STUDY NO. 7: RAMPING AND FLOW FLUCTUATIONS EVALUATION

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

ODFW Statement:

ODFW's objective for seeking this ramping rate information is to better predict the potential impacts of the Project operations on downstream macroinvertebrate and native fish populations and their habitat.

Hydroelectric facilities typically have the capability of increasing and decreasing flow levels downstream of the facilities. In general, the rate at which these changes occur is called the "ramp rate" or "ramping." From a fisheries perspective, ramping down the river flow has the potential to strand fish in areas of the channel that are relatively low-gradient, or where pockets or side channels exist in the river channel. Stranding is defined as the separation of fish from flowing water as a result of declining river stage from rapid decreases in flow ("down-ramping"). Smaller juvenile fish (less than about 50 mm long) are most vulnerable to potential stranding because of weak swimming ability and typical habitat preference. River channel configuration, channel substrate type, time of day, water temperature, and flow level before down-ramping (antecedent flow) are also key factors that determine stranding incidence. Artificial flow fluctuations from hydroelectric power operations can create a varial zone on the streambed where the biomass of algae and macroinvertebrates can be significantly reduced, especially if low-gradient riffle areas are dewatered frequently. Because macroinvertebrates are the primary food source for most riverine fish, extreme flow fluctuations can adversely affect fish growth in streams where the fish population is food-limited. Also, changes in flow that are too great or frequent can disrupt fish spawning success and dewater eggs incubating in the streambed gravels. Therefore, it is important to consider the season as well as the rate and magnitude of flow change when developing ramping regimes that minimize adverse impacts on fish.

The purpose of this study is to evaluate the potential for adverse fisheries and benthic macroinvertebrate impacts associated with current ramping regimes in each of the river reaches affected by the proposed hydroelectric Project. The objectives addressed by this set of studies are as follows:

- Describe the extent of potential flow fluctuations in terms of rate of stage change (ramp rate) and frequency in the riverine reaches of the Crooked River as affected by Project operations.

- Describe the physical extent of streambed habitat affected by proposed operations in the Crooked River reaches downstream of Bowman dam,

- Describe the potential for down-ramping to strand fish. Verify this with field observations in the river reaches downstream of Bowman dam.

- Characterize the potential impacts of Project ramping on fish resources.

The study would identify critical sites the river where there exists a high risk of juvenile salmonid (Redband Trout and Mountain Whitefish) stranding, such as near gravel and sand bars, shallow side channels and pools. It would determine stage-discharge relationships which provide the conversion of flow (always known and controlled within a hydroelectric facility) and stage (the underlying factor affecting fish stranding). The study would further determine lag time. This being the time a "parcel" of water takes to travel in the natural watercourse from either the intake or tailrace to each critical

site. Several lag times should be determined at different flows. The study would determine stage attenuation. Commonly referred to as flow routing, stage attenuation refers to the damping (or smoothing) of flow and stage changes as water moves downstream. Stage attenuation would be determined for a range of flows.

OID Response:

It should be noted that this study proposal is essentially the same as the FWS proposed study "Study No. 1: Instream flow continuity and ramping rates".

The Bowman Dam Hydroelectric Project is not what would normally be considered a typical hydroelectric project since operations would not regulate flow releases from Prineville Reservoir and would operate strictly run-of-release from Prineville Reservoir. The U.S. Bureau of Reclamation regulates how and when water is released and the project would not affect the flow downstream of Bowman Dam.

Water releases from Bowman Dam are made for the purpose of meeting the requirements of downstream water contracts and water rights. The project would not have control over these releases but would utilize a portion of the flow to generate power. Once water passes through the powerhouse it would combine with the remaining flow released from the dam. The result is that flow in the Crooked River downstream of the dam would always be equal to the amount of water released to meet the downstream needs. The amounts of water to be released to meet the contractual requirements are defined in the Crooked River Collaborative Water Security and Jobs Act of 2014, including an allocation of water for the benefit of fish and wildlife resources. The timing and rate of release of the water allocated for the benefit of fish and wildlife is the subject of ongoing negotiations.

Project design would include provisions to insure continuous flow from the dam. In the event of a powerhouse outage, flow releases would automatically shift from the powerhouse to the flow release system of the dam. The resulting flow would always be equal to the release from the dam.

7.2 Relevant Resources 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 Statement:

This investigation is intended to provide baseline information that, together with environmental data and results of other past and ongoing studies, can be used to assess effects of Project operations on fish resources and to help formulate recommendations for protection, mitigation, and enhancement measures consistent with agency and tribal management goals.

