Pacific Coast Federation of Fishermen's Associations and the Institute for Fisheries Resources

Watershed Conservation Office
850 Greenwood Hts. Dr.
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State Water Resources Control Board
Attn: Song Her, Clerk to the Board
1001 "I" Street
Sacramento, CA 95814
Email: comments@waterboards.ca.gov

29 October 2006
Emailed and mailed

Re: Comment Letter - Shasta River Watershed DO and Temperature TMDLs

Dear State Water Board Members:

The Klamath River was once the third most productive salmon river system in the world. As you know, the ongoing and accelerating collapse of the Klamath River's once-abundant salmon runs, particularly for ESA-listed coho salmon (which is not commercially harvested), but also for chinook salmon, is in <u>no small part</u> caused by serious water quality problems in its major tributaries (including the Shasta River) that currently limit salmonid production or threaten to eliminate it altogether in those important river reaches. PCFFA, as the west coast's largest trade association of commercial fishing families, and it's many member family fishing businesses, have too long borne the brunt of all these human-caused Klamath Basin water problems, now losing tens to hundreds of millions of dollars each year in coastal community revenues because of these water problems. This year's near-total Klamath ocean fishery closure is only the latest and worst of many Klamath-driven fishery failures.

The Regional Board's Draft Resolution R1-2006-0052 recognized the essential inseparability of water quality and water quantity in amendment number nine. One clear fact of hydrology is that high temperatures and low dissolved oxygen are always exacerbated by low flows.

Thus low flows in the Shasta River are a problem that <u>cannot</u> be ignored, and no TMDL can validly address the various water quality problems linked to low flows without taking low flows into account and mitigating through minimum instream flow requirements for this most fundamental problem.

The Regional Board staff has been thorough in their analysis and their conclusion is scientifically and legally sound that maintaining the recommended 45 cfs flows as an absolute minimum flow requirement must be accomplished in order to reduce high temperatures and meet water quality standards. This standard is the minimum in-stream flow that should be adopted by the State Board.

Specific actions to achieve the minimum flows for fish are not delineated, yet immediate steps are needed now to preserve remaining salmonid stocks. We are presently experiencing relatively favorable conditions for salmonids in the ocean and in a wet on-land cycle that will likely reverse sometime between 2015 and 2025 in what is known as the Pacific Decadal Oscillation (PDO) cycle. That coho salmon and fall chinook salmon populations are at such low levels or showing serious declines during the positive cycle of the PDO is not a good sign. In order to restore Shasta River chinook and coho salmon stocks, low flow and water quality problems must be remedied by 2015 or whenever the PDO switches to less favorable conditions for salmon stocks or further extinctions are likely to occur. A population that is already severely stressed even under relatively good oceans conditions will disappear when, as is inevitable, those cyclical conditions shift for the worse.

The Shasta River TMDL should also specifically target recovery of coho salmon, which are recognized as “threatened” under both the federal and California Endangered Species Act (CESA). Coho, unlike chinook salmon, spend up to 18 months in our river systems, and are thus especially susceptible to poor water quality and river dewatering during the summer months. Coho are also exceptionally tributary dependent. Coho spawning is well known in the Shasta (in fact, the Shasta represents some of the most historically important coho spawning areas), *yet the TMDL Action Plan proposal does not specifically focus protection or restoration on reaches or tributaries that presently harbor ESA-listed coho or which are important for coho recovery.* Coho restoration in the Shasta is a policy goal that is required under both federal and CESA listings for this stock.

Attachment A of this letter further details the link between water quantity, nutrients, high pH, high temperatures and low DO throughout the Shasta River. High temperatures stressful to salmon at the Shasta River’s mouth also flow into the mainstem Klamath and add to the water temperature problems there.

To implement the TMDL and comply with the Basin Plan Objectives, the Action Plan must adequately describe specific and measurable actions to achieve water quality standards, with reasonable assurance of success. Timelines with milestones and monitoring are needed to determine whether these actions are working over time.

Thousands of businesses and families downstream and along the coast are relying on the Water Boards to improve the illegally degraded condition of tributaries to the Klamath River and restore the beneficial uses, jobs and dollars this fishery traditionally provides. The ocean fishery has faced twenty-seven years of increasingly restrictive closures as Klamath River stocks continued to decline. Commercial fishing ports in California and most of Oregon, related fishing-dependent businesses, as well as the ocean and river sport fishing-related businesses and basic subsistence support fisheries for the Tribes, are all dependent on the Water Boards to restore conditions that will support viable salmon populations, and to do this soon -- while it is still possible at all.

We live in a time of rapid change, and people are often uncomfortable with and even fearful of change. Instream dedicated flows do not have to mean farmers and ranchers going out of business, nor is there any evidence to support such hysterical scare stories. There are in fact plenty of creative solutions, including working through the many existing water conservation programs to make better and more efficient use of the water already available for irrigation, curtailing illegal usages, and to use willing seller water bank or water trust programs as temporary solutions until more permanent solutions can be implemented.

However, one thing is clear: without sufficient cold water in the Shasta River, the once-abundant salmon runs originating in or dependent upon the Shasta will go extinct. This would further jeopardize thousands of coastal and in-river fishing-dependent jobs that are also threatened with extinction. Where the salmon go, so go the fishing men and women who depend on the salmon for their livelihoods.

We know that with community involvement and public funding, salmon runs can be restored. For example, the endangered spring run chinook on Butte Creek in the Sacramento River rebounded from less than 50 fish to between ten and twenty thousand adults in each of the last nine years. After the ESA listing, local organizations, landowners and agencies removed 5 dams, established minimum flows, installed 10 flow-monitoring stations, 11 fish ladders, and 5 fish screens.

Six local salmon fishing boats just left Eureka this June for Alaska, and five of them for the first time – in other words, these fishermen has to leave the state to try to earn a living. The permit costs $30,000, and it is a dangerous trip for a small fishing boat that takes ten days to get there under good weather conditions. One Bodega Bay fisherman fished the open area down south and caught only 31 fish for the entire month. The current salmon fishing season is a major disaster. I asked one of the fishermen who was leaving what he would like me to say to the Water Board about water quality in Klamath tributaries, and he replied: “Get with it.”

I also enclose Governor Schwarzenegger’s 6 June 2006 Proclamation of Disaster for ten California counties (Monterey, Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Humboldt, Del Norte and Siskiyou Counties), as Attachment B. Poor water quality and poor water flows are specifically cited in his Declaration as some of the underlying causes of the failure of the Klamath fishery and resultant near total closures of the rest of the coast. The least this Board can do is address those Shasta River water quality and quantity problems within its control.

We also recommend that the Regional Board adopt an Action Plan for the Shasta River that incorporates the recommendations of Coast Action Group, provided in their separate letter. Please refer to Attachment A for additional information on the importance of restoring minimum flows to the Shasta River as part of this process. The need for a baseline minimum flow with most reaches of the Shasta River, and the importance to salmon production (and the jobs that production represents) of maintaining minimum flows even during low water years cannot be over-stated.

As this letter is filed within the deadline for comment (comments are due by November 1st at Noon) please include this letter, with Attachments A and B, in the administrative record of this proceeding.

Sincerely,

Vivian Helliwell, for the
Watershed Conservation Office, PCFFA/IFR
850 Greenwood Heights Drive
Kneeland, CA 95549
(707) 445-1976

Attachment A -- Shasta River TMDL Supporting Information: Flow, Temperature, Nutrient Pollution and Potential for Loss of Pacific Salmon Stocks

Attachment B – A Proclamation by the Governor of California of Fisheries Disaster in the Klamath (6 June 2006)

Attachment A to PCFFA/IFR Comments

Shasta River TMDL Supporting Information: Flow, Temperature, Nutrient Pollution and Potential for Loss of Pacific Salmon Stocks

This attachment is to provide information related to the *Shasta River TMDL* demonstrating relationships of flow reduction on water quality impairment. Water quality in the Shasta River is severely impaired with regard to temperature, pH and dissolved oxygen and remediation will require increased flows. Pacific salmon population status in the Shasta River basin is discussed and information presented to show that the TMDL's 40 year time line for restoring water quality may not be sufficiently speedy to prevent major salmonid stock loss. The impacts of Dwinnell Reservoir on water quality and other flow issues related to salmon recovery are also covered below.

Low Flows in the Shasta River

The *Shasta River Adjudication* (CDPW, 1932) does not require a minimum flow level similar to the Scott River Adjudication (CSWRCB, 1980), which provides baseline targets for flow to support aquatic habitat on U.S. Forest Service lands. Consequently, the Bureau of Land Management holdings in the lower Shasta River (Figure 1) are not given flow allocations. Lower reaches of the Shasta River have appropriate gradient and habitat complexity to support juvenile salmonids, but show temperatures and water quality problems that are chronically stressful or lethal throughout summer. Although the *Draft Shasta Valley Resource Conservation District Master Incidental Take Permit Application for Coho Salmon* (ITP) sets a minimum flow target of 20 cfs to be met by 2015, that level of flow will not likely attain beneficial uses such as restoration of coho salmon or

Figure 1. This photo shows the Shasta River flowing through BLM land in the canyon reach in an area referred to as Salmon Heaven. Boulders were placed to improve fish habitat, but water quality is too poor to support salmonid juveniles during most of summer. Photo from KRIS Version 3.0 (TCRCD, 2003).

steelhead trout (see Temperature section). North Coast Regional Water Quality Control Board studies related to the TMDL support increasing minimum flows to 45 cfs to abate pervasive water quality problems.

Flow records from 2001 and 2004 from the U.S. Geologic Survey flow gauge just upstream of the convergence with the Klamath are displayed as Figures 2-3. These charts provide a reference for temperature and water quality summaries for the same years presented later in this paper. Average daily flows in dry years like 2001 fall to near 20 cfs or less for weeks at a time (Figure 2). Hourly data are not available, but lack of coordination of irrigation operations may sometimes cause flows to fall below the listed average and present an even greater challenge for fish survival.

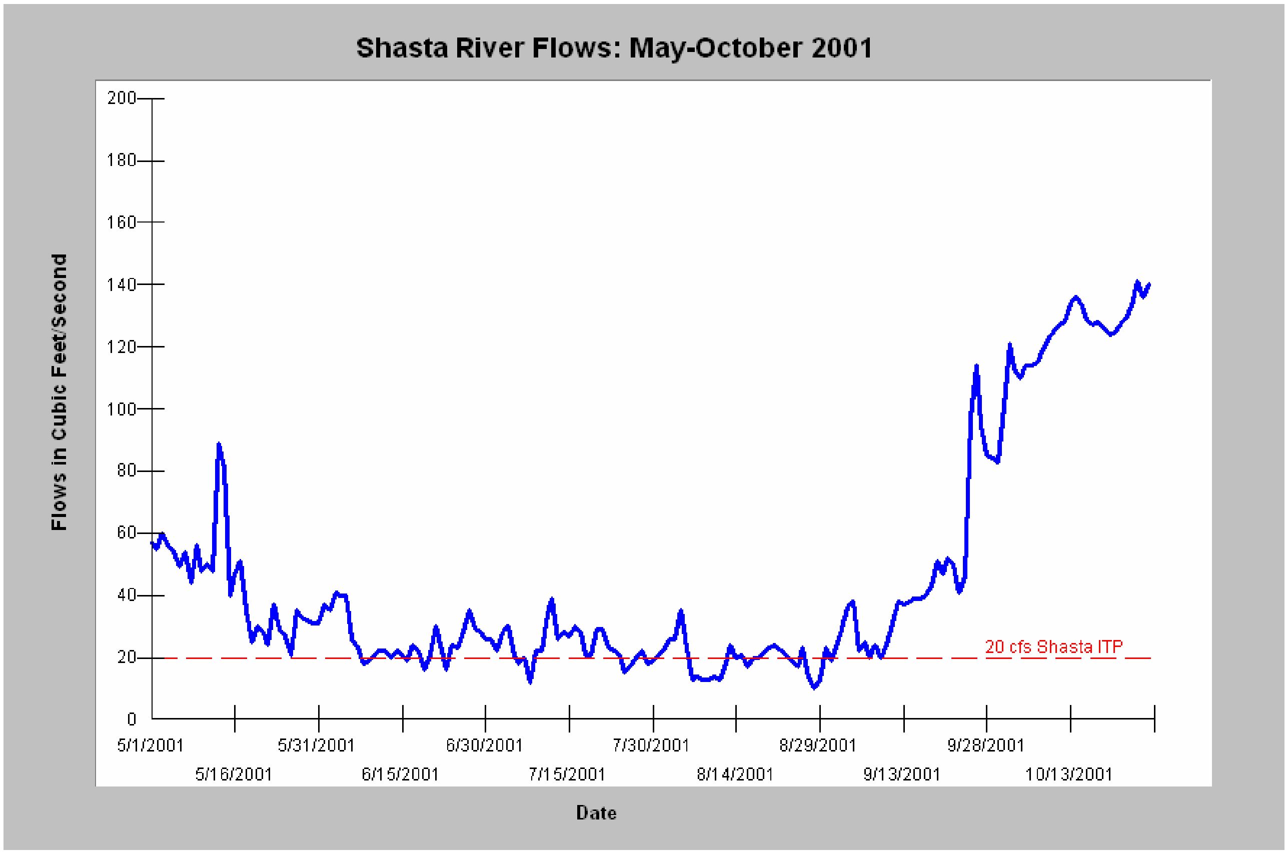

Figure 2. Average daily flow at the USGS Shasta River gauge for May through October 2001 shows a pattern of extremely low flows with many days falling below 20 cubic feet per second.

