Proposal to Initiate Negotiated Rule Making for Site Specific Temperature Criteria for Fall Chinook Salmon Spawning in the Hells Canyon Reach of the Snake River

Final

(Revision 1)

Idaho Power Company

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1. INTRODUCTION

In 2006, Idaho Power Company (IPC) submitted a proposal for Site Specific Criteria (SSC) to the Idaho Department of Environmental Quality (IDEQ) for fall Chinook salmon (*Oncorhynchus tschawytscha*) spawning temperature for the Snake River below the Hells Canyon Complex (HCC). The purpose of the proposal was to initiate an informal forum to discuss SSC preliminary to a formal petition for a rulemaking. The proposal was submitted for review to IDEQ only because the Oregon Department of Environmental Quality (ODEQ) indicated it preferred to participate in the process as an observer. IPC proposed a Snake River fall Chinook salmon spawning criterion not greater than 16.5 C as a daily maximum temperature on October 23 and subsequent daily maximum temperatures not to exceed levels equal to a 0.2 °C daily rate of decline through November 10. From November 11 through April 15, the daily maximum temperature was not to exceed 13 °C. These SSC were to be applied to the Hells Canyon Reach, the Snake River from Hells Canyon Dam [river mile (RM) 247.6] to the Oregon/Washington border (RM 176.1)[1].

The IDEQ held a meeting to discuss the technical merits of IPC's SSC proposal. In attendance were: IDEQ, ODEQ, U.S. Environmental Protection Agency (EPA), National Marine Fisheries Service (NOAA), U.S. Fish and Wildlife Service (USFWS), Idaho Department of Fish and Game (IDFG), Columbia River Inter-Tribal Fish Commission (CRITFC), Nez Perce Tribe (NPT), Idaho Rivers United (IRU), and American Rivers (AR). The group raised several issues including a concern that the proposed SSC was at the "edge of the envelope" for fall Chinook salmon and that the proposal would result in a standard with no inherent added protection, particularly when the resource is a species protected under the Endangered Species Act (ESA). Specifically, one concern was temperature changes downstream relative to the compliance location of Hells Canyon Dam. If water temperatures were to increase in a downstream direction, then compliance may not ensure that fall Chinook salmon embryos would not be exposed to temperatures higher than the standard. Further inquiry was made about accuracy of equipment used to measure temperature both in the river and at the compliance point and the accuracy of the temperature equipment involved in the Battelle study used as primary supportive information of the proposed SSC (discussed later in this document). Others also noted a desire to include an explicit margin of safety to ensure protection of the resource.

IPC has considered the comments and concerns expressed in reaction to the first proposal and continues to believe that the available information warrants a SSC greater than the existing Idaho and Oregon

[1] This proposal, at times, refers to the Hells Canyon Reach. This is intended to reference the Snake River from Hells Canyon Dam to the Salmon River confluence.

numeric criteria of 13 °C maximum weekly maximum (MWM)[2] and 13 °C seven-day average maximum[3], respectively, (standards which have been interpreted by IDEQ and ODEQ as functionally similar), but that a sufficient margin of safety could be incorporated. The purpose of this document is to provide technical support for this revised proposed SSC for temperature for Snake River fall Chinook salmon spawning and incubation below Hells Canyon Dam that is protective of the resource consistent with IDAPA 58.01.02.070.07 and OAR 340-041-0028(13).

This revision of the proposed SSC was made after review of the initial proposal by Dr. Charles C. Coutant and Dr. Dudley W. Reiser. Their letters of concurrence of this proposal are attached as Appendices 1 and 2, respectively.

The proposed SSC in Idaho and Oregon (presented again in greater detail in Section 3, with rationale in Section 4) that would be protective of Snake River fall Chinook salmon spawning are:

Proposed Amendment to Idaho IDAPA 58.01.02

286. SNAKE RIVER, SUBSECTION 130.01, HUC 17060101, UNIT S1, S2, AND S3; SITE-SPECIFIC CRITERIA FOR WATER TEMPERATURE

A maximum weekly maximum temperature of fourteen and an half degrees (14.5C) applies from October 23rd through October 31st and a maximum weekly maximum of thirteen degrees C (13C) applies from November 1st through April 15th to protect fall chinook spawning and incubation in the Snake River from Hell's Canyon Dam to the Salmon River.

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[2] Idaho DEQ defines the Maximum Weekly Maximum Temperature as the single highest weekly maximum temperature (WMT) that occurs during a given year or other period of interest, e.g., a spawning period. The WMT is the mean of daily maximum temperatures measured over a consecutive seven (7) day period ending on the day of calculation. When used seasonally, e.g., spawning periods, the first applicable WMT occurs on the seventh day into the time period. IDAPA 58.01.02.52.

[3] Oregon DEQ defines the Seven-Day Average Maximum Temperature as a calculation of the average of the daily maximum temperatures from seven consecutive days made on a rolling basis. OAR 340-041-0002(56).

Proposed Amendment to Oregon OAR 340-041-0028(4)

(g) The seven-day-average maximum temperature of a stream identified as having fall Chinook salmon spawning use may not exceed 14.5 degrees Celsius (58.1 degrees Fahrenheit) at the times indicated on Table 121B. The seven-day-average maximum temperature is calculation of the average of the daily maximum temperatures from seven consecutive days made on a rolling basis.

While the main focus of this proposal is the spawning life-stage, effects on other life stages as a result of the standard are also part of the consideration. This document is structured to provide background information on this SSC proposal, the status and life history of Snake River fall Chinook salmon, a description of the existing criteria relative to existing conditions, and the rationale for the proposed SSC. In 2007, IPC developed a Temperature White Paper that provided a comprehensive review of the effects of the HCC on fall Chinook salmon (Groves et al. 2007; Appendix 3). Much of the information presented in this document is summarized from this white paper. Subsequent to the submittal of the White Paper, the NPT filed, on August 30, 2007, with the Federal Energy Regulatory Commission (FERC) a review of the white paper conducted by the CRITFC (Appendix 4). In December, 2007, IPC filed a response with FERC to the CRITFC review that evaluated the principal criticisms made by CRITFC of the white paper (Appendix 5). As part of his review of this SSC proposal, Dr. Charles C. Coutant provided comments (dated June 10, 2010) relative to the August 30, 2007 review conducted by the CRITFC (Appendix 6). Further, as part of evaluating the temperature requirements of fall Chinook salmon, IPC commissioned a study through Battelle that investigated the effects of different thermal regimes on fall Chinook salmon egg incubation, fry development and growth. The findings of that study are also summarized in the white paper; the study was accepted for publication in the Transactions of the American Fisheries Society where it received full peer review (Geist et al. 2006).

2. BACKGROUND

The HCC consists of the Brownlee, Oxbow, and Hells Canyon hydroelectric projects, located from RM 343.0 to RM 247.6 on the Snake River. The Snake River is boundary water between Oregon and Idaho. IPC operates the three hydroelectric projects in the HCC pursuant to FERC license, Project No. 1971, which expired in 2005, and continues under an annual license. IPC filed an application with the FERC to re-license the HCC in July 2003. That application is currently pending before the FERC. In conjunction with the licensing process, IPC has also applied for Section 401 water-quality certification from Idaho and Oregon. IPC has developed the technical documentation necessary for the IDEQ and ODEQ to consider the SSC proposed in this document. Because the Snake River is boundary water, IPC anticipates that the IDEQ and ODEQ will develop a coordinated process to address the issues raised by this proposal.

In July 2003, and revised in June 2004, the IDEQ and ODEQ (2004) issued the Snake River–Hells Canyon Total Maximum Daily Loads (SR–HC-TMDLs) that cover the mainstem Snake River from RM 409 near the town of Adrian, Oregon, to the inflow of the Salmon River at RM 188.2; this river reach includes the HCC. IPC received load allocations through the SR–HC-TMDLs for temperature, dissolved oxygen (DO), and total dissolved gases. The EPA approved the bacteria, pH, pesticides, and total dissolved gases TMDLs in March 2004 and nutrients, nuisance algae, DO, and temperature in September 2004.[4]

2.1. Site Specific Criteria Process

By Idaho statute, the IDEQ may develop new or modified criteria through site specific analysis that effectively protect designated and existing beneficial uses. IDAPA 58.01.02.275. Specifically, IDAPA recognizes that temperature criteria as they relate to specific water bodies are appropriate for adjustment when doing so will fully support the designated aquatic life at a higher temperature. IDAPA 58.01.02.070.07. Likewise, Oregon regulations provide that the ODEQ may establish, by separate rulemaking, alternative SSC for all or a portion of a water body that fully protects the designated use. OAR 340-041-0028 (13). The EPA must approve any final SSC implemented by the states. 40 CFR 131.20(c). While Idaho, Oregon, and the EPA regulations provide the authority to promulgate SSC, they do not fully prescribe the procedure. Therefore, IPC proposes that IDEQ and ODEQ, jointly or separately, engage in a negotiated rulemaking to establish a revised SSC for temperature in the Snake River from Hells Canyon Dam to the Salmon River.

The negotiated rulemaking process for Idaho would include public notice of negotiated rulemaking, two public meetings, publication of the proposed rule on the Administrative Bulletin for public comment, submission of the proposed rule to the Idaho Board of Environmental Quality, review by the Idaho legislature, and submission of the revised rule to EPA for review. This process is expected to take approximately one year.

[4] Although EPA has approved the TMDLs, IPC has filed a petition for judicial review of those portions of the TMDLs that impose a temperature load allocation on the HCC. That petition is pending in Baker County, Oregon. This petition is independent of that pending legal proceeding.

The collaborative rulemaking process under Oregon rules is similar to the Idaho process, but the resulting rule does not require legislative approval. Any interested person may petition for a SSC rulemaking. ODEQ may hold a public hearing, but regardless must within 90 days approve or deny the petition, or initiate a rulemaking process. If ODEQ proceeds with a rulemaking, it may appoint a collaborative rulemaking committee or advisory committee to develop the rule. Public notice is given in inviting comment on the proposed rule; ODEQ may hold a public hearing to receive comment. Once the rulemaking record is complete, ODEQ may adopt the rule and file it with the Secretary of State. The SSC rule is then sent to EPA for review. This process is likely to take about one year.

