COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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June 24, 2011

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, Idaho 83706-1255

RE: Negotiated Rulemaking on the Snake River, Site Specific Criteria for Water Temperature

Dear Ms. Wilson:

Thank you for accepting our comments on this proposed rulemaking to institute site specific water quality criteria for temperature below the Hells Canyon Dam. The Columbia River Inter-Tribal Fish Commission (CRITFC), together with its member tribes, have been involved in the federal and state processes connected to this application for over a decade. As we informed the Oregon Department of Environmental Quality (ODEQ)[1], and as we discuss in the attached memo, this rulemaking is inappropriate, untimely and without merit. CRITFC does not support the proposed rulemaking.

The CRITFC tribes have lived and fished in the Columbia/Snake River basin since time immemorial. The aquatic resources of the Snake River contributed to the basin its economy, culture and sustenance for that time. It is well understood that with the construction of the Snake River dams, several populations of salmonids were forever extirpated from the basin, and other fish were severely affected by shifts in the Snake River's thermal regime and water quality balance. The present result is a seriously degraded and broken water system in need of repair.

The tribes place great emphasis on restoring habitat and improving productivity of the fish resource all over the basin. Part of this restoration has occurred because of the Nez Perce Tribe's immensely successful supplementation program for Snake River fall chinook. But for this program, the chinook would not be returning to the river in the numbers that they are today. Habitat conditions also play a major part in the recovery of

[1] Since the proposal before the Idaho DEQ is substantially the same as the proposal before Oregon, we incorporate by reference our comments and report filed in that forum. *See* Letter from CRITFC to Oregon Environmental Quality Commission, regarding Idaho Power Petition for Rulemaking (Jan 26, 2011). We also incorporate by reference comments filed by our member tribes, including the Nez Perce Tribe and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

these stocks, and currently there are many problems with the available habitat, including and especially temperature loads. With the presence of the dams, these temperature loads have increased over the natural regime, and substantial new evidence demonstrates that these temperatures will become a greater problem as the climate changes continue in the next few decades.

The purpose of Clean Water Act is to restore and maintain the chemical, physical and biological integrity of the waters of the United States and to protect to the most sensitive beneficial uses of those waters. To take a step backwards from that purpose is contrary to the goals of the Act, and in this case, devaluing the temperature criteria is a major step backwards in a water system that is clearly significantly broken. The Hells Canyon Reach supports temperature-sensitive species such as salmon, lamprey and bull trout that require much cooler habitat than other fish, and under the Act, these beneficial uses must be protected.

Contrary to what Idaho Power asserts, the current spawning temperature criteria of 13°C is not merely a generic application of a generic standard, but it is the result of many years of intense scientific study that involved regional experts and fish biologists from state and federal fish agencies. Indeed, NOAA advocated 13° C as protective for spawning, incubation and fry emergence.[2] NOAA noted that while most spawning occurs at temperatures between 4° and 14° C, optimal incubation temperatures are between 4° and 13° C.[3] NOAA has, in the past, advocated for a more precautionary approach to temperature management, protecting "existing high quality thermal habitat until fish can recolonize an area is consistent with conservation biology principles and would be more efficient than attempting to restore the thermal conditions after warming has been allowed".[4] We agree with NOAA's position in these papers. Allowing further warming in the Snake River is not the direction we should take.

This application to increase a water quality standard that Idaho Power is currently not meeting appears to be driven by a motivation to avoid implementing needed mitigation and restoration programs. Idaho Power is in the business of selling power and for decades has extracted immense benefit from the river without paying the real costs of that benefit. Our request for Idaho Power to help restore the water quality of the river through measures such as a temperature control structure (TCS) is not unique, nor is it unreasonable. Dams all over the region have implemented various mitigation options, including TCS and fish passage that have been roundly successful for restoring water quality and fish productivity. Idaho Power should not be allowed to avoid its responsibilities.

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[2] Letter from Russ Strach (NOAA) to EPA (July 10, 2002).

[3] *See* NOAA letter to EPA. D. Robert Lohn to Mike Gearheart. Endangered Species Act – Section 7 Consultation, Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. (Feb. 5, 2008).

[4] *Id.*

Idaho Power's application does not demonstrate how a change in water quality standards is consistent with recovery and delisting of Snake River fall chinook or the draft plans prepared by NOAA and Idaho in this regard. A copy of the early draft recovery plan chapter for Snake River Basin fall chinook prepared by NOAA in partnership with the State of Idaho can be found at: http://www.idahosalmonrecovery.net/pdfs/8_ESUSnakeRiverFallChinook.pdf . We request that this document be placed in the record of this proceeding, and incorporate it by reference.

As we recommended to Oregon, Idaho would be best served by focusing its resources on developing a robust § 401 water quality certification for the project to protect and restore the river and its water quality rather than waste resources on degrading its water system. Moving backwards on water quality at this time would not be in the best interest of Idaho's resource. For these reasons, we request that Idaho deny this proposed rulemaking.

If you have further concerns or questions, please contact Julie Carter at 503-238-0667. Thank you for your time.

Sincerely,

Babtist P. Lumley
Executive Director

Attachments

Attachment 1

Dale A. McCullough, Senior Scientist, CRITFC

Evaluation of Site Specific Criteria Proposal

IDEQ summary of the Regulatory Situation

(taken from http://www.deq.idaho.gov/rules/water/58_0102_1102_negotiated.cfm)

Overview

DEQ proposes to revise its Water Quality Standards, IDAPA 58.01.02, to include a site-specific temperature criterion for the Snake River to protect fall spawning of Chinook salmon from Hell's Canyon Dam to the Salmon River. This site-specific criterion would be a change from the current criterion of a maximum weekly maximum of 13°C from October 23rd through April 15th to a site-specific criterion of a maximum weekly maximum of 14.5°C from Oct 23rd through October 30th and a maximum weekly maximum of 13°C from October 31st through April 15th.

The proposed rule change recognizes the declining thermal regime in the Snake River during the fall spawning season and that higher temperatures at the outset of the spawning season are both protective and supportive of the fall Chinook salmon spawning and incubation occurring in the Snake River during this time. This proposed rule change recognizes that a need to change the site-specific temperature criterion in the Snake River between the Hell's Canyon Dam and the confluence with the Salmon River exists. The current site-specific criterion of 13°C between October 23rd and April 15th is not regularly met during the first week of the fall spawning season and yet salmonid spawning and incubation is at the highest levels of the last two decades. The proposed rule changes the temperature criteria to an intermediate criterion of 14.5°C for eight days and then reduced to 13°C for the balance of the fall and early spring.

The text of the rule will be drafted by DEQ in conjunction with a negotiating committee made up of persons having an interest in the development of this rule. All who fish and recreate in the Snake River, Idaho Power Company who operates the Hell's Canyon Dam, and Native American tribes may be interested in participating in this rulemaking.

Upon conclusion of negotiations, DEQ intends to publish a proposed rule for public comment in the summer of 2011 and then present the final proposal to the Idaho Board of Environmental Quality for adoption of a pending rule in the fall of 2011. If adopted by the Board, the pending rule will be reviewed by the 2012 Idaho Legislature.

Evaluation of the Situation Presented by IDEQ

IDEQ premises site specific temperature standards process upon a very weak basis. The following summarizes our response.

(1) The presence of the HCC in the Snake River has caused a 3-week shift in temperatures that presents an unnatural environment for the Snake River fall Chinook. Shifts in thermal regime have been occurring in the mainstem Columbia River also, and have been linked to shifts in migration timing of other salmon species (e.g., Quinn et al.). Although salmon have some capacity to accommodate thermal shifts, this capacity is limited. The life cycle of the Snake River fall Chinook has been significantly challenged by anthropogenic thermal shifts. Future climate change, which is considered to be highly likely to involve a significant water

temperature increase in the Snake River, will potentially stress the fall Chinook beyond their capacity to adapt.

(2) The fact that water temperatures do not often meet the standard by October 23 is not an indication that the standard needs to be changed. It is a reflection of the 3-week shift in water temperatures that does not allow the river to exhibit a normal thermal regime.

(3) The fact that there have been a couple years of high Chinook returns does not indicate that water temperatures are healthy. The fact that the fall Chinook population has demonstrated improved run size in the past couple years has more to do with the success of the supplementation program. If it were not for this, it is not likely that the wild component of the run would be able to sustain itself. The purpose of water quality standards is to provide high quality conditions to fully support the most sensitive species. It is not appropriate to develop water temperature standards on the basis of population abundance. Such information is not based on scientific studies of survival under water temperature conditions or field-derived measures of wild salmon productivity.

(4) The idea that the temperature standard will achieve 14.5°C for an interim period and then 13°C means only that the rate of temperature decline will not represent the natural rate of decline for at least 3 weeks.

(5) IDEQ opens the rulemaking process to all who have an interest in the standard. This is a formula for standard development based on popularity and not scientific merit.

The Idaho Power Company Scientific Rationale

The Idaho Power Company (IPC) proposal justifies a site-specific criterion (SSC) for water temperature, by relying on one major, but seriously flawed study (Geist et al. 2006) funded by the company itself. This study examined Chinook embryo survival under declining temperature regimes starting from initial temperatures such as 17°C, 16.5°C, 16°C, 15°C, 13°C. The adults captured and spawned for this study, however, did not have to hold in the high water temperatures ranging up to 22°C or 23°C typical of the migration route to the Hells Canyon Reach. These adults were trapped and returned to hatchery conditions of 12°C. Spawning was conducted in the hatchery at 12°C rather than under normal ambient conditions in the Snake River below Hells Canyon dam. This method allowed the fish to avoid the harsh conditions imposed by the Hells Canyon Complex. Consequently, the results are irrelevant to the conditions presented in the Snake River that the fish are actually exposed to. Currently, in early September, when fall Chinook adults are holding below Hells Canyon dam, they are exposed to temperatures of up to 22°C. It is important for the river temperatures to begin declining earlier during this holding period so that adults are not subject to higher than natural and adverse conditions for a prolonged period.

IPC supplements this study with another questionable study (Olson and Foster 1955). This study spawned test organisms from a single pair of fish. It is common knowledge in thermal effects studies that there is significant variation among family groups in thermal response. It is this variation that results in a median response to critical temperatures. 50% of the test organisms from a population would be expected to succumb to temperatures lower than the threshold value and 50% would survive. With test organisms representing only 1 family group, there is no way to tell what the results indicate to the population as a whole.

In the third study (Olson et al. 1970), IPC downplays the results from the fish spawned in October and averages away this effect by combining it with results from the previously mentioned flawed studies. It also emphasizes the results from the adults spawned in November. Again, spawning under cold water temperature holding conditions does not represent the early portion of the run that arrives in August and early September. IDEQ would be making a substantial mistake to direct a standard to apply to the late-arriving fish while allowing the early part of the run to be subject to adverse thermal effects.

The IPC argument was also based heavily on the argument that fish to redd ratios are stable enough that there is likely to be little variation in pre-spawning mortality. Coutant, in his review of the CRITFC comments on the IPC SSC proposal, skirted this issue as well as other biological effects suggested by the scientific literature that pertained to producing a natural thermal pattern. IPC must account for the fact that the Hells Canyon Complex produces a 3-week thermal shift and consequently, it must address the biologic impacts that involve the thermal shift. IPC uses the fish to redd ratio as a way to claim that it is not likely that pre-spawning mortality due to disease or thermal effects or bioenergetic depletion would be important. Earlier CRITFC comments showed that there are many potential scenarios in which variation in pre-spawning mortality can be hidden within the observed fish to redd ratios. IPC portrayed this as making up scenarios, but this is standard scientific practice of exploring potential causation of biological responses.

EPA did not intend for temperature standards to be interpreted as "20°C allowed up to October 23, but with 13°C required after October 23". Such a scenario is not physically feasible. It is important for water temperatures to begin declining early in September and to meet 13°C at least by October 23. The available data on historic spawn timing shows clearly that a large percentage of the spawning occurred in early October. Currently, with the HCC thermal shift in place, spawn timing has shifted primarily to after October 23. Fall Chinook, as with any fish species, has limits to its biological response and capacity to adapt to changing environmental conditions.

The IPC proposal also ignores the effects of climate change on the Snake River. A restoration of the thermal regime to the Snake River below HCD would permit the fish to spawn earlier and to begin downstream emigration earlier, prior to increases in reservoir temperatures. This would result in better early adult holding conditions, early incubation conditions, and earlier smolt emigration.

Climate Change

IPC totally ignores the potential impacts of climate change, which is acknowledged by regional climate experts to be significant in the Snake River basin. The National Research Council (2004) reported the recent history of water temperature increases in the Columbia basin.

> The regional climate influences water temperatures of the Columbia River basin. These water temperatures have been increasing over the last 45 years (1953 to 1998) in the Columbia River at a rate of about 0.38°C per decade or 1.9°C per 50 years (Figure 3-8). Some of this increase can arguably be accounted for by nonclimatic changes in the river basin such as dams and reservoirs, changes in land use, increases in water withdrawals, and other factors. However, the nearest river to the Columbia River of similar dimensions is the undammed Fraser River in Canada, which also has experienced temperature increases from 1953 to 1998 of about 0.2°C per decade or almost 1°C per

> 50 years (British Columbia Ministry of Water, Land and Air Protection). Average August temperatures of the Columbia River (Figure 3-8) are now about 5°C higher than the average summer temperatures of the Fraser River.

> National Research Council of the National Academies. 2004. Instream flows, water withdrawals, and salmon survival. Committee on Water Resources Management, Instream Flows, and Salmon Survival in the Columbia River Basin. The National Academies Press, Washington, D.C.

The National Research Council (2004) also reported on the projected future temperature increases.

> Prospective future climate changes (driven by greenhouse gas emissions) have been simulated, with many simulation model results suggesting that the water supply of the Columbia River may be reduced in the next half century. Scenarios of future changes in the Columbia River hydrograph suggest that future warming will move the river toward conditions, on average, that closely resemble conditions observed during the warm phases of ENSO and PDO during the last century (Hamlet and Lettermaier, 1999; Miles et al., 2000). These simulations were generated with two general circulation models (GCMs) for the years 2025, 2045, and 2095 using expected rates of carbon dioxide emissions. One model was from the Max Plank Institute in Germany and the other was the Hadley 2 model from the Hadley Center in the United Kingdom. Both models indicate warming in all months relative to historical air temperature from 1961 to 1997.

The potential impacts on fall Chinook were also analyzed by Yates et al. (2008) for the Sacramento River. Yates et al. demonstrated the importance of the available cold pool in Shasta Reservoir as a means to counter the water temperature increases projected under climate change. Allowing water temperatures to remain elevated in the fall period in the Snake River is the opposite of what is needed for protecting future viability of fall Chinook.

> Yates, D., H. Galbraith, D. Purkey, A. Huber-Lee, J. Sieber, J. West, S. Herrod-Julius, and B. Joyce. 2008. Climate warming, water storage, and Chinook salmon in California's Sacramento Valley. Climatic Change.

Examination of the Effects of Water Temperature on Gamete Viability

The IPC proposal downplays the importance of thermal impacts to gamete viability by a variety of diversionary arguments. It relied on the recent strength of the hatchery population in the river, the flawed study by Geist et al. (2006), and fish to redd ratios. It discounts studies on species other than fall Chinook or studies where water temperature regimes were not exactly like those in the Snake River. IDEQ should question whether a significant change in a standard based primarily on a single flawed study is sufficient grounds.

