8. ODFW requests that the fisheries management of Philips Reservoir be considered in the analysis of entrainment impacts. Tiger trout were stocked in 2011 and plans are underway to stock tiger muskie in the future. These species are being stocked in an effort to help control the yellow perch population and provide a unique fishing opportunity. Please include a discussion of the entrainment risks to these species. Additionally, the stocking regime for Philips Reservoir is likely to change during the life of the license. The current stocking regime for rainbow trout includes the stocking of adult fish in the summer and sub-adult fish in the fall. To meet the fisheries management goals for Philips Reservoir the long-term stocking goal is to instead stock fingerling rainbow trout. In addition to adult and sub-adult rainbow trout, the report should address the impact of entrainment and turbine mortality on stocked fingerling rainbow trout. In the past 100,000 to 200,000 fingerlings were stocked annually. ODFW requests the report assess impacts on the stocking of 200,000 3-inch fingerling rainbow trout.

9. Page 28, Entrainment Summary – Based on the species entrainment risk and additional studies, an entrainment estimate is provided for the major species. A range of entrainment rates is presented for rainbow trout. The high end of the range (2.6%) is stipulated because the reservoir it represents is regularly drawn down to 12% of its total volume. How does this proportion of drawdown and frequency compare to Philips Reservoir? How often could this be expected during the life of the license? An estimate of the number of rainbow trout entrained through Mason Dam presented based on a population estimate. It does not appear that empirical data are used to inform this estimate; therefore the upper end of the range should be used. Further, does the entrainment estimate include the impacts to stocked sub-adult and adult rainbow trout, as well as juvenile rainbow trout?

10. Page 28, Entrainment Summary, 2nd paragraph – ODFW appreciates the effort to analyze entrainment study results that are more compatible with Mason Dam. The factors influencing fish entrainment are not well understood. The potential entrainment range presented (17,325 to 61,875) is a reasonable estimate based on available information. However, without a scientific field study at Mason Dam, the actual entrainment is unknown. For the purposes of assessing the impacts of the Mason Dam hydroelectric project, ODFW requests further discussion of the final entrainment estimate.

ODFW appreciates the opportunity to work collaboratively with Baker County in the preparation of this report. We look forward to cooperating with you in the future. If you have any questions, please feel free to contact me at 541-962-1832 or Elizabeth.A.OsierMoats@state.or.us.

Sincerely,

Elizabeth A. O. Moats
NE Region Hydropower Coordinator

C: Ken Homolka, ODFW
Tim Bailey, ODFW
Gary Miller, USFWS
Dan Gonzales, USFS

FW: Mason Dam approach velocities
Rieber, Richard W to: jyencopal@bakercounty.org 11/27/2012 06:22 AM

Jason- below is information from Karl Ames, an Engineer's located in our Area Office. If there are any more specific questions related to this, I would recommend contacting Karl either by email (kames@usbr.gov) or phone – (208)383-2268.

Thanks

Rick

Richard W. Rieber
Fishery Biologist
Bureau of Reclamation
1150 N. Curtis Rd
Boise, Id 83706
(208)378-5313
(208)378-5066 fax
rrieber@usbr.gov

From: Ross, Robert W
Sent: Monday, November 26, 2012 1:35 PM
To: Rieber, Richard W
Subject: FW: Mason Dam approach velocities

Rick – see below – less than 2'/sec

From: Ames, Karl S
Sent: Monday, November 26, 2012 1:33 PM
To: Ross, Robert W
Subject: RE: Mason Dam approach velocities

I had that same question about a year and a half ago from the Baker County hydro guy. I came up with a velocity of 1.7 feet per second at the intake trashracks, at the outlet works capacity of 875 cfs.

You have the four intake sides, 10.25' x 11.33', and the top of the intake 10.58' square = an area of 576.5 ft^2. Less the trashrack bars, four intake sides, 21 bars each at 5/8" x 10.25' and the top bars, 20 bars at ¾" x 10.58' = 58.1 ft^2. Open area (A) at intake = 576.5 – 58.1 = 518.4 ft^2. With a capacity (Q) of 875 cfs, the velocity (V) = Q/A = (875 ft^3/sec)/518.4 ft^2 = 1.7 ft/sec. This meets Reclamation's dam intake trashrack design guideline of less than 2 ft/sec. The normal high flow through the outlet is 500 cfs, so the velocity normally would not exceed one foot per second.

If you have any questions on this let me know.

Karl

meeting follow-up
Rieber, Richard W to: jyencopal@bakercounty.org 11/23/2012 09:54 AM
Cc: "Ross, Robert W", "Vidergar, Dmitri"
History: This message has been forwarded.

Jason- I have asked some of our folks to address a few of the questions that came up at this week's meeting. As soon as I hear back, I'll let you know.

In regards to water quality impacts to bull trout near the intake pipe; at this time, Reclamation is not in a position to share information from our draft Biological Assessment. However, we have provided all of the water quality information to you that we have for Phillips Lake and hope that you can make your own interpretations from that information.

If you have any further questions, please contact either myself or Bob Ross.

Thanks

Rick

Richard W. Rieber
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Entrainment Study Work Session Reminder

Jason A Yencopal   to: Audie Huber, Carolyn Templeton, Carl Stiff, Colleen Fagan, GRIFFIN Dennis, Fred Warner, Gary Miller, Kenneth Hogan,   11/15/2012 02:34 PM

Cc: Heidi Martin, Jason A Yencopal

Hello All,

I just wanted to remind those who plan on attending that the work session will be November 20th at 10:00 am, at the Baker County Courthouse on 1995 Third Street in Baker City. For those participating by phone please call 877-820-7831 with a pass code of 8204693#.

Thank you and talk with you soon,

Jason Yencopal
Community Development Director
1995 Third Street
Baker City, OR 97814
541.523.9669 Office
541.523.8201 Fax
jyencopal@bakercounty.org

FISH ENTRAINMENT AND MORTALITY STUDY AMENDMENT COMMENTS

Gonzalez, Daniel -FS   to: jyencopal   11/13/2012 05:03 PM

Cc: "Bonanno, Kristen T -FS", "Tomac, Jeff -FS" , "Archuleta, Shannon R -FS"

Jason:

Thanks for the opportunity to provide comments for the preliminary draft fish entrainment and mortality study-amendment. In general the report documented and highlighted the issues and concerns many of the stakeholders had from the original report. However, many of the conclusions regarding entrainment of various fishes are unsupported. By way of example, the conclusions describing the level of entrainment for fish species found in Phillips Reservoir as describe in the report (none, minimal, low, moderate, and high), did not provide the rationale or justification to ensure the validity of the determinations.

Please review the comments provided and I will contact you and Leslie tomorrow to go over the report and see if I can further assist with developing the draft.

Thank you,

Daniel Gonzalez
Energy Coordinator
PNW Forestry and Range Sciences Lab
1401 Gekeler Lane
La Grande, OR 97850
Office: 541-962-6533
Fax: 541-962-6504

FISH ENTRAINMENT AND MORTALITY STUDY_WORD ONLY_October_2012 DG and KTB Comments 11_09_12.docx

Field Code Changed

FISH ENTRAINMENT AND MORTALITY STUDY
-AMENDMENT-
PRELIMINARY DRAFT

MASON DAM PROJECT
BAKER COUNTY, OREGON
Project Number P-12686-001

Prepared for

Baker County
1995 Third Street
Baker City, Oregon 97814

Prepared by

EcoWest Consulting, Inc.
Baker, OR 97814

October 2012

1.0 Introduction

Baker County conducted a study to address potential effects of the proposed Mason Dam Hydroelectric Project on entrainment and mortality of fish passing through Mason Dam (GeoSense 2011). Agency comments both pre and post study focused on addressing how the study results would translate to changes in mortality of individual species, as well as clarification of the range of baseline entrainment numbers. In addition, new information has been developed regarding how water quality during the seasonal hydroelectric operating period could affect the previous entrainment estimates.

This report provides an amendment to the 2011 entrainment and mortality study. Specific objectives of the amendment are to:

- Revise the baseline entrainment and related mortality rates based on new information regarding deep reservoir intakes, particularly deep, gated intakes.
- Provide updated information on project operation as pertinent to fish species.
- Add a discussion of the potential for individual fish species impacts.
- Update the study with new information from other regional reservoirs, particularly those containing similar fish species as those found in the Mason Dam project area.

2.0 Mason Dam Project Description

The proposed Mason Dam project is described in detail in GeoSense (2011) and not repeated herein other than to clarify project details specific to fish entrainment and mortality.

Based on numerous studies throughout the United States (US), a number of factors have been identified as important in distinguishing the differences between entrainment and mortality under various circumstances (see for example, summaries in FERC 1995, EPRI 1997, Ch2MHill 2003, NAI 2009, Symbiotics 2009; detailed summary in Appendix A).

These factors include:

- Reservoir Characteristics: Operation type, depth and changes in hydraulic head
- Intake Characteristics: Type, depth, velocity and water quality at intake
- Fish species, size and seasonal/daily movements

Each of these factors is discussed individually below.

Reservoir Characteristics

Philips Reservoir is a~~n~~ 2,234 acre-reservoir located behind Mason Dam. Mason Dam has a total height of 173 feet and a maximum hydraulic height of 157 feet. The reservoir has a total storage capacity of 95,500 acre-feet and an active storage capacity of 90,500 acre-feet. Average reservoir depths are 41 feet with a maximum depth of 125 feet (Shrader 2000). Approximately 13% of the full pool reservoir area is considered littoral habitat (Shrader 2000).

Mason Dam is currently regulated for flood control and irrigation. Water is generally stored between October and March and released by the Baker Valley Irrigation District (BVID) for irrigation between May and September 30. The BVID has an agreement with the Oregon Department of Fish and Wildlife (ODFW) to release enough water to meet a 10 cfs (cubic feet per second) minimum instream flow at Smith Dam, which is about 10 miles below Mason Dam. As a result of this requirement and the need to release water for flood storage during the spring, releases average approximately 10 cfs between October and January and increase to an average of 20 to 50 cfs during February and March. During the irrigation season, releases generally remain above 100 to 200 cfs and can go up to 350 cfs.

The proposed project would be run-of-release and not change the operation. The Mason Dam hydroelectric project would operate whenever releases by BVID exceed 100 cfs. These releases do not occur between October and January. Beginning in June and extending through September, releases exceed 100 cfs in 100% of the years. Between mid-March and mid-April, releases exceed 100 cfs in 10% of the years. Figure 1 depicts the frequency in which releases exceeding 100 cfs would occur during the January to June period.

As a result, the Mason Dam project would be expected to operate all or most of the time between May 1 and September 30, but not at all between October 1 and mid-March. The project would operate 10% of the time between mid-March to mid-April. During the last two weeks of April, the project would be operational between 30 to 70% of the time. Any potential entrainment mortality issues associated with the project operation would mostly occur between mid-April and the end of September, and occasionally between mid-March and mid-April.

Intake Characteristics

The Mason Dam intake is approximately 13 feet high, ranging in elevation between 3,975 and 3,988.25 feet above MSL. The bottom of the intake is located at an elevation of 3,975 feet above MSL, or 87 feet below full pool depth (4,062 feet above MSL). The intake bottom is located within the dead storage area and the intake top is within the conservation pool area. The intake is located approximately 290 feet west of Black Mountain Road. It is a gated intake, with a regulated outlet that produces high velocity flows.

Flows of up to 875 cfs can be conveyed through the dam for emergency purposes. There is a spillway for emergency flood releases that has not been used since the dam was constructed. Since dam operation began in 1968, all flows have been through the deep intake. Under current operation irrigation season releases range between 100 and 350 cfs.

From the intake, the concrete tunnel narrows midway through the dam to a main 56 inch pipe, with a 12 inch bypass flow pipe. The 56 inch pipe is subsequently bifurcated into two 33 inch pipes near the outlet. The regulating slide gates are contained within the 33 inch pipes.