2.2. Snake River Fall Chinook Status

Snake River fall Chinook salmon were listed as a threatened species in 1992 under the Endangered Species Act. Many factors led to their protected status, including development on the lower Snake and Columbia rivers and the corresponding necessity for the species to migrate through eight federal hydroelectric projects below the HCC. The HCC's effects on temperature below Hells Canyon Dam are not indicated as factors that contributed to the population decline.[5] However, as NOAA Fisheries has observed, Snake River fall Chinook salmon returns have been significantly higher since 2000 than had been observed in the two preceding decades (Declaration of D. Robert Lohn, Case No. CV01-00640-RE, June 12, 2003). While IPC has not changed project operations in a manner that would alter its effects on temperature, Snake River fall Chinook salmon returns and the number of redds constructed below Hells Canyon Dam have been steadily increasing (Figure 1), with 2009 having the highest redd count (3,476 redds) for Snake River fall Chinook salmon above Lower Granite Dam since intensive redd count surveys began in 1991[6]. Adult numbers have increased from 336 in 1990 to over 15,000 in 2009. The component of natural adults contributing to spawning has also increased substantially and has ranged from a low of 78 in 1990 to a high estimated in 2001 of over 5,000 (Debbie Milks, Washington Department of Fish and Wildlife, personal communication).

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[5] The IDEQ in its comments to the IPC's draft license application indicated that it has not identified any evidence that the fall Chinook salmon population below Hells Canyon Dam is impaired by the temporal shift in water temperatures influenced by the HCC. (See the FLA, Consultation Appendix [T. Dombrowski, 2002, "Idaho Department of Environmental Quality Comments on Idaho Power Hells Canyon Complex Draft Application," FERC]).

[6] Weekly helicopter surveys beginning in mid-October and extending through early December have consistently been conducted in all years since 1991 to count and document timing and distribution of redds in the Snake, Clearwater, Grande Ronde, Imnaha and Salmon rivers. In addition, deep-water video searches for redds in the Snake River have continued since 1993. Redd searches have been a coordinated effort by IPC, the U.S. Fish and Wildlife Service and the Nez Perce Tribe.

There are several reasons for the increased abundance. Increased hatchery supplementation is a primary factor[7]; however, increasing returns of non-hatchery salmon and steelhead, including Snake River spring Chinook salmon, Snake River steelhead and Snake River fall Chinook salmon, over the last several years suggest improvements in migration survival and/or ocean conditions. Regional management decisions on harvest levels, and the quality and quantity of habitat are also factors contributing to increased abundance. With the increased fall Chinook salmon returns, there is clear evidence that Snake River fall Chinook salmon are spawning successfully and that current conditions are supporting this beneficial use designated for the Snake River below Hells Canyon Dam. Recent studies demonstrate sufficient habitat in the Snake River to support a further increase in numbers of fall Chinook salmon (Groves and Chandler 2001; Connor et. al. 2001). Recent studies (Geist et al. 2006) also demonstrate that the fall thermal regime with initial spawning temperatures <16.5 °C does not impair survival of incubating fall Chinook salmon. Fall Chinook salmon spawn in periods of declining water temperatures. Fall Chinook salmon spawn in late fall in large mainstem river environments. Their typical life history is that of rearing for a brief period after emergence in early spring, and then migrating to the ocean as an Age-0 fish. These habitat and life history characteristics of fall Chinook salmon are sufficiently different from other races of Chinook salmon (e.g., spring /summer Chinook salmon, *Oncorhynchyus tschawytscha*) and other species of Pacific salmon (e.g., sockeye salmon, *O. nerka*) to suggest that temperature preferences or tolerances of other Pacific salmon should not be relied upon to describe those of fall Chinook salmon.

The Age-0 life history is dependent upon conditions that promote early emergence such that sufficient rearing, growth and energy reserves can be obtained before they migrate to the ocean. Migration must occur before summer temperatures become too warm. Warm fall and overwinter temperatures promote early emergence and the Age-0 life history. The primary historic spawning area of Snake River fall Chinook salmon was upstream of Swan Falls Dam (see Chandler 2007 for a review of historic conditions). This area is highly influenced by large volumes of spring flow into the Snake River that moderates fall and winter cooling and historically allowed for early emergence. Historically, the area below Hells Canyon Dam did not support a significant amount of spawning and was a cold over-winter environment, very similar to the Salmon River today. The moderated temperatures associated with construction of the HCC warmed fall and winter conditions and allowed continuation of the Age-0 life history. The habitat upstream of the HCC today is too degraded to support fall Chinook salmon (Groves and Chandler 2005). The Hells Canyon Reach of the Snake River, especially upstream of the Salmon River is the closest habitat available today to that of the historic environment that supported the Age-0 life history.

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[7] Consistent hatchery supplementation began in 1995 and has continued to the present. The numbers of hatchery reared juvenile fall Chinook salmon has ranged from 16,500 in 1995 to 6.5 million in 2009.

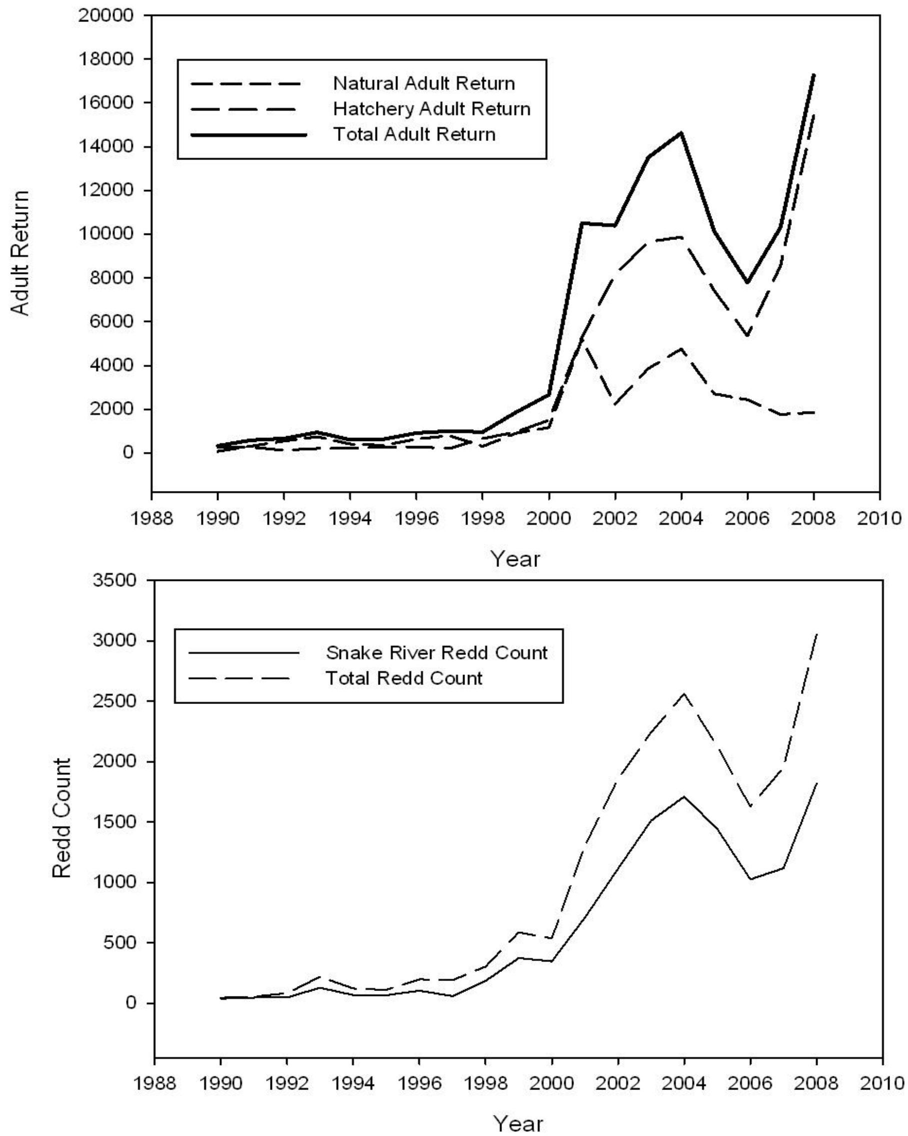

Figure 1. (*Top*) Hatchery and Natural Snake River adult returns (*Bottom*). Total redd counts and Snake River redd counts, 1990-2008. Total redd counts include all redds counted upstream of Lower Granite Dam which include the Snake, Grande Ronde, Clearwater, Imnaha and Salmon rivers (Source: Garcia et al. (2006) and IPC, USFWS, and the Nez Perce Tribe, unpublished information).

2.3. Existing Idaho and Oregon Water Quality Standards[8]

As noted, Idaho and Oregon have salmonid spawning temperature criteria applicable to the Snake River (Table 1). IDAPA 58.01. 02.286 and OAR 340-041-0028(4)(a). In addition, Oregon has species-specific and life-stage specific criteria.

Table 1. Idaho and Oregon salmonid spawning temperature criteria applicable to the Snake River below Hells Canyon Dam.

	Criteria	Spawning Period	Waters Protected
Idaho	Maximum Weekly Maximum of 13 °C	October 23 – April 15	Hells Canyon Dam to Salmon River confluence (RM 247.6 to RM 188.2)
Oregon	Seven-Day Average Maximum of 13 °C	October 23 – April 15	Hells Canyon Dam to the Salmon River confluence (RM 247.6 to RM 188.2)
Oregon	Seven-Day Average Maximum of 13 °C	November 1 through May 15	Salmon River confluence to the Oregon / Washington Border (RM 188.2 to RM 176.1)

Each state also has exclusions for natural conditions and air temperature. The natural conditions standards generally provide that should the IDEQ or ODEQ determine that the natural background temperatures exceed any biologically-based numeric criteria, that the natural background temperatures supersede the biologically-based criteria. IDAPA 58.01.02.053.04 and OAR 340-041-0028(8). Exceedences of biologically-based numeric temperature criteria that are attributable to maximum air temperatures that exceed the 90th percentile of a yearly series of temperatures specific to the State's criterion collected over specified periods of data are not violations of the standard. IDAPA 58.01.02.080.03. and OAR 340-041-0028(12)(c). Oregon's rules further provide that "the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern." OAR 340-041-0028(4)(d). Each state also allows anthropogenic temperature increases. Oregon allows a cumulative increase of no more than 0.3 °C. OAR 340-041-0028(12)(b)(B). Idaho allows a similar increase applicable to point source wastewater receiving waters. IDAPA 58.01.02.401.03.a.v. The SR–HC-TMDLs established a salmonid spawning temperature target of a maximum weekly maximum temperature of 13 °C, or if the natural thermal potential is greater, an allowable cumulative increase of no more than 0.14 °C (IDEQ and ODEQ 2004).[9]

[8] Because the Snake River is boundary water and IPC seeks the development of consistent standards by each state, IPC references the applicable water quality standards of both Idaho and Oregon in this petition.