Some highly relevant studies were conducted on thermal effects on gametes of Atlantic salmon that act as a good model for fall Chinook. Atlantic salmon have even greater thermal tolerance than fall Chinook, yet have significant impairment to gamete physiology. This effect is explained below.

The CRITFC comment on gamete viability:

Although all answers may not be provided by studies conducted on Snake River fall Chinook under declining temperature regimes (an unrealistic 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 6 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.

Coutant's comment for IPC:

Page 5, bottom paragraph and continuing to end of section on page 6: The King et al. (2003, 2007) studies cited by CRITFC do not appear to be relevant to the issues considered in IPC's Petition for a limited-duration, site-specific temperature standard of 14.5°C below Hells Canyon Dam for a short period in the fall. Summer temperatures in the Snake River that may reach 22°C are not the issue here. The results cited by CRITFC contrast the poor performance of adults held for 6 weeks at 22°C with presumed acceptable performance for holding at 14 and 18°C. Although the King et al. studies were of Atlantic salmon, these data would not support the CRITFC claim that 14.5°C is detrimental for Chinook salmon. The acknowledged differences in thermal tolerances between Atlantic and Chinook salmon tend to negate the relevance of the King et al. studies to the Snake River situation.

This comment from Coutant on egg viability for fall Chinook side-steps important effects and applies faulty logic. "The acknowledged differences in thermal tolerances between Atlantic salmon and fall Chinook salmon" do not negate the relevance at all. If the UUILT of Atlantic salmon juveniles is 27.8°C and that of Chinook juveniles is 25°C, and adults are known to have lower UUILT values than juveniles for any species, then we can assume that a thermal impact to Atlantic salmon is likely to be more severe than the same impact experienced by Chinook.

Further, the temperature impacts of the HCC on the Snake River that are the subject of CWA concern involve the achievement of 13°C as a spawning standard, 20°C as a summertime standard, and shifting the summer peak temperature to earlier (by at least 3 weeks) in the late summer period to match the historic annual temperature pattern. Even if the peak temperature were greater than 20°C, if it is shifted to earlier in the summer, migrating adult Chinook would not be exposed as long to water temperature peaks in the Hells Canyon Reach that frequently reach 22°C. The studies on Atlantic salmon showed that even a 3-day exposure to temperatures of 22°C during vitellogenesis caused negative impacts on these adults relative to fish held at 14 and 18°C. One would expect the impacts on adult Chinook would be even greater.

Another important conclusion from these studies is that holding Chinook prior to spawning at high temperatures, even for short periods, can cause negative impacts on embryo viability and development. IPC has invested extremely heavily in its argument based on the Geist et al. (2006) study that concludes that initial incubation temperatures as high as 16.5°C in a declining regime have little effect on embryo survival but that initial incubation temperatures of 17°C in a declining regime produce catastrophic impacts. IPC has conceded a 2°C "factor of safety" in their most recent proposal of 14.5°C as an initial incubation temperature in a declining regime, given the criticism of their first proposal. However, it has been repeatedly pointed out that Chinook, used to produce the gametes for the Geist et al. study, were collected and held at 12°C until they were spawned on November 22 at 12°C. Holding adults at temperatures of 12°C is extremely precautionary and is not the norm in aquaculture. These adults were also captured at Lyons Ferry Hatchery and did not have to swim either the entire length Lower Granite Reservoir or the Snake River below Hells Canyon dam. Consequently, their thermal exposure prior to spawning was much more benign than that experienced by wild/natural Chinook migrating all the way to the Hells Canyon Reach.

The Atlantic salmon research indicates that exposure temperatures of 22°C, which are not uncommon in the Snake River during fall Chinook migration, would easily be sufficient to cause a pre-spawning impact to gamete viability under natural conditions, especially for the early portion of the run. The more thermally sensitive nature of fall Chinook makes the conclusion based on Atlantic salmon research appears to be highly plausible. Even though the species contrasted are different, Atlantic salmon are a good surrogate for fall Chinook.

In the absence of perfect data, it is reasonable to make inferences from related studies and to use a precautionary approach. It is also reasonable to consider impacts throughout the life cycle. If all life cycle stages have highly probable impacts based on the weight of all scientific evidence on both the target species and all useable surrogates, it is worth exercising management precautions that balance the life cycle impacts rather than imposing a narrow focus only on what the temperature is on October 23 (the official date for observing the spawning temperature threshold).

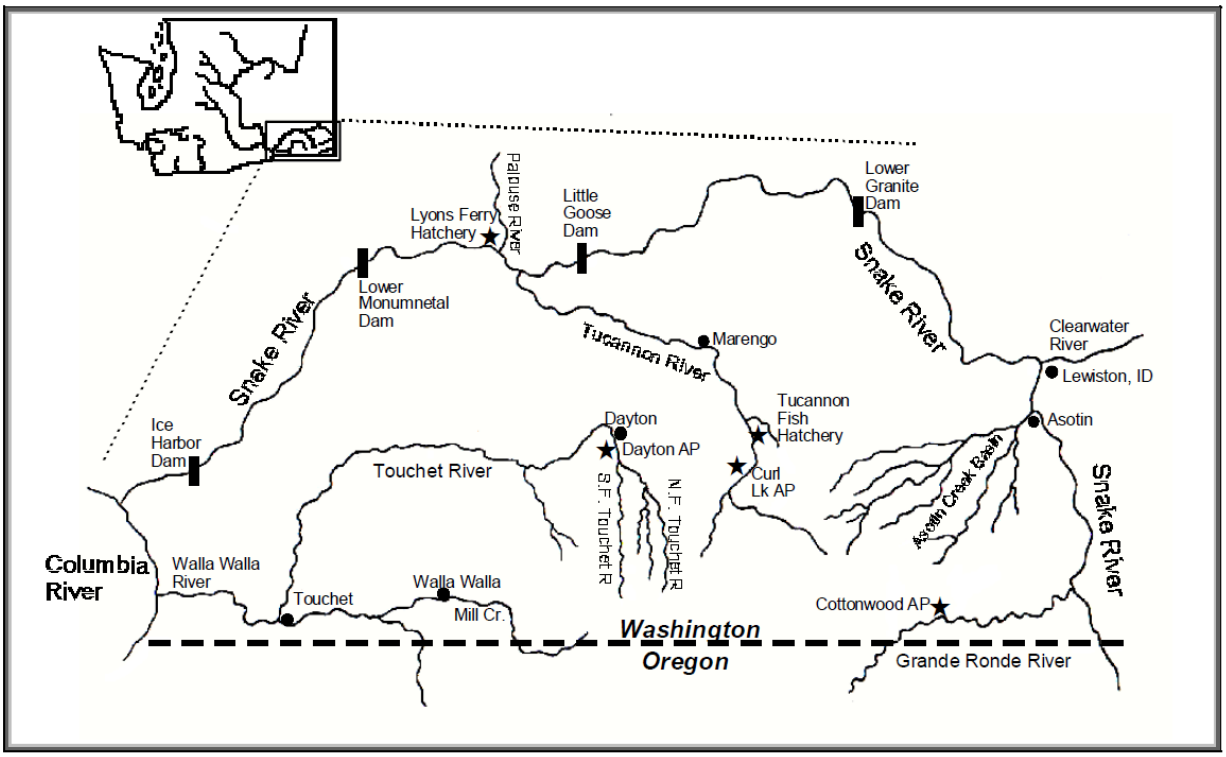

Figure 1. Map of major rivers and streams in Southeast Washington, and Lyons Ferry Complex facilities.

Abstracts from two Atlantic salmon studies

King, H.R., N.W. Pankhurst, and M. Watts. 2007. Reproductive sensitivity to elevated water temperatures in female Atlantic salmon is heightened at certain stages of vitellogenesis. Journal of Fish Biology 70(1):190–205.

[In order to compare the effects on reproductive performance of short-term or prolonged exposure to elevated temperatures during vitellogenesis, female Atlantic salmon Salmo salar were held at a

water temperature of 22° C for periods of 4 or 6 weeks during the austral summer and autumn. Plasma levels of 17ß-oestradiol (E2), testosterone (T) and vitellogenin (Vtg) were monitored and reproductive success was compared to that in groups of fish maintained at 14 or 22° C for 12 weeks from mid-January. Significant endocrine effects were observed within as few as 3 days of the commencement of exposure to 22° C, when plasma levels of E2 (c. 0·5 ng ml-1) and Vtg (c. 1·4 mg ml-1) were approximately half those observed in fish maintained at 14° C (c. 1·0 ng ml-1 and 2·7 mg ml-1 respectively). The fertility and survival to the eyed stage of ova from fish held at 14° C exceeded 85 and 70% respectively, whereas ova from fish held at 22° C for 6 or 12 weeks exhibited significantly reduced fertility (<70 and <45% respectively) and survival (c. 40 and 13% respectively). In spite of significant endocrine effects at all stages, a 4 week exposure to 22° C only generated significant reductions in egg fertility (<65%) and survival (c. 30%) when it occurred between mid-February and mid-March. Together, these data confirm that high temperature spikes can affect reproductive success as strongly as more prolonged exposures, and indicate that there is a critical period of reproductive sensitivity to elevated temperature in late February and early March in this stock of Atlantic salmon.]

King, H.R., N.W. Pankhurst, M. Watts, and P.M. Pankhurst. 2003. Effect of elevated summer temperatures on gonadal steroid production, vitellogenesis and egg quality in female Atlantic salmon. Journal of Fish Biology 63(1):153-167.

[Groups of Tasmanian female Atlantic salmon Salmo salar L. were maintained at 14, 18 and 22° C from mid-summer (January). Blood plasma levels of 17ß-oestradiol (E2),testosterone (T), cortisol and vitellogenin (Vtg) were measured at regular intervals, and in autumn (April) temperatures were reduced to 8° C to facilitate spawning and egg incubation. Maintenance at 22° C during vitellogenesis was associated with a general reduction in plasma E2 levels and an early reduction in plasma Vtg levels relative to those observed in fish held at 14 and 18° C. Significantly reduced oocyte diameters in ova from fish held at 22° C (5·4 mm cf. 5·7 mm) confirmed reduced maternal investment, and an increase in the incidence of previously undescribed chorion damage suggested that zonagenesis may also have been impaired. As a result, the fertility and survival of ova from fish exposed to 22° C (69 and 42%, respectively) were significantly reduced relative to those of ova from fish maintained at 14° C (93 and 86%) and 18° C (86 and 84%). Copyright 2003 The Fisheries Society of the British Isles To assess the effect of exposure to elevated water temperatures on vitellogenesis and egg quality in Tasmanian female Atlantic salmon (Salmo salar L.), groups of fish were maintained at 14, 18 and 22°C for 3 months from mid-summer (January). Blood plasma levels of 17â-estradiol (E2), testosterone (T), cortisol and vitellogenin (Vtg) were measured at regular intervals and in autumn (April) temperatures were reduced to 8°C to facilitate spawning and egg incubation. Maintenance at 22°C during vitellogenesis was associated with a general reduction in plasma E2 levels and an early reduction in plasma Vtg levels relative to those observed in fish held at 14 and 18°C. Significantly reduced oocyte diameters in ova from fish held at 22°C (5.4 mm c.f. 5.7 mm) confirmed reduced maternal investment and an increase in the incidence of previously undescribed chorion damage suggested that zonagenesis may also have been impaired. As a result, the fertility and survival of ova from fish exposed to 22°C (69% and 42% respectively) were significantly reduced relative to those of ova from fish maintained at 14°C (93% and 86%) and 18°C (86% and 84%).

Miscellaneous IPC Positions Expressed in June 21, 2011 Presentation

IPC claims that a "one size fits all" standard is not legitimate. The proposal, however, relies on this theory for fall Chinook as a means to impose a one size fits all scenario based on fall Chinook on the Snake River below Hells Canyon dam rather than relying on restoring the natural temperature regime or considering what is best for all downstream salmonids. It is rare that the historic natural thermal regime is not the best means of protecting the productivity of the full range of native species that evolved in the region. The basic principle used by scientists in developing water temperature standards is to direct protection to the most sensitive species but also to recognize the commonality in thermal response in the bulk of coldwater dependent species. Seeking to place in concrete the thermal degradation and thermal shift caused by construction and operation of the Hells Canyon Complex by essentially making the current condition the standard is counterproductive to fall Chinook viability.

Fall Chinook in the Snake River are supported by only one extant population. The Hells Canyon Complex was responsible to causing the extinction of the upriver fall Chinook populations. The future viability of this important population rests far more heavily on the current maintenance of high quality waters in the currently used habitat than it does on a vague wish for a small level of upriver habitat restoration that "might" call for passage at some future time. In attempting to impose a weaker water temperature standard in the Snake River, IPC will also be imposing a weaker water temperature standard on Oregon and Washington.

Fall Chinook do spawn in periods of declining water temperatures, but this is far from unique. All fall spawning salmon spawn under declining water temperatures.

The idea that fall Chinook cannot be compared to other races of Chinook or other species of salmon is spurious. IPC has provided no evidence whatsoever that all races of Chinook do not have essentially the same thermal tolerance. Life history variations may occur among the salmon, but even the fall Chinook have both yearling and subyearling life history. Differences in life history do not imply that physiology is different.

IPC states that fall Chinook "require conditions that promote early emergence to maintain an age-0 life history." Maintaining high water temperature until late in October do not promote early spawning and early emergence. The Hells Canyon Complex has caused a shift in initiation of spawning to later than what had been typical prior to Oxbow Dam.

IPC claims that spawning at temperatures ≤ 16°C is common for fall Chinook. Chinook have occasionally also been observed spawning at 19°C, but this does not mean that these temperatures are protective. Salmon may have to spawn because their bioenergetic

reserves are depleted and there is no choice but to either spawn or die. Embryo viability at 16°C is not ensured simply because fish are observed spawning at this temperature.

IPC attempts to show that conditions in the Snake River are adequate because they are only slightly worse than found in the Hanford Reach. The temperatures in the Hanford Reach are also significantly influenced by upriver dams and exhibit a 3-week thermal shift. Comparison to other impaired systems is no proof of adequacy of water quality.

Summary of the historical NOAA technical and policy position

NOAA and the USFWS both have a long history of providing official support to 13°C as a protective standard for providing full protection to salmon, including fall Chinook. This history is detailed below in significant reviews of the water temperature needs of salmon. Also, NOAA and USFWS considered the implementation of 13°C as the critical protective threshold based on a 3-year process in which a voluminous body of information was reviewed to arrive at protective standards. These positions can also be briefly summarized as follows:

1. NOAA supported the 13°C spawning standard developed by NOAA and USFWS technical staff, the three state agencies, and the Tribes (see 1, 2, 3, 4, 6. Also see 7 and 8).
2. NOAA recommended applying water temperature standards to protect cold water for not only ESA-listed salmonids, but all salmonids for which essential fish habitat has been designated (see 4).
3. NOAA emphasized its cooperative work with other federal agencies, states, and tribes in developing what it considered the best technical recommendations available (see 2).
4. The Oregon IMST conducted a peer review on the Regional temperature standards and considered them to be sound (see 5). In addition, EPA held an independent peer review of the Regional standards by a large panel of experts. This review also supported the technical value of the standards.
5. NOAA expressed great concern about the future impacts of climate change on viability of salmon populations (see 3).
6. NOAA expressed great concern about potential impacts of adults holding in warm water on gamete viability (see 3).
7. NOAA held that full implementation of the Washington and Oregon state water temperature standards would not jeopardize the ESUs covered in their biological opinions concerning each state's standards (see 3 and 6).
8. NOAA identified various RPAs (Reasonable and Prudent Measures) that would need to be followed under NOAA formal consultation. These were designed to avoid incidental take and required that EPA ensure that the states comply with the water temperature standards developed under the Regional guidance (see 3 and 6).