Average daily flow in years with more precipitation like 2004 may be much greater than 20 cfs on most days within the irrigation season (April 15-October 1), but can fall below that level on any given day. Summer rainfall may decrease the need to irrigate and summer thunderstorms are the cause of periodic increased flows.

The original need for adjudication on the Shasta River was driven by over-allocation, leading to water rights holders in the lower reaches being deprived of sufficient flow (CDPW, 1925). The Shasta River was blocked mid-way by the construction of Dwinnell Dam (Figure 4) in 1928. Flows are routed into a canal and down the east side of the valley for irrigation and there is no requirement for minimum flow in the reach of the Shasta River immediately below the dam. Water stored in the reservoir is augmented by diversion of Parks Creek into the Shasta River at Edgewood, even during winter when salmon and steelhead could otherwise be using this tributary. Storage capacity in the reservoir was increased through reinforcement of Dwinnell Dam in 1958 (Figure 5) leading to less need to spill excess winter flows in most years. The resulting lack of winter flood peaks decreases channel scour, which can lead to a build up of organic material (Gwynne, 1993) and increased biological activity with the resultant adverse water quality impacts.

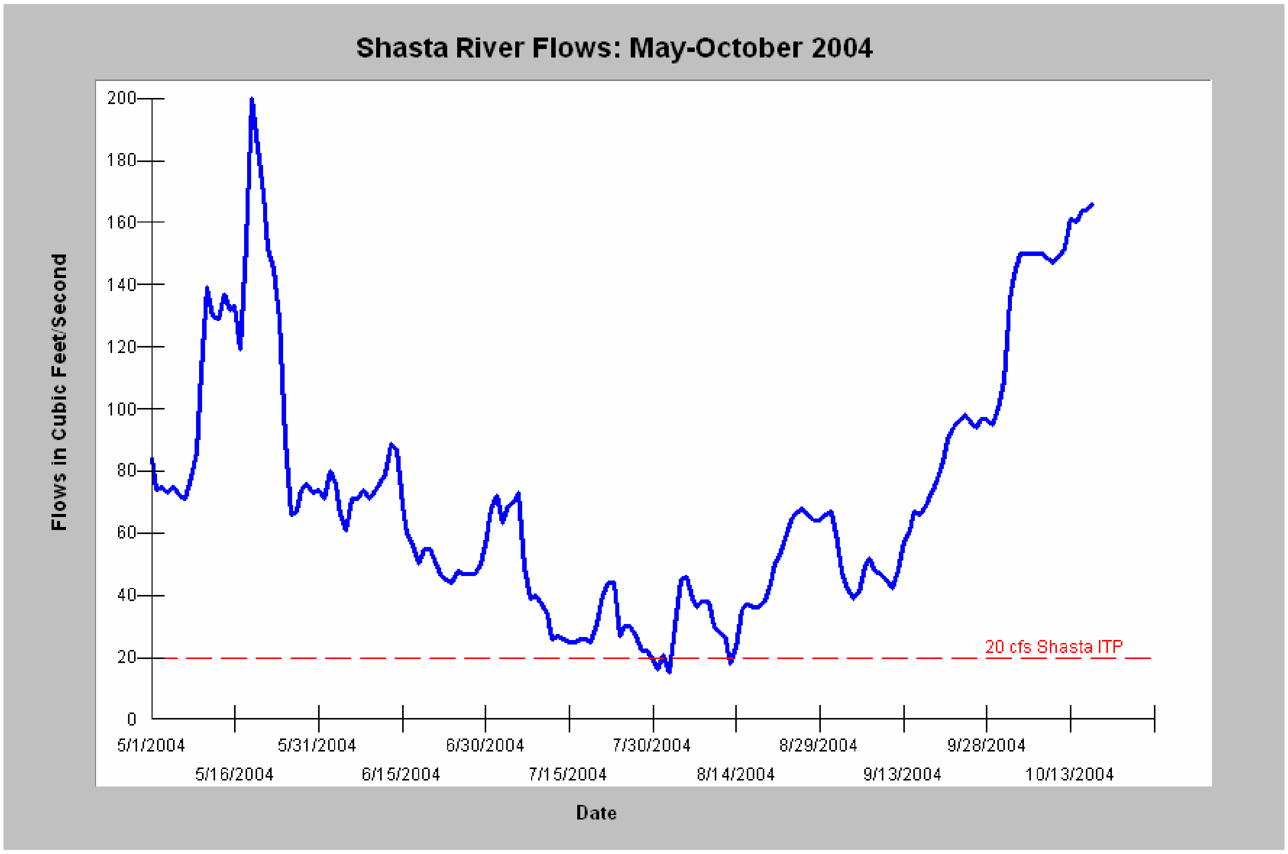

Figure 3. Average daily flow of the lower Shasta River from May to October 2004. Data from USGS.

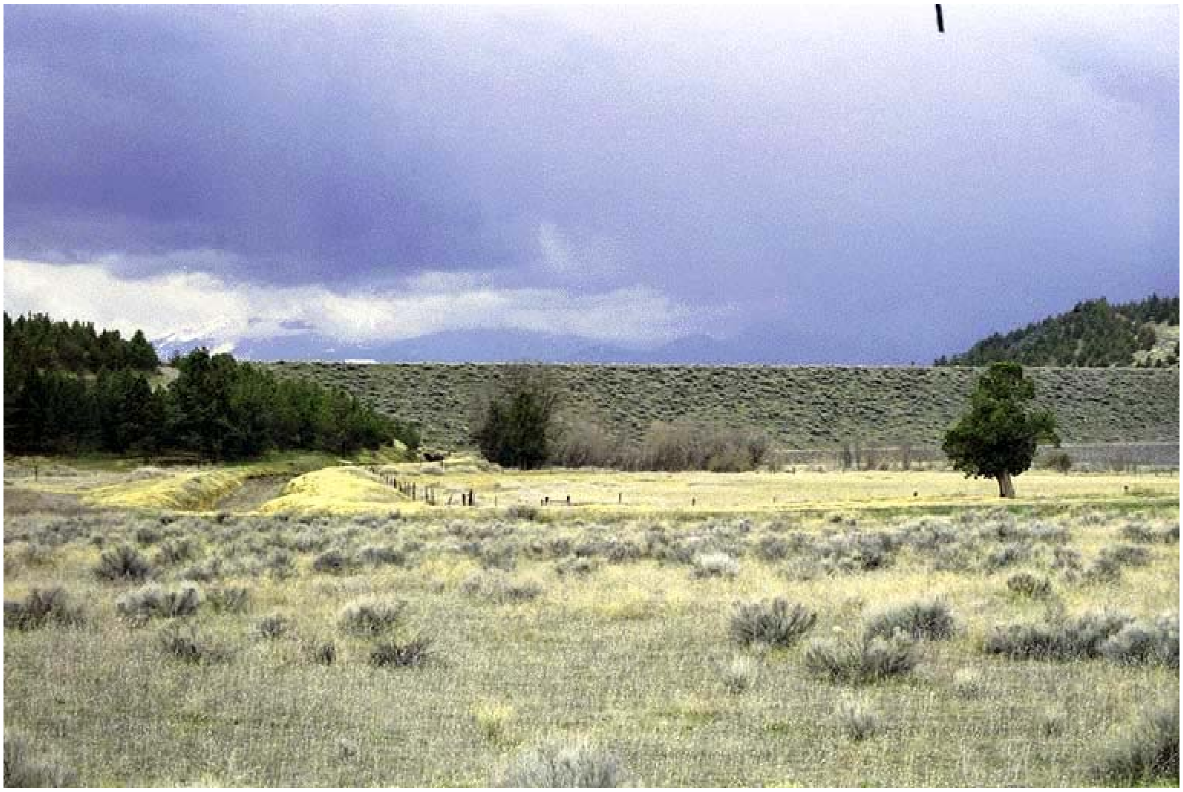

Figure 4. Dwinnell Dam looking south with the canal at left into which almost all flows from the reservoir are diverted. Photo from KRIS Version 3.0 (TCRCD, 2003).

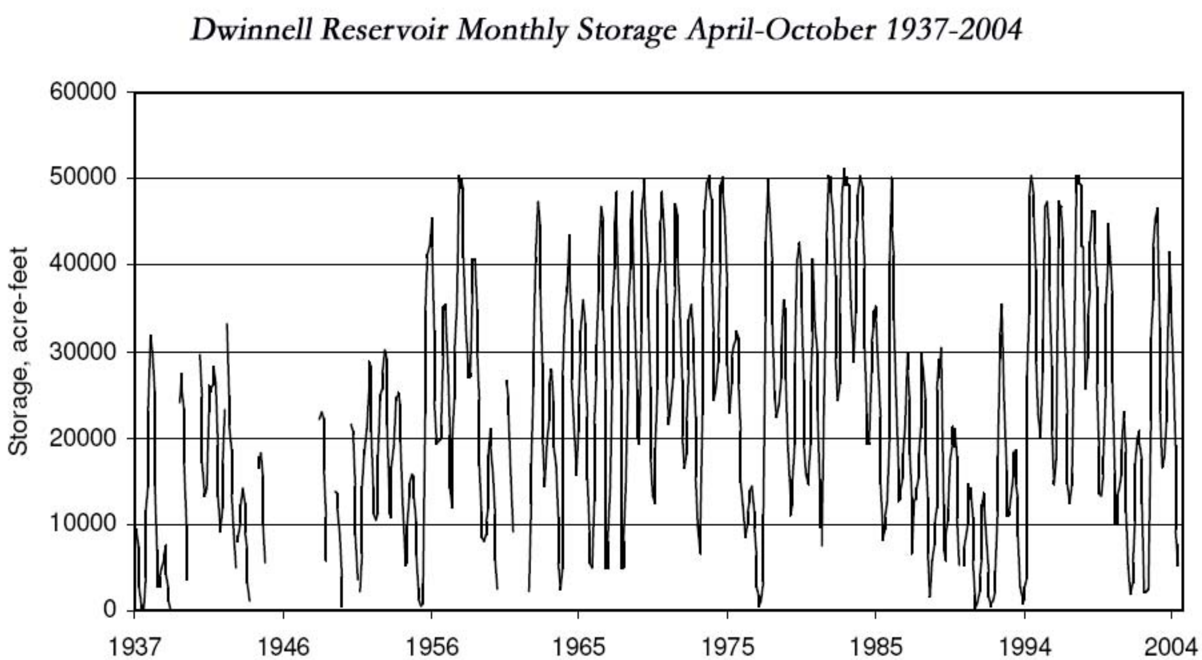

Figure 5. This chart was taken from the report *Lake Shastina Limnology* (NCRWQCB and UCD, 2005) and shows the storage capacity in acre-feet of Dwinnell Reservoir with a major increase after dam reinforcement in 1958.

There are major water quality problems in Dwinnell Reservoir (Figure 6) as a result of photosynthetic activity (NCRWQCB and UCD, 2005). Algae blooms cause very alkaline conditions, fluctuations in dissolved oxygen and periodic problems with dissolved ammonia. There is substantial seepage loss from the Dwinnell Reservoir and the reach of the Shasta River below the dam shows similar patterns of water quality impairment to those within the reservoir (NCRWQCB and UCD, 2005).

Dwinnell Dam blocks gravel transport downstream into reaches above Big Springs Creek, thus restricting supply of spawning gravels for salmonids. Similarly, the dewatering of Parks Creek (Figure 7) and other tributaries such as Willow Creek, Julian Creek and the Little Shasta River also reduces spawning gravel availability. Coutant (2005) pointed out that cumulatively gravel deprivation may have changed hydrologic function by decreasing the hyporheic zone and exchanges of surface and subsurface water that may have formerly cooled the Shasta River. Restoring access to cool headwater areas by removing Dwinnell Dam would also increase chances for restoring Pacific salmon.

Temperature Impairment and Relationship to Flow

The *Shasta TMDL* relies heavily on increasing shade and decreasing contributions of warm agricultural drain water, but also recognizes that decreased transit time from increased flows must also be used to attain beneficial uses. The National Research Council (NRC 2003) report entitled *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery* described the relationship of water flow to temperature in the Shasta River:

> "Low flows with long transit times typical of those now occurring in the summer on the Shasta River cause rapid equilibration of water with air temperatures, which produces water temperatures exceeding acute and chronic thresholds for salmonids well above the

Figure 6. Dwinnell Reservoir looking southeast off the dam with water levels at less than full pool in 2002. Long retention time and exposure to sunlight trigger algae blooms and nutrient pollution. Photo from KRIS V 3.0 by Michael Hentz.

Figure 7. Parks Creek is shown here below the diversion to Dwinnell Reservoir with surface flows almost completely depleted. This not only shuts off cool water that could buffer high Shasta River water temperatures but also blocks spawning gravel recruitment. Photo by Michael Hentz.

mouth of the river. Small increases in flow could reduce transit time substantially and thus increase the area of the river that maintains tolerable temperatures."