[9] Oregon has revised the anthropogenic temperature allowance standard to no more than 0.3 °C since the submission and the EPA approval of the SR–HC-TMDLs.

The IDEQ and ODEQ have interpreted the seven-day average maximum temperature to be the mean of daily maximum temperatures measured over a consecutive seven day period ending on the day of calculation. When used seasonally, as for spawning periods, the first applicable seven-day average occurs on the seventh day of the period. This interpretation is part of IDEQ water quality standards. IDAPA 58.01.02.010.52. The ODEQ has issued an Internal Management Directive with a similar calculation protocol (ODEQ 2008). Both follow the EPA recommended guidance (USEPA 2003). The salmonid spawning temperature criterion below the HCC starts on October 23 (Table 1). Applying the criterion in accordance with IDEQ and ODEQ interpretation and EPA's recommended guidance, the seven-day average maximum temperature is first calculated on October 29.

2.3.1. Snake River Fall Chinook Salmon Spawning Period

Idaho has identified a basin-specific period of October 23 through April 15 for fall Chinook salmon spawning and incubation for the mainstem Snake River from RM 188.2 (Salmon River confluence) to RM 247.6 ((Hells Canyon Dam; Table 1). IDAPA 58.01.02.286. Oregon has a basin-specific period of October 23 through April 15 for salmon and steelhead spawning through fry emergence for the mainstem Snake River from RM 188.2 to RM 247.6 consistent with Idaho, and also includes a period of November 1 through May 15 from RM 176.1 to RM 188.2. OAR 340-041-0028(4)(a) Figure 151B. OAR 340-041-0121. Table 121B only identifies the October 23 through April 15 salmon and steelhead through fry emergence period. The SR–HC-TMDLs, authored by both the IDEQ and ODEQ, utilized salmonid spawning criterion of a maximum weekly maximum no greater than 13°C that applies from October 23 through April 15 from Hell's Canyon Dam to the Salmon River (IDEQ and ODEQ 2004).

2.3.2. Snake River Fall Chinook Salmon Spawning Location

Idaho has identified waters of the Snake River that must support salmonid spawning (Table 1). IDAPA 58.01.02.130.01. Similarly, Oregon has identified a specific geographic location in which salmon and steelhead spawning through fry emergence must be protected for the mainstem Snake River. OAR 340-041-0028(4)(a) Figure 151B and OAR 340-041-0121 Table 121B. However, IPC believes the geographic extent identified in Table 121B is incorrect. Oregon identifies the Oregon/Washington border to be RM 169, which is actually near the confluence of the Grande Ronde River in Washington. The correct river mile for the Oregon/Washington border is RM 176.1. Additionally, OAR 340-041-0121 Table 121B sets a period of salmon and steelhead spawning through fry emergence different than Figure 151B. The SR–HC-TMDLs established that salmonid spawning must be protected in the Snake River from Hells Canyon Dam to the confluence with the Salmon River (IDEQ and ODEQ 2004).

2.4. Existing Conditions

Hydrology, inflowing warm water from sources upstream of the HCC, reservoir operations, and air temperatures all affect the magnitude and timing of seasonal warming and cooling in the Hells Canyon Reach. The SR–HC-TMDLs concluded that the hot, arid climate and non-quantifiable influences, such as upstream impoundments, upstream tributaries, water withdrawals, channel straightening, dikes, and removal of streamside vegetation, were the dominant causes of increased water temperatures in the Snake River (IDEQ and ODEQ 2004).

The HCC impoundments are uniquely located within a relatively narrow and steep-walled canyon. The HCC impoundments are not a heat source, but they do affect the timing of seasonal water temperatures exiting the Hells Canyon Dam. In the spring and summer, the HCC has an overall cooling effect on the downstream reach because, as upstream water temperatures increase, outflow from Hells Canyon Dam is composed of stored winter water, which remains cooler than the inflow to Brownlee Reservoir. This trend reverses in the fall as upstream water temperatures decline and outflow from the HCC is composed of stored spring and summer water, which is warmer than inflowing water. In addition, summer peak water temperatures in the outflow from Hells Canyon Dam are less than inflow, and base winter water temperatures in the outflow are warmer than the inflow.

A comparison of existing temperature conditions at Hells Canyon Dam in 1992, 1995, and 1997, which may be considered low, medium, and high flow (river discharge) years, respectively, to current salmonid spawning criteria show that Idaho's maximum weekly maximum criterion of no greater than 13 °C was exceeded in 1992 and 1995 and was equal to Idaho's maximum weekly maximum criterion plus allowable anthropogenic increase (i.e., 13.3 °C) in 1997 (Figure 2). While the calculation of a maximum weekly maximum temperature, by definition (IDAPA 58.01.02.52), is different than Oregon's seven-day average maximum temperature (OAR 340-041-0002(56)), attainment of the criteria, not to exceed 13 °C on the most critical consecutive seven-day period, are similar. Therefore, Oregon's seven-day average maximum (13.0 °C) was also exceeded in 1992 and 1995 (Figure 2). The magnitude and duration of numeric criterion exceedance varies by hydrologic and meteorological conditions among years as demonstrated by the years of 1991 to 2009 (Table 2).

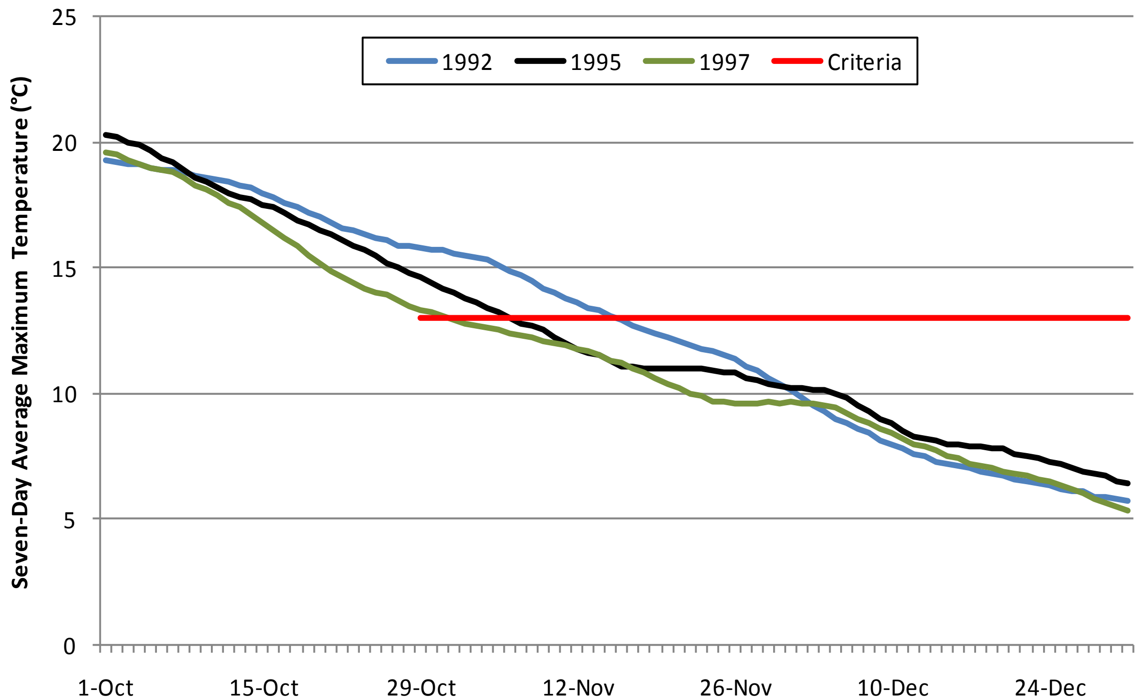

Figure 2. Snake River 7-day average maximum temperature at Hells Canyon Dam (RM 247.6) in 1992, 1995, and 1997 (calculated from October 23rd for a known result on October 29th) compared with maximum weekly maximum and 7-day average maximum criteria of 13.0 °C (existing criteria). These years may be considered representative of low, medium, and high flow years, respectively.

Table 2. Seven-day average maximum temperatures in degrees Celsius (°C) from 1991 through 2009 measured during the beginning of the designated salmonid spawning period for the Snake River at Hells Canyon Dam. Seven-day average maximum temperature is calculated as the daily maximum on a day and the six preceding days. NA indicates data were not available to calculate a seven-day average maximum temperature for that day.

