COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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January 26, 2011

SENT VIA EMAIL TO: Fonseca.Marilyn@deq.state.or.us

Bill Blosser, Chair
Oregon Environmental Quality Commission
DEQ Headquarters Office
811 SW 6th Avenue
Portland, OR 97204

RE: Idaho Power Petition for Rulemaking

Dear Mr. Blosser:

The Columbia River Inter-Tribal Fish Commission (CRITFC) appreciates this opportunity to provide comments on Idaho Power Company's (IPC) petition for rulemaking for a site-specific temperature criterion for the Hells Canyon Reach of the Snake River. We have reviewed and analyzed the full text of the petition and its appendices and have made specific comments (attached hereto). Based on our review, we recommend that the Commission deny IPC's petition.

Currently Oregon DEQ is reviewing a Clean Water Act (CWA) § 401 water quality certification application submitted by IPC. This review is using a great deal of limited state resources. At a time when Oregon's public funding is frozen and its budgets are shrinking, it would not be appropriate to use more of those limited resources for a rulemaking that will only benefit a large, well-financed private utility company. Allowing for increased temperatures in an already warm river that will likely be made even warmer under climate change will not benefit Oregon, or Oregon's future.

This rulemaking is intimately tied to the ongoing relicensing proceeding of the Hells Canyon Hydroelectric Project (Project) with the Federal Energy Regulatory Commission. Together with two of our member tribes, the Nez Perce Tribe and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) (collectively, Tribes), we have been "at the table" in this proceeding with many federal, state and non-governmental stakeholders for over a decade. We have also provided technical assistance and comments in the Oregon and Idaho § 401 water quality certification processes. Our goal has been to analyze alternatives and recommend new license conditions for this Project that are scientifically and holistically robust and will best protect and restore aquatic resources affected by the Project existence and operations over a likely fifty year new license term. Throughout this process, however, IPC has not been a willing collaborator.

The proposal to establish site-specific criteria for temperature in the Hells Canyon Reach requires a great deal of complex, technical analysis. What is certain is that the Project has significantly altered the Snake River's historical thermal and other regimes, blocked critical habitat for salmon, steelhead, Pacific lamprey and sturgeon, and contributes to a seriously degraded environment for the aquatic beneficial uses in the Snake River. Moreover, IPC owns and operates a series of hydroelectric dams above Hells Canyon which together, have contributed to and exacerbated serious water quality problems, both above and below the Project.

When contemplating a site-specific criterion, ODEQ cannot take a step backwards from the purpose of the Clean Water Act, which is to restore and maintain the chemical, physical and biological integrity of the waters of the United States. Furthermore, the beneficial uses of that water body, particularly the most sensitive use, must be fully protected. The Hells Canyon Reach supports temperature-sensitive species such as salmon, lamprey and bull trout that require much cooler habitat than other fish. Moreover, evidence collected relating to climate change and its projected effects on the Snake River do not bode well for these sensitive species. Diminishing protection for these species, as this proposal, if accepted, would do, would clearly not benefit Oregon's future.

IPC has taken the position that mitigation for their temperature violations would be costly and unreachable. However, it is important to note that a mitigation option such as a temperature control structure (TCS) is not a new or unique technology, but widely used in the basin and elsewhere with positive and quantifiable benefits. IPC is in the business of selling power and over the decades have extracted immense benefit from the river without having to pay the real costs of that benefit.

The Commission is required to consider the six points under ORS 183.390 when deciding their course of action on this position. We suggest the following:

- In the face of dire predictions related to climate change and significant increases in Snake River water temperatures and due to the nature of the sensitive species that need protecting in the Hells Canyon Reach, there is clearly a continued need for the current temperature criterion.

- The nature of our concerns stem from scientifically valid analyses and review. In light of currently available science, changing the temperature criterion to meet the request of IPC would be a giant step backwards for the beneficial uses of the Hells Canyon Reach and would benefit few.

- The complex nature of this rule is without question. There still remains a great deal of scientific uncertainty that would require a great deal of further research. But there also exists a large scientific literature on thermal effects on salmonids that would argue for taking conservative management approaches and minimizing exposure of salmonids to elevated temperatures.

- There are no known conflicts, duplications or overlapping of this rule with other rules or laws. In fact, the current temperature criterion falls within the standard practices conducted by Oregon all over the state and meets the goals and purpose of the Clean Water Act.

- Temperature problems are not going to improve under any projection or analysis based on existing conditions. The only change in the affected area under future human development scenarios and accompanying climate change would be for the water quality to degrade, not improve. Accordingly, it would be a major step backwards for the beneficial uses to allow for higher temperatures in this reach when measures are available to remedy the problem.

- The rule (or temperature criterion), as it stands, meets the minimum requirements under the Clean Water Act for protecting the beneficial use of the Reach. In order to change that standard, IPC must meet requirements for site-specific criterion. For reasons outlined in our attached "Specific Comments" section, we believe IPC has fallen short of meeting those requirements.

Oregon would be best served by focusing its resources on the § 401 water quality certification process currently underway. Instead of moving backwards on a scientifically-established water quality standard that Oregon devoted years to developing, it would be more beneficial for IPC to return to the table and work collaboratively with the states and all of the stakeholders to come to a mutually beneficial agreement. For these reasons we request that the Commission deny IPC's petition for rulemaking.

If you have further concerns or questions, please contact Julie Carter at 503-238-0667. Thank you for your time and consideration of this important issue.

Sincerely,

Babtist P. Lumley
Executive Director

Enclosure

Cc: Marilyn Fonseca

-Comments on IPC site specific petition

Dale A. McCullough, Senior Scientist, CRITFC
Bob Heinith, Hydro Program Coordinator, CRITFC

Egg Incubation

> p. 21/263. The SDAM temperature criterion of 13 °C is based on generic assumptions, whereas the proposed SDAM temperature criterion of 14.5 °C is based on a substantial body of data specific to fall Chinook salmon spawning temperature requirements below Hells Canyon Dam.

IPC states that their proposal is based upon a substantial body of data specific to fall Chinook. This evidence is not nearly as conclusive as they would claim, and at the same time IPC chooses to ignore the vast body of literature on thermal effects to salmonids in general by disqualifying this evidence on the basis of not conforming to the criteria they have imposed.