Water temperatures in the entire length of the Shasta River become unsuitable for salmonid juvenile rearing for most of each summer. Figure 8 shows maximum daily water temperatures of the Shasta River from Louie Road just below Dwinnell Reservoir downstream to Anderson Grade Road at the bottom of the Shasta Valley. While there may be some isolated refugia due to spring flows, most of the reach attains stressful or lethal temperatures for Pacific salmon species. McCullough (1999) found that all Pacific salmon species were stressed at temperatures greater than 20^{O} C and Welsh et al. (2001) noted that coho salmon are only found in rearing areas with an average weekly maximum temperature (MWAT) of 16.8^{O} C or less. Sullivan et al. (2000) recognized 25^{O} C as lethal for Pacific salmon.

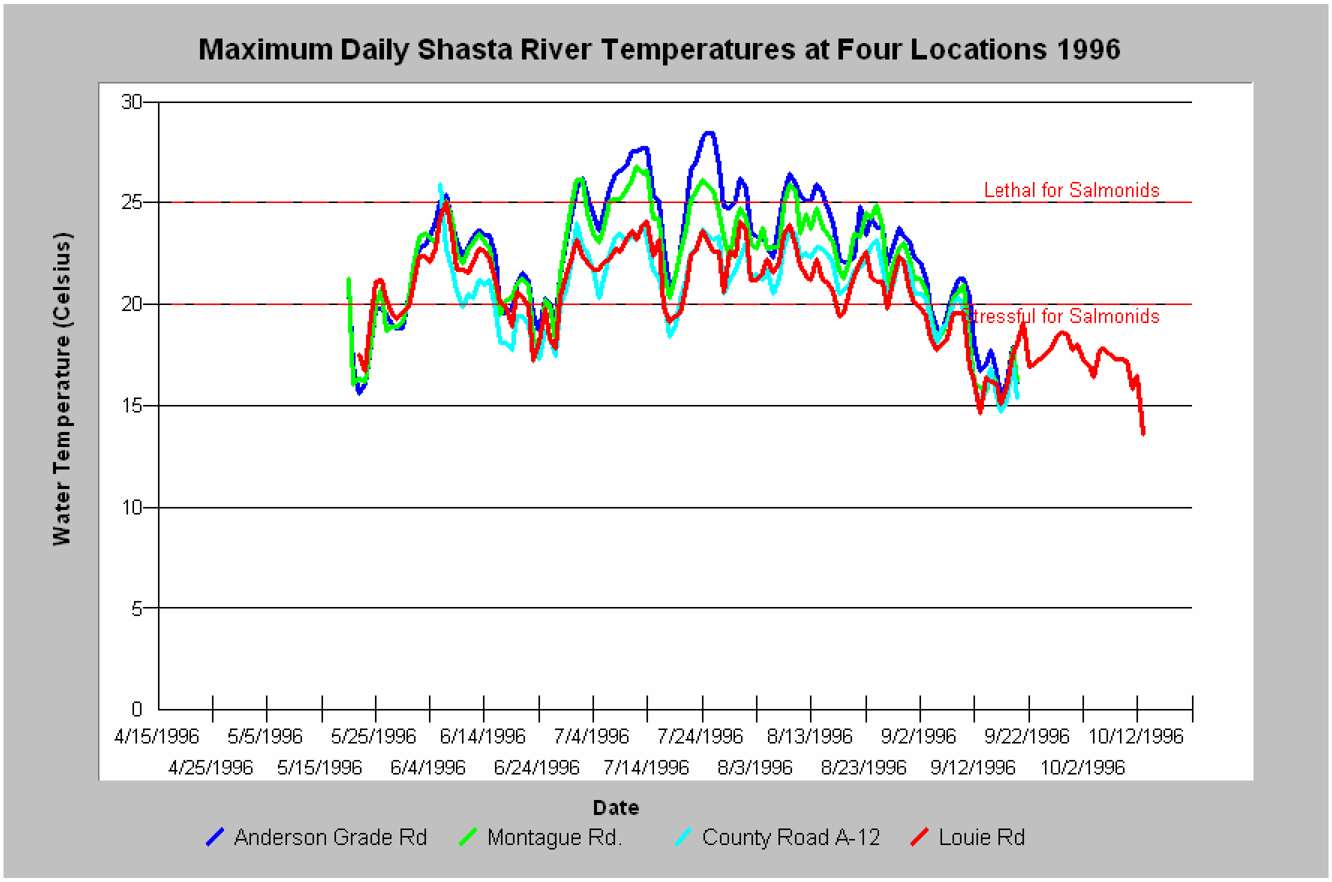

Figure 8. Maximum daily water temperatures are displayed above for the Shasta River at four locations from May through October of 1996. Temperatures exceeded stressful or lethal levels at all locations from June through August. Chart from KRIS V 3.0 and data from CDFG.

Lower mainstem Shasta River water temperatures and water quality have been measured by the U.S. Fish and Wildlife Service, the U.S. Bureau of Reclamation and USGS. Figure 9 shows minimum, average and maximum water temperature of the Shasta River just above its convergence with the Klamath River from May to October 2001. Even minimum temperatures exceeded stressful levels for salmonids and maximums often exceeded lethal levels. Fall chinook salmon use the lower Shasta River to spawn and the U.S. EPA (2003) defines the maximum temperature suitable for spawning as 13 ^{O} C or less as a seven day floating average. Water temperatures were above optimal for salmon spawning and egg incubation through the first week in October.

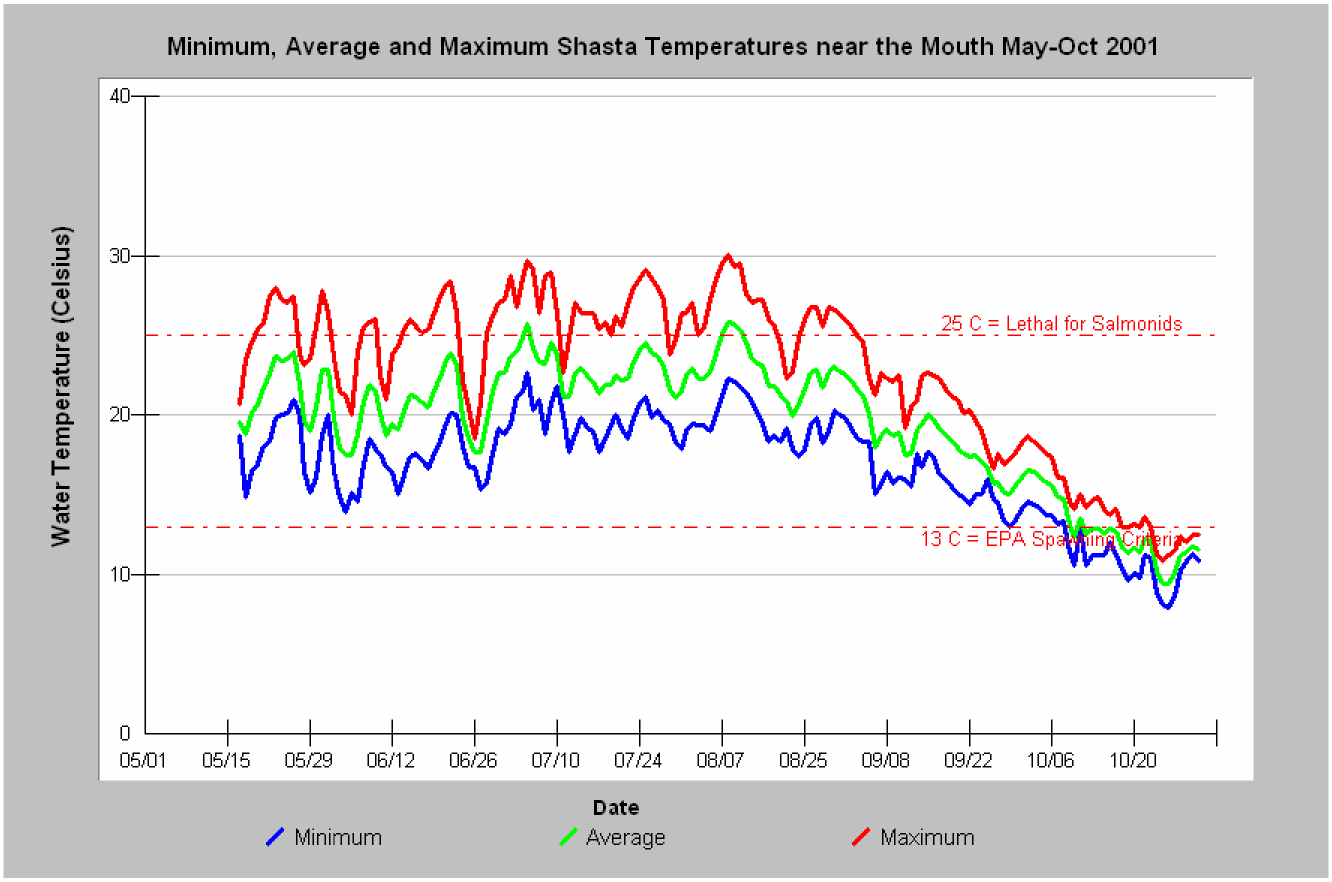

Figure 9. Minimum, average and maximum daily water temperature of the Shasta River above its convergence with the Klamath River in 2001. Chart from KRIS V 3.0 and data from USFWS.

Water temperatures patterns in the lower Shasta River in 2004 (Figure 10) showed a very similar pattern to those of 2001 despite higher flow levels. This indicates that other measures called for in the Shasta River TMDL such as improving riparian shade and reducing warm agricultural tail water contributions will also be necessary to reduce water temperatures and restore beneficial uses. Maximum water temperatures exceeded lethal levels for months at a time in 2004 and even minimum water temperatures failed to drop below stressful levels for much of June, July and August. Although water temperatures dropped with the end of irrigation season on October 1, they still were greater than optimal for salmon spawning until the second week in October.

Major increases in diversion of both surface and groundwater have greatly changed the temperature regime of the Shasta River. Mack (1958) measured flow in Big Springs Creek of 103 cfs, which is very similar to the measurements taken by the California Department of Public Works (1925) for the *Shasta River Adjudication* (CDPW, 1932). This spring source was at optimal temperatures for salmonid rearing and the California Department of Water Resources (1981) found that it was also the reach of the Shasta River with the highest spawning use. Kier Associates (1999) noted that increased ground water pumping and additional surface diversions in Big Springs and Little Springs Creeks were depleting surface flows and reducing salmonid carrying capacity.

The NRC (2003) report characterized the Big Springs area before increased groundwater extraction and surface diversion and its potential benefit to Shasta River water quality as follows:

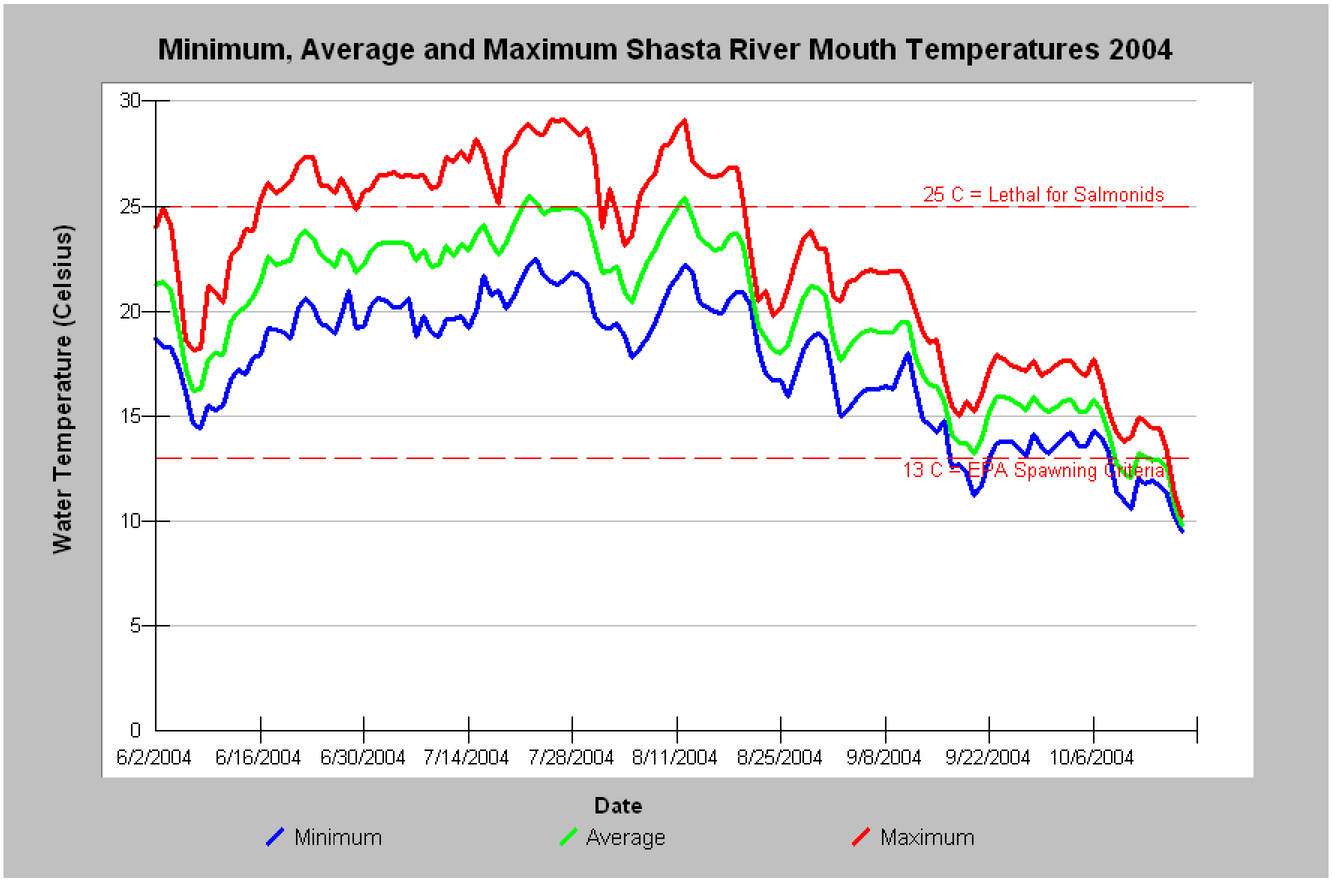

Figure 10. Minimum, average and maximum daily water temperature of the Shasta River above its convergence with the Klamath River in 2004. Data from USFWS.