9. NOAA was concerned about halting thermal degradation to support the ESUs (see 4).
10. NOAA was concerned about temperature impacts increasing the incidence of disease (see 4).
11. NOAA supported the use of a 20°C migration standard, but wanted this rule strengthened by requiring coldwater refugia (see 4).
12. NOAA was supportive of temperature modeling to ascertain risks (see 6).
13. NOAA had been supportive of conservation actions to minimize adverse modification of critical habitat (see 6).
14. NOAA had been interested in supporting studies that would provide needed information to remove knowledge gaps (see 6).
15. NOAA expressed the technical opinion that the salmonid spawning standard for fall Chinook (i.e., 13°C) would not adversely affect fall Chinook, but they were concerned that it might affect fish that spawn earlier (see 6).
16. NOAA wanted to reserve the right to reinitiate formal consultation if the water temperature criteria specified in the Regional guidance were not fully implemented by the states (see 6).

Excerpts from NOAA and related documents concerning the

Regional water temperature standards

(1) Letter from Russ Strach (NOAA) to EPA, July 10, 2002

We also support the proposed 13 C criterion recommendation as being supportive of spawning and incubation for anadromous salmonid fishes, and the proposed 16° C criterion as being supportive of juvenile salmonid rearing, provided that standards are written, and that beneficial uses are designated, in ways that will avoid jeopardy to, and adverse modification of critical habitat for, species listed under the Endangered Species Act, and help remove water temperature as an impediment to their recovery.

(2) NOAA Comments on EPA Region 10 Guidance for State and Tribal Temperature Water Quality Standards, 2nd Public Review Draft (October 10, 2002), Habitat Conservation Division, Northwest Region, National Marine Fisheries Service

NOAA Fisheries supports the proposed 13°C criterion recommendation as being protective of spawning, incubation and fry emergence for Pacific salmon, provided that beneficial use designations include the full spatial and temporal extent of known and potential spawning.

Although NOAA Fisheries supports EPA's intent to protect waters that are colder than the proposed criteria, we recommend that this provision apply not only to ESA-listed salmonids, but to all salmonids for which essential fish habitat has been designated under the Magnuson- Stevens Fishery Conservation and Management Act and its implementing regulations (50 CFR 600). Also, NOAA Fisheries recommends that these provisions apply in both known and potential habitat (i.e. habitat that would be occupied if habitat and/or fish passage were restored). Protecting existing high quality thermal habitat until fish can recolonize an area is consistent with conservation biology principles and would be more efficient than attempting to restore the thermal conditions after warming has been allowed.

Effects of Proposed Action

Implementation and attainment of water quality standards are critical to improving Washington's water quality. NMFS participated in the development of the Temperature Guidance and worked closely with EPA, the State, and Tribes in the development of Washington's revised rules, to ensure that the criteria, beneficial uses and narrative provisions meet the biological requirements of Pacific salmon.

Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (e.g., fecundity), sitespecific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

(3) NOAA letter to EPA, February 5, 2008. D. Robert Lohn to Mike Gearheart. RE/ Endangered Species Act – Section 7 Consultation, Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

Freshwater Spawning Sites. Most spawning occurs at temperatures between 4° and 14° C, and the optimal incubation temperatures are between 4° and 13° C. The EPA's approval of the 2006 revised standards adequately protects this PCE both in areas that have the 13° C spawning criterion applied and in areas that naturally cool from the designated use standard prior to the on-set of spawning. Some areas are populated by adults holding prior to spawning. Adult holding and spawning may occur prior to the dates the 13° C criterion becomes affective for the year, or incubation continues beyond the date 13° C is applied. In these periods, the applicable standard is either 16° C or 17.5° C. In years when significant numbers of early returns begin spawning prior to the applicability of 13° C, there could be heightened risk that some embryos will be affected and possibly reducing the overall population potential for that given brood year.

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Internal biological processes leading to complete sexual maturation in salmon begin many months before the fish reproduce in the species that typically have protracted residence in freshwater before spawning (i.e., some stocks of Chinook, sockeye, coho and steelhead). In addition to the long period of adult maturation, salmon have unusually protracted periods of embryonic development compared to most fishes (Norman and Greenwood 1975). Also, the spawning grounds may be many miles distant from the mouth of the river. Thus the two ends of the reproductive process – the initiation of gamete maturation and entry into freshwater to spawning – are greatly separated in time and often also in space (Quinn and Adams 1996). As a consequence of this temporal and spatial separation, water quality conditions experienced by adults from freshwater entry through migration to the spawning grounds may be directly connected to the developmental success of their offspring many months later.

Upriver migration to distant spawning grounds is energetically demanding and substantial levels of adult mortalities, prior to spawning, can occur. These pre-spawn mortalities are often associated with high temperatures which both weaken the fish and accelerate the proliferation of pathogens. Those fish may arrive on the spawning grounds with too little energy or die of infection along their migration to the spawning grounds.

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There is still a great deal of uncertainty associated with likely changes in timing, location and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007). However, several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state (ISAB 2007, Battin et al. 2007; Rieman et al. in press). In streams and rivers with temperatures

approaching or already at the upper limit of allowable water temperatures, the likelihood salmonids will be able to adapt to, or avoid the effects of climate change is uncertain. In sum, climate change is likely to be an important factor, acting in concert with WQS, affecting distribution of salmonids in Washington State.

According to model predictions, average temperatures in Washington state are likely to increase between 1.7° and 2.9° C (3.1°and 5.3° F) by 2040 (Casola et al. 2005). Should these changes in temperature occur, Ecology may have to respond by addressing each river affected through the TMDL process.

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After reviewing the best available scientific and commercial information available regarding the current status of the listed ESUs and DPSs covered in this Opinion, the baseline for the action area, the effects of the proposed action, and cumulative effects, NMFS concludes that EPA's proposed approval of revised Washington water quality standards for temperature, DO, and antidegradation implementation methods is not likely to jeopardize the continued existence of the ESUs and DPSs covered in this Opinion.

NMFS has worked extensively with EPA, Ecology, and Tribes in Washington during the development of the revised standards and believes that implementing the proposed standards will result in improved and functional water quality in many areas that support threatened and endangered Pacific salmon. NMFS acknowledges that the process of Rule making is arduous and expensive and recognizes that water quality revisions are an ongoing process required by Triennial Reviews. NMFS looks forward to the opportunities in the near future to update and further refine the standards for the benefit of listed fish. NMFS authorizes the incidental take of listed species of salmon and steelhead resulting from the proposed action that are likely to occur from: (1) adverse effects from not applying the summer spawning and incubation standard of 13° C in all areas where spawning and incubation is presumed to occur; (2) protecting most, but not all rearing areas with a "core summer salmonid habitat" designation; and (3) applying a water column DO standard that is unlikely to meet minimum IGDO requirements of incubating eggs. Incidental take that is caused by other water quality parameters outside the scope of this consultation is not covered by this incidental take statement.

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Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of listed salmon and steelhead:

1. Minimize the likelihood of incidental take resulting from EPA's approval of Ecology's water quality standards.

2. Ensure effectiveness of the conservation measures.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the EPA must comply with the following terms and conditions, which implement the reasonable and prudent measures stated above. These terms and conditions are non-discretionary. Where there are questions over technical definitions or interpretations (e.g., adverse effects, pockets of cold water) NMFS will work with EPA to achieve resolution. EPA will utilize its CWA authorities as necessary to ensure that the below terms and conditions are met. Generally, it is expected that EPA will ensure that Ecology implements these items through EPA's general coordination and oversight of the Ecology water program.

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c. EPA shall ensure that Ecology fully implement its water quality policies and procedures described in the BE and in this Opinion to maximally protect areas with existing cold water.

i. Rivers currently at or below their designated temperature criteria (e.g., those identified in Table 5) shall be protected using Ecology's Tier II antidegradation policy.

ii. Rivers currently at or above their designated temperature criteria, but which have pockets of cooler water that meet or only slightly exceed the criteria, shall be protected using Ecology's Tier I antidegradation policy.

iii. For a water body that is designated "Salmonid spawning, rearing, and migration use" with the applicable temperature criterion (i.e., 17.5° C, 20° C, or 21° C), and where a TMDL, or similar analysis, has been conducted that demonstrates the natural thermal potential of the water body is 16° C or below, the use designation shall be changed to the more appropriate "Core summer salmonid habitat use" as part of the process described in terms and condition number one above.

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When Ecology issues NPDES permits for sources with heat discharges, EPA shall ensure that the aquatic life designated uses are protected. EPA shall ensure that Ecology implement the following measures to reduce impacts from thermal plumes where applicable.

i. Prevent or minimize the potential exposure to salmonids from temperatures exceeding the 13° C spawning criterion in spawning, incubation and rearing areas;

(4) Letter to John Iani (EPA) from D. Robert Lohn (NOAA), November 26, 2002. Refer to: OHB2001-0329-GC. Letter RE/October 10, 2002, Draft EPA Region 10 Guidance for Pacific Northwest States and Tribal Temperature Water Quality Standards.

As lead agency and decision maker in this project, EPA has faced a difficult challenge of developing water temperature guidance that recognizes this complexity, yet encourages development of state and tribal temperature criteria that are both practical for regulatory use and protective of salmonid fishes. By working collaboratively with state, tribal and

Federal agencies, EPA is developing guidance that likely will not only help halt thermal degradation of Pacific salmon habitat so that progress toward long-term survival and recovery can begin, but will also lead to more efficient and timely approvals of water temperature standards under the Clean Water Act (CWA) and the Endangered Species Act (ESA).

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V.2. Adoption of Regulatory Provisions to Protect Existing Water Temperature that is Colder than the Numeric Criteria

Although NOAA Fisheries supports EPA's intent to protect waters that are colder than the proposed criteria, we recommend that this provision apply not only to ESA-listed salmonids, but to all salmonids for which essential fish habitat has been designated under the Magnuson- Stevens Fishery Conservation and Management Act and its implementing regulations (50 CFR 600). Also, NOAA Fisheries recommends that these provisions apply in both known and potential habitat (i.e. habitat that would be occupied if habitat and/or fish passage were restored). Protecting existing high quality thermal habitat until fish can recolonize an area is consistent with conservation biology principles and would be more efficient than attempting to restore the thermal conditions after warming has been allowed.

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The draft guidance acknowledges this risk of increased disease during summer maximum temperature conditions for rivers with little diurnal variation, but dismisses the concern since "out-migrating juveniles have generally completed their out-migration by this time and the number of adults migrating through these waters at this time is limited and of short duration." This information is not entirely accurate. Fall chinook juveniles from Columbia River tributaries out-migrate throughout the summer. Spring chinook generally enter freshwater in January-May (Columbia River), April-July (Puget Sound), April-August (Washington Coast), and April-July (Oregon Coast) (Bell 1991, Myers et al. 1998). Summer chinook generally enter freshwater in early to mid-summer. Due to these entry times, adults of both races of chinook often can be found migrating or holding in large and medium sized rivers during the summer maximum period. Summer steelhead migrate upstream in May-October (Busby et al. 1996). Since steelhead spawn in the spring, these fish must hold in spawning tributaries or in mainstem rivers throughout the summer while awaiting the spring to begin spawning.

In order to reduce the risk of increased disease in migrating or holding chinook salmon, NOAA Fisheries recommends that EPA extend the narrative criterion pertaining to cold water refugia to include mainstem rivers with chinook or steelhead where the 18°C (7DADM) criterion would be applicable (see also comments on the narrative criterion immediately below).

Salmon and Trout Migration (With Cold Water Refuge Narrative Provision).

NOAA Fisheries does not object to EPA's inclusion of a criterion of 20°C (7DADM) with a narrative criterion pertaining to cold water refugia, however, we have several recommendations to strengthen the provision. NOAA Fisheries recommends that EPA specify in the guidance that cold water refugia include the following features: (1) The alluvial aquifer, (2) the phreatic zone, (3) the hypothetic zone, (4) the paleochannel, (5) the streambed, and (6) the riparian zone (Poole and Berman 2001).

NOAA Fisheries also recommends that EPA provide guidance about how to develop the information needed to demonstrate that "maximum temperatures likely reached 20°C prior to significant human alteration of the landscape" (p. 26). This guidance could include a discussion of the types of modeling available, and of the utility of other information (e.g. historical temperature data and fish distribution data). We also recommend that the narrative criterion include not only a demonstration of the physical restoration of cold-water refugia, but also a discussion of how well the beneficial uses of salmonid migration and holding are being protected by the combination of the numeric and narrative criteria. Proposals to use this provision should be tied to the best available scientific information and subjected to interagency, public and scientific peer review.

The guidance would benefit from a discussion of how the numeric and narrative criteria would work together, and how they would be applied for both point- and non-point pollution sources.

Salmon and Trout Spawning, Egg Incubation, and Fry Emergence. NOAA Fisheries supports the proposed 13°C criterion recommendation as being protective of spawning, incubation and fry emergence for Pacific salmon, provided that beneficial use designations include the full spatial and temporal extent of known and potential spawning.

(5) Oregon's Independent Multidisciplinary Science Team (IMST) Technical Report 2004-1. Oregon's Water Temperature Standard and its Application: Causes, Consequences, and Controversies Associated with Stream Temperature."

Science Questions and IMST Conclusions

Science Question 1. Are the Oregon temperature standards for salmonids technically sound?

1. IMST concludes that the scientific basis for Oregon's temperature standards is credible.

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1. What is the purpose of Oregon's water quality standards?
The purpose of water quality standards is to formally describe the level of water quality necessary to protect aquatic life and desired human uses of water bodies. The Clean Water Act is a federal law, but it delegates authority to states and tribes to set water quality standards appropriate to their areas. The standards include 1) descriptions of the aspects of water quality to be protected (beneficial uses) and 2) thresholds that indicate potential problems in water bodies (water quality criteria). In simple terms, the criteria serve as a signal to warn that aquatic health may be problematic. As we describe in more detail later, once a stream passes these thresholds,

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4. What are Oregon's temperature standards?
Oregon revised its temperature standards in December 2003. The standards are designed to protect salmonids and other aquatic life. Water bodies must not be warmer than:

- 16.0 °C (60.8 °F) for core cold water habitat use,
- 18 °C (64.4 °F) for salmon and trout rearing and migration,
- 20 °C (68 °F) for migration corridor use,
- 20 °C (68 °F) for redband trout (*Oncorhynchus mykiss* subspecies)and Lahontan cutthroat trout (*O. clarki henshawi*) use,
- 13 °C (55.4 °F) for salmonid spawning, egg incubation, and fry emergence,
- .12 °C (53.6 °F) for native Oregon bull trout (*Salvelinus confluentus*) spawning and rearing, and
- 16.0 °C (60.8 °F) for native Oregon bull trout migration, foraging and sub-adult rearing.

