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May 2, 2008

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Reference: Project No. 1971-079—Idaho/Oregon
Hells Canyon Project
Idaho Power Company
Response to Nez Perce/CRITFC Review of Temperature White Paper

Dear Secretary:

By letter dated July 30, 2007, the Idaho Power Company submitted a White Paper entitled: *The Effects of the Hells Canyon Complex Relative to Water Temperature and Fall Chinook Salmon* (Groves/Chandler/Myers 2007) to the FERC for filing in the above matter. That Temperature White Paper comprehensively reviewed and analyzed Hells Canyon Complex temperature effects against the literature and the Company's own gathered data and concluded based on the best available science, that the temperature effects of the Hells Canyon Complex are benign or beneficial to Fall Chinook Salmon.

On August 30, 2007, the Nez Perce Tribe filed with the FERC its review of the Company's Temperature White Paper. (See: McCullough, D., *Review of Groves, Chandler and Myers (2007)*, Columbia River Inter-Tribal Fish Commission (CRITFC), August 27, 2007.) Enclosed for filing is the Idaho Power Company's response to the Nez Perce Tribe/CRITFC review of the Temperature White Paper.

If you have any questions, please do not hesitate to contact me.

Respectfully submitted,

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IPC's Evaluation of the Nez Perce Tribe's Review of the Temperature White Paper

In July 2007, Idaho Power Company filed its Temperature White Paper with FERC. See Groves, P.A., Chandler, J.A., and Myers, R.; 2007; "White Paper: The Effects of the Hells Canyon Complex Relative to Water Temperature and the Fall Chinook Salmon." ("Temperature White Paper.") That exhaustive review concluded that with the exception of a very small number of redds that in some years are exposed to water temperatures greater than 16 ºC, there is no evidence that the thermal shift caused by the construction of the HCC adversely affects fall Chinook salmon. In fact, the thermal shift created by the HCC provides an overall benefit to the population of Snake River fall Chinook salmon by creating conditions in the reach below Hells Canyon Dam that can now sustain the only spawning and rearing area accessible to and suitable for fall Chinook salmon in the Snake River. Prior to construction of the HCC, this reach of river did not support significant spawning, primarily because it was a very cold environment. The thermal shift increased the rate of thermal unit accumulation experienced by incubating fall Chinook salmon by extending the cooling period in the fall and maintaining warmer over-winter temperatures better suited for incubation than what occurred pre-project. This allowed emergence timing to be very similar to reaches upstream of the HCC that historically supported major spawning and incubation areas in the Snake River, reaches that are now too degraded to support spawning and incubation. Further, this thermal shift has allowed maintenance of the ocean-type life history whereby fall Chinook salmon juveniles migrate as an Age-0 fish following only a brief rearing period. This life history can be maintained because these fish are able to incubate and grow fast enough to migrate before water temperatures in the lower Snake River reservoirs become too warm. This is distinct from the later emerging fall Chinook salmon from the Clearwater River and other colder environments. These fish are only able to survive the migratory delay in the lower Snake River reservoirs because of the addition to the Snake River of colder summer water from Dworshak Reservoir that allows those later migrants to over-summer and move to the ocean as a yearling fish.

On August 30, 2007, the Nez Perce Tribe filed with FERC its review of IPC's Temperature White Paper. See McCullough, D., "Review of Groves, Chandler, and Myers (2007)", Columbia River Inter-Tribal Fish Commission, August 27, 2007 ("CRITFC.") In its review, the Tribe states at the outset that "[t]he work put into this IPC review was substantial and was thoughtfully done. Also, much new information was brought forward to this complex discussion that is useful in getting a fuller appreciation of the issues." CRITFC at 1. Nevertheless, the review takes exception to the Temperature White Paper's conclusions. It concludes that the current temperature regime below Hells Canyon Dam is "a detriment to the Snake River fall Chinook." Id. It also raises certain issues about the efficacy of the Ehist model. Id. at 22.

The Tribe's contention that the current temperature regime below Hells Canyon Dam is a detriment to fall Chinook salmon is not well taken. After carefully reviewing results from studies used by CRITFC for supporting evidence, IPC biologists have noted that those study reports have often not undergone critical peer-review, contain various flaws, and tend to overstate specific findings while ignoring other findings, as well as failing to completely analyze data presented in those studies. Also, studies conducted on other

species are consistently cited (i.e., sockeye salmon), which likely have little comparative value when assessing conditions for fall Chinook salmon. It is also apparent from its review of this topic that CRITFC fails to accord the proper deference to standard scientific principles. Throughout the White Paper, IPC endeavored to obtain and use information that has undergone either peer-review or has strong results based on rigorous scientific method, i.e., replicated samples providing statistically quantifiable and testable data that allow for the inclusion of variation inherent in any biological population. However, CRITFC did not rely on peer-reviewed, testable data, and indeed often relied on point-data of questionable quality.

In this summary IPC evaluates each of the principal criticisms the review levels at the Temperature White Paper and explains why each is without merit. The more detailed Appendix attached to this summary details the analysis that underlies the evaluations presented here. In sum, the Tribe's critique cannot serve to negate the findings of the Temperature White Paper.

The IPC Temperature White Paper, which is specific to temperature effects on fall Chinook salmon, covers eight major areas. The CRITFC reviewed each of these eight major areas as well as commented on the use and application of Ehist, an estimate of historic water temperatures.

The most important point to observe is that the Temperature White Paper was written in an effort to discuss potential effects on fall Chinook salmon due to changes in Snake River water temperature just prior to and following construction of the Hells Canyon Complex of dams and reservoirs. The paper was not intended to explore and produce conjecture on what the thermal character of the Snake River was prior to any water development projects being in place. The Tribe's review suffers from failing to proceed in parallel.

Section 1. Adult Migration

There is no evidence that the timing of adult fall Chinook salmon migration into the Snake River has been altered. While thermal conditions may have been altered within the Snake River after the construction of the HCC (especially due to Brownlee Reservoir), the timing of adult migration has not been altered. Within the context of altered adult migration timing, CRITFC cites a recent paper (Salinger and Anderson 2006) to support the position that the optimal swim speed temperature for adult Chinook salmon (all stocks combined, i.e., spring, summer, and fall) is 16.3°C. This appears reasonable, and as the authors of that paper noted, comports well with other studies. IPC does not find fault with this analysis. However, stating just what the "optimal" temperature for swim speed is (as CRITFC has done) is misleading. The authors of that paper also noted that swim speeds decline both above and below this temperature. This work indicates that, based on temperature, a proportion of the population will always experience a theoretical passage delay between Bonneville and Lower Granite Dam (distance of 462 km) when water temperatures differ from 16.3 °C. While 16.3 °C may be the temperature at which adult Chinook salmon theoretically swim the fastest (with reduced speed occurring above and below that temperature), the river system does not naturally remain stable at that

temperature during the Chinook salmon migration period (March through November). CRITFC did not explore this additional information provided in the report; this is unfortunately a common error in the review.