> p. 21/263. Specifically, research suggests that initial spawning temperatures of 16.1 °C to 16.5 °C in the declining fall thermal regime of the river are favorable to salmon reproduction (Olson et al. 1955; Geist et al. 2006).

IPC relies on two studies that provide evidence that a temperature of 16.1°C is a suitable initial spawning temperature. Olson et al. (1955) captured a pair of Chinook on the spawning grounds on October 26 and artificially spawned them. These fish had been subjected to unknown temperatures prior to capture, but at least were subject to the natural environment. The drawback with this study is that only two adults were used to create the juveniles used in the test. Scientific literature on family-level variation (i.e., parental influence) in temperature sensitivity shows clearly that there are very large differences in response (Burt et al. 2010). To use the offspring from only one pair of adults can easily produce results not reflective of the whole population. Studies of thermal effects typically use juveniles that are not all from the same parents so that test results represent the population and not just the parentage effect. Results from Olson et al. (1955) should be rejected on these grounds.

IPC relies on the Geist et al. (2006) as evidence of fall Chinook thermal insensitivity up to a temperature of 16.5°C. Although this study also used a series of declining temperature regimes, the adults were held and spawned at 12°C prior to subjecting the embryos to test temperatures. This benign treatment eliminates much of the potential impact of temperature on pre-spawning adults and totally eliminates the effect of water temperature on gametes and earliest stages of egg development, which are known to be sensitive to thermal impact.

The Geist et al. study used well water for egg incubation. While this helps control for outbreak of disease, (which can include temperature related disease), it potentially eliminates or reduces a natural source of mortality. The Geist et al. study appears to be a well-designed study, but it doesn't resolve all uncertainties about what happens under natural conditions. For this reason, it is important to also rely on what is known generally from the wider body of scientific literature. IPC attempts to impose what it claims is a high level of scientific rigor to inclusion or exclusion of studies as evidence. Based on appropriate relevance to natural conditions and complete disclosure of potential effects, these studies could be excluded.

Coutant acknowledges the potential importance of the exclusion of thermal effects on the earliest stages of egg development:

> p. 256/263. There are indications in the literature that specific early embryonic stages of salmon are the most sensitive but that the effects of damages at that stage do not appear until later in development (as noted in Olson et al. 1970).

IPC suggests that temperatures >16°C may occur between October 10 and October 18 on average so that no more that 2% of the spawning distribution's egg deposition would ever be potentially affected (p. 69). But IPC also claims that there is very little relationship between water temperature and spawning time. This claim is contradicted by their own statement that no more than 2% of an annual year's egg deposition is ever affected by the warm waters that would be found before October 18.   Taken to its logical conclusion, this would mean that a large percentage of Chinook would not spawn until water temperatures have dropped below 16°C. So in reality, there is a significant relationship between spawning and water temperature.

On the other hand, Chinook in the colder Clearwater River spawn up to three weeks earlier. More than simply the date of spawning initiation, the date of spawning of 10, 20, or 30% of the entire run would be more indicative of potential effects to population viability. Data from Rondorf and Tiffan (1997) indicate that in several years, a small percentage of the total run spawned prior to November 1. Rather than being an indicator that late spawning is good for the population and maintaining the thermal shift to late in the year is good in bring this about, it is probably more likely that reversing the thermal shift would result in earlier spawning of the population in general and consequently, earlier emergence and outmigration. This scenario would likely increase juvenile survival as both the lower Snake and Columbia rivers would have greater flows and lower temperatures at these earlier times (Connor et al. 2003a).

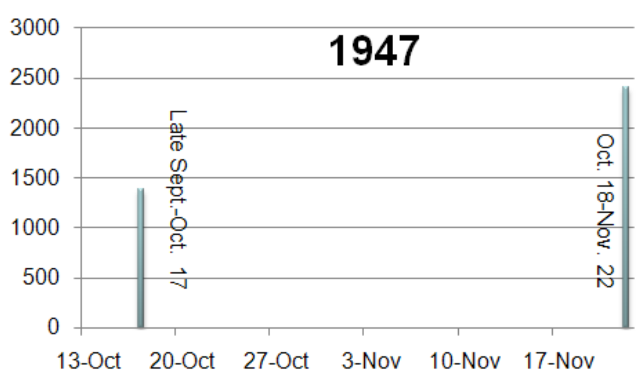
Spawn Timing

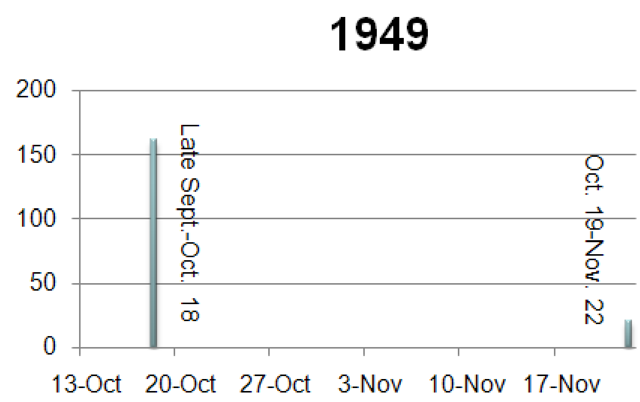
IPC claims that the present-day thermal regime imposed by the HCC (Hells Canyon Complex) with its 3-week thermal shift is actually a benefit to the Snake River fall Chinook. This claim is made by assuming that temperatures as high as 14.5°C to 16.5°C cause no harm. With this logic, if the current spawn time is the same as before creation of the HCC, the higher temperatures are not a detriment but a benefit, because the warmer water conditions will speed development of embryos, leading to earlier emergence and outmigration. However, IPC states that it has no explanation for why there has been a shift toward earlier outmigration timing over the past decade.

Yet, if there is no more than 2% of the total spawning population spawning between October 10 and 18, these fish are surely not making use of the supposedly good early incubation temperatures for some reason. Also, if there is a relatively low percentage of fish spawning in the window of warmed waters near the October 23 threshold, how would this minimal effect then be attributed to a large beneficial effect on the entire spawning population leading to early emigration? It is just as conceivable that spawning was earlier in the Snake River and that with extra days for development afforded by achieving optimal spawning temperatures earlier, juveniles would be able to emerge earlier and outmigrate earlier.