	Seven-Day Average Maximum Temperature (°C)																		
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Oct 23																			
Oct 24																			
Oct 25																			
Oct 26																			
Oct 27																			
Oct 28																			
Oct 29	16.4	15.8	15.7	15.5	14.6	14.8	13.3	14.0	14.5	15.0	NA	15.3	16.8	16.3	15.7	15.3	14.5	14.9	14.8
Oct 30	16.1	15.7	15.6	15.4	14.4	14.5	13.2	13.9	14.4	14.8	NA	15.1	16.7	16.1	15.6	15.0	14.4	14.7	14.6
Oct 31	15.9	15.7	15.5	15.3	14.2	14.4	13.1	13.8	14.3	14.5	NA	14.9	16.5	15.9	15.5	14.8	14.2	14.5	14.4
Nov 1	15.6	15.6	15.4	15.1	14.0	14.2	12.9	13.7	14.1	14.3	NA	14.7	16.3	15.7	15.4	14.5	14.0	14.2	14.2
Nov 2	15.4	15.5	NA	15.0	13.8	14.0	12.8	13.5	14.0	14.1	NA	14.4	16.0	15.5	15.2	14.3	13.9	14.1	13.9
Nov 3	15.1	15.4	NA	14.8	13.6	13.9	12.7	13.4	13.8	14.0	NA	14.1	15.7	15.3	15.1	14.0	13.7	13.9	13.7
Nov 4	14.8	15.3	NA	14.6	13.4	13.7	12.6	13.2	13.6	13.8	NA	13.8	15.4	15.1	14.9	13.8	13.6	13.8	13.4
Nov 5	14.5	15.1	NA	14.3	13.2	13.4	12.5	13.0	13.4	13.7	NA	13.5	15.1	14.9	14.7	13.5	13.5	13.7	13.2
Nov 6	14.2	14.9	NA	14.1	13.0	13.2	12.4	12.8	13.2	13.5	NA	13.2	14.7	14.7	14.5	13.3	13.4	13.6	13.0
Nov 7	13.9	14.7	NA	13.9	12.8	12.9	12.3	12.6	13.0	13.3	NA	12.9	14.4	14.5	14.4	13.1	13.2	13.5	12.9
Nov 8	13.6	14.5	NA	13.7	12.7	12.7	12.2	12.5	12.9	13.2	NA	12.6	14.1	14.2	14.2	12.9	13.0	13.3	12.7
Nov 9	13.4	14.2	NA	13.5	12.5	12.4	12.1	12.4	12.7	13.0	NA	12.3	13.8	14.0	14.0	12.8	12.9	13.2	12.6
Nov 10	13.1	14.0	NA	13.3	12.2	12.2	12.0	12.3	12.6	12.8	NA	12.1	13.6	13.8	13.8	12.7	12.7	13.1	12.5
Nov 11	12.9	13.8	NA	13.1	12.0	11.9	11.9	12.2	12.5	12.7	NA	11.9	13.3	13.5	13.6	12.6	12.6	12.9	12.3
Nov 12	12.8	13.6	NA	12.9	11.8	11.7	11.8	12.1	12.4	12.5	NA	11.7	13.1	13.4	13.4	12.6	12.4	12.7	12.2
Nov 13	12.7	13.4	NA	12.7	11.6	11.5	11.7	12.1	12.3	12.2	NA	11.6	12.9	13.2	13.2	12.5	12.2	12.6	12.0
Nov 14	12.6	13.3	NA	12.5	11.5	11.3	11.5	12.0	12.2	12.1	NA	11.5	12.7	13.0	13.0	12.5	12.1	12.4	11.9

Water temperatures generally decline as one moves downstream of Hells Canyon Dam during the fall and early winter months providing inherent additional protection of the resource further downstream if criteria compliance was not achieved at Hells Canyon Dam (Figure 3). This is because the warmer stored water released from Hells Canyon Dam in the fall cools in the downstream reach to approach thermal equilibrium with stream heating and cooling processes. Julian day average seven-day average maximum temperatures (1991-2009; measured with Hydrolab at 10 minute intervals at HC Dam penstocks and with thermographs at hourly intervals at RM 192) were generally 0-0.5 °C cooler nearer the Salmon River confluence than immediately below Hells Canyon Dam. Further, the Snake River would not be warmed by Salmon River inflows as the seven-day average maximum temperature in the Salmon River is on average approximately 5.5 °C cooler than the Snake River above the confluence during the same period of record (Figure 4). IDEQ and ODEQ (2004) stated the Salmon River is without significant impoundments to store water and the watershed is sparsely populated and contains large portions in wilderness or roadless area. These attributes likely combine to make the Salmon River closer to the fall equilibrium than the Snake River below Hells Canyon Dam.

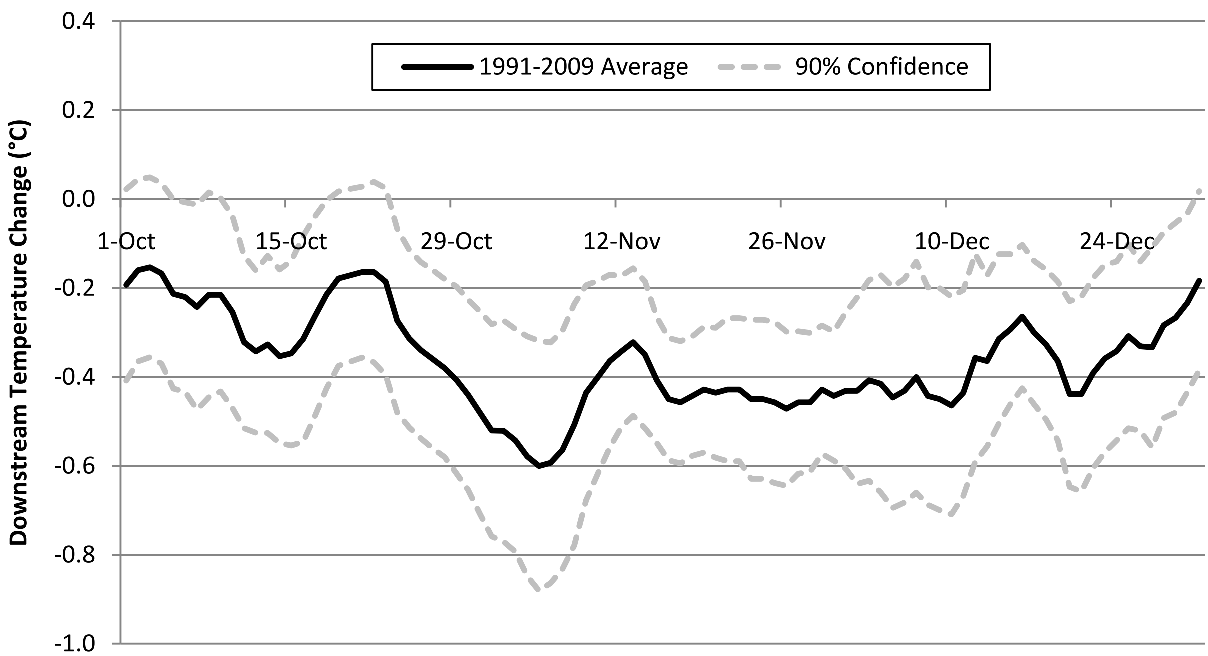

Figure 3. Summarized temperature differences from 1991-2009 between Hells Canyon Dam (RM 247.6) and just above the Salmon River confluence (RM 192). The temperature change represents the difference between the mean of the daily average for each Julian day between the two RM locations. Negative numbers indicate cooling. (Note: Data from all years were not available for all dates. Actual N for each day ranged from 12-15 for the 19 years.).

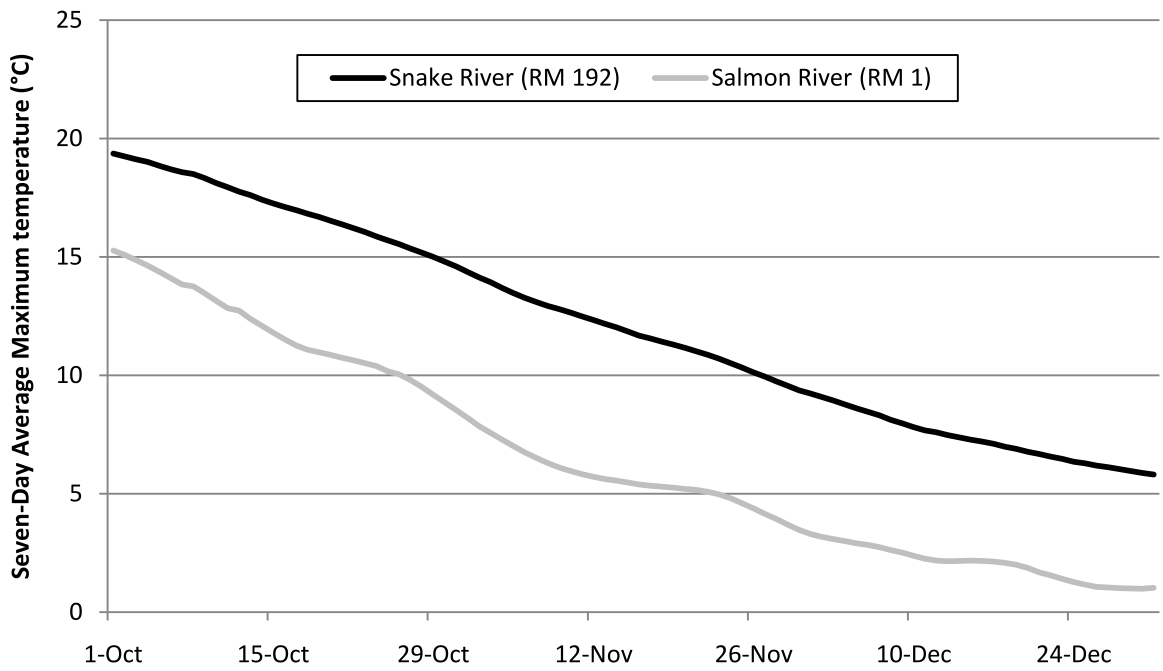

Figure 4. Julian Day seven-day average maximum temperatures of the Snake River (RM 192) just above the confluence with the Salmon River and the Salmon River (RM 1.5) recorded from 1991 through 2009.

3. PROPOSED SNAKE RIVER FALL CHINOOK SALMON SITE SPECIFIC TEMPERATURE CRITERIA

IPC proposes the following SSC in Idaho and Oregon that would be protective of Snake River fall Chinook salmon spawning.

Proposed Amendment to IDAPA 58.01.02

286. SNAKE RIVER, SUBSECTION 130.01, HUC 17060101, UNIT S1, S2, AND S3; SITE-SPECIFIC CRITERIA FOR WATER TEMPERATURE

A maximum weekly maximum temperature of fourteen and an half degrees C (14.5°C) applies from October 23rd through October 31st and a maximum weekly maximum of thirteen degrees C (13°C) applies from November 1st through April 15th to protect fall Chinook salmon spawning and incubation in the Snake River from Hell's Canyon Dam to the Salmon River.

Proposed Amendment to OAR 340-041-0028(4)

(g) The seven-day-average maximum temperature of a stream identified as having fall Chinook salmon spawning use may not exceed 14.5 degrees Celsius (58.1 degrees Fahrenheit) at the times indicated on Table 121B. The seven-day-average maximum temperature is a calculation of the average of the daily maximum temperatures from seven consecutive days made on a rolling basis.