Section 2. Pre-spawn Mortality

Regarding pre-spawn mortality, IPC maintains that there is no data that indicates or suggests that excessive pre-spawn mortality is occurring within the Snake River. Nor is there data to lend support or credence to the hypothesis that elevated water temperature is causing increased pre-spawn mortality of fall Chinook salmon. Even first-hand observation of the river corridor over 17 seasons of data collection, during early spawning surveys, does not reveal the potential for increased (or any) pre-spawn mortality.

As a further example of how CRITFC used non peer-reviewed papers as support for hypotheses, please note the reference to Keefer et al. (2004). While CRITFC uses this paper as "evidence" that increased incidences of pre-spawn mortality of fall Chinook salmon occur within the Snake River, the paper actually contains no data, and only speculates that elevated water temperature might have an effect on pre-spawn mortality. Further, CRITFC references several reports by the California Department of Fish and Game, none of which contains any data that relates water temperature to pre-spawn mortality. However, they do note that pre-spawn mortality can be difficult to ascertain, and can be quite variable from year to year, mostly depending on the physical state of the fish prior to entering the freshwater system.

Section 3. Gamete Viability

CRITFC argues that fall Chinook salmon that enter the Snake River are immediately and constantly exposed to elevated temperatures that have a significant, detrimental effect on gamete viability. IPC disagrees with this point. IPC does not disagree that there are some studies on other, less thermally tolerant salmonids that indicate that elevated temperature can have an effect on gamete viability. However, the few studies that have been attempted on larger Chinook salmon have not provided any evidence that fall Chinook salmon are exposed to water temperature conditions within the Snake River that result in detrimental gamete production or viability.

Within the CRITFC review of the IPC White Paper, two recent studies are cited that are intended to provide support for the theory that elevated water temperature experienced by early migrating adult fall Chinook salmon reduce gamete viability. These reports are Mann and Peery (2005), and Berijikian (2006); neither has been subjected to peer-review. Nor does either of these reports provide data that supports the proposition that fall Chinook salmon in the Snake River are experiencing reduced gamete viability due to exposure to elevated water temperature conditions.

Section 4. Disease Susceptibility

IPC does not dispute the general proposition that prolonged exposure to elevated water temperature may lead to higher disease susceptibility, or that increased incidence of

disease in a population of Chinook salmon could result in elevated pre-spawn mortality. However, as mentioned earlier, there is no evidence of increased pre-spawn mortality in the Snake River fall Chinook population, nor does it appear to be excessively elevated over other natural river/stream systems. Nor is there any evidence that the prevalence of disease within the population of Snake River fall Chinook salmon is excessive. IPC cites a 14 year data set (1993-2006) for the Snake River that shows a consistently low level of fish per redd ratio of approximately 3.2 (range 2.0-4.2), which does not suggest that a high incidence of disease, leading to increased pre-spawn mortality, occurs. CRITFC is critical of the use of fish per redd ratios, and provides a "what if" calculation of two different pre-spawn mortality estimates (with certainty that the elevated pre-spawn mortality is due to elevated temperature and increased disease) and a discussion of how both scenarios can result in the same fish per redd ratios. However, the scenarios postulated by CRITFC are not based on actual data and are not representative of anything other than speculation. Any number of theoretical scenarios could just as well be conducted, which could be just as easily biased to show that fish per redd ratios are in actuality much lower, and that no level of pre-spawn mortality exists at all. The "what if" examples CRITFC provides do nothing except provide a false appearance that disease within this Chinook salmon population is prevalent due to elevated water temperature, and that this leads to increased pre-spawn mortality.

Section 5. Spawn Timing

IPC is well aware that the State of Oregon uses the seven day average maximum temperature occurring ***after first spawning*** as the standard for salmonid spawning. Within the Temperature White Paper, IPC used the seven days ***prior to first redd observation*** for its analysis because it provides a more conservative approach, i.e., favoring the fish, for assessing the water temperature that is present during early spawning. Because redd surveys of the Snake River generally occur on a Monday, this means that new redds observed on the day of the survey were actually constructed during the week previous to when they were observed.

The table in the Temperature White Paper that was put together for the Snake River (Table 3) is meant to show that there is no consistent water temperature at which the fish begin to spawn. There is also no predictive power to the data. Finally, based on the data provided by Groves et al. (2007), there is no indication that "preferred" spawning temperatures are ≤13.0 °C. In fact, when the data from Table 3 are scrutinized carefully, it becomes apparent that the most common temperature at which spawning in the Snake River was initiated has been about 15.0 °C.

In all years, the water temperature in the Snake River, as spawning was initiated, was declining, even in 2001, when redds were observed on 9 October at a seven day mean temperature of 19.1 °C. That year, during the week prior, through the end of the week after redds were first observed, the daily mean water temperature declined from 19.7 to 17.4 °C (roughly a decline of 0.2 °C per day). IPC did not indicate (and does not suggest) that fertilization of gametes at temperatures as high as 19.1 °C would result in high survival of embryos.

Evidence for the pre-HCC spawn timing distribution does not come from the IDFG reports from 1958-1960. The best historical spawn timing data comes from the reports by Zimmer (1950, 1953). Based on all of the data provided in those reports, it appears that in the Marsing Reach of the Snake River spawning historically began during the first or second week of October, which is similar to what is observed in the contemporary spawning areas downstream of the Hells Canyon Dam. Data that Zimmer (1950, 1953) provides further indicates that peak spawning in the Marsing Reach historically occurred at a similar time as compared to what is presently observed downstream of the HCC (by the first to second weeks of November), and that spawning was completed during early December. Based on the best data available, there is no evidence that contemporary spawn timing has been altered with respect to historic timing, due to changes in water temperature, downstream of the Hells Canyon Dam.

Section 6. Incubation Survival

CRITFC is critical of merging data from different studies in order to conduct a relevant and thorough synthesis of the effects of water temperature on incubation survival. This type of analysis is quite valid, especially if those studies proposed similar hypotheses, were performed on similar species, and were conducted under similar conditions. By merging the data from the three studies in question, a rigorous statistical analysis can be completed that does not serve to create ambiguity in the results. The result is that an unbiased, scientific approach can be used to make an objective assessment of how naturally declining water temperatures may affect incubation survival of fall Chinook salmon embryos. The inclusion of data from the three studies in question allows for the introduction of natural variability into the analysis; this is paramount in a statistical evaluation of any natural population. It is thus inappropriate that in lieu of such an approach CRITFC uses specific, limited data from one of the studies.

There is no doubt that the process of setting a protective temperature standard was based on an abundant source of literature. Further, without relevant data, it seems reasonable that using the only available information (even if from constant temperature studies) could be a prudent way to set a temperature standard. However, when provided with a good, solid body of evidence that is contrary to the standard, and is applicable to a specific species within a natural setting, it also seems prudent and reasonable to use that data to set a "site-specific" standard that remains protective of the species. IPC continues to argue that naturally declining thermal regimes result in very different embryo survivals than what may be implicated through constant temperature studies, and that available data is sufficient to set a site-specific temperature standard for fall Chinook spawning and incubation within the Snake River.