5. Are Oregon's temperature standards (1996 and 2003) scientifically sound?
Yes. Oregon's 1996, and now the 2003, temperature standards are based on several technical reviews by regional and national scientists. Reviews since the development of the 1996 standards have only added additional support. Standards are reviewed and revised on a regular basis to incorporate more recent scientific information. The revision and adoption of new standards by the Oregon Environmental Quality Commission is an appropriate step to keep water quality standards up to date with the current state of knowledge. While there are many questions about how to best implement the standards, the standards are scientifically sound and provide a reasonable framework for developing watershed management plans. Oregon's TMDL process

and temperature standards are some of the most well-reasoned and well-developed approaches in the United States. We conclude that the standards were based on the best science available at the time.

(6) Letter of William Stelle, Jr. (NOAA) to Randall F. Smith (EPA), July 7, 1999. Re: Biological and conference opinion on EPA's approval of Oregon's water quality standards for dissolved oxygen, temperature and pH, and accompanying conservation measures. Refer to: OSB1999-0146.

VIII. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened

and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species, to minimize or avoid adverse modification of critical habitat, to develop additional information, or to assist the Federal agencies in complying with their obligations under section 7(a)(1) of the ESA. The NMFS believes the following conservation recommendations are consistent with these obligations and therefore should be implemented by the EPA:

1) Cooperate with NMFS in soliciting proposals for and funding three research projects that will address existing data gaps regarding water temperature and its effects on listed and proposed species:

a. an effort to compile historic temperature data for salmon-bearing watersheds in representative ecoregions of Oregon;

b. an effort to model what stream temperatures could be attained based on changes in vegetation, flow restoration, and restoration of hydrologic connections to groundwater and floodplains in representative ecoregions of Oregon;

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The EPA and ODEQ worked with the Services to develop measures intended to address adverse effects of the water temperature standards on the listed anadromous fish species (see Attachments 2, 3, and 4 of this Opinion). EPA will lead, and ODEQ will participate in, interagency technical and policy workgroups to review temperature issues and develop proposed EPA Region 10 stream temperature criteria over a two-year period. The goals of this project are (1) to develop EPA regional temperature criteria that meet the biological requirements of listed salmonid species for survival and recovery pursuant to ESA and the Clean Water Act (CWA), and can be reasonably implemented; and (2) expected criteria adoption by EPA Region 10 Pacific Northwest states and tribes.

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Literature reviewed by ODEQ (1995 b), Spence et al. 1996, McCullough 1997, and in the BA and its Appendix H indicate that the spawning standard would be protective of spring chinook spawning and incubation. Because most of the studies reviewed gave temperature ranges with an upper end somewhat higher than 12.8° C, temporary temperature increases due to the use of the seven-day moving average of the daily maximum as the measurement unit, while not an optimum situation, should not increase mortality significantly for chinook salmon. Although some of the available literature indicates fall chinook salmon may require water no warmer than 12°C for optimum incubation, this should not be a problem because these fish spawn after October 1, when water temperatures should be cool enough to avoid adverse effects. Fall temperature monitoring is needed to validate this assumption.

Although the numeric spawning criterion appears to be protective of these species, the identification of spawning and incubation areas in time and space affects the ability of this standard to avoid and minimize adverse effects. As discussed under the DO standard, NMFS

has identified several problems with the state's salmonid spawning table. In particular, early spawning spring and summer chinook salmon are not protected. Based on this information, NMFS concurs with EPA that the salmonid spawning temperature standard is not likely to adversely Snake River fall chinook salmon. However, NMFS does not concur with EPA's determination that the salmonid spawning temperature standard is not likely to adversely affect Snake River spring/summer, Upper Willamette River, Lower Columbia River, and Southern Oregon/California Coastal chinook salmon, because early spawning fish are not protected. Eggs and larvae of early spawning chinook salmon in these Oregon river basins are likely to suffer increased mortality under the rearing temperature standard, which would apply until the dates shown for ODEQ in Table 4.

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B. Reasonable and Prudent Measures

The NMFS believes that the following reasonable and prudent measure(s) are necessary and appropriate to minimizing take of the listed and proposed species and/or minimize the adverse modification of designated or proposed critical habitat: 1) EPA shall carry out the conservation measures described in Attachments 2 and 4 of this Opinion.

C. Terms and Conditions

1) EPA, working with the ODEQ and USFWS, shall assist NMFS in assessing consistency with the conservation measures contained in Attachments 2, 3, and 4 of this Opinion, at six month intervals.

2) Within 90 days of the completion of the Regional Temperature Criteria Development Project (Attachment 4 of this Opinion), EPA shall transmit the Regional Temperature Criteria to the ODEQ, and will recommend that ODEQ revise its temperature standard according to those criteria. The terms and conditions of an incidental take statement usually include reporting and monitoring requirements that assure adequate action agency oversight of incidental take. In this case, given the large geographic area and number of species addressed in this consultation, and the difficulty of detecting incidental take from water quality effects in waters meeting water quality standards, monitoring of incidental take would require a tremendous expenditure of resources. Also, incidental take is only authorized for a limited amount of time, by the end of which results of any monitoring would likely not yet be available. Therefore, NMFS did not include monitoring of incidental take. However, NMFS does request in its conservation measures that EPA (1) cooperate with NMFS in a field study of how temperature effects at a sublethal level affect anadromous fish distribution, reproduction and production; and (2) cooperate with ODEQ so that NMFS obtains the results of any fish kill investigations occurring within waters meeting ODEQ water quality standards for dissolved oxygen, temperature and pH.

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IX. Reinitiation of Consultation

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The NMFS will reconsider its conclusion on the effects of EPA's action, and will review whether this Opinion is still valid, if any of the following occur:

1) Based on the assessments described above, the ODEQ and EPA measures that were pivotal to the conclusion of this Opinion1 are not fully developed and applied according to the specified timelines included in Attachment 2, 3 and 4 of this Opinion. The NMFS will notify the EPA if such evidence is found, and the EPA will have 30 days to demonstrate sufficient corrective actions;

2) the Regional Temperature Criteria Development Project described in Attachment 4 of this Opinion is abandoned, or fails to develop regional temperature criteria, according to the specified timeline, that NMFS, working with the EPA, determines will meet the biological requirements of listed anadromous salmonids for survival and recovery; or

3) the ODEQ does not adopt the recommended temperature criteria as its temperature standard, according to the specified timeline, and EPA in turn does not promptly begin promulgation of the recommended temperature criteria in Oregon.

(7) NOAA (2004). Endangered Species Act Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation Operation of the Cowlitz River Hydroelectric Project (FERC No. 2016) through 2038.

5.3.2 Water Quality: Water Temperature

NOAA Fisheries defines PFC for water temperature as water temperatures not exceeding 13.9°
C. Water temperatures up to 15.6° C in spawning habitat and 17.8° C in rearing and migration
habitat are considered to be at risk; temperatures exceeding 15.6° C in spawning habitat and
17.8° C in rearing and migration habitat are considered to be NPF (NOAA Fisheries 1996).

(8) NOAA (2008). Endangered Species Act Section 7 Consultation, DRAFT BIOLOGICAL OPINION on the LONG-TERM CENTRAL VALLEY PROJECT AND STATE WATER PROJECT OPERATIONS CRITERIA AND PLAN

For purposes of this analysis, NMFS used the Balls Ferry temperature compliance point to evaluate effects, since most winter-run (98 percent) spawning distribution has shifted upstream in recent years (OCAP BA figure 11-38). Water temperatures exceed the 56$_{o}$F objective at Balls Ferry in 50 percent of years in September and 10 percent of years from May through June under (Study 7.1) near-term, and (Study 8.0) future conditions (figure 6-10). Using the incremental exposure rates in table 6-7 and the

modeled temperatures in figure 6-10, the loss rates for winter-run would be 8 percent egg mortality for those eggs exposed to 57$_{o}$F in 50 percent of the years, 15 percent egg mortality for those eggs exposed to 58$_{o}$F in 25 percent of years, 25-50 percent egg mortality for those eggs exposed to 59-60$_{o}$F, in 10 percent of years, and 50-100 percent egg mortality for those eggs exposed to 60-62$_{o}$F in 5 percent of years. In addition, exposure of newly hatched fry to lethal thermal stress would occur from 5-25 percent of years during August and September under future conditions. These conditions do not include climate change predictions, which would increase water temperatures from 1-3$_{o}$F. [note: 56°F equals 13.3°C. This was identified as the upper end of the optimum in Table 6 based on a Reclamation egg mortality model.].

Water Temperature Trends

The water temperature trends for the Columbia River have shown a steady increase from 1938 to 1997 of 0.039˚C per year (NPCC 2004) at Bonneville Dam. Between 1938 and 1997 there has been approximately a 1.67˚C increase in Columbia River water temperatures.

Progressive water temperature increases have been observed across the United States, so rather than being a speculative matter, this is a major environmental impact that salmon runs have had to contend with. The impacts of climate change have already been suffered by northern California salmon runs (Williams 2006). The ability to accommodate further changes in either maximum temperatures or shifts in thermal regime are limited by the species' behavioral and genetic plasticity (Myrick and Cech .

Recently Kaushal et al. (2010) reported that 50% of rivers they surveyed in the United States showed significant long-term upward trends (0.009–0.077°C/year) in water temperatures linked to increasing air temperature. They cautioned that "If stream temperatures were to continue to increase at current rates, due to global warming and urbanization, this could have important effects on eutrophication, ecosystem processes such as biological productivity and stream metabolism, contaminant toxicity, and loss of aquatic biodiversity.

Further, Williams (2010) argues that the prolongation of adverse water temperature regimes in the Snake River below Hells Canyon dam would subject the fall Chinook to a likely erosion in "genetic diversity, fitness, and resilience."

Kaushal, S.S., G.E. Likens, N.A. Jaworski, M.L. Pace, A.M. Sides, D. Seekell, K.T. Belt, D.H. Secor, and R.L. Wingate. 2010. Rising stream and river temperatures in the United States. Frontiers in Ecology and the Environment

Myrick, C.A. and J.J. Cech, Jr. 2001. Temperature Effects on Chinook Salmon and Steelhead: a Review Focusing on California's Central Valley Populations. Bay-Delta Modeling Forum. Technical Publication 01-1. Available at http

NPCC. 2004. Lower Columbia Salmon and Steelhead Recovery and Subbasin Plan.
Williams, J.G.. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science. Vol. 4, Issue 3 (December 2006), Article 2.
http://repositories.cdlib.org/jmie/sfews/vol4/iss3/art2).

Williams, R.N. 2010. Review of Idaho Power Company's Proposed Temperature Mitigation Projects Related to the Hells Canyon Complex (HCC). Prepared for Idaho Rivers United and American Rivers. 27p.