Comment [ktb1]: Please explain where BVID releases water relative to Mason Dam.

Comment [DG 2]: This is a little confusing. Please clarify whether the 10cfs instream flow requirement is for the water between Mason and Smith Dams or is it supplemental water to meet a 10cfs water release at Smith Dam?

Comment [DG 3]: Please explain what “run-of-release” means.

Comment [DG 4]: Does this statement mean the project will also notrun or operate if the flows fall below 100cfs?

Comment [DG 5]: Please explain what 100% of the years refers to. Does this refer to data recorded from all years between June and Sep and does the data show that flows exceed 100cfs from June to Sept? Have the flows ever gone below 100 cfs? Please cite the data sources are you using – gauging stations, BVID flow data, etc..

Comment [DG 6]: Please explain why the project would not operate between Oct1 – mid March.

Comment [DG 7]: Please explain whether this statement means the flows will be above 100cfs during this time as well.

Comment [DG 8]: This is a big range. Please explain why the Project would operate from 30 to 70%. Does the data show a trend in flows that give that range of conclusion. Please also identify whether the data shows that flow during this time are sufficient to operate the project and still maintain flows above 100cfs.

Comment [DG 9]: Please spell out this acronym and explain what it means.

Comment [DG 10]: Please explain where these emergency releases would occur from, i.e., spillway, or over the top of the dam?

During irrigation releases, intake approach velocities are approximately 1.7 feet per second (fps), with a maximum allowable approach velocity of 2 fps. Once water enters the 56 inch pipe (midway through the dam), velocities increase to 5.8 fps at discharges of 100 cfs and 20.5 fps at discharges of 350 cfs. At the bifurcation point (near the outlet), velocities suddenly accelerate again to between 36 fps (at 100 cfs) to 127 fps (at 350 cfs) in the smaller 33" pipes, or up to 86 miles per hour at 350 cfs releases.

Philips Lake is apparently well aerated throughout the water column during the winter and spring (late November tomid April/early May) with dissolved oxygen (DO) values greater than 8 ppm throughout the profile in May (EcoWest 2009). Winter temperatures are unknown but are less than 0 EC in the upper layers as portions of the lake freeze. Beginning in May, the lake starts to stratify with increasing temperatures near the surface and relatively constant temperatures near the bottom of the reservoir. These differences increase to 10 ^{B}C by July, as the surface layer warms to more than 20 ^{B}C, while the temperatures near the bottom of the reservoir near Mason Dam remain relatively constant between 10.4 to 11.2 ^{B}C.

Dissolved oxygen concentrations change as both the temperature changes and the reservoir starts to stratify according to temperature and water density. The surface layers (epilimnion) remain well oxygenated, but in the mid and lower layers (mesolimnion andhypolimnion) DO levels drop below 7 ppm beginning in June.

Table 1 depicts the range of water quality conditions at the intake between mid-May and October. Beginning in mid-June, DO concentrations drop below 6.0 ppm throughout the intake area and remain low until the beginning of September. Temperatures remain cool at the intake level until the beginning of August when they begin to exceed 15 EC and increase to 20.7 EC.

The water quality data were collected during 2007, which was considered a “dry year” and in which the reservoir surface level was 18 meters above the top of the intake during May and was drawn down to a level just 3 meters over the top of the intake in September. A thermocline started to develop in June between 5 and 15 meters below the surface, with the thermocline between 10 to 15 meters below the water surface at its greatest development. Below the thermocline, water was anoxic.

During 2010, a “wet” year, the reservoir water surface ranged between 16 to 23 meters over the intake top between May and October. Because the thermocline develops with increasing surface temperatures, it is likely that in wet years, temperatures at the intake elevations would remain cool longer during the summer. Conversely, with the thermocline developing above the intake elevations, conditions would likely remain anoxic for a longer period of time (e.g., through September).

Comment [DG 11]: This description is confusing, especially when trying to relate it to fish tolerance and escapement. Please explain these flows in a way that is consistent with fish limitations, similar to how it’s described later on in the document. It’s hard to follow cfs to fps to mph. Consider using consistent measurements.

Comment [DG 12]: Please explain what well-aerated means and what it’s being compare to?

Comment [DG 13]: If winter temps are not recorded or unknown, please explain where the data that is provided here is coming from and where the data came from for the rest of the year, i.e., May, July.

Comment [DG 14]: Please cite to where this data and information is coming from.

Comment [DG 15]: Please identify who collected the data. This matters because it may give the USFS a better idea of the protocols and methods used particularly if its ODFW or other agency.

Comment [DG 16]: From the beginning of the document to this point the measurement have gone back and forth between metric and standard. Please pick one format to maintain consistency throughout the document.

Table 1. Water Quality Conditions Within the Range of Mason Dam Intake Elevations During 2007.						
Date	Intake Elevation (m below surface)		DO (ppm)		Temperature (E C)	
	Top	Bottom	Top	Bottom	Top	Bottom
11-May	21.9	18.0	8.6	8.6	11.1	11.1
17-May	21.4	17.5	8.1	7.6	9.1	8.9
25-May	21.0	17.1	7.6	7.3	10.8	10.2
1-Jun	20.6	16.7	6.7	5.9	10.1	10.0
9-Jun	20.1	16.2	7.4	6	12.9	10.8
15-Jun	19.5	15.6	6.6	6.6	13.0	13.5
22-Jun	19.5	15.6	5.8	4.2	12.9	11.3
28-Jun	18.9	15.0	5.2	4.8	14.5	14.2
6-Jul	18.1	14.2	3.5	3.5	12.7	12.7
17-Jul	16.8	12.9	2.6	0.9	14.9	12.0
24-Jul	15.7	11.8	1.8	1	15.0	13.5
7-Aug	13.2	9.3	6.0	0.1	20.7	14.8
14-Aug	11.8	7.9	5.2	0.1	20.1	17.0
21-Aug	10.2	6.3	6.2	2.3	19.5	18.9
13-Sep	7.7	3.8	9.6	7.4	17.7	16.9
21-Sep	7.3	3.4	5.8	7.7	15.4	17.0
28-Sep	7.0	3.1	6.0	5.7	13.4	15.4
5-Oct	6.8	2.9	6.2	6.2	No data	No data
12-Oct	6.6	2.7	6.5	6.5	10.8	10.8

Fish species

Philips Reservoir was treated with rotenone on October 7, 1997, and restocked in April 1978 with 150,000 hatchery rainbow trout and an undetermined number of largemouth bass, crappie and coho salmon (PBWC 2001). Yellow perch and walleye were subsequently illegally introduced in the 1980s, with yellow perch first documented by ODFW within the reservoir in 1991. In 1993, ODFW stocked smallmouth bass and black crappie, although both species were present in the reservoir since at least 1985. PBWC (2001) identified that ODFW annually stocked up to 100,000 hatchery rainbow trout as both fingerlings and adults. However, currently, 33,600 adult rainbow trout on average are stocked throughout the summer, and 24,600 six inch trout in September for an average annual stocking rate of 58,200 (T. Bailey, ODFW, Pers. Comm.). No fingerlings are currently stocked. All stocking occurs close to Mason Dam. The northern pikeminnow occurred in the Powder River prior to the construction of Mason Dam and still occurs in both the river and the reservoir.

Between 1985 and 1999, the densities of smallmouth bass and crappie declined by 82 and 96%, respectively. Conversely, the yellow perch population increased by 245% (Shrader 2000). Efforts to reduce the number of perch within the reservoir have been conducted annually between 2009 and 2011 (Bailey 2012). These efforts have focused on netting the perch when they are concentrated in their spring littoral spawning areas. Since spawning occurs right after

Comment [DG 17]: Please explain what size constitutes an adult in comparison to a 6 inch trout.

Comment [DG 18]: Please explain how the northern pikeminnow got there. Is there data or information that identifies pikeminnows present prior to construction?

Comment [DG 19]: To the extent known, please explain why bass and crappie declined and yellow perch increased.

"ice-off", the netting typically occurs during a 7 to 10 day period in mid-April. The most productive perch spawning areas have varied within the reservoir based on reservoir level, but have included the north side of the reservoir near the Union Creek campground, the south side of the reservoir, and the western edge of the reservoir where the Powder River enters. When the reservoir is at full pool level, the last site appears to be the most productive spawning area. This site is also the furthest from the Mason Dam intake.

The April perch netting resulted in a low of 51,574 perch in 2009 and a high of 354,468 perch in 2011. Yearly total differences reflect the timing of the netting and the reservoir level. ODFW estimates that there are currently 1,636,575 yellow perch in the reservoir (Bailey 2012).

Between 2009 and 2011, a total of 769,489 fishes comprising 8 fish species were caught during the April littoral netting. Of these fishes, 99.6% of the individuals were yellow perch. Approximately 0.1% each of the individuals netted were northern pikeminnow, suckers and rainbow trout. Other species netted together comprised 0.1% of the catch and included bull trout (2), smallmouth and largemouth bass, and black crappie.

Fish species currently known in Phillips Reservoir include hatchery and wild rainbow trout (redband), black crappie, smallmouth and largemouth bass, yellow perch, walleye, northern pikeminnow and various species of sucker (Baker County 2009). One thousand six hundred (1600) sterile tiger trout were introduced to the reservoir in 2011.

Comment [DG 20]: Please identify where the last site appears and whether it is where the Powder River enters the reservoir. This area would not seem preferable to yellow perch and other warm-water fish considering temperature during ice-off are relatively cold with elevated silt loads.

Comment [DG 21]: If this is an estimate, consider round if off to the nearest 1000.

Comment [DG 22]: Please explain what "littoral netting" is.

Comment [DG 23]: Please explain why sterile tiger trout were recently introduced. These fish, once they reach maturity, will play a large role in predator/prey balances and will inevitably change the behavior of piscivores especially bull trout.

Table 2. Fish Species Known to Occur in Philips Reservoir.			
Species		**Native?**	**Percent of April Littoral Netting**
Common Name	**Scientific Name**		
Yellow perch	*Percaflavescens*	No	99.6
Walleye	*Sander vitreus*	No	0
Smallmouth bass	*Micropterusdolomieui*	No	<0.01
Largemouth bass	*Micropterussalmoides*	No	<0.01
Black crappie	*Pomoxisnigromaculatus*	No	<0.01
Northern pikeminnow	*Ptychocheilusoregonensis*	Yes	0.1
Suckers (bridgelip, largescale)	*CatastomuscolumbianusCatostomu smacrocheilus*	Yes	0.1
Rainbow trout (redband and hatchery)	*Oncorhynchusmykiss spp.*	Mix of native and non-native	0.1
Bull trout	*Salvelinusconfluentus*	Yes	<0.0001
Tiger trout	*Salmotrutta X Salvelinusfontinalis*	No	0

3.0 Methods

A literature review was undertaken to identify key factors important to fish entrainment and mortality with a focus on studies undertaken since 1995. The literature review summary can be found in Appendix A. Based on the key factors identified in the literature review, a subset of studies were analyzed to provide an updated estimate of overall potential entrainment, entrainment by species and baseline mortality rates. The reservoirs selected met the following characteristics:

- Located within the Pacific Northwest region.
- Dam height greater than 25 meters and with a deep intake.
- Reservoirs operated primarily for flood control/irrigation, as much as possible, or if operated for a different purpose then containing data on salmonid entrainment.

Comment [DG 24]: Please reference what "deep" means, i.e., greater than 40'?

Based on these criteria, 11 reservoirs were selected for analysis and comparison to Mason Dam. These reservoirs and their characteristics are listed in Table 3. Not all reservoirs had data for both mortality and entrainment rates. Of the 11 reservoirs, five were used to estimate baseline mortality rates and 10 contained species-specific data on entrainment. Only three of the reservoirs had data on full annual fish entrainment estimates. Only one reservoir, Fall Creek Reservoir, had data on all three items of interest for deep water intake-Pacific Northwest reservoirs: annual entrainment, entrainment by species and mortality rates. Data summaries developed for the Henry Jackson (Spada Lake) and Wickiup relicensing projects were also used in portions of the analysis (CH2MHill 2007, Symbiotics 2009).