Section 7. Effects of Intragravel Temperature

Data that CRITFC relied upon to support the proposition that redd temperatures (intragravel) are significantly warmer than water column temperatures come from studies that have collected data from the ambient, undisturbed substrate – not from natural or artificial redds (Geist et al. 1999; Geist 2000; Hanrahan et al. 2004; Arntzen et al. 2006; Hanrahan 2007). The data IPC collected in the Snake River, described by Groves et al.

(2007), and further described by Groves et al. (in press), was also collected at fall Chinook salmon spawning grounds, but from artificially created redds in close association with naturally created redds. The data IPC provided more closely represents the thermal conditions that would be expected to be present in naturally constructed redds. As well, other authors who have attempted to study either natural or artificial redds have noted the same type of findings (Ringler and Hall 1975; Vronskiy and Leman 1991; and Hanrahan 2007).

Section 8. Emergence/Outmigration Timing

Estimates of emergence timing of fry in the present-day Hells Canyon Reach (especially the upper section) is similar to historic estimates of emergence in the Marsing Reach (refer to Figure 5, page 16 of the Temperature White Paper), and has become more similar during recent years. Outmigration timing of juvenile, sub-yearling Snake River fall Chinook, observed at Lower Granite Dam, has been occurring earlier during the past few years (2000-2006) than what was observed during the 1990's. Not only has the timing advanced, it has become less protracted. The reason for this shift in outmigration timing and distribution is unknown; however, it is occurring earlier and is more like what was historically observed prior to the construction of the Hells Canyon Complex or the Lower Snake River dams. Were it not for the slack water conditions of Lower Granite Reservoir, the sub-yearling fall Chinook salmon emigrating from the Hells Canyon Reach during contemporary times would be passing through the Central Ferry region of the lower Snake River (downstream of the present-day Lower Granite Dam) at a time that would be comparable to what Mains and Smith (1964) described for sub-yearlings that allegedly emigrated from the Marsing Reach prior to the construction of the Hells Canyon Complex. CRITFC indicates that the recent trend in earlier emigration timing is due to the recent observation of a yearling life history strategy, most prevalent in very late emerging juveniles originating from the Clearwater River. The expression of a yearling life history strategy that is almost wholly characteristic of fish originating from the Clearwater River has absolutely nothing to do with the fact that the sub-yearling fish from the Snake River are exhibiting earlier emigration timing.

Section 9. Ehist

CRITFC is correct in noting that Ehist estimates during periods of missing data do not consider all factors that effect temperature, including air temperature and solar radiation. However, the claim that data provided by IPC do not indicate which days had synthesized data is not correct. The White Paper provides a summary of the Ehist methodology, but clearly and repeatedly references the January 31, 2007 Hells Canyon Complex 401 Water Quality Certification application as the source of Ehist details. Indeed, the information claimed to be lacking has been provided by IPC in Exhibit 6.1-2 of the 401 application. It appears CRITFC deemed the Ehist methodology flawed without reviewing the documentation that the White Paper references. CRITFC incorrectly states that Figures 6.1-3, 6.1-4, 6.1-5, and 6.1-6 were taken from the Snake River TMDL, when in fact they were reproduced from IPC's January 31, 2007, 401 certification application, which contains the information claimed to be lacking.

It appears that CRITFC misused the Ehist model in its analysis. Specifically, claiming the ability to define a significant amount of warming on October 1 using Ehist data by comparing the Ehist results with measured data is not valid. The model provides estimates of temperature trends and characterizes estimated historic temperatures. It is thus inappropriate to use the model to define an exact temperature that can be compared to measured present day outflow temperatures to quantify a specific-day temperature effect of the HCC.

In sum, CRITFC's critical evaluation of the Temperature White Paper is seriously flawed, and the IPC Temperature White Paper's conclusions remain sound.

Appendix to IPC's Evaluation of the Nez Perce Tribe's Review of the Temperature White Paper :

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.

Adult Migration:

1. CRITFC appears not to have observed how IPC has used the term "historical." In the initial portion of this discussion (altered timing of adult migration), IPC referenced an EPA report that stated (with no data) that the historic adult migration of fall Chinook salmon into the Snake River occurred in late August through November, with a peak in September. IPC understands that "historical" refers to a pre-development period prior to the late 1800's. IPC has clearly pointed out that contemporary passage timing remains similar to what has been described as "historical" migration timing through the lower Snake River, and that this has not changed, even after construction of the HCC in the upper Snake River, the construction of four additional federal dams in the lower Snake River, and with the very recent operations from Dworshak Reservoir on the Clearwater River used to cool the lower Snake River.
2. In the context of what IPC is describing for adult migration, the water temperature data analyzed from the Central Ferry location on the Snake River portrays what the water temperature conditions were for the Snake River near the location of the present-day Lower Granite Dam prior to when the Hells Canyon Complex (or any of the federal lower Snake River dams) existed. Because the IPC paper is intended to compare conditions pre- and post- construction of the HCC, this is a valid point to consider. CRITFC correctly indicates that Dworshak Reservoir operations have been used in recent years to modify the water temperature in the Snake River throughout the Lower Granite Reservoir. However, even if data for the years when these operations occurred are omitted from any analyses, the timing of contemporary adult migration of fall Chinook salmon still remains the same as it did "historically". As well, during the time period (mid- to late-1950's) from which Central Ferry temperatures were obtained for comparison with present-day conditions, the population of fall Chinook salmon was considered healthy and abundant. Even if the thermal regime of the Snake River during the 1950's was already altered, this would not be an effect of the HCC because the HCC did not then exist. Again, the White Paper is intended to assess the thermal effects attributable to the construction of the HCC on fall Chinook salmon in the Snake River.
3. CRITFC cites a more recent paper (Goniea et al. 2006) to support the hypothesis that temperatures >20.0 °C significantly reduce rates of adult travel to spawning grounds. IPC has reviewed this paper, and agrees that elevated water temperatures can have an effect on adult migration timing. It appears quite clear from the data presented in the report that a reduced rate of migration (from about 40 km/day to

about 20 km/day) occurs between 21.0 and 22.0 °C. This is obvious from figure 5 and table 2 in Goniea et al. (2006). This report also claims that historic run timing at Bonneville and McNary dams has been altered due to water temperature. This claim is based on the difference during each year between the 75% and 25% passage timing at each of those projects. Based on the way the data is presented, there does appear to be an alteration in the run timing, with the inter-quartile ranges expanding over time. However, the actual data for the quartile passage dates indicates that the earlier 25% passage (presumably during warmer conditions) has not changed at Bonneville Dam since 1938, but that the 75% passage time (as well as the 90% passage time) have each become later and they are occurring when water temperatures are cooler. Also, there is no indication that water temperature has caused this to occur. There is strong indication that data from 1938-1979 shows no increase in the inter-quartile range, and that while data from 1980 through 2006 indicates a larger inter-quartile range, it has not increased throughout that period. The authors obliquely note this by stating that at the Dalles Dam, during the period 1977 to present, they could detect no increase in the inter-quartile range of adult fall Chinook salmon passage.