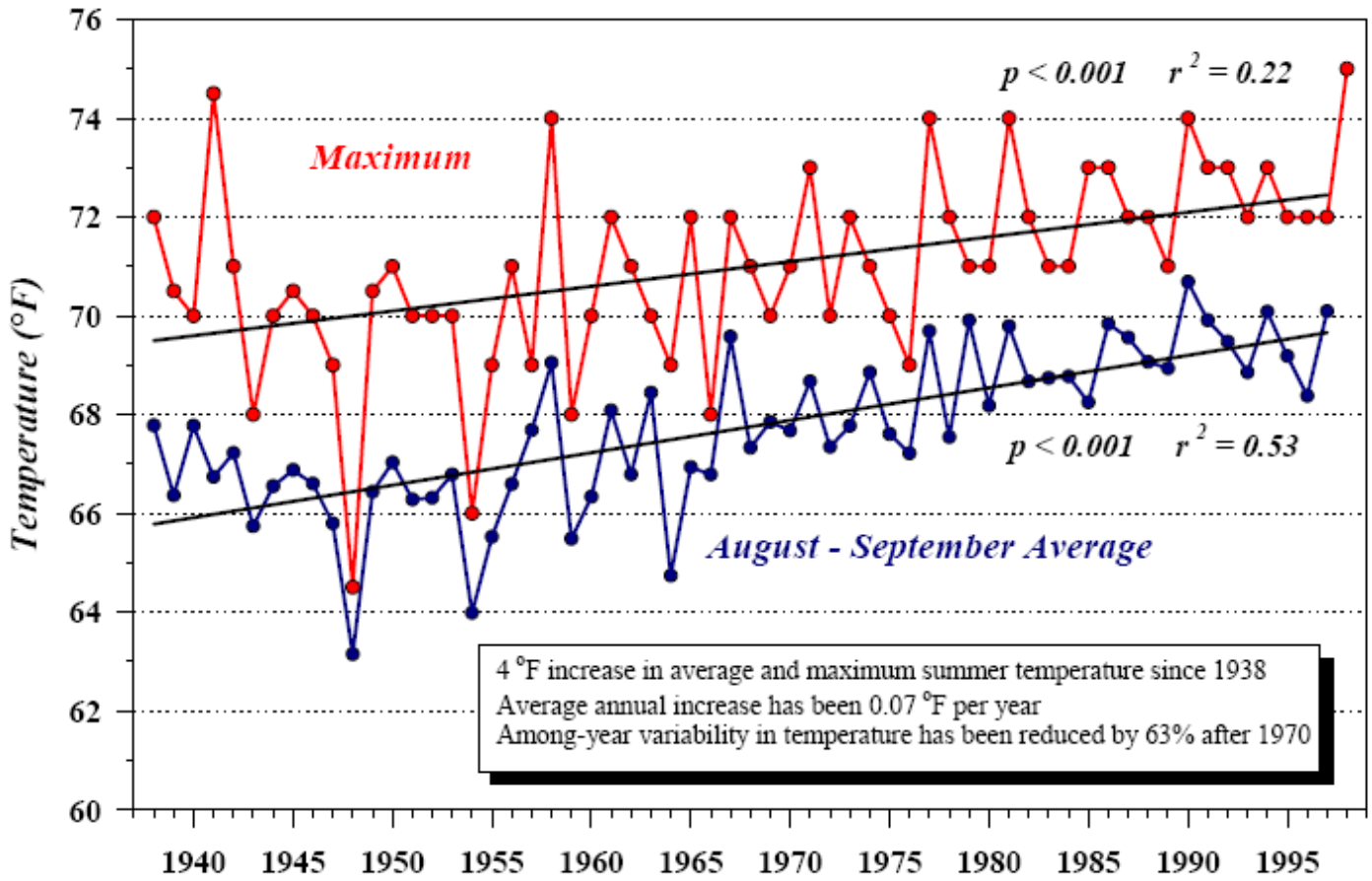


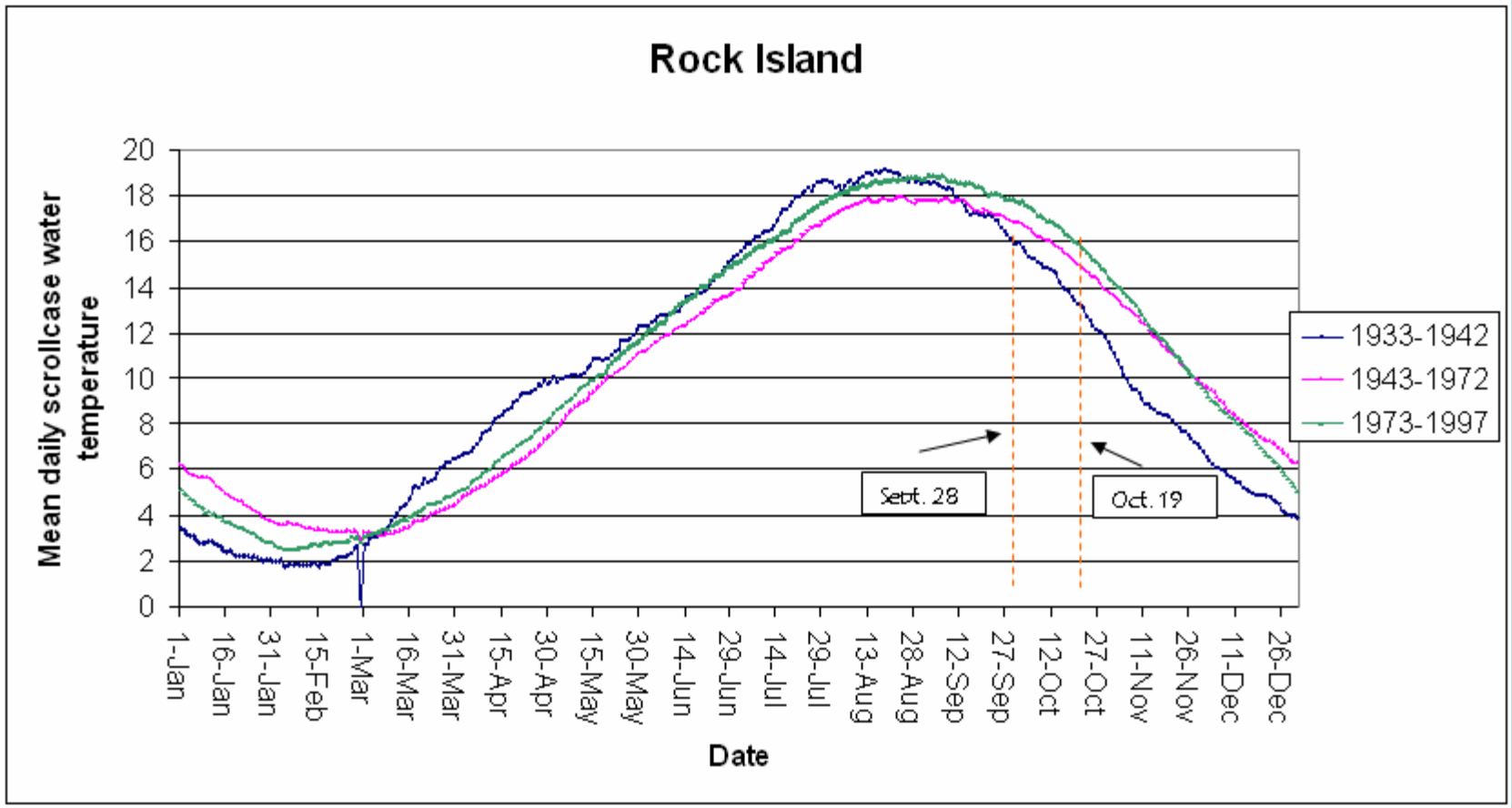
Figure 3-99. Historical changes in summer water temperatures at Bonneville Dam.

Source: NPCC. 2004. LOWER COLUMBIA SALMON AND STEELHEAD RECOVERY AND SUBBASIN PLAN

Thermal Shift in the Columbia River

Columbia River water temperatures at Rock Island Dam measured in the dam scroll case reveal a long-term pattern of shift in the thermal regime. These temperatures were segregated by date to reveal the changing pattern. Dates examined are 1933-1942, 1943-1972, and 1973-1997.

The date on first reaching a water temperature of 16˚C was September 28 in 1933-1942, but this was extended to October 19 based on the 1973-1997 record. This is a shift in the natural pattern by approximately 22 days. Because salmon cannot successfully spawn until appropriate water temperatures are achieved, the Columbia River fall Chinook would have to adjust their spawn timing or suffer increased mortality in pre-spawning adults or incubating eggs.



See file: Rock Island scroll case temperatures-1933-1997.doc

Thermal Shift in the Snake River

Snake River water temperatures can be contrasted between the USGS gauge at Weiser, Idaho (upstream of Brownlee Reservoir) and a point 10 miles downstream of Hells Canyon Dam. Although water temperature data collection has been spotty and inconsistent despite the level of hydropower development in the area, the shift in the thermal pattern is still obvious.

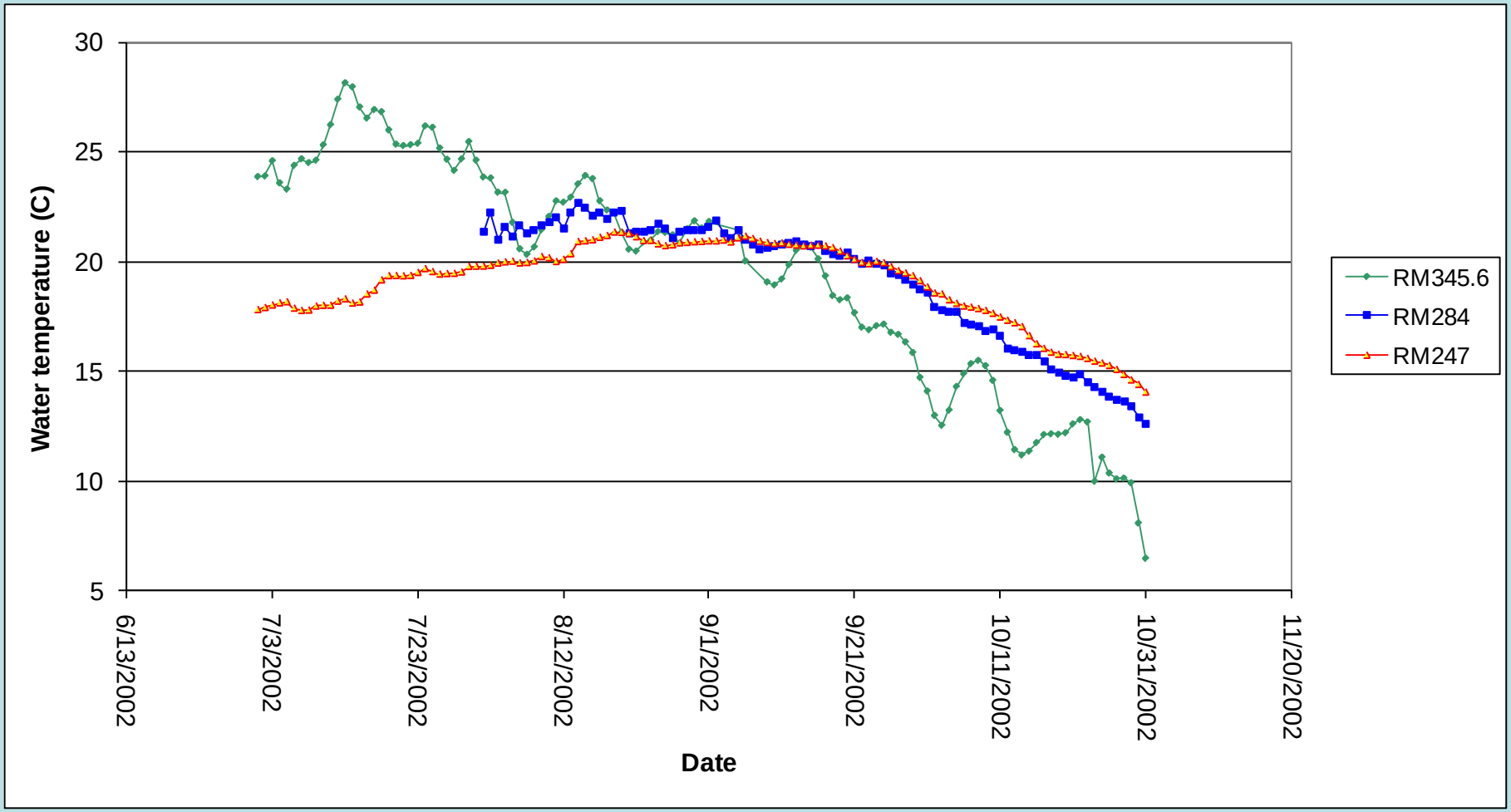
As in the Columbia River example, the date on first reaching a water temperature of 16˚C in a declining temperature period (September-October) was examined. This reveals that there is on average a 25-day shift in the timing of passing this temperature. That is, water temperatures below the dam achieve 16˚C 25 days later than they do above the Hells Canyon complex. Clearly, the presence of the dams causes this thermal shift. Again, the fall chinook would be forced to alter their spawn timing to accommodate the change to the thermal pattern because the temperature of optimal spawning and incubation survival is fixed, while the timing of the temperature decline has been shifted to later in the season.

Site	Date on first reaching 16°C	Day Number
10-mi downstream of HCD	Oct. 24, 1991	297
	Oct. 25, 1992	299
	Oct. 21, 1993	294
	Oct. 22, 1994	295
Mean		**296.3**
Snake River at USGS Weiser gage	Oct. 2, 1967	275
	Sept. 19, 1968	263
	Oct. 1, 1969	274
	Sept. 13, 1970	256
	Sept. 16, 1971	259
	Oct. 2, 1972	276
	Oct. 3, 1974	276
	Oct. 7, 1975	280
	Oct. 3, 1976	277
	Sept. 18, 1978	261
	Oct. 11, 1979	284
	Oct. 10, 1980	284
	Sept. 21, 1981	264
	Sept. 27, 1999	270
	Sept. 30, 2002	273
Mean		**271.5**

Thermal Shift in the Snake River (cont.)

Temperatures in the Snake River at Weiser begin declining in mid-July, but the water temperatures below Hells Canyon Dam (RM247) continue to increase until early October and then slowly decline. By late October the water temperatures remain higher than the inflow temperatures to Brownlee Reservoir. By October 23 the water temperatures below Hells Canyon Dam were still at least 3˚C warmer than the inflow temperatures.

Snake River Water Temperatures for 2002
Below Hells Canyon Dam (RM247) and near Weiser River (RM345.6)



SR-HCtemperaturedataforDMcCulloughCRITFC.xlsx (data supplied by T. Dombrowski)

Thermal Pattern in the Snake River (cont.)

The initiation of the fall Chinook adult upstream migration begins officially at Bonneville Dam on August 1. The current peak of water temperatures in the Snake River below Hells Canyon Dam occurs on approximately August 23 every year. According to data from the Snake River TMDL the maximum daily water temperatures on October 23 range from approximately 13˚C to 16˚C.

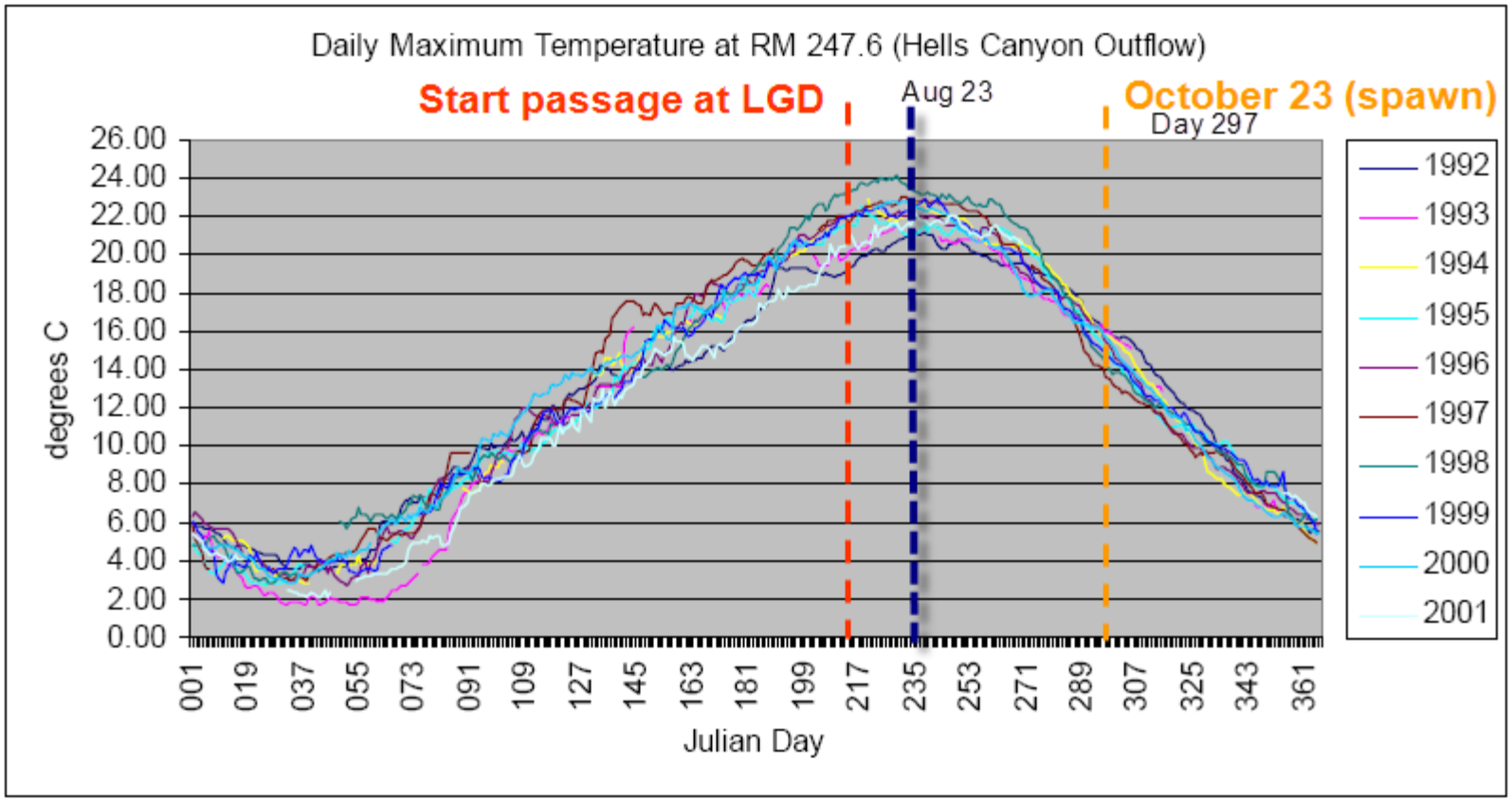


Figure 3.6.2 e. Water temperatures for the Downstream Snake River segment (RM 247 to 188) of the Snake River - Hells Canyon TMDL reach near Hells Canyon Dam.

Chart from Snake River TMDL

Thermal Pattern in the Snake River (cont.)

The sharp contrast between the thermal patterns expressed in the reservoir inflow water temperatures vs. the Hells Canyon Dam outflow temperatures reveals the current thermal shift that has occurred.

The same shift in timing of the temperature decline can be seen by looking at the water temperatures below Hells Canyon Dam at the Central Ferry location. The peak temperature in 1958 was reached by late July, after which temperatures declined.

