STUDY NO. 2: PRINEVILLE RESERVOIR FISH ENTRAINMENT STUDY

2.1 Goals and Objectives - §5.9(b)(1) —Describe the goals and objectives of each study proposal and the information to be obtained

ODFW Proposal:

The primary purpose of this study is to determine entrainment rates of various fish species from Prineville Reservoir over a two to three year period. Installation of the proposed hydroelectric facility may cause increased mortality of entrained fishes due to turbine-related injuries.

The objectives of this study are to: 1) Estimate total entrainment rates of various fish species over a two to three year period; 2) Describe temporal variation in entrainment rates of entrained fishes in relation to reservoir pool elevation and discharge; 3) Describe the physical condition of entrained fishes; and 4) Estimate survival of entrained fishes.

OID Response:

It is OID's understanding that ODFW's goals and objectives are to assess the effects of entrainment under current conditions on fish residing in Prineville Reservoir. Bowman Dam acts as a management barrier separating the tailrace fishery of native wild redband trout and mountain whitefish from the reservoir fishery consisting of stocked rainbow trout, predatory large and small mouth bass, and other introduced species. Therefore, the objectives of this study should be to first demonstrate that reservoir fish species are present in the river downstream of Bowman Dam, which would be suggestive of entrainment. The goal then should be to determine how effective Bowman Dam is as a barrier to the downstream movement of fish from the reservoir and the likelihood these fish are able to survive by evaluating the physical conditions of entrained fish.

2.2 Relevant Resource Management Goals - §5.9(b)(2) — If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

ODFW Proposal:

ODFW's Native Fish Conservation Policy mandates considering the biology and population status of wild and naturally producing fish when making resource and management decisions. This policy directs ODFW to "prevent the serious depletion of any indigenous fish species through the protection of native ecological communities, the conservation of genetic resources,... such that fish production is sustainable over the long term" (OAR 635-07-0503). Consistent with these objectives, ODFW can recommend the installation of screening or by-pass devices on water diversions to protect fish. ODFW's mission is to "provide diverse recreational opportunities for present and future generations". In certain waterbodies, including Prineville Reservoir, this is achieved through hatchery stocking programs and warmwater game fish management (OAR635-500-0055). Angling opportunity and success in the Reservoir is compromised by entrainment through the unscreened outlet.

The State of Oregon's fish screen law (Oregon Revised Statute 498.306) requires the owner or operator of a diversion located in waters in which native and naturally spawning fish are currently present to address fish screen requirements. ODFW recommends the Applicant to conduct an entrainment study to provide data to document how native resident and migratory fish and non-native fish are migrating out of the reservoir, and identify the timing and magnitude of passage. No data is available that describes fish entrainment in the water outlet used at the Bowman Dam.

By assembling the entrainment rates gained from this study, the description of dam facility operation, and information on fish distribution and abundance in the reservoir, the Applicant can report potential entrainment during downstream migration under current conditions. This study will help describe the effect of project operations on fish populations. ODFW will use this information to make recommendations as to whether the yet-to-be proposed mitigation will result in no net loss to fish populations. ODFW will also use this information to develop and implement strategies for fish management.

Proposals and construction of new hydroelectric projects in the State of Oregon are subject to state regulation. ORS 543 governs new projects and sets minimum standards for development of hydroelectric projects. A new project cannot be approved by the state if the project will cause a net loss of wild game fish, unless the losses are mitigated. ODFW considers information on downstream fish passage to be important for concluding whether the applicant can construct the project to meet the minimum standards for developing hydroelectric power in Oregon.

OID Response:

It appears that ODFW has two resource management goals or objectives established by state regulations: (1) Protection of the recreational cold water and warm water fisheries established in Prineville Reservoir, and (2) Protection of the native redband trout and mountain whitefish fishery in the Crooked River below Bowman Dam.

OID agrees and supports these management goals and objectives.

2.3 Background and Existing Information - §5.9(b)(4) — Describe existing information concerning the subject of the study proposal, and the need for additional information.