> p. 32/263. 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.

Although IPC states that Zimmer (1950) reported a spawning initiation of "early October," his exact statement is "It appears from the information available 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."





Also, from Zimmer's (1950) data, one can calculate that the distribution of redds for 1947 and 1949 shows a high percentage of the total redd count is present by the observation dates October 17 and October 18, respectively (see figures above). Rather than being a mere indication of spawning initiation by a certain date, these two years had a significant proportion of the run deposited prior to October 23 rather than run out into late November.

Gamete Viability

> p. 58/263. A through [sic] review of the literature demonstrates that studies often cited to suggest reduced gamete viability as a result of prolonged exposure to warmer temperatures should not be cited as supporting literature. The studies typically were not designed to address the question. One study that could be cited as supporting evidence (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.

IPC discounts many studies (peer-reviewed or not) that describe the effects of temperature on gametes merely because they couldn't find any studies on Chinook under a declining thermal regime. Rigid adherence to a "scientific" standard meant only to exclude the bulk of literature from examination is not a conservative management philosophy.

Coutant suggests a way that constant temperature data can be used when there is no declining temperature data available:

> p. 256/263. In an ideal situation, one could use results of constant-temperature tests incrementally to estimate thresholds and then apply a validation step testing incubation success using the actual temperature change.

IPC notes that daily temperature fluctuations in the Columbia and Snake Rivers are very minimal:

> p. 245/263. 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.

But it was noted that Chinook entering the Hells Canyon Reach in late August to early September can experience high, adverse temperatures.

> p. 98/263. The **earliest** fish entering the lower Hells Canyon Reach of the Snake River could conceivably experience water temperatures ≥19.0°C for about 32 days (with a maximum mean temperature of about 22.0°C).

IPC declined to use a constant temperature test on Chinook because it was an extended (40-d) exposure to elevated water temperatures. And despite its admission that water temperatures are relatively stable in the Snake River on a daily basis and over lengthy time periods (e.g., 32 days), it also discounted the influence of the HCC thermal shift in exacerbating the thermal experience of adults in the prespawning condition.

The Coutant review failed to recognize that a declining temperature regime with a 0.2°C daily decrement over a 5-day period was essentially a constant temperature analogue:

> p. 254/263. McCullough presents a convoluted argument on the top of page 7 that I could not follow, including that a temperature reduction of 0.2°C per day is a “relatively constant temperature over the initial 5 days.”

The reasoning behind this is that a 1°C total decline in temperature over a 5-day period (i.e., 0.2°C/day) is small enough that constant temperature experiments at a mean temperature equal to the mean for the period of decline will be useful. Granted, a 5-day exposure to a constant temperature is different from a 30-day exposure in overall magnitude of effect, but it is still useful as guidance. Most “constant” temperature experiments are not truly absolutely constant, but are reported to be some mean temperature with bounds of, for example, ± 0.5°C. It probably makes little difference whether the fluctuation over the 5-day period is a continuous decline or a random fluctuation over the same interval.

In growth rate studies, Imholt et al. (2010) found that constant temperature growth of Atlantic salmon juveniles was only slightly different from growth rates under naturally varying temperatures having the same means (where temperature variation was >7°C). While constant temperature growth data could be applied in an incremental fashion to estimate growth under a fluctuating temperature regime, the similarity between growth under constant and fluctuating regimes made it suitable to simply apply the constant temperature experience.

Although all answers may not be provided by studies conducted on Snake River fall Chinook under declining temperature regimes (a precondition for consideration of scientific literature set by IPC), significant insights have been provided for Atlantic salmon (King et al. 2003, King et al. 2007). King et al. (2007) found that Atlantic salmon held at a water temperature of 22°C for a period of 6 weeks during the austral summer and autumn had a fertility and survival of <65% and 30%, respectively, compared with the fertility and survival of adults held at 14°C, which were 85 and 70%, respectively. Their data confirmed that high temperature spikes can affect reproductive success as much as prolonged exposures. Also, significant endocrine effects were detected in as little as 3 days after exposure to 22°C. Adults held at 22°C had reduced oocyte diameters compared with those of fish held at 14 and 18°C and an increased incidence of chorion damage (King et al. 2003). Chinook in the Snake River encounter temperatures of 22°C frequently.

It is reasonable to give weight to these studies on Atlantic salmon because Atlantic salmon juveniles have an incipient lethal temperature of 27.8°C (Elliott 1991). Most likely Atlantic salmon adults have a somewhat lower UILT value. By contrast, the UILT of Chinook juveniles is 25°C (McCullough 1999). Coutant (1970) identified the incipient lethal temperature for Chinook jacks as 22°C with prior acclimation to 19°C (estimated from ambient river temperatures). Consequently, Atlantic salmon appear to be more resistant to lethal effects of temperature than Chinook, yet they have a sensitivity in the pre-spawning phase that is able to seriously impair population viability.

Pre-Spawning Mortality

> p. 98/263. The **earliest** fish entering the lower Hells Canyon Reach of the Snake River could conceivably experience water temperatures ≥19.0°C for about 32 days (with a maximum mean temperature of about 22.0°C).

IPC states that the exposure of Chinook to temperatures between 19° and 22°C could be a maximum of about 32 days below the lower Hells Canyon Reach. The lower Hells Canyon Reach is that portion of the Snake River below HCD (Hells Canyon Dam) that is downstream of the Salmon River, a cooling influence. Consequently, this reach should be more benign than the upper Hells Canyon Reach. Connor et al. (2003b) show clearly that the upper Snake (397—303 river kilometers [rkm]) temperatures are considerable higher than the lower Snake temperatures (rkm 303—224) in September and October. [Note: HCD is at rk398.] Further, IPC states:

> p. 81/263. It is reasonable to assume that if adult fall Chinook salmon remained for long periods of time where water temperatures remain ≥19.0°C, then significant pre-spawn mortality could likely occur.

This is the reason for concern about pre-spawning fish.