The older data set was not used further as it contained only shallow reservoirs that do not stratify and Ch2MHill (2003) showed that shallow, non-stratified reservoirs had substantially greater entrainment rates than deeper reservoirs.

Comment [DG 25]: Please clarify what "older data set" refers to. Is this from the Ch2MHill study?

In addition, scientific studies on fish species life history, behavior, and swimming speeds were reviewed for the species known to occur in Philips Reservoir. Tiger Trout ~~Newly introduced non-native species for which consultation with FWS is ongoing~~ were not addressed.

The mortality data for Mason Dam under the proposed project operation as described in GeoSense (2011) was used to identify how mortality rates might change under project operation for the species most likely to be entrained.

Table 3. General Characteristics of Regional Reservoirs with Deep Intakes, with Mason Dam Characteristics for Comparison.

Reservoir Name	Location	Size		Intake Characteristics		Flow Range (cfs)	Operation	Data Type Available		
		Acres	Acre-Feet	Depth (m)	Type			Total Entrainment	Species-Specific Entrainment	Baseline Percent Mortality
Cougar	W OR	1,280	207,759	28	Slide Gate	440-1000	Irrig, FC	X		X
Fall Creek	W OR	1,820	115,100	49	Slide Gate	450-1000	FC, Recr	X	X	X
Trail Bridge	W OR	73	2,088	18	Slide Gate	to 2,000	FC	X	X	
Blue River	W OR	1,420	> 80,000	68	Slide Gate	300-2,400	FC, Recr			X
Wickiup	C OR	Unkn	200,000	24.7	Tube Valve	100-2,000	Irrig		X	X
Tieton	E OR	2,530	198,000	60	Tube Valve	300-2,190	Irrig		X	X
Beulah	E OR	Unkn	59,212	23	Jet Valve, Spillway	0-950,gen 300-400	Irrig		X	
Arrowrock	W ID	3,150	286,600	62	Clam Shell	54-3,000	Irrig, FC		X	
Timothy Lake	W OR	1,280	Unkn	24	Valve	0-300	Recr, FC		X	
Lake Lemolo	SW OR	415	Unkn	22	Unknown	436	Hydro		X	
Cooper Lake	AL	2,800	Unkn	9.7	Unknown	380	Hydro		X	
Philips Reservoir/ Mason Dam	E OR	2,234	95,500	30	Slide Gate	10-400	Irrig, FC			

4.0 Results

4.1 Entrainment

4.1.1 Estimated Annual Entrainment

Total annual entrainment has been measured at only a few regional reservoirs, with most studies primarily evaluating percent population entrainment or evaluating entrainment potential by species. Annual entrainment numbers were available for three reservoirs -- Cougar, Fall Creek and Trail Bridge, all located within Oregon and all containing gated outlets. All contain anadromous fish. Of these reservoirs, only Cougar is known to stratify, but it does not become anoxic near the intake.

Comment [DG 26]: Please clarify this conclusion as it seems to say stratification causes anoxic conditions, which may not be necessarily what was intended in this description.

Table 4. Estimated Annual Entrainment from Oregon Reservoirs with Deep Intakes, with Mason Dam Characteristics for Comparison.

Reservoir	Size		Intake Characteristics		Flow Range (cfs)	Entrainment (# fish)	
	Acres	Acre-Feet	Depth (m)	Approach Velocity (fps)		All fish	All non-anadromous fish
Cougar	1,280	207,759	28	Unknown	440-1000	78,737	Unknown, almost all fish entrained were Chinook salmon
Fall Creek	1,820	115,100	49	Unknown	450-1000	77,000-275,000	17,325-61,875
Trail Bridge	73	2,088	18	> 3.3	Up to 2,000	up to 22,040	694
Philips Reservoir/ Mason Dam	2,234	95,500	30	1.7	10-400	Unknown	Unknown

The majority of fish entrained at these reservoirs consisted of anadromous fish (from 77 to 96% of the fish entrained). Non-anadromous fish entrainment ranged from an estimated 694 to 61,875 fish per year. At Trail Bridge Reservoir, video monitoring identified entrainment rates as less than 1 fish per hour (even with approach velocities greater than 3.3 fps) between May and September, with higher rates during chinook salmon migratory periods.

Comment [DG 27]: There are too many comparisons here that are relative but not in comparison. For example, the description goes from % entrained to entrainment per year to entrainment per hour. Interesting info but hard to relate unless more info about each system is provided and how it relates to the project area.

The reservoir with the closest fit to the Mason Dam project is Cougar Reservoir as it is operated for both irrigation and flood control, has a similar intake depth, and is known to stratify, but the non-anadromous fish composition is unknown. As a result, the range of annual non-anadromous fish entrainment at Mason Dam was preliminarily estimated as similar to that of Fall Creek (17,325 to 61,875). However, Fall Creek Reservoir does not stratify and its discharges well exceed those of Mason Dam (i.e., Fall Creek Reservoir minimum discharges exceed Mason Dam maximum discharges). Annual entrainment at Mason Dam is likely to be much lower as a result of the seasonal water quality ~~barriers~~ limitations near the intake and the low approach

Comment [DG 28]: This statement would have more meaning if the importance of stratification to fish and lake systems was explained.

velocities. Much of the recent data collected on regional reservoirs has focused on species-specific entrainment and this general estimate was subsequently refined in light of the more detailed fish species information presented below in section 4.1.2.

Comment [DG 29]: Please reference similar studies to validate this statement.

4.1.2 Species-Specific Entrainment PotentialOverview

Introduction

The entrainment potential for individual fish species or group of related fish species was based on the likelihood that a fish would occur near the intake during the Mason Dam hydroelectric project operating period of mid-March to September 30. The following factors were used to evaluate the entrainment potential:

- Species spawning habitat type and location, and spawning timing.
- Seasonal movement patterns.
- General location within the water column.
- Water quality requirements-particularly Dissolved Oxygen (DO) and Temperature.

Comment [DG 30]: Please clarify this statement and whether it was intended to describe where fish are generally located in the reservoir. If so, please explain whether stratification of the lake changes these locations too.

Potential entrainment was evaluated according to the following categories:

None: There is no habitat requirement/tolerance or fish behavior that would place the species near the intake during the Mason Dam operating period.

Minimal: The species may inadvertently occur near the intake, but the intake is generally located outside of species habitat tolerances.

Comment [DG 31]: Please explain whether this statement refers to a fish's general life history needs or some arbitrary threshold for the types of habitats they will use?.

Low: The species may occasionally occur near the intake, but the intake is generally located outside of species habitat preferences, or the project would only occasionally be in operation during the time period that species could occur near the intake.

Moderate: Species may routinely or seasonally occur near the intake.

High: Species is very likely to occur near the intake during most of the project operating period.

In addition, entrainment potential was also evaluated according to the following question: "If a fish's behavior placed it in proximity to the intake, would it be able to swim out of the flow field which has a maximum allowable velocity of 2 feet/second (fps), but a more normal approach velocity of 1.7 fps or less?"

Comment [DG 32]: Please clarify whether this statement refers to the water velocity at the intake valve or something else.

Entrainment potential was evaluated for spawning, adult and juvenile life history stages.

4.1.3 Salmonids

Bull TroutLife History

Bull trout spawn in the late summer or fall, generally between mid-September to October. The eggs hatch during the winter, with fry emerging from the gravel in April or May. Juveniles exhibit a strong benthic orientation, hiding within cobbles, boulders, woody debris and other cover during the day and are more active at night. Juveniles feed mostly on macroinvertebrates, shifting to a piscivorous diet when they reach sizes of 100 to 200 mm (or 2 to 3 years old). Although juveniles can migrate to lakes at any age, it is unusual to find young less than 200 mm in lakes and reservoirs. The majority of adfluvial juveniles migrate to lakes when they are 2 or more years old (Pratt 1992, Goetz 1997, Flatter 2000).

Sexual maturity is not reached until at least four years of age, with an estimated longevity of 5 to 7 years, and up to 12 years (FWS 1998). Adults may spawn either every year or in alternate years. The bull trout can exhibit either migratory or resident life history strategies. Resident fish complete their life history cycle in the same stream in which they spawn. Migratory bull trout hatch and rear in tributary streams and then migrate to larger streams (fluvial form) or lakes (adfluvial form) to mature, returning to the smaller streams only to spawn. Both forms can co-occur and resident fish can produce migratory forms.

Comment [DG 33]: Please provide a study reference to support this statement.

Habitats used by migratory bull trout include bottoms of deep pools in streams and also large coldwater lakes and reservoirs. Within lakes and reservoirs, bull trout inhabit the cold, deeper sections and primarily occur within the upper hypolimnion (Goetz 1989, Fraley and Shepard 1989, McPhail and Baxter 1996, Flatter 2000, Petersen et al. 2002). Bull trout also forage in cool, shallow, littoral zones which tend to occur in the upper reservoir arms where tributaries enter the reservoir. However, bull trout location within a given lake or reservoir varies by season and type of lake.

There are a number of lakes/reservoirs in which bull trout have (1) been documented and (2) for which data on habitat preferences and seasonal movements exist. These include Beulah Reservoir (Gonzalez 1998, Schwabe et al. 1999, Schwabe et al. 2002, Petersen et al. 2002) and Lake Billy Chinook (Ratliff et al. 1996, Beauchamp and Van Tassel 2001) in Oregon, and Flathead Reservoir in Montana (Flatter 2000, Fraley and Shepard 1989). The two Oregon reservoirs differ in thermal regime. Beulah Reservoir temperatures rarely exceed 15 EC and DO levels generally remain above 6.5 ppm, without developing anoxic conditions. Lake Billy Chinook does thermally stratify with temperatures in the epilimnion reaching 15 to 21 EC during the summer. In both of these reservoirs, studies have shown that bull trout migrate out of the main body of the reservoirs during the spring into either upstream tributaries or the unstratified reservoir tributary arms (March to mid-May in Beulah and June to mid-July in Lake Billy Chinook). Migration back to the reservoirs, where the bull trout overwinter, occurs between late October and November.

At Flathead Lake, bull trout use all parts of the reservoir depending on the season, tending to use littoral zones in the spring and fall, deeper water in the winter and migrating out of the reservoir during the summer (Flatter 2000). The bull trout congregate at the upper end of the reservoir in the spring, moving into the tributaries by mid-June. They return between mid-September to mid-October to the upper portion of the reservoir, where they stay for several weeks before dispersing throughout the reservoir. Fraley and Shephard (1989) suggested that the seasonal movements out of the reservoir reflected a response to changes in temperature, photoperiod and discharge as the lake is oligotrophic, lacking strong stratification.

In meso and eutrophic lakes, such as Phillips Lake, oxygen levels tend to be depleted during the summer. In these types of lakes, bull trout migrate out of the lake in the spring when conditions in the hypolimnion become unsuitable, returning in the fall and using the water body primarily as overwintering habitat (see for example, Flatter 2000, Stoval 2001, Petersen et al. 2002 and 2003, McPhail and Baxter 1996). As for other reservoirs, it is highly likely that beginning in June (or earlier), any bull trout near the eastern end of Philips Lake would migrate to areas with more favorable temperature and DO regimes. A seasonal migration to more favorable habitats would likely occur when temperatures reach approximately 15 EC, consistent with the patterns observed within other lakes used as overwintering and foraging habitat, which is also when the water quality barrier in the vicinity of the Mason Dam intake develops. The documentation of two bull trout within the Philips Lake littoral zone in April 2011 is consistent with the seasonal patterns observed in other reservoirs.

Comment [DG 34]: This statement would be stronger if the data that supports these types of characteristics for Philips Lake is cited to here.