4. CRITFC cites another recent paper (Salinger and Anderson 2006) to support that the optimal swim speed temperature for adult Chinook salmon (all stocks combined, i.e., spring, summer, and fall) is 16.3°C. This appears reasonable, and as the authors noted, comports well with other studies. However, stating just what the "optimal" temperature for swim speed is can be misleading. The authors also note that swim speeds drop off both above and below this temperature. This work indicates that based on temperature a proportion of the population theoretically experiences a passage delay between Bonneville and Lower Granite Dam (distance of 462 km), as temperatures get warmer or cooler than 16.3 °C. The results indicate that passage delays increase by about 3.3 days at 17.0 °C, and by 4.7 days at 8.0 °C. At 21.0 °C the delay is estimated to be approximately 4.1 days, and at 13.0 °C about 3.9 days. These are very small differences even between the extremes, and it is difficult to believe that a potential migration delay of 4 days will result in a detriment to the population. More importantly, while 16.3°C may be the temperature at which adult Chinook salmon theoretically swim the fastest (with reduced speed occurring above and below that temperature), the question then becomes, should the entire lower Snake and Columbia rivers be maintained at 16.3 °C from approximately 1 March through 30 November every year (the basic time-frame of adult Chinook salmon upstream migration)? The question seems to answer itself in the negative.
5. CRITFC cites another recent paper (Naughton et al. 2005) to support the proposition that slowed migration is associated with cumulative effects of the hydrosystem and impairs migration success. This paper is specific to sockeye salmon. Sockeye salmon are much smaller than fall Chinook, and have less energy stores with which to cope with elevated bio-energetic needs at elevated water temperatures. This is one reason why sockeye salmon do not tolerate elevated temperature conditions as well as Chinook salmon do. The sockeye salmon that were reported to perform the worst, i.e., had the highest estimated in-river mortality, were tagged at Bonneville Dam in 1997 during the period 24 July

through 5 August. Water temperature in the forebay of Bonneville Dam during 1997 was consistently over 20.0 °C from 24 July through 21 September, and was elevated over 22.0 °C from 10 August through 4 September. While temperature conditions generally cooled as the fish moved upstream, within the lower Columbia (downstream of Priest Rapids Dam) they continued to be subjected to water temperatures above 20.0 °C from about early-August through late-September. The median passage time for tagged sockeye salmon to move from Bonneville Dam to the forebay of Priest Rapids Dam was 13 days (range between 8.5 to >30 days). Certainly fall Chinook salmon were also within the lower Columbia River during the same time frame; their migration period at Bonneville Dam is managed as beginning 1 August. However, as noted previously, and throughout the IPC White Paper, sockeye and Chinook salmon have different biological responses to elevated temperature conditions, with Chinook salmon having a significantly higher thermal tolerance.

Pre-spawn Mortality:

1. IPC agrees that continual holding at elevated water temperatures (>19.0 °C) would likely result in elevated pre-spawn mortality of adult fall Chinook salmon. IPC also agrees that, depending on the year, temperature conditions in the Hells Canyon Reach of the Snake River (upstream of the Lower Granite Reservoir) can be ≥19.0 °C from mid-August through mid-September or early-October. However, CRITFC assumes that each year the entire population of adult fall Chinook salmon moves immediately into areas of elevated water temperature and is thereby subjected to poor environmental conditions. CRITFC also ignores the potential for cool-water refuges that likely exist throughout the free-flowing reach of the Snake River above Lower Granite Reservoir.
2. It is abundantly clear that CRITFC is not spatially familiar with the free-flowing reach of the Snake River. IPC agrees that Dworshak Reservoir releases assist in cooling the Lower Granite Reservoir, and provide a significant cool-water refuge for adult fall Chinook salmon at the upper end of Lower Granite Reservoir. As well, there are several potential cool-water refuges throughout the free-flowing reach of the Snake River between the upper end of the Lower Granite Reservoir and the Hells Canyon Dam. IPC listed the larger tributaries (Grande Ronde, Salmon, and Imnaha rivers), as well as a large number of smaller tributaries, that are distributed throughout the free-flowing reach and which can provide significant thermal refugia for adult fall Chinook salmon, and which are not highly distant from spawning grounds. As one major example, the Grande Ronde River cools appreciably by the first of September, and its plume remains relatively unmixed within the main Snake River for approximately two miles downstream. Five large spawning areas are within two miles of this plume. CRITFC mentions diversion and land-use practices on many of the smaller tributaries that may affect their usefulness as thermal refugia. Again, it is apparent that CRITFC has no understanding of the Hells Canyon Reach, and that most of the smaller tributaries are within the boundaries of wildlife management areas or are within the boundary of the HCNRA, and as such are not appreciably altered due to diversions or poor land-use practices.

3. The Keefer et al. (2004) paper cited by CRITFC provides no data and therefore only speculation on potential pre-spawn mortality due to water temperature in the Snake River.
4. IPC does not agree that a 7 day average maximum temperature of 13.0 °C is necessary to protect spawning of fall Chinook salmon. The standard that has been developed is based on data from constant temperature incubation studies, most of which are specific to other salmonids, and does not represent natural environmental conditions.
5. CRITFC's review on this topic fails to accord the proper deference to standard scientific principles. Throughout the Temperature White Paper, IPC endeavored to obtain and use information that has undergone peer-review, or has strong results based on rigorous scientific method employing replicated samples providing statistically quantifiable and testable data that allow for variation inherent in any biological population. However, CRITFC relies consistently on point-data of questionable quality in lieu of peer reviewed data.
6. Data from the California Department of Water Resources concerning pre-spawn mortality indicates that pre-spawn mortality is difficult to ascertain, and can be quite variable from year to year, mostly depending on the physical state of the fish prior to entrance into the freshwater system. Their reports actually provide no data that is useful in determining how temperature affects pre-spawn mortality, or how to use temperature data to assess or estimate pre-spawn mortality. IPC submits that pre-spawn mortality within the Snake River is not excessive and in fact is similar to other river systems throughout the Pacific Northwest.
7. The Brown and Geist (2002) paper cited by CRITFC concerning the potential of pre-spawn mortality states this in its Executive Summary: **"Out of necessity, we captured fish which already had passed through difficult passage conditions. Thus, our study protocol may have biased our results. All of the fish used in our study were captured while trying to pass Lyle Falls, tagged, and then returned downstream where they were released. Thus, the fish tracked during this study likely had lower energy reserves and were more mature than fish that were approaching the lower river for the first time. This factor should be weighed when interpreting results."** CRITFC appears to have ignored or unreasonably discounted this important caveat.
8. It is also important to note that migration rates of fall Chinook salmon in the Klickitat River study of Brown and Geist (2002) averaged a little over 2.0 km/day (range between about 0.8 – 3.8 km/day, depending on type of tag used), while fall Chinook tagged and followed within the Columbia and Snake River tend to have average migration rates between about 20.0 to 40.0 km/day (Goniea et al. 2006). CRITFC misuses the lower migration rate of Klickitat fish as a surrogate for Snake River fall Chinook in order to support the theory that delayed migration of Snake River fall Chinook salmon, due to very low migration rates, results in elevated pre-spawn mortality. In reality, Snake River fall Chinook migrate upriver at significantly faster rates.
9. The Brown and Geist (2002) study was specifically aimed at determining how the use of stored energy through fast velocity water and during attempts to pass multiple barriers, such as large falls, may affect the potential for fish to reach their

spawning grounds in relatively good shape and health. Their findings determined that multiple large falls and long reaches of fast velocity water, with very little velocity refugia, in the Klickitat River may be depleting energy stores and leading to upstream migration delays of between 9-11 days. This has very little relevance or comparative value to the Columbia/Snake River system.