ODFW Proposal:

A literature review of fish entrainment risk at hydroelectric facilities for the Carmen Smith Hydroelectric Project (Stillwater 2005) concluded, "A major source of direct and indirect mortality for certain fish populations residing in the vicinity of hydroelectric projects is the physical damage or stress individuals incur as they attempt passage through hydropower facilities (OTA 1995, NRC 1996, Cada et al. 1997, all cited in Coutant and Whitney 2000)." (Stillwater Sciences 2005). The authors of the fish entrainment review concluded that, "As an alternative to conducting site-specific evaluations, making confident inferences from other studies about the rate of entrainment-related mortality or injury is not broadly supported by the literature. As noted in the EPRI (1992) study, the limited number of observations and substantial variability between studies precludes establishing a predictive relationship between turbine mortality and variables such as fish size, turbine head and peripheral runner speed associated with the turbine structure itself. In particular the authors caution that variability between different studies designed to examine relationships between fish size, species, and mortality or injury rates makes forming simple conclusions difficult and risky (EPRI 1992). There was generally little or no agreement on the relative contribution to entrainment "risk" of physical attributes associated with hydropower facilities, including: the type of turbine; the efficiency of turbines as operated; the capacity in terms of flow volume; the size, depth, and approach velocities at the intake; or the dimensions and turnover rate of the reservoir (FERC 1995, EPRI 1992). The significance of a given feature at one facility may be less at another, and there is no statistically valid way to assign a quantitative entrainment risk for a given condition.

In the evaluation of studies at 46 hydropower facilities, variability in entrainment results between projects allowed little statistical basis for extrapolation of study results to untested facilities (FERC 1995). The one specific example most relevant to the objectives of this review done for the Chester Morse Reservoir complex on the Cedar River, Washington, found very little basis for making reliable estimates of entrainment rates from other studies (Knutzen 1997). These estimates of entrainment rates spanned two orders of magnitude."

There are desk analysis of existing data used at some project developments, including one collected as part of an earlier Bowman Dam Hydropower FERC application (Symbiotics LLC. - FERC No 11925). However, as indicated by the Stillwater Sciences review and per ODFW's review it is not one that ODFW feels is an adequate methodology.

The outlet from Prineville Reservoir is a hypolimnetic release of water from the bottom of the reservoir. This structure is unscreened and enables an unquantified level of entrainment of fish from the reservoir into the lower Crooked River. High emigration rates appear to coincide with severe drawdown (Stuart et. al 1996). Entrainment of hatchery rainbow trout and non-native warmwater species are of primary concern. Hatchery rainbow trout may successfully spawn in the lower river resulting in genetic introgression with wild redband trout. This could lead to reduced viability of the native population. Additionally, the consumptive trout fishery in Prineville Reservoir has declined in recent years. This is largely due to interspecific competition with illegally introduced species. However, losses to entrainment are cumulative with other depressing factors on the Reservoir trout fishery. Entrained warmwater fish compete with native fish for available forage, distribute pathogens and disrupt the aquatic ecology. Currently no information exists on entrainment of fish from the reservoir into the stream below the dam. ODFW will require this information to assess the potential impacts of Project operation, and determine whether the Project can be constructed and operated consistent with state law. This information will assist ODFW in making management decisions for native and non-native game fish affected by the Project and assessing mitigation measures proposed by the Applicant.

OID Response:

OID agrees that little information exists regarding the occurrence and rate of entrainment at Bowman Dam. Also, there does not appear to be any information regarding the survival of fish that may be entrained from Prineville Reservoir and passed downstream of the dam. ODFW has been collecting population data on redband trout and mountain whitefish for many years using electrofishing techniques and if reservoir fish are being entrained then it is possible that ODFW has some empirical data collected during surveys (Porter, T, and B. Hodgson. 2016). OID has requested the field data from ODFW to examine it for information on reservoir species captured during sampling periods. The presence of rainbow trout and introduced warm water species in the lower river would indicate that entrainment is occurring and, to at least some degree, fish are surviving after passage. However, the survival of entrained fish is likely to decrease following the installation of energy dissipation equipment and hydroelectric turbine generators minimizing the risk of introducing reservoir species into the tailrace fishery.

2.4 Project Nexus - §5.9(b)(5) — Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

ODFW Proposal:

By assembling the entrainment rates obtained from this study, the description of dam facility operation, and information on fish distribution and abundance in the reservoir (study request #1), the Applicant can report potential entrainment during downstream migration under current conditions. This study will help describe the effect of project operations on fish populations. ODFW will also use this information to develop and implement strategies for fish management. The entrainment study is necessary to provide data for ODFW to quantify the impacts of Project operation on native game fish**.** ODFW will use this information to make recommendations as to whether the yet-to-be proposed mitigation will result in no net loss to native game fish populations. ODFW will also use this information to determine the need for fish screens, and to develop and implement management strategies for fish management such as trapping, sorting, and relocating warm water game fish. Proposals and construction of new hydroelectric projects in the State of Oregon are subject to state regulation. ORS 543 governs new projects and sets minimum standards for development of hydroelectric projects. ODFW considers information on downstream fish passage to be important for concluding whether the applicant can construct the project to meet the minimum standards for developing hydroelectric power in Oregon.