Comment [DG 35]: Please describe what unsuitable conditions are being referred to here. Bull trout have many other factors that trigger spring movement. This seems to state that a condition at the bottom of the lake causes their movement? Without clarification, this statement is incorrect and should be better described to understand the meaning of what "unsuitable conditions" cause bull trout to move.

Comment [DG 36]: Seasonal movement in bull trout is primarily triggered by declining photoperiods, discharge influences, competition, predator/prey balances – all thereby enhanced by cold temperatures (Fraley and Shepard 1989; Rode 1990, Brenkman 1998). Please explain why bull trout would chose to move when temperatures reach 15 degrees C. Also please explain what water quality barriers or parameters you're referring to that affect bull trout life histories.

Comment [DG 37]: Please specify what patterns are being referred to, i.e., movement, foraging, thermal, etc..

Bull trout require among the coldest water temperatures of any native Pacific Northwest salmonid (FWS 2002, FWS 2010), requiring temperatures between 2 to 15 EC with thermal refugia where temperatures exceed the upper limit, and with different temperature ranges necessary in different life history stages (e.g., optimal temperatures of 5 to 9EC for spawning, 2 to 4 EC for incubation, and 7 to 8 EC for growth). Bull trout also require well oxygenated water. DO levels > 8 ppm are preferred, with short term tolerances of DO levels between 6 to 8 ppm. The species can not tolerate DO levels less than 6 ppm.

Comment [DG 38]: Please reference the study or information used to support this statement.

Adult bull trout (300 mm or greater) are able to swim at 15.08 fps, with burst velocities of 22.5 fps (Taylor and Lewis 2010). Juvenile bull trout (less than 200 mm) have a maximum swimming speed of 1.79 fps, similar to that of yellow perch.

Bull Trout Entrainment Potential

Bull trout entrainment data has been collected at Beulah and Trail Bridge Reservoirs in Oregon. Entrainment at Beulah was measured according to two different water release scenerios: through spillway releases and through a deep water intake. With spillway releases, the entrainment risk was greatest in winter and spring. When the water releases occurred solely through the intake, bull trout entrainment was reduced by 80% in 2001, and subsequently reduced to 0 in 2002. Regardless of the release type, Schwabe et al. (2002) identified that entrainment was minimal between mid-June and October. At Trail Bridge Reservoir, 0 bull trout out of an estimated 2,000 fish population were entrained during the monitoring period (Stillwater Sciences 2006).
As of spring 2012, there were no known adult bull trout in Philips Lake. Two subadults were found in 2011, but their status is unclear (i.e., entered reservoir during extremely high spring flows or resident). The analysis presented herein is for the population that currently occurs (2 subadults, > 200 mm) or any population that establishes in the future.

Comment [DG 39]: Please explain whether 2,000 fish are the total fish population in the reservoir or otherwise what this number means.

Spawning: Bull trout spawn in cold tributaries which are located well away from and upstream of the intake. There is **no** potential for entrainment of spawning bull trout.

Adults: Although temperatures are suitable for adult bull trout at the intake elevation during much of the summer, they are not suitable in August and September. Conversely, DO concentrations are not suitable during the summer and begin to increase in September. The combination of low DO concentrations and high temperatures through the range of the dam intake elevations effectively creates a water quality barrier to adult bull trout movement around the intake and adjacent deep water areas between mid-June to mid-September (see figures 2 and 3). As for other reservoirs, it is highly likely that beginning in May to June (or earlier), any bull trout near the eastern end of Philips Lake (where the intake is located) would migrate to areas with more favorable temperature and DO regimes. A seasonal migration to more favorable habitats would likely occur when temperatures reach approximately 15 EC. The only time period in which the project would be both (1) in full operation in most years, and (2) in which the water quality would be suitable near the Mason Dam intake for adult bull trout would be between mid-April to May. If there are adult bull trout in the reservoir, they would overwinter at deep levels, such as near the intake. Movements between deep wintering habitat and more shallow lake levels during the spring could put adults in the vicinity of the intake between mid-March and mid-April when the project would operate 10 to 30% of the time.

Approach velocities between mid-March and May would be less than 1.7 fps, well under both maximum and sustained bull trout swimming speeds. Any fish entering the intake vicinity would easily be able to outswim the intake velocities. The potential for adult bull trout entrainment during project operation is **none to minimal.**

Juveniles: Temperature and DO conditions are more restrictive for juvenile bull trout. There would be no months during which the project would be in full operation each year and in which the water quality would be suitable near the Mason Dam intake for juvenile bull trout. The only time period during which both juvenile bull trout entrainment could occur and the Mason Dam project would be operational would be between mid-March and April, during which time, the project is anticipated to run approximately 10 to 30% of the years. If juvenile bull trout 200 mm or less entered the intake area, they may or may not be able to outswim the intake velocities. However, there is almost no likelihood of juveniles less than 200 mm even occurring within the reservoir, or if within the reservoir, outside of upstream littoral zones. Juvenile bull trout between 200 to 300 mm could occur outside of littoral zones. Fish this size could swim at faster speeds than the intake velocities

The overall risk of juvenile bull trout entrainment is **none to minimal.**

Rainbow TroutLife History
According to the ODFW, there are two rainbow trout subspecies in Philips Lake, the native redband trout and the stocked rainbow trout.

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Comment [DG 40]: These conditions do not entirely create a barrier to any fish. If prey is available or escapement is preferable in the general vicinity of the intake, fish will use it. Adult fish tend to use shallow areas for food sources where temps and DO are naturally low. Please provide references here to support this document's conclusions.

Comment [DG 41]: The primary reason adult bull trout would migrate during these periods is for spawning and not to find areas of higher DO and lower temps. Please provide references here to support this conclusion.

Comment [DG 42]: Adult bull trout would more likely be found near the mouth of their natal streams staging for migration to spawning areas during this time of the year. What is typically found are subadultsmoving into adult niches in search of food and cover. This makes subadults and juveniles vulnerable to entrainment during springtime. Some subadults will stage and even make attempts to migrate but generally turn back as flows recede and the prey-base (generally outmigrants) settle in the shallows of the reservoir. Please explain in more detail the rationale for the "none-minimal" call made on entrainment potential base on the information provided in this comment.

Comment [DG 43]: This is why ODFW caught 2 subadults/juveniles last year during their spring surveys. Juveniles and/or outmigrants spend up to 3 years in a reservoir system until they reach spawning maturity. Fish are naturally curious and will venture to all areas of their reservoir home which makes them particularly vulnerable for entrainment. Please elaborate on the rationale for determining a "none to minimal" call for risk of juvenile entrainment.

Comment [DG 44]: Please explain or clarify what is meant by "littoral zones." Littoral Zone by definition is the shallows of a lake or large body of water or the edges of a waterbody system. This could be contradictory to earlier statements in the document where it says that low DO and higher temps are water barriers to fish, when a majority of their food sources are found in these areas.

Comment [DG 45]: Similar to what was stated in comment 43 and 44, juveniles are more at risk of entrainment. The determination should be reflected as "moderate" to illustrate these possibilities. Please provide additional information and cited literature to validate the current call of "none to minimal" .

Optimal lacustrine habitat for both subspecies is characterized by clear, cold, deep lakes. Both rainbow trout subspecies are primarily stream spawners and generally require tributary streams with gravel substrate in riffle areas for reproduction to occur (Raleigh et al. 1984). Redband trout spawn in the spring between April and May in tributaries to Philips Reservoir. Migration timing is affected by water temperature and stream flow. After spawning, resident redband trout maintain restricted home ranges until migrating to overwintering areas in the fall (Thurow 1990). Juveniles of migratory forms typically move downstream to lakes or rivers after one to three years in natal streams. At any one time, there could be both fluvial and adfluvial populations in Philips Reservoir as well as non-reproducing juveniles (ODFW 2009).

Comment [DG 46]: Please provide evidence to support this statement.

Optimal oxygen levels for rainbow trout in general are at least 7 ppm, with oxygen needs increasing as the temperatures increases (Raleigh et al. 1984). The lethal DO level is 3 ppm, but the species exhibits strong avoidance behavior of water with DO levels less than 5 ppm. The optimal temperatures for rainbow trout are between 12 to 18 EC, with adults residing in lakes selecting waters with temperatures between 7 to 18 EC and avoiding areas with temperatures greater than 18 E C .

The depth distribution of adult lake rainbow trout is generally a function of dissolved oxygen, temperature, and location of food sources. Some reservoir studies have noted a strong tendency for rainbow trout to follow the 18 EC isotherm, as long as DO remains at satisfactory levels. CH2MHill (2007) noted a tendency for rainbow trout within the Pacific Northwest to be surface oriented. Studies at the Carmen-Smith hydroelectric project in western Oregon also noted that rainbow trout were rarely found below the thermocline, even when conditions in the hypolimnion were favorable (Stillwater Sciences 2006). The same study showed that young trout remained in shallow water with abundant vegetative cover and observed no trout more than 10 meters (33 feet) below the surface during spring and summer.

Rainbow trout swimming speeds have been identified as being similar to those of bull trout (Mesa et al. 2004), but studies in the eastern US have identified lower average swimming speeds of 4.3 fps (NY Power Authority 2005) and CH2MHill (2007) estimated maximum rainbow trout swimming speeds at 5 fps.

Rainbow TroutEntrainment Potential

CH2MHill (2007) reviewed 12 studies in the Pacific Northwest and northern California in which trout entrainment was measured. All of the study reservoirs contained cold and coolwater fisheries and had deep water intakes. No trout were entrained at 9 of the 12 reservoirs. Trout entrainment rates were estimated at two Oregon reservoirs as less than 0.001% of the population (1 trout out of an estimated 100,000 at Timothy Lake on the upper Clackamas River, Oregon) and 2.6% of the population (at Lake Lemolo on the North Umpqua River, Oregon). At Lake Lemolo, almost all of the trout were juvenile brown trout (less than 100 mm) entrained in the fall as the reservoir was drawn down to its lowest level, which was 12% of its full pool volume. Lake Lemolo is also operated specifically for hydropower production, which is different than the other reservoirs examined in the study. At the Tieton project in eastern Washington, the total trout population is not known, but 60,000 rainbow trout are stocked annually. Entrainment studies

Comment [DG 47]: Please provide what the total population at Lemolo is.

identified 37 total rainbow trout, of which 28 were suspected to have been resident in the tailwater below the dam and not entrained fish. Regardless, less than 0.1% of the known rainbow trout population was entrained at this facility. During their review of regional studies, CH2MHill (2007) identified minimal risk to rainbow trout being entrained if approach velocities are 3.5 fps or less as long as the trout are greater than 6 inches.

Entrainment studies at Trail Bridge Reservoir identified that 0.01% of the estimated reservoir rainbow trout population was entrained.

Spawning: Rainbow trout spawn in the Philips Reservoir tributaries which are located well away from and upstream of the intake. There is **no** potential for entrainment of spawning rainbow trout.

Adults: Although redband and other rainbow trout are adapted to a wider range of environmental conditions than other salmonids, they still exhibit seasonal movements and are restricted by very low oxygen conditions. The temperature and DO conditions at the Mason Dam intake are not tolerable by adults between the end of June and the end of August. Conditions would fall within adult rainbow trout tolerances in May to early June and within the preferred range in September. The most likely time for adult rainbow trout to occur within the intake vicinity during project operation would be in September. If adult rainbow trout encountered the intake, they would be easily able to outswim the maximum 1.7 fps approach velocities. Other regional studies of adult trout entrainment with deep intakes show that it is highly unlikely for entrainment to occur. Based on the regional trout studies, the water quality conditions at the Mason Dam intake and the strong rainbow trout swimming speeds, the adult rainbow trout entrainment potential is **none to minimal.**

Juveniles: Juvenile rainbow trout would also exhibit intake avoidance due to temperature and DO conditions and would not be expected to use the habitat in the intake vicinity. The tendency of redband trout to both (1) remain within tributaries before moving to reservoirs or (2) as subadults to remain within littoral or other shallow water areas would limit the potential for entrainment outside of the fall when the reservoir is at it lowest level. If occurring within the intake vicinity, juveniles may or may not be able to outswim the intake velocities. Because of the very low likelihood that native juveniles would occur in the intake vicinity during project operation, their overall entrainment potential is **minimal.**

Stocked Fish: Only subadult and adult rainbow trout are currently stocked in Philips Reservoir. The potential for these fishes to be entrained would depend on their condition during the September stocking period. Hatchery fish are released in September near the intake and would likely come into contact with the intake at a higher rate than resident or native species. If in good condition, the newly released fish would be able to outswim the intake velocities. However, if disoriented the newly released fish could be entrained. As a result, the overall potential for stocked fish to be entrained is rated as **low to moderate**. The entrainment potential would be highest in dry years in which the intake is relatively close to the low water surface.