ODFW's wildlife policy (ORS 496.012) establishes wildlife management policy to prevent serious depletion of any indigenous species and maintain all species of fish and wildlife at optimum levels. The wildlife diversity program's goal is to maintain Oregon's wildlife diversity by protecting and enhancing populations and habitats of native wildlife at self-sustaining levels throughout natural geographic ranges (OAR 635-100-0010). The Fish and Wildlife Habitat Mitigation Policy (OAR 635-415-0010) requires or recommends, depending upon the habitat protection and mitigation

opportunities provided by specific statutes, mitigation for losses of fish and wildlife habitat resulting from development actions.

Additionally, ODFW has multiple resource management goals derived from Oregon statute and adopted rules that guide our recommendations in hydro licensing processes. Permeating each of these policies is the goal of protecting and restoring native fish and wildlife populations for use and enjoyment by present and future generations. Key directives to ODFW for implementing fish and wildlife strategies include; avoidance of impacts to these populations, protection of genetic diversity, and protection and restoration of natural habitats on which these populations are dependent.

OID Response:

OID understands and supports ODFW's management goals. However, the Bowman Dam Hydroelectric Project would not control flow releases from Bowman Dam and therefore flows in the Crooked River would remain as they are under current conditions.

7.3 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:

Quickly increasing or reducing reservoir releases for potential hydropower operations can impact downstream fish and wildlife populations. Changes to reservoir releases should be designed towards a more gradual release schedule that provides more opportunity for an appropriate downstream fish response.

The rate of change of streamflow over a specified time when diversion is started, stopped, or changed is referred to as the ramping rate. Ramping rate is a concern for fish protection because rapid decrease in flow can strand fish on gravel bars, trap fish in disconnected channels or pools, and dewater fish eggs. In some river systems drops in flow, even as little as 1 inch of water surface elevation per hour, can impact fish populations. Other effects, including depletion of aquatic invertebrates on which fish feed, behavioral responses to changes in flow, and impacts to water quality may also reduce fish production but are not as well understood. The impacts of flow fluctuation may be reduced by specifying the ramping rate and times during the day and year when those ramping rates would apply. Usually, ramping recommendations are in inches or tenths of a foot per hour of water elevation (stage) change.

Ramping transects are evaluated to determine the maximum rate of flow change to meet interim ramping rates, so that engineers have specific design criteria to work with. Some of the data needed (channel shape and stage-discharge) is similar to that collected for part of PHABSIM studies.

OID Response:

The Bowman Dam project would not control the flow releases from Prineville Reservoir or ramping rates. Therefore OID suggests that sufficient information already exists to describe the downstream aquatic habitat and no additional study should be required. The following excerpts, taken from the Deschutes Basin Habitat Conservation Plan, provide a description of flow and fish habitat in the Crooked River between Bowman Dam and Crooked River Diversion (RM 70.5 - RM 57.0).

Channel Characteristics

Riparian and instream habitat conditions remain fair to good throughout the reach; however, tailrace releases from the dam may limit riparian vegetation growth in a portion of the reach. The regulated flows below Bowman Dam are somewhat opposite of natural flows, which were typically high in late winter and low in summer and early fall. Water is now stored in winter and spring, and released for downstream diversion throughout the irrigation season. High flows during the growing season may reduce the area available for riparian vegetation along this confined channel (NPCC 2004).

Flow Characteristics

Operations at Bowman Dam have changed the magnitude and timing of peak flows in the lower Crooked River. Before dam construction and operation, 66 percent of the average flow of the Crooked River occurred in the months of March, April, and May. Today, flows are typically 200-250 cfs during the summer irrigation season and 30-75 cfs during the winter storage season. Before the construction of Bowman Dam in 1961, average peak discharges typically ranged from 3,000-7,000 cfs (Whitman 2002). Since construction of the reservoir, flows have ranged from as low as 10 cfs during winter months, the minimum flow required by the project, to as high as 3,000 cfs (Whitman 2002). The goal of flood control operations at the dam is to limit the outflow from the reservoir so as not to exceed 3,000 cfs.

Monthly flow exceedance curves at the Prineville gage for the period of record following Bowman Dam construction are shown in Figure 2-11.