It's the policy of the state of Oregon (ORS 543.015): 1) to protect the natural resources of the state from possible adverse impacts caused by the use of the waters of this state for the development of hydropower; 2) to permit siting of hydroelectric projects subject to strict standards established to protect the natural resources; and. 3) to participate to the fullest extent in federal proceedings related to hydroelectric power development in order to protect the natural resources of Oregon". Assessment of current out-migration of fishes from the reservoir and potential turbine-related mortality is therefore necessary to determine the potential impacts of entrainment on these resources and eventually to work toward an acceptable form of mitigation to compensate for these impacts.

OID Response:

*ODFW states, "*By assembling the entrainment rates obtained from this study, the description of dam facility operation, and information on fish distribution and abundance in the reservoir (study request #1), the Applicant can report potential entrainment during downstream migration under current conditions." *The study referenced addresses impacts of sedimentation on redband trout and mountain whitefish in the river downstream of the dam. It does not address distribution and abundance of fish in the reservoir.*

OID agrees that evaluating fish entrainment is important to assessing the effects of placing a hydroelectric project at Bowman Dam. Under the existing conditions, fish may pass Bowman Dam either over the spillway during high flow spill events or by way of the outlet gate near the bottom of the dam. The presence of fish normally found in Prineville Reservoir in the river downstream of the dam would indicate that passage and survival over or through the dam is currently occurring.

If downstream passage and survival of fish from the reservoir to the river is happening under existing conditions, then the goal should be to evaluate if the project will create a change to the current condition. It is unknown if the fish will be more or less likely to survive passage through the energy dissipating device and the project turbines. However, OID anticipates that the project has the potential for decreasing survival of entrained fish and therefore may benefit the management of the downstream fishery.

2.5. Proposed Methodology - §5.8(b)(6) — Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field seasons(s) and the duration) is consistent with

generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

ODFW Proposal:

The methodology involves operating a rotating screw trap immediately downstream from the dam to sample and estimate the numbers of fish exiting the reservoir. To the extent possible ODFW recommends year round trap operation to monitor emigration rates at variable release flows and reservoir pool levels. Location of the trap will be critical in facilitating adequate efficiency rates to quantify entrainment levels. The trap should be located as close to the outlet structure as possible where water depth is adequate for screw rotation at variable flows. We recommend the trap be anchored utilizing an overhead cable system with blocks and pulleys. This will enable moving the trap to optimize efficiency.

A floating, 5-foot or 8-foot rotary downstream migrant collector, or screw trap, would be used to address Objectives 1, 2, and 3. The size of the trap used would depend on the water depth at the site during base flows. These types of traps are commonly used in reservoir entrainment and salmon smolt out-migrant studies (McLemore et al. 1989, Downey and Smith 1990, Thedinga et al. 1994, Roper 1995, Demko et al. 2000). The trap should be installed as close to the outlet as possible to reduce potential incursion from the river. Trap installation and operation would be coordinated with ODFW biologists. It is anticipated that the screw trap would be operated most days per week as necessary to obtain statistically robust estimates of fish entrainment for the duration of the study.

It may be necessary to construct a weir isolating the trapping site from upstream migrating redband trout and whitefish. These fish may be attracted to release flows from the outlet particularly during spawning periods in the spring (redband) and fall (whitefish). Capture of these fish would distort results. Calibration of trapping efficiency would be achieved by periodic, upstream releases of a known number of different sized, group marked - fish obtained from the trap. Different marks would be used on alternating days. Calibration releases would occur opportunistically depending on the availability of fish and changes in flow releases and reservoir elevation. The intent would be to determine trap efficiency for various sizes of each species over a broad range of stream discharges and to apply the appropriate flow-related efficiency correction factor to each sampling week based on mean flow during that week.

Estimation of the total number of fishes annually passing the trap would be achieved using the following formula (modified from http://oregonstate.edu/Dept/ODFW/life-cycle/TRPMETH3.HTM).