> "Flows of that magnitude would have had very short transit times (less than 1 day to the Klamath River), thus maintaining cool water throughout summer for the entire river. Consistency of flow and cool summer water were the principal reasons that the Shasta River was historically highly productive of salmonids."

Thermal infrared radar (TIR) imagery captured by Watershed Sciences (2003) illustrates how flow depletion affects water temperature (Figure 11). The image shows water temperatures below 20^{O} C only immediately downstream of Big Springs Lake. Instead of having water temperatures sufficiently cool to support coho, Figure 12 shows that Big Springs Creek warms to 21.7^{O} C (Watershed Sciences, 2003).

The reach of the Shasta River below Dwinnell Dam was formerly cooled significantly by Big Springs Creek (CDWR, 1981; CH2M Hill, 1985; Kier Associates, 1991). Figure 11 shows that the Shasta River and Big Springs Creek were essentially the same temperature on July 27, 2003, when the TIR data were collected. Consequently, flow depletion in the Big Springs Creek drainage decreases thermal buffering of the mainstem Shasta River and decreases suitability and carrying capacity for salmonids.

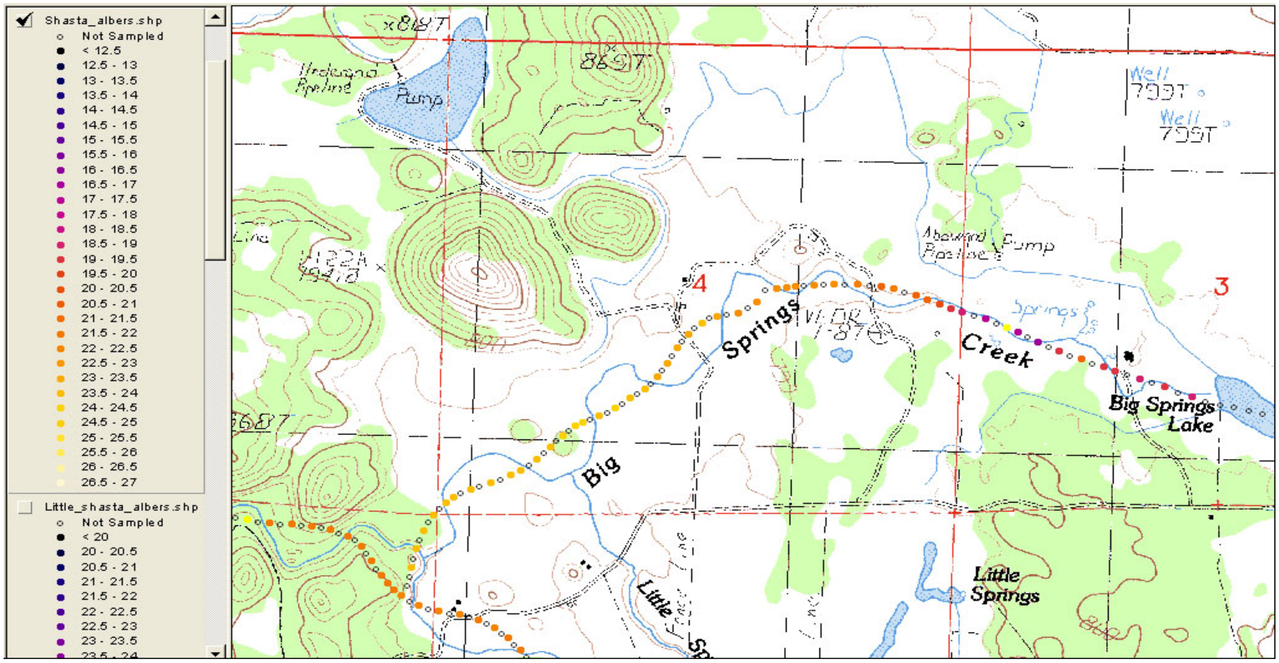

Figure 11. Thermal infrared radar (TIR) map of Big Springs Creek shows that the stream warms rapidly as a result of diversion and now is too warm for optimal salmonid rearing. Data from Watershed Sciences (2003) provided as GIS by NCRWQCB staff.

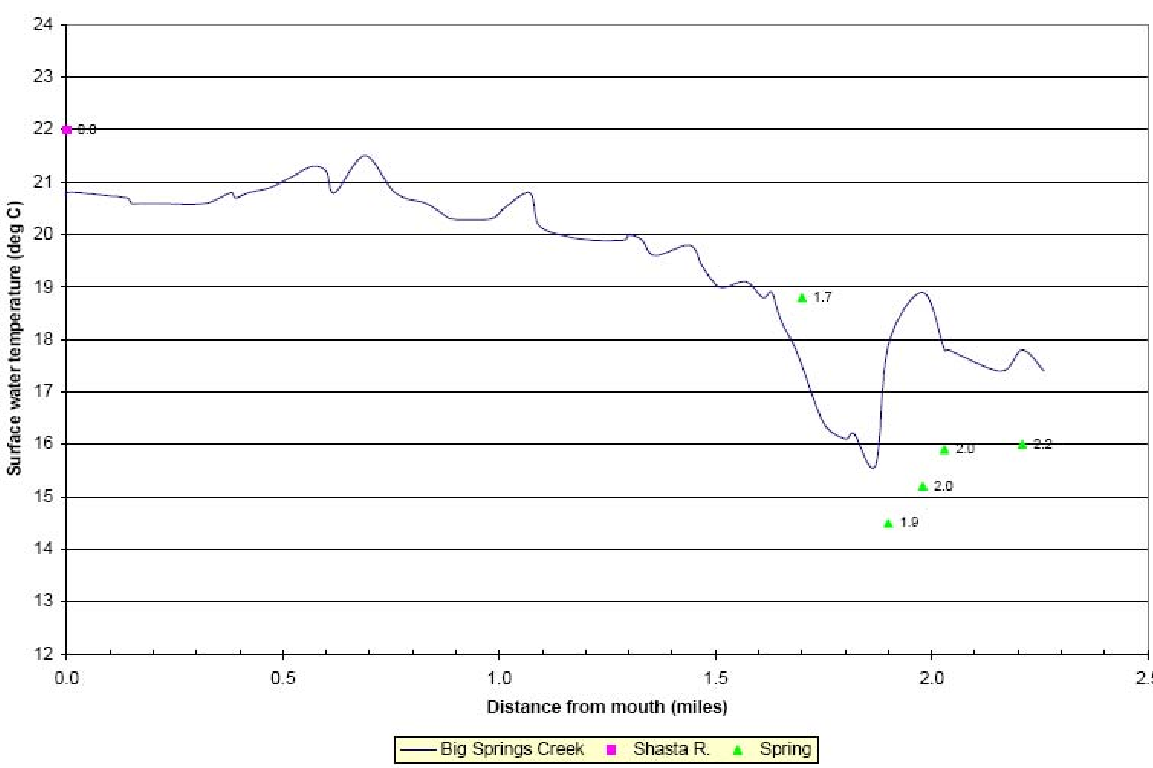

Figure 12. Temperature profile of Big Springs Creek by stream mile according to TIR data. Taken from Watershed Sciences (2003) where it appears as Figure 25.

Parks Creek springs create reaches with temperatures somewhat suitable for salmonids (22 ^{O} C), but irrigation diversions in the lower reach depicted in Figure 13 cause the stream to go dry (Watershed Sciences, 2003). TIR data show Parks Creek temperatures of nearly 30 ^{O} C as it meets the Shasta River. Warm water below the dry reach is likely a result of agricultural return water. Parks Creek could serve as a refugia in combination with Big Springs Creek, if flows were restored (see Recovering Pacific Salmon).

The Shasta River itself has dry reaches below Dwinnell Dam (Figure 13) and water temperatures in flowing reaches largely unsuitable for salmonids. Discussions below on nutrient enrichment cover other impairments to water quality caused by tail water releases from the reservoir.

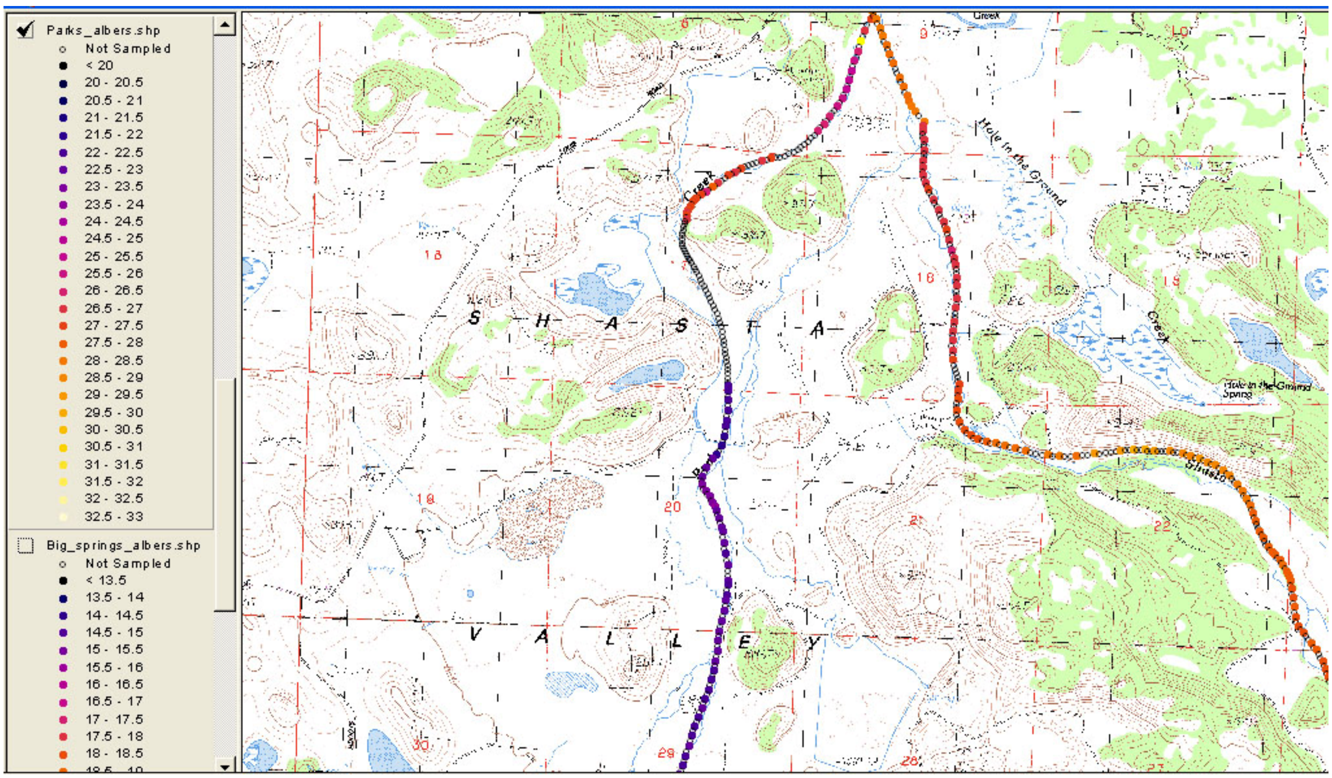

Figure 13. Thermal infrared radar (TIR) map of Parks Creek and the mainstem Shasta River downstream of Dwinnell Reservoir show little habitat with temperatures cool enough to support salmonids. Gray areas are dewatered. Data from Watershed Sciences (2003) provided as GIS by NCRWQCB staff.

The upstream extent of the Parks Creek TIR data from Watershed Sciences (2003) actually begins in a reach already impacted by flow depletion. The China Ditch is a major diversion that routes water down the west side of the Shasta Valley from Parks Creek just below where it emerges from forest lands. This ditch was built to supply water to Yreka and for mining activities but now supplies agricultural water to land south of Gazelle. Figure 14 from Watershed Sciences (2003) shows lethal water temperature conditions for salmonids (> 30 ^{O} C) at the top of the survey reach as a result of low flows. Dramatic cooling is as a result of springs, but diversion dries up Parks Creek just over two miles upstream of its convergence with the Shasta River.