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Comment [DG 48]: Rainbow trout can tolerate higher temperatures and have been known to grow faster than those in constant colder regimes. See **Temperature influences on California rainbow trout physiologicalperformance.** C. A. Myrick_ and J. J. Cech, Jr., 2000. It would be better described to illustrate how higher temperatures could affect the use of the intake areas by trout. Please also indicate the level of temperatures expected at the intake and why and how this would differ from the rest of the reservoir temperatures.

Comment [DG 49]: Similar to the temperature comments in 48 (above) Dissolved Oxygen would make a better case for this call but is unsupported without other studies or references to justify and validate the determination. Please add references of studies or research that verifies the determination here.

Comment [DG 50]: Depending on the infrastructure of the intake system, it is possible that DO levels could be higher through the generation of water movement and transfer. Short-term use of higher temperature is not necessarily a barrier to trout. Please explain these ideas with more details on the relationship of possible fish uses in and around the intake system vs long and short term use of littoral areas particularly when subadults and adults are constantly moving throughout the reservoir in search of forage, prey, and other life history needs. With constant fish movement, there is always a potential of entrainment. As long as water is going over the dam or through an unscreened system, fish, including rainbow trout, have the potential for entrainment especially outmigrants, juveniles and subadults.

Comment [DG 51]: Emigration of juvenile trout from natal streams back to reservoir systems have been known to occur between April through May. Their presence and life history needs while in the reservoir will increase the chance of entrainment particularly when discharge from the reservoir peaks at the same time juvenile are entering the reservoir. Please include the rationale used to verify this determination or consider adjusting the call to a 'moderate' possibility given the information in this comment. Please use the following as references to assist with a revised determination: Russell F. Thurow[a], Danny C. Lee[a]&Bruce E. Rieman.1997.Distribution and Status of Seven Native Salmonids in the Interior Columbia River Basin and Portions of the Klamath River and GreatBasins **DOI.** ... [1]

Comment [DG 52]: Experience shows that stocked fish tend to stay in the general vicinity of their release point for at least 7-10 days if not lnoger. Hatchery fish endure a high level of stress, disorientation, gas saturation, and crowding from the time they are taken from the hatchery and loaded into trucks. Then, to add more stress and complications, when they are released, there is a short period of shock and awe they go through when their bodies have to adjust to their new environments. Here in eastern Oregon, it's generally poorer water quality conditions and the fact that they no longer have a human hand feeding them. ... [2]

4.1.4 Percids

Yellow Perch-Life History

Yellow perch often occur in meso and eutrotrophic lakes with adults preferring summer temperatures of 17.6 to 25 E C. Spawning typically occurs at temperatures from 6.7 to 12.2 E C. Yellow perch can successfully overwinter at temperatures from 4 to 6 EC , although growth tends to stop below 8 to 10 E C . They are active in the winter beneath ice or in deep water (Scott and Crossman 197, FWS 1983). Upper lethal temperatures are from 26 to 30 E C.

Optimal DO levels for yellow perch are 5 ppm or greater, but the species is adaptable to a wider range of conditions (DO levels of 2 to 4 ppm, even as low as 1 ppm in some cases), and cooler temperatures. The ability to tolerate very low DO levels allows the species to inhabit deeper water of stratified reservoirs which are often very low in oxygen.

Yellow perch are slow swimmers with maximum speeds of 1.77 fps and average speeds closer to 0.88 fps. They do not accelerate quickly. As a result, yellow perch tend to travel in large schools of 50 to 200 fish which provides protection for younger fish and easier prey capture for older fish (Herman et al. 1959, Craig 1987). Young of the year perch tend to school more than older fish, which occasionally travel alone (Helfman 1979).

Perch exhibit strong diurnal behavior. They are active and feed during the day in open water or shoreline habitat. At night they appear to rest on the bottom and refrain from feeding. The exception occurs during spawning, as the perch become active both day and night.

Generally, yellow perch follow a seasonal migratory pattern that brings them in to littoral zones in the spring, to mid reservoir levels as temperatures rise in the summer, and into very deep water during the winter. They are typically found in water around 30 to 40 feet deep (9 to 12 m), but may seek deeper water in the winter.

Spawning in Philips Reservoir occurs immediately after ice-out, which generally occurs in mid-April. Littoral habitats found in shallow embayments are used for spawning. The embayments most commonly used for spawning are located a minimum of 1,700 feet from the dam intake (measured from data presented in Bailey [2012]).

Although tolerant of the temperatures and DO levels near the Mason Dam intake during most of the year, yellow perch seasonal behavior and depth preferences would place them near the intake most often between mid-July and September. In October when the pool is drawn down to 30 to 40 feet, they would be seeking the deepest water possible, which may or may not be near the intake.

Yellow perch typically inhabit lakes, ponds and reservoirs, but they can occur in river systems. In rivers, they occur in habitats similar to their typical lacustrine habitat, such as low velocity deep pools, backwaters and side channels. Rapidly flowing water does not provide suitable habitat for the species and young perch can not tolerate flows greater than 0.08 fps.

Yellow Perch-Entrainment Potential

Spawning: Spawning occurs in shallow embayments and the nearest known spawning habitat is 1,700 feet from the Mason Dam intake. There is **no** potential for entrainment of spawning yellow perch.

Comment [DG 53]: Please provide references in support of the conclusion that verifies spawning locations of yellow perch in the reservoir.

I don't know of any but would seem to think Tim might have creel surveys that may give better information and relevance to this statement. From my recreational and work related investigations I've done at the lake there seems to be more spawning habitats that are conducive to perch on the south and north side of the reservoir that are within 500 feet of the dam. The likelihood of entrainment would be more palatable at minimal to moderate primarily because of their movements in early spring when they are searching for suitable spawning habitats. Please describe your rationale that indicates no other spawning areas for this species are found or available within 1700 feet of the dam and the site indicated in this statement.

Adults and Juveniles: The temperature and dissolved oxygen conditions would be suitable for yellow perch at the intake most of the time the Mason Dam project would be in operation. Both the daily and seasonal perch migration patterns could place the perch in the intake proximity. The species' seasonal behavior and depth preferences would place them near the intake most often between mid-July and the end of September. In October when the pool is drawn down to 30-40 feet, they would be seeking the deepest water possible, which may or may not be near the intake. Because the Mason Dam hydroelectric project would not be operational in the fall or early winter, yellow perch behavior during these seasons was not considered in the entrainment potential analysis

Yellow perch are slow swimmers with average or sustained speeds much less than the approach velocity and maximum speeds roughly equal to the intake velocities. Any yellow perch, adult or juvenile, that approached the intake too closely would likely be entrained. The tendency for yellow perch to travel in large schools could result in episodic entrainment events. Large numbers of dead yellow perch immediately below Mason Dam have been observed from mid-August to mid-October, underscoring the high potential for yellow perch entrainment from late summer into fall (Jeff Colton, BVID, PersComm; Leslie Gecy, observations made during other Mason Dam project biological studies).

The potential for both adult and juvenile yellow perch entrainment during project operation is **high.**

Walleye-Life History

Walleye are a highly piscivorous, cool, deepwater species whose native range is centered in the Great Lakes region (Scott and Crossman 1973). The species eyes' are highly sensitive to light which tends to result in a diurnal pattern of spending daylight hours in deep water and shallower waters in the evening or at other times when light is low, such as under thick ice or in other areas with underwater cover. Although described as an opportunistic feeder, the walleye's diurnal behavior of moving to different water depths at dawn and dusk tends to place them in frequent contact with yellow perch. As a result, where yellow perch and walleye coexist, yellow perch tend to be the walleye's primary prey. On a seasonal basis, walleye tend to follow a similar pattern as yellow perch as they move to shallow waters in the spring and to deeper reservoir areas in August and September. Lacustrine spawning habitat consists of shallow (1 to 6 ft deep) rocky shores or other areas with rip-rap or rubble, inlet streams or flooded marshes.

Preferred adult temperatures are from 20 to 24 EC , with greatest activity between 15 to 18 E C , and adult growth stopping below 12 E C . Spawning tend to occur between temperatures of 6 to 11 E C and temperatures of less than 10 E C are required for gonad mauration. Upper lethal temperatures are from 29 to 32 EC (Kerr et al. 1997). Walleye prefer temperatures at or near the thermocline in stratified lakes, even if less than optimal dissolved oxygen levels (Fitz and Holbrook 1978).

Adult walleye can tolerate DO levels as low as 3 ppm for a short period of time, but prefer DO levels greater than 5ppm. DO levels below 2 ppm tend to be lethal (Kerr et al. 1997).

Juvenile fish require slightly warmer water than adults and tend to seek shallow water habitat in the spring and early summer. As summer progresses, juveniles tend to move to deeper habitats similar to those of adults.

Walleye are vigorous swimmers, with burst speeds measured from 6.02 fps for juveniles and up to 8.57 to 11.2 fps for adults (NAI 2009).

Walleye-Entrainment Potential

Spawning: Spawning occurs in shallow water near rubble or rocky shores, flooded marshes or tributary inlets. The nearest tributary inlet or flooded marsh is located more than 2,000 feet from the dam intake. The nearest shallow, rocky shore habitat during the spring spawning period is located more than 65 to 100 feet from the Mason Dam intake. There is no potential for entrainment of walleye spawning in flooded marshes or lake tributary inlets. There is no potential for entrainment of walleye spawning on rocky shores, as the intake is located away from the nearest potential habitat, but there is some potential for walleye to travel near the intake while moving between deepwater and shallower spawning habitats. Overall there is a **minimal** risk of spawning walleye entrainment.

Adults: The adult walleye diurnal and seasonal patterns of moving between deeper and shallow water mimic (in reverse) those of the yellow perch, its primary prey species. However, yellow perch can tolerate lower DO conditions than walleye. The walleye's general behavior could place it near the Mason Dam intake during most, but not all, of the time the project would be in operation. However, water quality conditions would limit the likelihood of the walleye being near the intake during the project operation to late summer and September.

If an adult walleye approached the intake during this time period, it would not likely be entrained as it is a vigorous swimmer well able to outswim the intake velocities. Even at less than optimal conditions, walleye's could easily escape the intake approach velocities. The exception could occur if walleye follow their yellow perch into very low oxygen areas, where their swimming ability would be severely comprised.

The potential for adult walleye entrainment during project operation is**minimal**

Juveniles: Because juvenile fish require warmer water than adults, their behavior would limit their likelihood of being near the intake during project operation to late August and September when the intake is oxygenated. As for adults, juveniles are vigorous swimmers with both maximum and sustained speeds greater than intake velocities.

The potential for juvenile walleye entrainment during project operation is**minimal**.

4.1.5 Centrarcids

Bass and Crappie-Life History
Bass and crappie tend to occupy littoral habitats. Optimal conditions for largemouth bass are lakes with extensive areas of shallow water (i.e., less than 6 m) to support submerged aquatic vegetation, but deep enough to allow overwintering (Scott and Crossman 1973).

Largemouth bass spawn during the spring in shallow, littoral habitats and remain to guard the young once hatched. Fry remain in shallow, protected habitats such as coves and flooded tributary mouths as the adults return to other shallow lacustrine habitats with abundant vegetation.