IPC then proceeds to list numerous streams in the upper Hells Canyon Reach, such as Wolf Creek, Getta Creek, Tryon Creek, Sluice Creek, etc. that it proposes, with no data, would provide thermal cold refuges, either directly, or by drainage into the Snake River. There is no information provided on whether these streams even run during September or contribute any substantial subsurface drainage. The lack of information on the extent of actual thermal refuge is obvious in IPC's statement below:

p. 99/263. However, it is unknown whether adult fall Chinook salmon tend to immediately move into the upper Hells Canyon Reach, or the extent to which they may use cool water refuges mentioned above.

p. 78/263. While the presence or amount of potential thermal refugia is unknown throughout the Snake River (either downstream or upstream of Lower Granite Dam)….

IPC provides no information by which to infer that any of the streams it lists actually do anything to provide cold refugia for Chinook.

IPC bases its entire claim of no significant pre-spawning mortality on fish to redd ratios:

p. 33/263. 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).

p. 58/263. 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.

p. 81/263. Additionally, fish to redd ratios for the Snake River upstream of Lower Granite Dam provide further evidence that pre-spawn mortality is not a significant problem.

p. 139/263. However, fish-to-redd ratios documented in the Snake River do not suggest excessive pre-spawn mortality of fall Chinook salmon.

p. 240/263. 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).

Unless conditions are the same from year to year, there is no reason to assume that actual variations in pre-spawning mortality could not be obscured in the other environmental or biological variation producing variation in fish to redd ratios.

p. 228/263. 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.

Again, IPC tends to disregard scientifically valid reports and studies merely because they have not been peer reviewed, or involve a related species, or did not employ a declining temperature regime. However, IPC made an exception for the Olson (1955) study, which they rely on to support their contention that 16.1°C is a suitable initial incubation temperature. This study has no acknowledgements to peer reviewers.

> p. 243/263. 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.

IPC contests the Olson et al. (1970) study results for October 30. In this study, the egg batch labeled Series 3 starts at 58.6°F (14.8°C) and the uptick just after the start is to about 59.5°F (15.3°C). This small increment is about 0.6°C increase and lasted less than 1 day. Ironically, the temperature was far from approaching the 16.5°C that IPC claims is a 100% safe level. So, their protest that 1 day spent at 15.4°C invalidates this test rings false by their standards.

IPC purports to be able to know that an increase in mortality from 3.6% to 11.0% (representing a change from an initial incubation temperature of 13.6°C for Series 2 to 14.7°C in Series 3) is merely an artifact of no replication, but the increase from 11.0% to 28.1% (representing a change in initial incubation temperature from 14.7°C in Series 3 to 15.9°C in Series 4) is a clear demonstration of thermal effect. No one is arguing that replication is not important, but in the absence of better data, precautionary management would consider potential effects.

Ironically, IPC criticizes the Olson et al. (1970) study because of the upward "tick" "by as much as 0.5°C (see p. 243/263). Series 3 in the October 30 test showed that at an initial incubation temperature of 14.7°C (with a 1-day uptick of 0.5°C), IPC would argue that the effective starting temperature was 15.2°C. In the Snake River, IPC takes the typical temperature decline rate to be 0.2°/day. At an initial water temperature of 15.2°C, declining at 0.2°C/day, the 7DADM temperature would be 14.6°C. The 14.6°C 7DADM temperature in almost exactly the IPC proposal, yet the rear-weighted averaging procedure used, where temperatures from October 23-October 29 are averaged to produce a 7DADM, means that an initial incubation temperature of 15.2°C is allowed. This is the temperature that IPC was concerned about in creating the increase in mortality.

> p. 243/263. 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) 10 and 12.4% (at 15.6 °C).

IPC's argument that a change in mortality from 7.3% to 17.0% is not a doubling over a base case is erroneous. It is totally valid to express an increase in rates as a doubling. It is also possible to discuss an increase in absolute percentages, or also to describe a percentage increase. Spurious quibbling with statistics is not relevant to a discussion on the important issues.

The IPC claim that there is no demonstrable pre-spawning mortality or disease is wholly linked to fish to redd ratios as evidence. IPC mocks the CRITFC discussion of fish to redd ratios as a way to discredit the idea that prespawning mortality from thermal effects could be serious. However, its own admission of a range of prespawning mortality from 0 to 44% indicates that it could be a significant impact to the population.

> p. 240/263. 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).

> p. 240/263. 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.

> p. 240/263. 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).

> p. 240/263. 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.

> p. 240/263. More importantly, deepwater redd searches are not conducted in the Clearwater River, where the potential exists for deepwater spawning to occur.

> p. 33/263. 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).

It is difficult to know what IPC means when it uses fish to redd ratios as evidence that prespawning mortalities are not high or excessive. Is this meant to imply that the operation of the HCC could be responsible for annual shifts in prespawning mortality from 0 to 44% and it would not be considered excessive? Or is this level of variation supposed to be considered normal, so if HCC had any responsibility for the mortality rate, it would either be relatively so small as to be negligible, or it could be too difficult to prove what was responsible—HCC or environmental variation? The point is that under the annual conditions where water temperatures are above average, the effects of HCC's thermal shift in addition to natural variation could contribute to increasing prespawning mortality.

IPC attempts to discredit model building as playing "what if" games that have no scientific value. Yet IPC advances its own assumptions, e.g., the idea that fallback rates are fully accounted for and not estimated, that the female/male ratios of fish allowed to spawn above Lower Granite are the same as in the population taken into the hatchery, that the percentage of fish spawning in the Clearwater is known and is constant, that the percentage of redds observed is constant, etc. Yet IPC discounts the utility of exploring the myriad of reasons how apparent fish to redd ratios could be obtained.

A more in-depth examination of fish to redd ratios was conducted by CRITFC (see attached spreadsheet) by varying the assumptions of (variable A) % prespawning mortality, (variable B) female/male ratio, (variable C) % of females that actually spawn, and (variable D) % of redds observed. Prespawning mortalities were varied from 10 to 50%. If variables B, C, and D, were 1/1, 100%, and 100%, respectively, the fish to redd ratios varied from 2.2 to 4.0. This range corresponds to what was observed in the Snake River. A range this large may have a significant component attributable to natural environmental variation, but during extreme temperature events, the added impact of HCC could provide significant impacts. This analysis also shows that by varying variable B, C, and D, the same fish to redd ratios can be produced while variable A (% prespawning mortality) varies from 10 to 50%. The point of having alternate hypotheses, another common scientific practice, is to allow testing of our concepts about the presence of prespawning mortality.