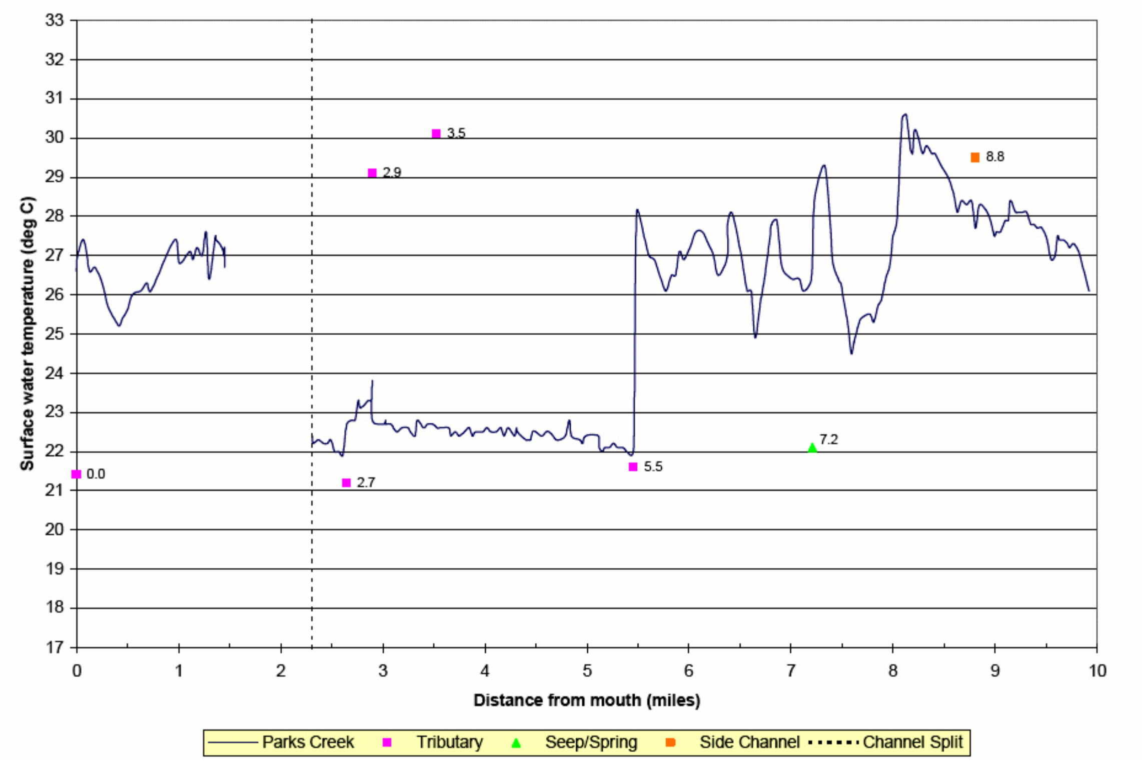

Figure 14. This temperature profile of Parks Creek shows that water temperatures are already elevated at the top of the reach as a result of flow depletion by upstream diversions. Spring flows feed the stream above river mile 5 (RM 5), but diversions dry the channel just above river mile 2 (RM 2.3). From Watershed Sciences (2003) where it appears as Figure 24.

Nutrient Pollution Problems Increase With Decreasing Flows

Nutrients themselves do not harm Pacific salmon, but as they stimulate excessive algae growth, dissolved oxygen decreases while pH and dissolved ammonia increase and may cause stress or mortality (U.S. EPA, 2000). Low flows in the Shasta River allow build up of aquatic plants and promote warming that stimulates plant growth. Gwynne (1993) noted that lack of winter flood peaks because of Dwinnell Dam also inhibited flushing of nutrients and promoted high biological activity in the Shasta River.

pH: High maximum pH and high diurnal ranges of pH are often symptomatic of nutrient enrichment and excessive growth of aquatic plants, which makes pH a highly useful index of photosynthesis. The *Shasta River TMDL* failed to note that the river regularly exceeds NCRWQCB *Basin Plan* (2002) standards for pH, which is a maximum of 8.5. Evidence from laboratory studies indicates that any pH over 8.5 is stressful to salmonids and 9.6 is lethal (Wilkie and Wood, 1995). Studies show that as water reaches a pH of 9.5, salmonids are acutely stressed and use substantial energy to maintain pH balance in their bloodstream (Wilkie and Wood, 1995), while pH in the range of 6.0 to 8.0 is normative.

The mouth of the Shasta River has been monitored with automated water quality probes since 2000 and shows that maximum pH typically exceeds 8.5 for most days from June through September (Figure 15). Pulses of extreme pH occurred in seasons of downstream juvenile migration (June) and during periods when adult Chinook salmon may be holding (September) in the lower Shasta River or downstream of the mouth in the Klamath River. The early spike in pH to 9.5 is of particular concern because of the findings of Goldman and Horne (1983) that under these conditions nearly all ammonium ions would be converted to dissolved ammonia, which is highly toxic to salmonids (U.S. EPA, 1986; 1999).

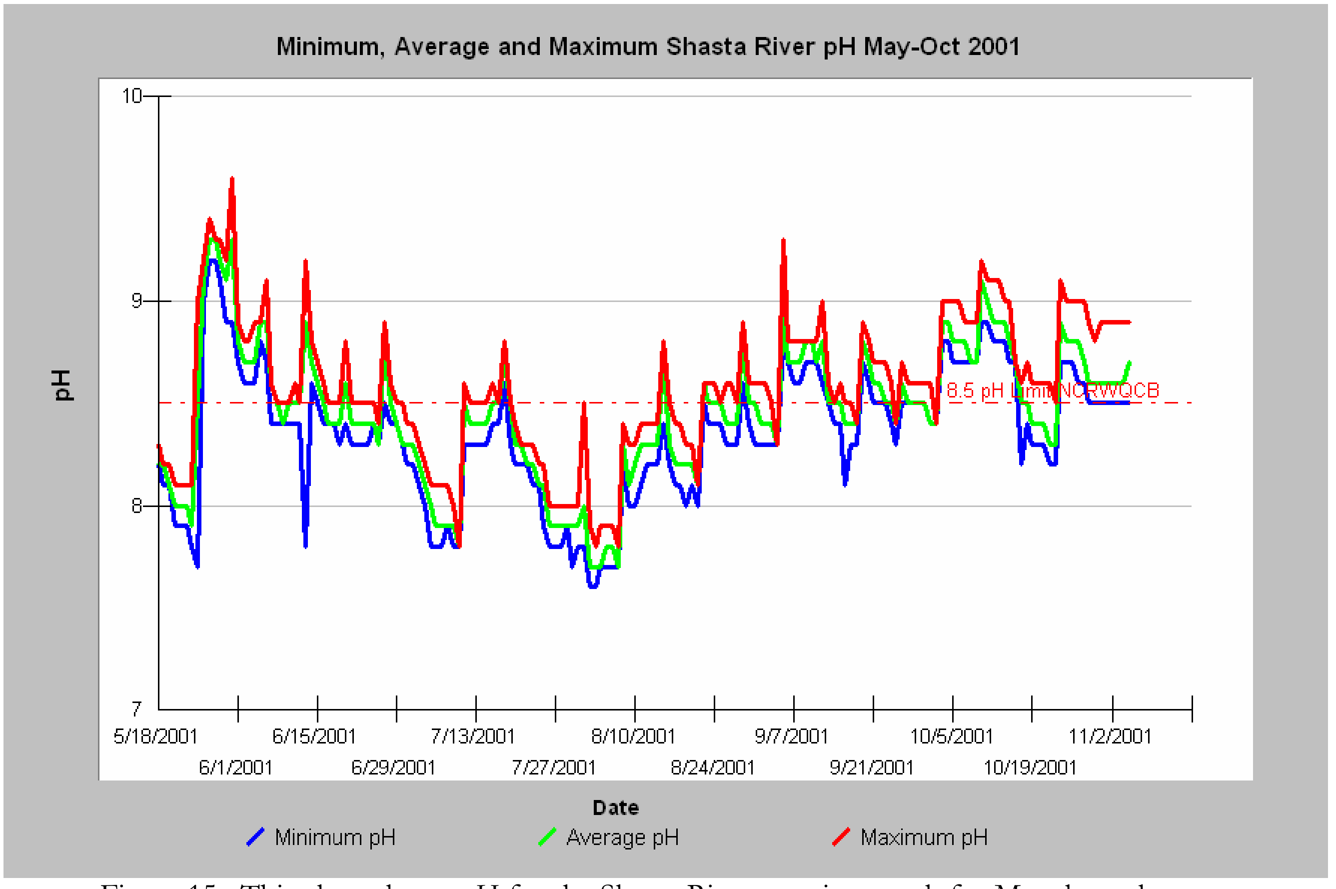

Figure 15. This chart shows pH for the Shasta River near its mouth for May through November 2001 with a reference value showing the NCRWQCB (2002) maximum pH *Basin Plan* standard of 8.5. Data are from the *Klamath TMDL* database, with data originally collected by the U.S. Fish and Wildlife Service.

The minimum, average and maximum pH data for the same lower Shasta River location in 2004 is displayed as Figure 16 and shows a more moderate fluctuation, but with values still consistently above the NCRWQCB *Basin Plan* (2002) standard of 8.5. The maximum pH was once again within stressful ranges for salmonids (>8.5) from June through October.

There are presently no data for dissolved ammonia in the Shasta River, but it is likely that such a problem exists because conditions of high water temperature and high pH coincide and agricultural tail waters are high in nitrogenous waste. Goldman and Horne (1983) show a logarithmic increase in conversion of ammonium ions to dissolved ammonia as pH increases above 8.0 and water temperatures exceed 25 C. (Figure 17). TMDL implementation should involve collecting further data on presence of dissolved ammonia and monitoring the abatement of this water quality impairment if it is found to exist. Dissolved ammonia is toxic to salmonids at levels as low as 0.025 mg/l (U.S. EPA, 1986).

Dissolved Oxygen (D.O.): The Shasta River TMDL clearly shows that tail water returns are increasing nitrogen levels, which increases growth of aquatic plants. Nocturnal respiration of aquatic plants is by far the largest contributor to dissolved oxygen demand in the Shasta River and creates major D.O. sags into ranges that are stressful for salmonids. Juvenile salmonids avoid areas with a D.O. of less than 5 mg/l, have impaired swimming ability at levels below 7.0 mg/l, and die at levels lower than 3.7 mg/l (White, 2002). Gwynne (1993) showed a pattern of elevated Shasta River D.O. during the day and depressed D.O. at night, indicative of high photosynthetic activity (Figure 18) indicating major problems for salmonid suitability in mainstem reaches throughout the Shasta Valley (Figure 19).

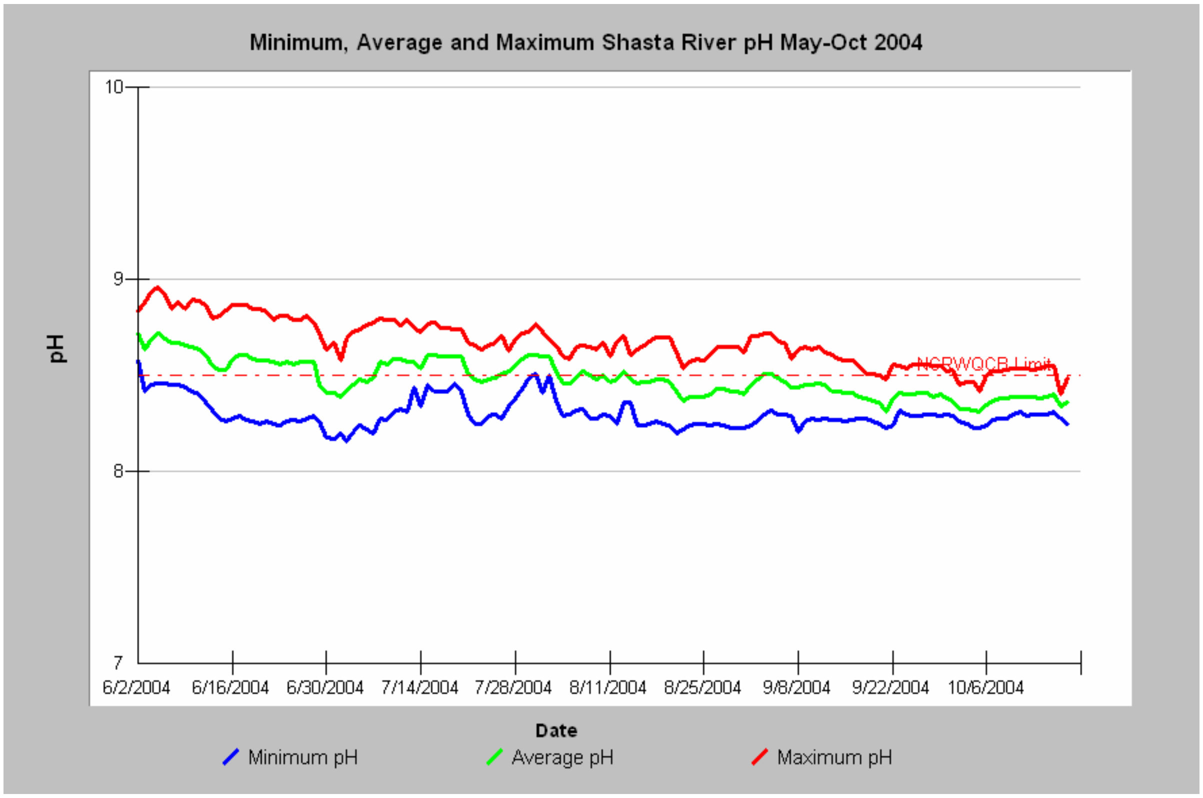

Figure 16. This chart shows pH for the Shasta River near its mouth for May through November 2004 with a reference values showing the NCRWQCB (2002) maximum pH *Basin Plan* standard of 8.5. Data are from U.S. Fish and Wildlife Service.