Table 121B

BENEFICIAL USE DESIGNATIONS – FISH USES

MAINSTEM SNAKE RIVER

Geographic Extent of Use	Salmon and Steelhead Migration Corridors (20°C)	Redband or Lahontan Cutthroat Trout (20°C)	Fall Chinook Salmon Spawning (14.5°C)	Salmon and Steelhead Spawning through Fry Emergence (13°C)
Mainstem Snake River				
Oregon/Washington Border to Salmon River (RM 176.1 to RM 188.2)	X		October 23-October 31	November 1-May 15
Salmon River to Hells Canyon Dam (RM 188.2 to RM 247.6)	X		October 23-October 31	November 1-April 15
Hells Canyon Dam to Idaho Border (RM 247.6 to RM 409)		X		

4. Rationale for Snake River Fall Chinook Salmon Spawning Temperature Site Specific Criteria

A single salmonid spawning temperature criterion is not equally appropriate for all waters, for all species, or even for the entire spawning season in a single year. The current temperature criteria (13°C MWM or seven-day-average maximum) are based on available literature largely consisting of exposing incubating embryos to constant temperature regimes (see Davis 1975 and McCullough et al. 2001). However, thermal regimes in the natural environment are rarely constant and in the case of fall Chinook salmon and other fall spawning fish temperatures decline during spawning and early incubation. IPC seeks to establish a SSC that closely reflects the temperature requirements of the Snake River fall Chinook salmon during the spawning and early incubation stage.

Idaho regulations provide the Director with discretion to recognize that higher temperature criteria, that are protective of the beneficial uses, are appropriate in particular water bodies.

> **07. Temperature Criteria.** In the application of temperature criteria, the Director may, at his discretion, waive or raise the temperature criteria as they pertain to a specific water body. Any such determination shall be made consistent with 40 CFR 131.11 and shall be based on a finding that the designated aquatic life use is not an existing use in such water body or would be fully supported at a higher temperature criteria. For any determination, the Director shall, prior to making a determination, provide for public notice and comment on the proposed determination. For any such proposed determination, the Director shall prepare and make available to the public a technical support document addressing the proposed modification.

Hells Canyon reach, with its declining thermal regime in the fall, is just such a water body.

The EPA Region 10 Guidance (USEPA 2003) reflects the Agency's current analysis of temperature considerations for Pacific Northwest salmonid species. Specifically, it does not require strict compliance with the guidance; however, EPA intends to consider it when reviewing or promulgating temperature standards.

> "…this guidance does not preclude States or Tribes from adopting temperature WQS different from those described. . . EPA would approve any temperature WQS that it determines are consistent with the applicable requirements of the CWA [protection and propagation of fish, shellfish, and wildlife] and its obligations under the ESA."[10]

The supporting science available at the time of the development of the EPA Region 10 Guidance (USEPA 2003) did not have the benefit of the more recent available literature demonstrating thermal requirements of incubating fall Chinook salmon (species and site specific information) and therefore the guidance is not as applicable to natural spawning of fall Chinook salmon as more recent published literature (e.g., Geist et al. 2006). Further, the guidance over-simplifies the complex issue of temperatures necessary to support designated beneficial uses (IPC 2002). Indeed, the guidance recognizes this by allowing the ability to adopt other temperature criteria that are protective.

4.1. Information Supportive of Fall Chinook Salmon Spawning Site Specific Temperature Criteria

4.1.1. Current Science Supporting Fall Chinook Salmon Site Specific Temperature Criteria

Numerous research studies report that temperatures greater than the current Oregon and Idaho salmonid spawning criteria of 13°C have comparable survival levels. Some of these studies are cited in the EPA Region 10 Guidance document. The most instructional research relative to SSC are those specific to fall

[10] NOAA Fisheries' response to the EPA Region 10 Guidance included a statement that while the guidance provides a good general overview, the Agency cannot pre-judge the effects of any proposed standard with respect to the Endangered Species Act or Essential Fish Habitat consultations. EPA and NOAA Fisheries expect to consult on each set of standards that EPA proposes to approve under the CWA.

Chinook salmon and those that evaluate naturally varying thermal regimes as opposed to constant thermal regimes (see Groves et al. 2007 for a complete review of 22 studies of temperature effects on incubation). Different species of Pacific salmon and even different races of Chinook salmon can differ substantially in their thermal tolerances and preferences (Beacham and Murray 1990, Beacham and Withler 1991).

The most pertinent studies for this proposal are those that simulated a naturally declining thermal regime for fall Chinook salmon. There are three such studies: Olson and Foster (1955), Olson et al. (1970) (which includes results of Olson and Nakatani (1968)), and Geist et al. (2006). Each study exposed newly spawned eggs to variants of a naturally declining thermal regime. The studies by Olson and Foster (1955) and Olson et al. (1970) were conducted using fall Chinook salmon from the Hanford Reach of the Columbia River, whereas the Geist et al. (2006) study used Snake River fall Chinook salmon. All three studies indicated a sharp increase in mortality when a threshold temperature during incubation was exceeded. Geist et al. (2006) reported a temperature threshold value of 16.5°C, where mortality began to sharply increase during incubation, whereas Olson and Foster (1955) study reported a value of 16.1°C. The Olson et al. (1970) did not report a threshold value, but rather looked at incremental temperature increases above the base Columbia River temperature during the fall Chinook salmon spawning period. The threshold increment above ambient river temperature at initial incubation yielded a temperature threshold for mortality similar to that found in the Olson and Foster (1955) report. Generally, the three studies are comparable, but have some differences that warrant consideration. The Geist et al. (2006) study used a 0.2°C daily rate of decline, which was comparable to data from the Snake River, whereas the Olson and Foster (1955) study used a daily rate of decline of 0.18°C. The Olson et al. (1970) study had a more variable rate of decline ranging from 1.1°C/d to 1.7°C/d (estimated from figures in the report) because they used Columbia River water at the existing temperatures as the baseline. The two Hanford Reach studies used Columbia River water, whereas the Geist et al. (2006) study used well water. The Hanford Reach studies monitored survival to a point past emergence whereas the Geist et al. (2006) monitored survival to emergence. Olson et al. (1970) was replicated over four spawning dates, whereas the Olson and Foster (1955) and the Geist et al. (2006) was conducted using one spawning date. These differences may be factors in the slightly higher threshold reported by Geist et al. (2006) than observed by Olson and Foster (1955). The three studies are similar enough, however, that a combined analysis of the three studies is warranted relative to the determination of a threshold value.

Using segmented regression analysis on the combined data, a spline model was created with two line segments. The point where the two lines come together is referred to as the join point, which could also be thought of as the threshold temperature where mortality begins to change. The join point from the combined data is estimated at 16°C, with 95% confidence intervals (CI) ranging from 15.3°C to 16.6°C (Figure 5).[11]

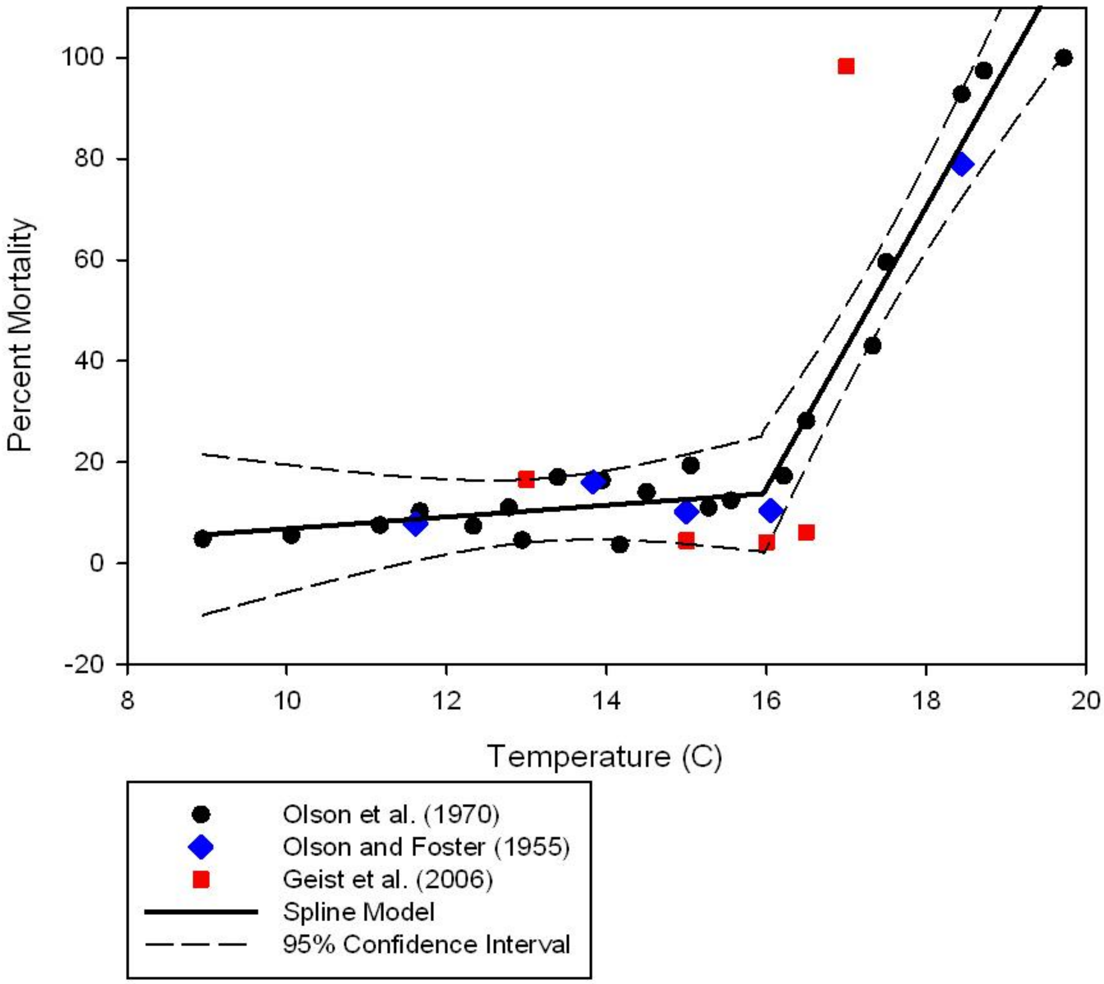

Figure 5. Combined data from three studies (Olson and Foster 1955, Olson et al. (1970) and Geist et al. (2006)) of fall Chinook salmon initial incubation temperatures and associated mortality to fry emergence under a declining thermal regime. Two line segments form a single spline model that estimates the join point (threshold value) of 16°C, with a 95% confidence interval ranging from 15.3°C to 16.6°C.