IPC provided no independent evidence to show that prespawning mortality was not occurring or that other factors could not logically be responsible for observed variation in fish to redd ratios. There are other variables that could also be tested. For example, we assumed a constant number of fish entering the Snake River above Lower Granite Dam. If there were the same actual number of fish passing above the dam, but due to unaccounted for fallback, we observed 25% more fish, the fish to redd ratios would increase by 25%. An error in the other direction would result in a commensurate reduction in the fish to redd ratios. There are many factors responsible for fish to redd ratio values. IPC's interpretation of fish to redd ratios to eliminate all concern for prespawning mortality or disease susceptibility is unwarranted. IPC favors testable hypotheses, but offers no tests. In addition, it is unwilling to acknowledge that temperatures such as experienced by fish in the Snake River migration corridor and also continued in the reach below HCD in September prespawning period could be exacerbated by the thermal shift produced by the HCD.

Female to observed redd ratios are no more reliable with which to conclude that there is no problem with pre-spawning mortality in the Snake River below HCD. Prespawning mortality can vary from 10% to 50%, but female to observed redd counts can vary from 2.1 to 2.2 by various adjustments in only % of females that are successful in finding mates and creating redds and % of redds observed. There would be added variation and uncertainty in the calculations if fallback and counting of adults migrating are in error, or if our estimates of female/male ratios are not accurate. These ratios may alert a manager to extreme problems, but variations between 10 and 50% mortality, which are nonetheless biologically significant and could be relatable to water quality exceedances, cannot be reliably detected using fish/redd or female/redd. Fish/redd ratios are potentially more unusable than female/redd ratios because female mortality rates are often greater under a given thermal stress than for males (Keefer et al. 2010).

IPC ignores a large body of peer reviewed literature on the effects of pre-spawning mortality caused by thermal effects. In a recent publication, Burt et al. (2010) references 41 peer-reviewed publications on the effects of water temperature on pre-spawning adult salmonids.

Thermal Shift

CRITFC's previous technical comments on the thermal shift can be found in Appendix XX and should be considered in the context of this petition.

IPC contracted a review of its work by Dr. Charles Coutant. In the excerpt below, Dr. Coutant misunderstands the full nature of the Oregon temperature standards. In particular, there is the requirement for the annual thermal pattern to mimic the natural pattern. Consequently, the temperatures existing prior to the October 23-29 window are relevant.

> p. 253/263. Pre-spawn mortality (page 3-5, 7): The issue of pre-spawning mortality or energetic stress for salmon holding below HCC at temperatures above 19°C is not directly relevant to the proposal. The proposal seeks a change in the temperature standard for one week in October (23-29) from 13°C to 14.5°C. Other times are covered by other standards: 20°C until October 23 and 13°C after October 23 (currently). These discussions of prespawning conditions by both Groves et al. and McCullough would pertain to the sufficiency of the 20°C standard in view of migration dynamics and holding patterns by migrants. But that is a different issue for a different time.

What is ignored by this approach is that water temperatures of 20°C up to October 22, followed by declining temperatures with a mean of 13°C between October 23 and October 29 are not acceptable. Temperatures must follow a natural seasonal pattern, which means that the initiation and rate of the decline must mimic the natural pattern.

> p. 241/263. 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.

If IPC wished to be conservative with the salmon resource, by its own admission, it would use a forward weighting to the water temperatures. CRITFC has recommended this method from the start of the FERC process. What could the biological relevance be to the fish what the mean temperature was during the week after the spawning threshold is reached? EPA (2009) also contests the method used by Oregon in calculating the 7DADM.[1]

The TMDL process neglected to include the cumulative thermal impacts of all the IPD upstream hydropower projects, a major shortfall of the TMDL.

> p. 63/263. IPC concurred that natural condition temperatures for the Snake River prior to Euro- American settlement cannot be precisely determined. However, during the SR-HC TMDL public comment period, IPC asserted that the SR-HC TMDL temperature analysis improperly ignored upstream anthropogenic effects on water temperature (IPC 2002). In its revised § 401 certification application, IPC presented an alternate analysis to estimate site potential of the Snake River. IPC developed estimated historic (EHist) temperature to illustrate that, while quantifying all upstream anthropogenic effects on temperature may not be possible, estimating additional anthropogenic effects beyond what were captured in the SR-HC TMDL is possible.

IPC has a responsibility for its thermal impacts to the inflow temperatures to Brownlee Reservoir. Consequently, IPC should have responsibility to make temperatures better than those that existed just prior to the HCC. Also, the current IPC claim that they only need to compare current conditions with those present just before the HCC is not a conservative one. This allows for incremental degradation. IPC does not maintain conditions such as they were prior to HCC, because the thermal shift is not addressed in their petition or in their management decisions.

Adult migration

IPC states:

> p. 32/263. Adult fall Chinook salmon experience a similar period of exposure to temperatures elevated above 20ºC 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 1950s, prior to construction of the HCC or the lower Snake River reservoirs.

This theory proposed by IPC is based on information that may not be in proper context. The water temperatures that occurred in the mid-1950s at Central Ferry were taken strictly for the years 1955-1958. The 1958 (the year that Brownlee Dam was completed) summer season had some of the highest temperatures recorded in the Snake River. Consequently, to say that

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"EPA believes the October 23 7DADM criteria should be based the October 20 though October 26 period to account for the small diurnal temperature variation in the Snake River." From EPA, April 9, 2009 letter to ODEQ and IDEQ.

current temperatures are lower than historical temperatures (i.e., prior to the HCC and specifically by contrast with Central Ferry in the mid-1950s) is not making a significant claim.

Future climate change will most likely make adult migration conditions even more rigorous than they currently are. Operation of the HCC so that cold water releases are provided can provide a significant thermal benefit to the Snake River downstream of HCD (Hells Canyon Dam) as demonstrated by McCulloch et al. (2009).