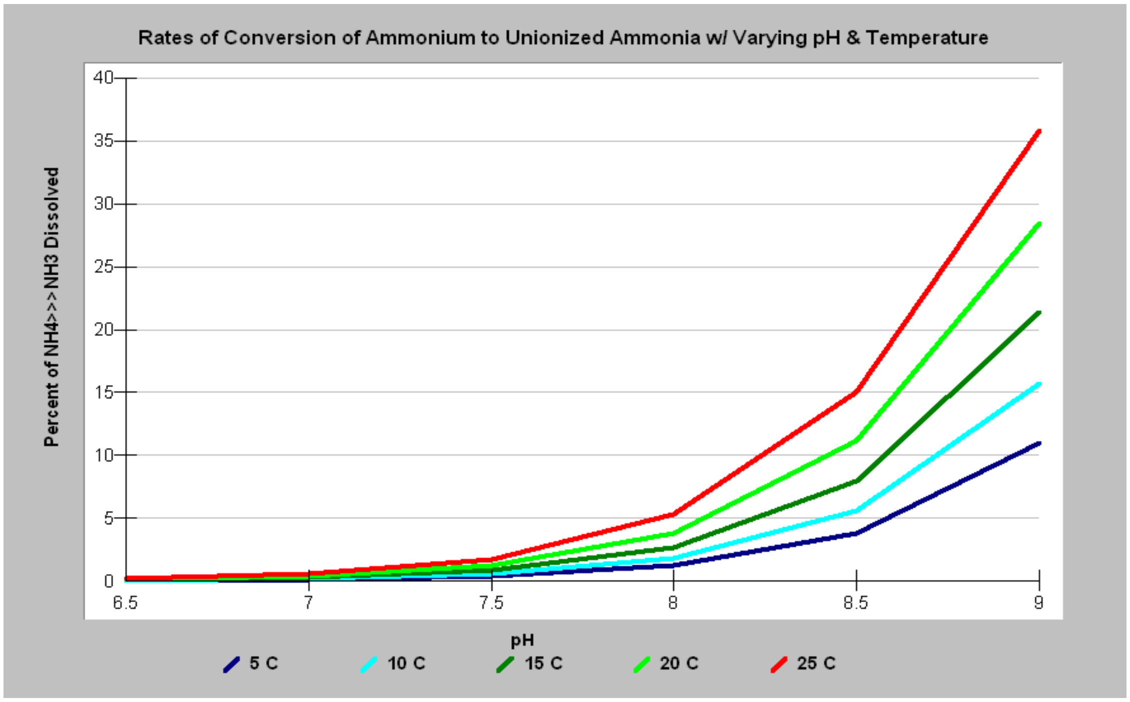

Figure 17. Chart showing the percent conversion of ammonium to dissolved ammonia with increasing pH and water temperature. Data from Goldman and Horne (1983).

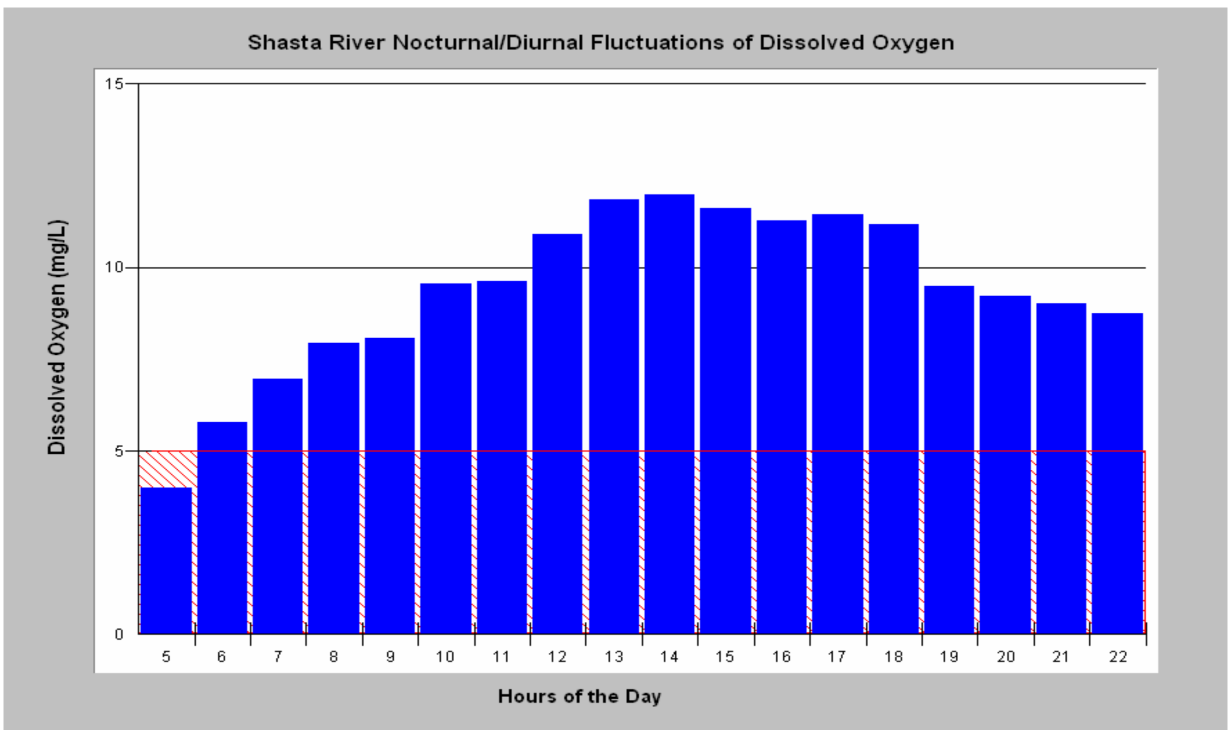

Figure 18. The chart above is based on data from Gwynne (1993) and shows supersaturated D.O. levels during the day but depressed D.O. before sunrise.

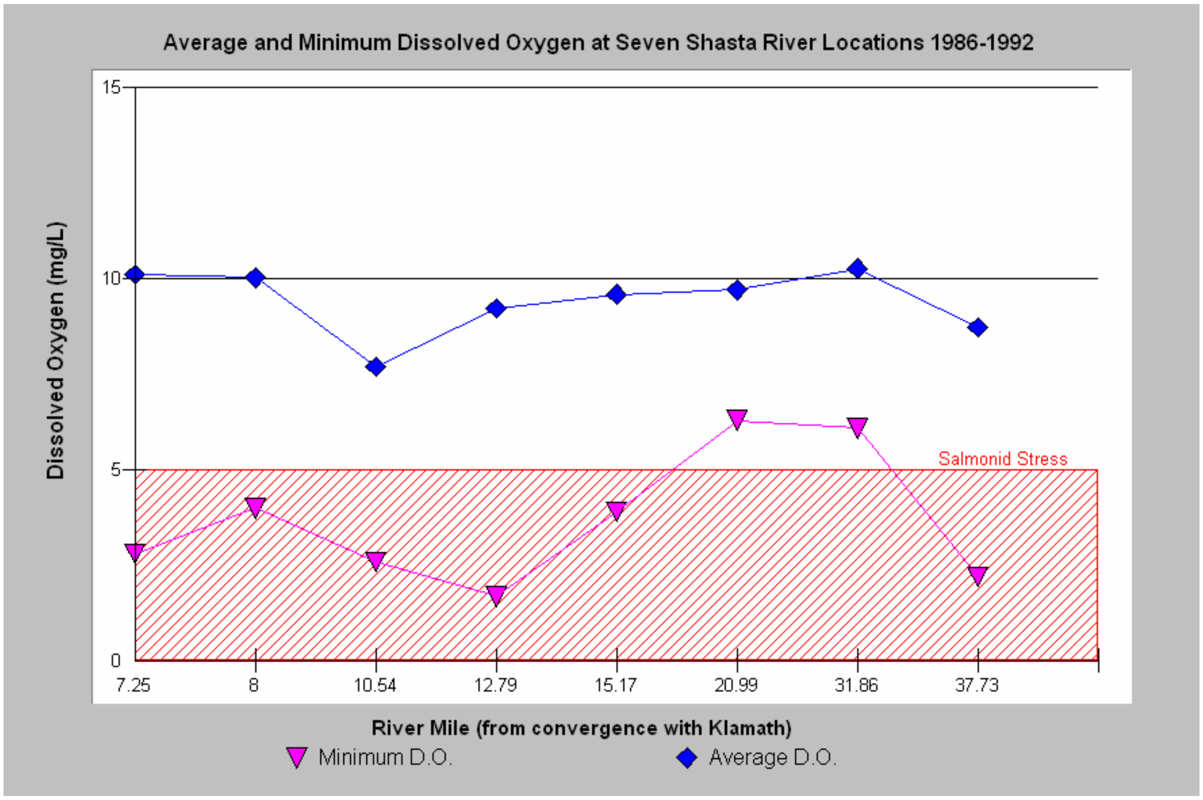

Figure 19. Average and minimum dissolved oxygen levels measured by Gwynne (1993) show that levels fell below those required for salmonid rearing at most locations. Chart from KRIS V 3.0.

Minimum dissolved oxygen readings shown in Figure 19 are the minimum of all readings for each station during the entire period of record (1986-1992). Acute problems with D.O. levels occur both in the upper Shasta Valley, just below Dwinnell Dam (RM 37.73), and in the reach from the Montague-Grenada Road (RM 15.17) to Highway 263 (RM 7.25). Dissolved oxygen problems may be moderated in the reach from Louie Road (RM 31.86) to below County Road A-12 (RM 20.99) by increased flows and cooler water from springs.

Continuous recorders placed near the mouth of the Shasta River have also captured dissolved oxygen data (Figure 20-21). Although this data shows that dissolved oxygen does not drop to levels lethal for salmonid juveniles, minimum and average levels often fall to stressful levels.

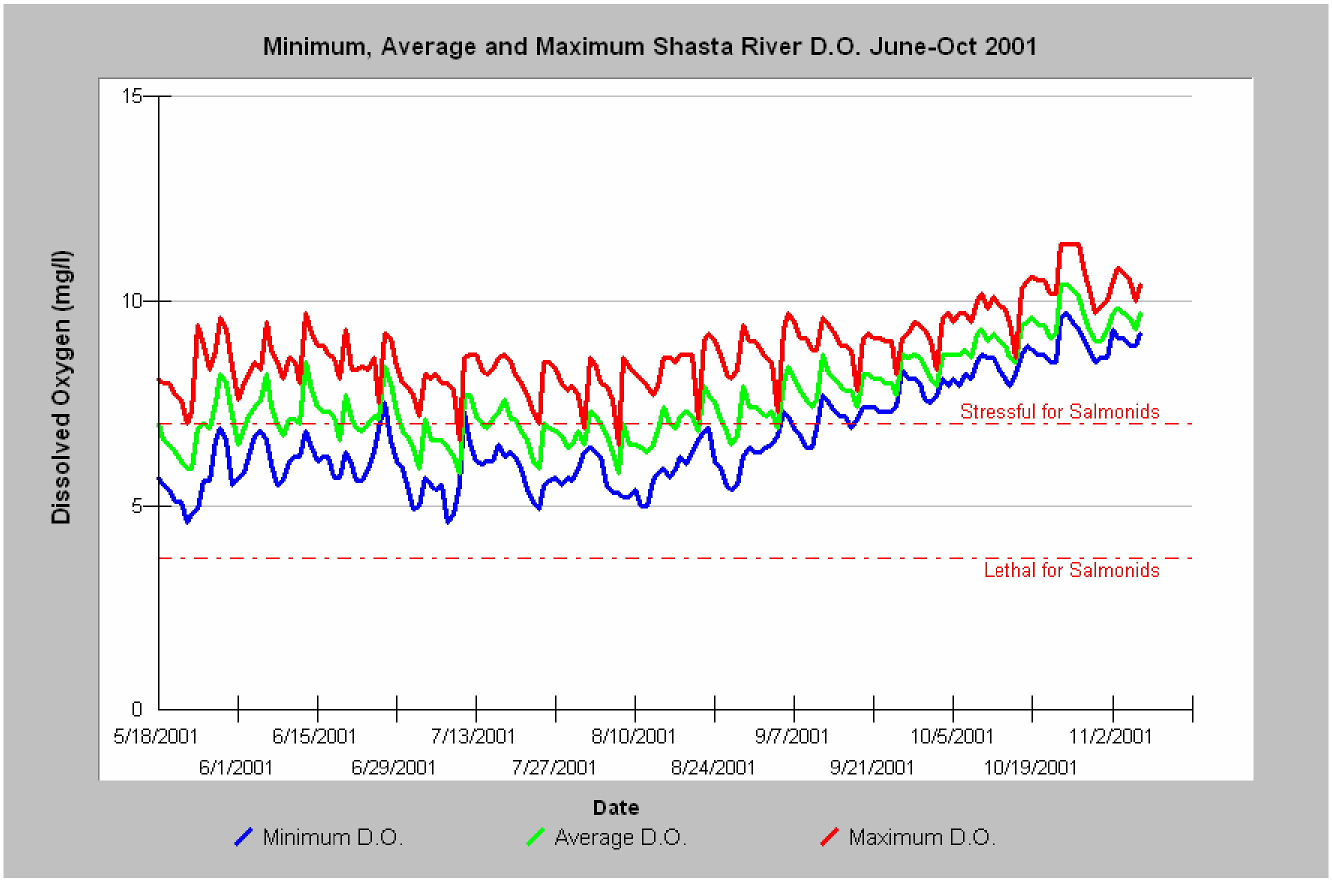

Figure 20. Minimum, average and maximum D.O. levels from May through November 2001 are displayed in the chart above indicating high levels of photosynthetic activity and nocturnal depressions likely to stress juvenile salmonids.