Below this temperature threshold, incubation mortality does not significantly differ (i.e., a line segment with a slope not significantly different from zero). Above the join point, mortality increases with a slope

[11] Data from the third spawning series in the Olson et al. (1970) report were excluded from the pooled study analysis consistent with the author's recommendations. Exclusion did not significantly affect the findings from the combined data analysis.

of 27.8 (i.e., mortality increases by this percentage with each 1°C increase in temperature). Using the estimated join point of 16°C as the initial incubation temperature and assuming a 0.2°C rate of daily cooling, the associated MWM would equal 15.4°C. Based on the 15.3°C (the lower 95% CI around the join point) as the most conservative initial incubation temperature where mortality would begin to increase with increasing temperature and the same assumed cooling rate, the associated MWM temperature would be 14.7°C (0.2°C greater than the proposed SSC).

4.1.2. Reasonable Assurance

Understanding thermal requirements of aquatic organisms invariably requires laboratory experiments where temperature can be isolated from other often confounding or synergistic factors. Many factors can influence the applicability of a laboratory study to a natural environment such as the Snake River. These can include flow through the redd environment, differences in redd temperatures relative to water column temperatures and potential synergies between DO levels, temperature and survival.

The Geist et al. (2006) study is especially relevant to temperature-oxygen relationships as they may affect a SSC for Snake River fall Chinook salmon. The study evaluated survival, development and growth of fall Chinook salmon embryos during the incubation period that were exposed to both variable temperature and DO regimes. This study allows an examination of potential synergies between temperatures and DO that might influence a SSC. The results showed that the mortality of incubating fall Chinook salmon exposed to variable temperature and DO conditions was not affected by DO levels as low as 4 mg O_2/L from initial temperatures of 15°C to 16.5°C, the temperature range at which DO was varied. Further, mean wet weight and mean fork length at emergence did not differ among any of the temperature and DO treatments. There are periods in the late summer and early fall when DO levels can be near 4 mg O_2/L in Hells Canyon, primarily in the upper portion of the Hells Canyon Reach. However, DO levels increase in the Hells Canyon Dam discharge during the fall months and increase even more with distance downstream as many of the larger rapids aerate the water. The SSC proposal of a Maximum Weekly Maximum of 14.5°C is within the variable temperature and DO ranges evaluated in the Geist et al. (2006) evaluation[12], and therefore it is reasonable to conclude that a synergistic affect relative to DO at levels as low as 4 mg O_2/L would not occur.

Another factor that could influence applicability of the lab study to the natural environment is the potential that temperatures experienced in the redd environment in some systems can differ from those in the surface water. Surface water can most readily be measured as the basis of determining compliance

[12] A MWM of 14.5°C would have an initial daily maximum temperature on October 23 of 15.1°C, assuming a 0.2°C/d rate of decline.

with state standards. Groves et al. (2008) compared temperatures within artificial redds and surface water and found no significant differences between the two environments in the Snake River. This is indicative that flow of surface water through the redd environment in the Snake River is relatively high, which allows for direct applicability of surface water temperatures when applying the lab study to the natural environment. This conclusion is also supported by DO levels and egg survival within artificial redds in the Hells Canyon Reach. The DO levels measured in artificial redds in the Hells Canyon Reach were consistently above 9 mg/l and generally < 2 mg/l different from the surface water, further suggesting high flow of surface water through the redd environment (see Chandler 2007 for a complete summary of artificial redd and egg survival in the Hells Canyon Reach).[13]

These findings suggest that the results of the referenced laboratory studies can reasonably be applied to the natural environment of the Snake River in the Hells Canyon Reach and provide reasonable assurance that this proposal for a MWM temperature of 14.5 °C during the October 23rd to October 29th time period is fully protective of fall Chinook salmon spawning and incubation. Reasonable assurance of beneficial use protection comes primarily from the combined data analysis discussed above (see Section 4.1.1; Figure 5). IPC has based its proposed SSC on the initial daily maximum temperature derived from statistical analysis of the combined data sets (the lower 95% CI around the join point). IPC's proposed SSC of a MWM temperature of 14.5 °C is indistinguishable, using the reported accuracy of temperature instrumentation of 0.2 °C, from the calculated MWM temperature of 14.7 °C that is associated with the initial daily maximum of 15.3 °C (the lower 95% CI around the join point) at similar rates of temperature decline. That is, the MWM of 14.7 °C would be considered the most conservative value that would define a threshold where mortality would begin to increase. Statistically, there is no difference in survival of fall Chinook salmon embryos through spawning and incubation starting at a daily maximum temperature of 15.1°C (MWM of 14.5°C) as compared to the current criteria of no initial daily maximum temperatures greater than 13.6 °C (MWM of 13°C). Additionally, IPC has illustrated (see Section 2.4; Figure 3) that temperatures decrease downstream of Hells Canyon Dam, further adding assurance that the proposed SSC monitored at the dam discharge will not be exceeded in the reaches where Chinook salmon spawn and incubate. This weight of evidence strongly supports a conclusion that IPC's proposed SSC provides reasonable assurance that the resource is protected.

4.2. A Comparison of Regional Fall Chinook Salmon Spawning Thermal Regimes

Evaluations of a declining temperature regime in the Columbia River demonstrate that healthy fall Chinook salmon populations initiate spawning at temperatures above 13 °C. Fall Chinook salmon begin

[13] No change in the DO standards are proposed in this SSC proposal.

spawning in October when ambient air and water temperatures are declining. Temperature at the initiation of fall Chinook salmon spawning in the natural environment is typically near 16 °C (Healey 1991). Exposure to higher temperatures is typically for short periods for small numbers of eggs at the beginning of the spawning season as the thermal regime begins to decline. For example, Chandler et al. (2001) estimated that 2% or less of redds are constructed below Hells Canyon Dam early enough for eggs to experience temperatures greater than 16 °C. Similar observation of fall Chinook salmon spawning above 16 °C have been reported for the Hanford Reach of the Columbia River (Dauble and Watson 1990) and for the lower Columbia River (Van der Naald et al. 2000).

The degree to which a beneficial use is being met in a particular location is often evaluated by comparing that location to a reference site or condition. Reference conditions should represent the best range of conditions or desirable conditions that can be achieved in similar waters in a particular ecological region. Reference conditions can be established using a combination of methods, including reference sites when known reference sites exist, historical data, paleoecological data, experimental laboratory data, quantitative models, and best professional judgment. Because there are few waters of similar watershed size, hydrologic characteristics, and similar biologic communities as the Snake River below the HCC, few comparable sites exist. The Hanford Reach of the Columbia River is the most comparable site. The Hanford Reach is considered an important production area for fall Chinook salmon; this stock of the most inland fall Chinook population is the most robust and healthy remaining in the Columbia River Basin and is not protected under the ESA (Huntington et al. 1996; Dauble and Watson 1997; Dauble and Geist 2000). The high level of fall Chinook salmon production in the Hanford Reach suggests that, among other conditions affecting beneficial use support, temperature-related conditions during immigration, spawning, and fry emergence are favorable for fully supporting an ocean-type life history.

IPC compared the thermal conditions and spawn timing of the Snake River below the HCC and the Hanford Reach of the Columbia River. Thermal data available for the Snake River included the years 1991-2003 (IPC unpublished information) and the years 1974-1992 for the Hanford Reach of the Columbia River (reported either from gaging station 12472900 located at Vernita Bar on the Columbia River or gaging station 12473520 located at Richland, Washington). The timing of spawning was compared using available data for the Hells Canyon Reach (1992 to 2002; IPC unpublished data) and available data for the Hanford Reach (1949 to 2002; provided from Battelle Memorial Pacific Northwest Laboratory, Richland Washington). Although initial spawning in the Hanford Reach was slightly earlier than the Hells Canyon Reach, the peak and final spawning times were not different (Table 3). The thermal regime of the Hanford Reach of the Columbia River and the Hells Canyon Reach upstream of the Salmon River are also very similar (Table 4). During the initiation of fall Chinook salmon spawning, the daily mean temperature of the Snake River upstream of the confluence with the Salmon River to the Hells Canyon Dam (14.7 °C) was not statistically different from that of the Hanford Reach (15.6 °C). Both were statistically warmer than the Snake River downstream of the confluence with the Salmon River (12.6 °C). Similar results were reported through peak spawning (occurring in early November). Both the upper Hells Canyon Reach and the Hanford Reach had daily mean temperatures of 12.5 °C at peak spawning.

Table 3. Julian date corresponding to specific spawning phases observed within the Hanford Reach of the Columbia River (HAN), and the lower and upper Snake River sub-reaches (LSR and USR, respectively). (Julian day 285 is 11 October; different letters within each row indicate significant differences at α=0.05.)

Spawning Phases	Julian date of occurrence within reaches		
	HAN	LSR	USR
Initial	289 $_{A}$	298 $_{B}$	297 $_{B}$
Peak	313 $_{A}$	312 $_{A}$	310 $_{A}$
Final	326 $_{A}$	330 $_{A}$	335 $_{A}$

Table 4. Mean water temperature (°C) present during specific spawning phases within the Hanford Reach of the Columbia River (HAN), and the lower and upper Snake River sub-reaches (LSR and USR, respectively). (Different letters within each row indicate significant differences at α=0.05.)

Spawning phases	Reach water temperature (°C)		
	HAN	LSR	USR
Initial	15.6 $_{B}$	12.6 $_{A}$	14.7 $_{B}$
7 days pre-initial	16.0 $_{B}$	13.5 $_{A}$	15.3 $_{B}$
Peak	12.5 $_{B}$	9.8 $_{A}$	12.5 $_{B}$
7 days pre-peak	12.9 $_{B}$	10.2 $_{A}$	13.0 $_{B}$
Final	10.5 $_{C}$	7.1 $_{A}$	8.7 $_{B}$
7 days pre-final	10.9 $_{C}$	7.6 $_{A}$	9.1 $_{B}$

A comparison of maximum weekly maximum temperatures (on October 29) was also made using recent information from the Hells Canyon Dam (RM 247.6), the Upper Hells Canyon Reach upstream of the Salmon River confluence (RM 192.3) the Lower Hells Canyon Reach downstream of the Grande Ronde

River (RM 165.7) and the Hanford Reach using provisional data available from the Grant County PUD from the tailrace of Priest Rapids Dam, the first dam on the Columbia River upstream of the Hanford Reach[14]. Data were available for 2006, 2008 and 2009. The comparison is consistent with the previous comparison, and demonstrates a very similar thermal regime between the Upper Hells Canyon Reach and the Hanford Reach (Table 5). Weekly Maximum temperatures on October 29 are the Maximum Weekly Maximum temperature during the designated fall Chinook salmonid spawning in the Snake River in the fall as temperatures decline.