The mid-1950s were also a period in which high incidence of warm water disease and pre-spawning mortality of Columbia River salmon were experienced (see McCullough 1999).

Although August air temperatures in Lewiston and Kennewick were high in the 1950s, air temperatures have been higher in recent years and have been on a significantly increasing trend from 1948 to 2000 (Peery et al. 2003). Air temperatures are directly linked with water temperatures, and an increasing trend in air temperatures portends increasing water temperatures.

Disease Susceptibility

> p. 58/263. Disease susceptibility – Similar to the findings discussed under pre-spawn mortality, adults held in confined hatchery environments under prolonged periods of elevated temperature appear to have a greater susceptibility to disease or fungal infections. How this pertains to free-ranging adults is uncertain. However as discussed above, fish-to-redd ratios do not suggest a high level of pre-spawn mortality below Hells Canyon Dam.
>
> p. 97/263. There is no evidence of major disease outbreaks occurring in the natural population of returning adult fall Chinook salmon that presently migrate upstream past the four lower Snake River dams. This is supported by the low fish to redd ratios observed in the Snake River Basin (discussed earlier), which do not indicate that problems due to disease or pre-spawn mortality in general in the natural population upstream of Lower Granite Dam is of concern.
>
> p. 140/263. Disease susceptibility – Similar to the findings discussed under pre-spawn mortality, adults held in confined hatchery environments under prolonged periods of elevated temperature appear to have a greater susceptibility to disease or fungal infections. How this pertains to free-ranging adults is uncertain. However as discussed above, fish to redd ratios do not suggest a high level of pre-spawn mortality below Hells Canyon Dam.

IPC argues that Snake River fall Chinook will not have higher incidences of disease due to thermal impacts. To support their arguments, IPC relies on fish to redd ratios. As explained above, this index is interesting, but not highly specific in explaining the cause for its variation. Relative to fish to redd ratios, IPC states:

> p. 230/263. 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.

CRITFC has no intent to provide a false appearance that disease is prevalent. What is likely, however, is that disease is of periodic significance when water temperatures are abnormally high. This may not occur every year, but can be periodically important. IPC provides no direct evidence that this is not the case. By allowing temperatures to remain at high levels late into the fall period and extending the exposure to warm water, IPC increases the risk that warmwater diseases will result in mortalities prior to spawning is achieved.

It has been documented in past studies of the Columbia River that incidence of disease has been linked to high water temperatures, not unlike those found currently. See a quote from McCullough (1999):

> Surveys of infection frequency of sockeye and chinook in the Snake River in July and early August of 1955-1957 revealed 28-75% of fish infected when water temperature was >21.1°C (Ordal and Pacha 1963, as cited by Pacha and Ordal 1970). During this same period the disease was widespread in the Yakima and Okanogan Rivers. In 1958 high percentages of salmon were infected based on samples taken at several mainstem Columbia River dams from Rock Island to Bonneville, as well as on the Yakima, Wenatchee, and Okanogan River. In 1958 water temperatures in the Okanogan were so warm that the run was vastly damaged by columnaris. Thousands of adults left the Okanogan to seek the cooler temperatures of a tributary (the Similkameen River), only to die there from columnaris infection (Pacha and Ordal 1970). Over the years 1955 to 1959 the sockeye run to Redfish Lake, Idaho declined by an order of magnitude, coincident with a large increase in Columbia River water temperatures. In 1955 and 1956 the frequency of infected sockeye was 34 and 50%, respectively, in samples taken at Clarkston, Washington (Pacha 1961). Even though these infection frequencies were high, it is likely that they became higher as the fish migrated toward their spawning grounds. Pacha (1961) reported that Anacker (1956) sequentially sampled the sockeye run into the Okanogan River, finding that columnaris frequency rose from 6.3% in August at Rock Island to 23.8% and then 38% in 9 and 15 d further along in the migration. At the termination of the run the disease incidence was 55% (Pacha and Ordal 1970).

IPC provided no direct information on the condition of fall Chinook subject to pre-spawning mortalities even though it stated that an average mortality load of 23% was probably normal in the population. This would presumably be associated with a moderate temperature year. Others (e.g., Mann et al. 2010) have documented incidence of disease in Oregon Chinook associated with mortalities and have attributed it to temperature extremes:

> Results from disease screening of adults collected during spawning surveys revealed that all of the fish examined had one or more of the following conditions that were, at least in part, responsible for death: swelling or hemorrhaging of internal organs, external evidence of trauma, and histological evidence of severe pathogenic infection. Severe infections of five pathogens (Ceratomyxa shasta, Nanophyetus salminocola, Apophallus sp., Echinochasmus milvi, and Parvicapsula minbicornis) were more frequent in adults that died prior to spawning compared to adults that successfully spawned. Nearly two-thirds of the fish that died prior to spawning were severely infected with one or more of these parasites. All adults were infected. Results of this study, in combination with previous Willamette River Chinook salmon

studies, suggest prespawn mortality is caused by an interaction of environmental factors (particularly water temperature), fish condition and disease load, and energetic status.

Bioenergetic Exhaustion

IPC placed in bold letters an important caveat that they claim should be used in evaluation of Brown and Geist (2002):

> p. 237/263. 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.

By choosing to take a narrow view of bioenergetic impacts, IPC overlooks the main thrust of these arguments which is that maintaining water temperatures at high levels rather than having a natural thermal pattern in the fall period subject Chinook and other salmonids in the river to increases bioenergetic stress.

Mann et al. (2009) summarize significant points relative to bioenergetic stress for Chinook:

> Between river entry and death after spawning, Chinook salmon and other semelparous salmonids experience an almost complete exhaustion of lipids and considerable loss of protein (Gihousen 1980; Brett 1995; Jonsson et al. 1997; Hendry and Berg 1999). These physiological changes reflect the energetic demands of migration, maturation, competition for mates, redd construction, and spawning. The relatively high initial muscle lipid content in SFSR Chinook salmon (~22% for males and females, see Chapter 1) is at the high end of the observed range for Chinook salmon. The high initial fat content reflects the long migration distance for SFSR salmon (~1,150 rkm) and is consistent with estimates for long-distance migrants from other river systems (Iverson 1972; Brett 1995).