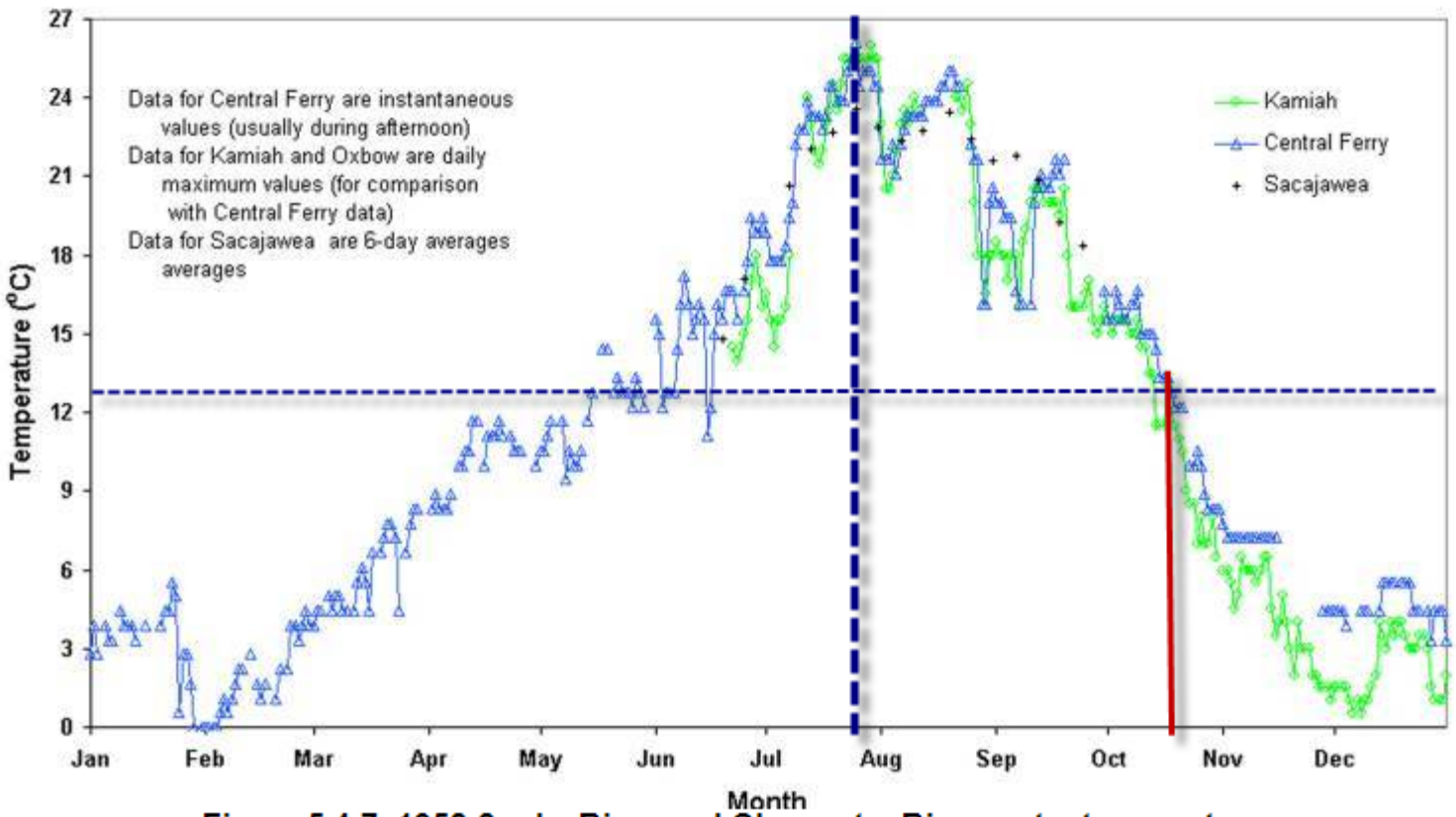


Figure 5.4-7. 1958 Snake River and Clearwater River water temperatures

Oxbow (approximately 130 miles upstream of the confluence), and for the Clearwater River at Kamiah (approximately 69 miles upstream of the confluence).

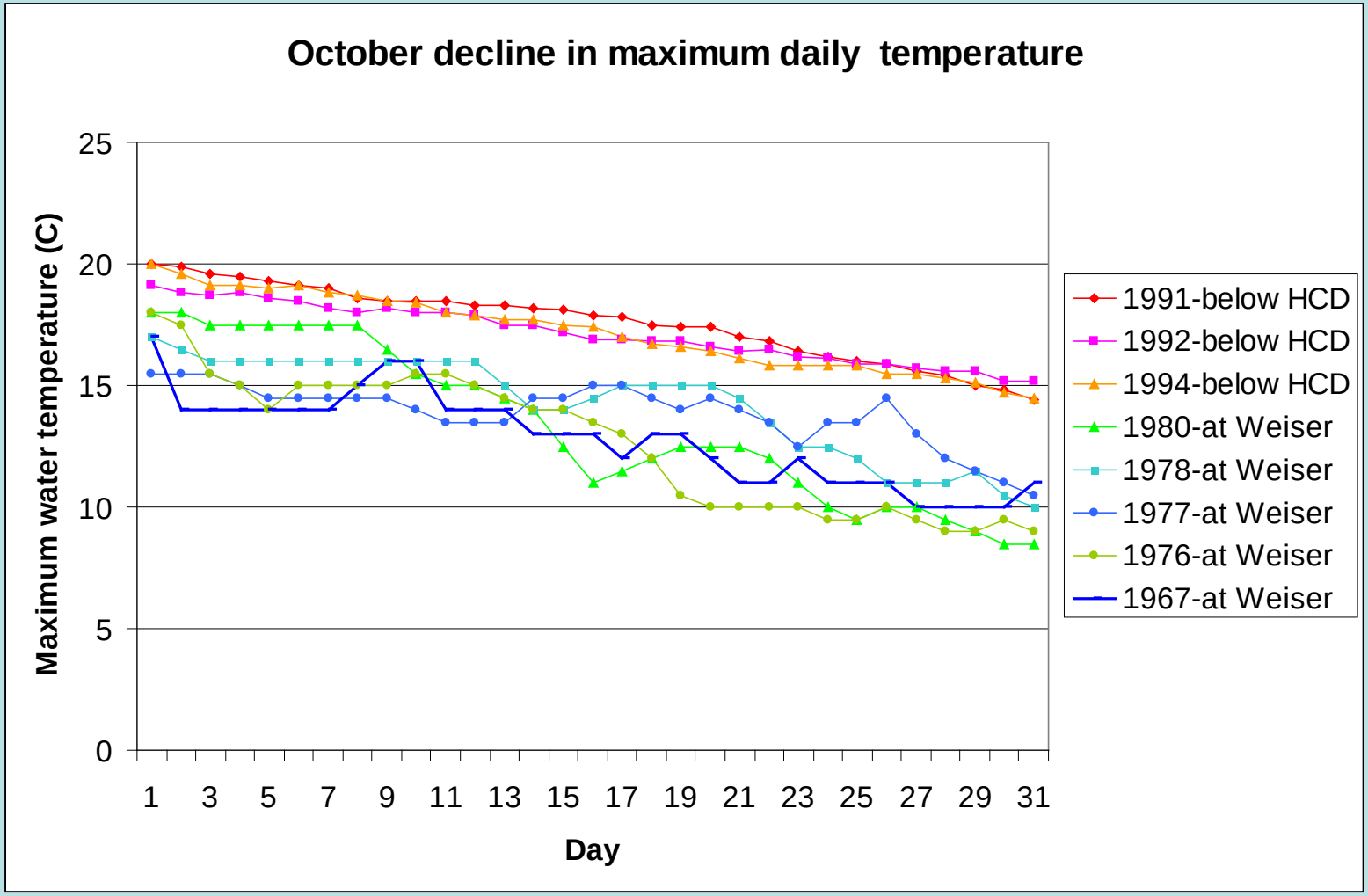
USACE. 1999. Lower Snake River Water Quality and Post-Drawdown Temperature and Biological Productivity Modeling Study. US Army Corps of Engineers, Walla Walla District. 323 p.
http://www.nww.usace.army.mil/lsr/reports/water_quality/model.htm

Thermal Pattern in the Snake River (cont.)

Under current conditions, water temperatures decline during October in the Snake River below Hells Canyon Dam but in 1991, 1992, and 1994, water temperatures still remained above 16˚C by October 23.

In contrast, the water temperatures at Weiser, Idaho on the Snake River (i.e., above Brownlee Reservoir) were consistently 2 to 5˚C cooler. The reservoir system produced by the Hells Canyon Complex results in very prolonged cooling rates.

Comparison of the rate of decline in maximum water temperature in the Snake River measured at the Weiser gage and at a station 10 miles downstream of Hells Canyon Dam.



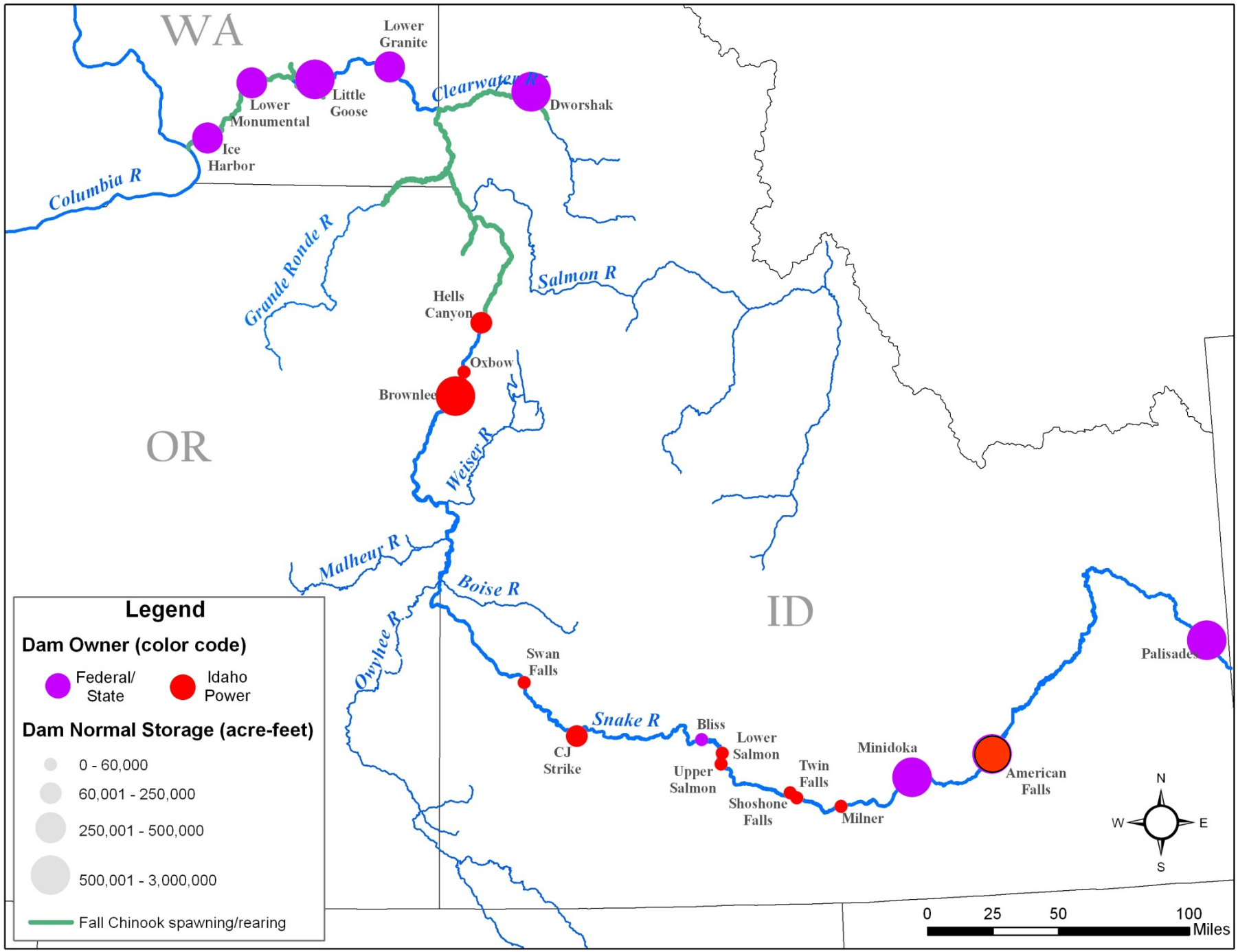
See file:Water temperature-Weiser vs below HCD-October.doc

Thermal Pattern in the Snake River (cont.)

A water temperature standard of 20˚C was set by Oregon as a protective standard for the mainstem Columbia and Snake Rivers. The effectiveness of this standard was seen as dependent upon the existence of thermal refugia in the mainstem to aid salmon in their upstream migration and holding prior to spawning.

Although it is recognized that maximum daily water temperatures were above 20˚C during parts of July in the 1950s, the Snake River mainstem had already been heavily affected by hydropower development and mainstem reservoirs. Much of this development started in the early 1900s and was also controlled by Idaho Power Company. Oregon has a provision to modify a water temperature standard to correspond to the natural background in cases where the proposed standard is higher than natural. In the case of the Snake River, the water temperatures observed in the 1950s were in no way natural.

The harm caused by the current water temperature regime stems from the prolongation of high temperatures late in the summer/fall period when adult fall chinook are holding prior to spawning. This subjects holding adults to prolonged exposure to adverse temperature conditions that can increase mortality due to a combination of disease, gamete impairment, excessive delays in reproduction, and bioenergetic stress. Current mainstem water temperatures are also minimally variable from day to day, so when high temperatures are reached, there are no opportunities for biological recovery that might occur from one day to the next. A natural thermal regime that has greater inter-day variation provides adults some recovery time when temperature spikes occur.


WA
OR
ID
Lower Granite
Little Goose
Lower Monumental
Ice Harbor
Dworshak
Clearwater R
Columbia R
Grande Ronde R
Salmon R
Hells Canyon
Oxbow
Brownlee
Weiser R
Malheur R
Boise R
Owyhee R
Swan Falls
Snake R
CJ Strike
Bliss
Lower Salmon
Upper Salmon
Twin Falls
Shoshone Falls
Milner
Minidoka
American Falls
Palisades
Legend
Dam Owner (color code)
Federal/ State
Idaho Power
Dam Normal Storage (acre-feet)
0 - 60,000
60,001 - 250,000
250,001 - 500,000
500,001 - 3,000,000
Fall Chinook spawning/rearing
N
W
E
S
0
25
50
100
Miles

Spawn Timing

Even though water temperatures in the 1950s, as recorded at Central Ferry on the Snake River mainstem (21 km upstream from Little Goose Dam) were relatively high (USACE 1999), reaching peaks of 25 to 26˚C between 1956 and 1958), these peaks temperatures were not sustained the same way that temperatures are with an immediate upstream reservoir effect, and inter-day variation was considerable.

In 1947, fall chinook spawning between Swan Falls and Marsing occurring between September 30 and October 17 was a significant proportion of the entire distribution (Zimmer 1950). This was prior to the development of the Hells Canyon Complex. On the other hand, between 1991 and 1995 spawning commenced essentially around October 23 (Rondorf and Tiffan 1997).