Table 5. A comparison of the Weekly Maximum temperature (°C) on October 29th (i.e., from October 23) between the Hanford Reach of the Columbia River (as measured at Priest Rapids Dam tailrace), Hells Canyon Dam penstock, RM 192.3 (upstream of Salmon River confluence) and RM 165.7 (downstream of Grande Ronde River in lower Hells Canyon) for the years 2006, 2008 and 2009 (2007 data not available for Priest Rapids tailrace).

Year	Priest Rapids Tailrace	Hells Canyon Dam	RM 192.3	RM 165.7
2006	15.0	15.3	15	12.8
2008	14.3	14.9	14.8	12.6
2009	14.2	14.8	14.4	12.3

Several authors have estimated favorable ranges for large mainstem river Chinook salmon incubation including fall Chinook salmon. Boles et al. (1988) determined that initial spawning temperatures under a declining temperature regime could be as high as 15.5 °C for Sacramento River fall-run Chinook salmon. Bell (1986), as cited in Bjornn and Reiser (1991), estimated favorable incubation conditions for fall Chinook salmon to occur between 5.0–14.5 °C. Raleigh et al. (1986) recommended a range of between 6.0–14 °C. Comb and Burrows (1957) estimated upper temperature thresholds for incubation to occur between 14.2–15.5 °C. McCullough et al. (2001) suggested daily maximums during the incubation period not exceed 13.5–14.5 °C. The studies specific to declining thermal regimes for fall Chinook salmon suggest favorable upper initial temperatures as high as 16.1 to 16.5 (Olson et al. (1955); Geist et al. (2006)).

[14] (http://www.gcpud.org/resources/resLandWater/waterQuality.htm)

Higher initial incubation temperatures lead to shorter times to hatching and emergence, with resulting higher survival. Geist et al. (2006) showed that, as initial incubation temperature increased under a declining thermal regime, the time to hatching and emergence decreased. The inverse relationship between temperature and development time observed in that study is common among all salmon species (reviewed in Weatherly and Gill 1995). This earlier emergence has significant implications for Snake River fall Chinook salmon in the maintenance of an Age-0 life history. Survival of sub-yearling fall Chinook salmon that begin moving downstream the first week of July (after flows begin to decline and downstream reservoirs warm) survive at rates of only 5–20%, whereas those that initiate movement earlier in late May survive at rates of 65–90% (Connor et al. 2003; Smith et al. 2003). Many late emerging fall Chinook salmon, typical of the colder incubation thermal regime of the Clearwater River adopt an Age-1 life history, where they over-summer in the mainstem Snake and Columbia rivers before entering the ocean the following spring (Connor et al. 2002).

Because of the implications of earlier spawn timing relative to emergence timing, there is some thought that cooling river temperatures might promote earlier spawning and earlier emergence. Groves et al. (2007) compared initiation of spawning in the Upper Hells Canyon Reach (upstream of the Salmon River confluence), the Lower Hells Canyon Reach (downstream of the Salmon River confluence), and the Grande Ronde River (a Snake River tributary slightly downstream of the Salmon River confluence) based on weekly helicopter redd surveys since 1991. These systems all have different thermal regimes, with the Upper Hells Canyon Reach being the warmest. The three spawning stocks all follow the same route up the mainstem Snake River. Groves et al. (2007) concluded that there is no clear pattern of initiation of spawning and water temperature among these three nearby locations. Groves et al. (2007) also compared reports of spawn timing in the early 1950's (Zimmer 1950) upstream of the HCC site to spawn timing distribution today. Spawning was initiated in early October and extended over a relatively prolonged period through early December, with peak spawning occurring around the first week of November (Zimmer 1950). This is very similar to what has been observed today in the spawning area below Hells Canyon Dam. Thus, initiation of spawn timing does not seem strongly tied to a specific water temperature with the exception that as noted by Healey (1991) spawning generally commenced when temperatures begin to drop below 16ºC and that temperatures are on a declining limb associated with fall cooling..

4.3. Other Life Stage Considerations

The applicable aquatic life criterion for the state of Oregon for a stream identified as having a migration corridor use for salmon and steelhead is the seven-day average maximum temperature not to exceed 20.0 °C. OAR 340-041-0028(4)(d). This criterion is applicable to the Snake River from the Oregon/Washington border to Hells Canyon Dam (RM 176.1-247.6). In addition, there must be sufficiently distributed coldwater refugia to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body. Finally, the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern. For the state of Idaho, temperature limits for the protection of cold water aquatic life are a daily maximum not to exceed 22 ºC with a maximum daily average of no greater than 19 ºC. IDAPA 58.01.02.250.02.b..

Although the focus of this proposal is for a SSC specific to fall Chinook salmon spawning, some reviewers of the initial IPC proposal raised concerns over possible effects of an SSC on other life-stages of fall Chinook salmon due to the warmer fall environment associated with the HCC. One specific concern was that higher pre-spawn temperatures might influence spawning success because gametes may be less viable under warmer conditions. A similar concern is that warmer pre-spawn and initial spawn temperatures may be associated with a high pre-spawn mortality of adults or a delay in spawn timing. The aquatic life criteria identified for a migratory corridor of anadromous fish for Oregon and Idaho presumably was established to be protective of the pre-spawn environment. Other life stages of fall Chinook salmon have been reviewed for thermal limitations by Groves et al. (2007; Appendix 3). The findings from this review are summarized as follows:

- *Adult migration* – There has been no apparent shift in adult migration timing compared to the pre HCC environment. Adult fall Chinook salmon experience a similar period of exposure to temperatures elevated above 20 ºC between mid-August and mid-September as they did pre-HCC, but experience a lower maximum temperature than occurred historically. This is based on water temperatures present at Central Ferry in the early to mid-1950's, prior to construction of the HCC or the lower Snake River reservoirs.
- *Pre-spawn mortality* – Some level of pre-spawning mortality among anadromous salmonids is common. There is evidence that adult salmon in hatchery holding environments exposed to prolonged periods of water temperatures > 19 ºC could be subject to significant pre-spawn mortality. In hatchery holding situations, the mortality is usually associated with increased susceptibility to disease. However, fish-to-redd ratios documented in the Snake River do not suggest excessive pre-spawn mortality of fall Chinook salmon in the wild. Redd numbers relative to the total number of adult fall Chinook salmon allowed to pass upstream of Lower Granite Dam (with fallback and over-counting at the dam taken into account), the resulting fish to redd ratio has averaged 3.2 (range 2.0-4.2, data from 1993-2006). This comports well with (or better than) estimates of fish to redd ratios for the Hanford Reach of the Columbia River (3.0-16.0), where pre-spawn mortality is not considered to be a problem (Visser et al. 2002). It may be that the non-confined environment of a large river under a naturally declining thermal regime and the availability of cold water refugia make fish less susceptible to disease and mortality. In addition, the HCC has cooled late summer outflows relative to temperatures of the inflow. Also, the operations of Dworshak Reservoir on the Clearwater River release cold water in

the summer that substantially cools portions of Lower Granite Reservoir, creating thermal refugia during the early pre-spawn environment. Thus, thermal conditions in the Snake River prevalent today are better (cooler) for pre-spawning adults than conditions prior to the HCC.

- *Gamete viability* – Studies cited to suggest reduced gamete viability as a result of prolonged exposure to warmer temperatures are not often relevant because they were not specifically designed to test this conjecture or because of the nature of the test exposures. For example, Jensen et al. (2006) did not hold adult Chinook salmon in a declining thermal regime typical of a riverine environment, but rather exemplified relatively long-term (40-days) exposure to elevated water temperatures. In addition, the control group held fish in a constant thermal environment of between 8 and 9 ºC, which cannot be compared to a declining thermal regime under more normative environments. Based on the available information, there is no evidence that the HCC has had an adverse effect on development of gametes in returning adult fall Chinook salmon.
- *Spawn timing* – There is no evidence that spawn timing has been greatly altered in the Snake River when comparing pre-HCC spawn distribution to that of the present-day Hells Canyon Reach spawn distribution.

5. SITE SPECIFIC CRITERIA WARRANTED

In summary, a SSC of 14.5°C Maximum Weekly Maximum is warranted for the Snake River downstream of the HCC to protect fall Chinook salmon spawning during the later part of October (October 23 through October 31) based on the body of scientific literature available and the thermal conditions observed in other fall Chinook salmon populations. Fall Chinook salmon spawn in lower elevation large mainstem rivers where warmer temperatures are prevalent. Initial spawning at temperature ≤ 16°C is common for fall Chinook salmon, even in systems other than the Snake River. The Age-0 life history is dependent upon conditions that promote early emergence. Warm fall and overwinter temperatures promote early emergence and the Age-0 life history. The Hells Canyon Reach of the Snake River, especially upstream of the Salmon River is the closest habitat available today to that of the historic environment and should be maintained. This proposed SSC protects and supports the beneficial use designated by both Idaho and Oregon and is more reflective of this large river environment and the life history of this fish.

6. SIGNATURE

For the reasons stated above, IPC respectfully submits this proposal to initiate the process to establish negotiated rulemaking for SSC for temperature as described in Section 2.1. herein.

IDAHO POWER COMPANY

Date: June 3, 2010

BY: _________________________________

Title: Director, Environmental Affairs

7. LITERATURE CITED

Beacham, T.D., and C.B. Murray. 1990. Temperature, egg size, and development of embryos and alevins of five species of pacific salmon: a comparative analysis. Transactions of the American Fisheries Society 119:927-945

Beacham, T.D., and R.E. Withler. 1991. Genetic variation in mortality of Chinook salmon, *Oncorhynchus tshawytscha* (Walbaum), challenged with high water temperatures. Aquaculture Fisheries Management 22:125-133.

Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers, Office of the Chief of Engineers, Fish Passage Development and Evaluation Program, Portland, Oregon.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publications 19:83-138.