Combining results across the entire duration of the study, it appears that monitoring lipid levels and energy condition of fish entering migration corridors can be a useful tool to determine how successful a year class may be. Furthermore, it is likely that successful management of adults in the Hydrosystem and on the spawning grounds can be improved by gathering reliable information on the true level of an energetic/lipid threshold, the mean condition of stocks as they enter the river and the relative costs of migrating through the Hydrosystem in years with different environmental and operational conditions. This is particularly important in the face of changing ocean conditions, and the warming climate expected for the Pacific Northwest (Eaton and Scheller 1996; Mote et al. 2003).

Changing ocean and Pacific Northwest regional climate will undoubtedly affect the migration corridor. In particular, flow and temperature conditions will likely impact migration costs. Forecasts for decreasing total discharge may lower energetic demands, because of lower current velocities encountered. However, this may be offset by the forecast of higher temperatures, which would directly increase energetic demand by increasing metabolic activity. Increasing migration corridor temperatures may also add indirect costs via slowed or failed migration as adults seek cold-water refugia, as documented for Columbia and Snake River Chinook and steelhead runs (Goniea et al. 2006; Mann 2007; Keefer et al. *in press*) and both Columbia and Snake River sockeye salmon (Hyatt et al. 2003; Keefer et al. 2008b), runs that co-migrate with SFSR Chinook salmon. For both direct and indirect effects, monitoring population-level energy condition is important for understanding fitness responses to climate change, ocean

If the common condition of Chinook is to complete migration and spawning with near complete exhaustion of body lipids and depletion of protein, they certainly do not benefit from water temperature violations and thermal shifts that prolong exposure of prespawning adults to thermal stress that have to endure elevated mainstem temperatures and migration delays. Columbia River salmon have adapted too many of the increasing temperature trends that have been present over the past decades (Hodgson and Quinn 2002), but here is a limit to their continued ability to adapt to these stresses.

Synergistic Effects

Increases in temperature also subject adult salmon and steelhead to decreases in dissolved oxygen. Further, temperature increases act synergistically with other abiotic factors such as pH and metal compounds to present additional challenges to fish respiration systems (Jensen et al. 1993 in Karr et al. 1998). Elevated water temperature increase the uptake of toxics in fish tissue (Materna 2001).

Swim Speed

Goniea et al. (2006) showed that mean and median migration rates through the lower Columbia River slowed significantly when temperatures were above 20 degrees C., while High et al (2006) noted that steelhead destined for upper basin spawning areas under historical temperature regimes now seek and hold in cool water tributaries of the lower Columbia.

Other Water Quality Considerations

Although Oregon has to consider its summertime rearing standard, the spawning standard, and the Natural Temperature Pattern Standard, EPA must also consider the water quality violations caused by the project downstream as the Snake River enters Washington's border. Washington's criterion specifies that no temperature increases, at any time, exceed 0.3°C due to any single source or 1.1°C from all sources combined. This criterion applies at the Washington border downstream of Hells Canyon dam. EPA's current information indicates that the Project impact in the fall exceeds this standard.

Impact of the HCC on the Snake River

Based on a simple comparison between temperatures that provide inflow and outflow to the Project (i.e., the observed temperature impact), the Project causes the Snake River to be 3.4°C warmer in late October (October 23 through October 29). In fact, data indicate that the 3.4°C observed impact of the Project is not related to inflowing summer temperatures or annual flow. That is, the 3.4°C average observed Project impact is very consistent year-to-year and does not vary depending on summer inflow temperature or annual flow. That said, data in do indicate that during high flow years and during years with cooler summer inflow temperatures the inflow temperatures to the Project, and resultant outflow temperatures, are cooler. But importantly, the 3.4°C average impact of the Project does not change. For example, during the high flow years (1996-1999, 2006), the Project inflow and outflow temperature is lower than during low flow years (2000-2005), but the Project observed impact remains about the same. In fact, during the high flow years, the Project impact is slightly greater (3.6°C for high flow years versus 3.4°C for low flow years). These data clearly indicate that the Project is solely responsible for the 3.4°C increase in Snake River temperatures observed in late October.

Table 1
Estimated HCC Impact Based on a Comparison between Upstream and Downstream Temperatures

All values are 7DADM for 7 days leading to October 29

Average for:			
Low Flow Years	12.3	15.7	3.4
High Flow Years	10.8	14.4	3.6

Climate Change

Studies using projected climate change model results indicate that viability of salmon populations in the future may be significantly reduced under increased water temperature regimes in the Columbia Basin (Crozier and Zabel 2006; Crozier et al. 2007; Crozier et al. 2008; WGA 2008; ISAB 2007; Mantua et al. 1997, 2001, 2009, 2010; Miles et al. 2000; Mote et al. 2003; Neitzel et al. 1991; OGWC 2008). Impacts of climate change on salmon in the nearby Fraser River, where the added impacts of hydro facilities are not even a significant concern, are illustrated in literature such as Martins et al. (2010), McDaniel et al. (2010), Morrison et al. (2002), Farrell et al. 2008), and Hague et al. (2010). In other salmonid habitats, the likely effects of climate change have been detailed in literature such as Jonsson and Jonsson (2009), Clews et al. (2010). Granting Idaho Power a SSC now will make the Snake River more susceptible to future climate change impacts on temperatures. A restoration to natural thermal patterns would provide greater stability in the system to counter the effects of anthropogenic climatic warming. Idaho Power needs to reduce temperatures now in preparation for increases in water temperature that global climate models and downscaled models predict will come sooner rather than later (Hamlet 2010, pers comm.).

Temperature Control

Some progress has been made in reducing temperature by release of cool water from dams with high head reservoirs . For example, temperature control structures have been implemented at Dworshak Dam in the North Fork Clearwater River to cool the lower Snake mainstem as a result of tribal studies (Karr et al. 1998) and at Cougar Dam in the Willamette River. A similar capability exists to release cold water held in Brownlee Reservoir to cool the Snake River from below HCD to Lewiston. CRITFC and its member tribes have advocated for such temperature control structures in the Snake River to augment the somewhat inadequate capacity of Dworshak Reservoir to safeguard the Lower Snake River. The importance of providing a source of cold water from a reservoir to the downstream Chinook resource is illustrated by Yates et al. (2008).