Gamete Viability:

1. CRITFC continues to argue that fall Chinook salmon that enter the Snake River are immediately and constantly exposed to elevated temperatures that have a significant, detrimental effect on gamete viability. IPC disagrees with this point. IPC agrees, for the little it is worth in this context, that there are some studies on other, less thermally tolerant salmonids that indicate that elevated temperature can have an effect on gamete viability. But this does not necessarily say anything about fall Chinook, and in fact the few studies that have been attempted on larger Chinook salmon have not provided any evidence that fall Chinook salmon are exposed to water temperatures conditions within the Snake River that will lead to detrimental effects on gamete production or viability.
2. The Mann and Peery (2005 – *not 2004*) is quite recent, and IPC was not aware of it at the time the White Paper was completed. CRITFC uses the results from this study to support the assertion that elevated Snake River water temperatures have a detrimental effect on gamete viability in fall Chinook salmon. But the data presented in this report do not provide any, let alone any strong evidence for this contention. The authors state that, "Five fish with the highest temperature exposures, calculated as degree days above 20.0 °C, had five of the six highest mortalities for both stages of embryo development" (Mann and Peery 2005). This statement is true, but is also misleading if not properly explained. The actual data is more enlightening. Of the 13 females that had useable thermal exposure data prior to spawning, the final embryo mortalities of 12 were all <9%, and 10 were less than 6% (mean eye-up mortality 4.0%, range of 0.5-19.5%; mean button-up mortality 4.9%, range of 1.4-19.8%). Only the progeny from a single female had embryo mortality as high as ≈20%, and that one female was exposed to the ***coolest*** water temperatures (median temperature = 17.5, maximum temperature = 18.5, degree days >18.0 °C = 0.3, degree days >20.0 °C = 0). The authors provided a plot of embryo mortality as a function of degree day exposures, but failed to provide analyses of these relationships, which remarkably, all have r^2 values of <0.05, and are not significant. Finally, the data can be analyzed as an "exposure vs. non-exposure" experiment, with an hypothesis asking whether there is a difference in embryo mortality for gametes from adults that were exposed to water temperatures above 20.0 °C, and those that were not. The resultant P-values for the eye-up and button-up mortalities, are 0.655 and 0.709, respectively, indicating that there is no evidence for claiming a difference in embryo mortality based on exposure to elevated water temperature. Further, CRITFC misquotes references: the CRITFC review states that fish that had been "exposed to temperatures as high as 23.6°C during migration had a high incidence of embryo mortality" (CRITFC page 8) In fact, for the embryo mortality tests conducted by Mann and Peery (2005), the highest temperature to which adults were exposed

(adults which had data that could be analyzed) during the pre-spawn period was 21.9 °C. There were fish that were exposed to temperatures as high as 23.6 °C, but their gametes were not used in the embryo mortality tests, and did not provide any data or information concerning the effect of adult temperature exposure and gamete viability Contrary to CRITFC's review, the most recent report edited by Berijikian (2006) provides no evidence of altered gamete viability due to elevated adult thermal exposure. Further, it should be pointed out that these series of studies are not representative of fish in a natural environment, but rather are tests on spring Chinook salmon that have been bred and reared their entire lives within a captive broodstock environment. The report does allude to the possibility of slightly advancing ovulation timing (and theoretically spawn-timing) by providing a cooler pre-spawn environment during the ocean portion of their lives; however, this point was not strongly supported by the results. Nonetheless, the following is taken directly from the Berijikian (2006) report:

a. "The number of eggs retained at death did not differ significantly among treatments (U=53, P=0.514).

b. "The number of fry produced by chilled and ambient females did not differ significantly (U=40.0, P=0.277)"

c. "The two ambient females that spawned had estimated egg-to-fry survival of 10% and 34%, and egg-to-fry survival of the three chilled females was 4%, 20%, and 42%." (Note that the mean for ambient and chilled test subjects was 22%).

d. "We hypothesized that a more natural (cooler) seawater temperature profile would improve reproductive performance. The results suggest that this factor alone is not responsible for the poor reproductive success of captively reared Chinook salmon in this study and indications of poor breeding success in previous investigations of captively reared Chinook salmon (Berijikian et al. 2001, 2003)."

Disease Susceptibility:

1. Fish counts collected at the lower Snake River dams do include jacks. Counts at Lower Granite Dam are separated into both jacks and adults. Fish to redd ratios for the Snake River upstream of Lower Granite Dam are calculated using only the adult portion of the count.
2. There is annual variation in the female to male ratio within the adult (excluding jacks) portion of the Snake River fall Chinook population. There is no data available concerning the female to male ratio for the portion of the population that is allowed to escape upstream of Lower Granite Dam. However, there is data on this topic for the fish that are collected at Lyons Ferry Hatchery on the Lower Snake River. That data shows that between 1991 and 2002 the percentage of females in the adult portion of that population has been 0.48 (range of 0.27-0.53). In order to use this data we have to assume that the portion of the population that is allowed to escape upstream of Lower Granite Dam has a similar female to male

ratio. Using these data and an estimate of overcount at Lower Granite Dam, the female to redd ratio between 1993 and 2006 has averaged 1.3 (range of 0.9-1.8). We exclude data prior to 1993 because of significant differences in how redd counts were collected in earlier years. If our redd counts and adult counts were perfect we would expect the female to redd ratio would be 1.0 – indicating that each female in the population survived and completed one redd. CRITFC is correct in pointing out that our redd counts are not perfect, and that is one reason why we do not (and will not ever) have consistent female to redd ratios of 1.0. One crucial reason for this is that it is likely that we will never be able to obtain a complete census of all redds constructed at water depths greater than about three meters. While deepwater video searches are conducted throughout the Hells Canyon Reach of the Snake River, indicating that an average of about 30% of the redds in that system can be at depths greater than three meters, we are quite certain that for reasons beyond our control every single redd is not counted. More importantly, deepwater redd searches are not conducted in the Clearwater River, where the potential exists for deepwater spawning to occur. So, while the female to redd ratio (based on the best available data) averages 1.3, it is more than likely lower than that. As any reviewer would likely point out, a female to redd ratio of 1.3 indicates that there are either redds not being accounted for, females in the population that are not constructing redds, or a percentage of the population that is perishing prior to spawning, and that approximately 23% (ranging between 0-44%) of the female population is being lost to prespawn mortality (due to disease or a myriad of other factors). As mentioned earlier, we are certain that we are not counting every single redd (we would expect that the true female to redd ratio would be less than 1.3). Also, in any population there is always some level of prespawn mortality – even due to disease – that occurs (again, the true female to redd ratio would be less than 1.3). Based on reports from other systems, a level of prespawn mortality ≈23% is not excessive. Because the female to redd ratio is so consistent from year to year, and has a very narrow range, it does not suggest that some dynamic event is occurring within the Snake River that triggers massive outbreaks of disease or prespawn mortality.