Smallmouth bass were originally limited in range to eastern central North America, but have been widely stocked elsewhere (Scott and Crossman 1998). Unlike the warm, weedy lakes and slow moving rivers preferred by the largemouth bass, cooler lakes, streams, and rivers are preferred by smallmouth bass. Lakes that hold populations of smallmouth bass are generally over 100 acres in size, over 30 feet deep and thermally stratified, and have clear water and large areas with rock or gravel substrate (Scott and Crossman 1998).

Smallmouth bass also move toward shore in early spring, but select sites with a clean stone, rock, or gravel substrate for spawning. As for largemouth bass, the smallmouth guard their young after hatching and the young remain in shallow protected areas after the adults leave. During winter, the adults tend to move to deeper water (Langhurst and Schoenike 1990). Smallmouth bass are found almost exclusively in the epilimnion during summer stratification in northeastern Wisconsin and Ontario, but frequent depths up to 12 m in northern New York (NAI 2009).

Lacustrine black crappie habitat can be characterized as the littoral zone of large warmwater reservoirs and lakes, usually with some type of in-water cover such as sunken logs (Scott and Crossman 1973). Spawning occurs primarily in April, typically in coves and shallow embayments, near but just beyond the edge of submerged vegetation (approximately 2 to 5 m deep, ODFW 2012). Although this species does not do well in the main body of large lakes, it can become abundant in shallow areas and bays (Scott and Crossman 1973). Crappie feed on the surface during dawn and dusk. During the winter, crappies often move to deeper water along vertical structure such as pilings or dams (NAI 2009).

In general, optimal temperatures for growth of adult bass range from 24 to 30̊ C, with very little growth below 15̊ C. However temperature tolerances differ among species. Lakes and rivers that are clear enough and rocky enough to be suitable for trout, but in which the water temperature is too high for trout, are generally suitable for smallmouth bass. Preferred smallmouth bass temperatures are between 16 EC and 26 E C , although nest building and spawning can occur at lower temperatures. Largemouth bass are considered warmwater species, preferring temperatures between 27 to 30 EC . However, the largemouth bass is intolerant of low dissolved oxygen concentrations and is therefore susceptible to winterkill in its vegetated, high oxygen demand habitat

Optimal temperatures for black crappie are between 22 to 25° C; with no growth below 11° C or above 30°C .

Smallmouth bass require more than 6 ppm DO for optimal growth and largemouth bass more than 8 ppm. Both species can tolerate DO levels as low as 4 ppm, but show distress at these levels. Levels below 2 ppm cause mortality. DO requirements for black crappie are assumed to be above 5 ppm, the general level for warmwater fish.In lacustrine environments, these three species tend to select temperature strata with suitable oxygen levels, although, as noted above, the largemouth bass preference for shallow, high temperature vegetated areas tends to result in late season or winterkill mortality.

Sustained swim speeds for small juvenile largemouth bass range from 1.01 to 1.64 fps within a temperature range of 15 to 30°C (NAI 2009). Swim speeds were higher for larger juveniles and small adults (1.80-2.17 fps). Maximum juvenile or "burst" speeds are estimated at 3.2 to 4.2 fps and higher for adults.

Smallmouth bass sustained swim speeds have been estimated as 1.8 fps for juveniles and 3.9 fps for adults. Maximum speeds of 3.6 to 7.8 fps for juvenile and adults, respectively have been estimated (NAI 2009).

Black crappie swim speeds have not been studied. However, studies of the related white crappie indicate that crappies are quite slow swimmers, with speeds from 0.5 to 0.75 fps at optimal temperatures, and reduced to 0.18 fps in cold water. Maximum speeds have been estimated at 1.0 to 1.5 fps. However, poor orientation to current has also been exhibited (NY Power Authority 2005, NAI 2009).

Swimming speeds of all of the above species is reduced in cold water.

Bass and Crappie-Entrainment Potential
Most regional entrainment studies are focused on salmonids. Entrainment studies over a 2-year period at Fall Creek Reservoir (Downey and Smith 1992) identified that although anadromous salmonids comprised 77.5% of the total fish moving through the reservoir outlet, that black crappie comprised another 21.9% of the entrained fish. Crappie entrainment occurred almost entirely during November and December.

Spawning: All species spawn in shallow water. Largemouth bass tend to spawn in shallow, vegetated or other littoral habitat, which is located more than 1,700 feet from the intake. Black crappie spawn in shallow water (2-5 m deep), which occurs well away from the Mason Dam intake. There is **no** potential for entrainment of spawning largemouth bass or black crappie.

Smallmouth bass spawn along shallow or rocky shorelines. The nearest potential habitat is located 65 to 100 feet north and east, respectively from the Mason Dam intake. Although the intake is relatively close to potential spawning habitat , smallmouth bass would not be spawning at the depth of the Mason Dam intake. There is **minimal** potential for entrainment of spawning smallmouth bass.

Adult: Both adult largemouth bass and black crappie prefer shallow, warm water habitats and not deep, cool open water areas. Largemouth bass, in particular are strongly oriented towards shallow, vegetated habitats limiting any exposure to a deep intake. There is **no** potential for entrainment of adult largemouth bass.

Although generally preferring shallow water, crappie may move to deeper water during the winter. It is possible that during late fall movements they could occur near the intake, as has been observed at the Fall Creek Reservoir. The Mason Dam hydroelectric project would not be operational during this time period. If crappie did occur near the intake, they would likely be entrained, as they are poor swimmers. However, the potential for black crappie to be entrained during project operation would be restricted to late September. As a result, the overall potential for black crappie during project operation would be **minimal to low**, with the greatest likelihood of entrainment occurring during the fall after the project has ceased operation.

Smallmouth bass are cool water species with strong preferences for well-oxygenated water. Although smallmouth bass may overwinter in deep water, the Mason Dam hydroelectric project would not be operational during this time period. DO levels are suitable for smallmouth bass near the intake during the spring, but temperatures are too cold. As described for the salmonids, as temperatures warm near the intake, DO levels drop. This combination results in unsuitable smallmouth bass conditions during most of the project operational period. Smallmouth bass could occur near the intake during September. Because adult smallmouth bass are vigorous swimmers, they would not likely be entrained. The overall risk of adult smallmouth bass entrainment is **minimal**.

Juveniles: Both juvenile largemouth bass and black crappie reside in shallow water. There is **no** potential for entrainment of juvenile largemouth bass or black crappie.

Juvenile smallmouth bass would be vulnerable to entrainment if they occurred within the intake vicinity, but their preference for shallow littoral areas and protected coves limits their exposure to a deep intake. Larger juveniles could move from littoral habitats during the late season and occur within the intake vicinity during September. However, by this time, the larger juveniles would be able to escape the intake approach velocities. The overall risk of juvenile smallmouth bass entrainment is **none** for small juveniles and **minimal** for larger juveniles.

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Comment [DG 54]: Please provide references that support this conclusion. It is not clear how entrainment would be higher in the fall when flows and reservoir levels drop. Please provide information that explains why fall periods would have the greatest likelihood of entrainment.

Comment [DG 55]: Smallmouth bass are some of the most tolerant and adaptable warmwater fish species. Because of this, lower DO levels and warmwater temperatures would not be entirely unsuitable to them. Smallmouth bass can spawn in most gravel substrates in depth of 2-20 feet which can also vary in temperature and DO. Males guard the nest for a short time after the fry emerge but leave the nest area in search of prey which makes them more susceptible to entrainment between mid-June and so on. Therefore this conclusion should be changed to show that the overall risk will be at least "minimal." Please provide rationale and references should the determination remains as is.

Comment [DG 56]: Depending on the suction of the intake valve and drawdown effect, fish are susceptible to getting caught in the suction vortex and be entrained regardless of how their swimming ability. Therefore it is recommended this conclusion be changed to show the overall risk as "moderate".Please provide rationale and references should the determination remains as is.

Comment [DG 57]: This finding does not mean they stay in these areas for any length of time. Warmwater fish rely on structure, their spiny rays, and size for protection and defense. Shallow water makes them susceptible to avian and mammal predation which causes them to move around in search of prey, cover, and optimum habitats. The dynamics of a reservoir is ever changing with the rise and fall of storage release which means fish are also required to move and relocate as conditions become unfavorable or resources are depleted. Constant movement of fish for these reasons makes the possibility of entrainment in any life stage possible. It is suggest that language for this determination be revised to a "minimal to moderate" level based on the information provided in this comment. Please provide rationale and references should the determination remains as is.

4.1.6 Cyprinids

Northern Pikeminnow-Life History

The northern pikeminnow is a native fish that prefers lakes and slow-moving water. The species feeds on aquatic invertebrates as juveniles (up to 300 mm), with crayfish and small fish increasing in importance as the fish grows larger (Gadomski et al. 2001). Adults continue to feed on crawfish, molluscs, and other macroinvertbrates as well as fish. Preferred species include salmonids, sculpins and suckers. Although the pikeminnow has been identified as an important salmonid predator, a number of studies have identified crayfish as a key prey item (Zorich 2004).

Northern pikeminnow spawn in the spring when temperatures reach 12 to 18 EC . Once spawning occurs, the adults leave the spawning area without parental care. Spawning habitat includes gravelly areas at tributary inlets, and clean rocky substrate along lakeshores in both shallow and deep littoral areas. Spawning typically occurs in slow-moving water.

Seasonally, the pikeminnow tends to move towards the shoreline areas in the spring and into deeper water later in the season (Martinelli and Shively 1997). Within rivers, they are frequently associated with riprap, rocky outcrops or structures (Zorich 2004).

Northern pikeminnow can tolerate a wide range of temperatures. No specific tolerances were located in the literature, but as a coolwater species, the temperature tolerances were assumed to be similar to that of the smallmouth bass.

The pikeminnow is not a strong swimmer with sustained speeds of 0.74 fps and maximum speeds of 1.6 to 2.7 fps (Mesa and Olsen 1993, Zorich 2004).

Northern Pikeminnow-Entrainment Potential

Spawning: Spawning habitats can include both shallow, gravelly areas in embayments and near tributaries, as well as rocky lakeshores. The nearest embayment/tributary habitat is located 1700 feet west or southwest of the intake. There is no potential for nothern pikeminnow entrainment during spawning in these habitats. The intake is located 65 to 100 feet from a rocky shore that could possibly used for spawning. There is some potential for the pikeminnow to travel near the intake while moving between deepwater and shallower spawning habitats. Overall there is a **minimal** risk of spawning northern pikeminnow entrainment.

Comment [DG 58]: Please provide a map that depicts the location of this embayment. As suggested, there appears to be more cove type habitats and shoreline recesses suitable for pikeminnow spawning and rearing. As suggested in comment 53, Please describe your rationale that indicates no other spawning areas for this species are found or available within 1700 feet of the dam and the site indicated in this statement.

Adult: The combination of seasonal movements from shallow to deep water and the northen53pikeminnow temperature preferences could place fish within portions of the intake vicinity between mid-August and September. The pikeminnow are relatively slow swimmers, and if they occur within the intake vicinity, would likely be entrained. Entrainment might also be high following the September rainbow trout stocking, which occurs near the dam. There is a**moderate potential**of adult northern pikeminnow entrainment during the late summer and early fall.

Juveniles: Juvenile pikeminnow tend to remain in shallow water areas where aquatic invertebrates and small fish are readily available. As the reservoir draws down in September and suitable temperature and DO conditions occur near the intake, juveniles could occur in the intake vicinity. If juveniles occur near the intake they would likely be entrained. Because the overall likelihood of juveniles being near the intake during project operation is low and restricted to the fall, the overall risk of juvenile northern pikeminnow entrainment during project operation is**minimal tolow**.