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Males and females	** Pre-spawning mortality	Spawning Pop.	**Female /male	Number of females alive abv LGD	Number of females assuming 1/1	** % of females spawned	actual redds	** % of redds observed	Number of redds observed	Gross fish/actual redds	Gross fish/redds obs.	Est. females/ obs. Redds	Gross females/ obs. redds assuming 1/1	Females assumed	Females/ actual redds	Females/ obs. Redds
200	10%	180	1	90.0	90.0	100%	90	100%	90	2.2	**2.2**	1.0	1.0	100.0	1.1	1.1
200	20%	160	1	80.0	80.0	100%	80	100%	80	2.5	**2.5**	1.0	1.0	100.0	1.3	1.3
200	25%	150	1	75.0	75.0	100%	75	100%	75	2.7	**2.7**	1.0	1.0	100.0	1.3	1.3
200	50%	100	1	50.0	50.0	100%	50	100%	50	4.0	**4.0**	1.0	1.0	100.0	2.0	2.0
200	10%	180	0.8	80.0	90.0	100%	80.0	100%	80	2.5	**2.5**	1.0	1.1	88.9	1.1	1.1
200	20%	160	0.8	71.1	80.0	100%	71.1	100%	71	2.8	**2.8**	1.0	1.1	88.9	1.3	1.3
200	25%	150	0.8	66.7	75.0	100%	66.7	100%	67	3.0	**3.0**	1.0	1.1	88.9	1.3	1.3
200	50%	100	0.8	44.4	50.0	100%	44.4	100%	44	4.5	**4.5**	1.0	1.1	88.9	2.0	2.0
200	10%	180	1	90.0	90.0	90%	81	100%	81	2.5	**2.5**	1.1	1.1	100.0	1.2	1.2
200	20%	160	1	80.0	80.0	90%	72	100%	72	2.8	**2.8**	1.1	1.1	100.0	1.4	1.4
200	25%	150	1	75.0	75.0	90%	67.5	100%	68	3.0	**3.0**	1.1	1.1	100.0	1.5	1.5
200	50%	100	1	50.0	50.0	90%	45	100%	45	4.4	**4.4**	1.1	1.1	100.0	2.2	2.2
200	10%	180	0.8	80.0	90.0	80%	64.0	100%	64	3.1	**3.1**	1.3	1.4	88.9	1.4	1.4
200	20%	160	0.8	71.1	80.0	80%	56.9	100%	57	3.5	**3.5**	1.3	1.4	88.9	1.6	1.6
200	25%	150	0.8	66.7	75.0	80%	53.3	100%	53	3.8	**3.8**	1.3	1.4	88.9	1.7	1.7
200	50%	100	0.8	44.4	50.0	80%	35.6	100%	36	5.6	**5.6**	1.3	1.4	88.9	2.5	2.5
200	10%	180	0.8	80.0	90.0	80%	64.0	80%	51	3.1	**3.9**	1.6	1.8	88.9	1.4	1.7
200	20%	160	0.8	71.1	80.0	80%	56.9	80%	46	3.5	**4.4**	1.6	1.8	88.9	1.6	2.0
200	25%	150	0.8	66.7	75.0	80%	53.3	80%	43	3.8	**4.7**	1.6	1.8	88.9	1.7	2.1
200	50%	100	0.8	44.4	50.0	80%	35.6	80%	28	5.6	**7.0**	1.6	1.8	88.9	2.5	3.1
200	20%	160	1.4	93.3	80.0	80%	74.7	90%	67	2.7	**3.0**	1.4	1.2	116.7	1.6	1.7
200	25%	150	1.4	87.5	75.0	80%	70.0	90%	63	2.9	**3.2**	1.4	1.2	116.7	1.7	1.9
200	50%	100	1.4	58.3	50.0	80%	46.7	90%	42	4.3	**4.8**	1.4	1.2	116.7	2.5	2.8
200	10%	180	0.8	80.0	90.0	100%	80.0	100%	80	2.5	**2.5**	1.0	1.1	88.9	1.1	1.1
200	20%	160	0.8	71.1	80.0	100%	71.1	100%	71	2.8	**2.8**	1.0	1.1	88.9	1.3	1.3
200	25%	150	0.8	66.7	75.0	100%	66.7	100%	67	3.0	**3.0**	1.0	1.1	88.9	1.3	1.3
200	50%	100	0.8	44.4	50.0	100%	44.4	100%	44	4.5	**4.5**	1.0	1.1	88.9	2.0	2.0
200	10%	180	1	90.0	90.0	100%	90	80%	72	2.2	**2.8**	1.3	1.3	100.0	1.1	1.4
200	20%	160	1	80.0	80.0	100%	80	80%	64	2.5	**3.1**	1.3	1.3	100.0	1.3	1.6
200	25%	150	1	75.0	75.0	100%	75	80%	60	2.7	**3.3**	1.3	1.3	100.0	1.3	1.7
200	50%	100	1	50.0	50.0	100%	50	80%	40	4.0	**5.0**	1.3	1.3	100.0	2.0	2.5
200	10%	180	1	90.0	90.0	90%	81	80%	65	2.5	**3.1**	1.4	1.4	100.0	1.2	1.5
200	20%	160	1	80.0	80.0	90%	72	80%	58	2.8	**3.5**	1.4	1.4	100.0	1.4	1.7
200	25%	150	1	75.0	75.0	90%	67.5	80%	54	3.0	**3.7**	1.4	1.4	100.0	1.5	1.9
200	50%	100	1	50.0	50.0	90%	45	80%	36	4.4	**5.6**	1.4	1.4	100.0	2.2	2.8
200	10%	180	1	90.0	90.0	100%	90	60%	54	2.2	**3.7**	1.7	1.7	100.0	1.1	1.9
200	20%	160	1	80.0	80.0	100%	80	60%	48	2.5	**4.2**	1.7	1.7	100.0	1.3	2.1
200	25%	150	1	75.0	75.0	100%	75	60%	45	2.7	**4.4**	1.7	1.7	100.0	1.3	2.2
200	50%	100	1	50.0	50.0	100%	50	60%	30	4.0	**6.7**	1.7	1.7	100.0	2.0	3.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]