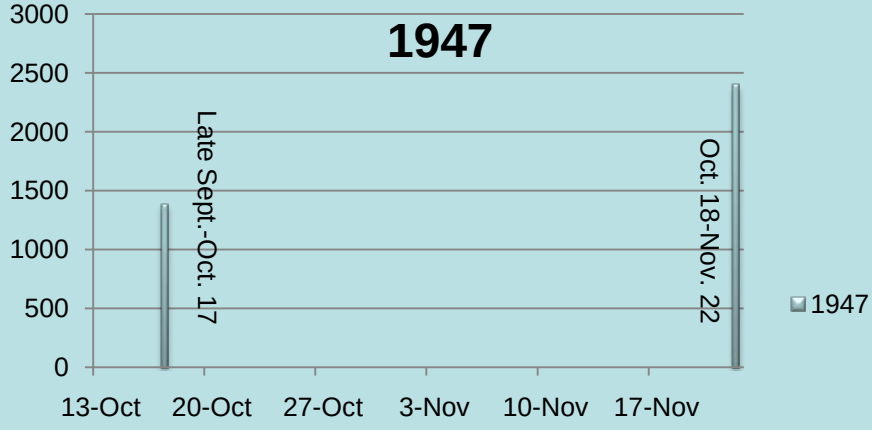
The ability of fall chinook to spawn earlier when water temperatures are colder can be witnessed in the Clearwater River.

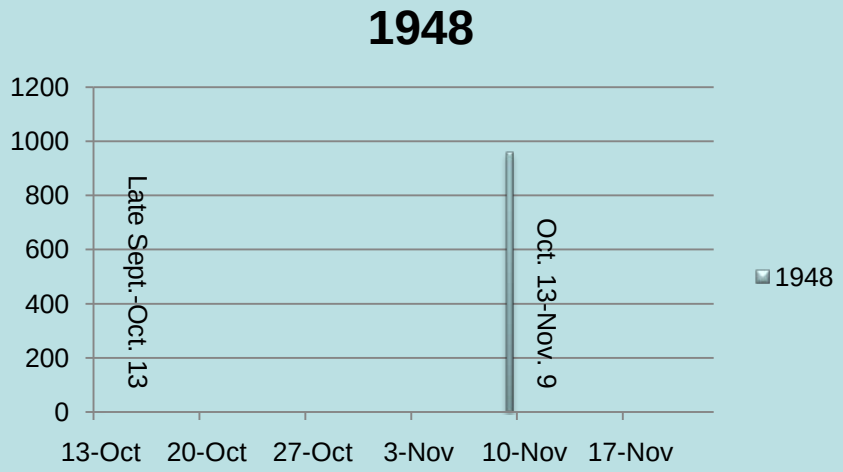
Rondorf, D.W. and K.F. Tiffan. 1997. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. Bonneville Power Administration, Division of Fish and Wildlife, Lower Snake River Compensation Plan Office, U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Project No. 91-029, Contract No.DE-AI79-91BP21708, (BPA Report DOE/BP-21708-1) 112 electronic pages

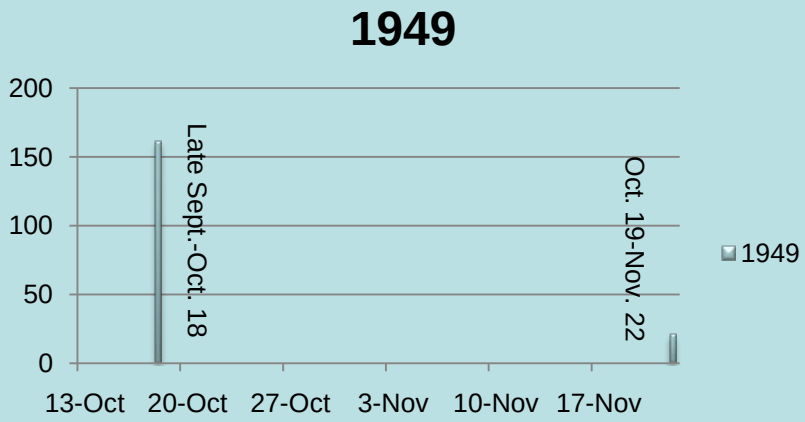
USACE. 1999. Lower Snake River Water Quality and Post-Drawdown Temperature and Biological Productivity Modeling Study. US Army Corps of Engineers, Walla Walla District. 323 p. http://www.nww.usace.army.mil/lsr/reports/water_quality/model.htm

Zimmer, P.D. 1950. A Three Year Study of Fall Chinook Salmon Spawning Areas in the Snake River Above Hells Canyon Dam Site. Supplements in 1951 and 1953. U.S. Fish and Wildlife Service Report.

Distribution of Fall Chinook Redds [1]Observed by Plane From Swan Falls to Marsing





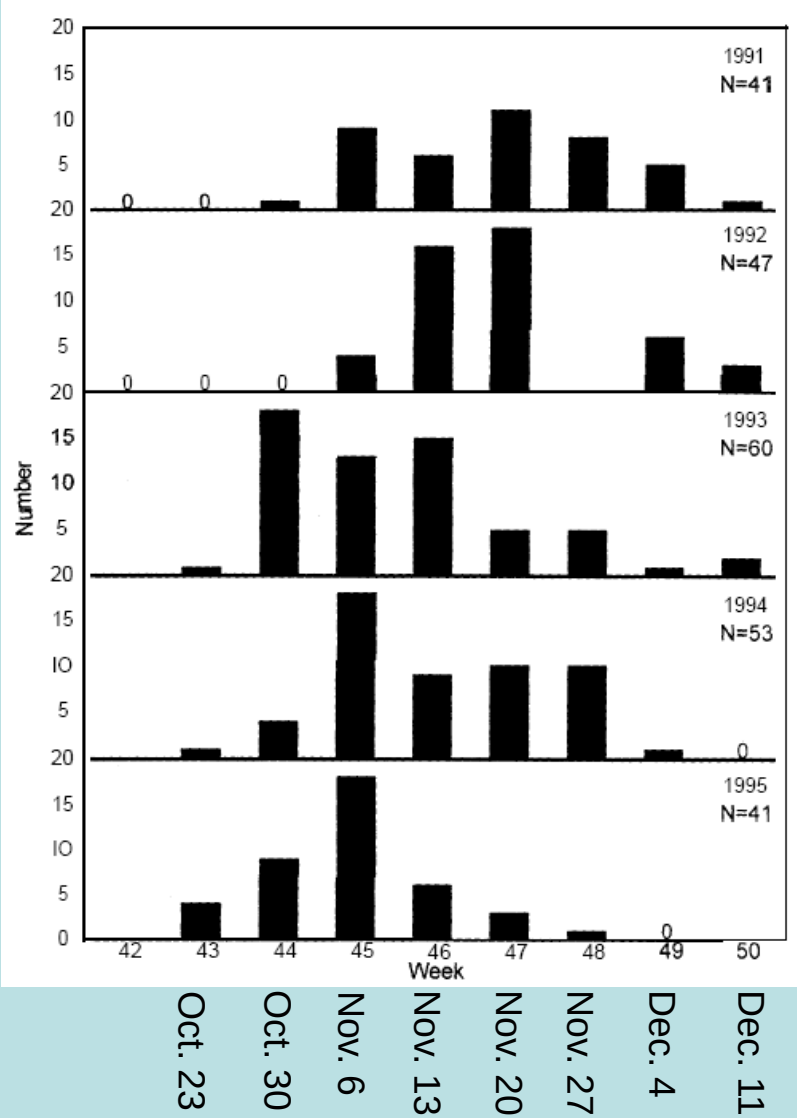


SUMMARY

27. Excellent spawning and rearing conditions for fall chinook salmon are present in the section of Snake River between upper end of Hells Canyon and Swan Falls, Idaho.

28. 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.

1. Note: redds observed at $time_2$ are presumed to be unique and not duplicating those observed at $time_1$
Data from Zimmer (1950)



Redd counts- rkm 244 to rkm 396 (HCD)
Rondorf and Tiffan (1997)

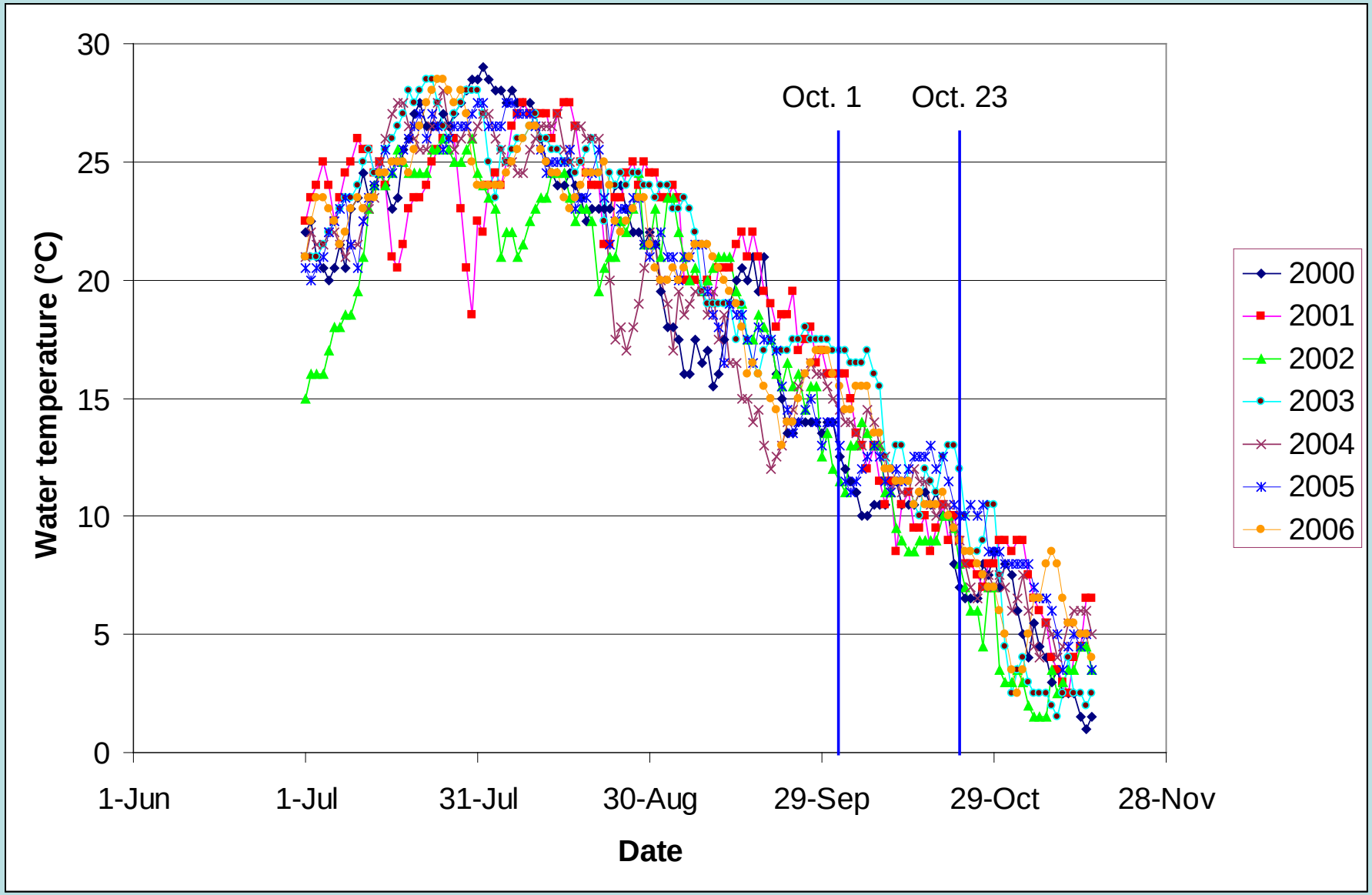
Spawn Timing

With the releases of cold water from Dworshak Reservoir on the North Fork Clearwater, water temperatures downstream in the Snake River have been significant reduced in the period from August 1 to October 23. Water temperatures on October 1 in the Clearwater River at Orofino ranged from approximately 12 to 17˚C, whereas at Spalding, Idaho they ranged from approximately 12 to 15˚C. Maximum August temperatures were as high as 28˚C at Orofino, but downstream at Spalding they were about 15˚C. In each case, water temperatures reached approximately 8 to 12˚C by October 23.

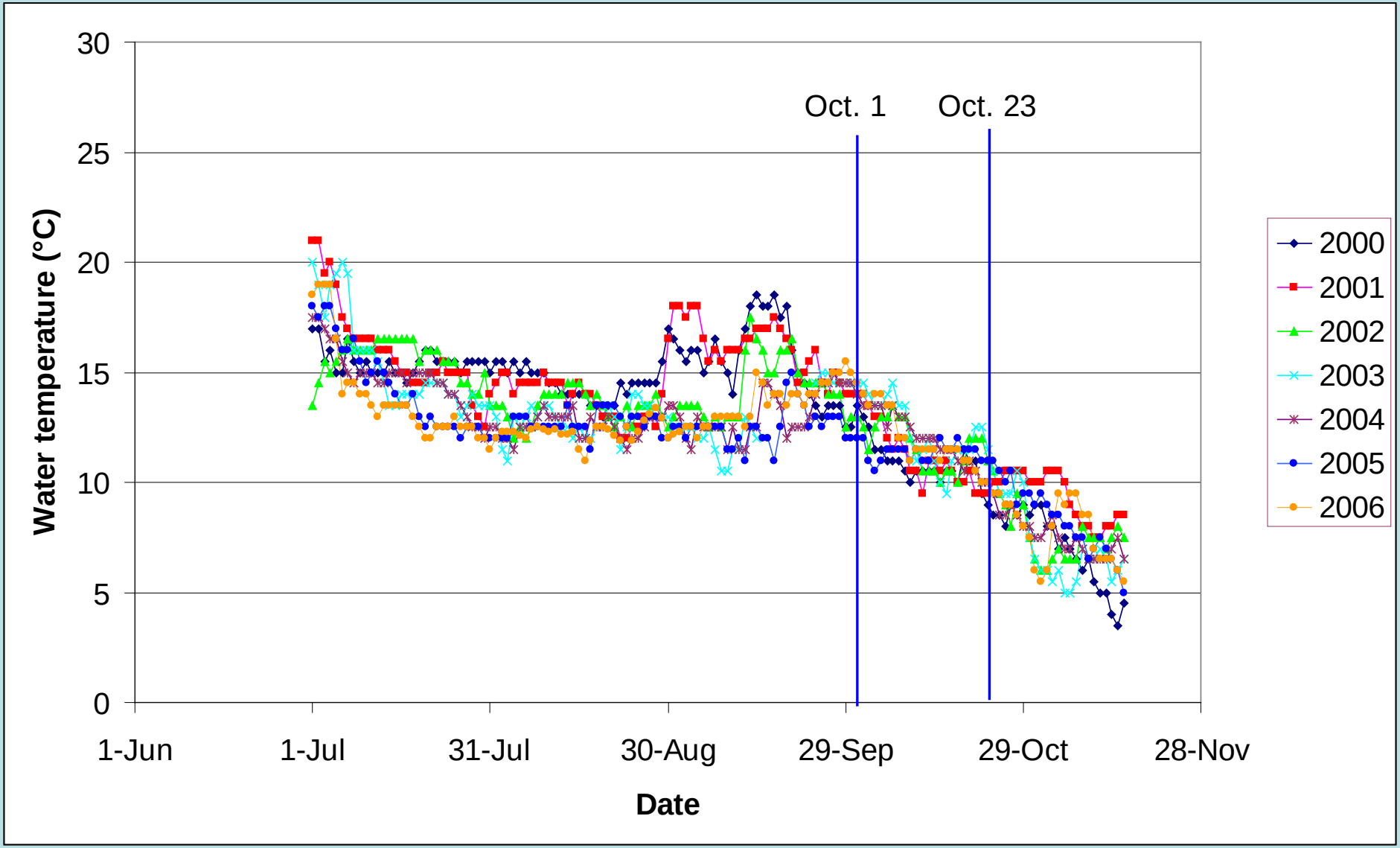
Since the release of water from Dworshak Dam into the lower Clearwater, the spawning time has commenced in late September in this river reach. Between 2001 and 2006, spawning has been 10 to 70% complete by October 23 (data from Nez Perce Tribe).