4.1.7 Catastomids

Suckers-Life History

Suckers are very abundant throughout the Columbia River drainage (Scott and Crossman 1973). Because of their abundance, they have not been as extensively studied as rarer species, introduced species or predaceous fish (Schmetterling and McFee 2006). Their habitat generally occurs within slow-moving portions of rivers and in lakes. Largescale sucker fry feed on zooplankton, but juveniles and adults feed on benthic invertebrates, diatoms, filamentous algae and other plant material. Little is known about seasonal or daily sucker movements in lakes and reservoirs, but adults seem to be relatively sedentary benthic feeders outside of the spawning period. During the summer, adults have been caught both above and below the thermocline in stratified reservoirs.

Largescale suckers use a wide range of substrates and water depths for spawning and are not generally considered spawning-habitat limited. However, some studies have indicated a preference for sandy or gravelly lake shoals in the Columbia River system (Dauble 1986, Baxter 2002).

The bridgelip sucker occurs in lakes and river backwaters with sandy or muddy substrates. Spawning occurs in the spring shortly after ice-out. Their diet consists of aquatic insects, crustaceans and algae that is scraped off of bottom rocks.

Suckers in general prefer DO levels greater than 3 ppm and can not tolerate DO levels less than 2.4 ppm. There is little documentation on temperature preferences.

Sustained swimming speeds for various species of sucker have been measured at 1.4 to 4.9 fps, with maximum speeds from 4.0 to 7.9 fps (Baxter 2002).

Suckers-Entrainment Potential

Most regional entrainment studies have focused on salmonids. Entrainment studies over a 2-year period at Fall Creek Reservoir (Downey and Smith 1992) identified that anadromous salmonids and black crappie comprised 99.4% of the total fish moving through the reservoir outlet, with other fishes (including suckers) cumulatively totaling less than 1% of the annual entrainment. At the Blue River Reservoir, juvenile suckers comprised 4% and adult suckers 0.5% of the measured entrainment (Downey and Smith 1989). Most of the sucker entrainment occurred between October and December, a time period during which the Mason Dam hydroelectric project would not be operating.

Spawning: Reservoir sucker habitat can be varied but given the depth of the Mason Dam intake during the spring (more than 20 m below the surface), it is not likely that spawning would occur within the vicinity. The nearest likely spawning habitat is located more than 1,000 feet from the intake. The potential for entrainment of spawning suckers is **none to minimal.**

Adult: As benthic feeders, adult suckers could occur within the intake vicinity during much of the time the project is in operation. The exception would be between July and August when the bottom near the intake is anoxic. The sucker feeding behavior could place them in close proximity to the intake in other months. Suckers are relatively strong swimmers and can outswim the approach velocities if aware of the intake. However, because sucker behavior would place them within the intake vicinity most of the time, the overall entrainment potential is rated as **Low to Moderate**.

Juveniles: Juveniles are also benthic feeders that could occur within the Mason Dam intake vicinity during much of the project operation. Details regarding juvenile bridgelip and largescalesuckers movements within reservoirs are sparse. Because of the uncertainty or reservoir movements, the known benthic orientation, and the lower swimming abilities than adults, the overall entrainment potential for juvenile sucker entrainment is rated as **Moderate .**

4.1.8 Entrainment Summary

The fish species most susceptible to entrainment during both the proposed Mason Dam hydroelectric project 4 to 6 month operating period and the 6 to 8 month non-operating period is the yellow perch. Yellow perch behavior and low oxygen tolerance place them frequently within the intake vicinity and their low swimming speeds would likely result in entrainment if they were near the intake. There are an estimated 1,636,575 yellow perch in Philips Reservoir, with a high potential for entrainment, particularly during late summer and fall. Studies in reservoirs with high perch populations have indicated that from 1 to 3 % of the total perch population is entrained annually (see for example, summaries in Kleinschmidt [2011]). Because these studies were conducted in non-stratified, warmwater reservoirs, it is highly likely that the percent of the population entrained at Mason Dam would fall at the lower end of the range (or 1%). This would equate to a existing annual average entrainment rate of 16,000 yellow perch through Mason Dam.

Other species susceptible to entrainment during both the project operational and non-operational periods include the native northern pikeminnow, suckers and black crappie. Although vigorous swimmers, walleye could occasionally be entrained while following their prey into less than optimal dissolved oxygen conditions. Adult suckers are also relatively strong swimmers, but their behavior would place them within the intake vicinity most of the time, potentially resulting in some inadvertent entrainment. Juvenile suckers would have a higher likelihood of being entrained. Black crappie are poor swimmers and any movement within the intake vicinity would likely result in entrainment. Entrainment rates would be highest during the late summer and fall and during dry years.

Bull trout entrainment during the proposed project operating period is highly unlikely due to the bull trout's inability to tolerate the water quality conditions near the intake during most of the project operational period and its very strong swimming ability that would allow it to escape the relatively low intake approach velocities at other times. Likewise, the potential for rainbow trout entrainment would generally be minimal.

Comment [DG 59]: Unless there are supporting studies or literature showing water quality, temperatures and swimming abilities are solid reasons for low entrainment potential, this sentence should be modified to state that bull trout entrainment is minimal to moderate. Because bull trout are pisciverous, they are constantly on the move and will go where the food is even if temperatures exceed their upper limits. As mentioned, depending on the drawdown velocities of the intake valve and vortex conditions, entrainment is possible regardless of swimming ability.

Based on a study by CH2MHill (2007) of 12 other regional reservoirs that both support trout and contain a deep intake, the potential for rainbow trout entrainment would be from 0 to 2.6% of the population on an annual basis. The 2.6% entrainment rate was developed from a reservoir operated strictly for hydropower production and in which the reservoir is routinely drawn down to 12% of its total volume, an operation that only occasionally occurs at Mason Dam. Using the results from the other 11 studies, the range of regional trout entrainment is from 0 to 0.1% of the total population. With an estimated population of 60,000 to 100,000 rainbow trout (the annual stocking rate of 58,200 fish plus an unknown number of additional residents), this would equate to an average of 0 to 100 rainbow trout being entrained over the course of a year, with the majority likely being stocked fish. The exception would be in dry years in which up to 1,500 to 2,500 additional rainbow trout might be entrained, mostly stocked fish and juveniles.

The entrainment potential for other species during the proposed project operating period (smallmouth bass, largemouth bass) is nonexistent or very low. These species tend to be entrained in high numbers within reservoirs with shallow intakes located within littoral zones. Entrainment through a deep intake within a stratified reservoir, such as occurs at Mason Dam, is very unlikely, except in very dry years in which the reservoir is drawn down to a small pool volume.

The preliminary estimate of fish entrainment through Mason Dam was identified as falling within a range of 17,325 to 61,875 fish per year, with these estimates being on the high end as they do not account for the strong summer stratification and low approach velocity (see section 4.1.1). Using species-specific entrainment data and known Philips Reservoir population data (where available), the following fish species would be anticipated to be entrained on an annual basis. An annual basis was identified for those species that would be susceptible to entrainment both during project operation and outside the project operating period, as the existing data does not allow for accurate monthly entrainment estimates.

- 16,000 yellow perch
- 0 to 100 rainbow trout
- Unknown number of black crappie. The population number is unknown but Shrader (2000) identified that the population was in serious decline. With the known very reduced densities, the total number of entrained black crappie would likely be quite low.
- Unknown number of other species, but based on other studies identifying the remaining species as typically comprising 1% or less of total entrainment, from 100 to 200

additional suckers, northern pikeminnow and occasional individuals of other species would likely pass through the outlets.

The following species would not likely be entrained during the proposed project operating period: bull trout, smallmouth bass and largemouth bass. Neither late fall/winter nor annual entrainment estimates were derived for these species.

This would account for a total revised annual entrainment estimate of slightly less than 17,325 fish[1] or the low end of the estimate based on the Fall Creek reservoir data. During very dry years, entrainment could increase by up to 1% of the perch population and by to 2,500 additional fish (rainbow trout and black crappie) as the reservoir volume is drawn down very low, for an upper revised annual estimate of 34,700 fish during very dry years.

As total annual entrainment estimates, these number represent fish entrained both during the time the project is operational (from 33 up to 50% of the year, see Figure 1 in Section 2.0) and when the project is not running (from 50 to 67% of the year). The highest levels of entrainment are expected to occur during the late summer and fall and the project would only be operating within a portion of that time.

Comment [DG 60]: Please provide references that support this conclusion.

[1] Excepting bull trout, smallmouth bass and largemouth bass which are not likely to be entrained during the Mason Dam hydroelectric project operating period and for which late fall/winter entrainment estimates were not derived.

Table 4. Summary of General Habitat Requirements for Fish Species Known to Occur in Philips Reservoir.

Species	Water Quality Requirements				Swimming Speeds (ft/sec)		Reservoir Habitat Preferences
	Preferred		Tolerable		Max	Sustained	
	DO (ppm)	Temp (E C)	DO (ppm)	Temp (E C)			
Salmonids							
Rainbow trout subspecies	∃ 7	12-18	∃ 5	0-25	1.79 juv 4.3+ adult	4.3+ adult	Cool, oxygenated habitat, move within reservoirs based on temp, DO + food sources
Bull trout	> 8	2-15	6-8	0-22	1.79 juv 22.5 adult	15.1 adult	Cold, deep oxygenated water in winter, migrate to tributaries when lakes warm or stratify
Percids							
Yellow perch	∃ 5	17.6-25	<2	4-30	1.77	0.88	Move daily and seasonally between littoral or shoreline areas and deep water
Walleye	> 5	15-18	∃ 3	6-32	6.02-11.2	3.3-4.8	
Centrarchids							
Smallmouth bass	> 6	16-26	∃ 4	0-30	3.6-7.8	1.8 juv 3.9 adult	Rocky shorelines, move to deeper water in winter
Largemouth bass	> 6	27-30	∃ 4.5	? - 30	3.2-4.2	1-1.6 juv 1.8-2.2 adult	Shallow, vegetated habitats
Black crappie	> 5	22-25	∃ 4	? - 30	1-1.5	0.5-0.75	Shallow habitats, move to deeper water in winter
Cyprinids							
Northern pikeminnow	>5	16-26*	>3	0-30*	1.6-2.7	0.74	Seasonal movements between shoreline areas and deep water
Catastomids							
Suckers	>3		>2.4		4.0-7.9	1.3-4.9	Relatively sedentary benthic feeders

* estimated as similar to smallmouth bass, another "coolwater" species.

Table 5. Species Entrainment Potential during the Mason Dam Mid-March to Sept 30 Operating Period.		
Species	**Life Stage**	**Entrainment Potential**
Salmonids		
Bull trout	Spawning	None
	Adult	None to Minimal
	Juvenile	None to Minimal
Rainbow trout subspecies	Spawning	None
	Adult	None to Minimal
	Juvenile	Minimal
	Recently stocked fish	Low to Moderate
Percids		
Yellow perch	Spawning	None
	Adult	High
	Juvenile	High
Walleye	Spawning	Minimal to Low
	Adult	Minimal
	Juvenile	Minimal
Centrarcids		
Smallmouth bass	Spawning	Minimal
	Adult	Minimal
	Juvenile	None to Minimal
Largemouth bass	Spawning	None
	Adult	None
	Juvenile	None
Black crappie	Spawning	None
	Adult	Minimal to Low
	Juvenile	None

Table 5. Continued.		
Cyprinids		
Northern pikeminnow	Spawning	Minimal
	Adult	Moderate
	Juvenile	Minimal to Low
Catastomids		
Suckers	Spawning	None to Minimal
	Adult	Low to Moderate
	Juvenile	Moderate

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APPENDIX A: Entrainment and Mortality Background Summary

Numerous studies have been conducted at reservoirs and hydrolelectric facilities throughout the US and Canada. The results have shown variation in entrainment rates according to fish species composition, reservoir operation type and depth, and intake characteristics. However, some general trends have been observed and summarized in a number of reports (FERC 1995, EPRI 1997, Ch2MHill 2003, NY Power Authority 2005, CH2MHill 2007, NAI 2009, Symbiotics 2009, City of New York 2011):

Fish Species

- Entrainment is relatively low (less than 20 fish/hour) for most resident warmwater/coolwater fish communities. Residents tend to be entrained inadvertently in relation to their use of habitats near the intake. Episodic entrainment events have been noted for anadromous salmon and other obligate downstream migrants, as well as fish species that travel in large schools.