Boles, G. L., S. M. Turek, C. D. Maxwell, and D. M. McGill. 1988. Water temperature effects on Chinook salmon (*Oncorhynchus tshawytscha*) with emphasis on the Sacramento River. California Department of Water Resources, Northern District. Sacramento, CA.

Chandler, J.A. 2007. White Paper: An evaluation of reintroduction of anadromous fish upstream of the Hells Canyon Complex. Idaho Power Company. Boise, Idaho.

Chandler, J. A., P. A. Groves, and P. Bates. 2001. Existing habitat conditions of the mainstem Snake River habitat formerly used by anadromous fish. In: J. A. Chandler, editor. Chapter 5. Feasibility of reintroduction of anadromous fish above or within the Hells Canyon Complex. Technical appendices for Hells Canyon Complex Hydroelectric Project. Idaho Power, Boise, ID. Technical Report E.3.1-2.

Combs, B. D., and R. E. Burrows. 1957. Threshold temperatures for the normal development of Chinook salmon eggs. Progressive Fish-Culturist 19:3-6.

Connor, W. P., H. L. Burge, J. R. Yearsley, and T. C. Bjornn. 2003. Influence of flow and temperature on survival of wild subyearling fall Chinook salmon in the Snake River. North American Journal of Fisheries Management 23:362–375.

Connor, W.P., H.L. Burge, R. Waitt, and T.C. Bjornn. 2002. Juvenile life history of wild fall chinook salmon in the Snake and Clearwater rivers. North American Journal of Fisheries Management 22:703-712.

Connor, W. P., A. P. Garcia, A. H. Connor, E. O. Garton, P. A. Groves, and J. A. Chandler. 2001. Estimating the carrying capacity of the Snake River for fall Chinook salmon redds. Northwest Science 75(4).

Dauble, D. D., and D. R. Geist. 2000. Comparison of mainstem spawning habitats for two populations of fall Chinook salmon in the Columbia River Basin. Regulated Rivers: Research and Management 16: 345–361.

Dauble, D. D., and D. G. Watson. 1990. Spawning and abundance of fall Chinook salmon (*Oncorhynchus tshawytscha*) in the Hanford Reach of the Columbia River, 1948–1988. Report from Pacific Northwest Laboratories Prepared for the U. S. Department of Energy, Contract DE-AC06-76RLO 1830.

Dauble, D. D., and D. G. Watson. 1997. Status of fall Chinook salmon populations in the mid-Columbia River 1948–1992. North American Journal of Fisheries Management 17: 283–300.

Davis, J.C. 1975. Minimal dissolved oxygen requirements of aquatic life with emphasis on Canadian species: a review. Journal of the Fisheries Research Board of Canada 32:2295-2332.

Dombrowski, T. 2002. Idaho Department of Environmental Quality comments on Idaho Power Company Hells Canyon Complex draft application. In: Hells Canyon Hydroelectric Project Final License Application—Consultation Appendix. Idaho Power Company, Boise ID.

Garcia, A., S. Bradbury, B. Arnsberg, S. Rocklage, P. Groves. 2006. "Fall Chinook Salmon Spawning Ground Surveys in the Snake River Basin upriver of Lower Granite Dam", 2005-2006 Annual Report, Project No. 199801003, 66 electronic pages, (BPA Report DOE/BP-00020366-2)

Geist, D. R., C. S. Abernathy, K.D. Hand, V.I. Cullinan, J.A. Chandler, and P.A. Groves. 2006. Survival, development, and growth of fall Chinook salmon embryos, alevin, and fry exposed to variable thermal and dissolved oxygen regimes. Transaction of the American Fisheries Society 135:1462-1477.

Groves, P.A., J.A. Chandler and T.J. Richter. 2008. Comparison of temperature data collected from artificial Chinook salmon redds and surface water in the Snake River. North American Journal of Fisheries Management 28:766-780.

Groves, P.A., J.A. Chandler and R. Myers. 2007. White Paper: The effects of the Hells Canyon Complex relative to water temperature and fall Chinook salmon. Idaho Power Company. Boise, Idaho.

Groves, P. A., and J. A. Chandler. 2001. The quality and availability of fall Chinook salmon spawning and incubation habitat downstream of the Hells Canyon Complex. Chapter three *In* P.A. Groves, editor. Evaluation of anadromous fish potential within the mainstem Snake River, downstream of the Hells Canyon Complex of reservoirs. Technical appendices for new license application: Hells Canyon Hydroelectric Project. Idaho Power, Boise, ID. Technical Report Appendix E.3.1-3.

Groves, P.A., and J.A. Chandler. 2005. Habitat quality of historic Snake River fall Chinook salmon spawning locations and implications for incubation survival. Part 2: Intra-gravel water quality. Rivers and Research Applications 21:469-484.

Healey, M. C. 1991. Life history of Chinook salmon *(Oncorhynchus tshawytsch*a). In: C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia, Vancouver, B.C. Pages 313–393.

Huntington, C. S., W. Nehlsen, and J. Bowers. 1996. A survey of healthy native stocks of anadromous salmonids in the Pacific Northwest and California. Fisheries 21(3):6-14.

Idaho Department of Environmental Quality (IDEQ) and Oregon Department of Environmental Quality (ODEQ). 2004. Snake River-Hells Canyon total maximum daily load (TMDL). IDEQ, Boise Regional Office, Boise, ID, and ODEQ, Pendleton Office, Pendleton, OR. 710 p. plus appendices.

Idaho Power Company (IPC). 2002. Letter dated December 3, 2002 to U.S. Environmental Protection Agency regarding the draft EPA Region 10 guidance for state and tribal temperature water quality standards. Idaho Power Company, Boise, ID. 3 p.

Jensen, J.O.T., W.E. McLean, T. Sweeten, W. Damon, and C. Berg. 2006. Puntledge River high temperature study: influence of high water temperatures on adult Chinook salmon (*Oncorhynchus tshawytscha*) in 2004 and 2005. Canadian Technical Report of Fisheries and Aquatic Sciences 2662.

Lohn, D. R. June 12, 2003. Declaration of National Oceanic and Atmospheric Association Fisheries to Case No. CV01-00640-RE. Seattle, WA.

McCullough, D. A., S. Spalding, D. Sturdevant, and M. Hicks. 2001. Summary of technical literature examining the physiological effects of temperature on salmonids. Issue paper 5. EPA Region 10

Temperature Water Quality criteria guidance development project. EPA-910-D-01-005.United States Environmental Protection Agency. Seattle, WA.

Northcote, T.G., and G. L. Ennis. 1994. Mountain whitefish biology and habitat use in relation to compensation and improvement possibilities. Reviews in Fisheries Science 2:347–371.

Oregon Department of Environmental Quality (ODEQ). 2008. Temperature water quality standard implementation. A DEQ internal management directive. Oregon Department of Environmental Quality. Available at http://www.deq.state.or.us/wq/pubs/imds/ Temperature.pdf.

Olson, P. A., R.E. Nakatani and T. Meekin. 1970. Effects of thermal increments on eggs and young of Columbia River fall Chinook. Battelle Memorial Institute, Pacific Northwest Laboratories. BNWL - 1538, UC 48. Richland, Washington.

Olson, P. A., and R. E. Nakatani. 1968. Effect of elevated temperatures on mortality and growth of young Chinook salmon. Battelle Memorial Pacific Northwest National Laboratories, Richland, WA.

Olson, P. A., and R. F. Foster. 1955. Temperature tolerance of eggs and young of Columbia River Chinook salmon. Transactions of the American Fisheries Society 85:203-207.

Raleigh, R. F., W. J. Miller, and P. C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Chinook salmon. U.S. Fish and Wildlife Service. Biological report 82 (10.122).

Smith, S. G., W. D. Muir, E. E. Hockersmith, R. W. Zabel, R. J. Graves, C. V. Ross, W. P. Connor, and B. D. Arnsberg. 2003. Influence of river conditions on survival and travel time of Snake River sub-yearling fall Chinook salmon. North American Journal of Fisheries Management 23:939–961.

U.S. Environmental Protection Agency (USEPA). 2003. EPA Region 10 guidance for Pacific Northwest state and tribal temperature water quality standards. EPA 910-B-03-002. USEPA, Region X, Office of Water, Seattle, WA. 49 p. plus attachments.

Van der Naald, W., B. Spellman, and R. Clark. 2000. Evaluation of fall Chinook and chum salmon spawning below Bonneville, the Dalles, John Day, and McNary Dams: Annual Report 2001–2002. Prepared by Oregon Department of Fish and Wildlife for Bonneville Power Administration, Portland, OR. Contract 99BI15006/99BI15007, Project 99-003-01/99-003-02.

Visser, R., D.D. Dauble and D.R. Geist. 2002. Use of aerial photography to monitor fall Chinook salmon spawning in the Columbia River. Transactions of the American Fisheries Society 131:1173-1179.

Weatherley, A. H., and H. S. Gill. 1995. Growth. Pages 101–158 *in* C. Groot, L. Margolis, and W. C. Clarke, editors. Physiological ecology of Pacific salmon. University of British Columbia Press, Vancouver, British Columbia, Canada.

Zimmer, P.D. 1950. A three year study of fall Chinook salmon spawning areas in Snake River above Hells Canyon Dam site. Report of Fish and Wildlife Service, Region 1. Portland, Oregon.

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Appendix 1. Letter of concurrence by Dr. Charles C. Coutant that the proposed SSC is fully protective of fall Chinook salmon spawning and incubation based on best available scientific information.

Appendix 2. Letter of concurrence by Dr. Dudley W. Reiser that the proposed SSC is fully protective of fall Chinook salmon spawning and incubation based on the best available scientific information.

Appendix 3. Groves, P.A., J.A. Chandler, and R. Myers. 2007. White Paper: The effects of the Hells Canyon Complex relative to water temperature and fall chinook salmon. Idaho Power Company. Boise, Idaho.

Appendix 4. McCullough, D. 2007. “Review of Groves, Chandler, and Myers (2007)”, Columbia River Inter-Tribal Fish Commission. Portland. Oregon.

Appendix 5. Idaho Power Company. 2007. IPC's Evaluation of the Nez Perce Tribe's/CRITFC's Review of the Temperature White Paper.

Appendix 6. A Review of Comments by Dale A. McCullough (August 27, 2007) on white paper by Groves et al. (July 2007). Charles C. Coutant . June 8, 2010.