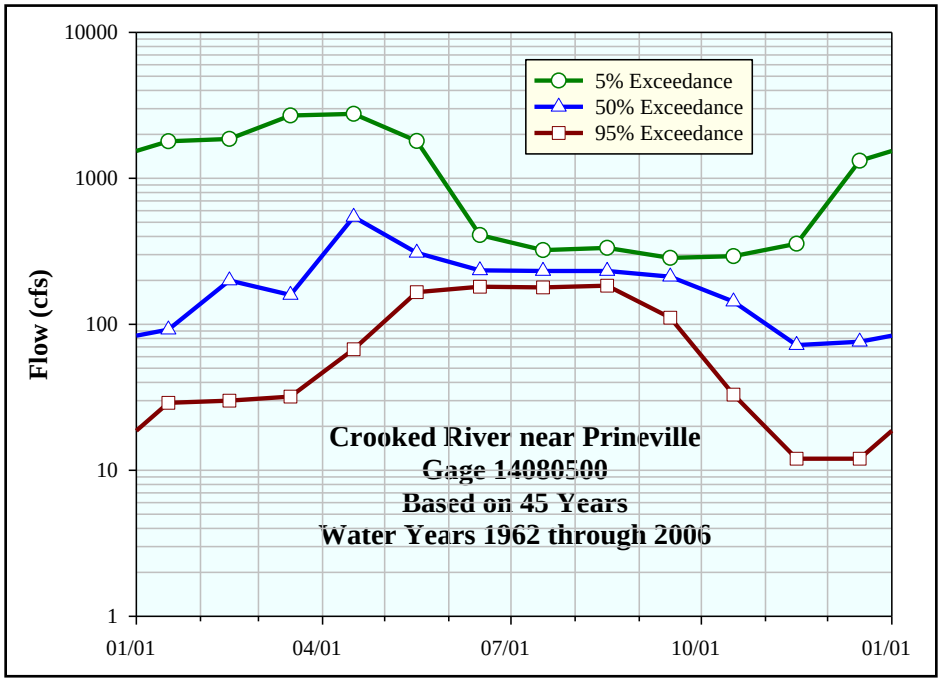

Figure 2-11. Monthly flow duration curves for the Crooked River near Prineville Gage # 14080500. **Source: USGS/OWRD data**

Channel conditions in the upper reach remain stable, though flow regulations limit the ability of the stream channel to rejuvenate through landform developing processes such as large floods. Peak flows that used to occur every 2.5 years (about 4,000 cfs) now occur about every 50 years on

average. This modification has had an effect on channel morphology (Fies et al. 1996; McSwain 1999; Whitman 2002).

Fish Habitat

This reach of the Crooked River contains limited spawning habitat. Cold-water reservoir releases since the 1960s have decreased the ambient water temperatures in the Crooked River below Bowman Dam. Summer water temperatures typically average between 8.3°C (47°F) and 10.0°C (50°F) annually, with a high of 12.4°C (54°F). Winter temperatures average between 2.8°C (37°F) and 4.4°C (40°F) annually, with an absolute recorded low of 0.0°C (32°F) (NPCC 2004). The cold-water releases substantially improve summer water quality and fish habitat in this reach (Stuart et al. 1996), and have created a "tailrace redband trout fishery" that did not exist under pre-dam conditions.

Sediments suspended in the reservoir from the upper watershed create turbid flow in the Crooked River downstream from the dam. Water in the Crooked River is generally turbid throughout the lower basin downstream to RM 16, where sufficient spring inflow contributes to good water clarity and cooler temperatures (Stuart et al. 1996). As discussed in Study 15, this reach of the Crooked River is included on the state 303(d) list for exceeding the total dissolved gas criterion.

Spateholts (2008) used HabRate methods generated by Burke et al. (2003) for qualifying life history stage habitat conditions to produce spring Chinook salmon. The assessment indicated this reach is fair to poor for egg to fry survival, poor for fry to parr survival, and fair for parr to smolt survival, with an estimated smolt capacity of 1,477 smolts per mile or 19,940 outmigrating spring Chinook smolts (Spateholts 2008).

Similarly, following the work of Ackerman et al. (2007), Spateholts (2012) used UCM to estimate the summer steelhead parr production capacities. This reach was estimated to produce 74,920 summer parr, all of which were predicted to be of the resident life history form. Based on the stable river flows and relative cool water temperatures, this reach has been delineated as primarily producing resident redband trout (Zimmerman and Reeves 2000; Ackerman et al. 2007; Spateholts 2008, Courter 2011). These authors suggest flow regimes that provide cool temperatures and maintain depth and velocities necessary to sustain adult redband trout throughout the summer and fall seasons will result in increased resident trout populations and decreased steelhead trout abundance.