3. A female can dig more than one redd, and it is quite possible that a female may construct a redd and actually never spawn. However, this occurrence is not known to be common within any population.
4. Turbidity can reduce the ability for observers to obtain good counts of redds. This actually occurs in most years along the Clearwater River, and is another reason why it is likely that our redd counts are not complete, and the fish to redd and female to redd ratios are not perfect. Because we do not count every single redd, the fish to redd and female to redd ratios in the Snake River basin are higher than what they truly are, which is another point indicating that excessive prespawn mortality is not occurring.
5. CRITFC conducted an interesting "what if" scenario for illustrating how the fish to redd ratios can mask a large amount of prespawn mortality (which is allegedly entirely due to temperature). We could conduct a similar exercise and posit that the fish to redd ratio averages 2.1, and is 2.0 one year, but is 2.2 the next year. It is possible that prespawn mortality could be 0% the first year and 0% the second

year. In each year 200 fish were counted passing the dam, yet in year one 100 redds were observed (ratio 2:1, or stated as 2.0), while in year two only 90 redds were counted (ratio 2.2:1, or stated as 2.2). The reason for the difference is that in year one, the observers actually got lucky and the female to male ratio was exactly 1:1, there was absolutely no prespawn mortality (not likely in any population) and the observers counted every single redd. However in year two, with similar conditions, the observers missed 10 redds that were constructed in the deepwater of one site that was not searched. Any number of potential scenarios could be "made up". None of them would have scientifically demonstrable value.

Spawn Timing:

1. IPC is well aware that the State of Oregon uses the seven day average maximum temperature occurring after first spawning as the standard for salmonid spawning. IPC used the seven days prior to when the first redds were observed for its analysis because it provides a more conservative approach for assessing the water temperature that is present during early spawning. Because Snake River redd surveys generally occur on a Monday, this means that redds observed on the day of the survey were actually constructed sometime during the week previous to when they were observed.
2. Evidence for the pre-HCC spawn distribution does not come from the IDFG reports from 1958-1960.
3. The table within the Temperature White Paper that was put together for the Snake River (Table 3) was meant to show that there is no consistent water temperature at which fall Chinook salmon begin to spawn. For the years 1991-2006, within the upper Hells Canyon Reach the mean temperature during the seven days prior to spawning was 15.7 °C, with a range of 12.5 – 19.1 °C; moreover, there is no predictive power to the data (one cannot predict when spawning will begin based on water temperature). Also, in all years, the water temperature was declining, even in 2001, when redds were observed on 9 October at a seven day mean temperature of 19.1 °C. During the week prior, through the end of the week after the first redds were observed, the daily mean water temperature declined from 19.7 to 17.4 °C (roughly a decline of 0.2 °C per day). IPC did not indicate that fertilization of gametes at temperatures as high as 19.1 °C would result in high survival of embryos.
4. IPC also intended to indicate with Table 3, that even though the water temperatures are cooler earlier within the lower Hells Canyon Reach, spawning in that reach does not consistently occur at an earlier date than in the upper Hells Canyon Reach. In only 4 of 16 years did spawning occur earlier in the lower Hells Canyon Reach, and in 5 of 16 years spawning occurred later in the lower Hells Canyon Reach. Cooler conditions did not consistently trigger earlier spawning within the lower Hells Canyon Reach. The most notable example of this occurred in 2000, when fish in the upper Hells Canyon Reach began spawning around 9 October at a water temperature of about 17.3 °C, while fish in the lower Hells Canyon Reach began spawning around 23 October at a temperature of about 13.6 °C. Based on the available data, and previous years' observations, it is

conceivable that the fish in the Lower Hells Canyon Reach could have begun spawning two weeks earlier (around 9 October) at a temperature of about 16.1 °C; or they could have begun spawning at least one week earlier at a temperature of about 14.3 °C. They did not, and as CRITFC points out, this could have been due to any number of reasons. What should be clear, however, is that water temperature does not provide a predictive element explaining why the later spawning occurred.

5. With the contemporary spawning and thermal data provided in Tables 3 through 5 of the Temperature White Paper, IPC is indicating that there is no consistent pattern that links the initiation of spawning to any particular temperature. In the end, it is not reasonable to expect spawning to be consistently initiated earlier just because water temperatures are reduced. However, IPC does not gainsay the possibility that spawning within the Snake River could begin earlier if the river were to be cooled substantially, by about 6.0 °C by the last week of September. However, based on the data that is available, while there would be no guarantee that spawning would actually begin earlier, this level of cooling would likely result in a delay in early emergence.
6. In summary, based on the data provided by Groves et al. (2007), there is no indication that preferred spawning temperatures are ≤13.0 °C.
7. The best historical spawn timing data comes from the reports by Zimmer (1950, 1953). He reported that redds were first observed on 3 October, 1947 (a flight was conducted during September, but no spawning was observed); first spawning was observed on 13 October, 1948 (1 redd observed); the earliest survey in 1949 occurred on 13 October, and 148 redds were observed (indicating that spawning likely began prior to that date); the earliest survey of 1950 was conducted on 29 September, but no redds or live salmon were observed; early surveys in October of 1951 were not successful in identifying spawning due to high turbidity; the earliest surveys conducted in 1952 occurred between 8-12 October, the water clarity was described as very clear, and no indications of spawning were detected. In his early report Zimmer (1950) concluded that, "… the spawning period of fall Chinook salmon in the Snake River above Hells Canyon Dam site starts in late September ***or*** early October and is completed by early December." This was written after the surveys of 1949. Based on following years' data, and looking at all of his data as a whole, it appears more reasonable that historically, spawning in the Marsing Reach of the Snake River typically began during the first or second week of October, which is similar to what is observed in the contemporary spawning areas downstream of the Hells Canyon Dam.
8. Data that Zimmer (1950, 1953) provides indicates that peak spawning in the Snake River occurred at a similar time historically (late 1940s', early 1050s') as compared to what is presently observed (during first to second weeks of November).
9. Based on the best data available, there is no evidence that contemporary spawn timing has been altered, with respect to historic timing, downstream of the Hells Canyon Dam.