If a natural seasonal thermal pattern (NSTP) were re-established in the Snake River by ameliorating the thermal shift that has occurred, there is every reason to believe that spawning would be able to start earlier. In addition, adult survival and gamete viability would be more assured. There are no hatchery facilities that place their broodstock at risk by leaving them in holding ponds at temperatures approaching those found in the Snake River below Hells Canyon Dam.

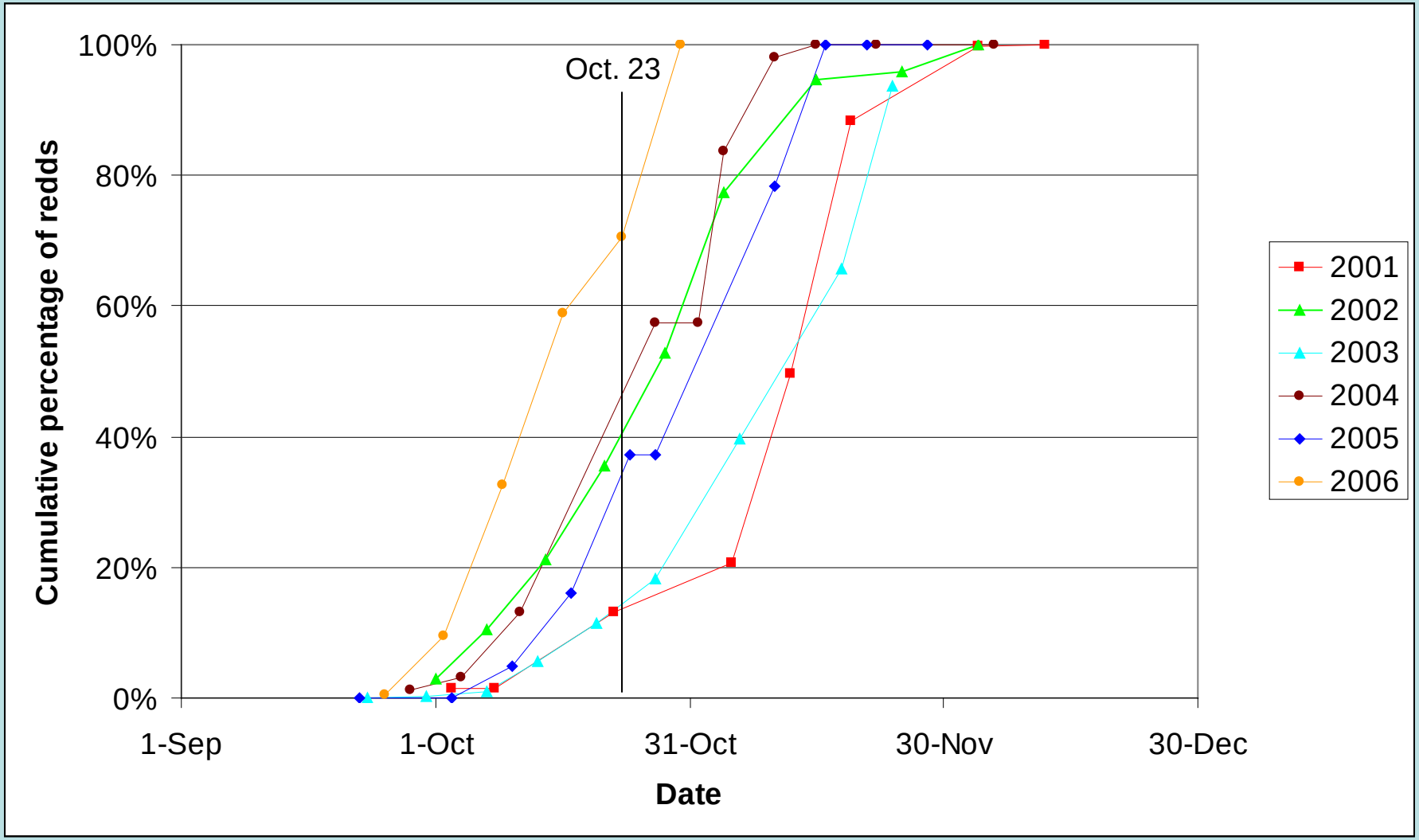
Maximum Daily Water Temperatures Clearwater River at Orofino, Idaho



Maximum Daily Water Temperatures Clearwater River at Spalding, Idaho



Cumulative Percentage of Redds Deposited in Lower Clearwater River Upstream to Ahsahka Islands



Source: Nez Perce Tribe annual reports

Natural Seasonal Thermal Pattern (NSTP)

Oregon DEQ (2008) described in their water temperature standards implementation document what is meant by a natural seasonal thermal pattern (NSTP). This guidance illustrates that a NSTP requires that there be a natural pattern to use as a template. Although the NSTP that existed prior to the system of mainstem Snake River dams above the Hells Canyon Complex may not be known, the pattern reflected in the current inflow to Brownlee Reservoir and the 1956-1958 temperatures recorded at Central Ferry may a useful example. These examples both reveal that there has been an approximate 25-day shift in the annual maximum temperature and a similar shift in the entire seasonal decline in temperatures leading to the spawning period.

This shift in the NSTP would require that water temperatures be lowered starting about August 1. Also, with the cold water available in Brownlee Reservoir, there should be efforts applied to meet the summer water temperature standard.

CRITFC also believes that the water temperature standard of 13˚C should be met no later than October 23. In fact, it appears that in 1947 and 1948 that spawning commenced in late September, similar to the current lower Clearwater spawning pattern. Consequently, there is a case to be made to move the date of reaching 13˚C earlier. Also, the current practice of averaging the daily maximum temperatures from October 23-October 29 to arrive at a temperature of 13˚C is unacceptable. This gives several more days of non-compliance to IPC.

Natural Seasonal Thermal Pattern (NSTP)

Oregon DEQ. 2008. Temperature Water Quality Standard Implementation – A DEQ Internal Management Directive. Oregon Department of Environmental Quality. Portland, Oregon.

As an illustration, Figure 7-1 compares the seasonal temperature profiles of two rivers. In these profiles, the rising and falling slopes are very similar, peak widths are similar and timing of onset of temperature increases and decreases are nearly identical between River A and River B. If River A were representative of a natural seasonal thermal pattern, River B would reflect that pattern and would meet the natural seasonal thermal pattern requirements. In Figure 7-2, the seasonal pattern has been shifted below the reservoir, even though the maximum temperature has not increased.

Figure 7-1: Two Temperature Profiles

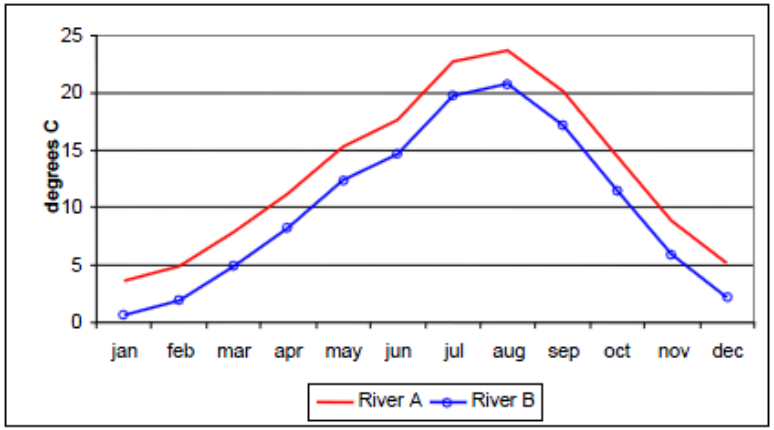
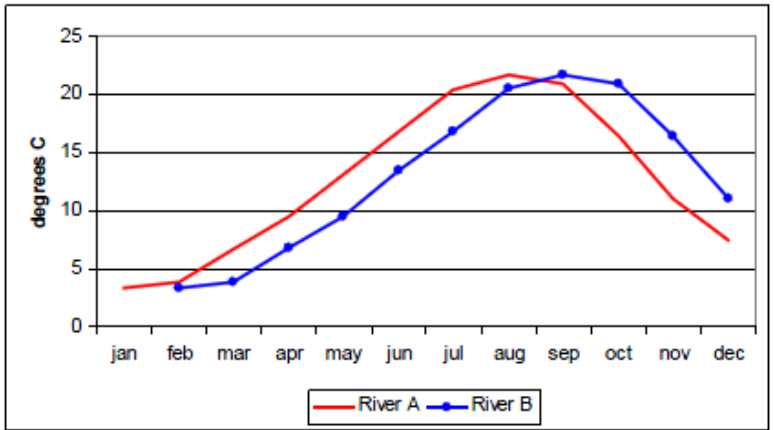


Figure 7-2: Shifted Seasonal Temperature Pattern

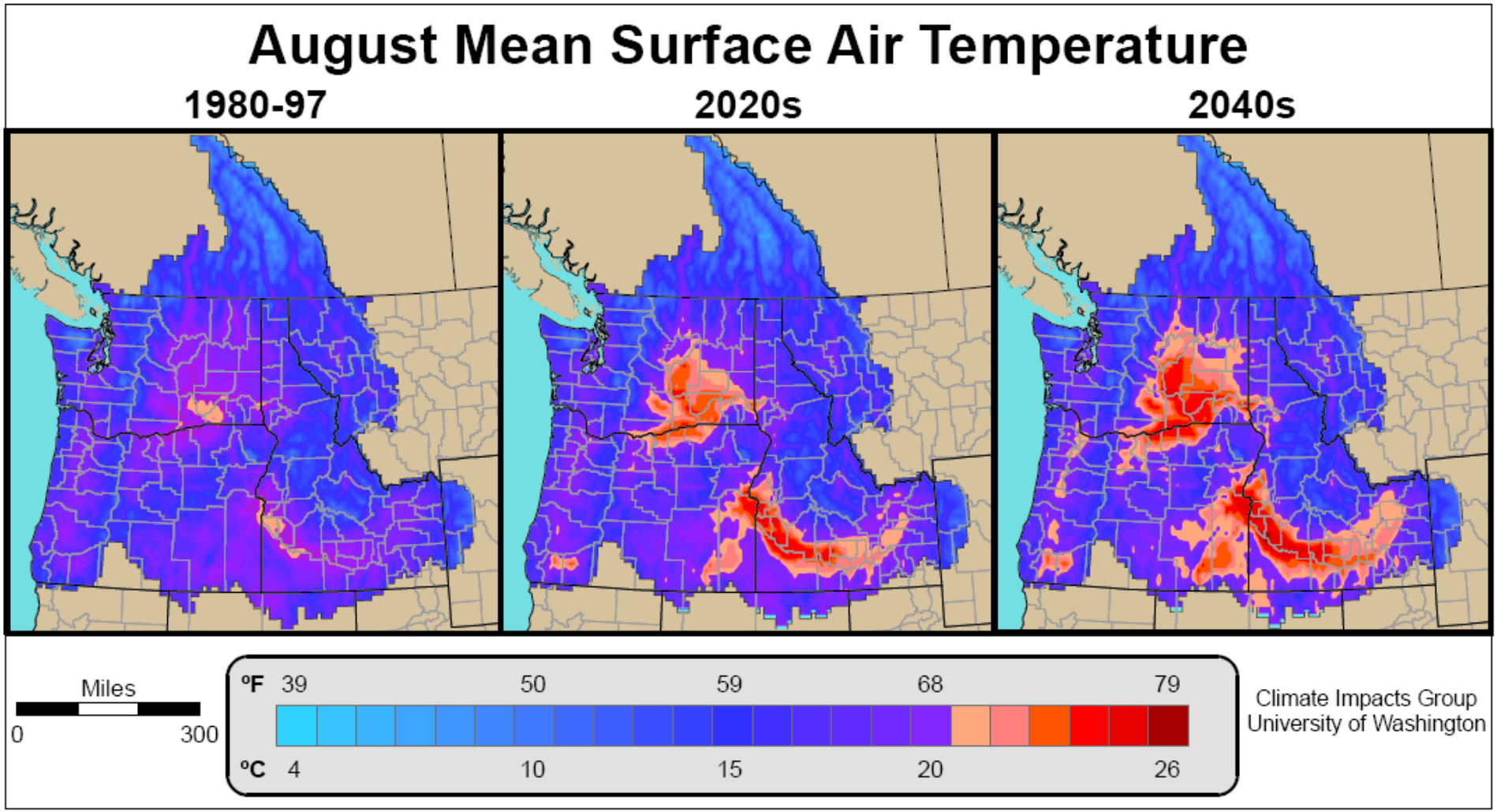


Climate Change--Future Trends

The upward trend in Columbia River water temperature maxima has been dramatic since 1939 as shown earlier. Future trends will be linked to projected changes in air temperatures. The University of Washington Climate Impacts Group has applied regional climate modeling to predict future August mean surface air temperatures across the Columbia and Snake basins. By 2040 the relatively hot August air temperatures will be pervasive throughout the Snake basin. This will surely continue to increase summer water temperatures.

The probable increases in summertime water temperatures in the Snake River mainstem will necessitate having management tools with near-term effectiveness to control water temperatures. This means that use of long-term upper basin riparian restoration will be ineffective within the life of the hydro-license agreement to reduce downstream water temperatures below Hells Canyon Dam. Although increased air temperatures may be accompanied by decreased water flows, it is under these conditions that colder water temperatures are available below the thermocline in Brownlee Reservoir (McCulloch et al. 2009). A TCS able to operate from August through October is likely the only means to bring about the correction of the NSTP, reduce summer temperature exceedances, and also meet the fall spawning standard.

McCulloch, A., C. Berger. and S. Wells. 2009. Brownlee Reservoir Cold Water Analysis and Downstream Impact of Cooler Water Temperatures Released from Hells Canyon Dam. Technical Report EWR-05-09. Water Quality Research Group, Department of Civil and Environmental Engineering, Maseeh College of Engineering and Computer Science, Portland State University
Portland, Oregon. 34p.



Recent and Projected Average August Surface Air Temperature in the Columbia Basin. The left panel shows observed August temperatures in the Columbia River Basin. Future temperature projections made with a relatively cool climate model are shown in the center and right panels.