Although minimum dissolved oxygen levels in 2004 in the lower Shasta River (Figure 21) were slightly higher than in 2001, they still fell into stressful ranges for salmonids. White (2002) points out that salmonid egg incubation requires a dissolved oxygen of greater than 6.5 mg/l in the gravel matrix, which would require surface water D.O. of greater than 8.0 mg/l. Both 2001 and 2004 data suggest that D.O. sags are abated by October 1, although there was a brief late season depression in the spawning period in 2004.

Increased winter flows would increase scour and decrease embedded organic material that partially fuel nutrient enrichment. Increased flows of cold, clean spring water recommended by the Shasta TMDL would decrease water temperatures, decrease transit time and result in decreased problems with D.O.

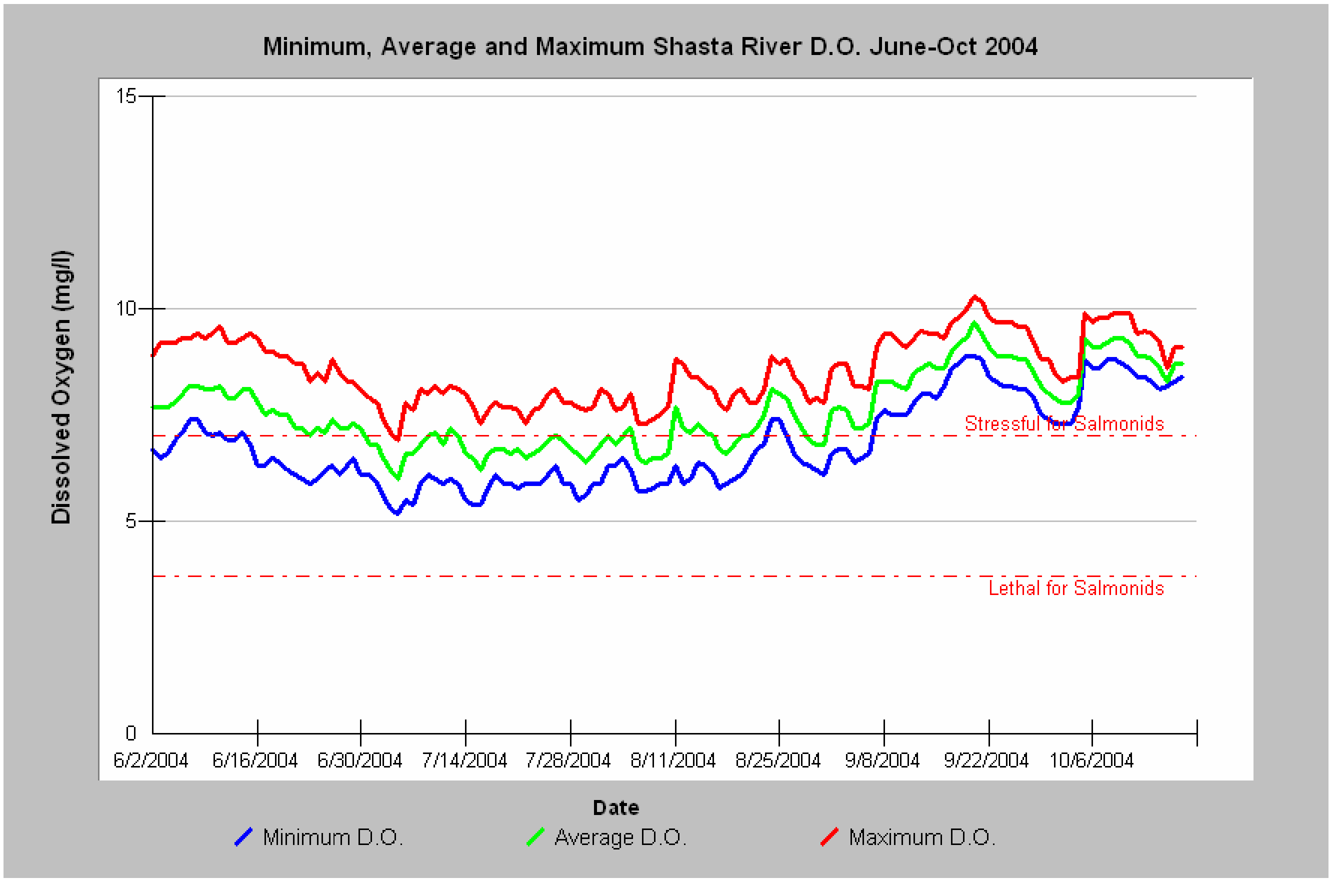

Figure 21. Minimum, average and maximum D.O. levels from June through October 2004 are displayed in the chart above indicating high levels of photosynthetic activity and nocturnal depressions likely to stress juvenile salmonids. Data from USFWS.

Shasta River Pollution and Klamath River Cumulative Watershed Effects

Studies related to Klamath Hydroelectric Project relicensing have demonstrated extreme problems with nutrient pollution in the mainstem Klamath River (Kier Associates, 2004; 2006). Nitrogen fixing algae in project reservoirs cause nutrient enrichment of reaches just below Iron Gate Dam. As algae beds below Iron Gate decay or shed segments, nutrients are transferred downstream where they trigger periphyton blooms in what is known as "nutrient spiraling." Acute salmonid stress from high pH, temperature and ammonia in combination with depressed D.O. result in immunosuppression in juvenile salmonids and massive annual die-offs. The very warm and nutrient-rich waters of the Shasta River add to these mainstem Klamath River problems. McIntosh and Li (1998) used forward-looking infrared radar (FLIR) to characterize the pattern of temperature problems in the mainstem Klamath River. Figure 22 shows a July 1998 FLIR image of the Shasta River joining the Klamath River. The thermal signature indicates that the Shasta River is approximately 29^{O} C and has a warming influence on the mainstem Klamath.

The *Shasta TMDL* should have pointed out that the Shasta River has the potential in a restored condition to buffer mainstem Klamath River water temperatures and provide a refugia for juvenile salmonids in its lower reaches. In its present condition, however, it exacerbates nutrient and temperature pollution instead of assisting in abating these problems in the mainstem Klamath River.

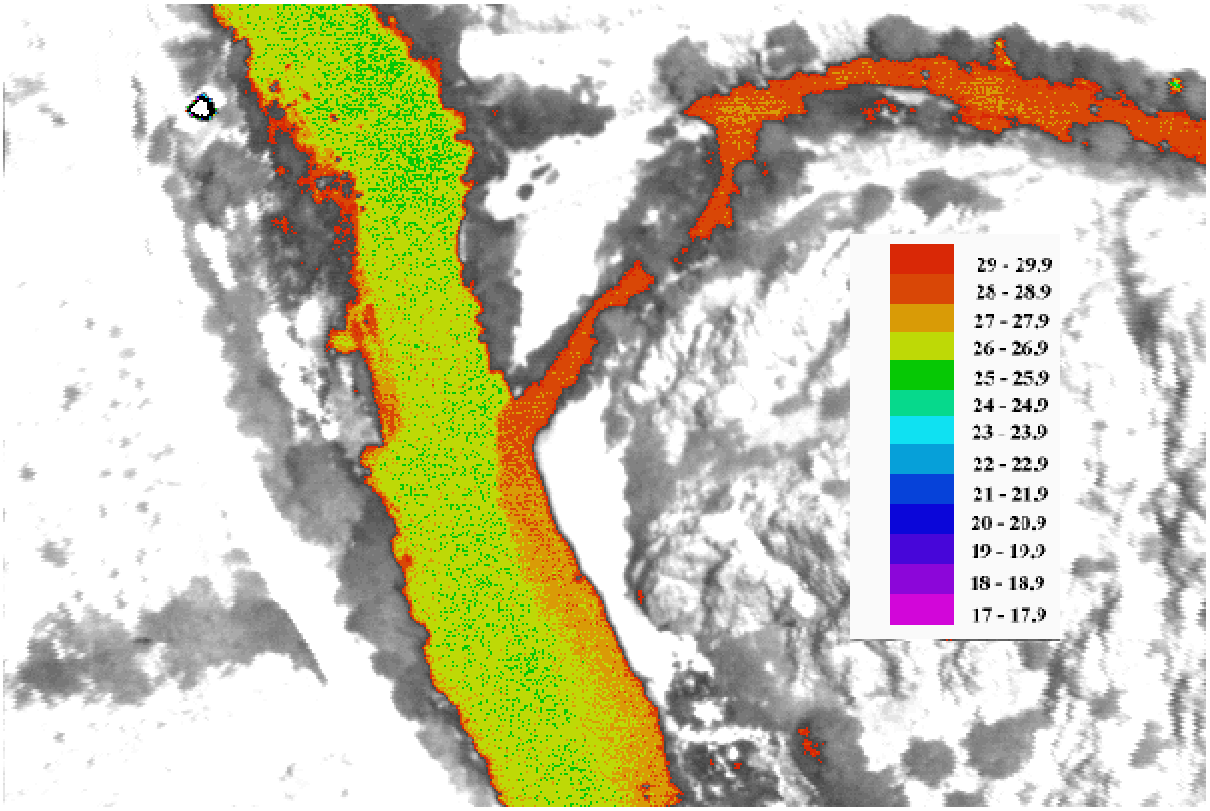

Figure 22. Thermal Forward Looking Infrared Radar Image (FLIR) showing the confluence of the Klamath River (flowing from the top of the image to the bottom of the image) and the Shasta River (flowing right to left in the image). The Shasta River is approximately 29 degrees C. and a warm water plume is observed in the Klamath River below. From McIntosh and Li (July 1998).

Shasta River Pacific Salmon Populations at Risk of Extinction

The *Shasta TMDL* goal of remediating water quality problems over a 40-year period ignores cycles of Pacific salmon productivity attendant with ocean conditions and climate. The Pacific Decadal Oscillation (PDO) cycle causes major shifts in ocean productivity and shifts from favorable for salmon to unfavorable conditions approximately every 25 years off the coast of California, Oregon and Washington. Good ocean conditions are linked to wetter weather cycles and prevailed from 1900-1925 and 1950-1975 and switched to favorable again in 1995 (Hare et al., 1999). Poor ocean productivity and dry on-land cycles from 1925-1950 and 1976-1995 created very adverse conditions for salmon. If freshwater habitat in the Shasta River basin is not improved by the time ocean conditions change back to less favorable and we enter a drier climatic cycle sometime between 2015 and 2025, major salmonid stock losses are likely to result (Collison et al, 2003). Likewise, any long-term TMDL program must take into account long-term climate cycle stressors in a precautionary approach to such trends. Populations must not already be stressed under what are currently favorable conditions, or these stresses will lead to extinctions when such cyclical conditions change, as they inevitably must, for the worse.

Coho salmon populations in the Shasta River are also at very low levels as indicated by downstream migrant trap data (Figure 23), with between 212-747 juveniles captured during several months of trapping from 2001-2003 (Chesney 2001; 2002; Chesney and Yokel, 2003). The requirement of juvenile coho for water temperatures under 16.8^{O} C makes it almost impossible for this species to survive throughout summer in any reach of the Shasta River. Favorable ocean conditions and more precipitation in most years since 1995 have allowed coho to rebound somewhat, but the population remains at remnant levels and is likely to go extinct in the next negative PDO cycle unless Shasta River conditions improve dramatically.

The Shasta River fall chinook population is failing to rebound in the recent favorable PDO cycle despite mostly above average rainfall and mostly favorable ocean conditions (Figure 24).