Incubation Survival:

1. CRITFC is inappropriately critical of merging data from several studies in order to present a more complete analysis/synthesis of a hypothesis or theory. Merging data from studies is quite valid, especially if those studies proposed similar hypotheses, were performed on similar species, and were conducted under similar conditions.
2. By merging the data from the three studies in question (Olson and Foster [1955], Olson et al. [1970], and Geist et al. [2006]), rigorous statistical analyses can be completed that lead to unambiguous results; an unbiased, thorough, scientific approach can be used to make an objective observation on how naturally declining water temperatures may affect incubation survival of fall Chinook salmon embryos.
3. CRITFC is correct in pointing out that one set of data (23 November) from the Oslon et al. (1970) report was noted by the authors as "erratic", and was omitted from their analysis. IPC also omitted that data from its analysis and it makes no difference in the final results or conclusions.
4. CRITFC argues that the use of the 30 October test of Olson et al. (1970) is the single best test to use as a surrogate for Snake River fall Chinook salmon embryo mortality dependant on temperature conditions. CRITFC notes that it is "reasonable" to conclude that a significant increase in mortality occurred between the initial test temperatures of 56.6 and 58.6 °F (13.7 and 14.8 °C). It seems that the temperatures within each test group of this test date "ticked" upward, and the actual highest temperature for these two tests were about 57.5 and 59.5 °F (14.2 and 15.3 °C). Total mortality between these two tests (without replication – a very important item to note) was 3.6% and 11.0%, respectively (a difference of 7.4%). It is also just as reasonable to conclude that because there was no replication this difference in mortality is not significant, and is wholly explainable by normal variation within a population. This is the single most important reason to have replication within a biological/ecological study design – to be able to account for natural variation. CRITFC also inappropriately discounts the fact that the water temperature "ticked" up during the test; however, it is very important in reviewing the results to take into account that the temperature did indeed "tick" upward by as much as 0.5 °C even if it had done so only for a single day. More importantly, for the series of tests begun on 30 October, a large increase in total mortality was noted between series three (11.0%) and four (28.1%), indicating a difference in mortality of about 17.1%. Even without replication, it is reasonable to conclude that this is likely a significant increase in mortality. The series four embryos were subjected to early incubation temperatures as high as 61.6 °F (16.4 °C), and this continues to support and illustrate that within a natural thermal environment the temperature exposure break-point in increasing embryo mortality lies between 16.0 and 17.0 °C. There is nothing untoward with this interpretation of the data.
5. CRITFC discusses the Olson et al. (1970) 8 December test groups in a very odd manner, indicating that total mortality "doubled" (and remained "doubled") with an increase of initial exposure temperature of 12.3 to 13.4 °C. The mortality changed from 7.3% to 17.0% (a difference of 9.7%), respectively for those two test groups, but at higher initial test temperatures dropped to 14.1% (at 14.5 °C)

and 12.4% (at 15.6 °C). While a difference in mortality as high as 9.7% may at first seem excessive, the difference at the highest temperature fell to 5.1%, and does not seem excessive (nor is it "doubled"). This test illustrates the need for replication within groups, as without replication within each test group, it is impossible to know what part natural variation plays in the interpretation of these results and whether there are actual differences in these results that can be attributed to the exposure condition.

6. Concerning the 8 December test groups in the Olson et al. (1970) study, if we were to continue with CRITFC logic, then the best temperature at which to begin incubation would actually be 8.9 °C. Those test embryos had a total mortality of 4.8%, which was the lowest compared to all others in that test group. However, during the 30 October test, the group that had the highest test temperature of 14.2 °C had the lowest total mortality –3.6% --observed throughout the entire study. That should certainly be the "best" temperature at which to begin incubation. But, we can become more confused: another group begun at 13.9 °C on 14 November (only 0.3 °C cooler than 14.2 °C but higher than 8.9 °C) had total mortality of 16.4%. Mortality increased from 4.8% at 8.9 °C to 16.4% at 13.9 °C and then dropped to 3.6% at 14.2 °C. To make matters more confusing, there were two different groups that had equal total mortalities of 11.0% but which had very different high test temperatures – one was 12.8 °C and the other was 15.3 °C. In the final analysis, which data point should we choose as best? This illustrates why the introduction of replication into the study design, which would help account for variation, would make the results more easily understood.
7. When stating that the HCC is presently more amenable to a sub-yearling life history strategy for fall Chinook than was historically the case, it is imperative to understand that IPC is talking about the reach of the river downstream of the HCC. IPC is making a comparison between the Hells Canyon Reach as it presently is, and the Hells Canyon Reach as it historically was.
8. IPC must emphasize that naturally declining thermal regimes result in very different embryo survivals than what may result from constant temperature studies.
9. There is no doubt that the process of setting a protective temperature standard was based on an abundant source of literature. Further, without relevant data, it would seem reasonable that using the only available information (even if from constant temperature studies) would be a prudent way to set a temperature standard. However, when provided with a good, solid body of evidence that is contrary to the standard, and is applicable to a specific species within a natural setting, it also seems prudent and reasonable to use that data to set a "site-specific" standard that remains protective of the species.
10. CRITFC mentions that when discussing temperatures we should be concerned with the daily fluctuations in temperature, and how they might affect incubation survival. This is a case in point illustrating CRITFC's lack of first-hand understanding of the Snake River system, especially during the fall. The diel temperature fluctuation of the Snake River during the fall is generally about 0.4 °C (Groves et al. in press), and it tends to cool at a rate of about 0.2 °C per day. This is a very consistent level of diel fluctuation, as well as rate of decline.

CRITFC notes that a decline in temperature of 0.2 °C per day, over a 5-day period is analogous to a constant temperature regime. This is not likely, as it represents a change over a 5-day period of 1.0 °C; this is a considerable amount of cooling in a large river.

11. CRITFC again falls back on an odd "what if" type of analysis to cast doubt onto naturally varying temperature experiments, saying that one test might have a daily fluctuation of ±1.0 °C, whereas another might have a daily fluctuation of ±4.0 °C. CRITFC notes that these would be very different experiments, and would likely provide different results. IPC would agree. However, the three incubation survival studies that have been conducted on fall Chinook salmon, using naturally variable temperature conditions (Olson and Foster [1955], Olson et al. [1970], and Geist et al. [2006]) mimicked the thermal character of a large river (either the Columbia within the Hanford Reach, or the Snake River within the Hells Canyon Reach). These two river sections have very similar daily fluctuations that do not fluctuate by more than about 0.5 °C per day. Please note that this type of fluctuation refers to a variation around the daily mean temperature of +0.25 and -0.25 °C per day. The data resulting from those studies are very relevant (more relevant than constant temperature studies on sockeye salmon, for example) to setting more realistic temperature standards for fall Chinook salmon of the Snake River.
12. With respect to Combs (1965) and the constant temperature conditions that his test organisms were exposed to, that author was obviously referring to the fact that a constant temperature regime maintained throughout the entire incubation period could not realistically be expected to occur in a natural stream or river environment.
13. It is our understanding that the notation by Beacham and Murray (1990), concerning the fact that their test conditions would not be expected to be representative of a natural environment, was made in order that over-zealous resource managers would not be so quick to use their information as representative of what might occur in a natural environment. The authors were not "caught red-handed" (CRITFC page 17); they were simply stating that their tests were not representative of what occurs in nature.