Nt~ = r.N~ = (n)/(mrecap/mreD

where: N~ = total number of migrants passing the trap during week i

n~ = number of unmarked fish caught in the trap during week i

mrecapt = number of marked fish recaptured during week i

mre~ = number of marked fish released above the trap during week i

The trap would be checked in the morning because downstream migration is often most intense after dusk. Traps may be checked more than once each day, if necessary, during periods of intense out-migration. All fishes of a particular species would be classified into estimated size categories as proposed by the applicant and conditional upon approval by ODFW. The intent of this technique would be to reduce handling stress that would be incurred if actual length measurements were taken.

AQUI-S would be used as an anesthetic as fishes will be released. The physical condition of captured fishes under existing operational conditions would be assessed using protocol described by Downey and Smith (1990) via three general categories: uninjured, injured, and dead on arrival. The physical condition of each injured fish will be evaluated using a general description of the type and location of a particular injury. Opportunistically, a random sample of injured and uninjured fish will be held in a floating live box for a period of 72 hours to estimate delayed mortality by species and life stage, if possible. Surviving fishes would be released downstream of the screw trap. This information would be vital toward assessing background survival rates of fishes exiting the reservoir under current operations.

This type of analysis is consistent with other fish protection analyses completed during licensing proceedings for hydroelectric projects.

While a desk analysis of existing data used at some project developments, including one collected as part of an earlier Bowman Dam Hydropower FERC application (Symbiotics LLC. - FERC No 11925) are available, it is not one that ODFW believes is an adequate methodology and therefore we recommend that data be collected onsite using field sampling methods consistent with generally accepted practices in the scientific community, such as the use of screw traps with a statistically robust sampling schedule, both weekly and seasonally.

A similar entrainment study was conducted by Symbiotics LLC as part of the proposed Wickiup Dam Hydropower Project (FERC Project No. 12965-002).

OID response:

A first step of this study would be to make a determination if passage and survival of reservoir fish currently exists. This determination could be made by examining existing electrofishing data collected by ODFW to determine if reservoir fish species are routinely captured during sampling efforts. Absence of reservoir fish species may indicate that either entrainment is not occurring, it is occurring at very low levels, or fish do not survive passage. On the other hand, if reservoir fish species are routinely captured it would indicate passage and survival does occur. If downstream passage and survival are occurring, it is hypothesized that the installation of energy dissipation equipment and hydroelectric turbine generators would reduce survival of entrained fish and thereby further prevent movement of fish between habitats. Since the project will not change the location of the intake, alter reservoir elevation, change flow release rates, or control spillway flows the potential for entrainment would remain the same as current conditions.

OID will describe the dimensions of the equipment to be installed, approach and discharge velocities, and the pressure gradient fish would pass through if entrained. This will allow for a desktop analysis to determine the potential for fish to survive passage through the project turbines and energy dissipating valve.

If entrainment is occurring, OID proposes to systematically operate a rotating screw trap throughout a single year. The objective of ODFW is to evaluate relative entrainment during varying reservoir levels. It is believed that entrainment may greatest at low and high reservoir levels. Therefore, 3-4 screw trapping events will occur during periods that are representative of seasonal low, mid, and high reservoir levels. Reservoir levels are typically lowest from October through March and highest between April and June. Mid reservoir levels would occur between July and September. During each trapping period, the screw trap would be operated for one month and be checked daily. This would result in approximately 3 months of data representing multiple reservoir level scenarios. Analysis

would result in a relative rate of entrainment used to determine when entrainment risk is highest relative to reservoir conditions. Fish condition would be assessed as described to qualitatively assess survival through the dam. Calibration of trap efficiency would also be conducted as described.

2.6 Level of Effort and Cost - §5.9(b)(7) — Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

ODFW Proposal:

OID will need to obtain a scientific taking permit from ODFW. In the best of conditions the study would be designed, permits obtained, and field studies initiated before the end of 2020. The highest magnitude of fish migration may coincide with reservoir drawdown in the fall. Therefore, OID should begin the study in fall of 2020 and continue through the fall drawdown of the reservoir in 2021, with results reported by December of 2021 or if three years of data are collected, December of 2022.

The total cost for conducting the analysis and preparing the report is estimated to be approximately $100,000. Two analysts would be expected to work for approximately 7 days a week, 4 hours a day on the collection of data. Additionally, two analysts would be expected to work for approximately twenty days preparing the draft report and final report.

The evaluation of anadromous fish habitat above Bowman Dam study would be completed during the 2020 study season with the draft annual report available for comment by the federal agencies and ODFW prior to December 31 for each year of the study.

OID Response:

The total cost for equipment, trap operations, data collection, data analysis, and preparing the report is estimated to be approximately $100,000-$150,000 for a one-year study beginning in 2020.