- Entrainment rates vary by species and are not necessarily related to the relative composition of a water body. Yellow perch, northern pike and smallmouth bass are species that are particularly susceptible to entrainment. Species less susceptible to entrainment include rainbow trout and some sucker species.

- Species entrainment rates vary both diurnally and seasonally according to species behavior.

- Young-of-year (YOY) and juvenile fish are more susceptible to entrainment than adult fish.

Reservoir Characteristics

- Entrainment rates are much higher for shallow reservoirs than deeper reservoirs, with up to twice as many fish entrained in reservoirs with dams less than 50 feet high (15 meters) than those greater than 50 feet.

- Reservoirs that are operated to be drawn down over the winter and allow for spring storage can increase winter entrainment rates as more fish are placed in closer proximity to the intake.

Intake Characteristics

- Intakes adjacent to shorelines tend to entrain more fish than those located away from the shoreline as many fish species tend to follow shorelines or orient to the physical structure associated with shorelines.

- The littoral zone is the most productive area within a reservoir and many species spawn and rear there. Intakes in littoral zones entrain more species than deeper intakes.

- Poor water quality near the intake can form a barrier and reduce fish susceptibility to entrainment. This is particularly true if there is low dissolved oxygen in the hypolimnion.

Fish swim speeds in relation to velocities at the intake can also affect entrainment potential. The ability to avoid entrainment depends on both the fish's swimming speed, and its ability to detect and respond quickly to a change in velocity. Detection can be comprised by darkness, turbidity or cold temperatures. If a fish does not respond to a velocity acceleration until it can only maintain position in the flow, it would find itself quite close to the intake and may not have enough time or strength to scape. Detection for strong swimming fish is generally only an issue for river intakes or where approach velocities are greater than or equal to 5 ft/sec. Swimming performance can be decreased by as much as 50% when temperatures fall outside a species' preferred range (Bell 1997). This latter item most often occurs as winter approaches and temperatures cool.

Of all the factors examined by studies of reservoirs with deep intakes, the intake depth and the water quality near the intake tend to be the most important factors affecting fish entrainment. This is because the DO, temperature and depth in relation to other habitat features affect the fishes' potential to occur in the intake vicinity. The reservoir size is not as important.

Once entrained, a separate set of factors affects whether or not the fish survives. Fish mortality from entrainment is generally related to two factors: (1) sudden differences in pressure from being entrained underwater to being suddenly ejected into atmospheric conditions, and (2) physical damage as a result of being thrown about at high velocities (Battelle Research Laboratory 1997). Also important is the type of intake. Valve outlets appear to cause more mortality to fish than gate-controlled flow regulators, perhaps because of increased shear stress around the valve cone. Mortality rates associated with spillways are variable, influenced by velocity and head height, but tend to be lower than those of regulating structures. Multi-intake tower mortality rates are also variable as they draw water from different depths of the reservoir.

Other factors influencing fish mortality during entrainment includes fish species and size, and reservoir operation (e.g., type of operation, hydraulic head, discharge, water velocity). General mortality trends include:

- Young fish are more likely to be entrained and survive than mature fish; conversely mature fish are less likely to be entrained but if they are, their survival rate is lower. According to EPRI (1997), more than 90% of the fish entrained at hydroelectric projects are less than 4-8 inches (approximately 100 to 200 mm), and their high survival rate tends to reduce the overall entrainment impact on fish populations.

- Mortality tends to be positively correlated with both discharge and reservoir head. The higher the discharge and the higher the hydraulic head, the greater mortality will be.

- Mortality rates via pressure change vary by species, with perch, crappie and bass more susceptible to mortality than salmonids and minnows. Survival of percids tends to be very low, 0 to 10%, with large differences in pressure.

- Mortality due to pressure changes is reduced as the reservoir lowers.

- Mortality is relatively low in spillways with water velocities less than 50 fps, but increases sharply at velocities greater than that, with 100% mortality observed at velocities more than 80 fps.

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Emigration of juvenile trout from natal streams back to reservoir systems have been known to occur between April through May. Their presence and life history needs while in the reservoir will increase the chance of entrainment particularly when discharge from the reservoir peaks at the same time juvenile are entering the reservoir. Please include the rationale used to verify this determination or consider adjusting the call to a 'moderate' possibility given the information in this comment. Please use the following as references to assist with a revised determination: Russell F. Thurow[a], Danny C. Lee[a]&Bruce E. Rieman.1997.Distribution and Status of Seven Native Salmonids in the Interior Columbia River Basin and Portions of the Klamath River and GreatBasins **DOI.**

russell f. thurow* and bruce e. rieman, danny c. lee, philip j. howellraymond d. perkinson. 2007. Distribution and Status of Redband Trout in the Interior Columbia River Basinand Portions of the Klamath River and Great Basins. U.S. Department of Agriculture-Forest Service

Page 15: [2] Comment [DG 52]	Gonzalez, Daniel -FS	11/13/2012 3:39:00 PM

Experience shows that stocked fish tend to stay in the general vicinity of their release point for at least 7-10 days if not lnoger. Hatchery fish endure a high level of stress, disorientation, gas saturation, and crowding from the time they are taken from the hatchery and loaded into trucks. Then, to add more stress and complications, when they are released, there is a short period of shock and awe they go through when their bodies have to adjust to their new environments. Here in eastern Oregon, it's generally poorer water quality conditions and the fact that they no longer have a human hand feeding them. The likelihood of entrainment, especially if fish are released near the dam is very high. Please provide references that supports the conclusions made here.

RE: Fish Entrainment and Mortality Study

DADOLY John to: jyencopal@bakercounty.org 10/22/2012 08:52 AM
Cc: DADOLY John

Jason, thanks for the update on your project. I looked through the updated report and I do not see any major water quality issues that were not covered by DEQ's previous comments that were sent to you in May 2010. I don't think I need to participate in the Fish Entrainment and Mortality Study work session proposed for next month.

I will continue to review information and participate as needed. The presence of Bull Trout in the Powder river below the dam is the only potential issue I can see at this time. If Bull trout were confirmed to be present below the dam DEQ would have to modify its comments regarding temperature and dissolved oxygen levels.

Thanks
John Dadoly
DEQ Water Quality Program

From: jyencopal@bakercounty.org [mailto:jyencopal@bakercounty.org]
Sent: Thursday, October 18, 2012 2:56 PM
To: Audie Huber; Carolyn Templeton; Carl Stiff; FAGAN Colleen E; GRIFFIN Dennis; Fred Warner; Gary Miller; Kenneth Hogan; GRAINEY Mary S; Randy Joseph; KIRK Steve; Quentin Lawson; LUSK Rick M; Robert Ross; Shawn Steinmetz; Susan Rosebrough; STAHL Thomas; Timothy Welch; Joseph Hassell; Carl Merkle; lgecy@ecowest-inc.com; ted@tsorenson.net; gsense@cableone.net; HOMOLKA Ken; Jeff Tomac; Rick Rieber; DADOLY John; OSIERMOATS Elizabeth A
Subject: Fish Entrainment and Mortality Study

Dear, Stakeholders,

I would like to start by thanking all of you for your contributions to this updated draft fish entrainment and mortality report. As you will read we focused on the entrainment issues first and would like your feedback before updating the mortality portion of the report. This way we can ensure we are on the right track as we move forward.

As a work in progress, we hope that you would be willing to provide feedback in an informal fashion within a work session to be scheduled in mid-November. If you would like, you could also send informal written comments at anytime. Those that we receive early we will try and respond to prior to the meeting to keep the discussion going. We are particularly interested in any information you feel pertinent that we may have missed or any conclusions that you feel need additional clarification. You will find that we have added additional baseline and proposed project details that are pertinent to both the potential for entrainment and mortality and tried to compare data from those Pacific Northwest projects that are most similar, suing ODFW and Tribal/BOR project data. We would also like to have feedback on whether or not we missed any key studies that you have access to and that should be reviewed.

We would like to schedule a work session prior to Thanksgiving if at all possible to keep things moving. Please let me know your availability for November 12th through the 21st.

Thank you for your time and continued help with this project.

Jason Yencopal
Community Development Director
1995 Third Street
Baker City, OR 97814
541.523.9669 Office
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jyencopal@bakercounty.org

Fish Entrainment Study

Gonzalez , Daniel -FS to: jyencopal@bakercounty.org 05/02/2012 09:47 AM

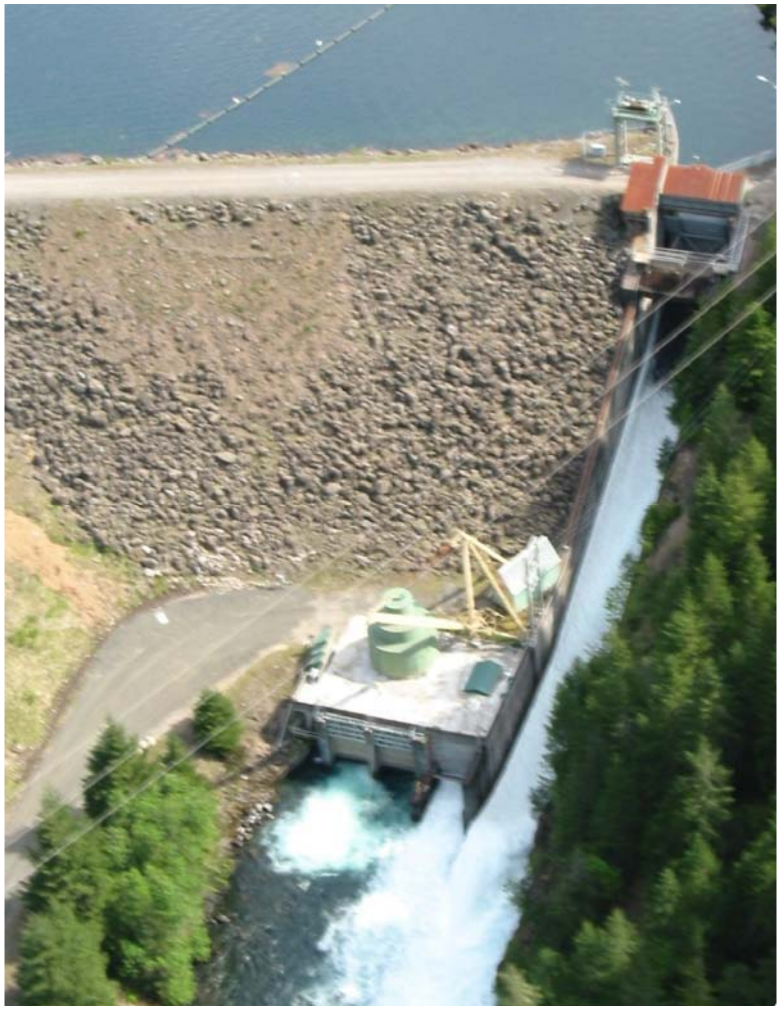
History: This message has been forwarded .

Jason:

Good to see you at our last meeting. Attached is a study I thought would be helpful to you and Lesley, unfortunately my emails don't always work when I try and contact her. Please forward this to her when you can. Thanks and stay in touch. DG

Daniel Gonzalez
Forestry and Range Sciences Lab
1401 Gekler Lane
La Grande, OR 97850
Office: 541-962-6533

 Carmen_Smith Fish Entrainment regarding the Project under P_2242 Jan 06.pdf



Fish Entrainment
at the Carmen-Smith Hydroelectric Project, Upper McKenzie River Basin, Oregon

Final Report

Prepared for
Eugene Water & Electric Board
Eugene, Oregon

Prepared by
Stillwater Sciences
Arcata, California

January 2006

Stillwater Sciences