Effects of Intragravel Water Temperature:

1. CRITFC misunderstands this section of the Temperature White Paper. Data collected in the Snake River by Hanrahan et al. (2004) was collected at known fall Chinook salmon spawning grounds. However, the data was collected from undisturbed, ambient substrate, and from several different depths in the gravel matrix, most of which were deeper than what would normally be considered egg-pocket depth. Data that CRITFC continues to rely on to support the contention that redd temperatures are significantly warmer than water column temperatures come from studies that have collected data from the ambient, undisturbed substrate – not from natural or artificial redds (Geist et al. 1999; Geist 2000; Hanrahan et al. 2004; Arntzen et al. 2006; Hanrahan 2007). The data collected in the Snake River by IPC, described by Groves et al. (2007), and also described by Groves et al. (in press) was also collected at fall Chinook salmon spawning grounds, but from artificially created redds located throughout those spawning

grounds in very close association with naturally created redds. The data provided by IPC most closely simulates the thermal conditions that would be expected to be present in naturally constructed redds. As well, other authors who have attempted to study either natural or artificial Chinook salmon redds have noted the same type of findings (Ringler and Hall 1975; Vronskiy and Leman 1991; and Hanrahan 2007).

2. Chinook salmon do not "exclusively" spawn in downwelling zones; however, those types of environments are more commonly used by Chinook salmon, and this has been shown in several different studies, in several different river systems (Vronskiy 1972; Leman 1988; Vronskiy and Leman 1991; Geist 2000; Geist et al. 2002; Hanrahan et al. 2004). Additionally, several researchers have demonstrated that the physical structure of large salmonid redds tends to alter the local hydraulics that are typical over relatively flat, undisturbed gravel beds. The physical structure of a salmonid redd acts to increase the infiltration of surface water into the gravel structure of the redd (Stuart 1953; Vaux 1968; Cooper 1965). The infiltration of surface water into the redd structure can be at least as deep as about 46 cm (Cooper 1965). Redistribution and cleaning of the substrate during redd construction, the increased infiltration of surface water due to the redd structure, and the disposition to spawn where down-welling occurs naturally all facilitate increased interaction between surface water and the incubation environment within Chinook salmon redds, as especially noted within the Snake River. This can result in physicochemical similarities between surface waters and the intra-redd environment, specifically with relation to temperature. This is true whether redds are created in an upwelling or downwelling environment.
3. In all instances of creating artificial redds, it has been noted that during the early part of the redd "life" the water temperature conditions found within redds is generally equivalent to the water column conditions, and within the accuracy limits of instrumentation (0.2 °C). Please note figures 16-23 on pages 70-74 of Groves et al. (2007), and data reported by Groves et al. (in press). These quotes are taken directly from Groves et al. (in press):
    a. "During the first 14 days of the 2003-2004 incubation period, the mean daily absolute temperature difference between the intra-redd and surface water environments of the Lower Hells Canyon section (below the Salmon River; LHC) was 0.10°C (SE=0.01). Within the Upper Hells Canyon section (UHC), the mean daily absolute temperature difference between the intra-redd and surface water environments during the first 14 days of the incubation period was 0.08°C (SE=0.01)."
    b. "During the first 14 days of the 2004-2005 incubation period, the mean daily absolute temperature difference between the intra-redd and surface water environments of the LHC was 0.12°C (SE=0.01). Within the UHC, the mean daily absolute temperature difference between the intra-redd and surface water environments during the first 14 days of the incubation period was 0.13°C (SE=0.01)."
    c. "During the first 14 days of the 2005-2006 incubation period, the mean daily absolute temperature difference between the intra-redd and surface water environments was 0.14°C (SE=0.01)."

Emergence/Outmigration Timing:

1. Emergence timing in the present-day Hells Canyon Reach is similar to what occurred historically in the Marsing Reach (refer to White Paper Figure 5, page 16), and has become more similar during recent years.
2. Outmigration timing of juvenile, sub-yearling Snake River fall Chinook, observed at Lower Granite Dam, has been occurring earlier during the past few years (2000-2006) than what was observed during the early through late 1990's. From 1995-2006 the mean passage date of wild pit-tagged sub-yearlings has steadily changed from Julian date 207 (25 July) to 172 (20 June). The trend seen for the mean is also apparent in the middle 80% of the run. During 1995 the middle 80% of the run occurred from Julian day 182-241 (30 June – 28 August; 59 days), while in 2006 it occurred from Julian day 151-184 (30 May – 2 July; 33 days). Not only has the timing become earlier, it has become less protracted. These trends are also characteristic of the entire sub-yearling smolt passage index. From 1995 through 2006 the outmigration timing of sub-yearling Chinook salmon has become earlier by about 35 days. . The reason for this shift in outmigration timing is unknown; however, it is occurring earlier and more like what was historically observed prior to when the Hells Canyon Complex or the Lower Snake River dams were constructed.
3. There is no doubt that the slack water condition of Lower Granite Reservoir has a delaying effect on the rate at which sub-yearling fall Chinook salmon migrate downriver. Were it not for the slack water conditions of Lower Granite Reservoir, the sub-yearling fall Chinook salmon emigrating from the Hells Canyon Reach during contemporary times would be passing through the Central Ferry region of the lower Snake River (downstream of the present-day Lower Granite Dam) at a time that would be comparable to what Mains and Smith (1964) described for sub-yearlings that allegedly emigrated from the Marsing Reach prior to the construction of the Hells Canyon Complex.
4. CRITFC urges that IPC should take steps to mitigate for the slack water conditions of the Lower Granite Reservoir. But that is a federal responsibility, not an IPC responsibility.
5. CRITFC indicates that the trend in earlier emigration timing is due to the recent observation of a yearling life history strategy, especially exhibited by very late emerging juveniles originating from the Clearwater River. The expression of a yearling life history strategy has absolutely nothing to do with the fact that the sub-yearling fish from the Snake River are exhibiting earlier emigration timing.
6. Prior to the Hells Canyon Complex being constructed, the mean water temperature through the Hells Canyon Reach during the period 15 December through 15 February was approximately 1.7 °C. Presently, the mean temperature during this same time period, for the river reach from the Hells Canyon Dam to the Salmon River confluence, is approximately 4.6 °C, and for the Snake River downstream of the Salmon River it is 3.9 °C. This represents a significant warming of the base winter flows of the Snake River downstream of the Hells Canyon Dam. For comparative purposes, the mean water temperature of the Marsing Reach, for the period 15 December through 15 February, was about 4.4

°C. It would seem that the Hells Canyon Reach is presently more like the historic Marsing reach environment than it was prior to when the Hells Canyon Complex was constructed.