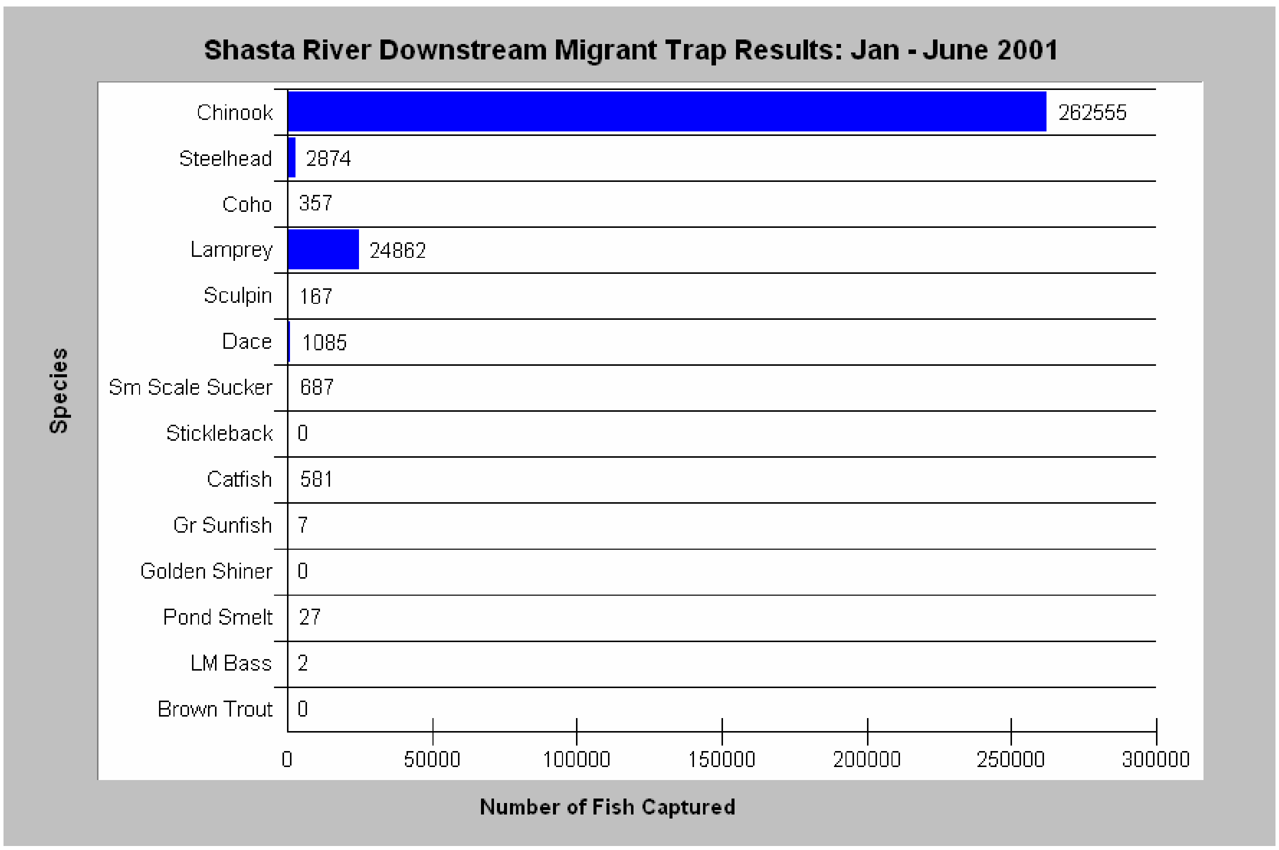

Figure 23. Downstream migrant trap results from the lower Shasta River for the period of January through June 2001 show chinook salmon juveniles to far out number steelhead and coho salmon. Chart from KRIS V 3.0 with data from CDFG.

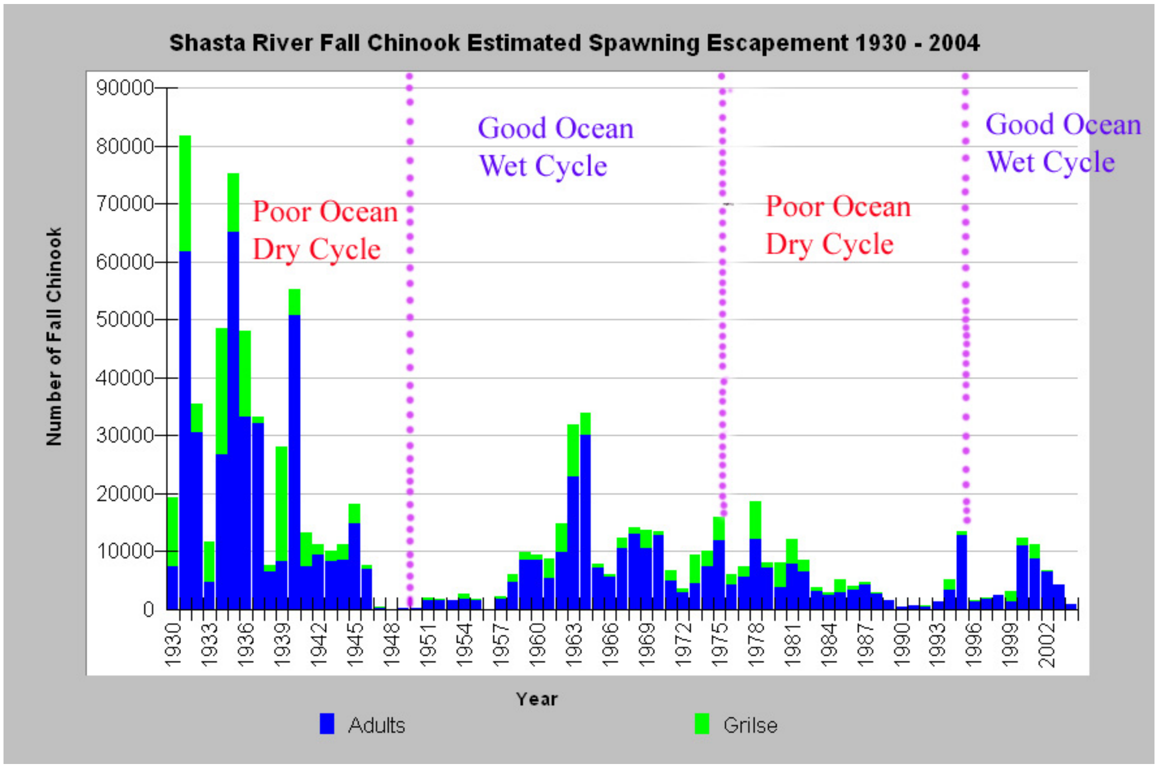

Figure 24. Shasta River Chinook salmon returns from1930 to 2005 are displayed in this chart along with known Pacific Decadal Oscillation cycles (Hare et al., 1999). Data from CDFG.

When long term population trends from the Shasta Racks are analyzed it becomes apparent that each successive positive cycle of the PDO has decreased peak returns and lower minimum returns.

Shasta fall chinook stocks ranged from lows of 533-726 from 1990-1992 during the last dry climatic cycle, a critically low level for maintaining genetic diversity (Gilpin and Soule, 1990). Consequently, if flow and water quality conditions are not improved for chinook salmon spawning and rearing in the Shasta River before the next switch to less productive ocean conditions and a period of less precipitation, there is a high risk that this important chinook salmon stock could be lost. The final *Shasta TMDL* should cite the findings of Hare et al. (1999) and use it as a reason for urgency to move forward on a TMDL Implementation Plan.

Steps Necessary for Salmon Recovery

This paper has demonstrated conclusively that low flow conditions resulting from agricultural diversions in the Shasta River compound water quality problems and that temperature impairment and nutrient pollution will not be abated unless water flows are increased. The *Shasta River TMDL* actions to restore Pacific salmon are dependent on parallel processes currently underway such as the Shasta River incidental take permit (ITP) for coho salmon (SVRCD, in review) and the California Department of Fish and Game (2004) *Coho Recovery Strategy*. These processes have very long time frames for action, often rely on voluntary measures and may achieve incremental improvements that are not sufficient for recovery of salmon and steelhead in a meaningful time frame.

Bradbury et al. (1995) provide one of the most scientifically valid approaches to restoring Pacific salmon populations and stress protecting the best habitats available as a priority. The NRC (2003) report points out that loss of cool water flows due to increased groundwater and surface water diversion in the Big Springs Creek drainage reduced the carrying capacity of this important salmonid spawning and rearing area. U.S. EPA (2003) cites the need to protect and restore well distributed refugia when other factors confound meeting temperature requirements of salmonids in mainstem environments. Restoration of cold water flows in Big Springs Creek should, therefore, be of the highest priority.

Lower Parks Creek converges with the Shasta River very near Big Springs Creek. Kier Associates (1999) suggested restoring flows and improving riparian conditions in lower Parks Creek could provide a core refuge area in the heart of the Shasta Valley. Reconnecting Parks Creek to the Shasta River would also help improve the supply of spawning gravels to the mainstem.

The NRC (2003) report recommends consideration of removal of Dwinnell Dam because the Shasta River will become increasingly important to the Klamath River as global warming advances, because Mount Shasta will be one of the few places where snowfall increases are likely in the entire West. The *Shasta TMDL* approach of attempting to mitigate water quality problems in Dwinnell Reservoir so that water quality could be improved and tail water flows augmented is not realistic or practical. The reservoir has the same suite of problems as Klamath Hydroelectric Project impoundments and only decommissioning can lead to substantial abatement of water quality impairment (Kier Associates, 2006).

Appropriate actions to restore salmon may be challenging because of resistance to changes in water use. Studies may be necessary that prove that unpermitted wells in the Pluto's Cave basalt formation around Big Springs are causing loss of surface flows. The existing adjudication and Watermaster services, which the NRC (2003) report found lacking, may have to be revisited. "The 1932 adjudication of surface waters in the basin, as currently administered, is insufficient to supply the quantity and quality of water necessary to sustain salmonid populations in the basin." The fact that riparian water rights below Dwinnell Dam are not part of adjudication means that the Watermaster has no authority over them. Consequently, increased flows gained through TMDL Implementation or other processes, including efforts by other landowners, could all be confounded by increased riparian diversions elsewhere. Despite these hurdles, the SWRCB must act to increase flows because they are clearly related to water quality impairment and beneficial uses will not be attained in the needed time frame unless this action is taken.

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A PROCLAMATION

BY THE GOVERNOR OF THE STATE OF CALIFORNIA

WHEREAS California's salmon runs are a vital component of our great State's resources that provide significant environmental, recreational, commercial, and economic benefits to the people; and

WHEREAS Klamath River Basin Chinook Salmon have been significantly impacted by poor ocean conditions, drought, water management, water quality, water flows, disease, and the elimination of access to historical spawning habitat; and

WHEREAS the Klamath Basin Chinook Salmon that commingle with other runs of salmon in ocean waters off of California and Oregon have been declining in abundance to a point where California's and Oregon's recreational, commercial, and tribal fisheries are being significantly constrained to conserve Klamath River Chinook Salmon; and

WHEREAS Klamath River Basin Chinook Salmon are predicted to have extremely low ocean abundance for 2006 in waters from Cape Falcon in Oregon to Point Sur in Monterey County, California, and in the Klamath River Basin; and

WHEREAS restoration of habitat and improved water quality and flows are critical to restoring an environment suitable to the long-term sustainability of the Klamath River Basin Chinook Salmon and other anadromous fish species; and

WHEREAS appropriate management of the Klamath River Basin Chinook Salmon population is critical to California's businesses, and local communities that provide goods and services in support of California's salmon fisheries; and

WHEREAS on April 5, 2006, I requested Secretary of Commerce Carlos Gutierrez to use his authority under the Magnusen-Stevens Fishery Conservation and Management Act to determine that there has been a commercial fishery failure due to a fishery resource disaster; and

WHEREAS on April 28, 2006, the National Marine Fisheries Service adopted an emergency rule to implement the recommendations of the Pacific Fisheries Management Council that resulted in severe restrictions on the commercial ocean salmon and Klamath Basin tribal and recreational fisheries and included restrictions on the recreational ocean salmon fishery; and

WHEREAS these restrictions will have significant impacts to California's commercial ocean salmon and in-river salmon fisheries and will result in severe economic losses throughout the State; and

WHEREAS the Department of Finance has determined that approximately $778,000 is continuously appropriated and available in the Small Business Expansion Fund (Fund 918) for disaster purposes under the Corporations Code section 14030 et seq.; and

WHEREAS the Small Business Expansion Fund's available monies can be leveraged to guarantee up to approximately $9.2 million in loans for disasters, including guaranteeing loans to prevent business insolvencies and loss of employment in an area affected by a state of emergency within the state; and

WHEREAS Governor Ted Kulongoski of Oregon and I signed The Klamath River Watershed Coordination Agreement along with the responsible federal agencies in order to address the impacts to the fisheries in the region and to develop a long-term management approach, common vision, and integrated planning associated with the Klamath Basin; and

WHEREAS the serious circumstances of the Klamath River Chinook Salmon run put at risk the livelihoods of families and businesses dependent upon them.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, find that conditions of disaster or of extreme peril to the safety of persons and property exist within the California counties of Monterey, Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Humboldt, Del Norte, and Siskiyou due to the poor ocean conditions, drought, water management, water quality, water flows, disease, and the elimination of access to historical spawning habitat and resulting from the significant restrictions that have been imposed on the State's salmon fisheries. Because the magnitude of this disaster will likely exceed the capabilities of the services, personnel, and facilities of these counties, I find these counties to be in a state of emergency, and under the authority of the California Emergency Services Act, I hereby proclaim that a State of Emergency exists in these counties.

Pursuant to this Proclamation, I hereby direct the Director of the California Department of Fish and Game and the Secretary of the Resources Agency to: (1) report to me immediately upon final action of the Department of Commerce and the California Fish and Game Commission on any further actions necessary to ensure the protection of the resource and of the economic livelihood of the fishery participants, tribes, and local communities; and (2) continue discussions for long-term restoration and management of the Klamath Basin with the State of Oregon, federal agencies (including the Secretaries of Commerce, the Interior, and Agriculture), tribal governments, and representatives from conservation, fishing, and agricultural organizations.

I FURTHER DIRECT the Secretary of the Business, Housing and Transportation Agency, with the cooperation of the Department of Finance, to activate the Small Business Disaster Assistance Loan Guarantee Program to guarantee loans to prevent business insolvencies and loss of employment in the counties of Monterey, Santa Cruz, San Mateo, San Francisco, Marin, Sonoma, Mendocino, Humboldt, Del Norte, and Siskiyou as a result of this State of Emergency.

I FURTHER DIRECT that as soon as hereafter possible, this proclamation be filed in the Office of the Secretary of State and that widespread publicity and notice be given of this proclamation.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 6th Day of June 2006.

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ARNOLD SCHWARZENEGGER
Governor of California

ATTEST:

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BRUCE McPHERSON
Secretary of State