Courter (2011) estimated the reach downstream of Bowman Dam could support between 15 and 80 adult steelhead spawners, depending on flow conditions. Juvenile steelhead productivity for the reach could range between 11 and 12 smolts per spawner. Based on competition with other species, this estimate is less than half the juvenile steelhead production anticipated for the downstream Prineville Valley reach during a wet year. Based on habitat-flow relationship patterns, IFIM study results (1993, 2001) suggest higher flows than currently exist may enhance fish production in this reach.

7.4 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:

ODFW's objective for seeking this water flow information is to better predict the potential impacts of the Project on downstream macroinvertebrates and fish habitat and insure the necessary ramp release rates are adopted as part of the operational conditions.

OID Response:

As stated above the project would not control flow releases from Prineville Reservoir or ramping rates. The maximum flow through the powerhouse would be ____ cfs and the minimum would be ___cfs. Any flow in excess of the maximum would be released through an energy dissipating valve as well as any flow releases below the operating range of the powerhouse. Flow through the powerhouse and released through the energy dissipater would come together at the plunge pool at the base of the spillway. Below this point the flow would be the same as if the powerhouse were not built and operating.

7.5 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 ramping rate study framework summarized below is provided to give OID guidance for designing the flow ramping. Study:

1. *Identify critical sites*. Critical sites are described as areas in a river where there exists a high risk of juvenile salmon stranding, such as near gravel and sand bars, shallow side channels and pools.

2. *Determine stage-discharge relationships*. Stage-discharge relationships provide the conversion of flow (always known and controlled within a hydroelectric facility) and stage (the underlying factor affecting fish stranding).

3. *Determine lag time*. The lag time is the time a "parcel" of water takes to travel in the natural watercourse from the intake to the tailrace. Lag time scan also be determined from either the intake or tailrace to each critical site. Several lag times should be determined at different flows.

4. *Determine stage attenuation*. Commonly referred to as flow routing, stage attenuation refers to the damping (or smoothing) of flow and stage changes as water moves downstream. Stage attenuation should be determined for a range of flows.

5. Identify aquatic species and life stages that are potentially vulnerable to rapid flow changes and their periods-of-occurrence.

6. Use stream cross sections and corresponding stage-discharge relationships from instream flow studies to quantify the varial zone and impact zone (for alternative scenarios) between various flow increments.

7. Conduct field observations of actual down-ramp events to determine the lag time of flow change events and any attenuation in the rate-of-change of stage between the powerhouse and Copco reservoir.

8. Conduct concurrent observations of fish stranding incidence and fish condition during actual down-ramp events.

The ramping studies needs to be conducted in consultation with the Oregon Department of Fish and Wildlife, United States Fish and Wildlife Service, and Oregon Department of Environmental Quality to ensure critical site selection and study methodology meets their satisfaction.

This type of analysis is consistent with other fish protection analyses completed during licensing proceedings for hydroelectric projects that have the potential to adversely affect resident and anadromous salmonids and ESA-listed fish species.

OID Response:

OID agrees that a ramping rate study would typically be a requirement for the licensing of a hydroelectric project where the project controls the flows in the downstream reaches of the river or stream. The Bowman Dam project would not control the flow in the river downstream of the dam once it combines with flows released to the dam spillway channel. Therefore OID suggests that sufficient information already exists to describe the downstream aquatic habitat and no additional study should be required.

7.6 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:

The total cost for conducting the analysis and preparing the report is estimated to be approximately $30,000. Two analysts would be expected to work for approximately 10-12 days on various alternatives and costs for downstream fish passage protection. Additionally, two analysts would be expected to work for approximately 5-7 days on the preliminary conceptual design of the preferred alternative for structural measures for downstream fish protection, and two analysts would be expected to work for approximately two days incorporating agency comments into the final report.

The ramp rate analysis would be completed during the first study season of the Traditional Licensing Process with the draft report available for comment by the NMFS, FWS, and ODFW prior to December 31, 2020,

ODFW has proposed ramp rate guidelines for the hydropower release as a means of protecting the aquatic resources in the Crooked River below the proposed Project. However, a site specific study as prosed in this study would allow more give assurance that all the aquatic resources are being adequately protected in respect to the up ramping and down ramping schedule for proposed Project.

OID Response:

OID agrees that a ramping rate study would typically be a requirement for the licensing of a hydroelectric project where the project controls the flows in the downstream reaches of the river or stream. However, the Bowman Dam project would not control the flow releases from Prineville Reservoir or ramping rates. Therefore, OID suggests that no additional study should be required.