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August 30, 2010

Mr. Jeffrey Shu
State Water Resources Control Board
Division of Water Quality
P.O. Box 100
Sacramento, CA 95812-0100

Re: Request for Recognition of Shasta River as Flow Impaired and Addition to the 2012 California 303d List

Dear Mr. Shu,

These comments are in response to your Notice of Public Solicitation of Water Quality Data and Information for 2012 California Integrated Report [Clean Water Act Sections 305(b) and 303(d)]. I am preparing this request for listing of the Shasta River for flow impairment and groundwater pumping for Klamath Riverkeeper, a non-profit advocacy group that uses expert-informed opinion to help guide natural resource policy and regulatory processes. Klamath Riverkeeper is joined in this request by the Institute for Fisheries Resources, Pacific Coast Federation of Fisherman Associations, the Environmental Protection Information Center and the Klamath Forest Alliance. There is precedent for listing of more than 100 rivers or stream segments across the nation as impaired due to reduction in flow and due to groundwater pumping (U.S. EPA 2010, CSWRCB 2006). I make the case below that the Shasta River is water quality impaired because of the reduced volume in mainstem and tributary reaches. The recognized problems with elevated water temperature and depressed dissolved oxygen cannot be remediated without increasing flow. I am not submitting new data to argue for this listing of the Shasta River because previous studies and restoration related documents have chronicled the impairment of the Shasta River with regard to nutrients, temperature and flow (Clawson et al. 1985, Gwynne 1993, CH2M Hill 1985, Kier Associates 1991, Ricker 1997, Kier Associates 1999, NAS 2004).

My Qualifications

I have been a consulting fisheries biologist with a specialty in salmon and steelhead restoration and an office in Arcata, California since 1989. In that capacity I wrote chapters of the *Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program* (Kier Associates 1991), which characterized Shasta River impairment. I was a major contributor to the *Mid-term Evaluation of the Klamath River Basin Fisheries Restoration Program* (Kier Associates 1999), which included an update on the progress of restoration and also documented acute on-going pollution problems in the Shasta River. I assisted with design and implementation of a regional fisheries, water quality and watershed information database system, known as the Klamath Resource Information System or KRIS (www.krisweb.com). There have been three versions of KRIS released for the Klamath-Trinity Basin, which include dozens of databases and summary charts regarding Shasta River fisheries, water quality and flows.

My work from 2004 to 2010 for the Klamath Basin Tribal Water Quality Work Group, a consortium of environmental departments of Lower Klamath River Basin Indian Tribes, entailed improving enforcement of the Clean Water Act and expediting Klamath Hydroelectric Project removal (www.klamathwaterquality.com). I assisted with comments regarding draft and final versions of the *Action Plan for the Shasta River Watershed Temperature and Dissolved Oxygen Total Maximum Daily Loads Through work on review of Total Maximum Daily Load (Shasta TMDL)* (NCRWQCB 2006a) for the Work Group. My experience preparing comments on the environmental impact statement for the proposed California Department of Fish and Game (CDFG) incidental take permit for Shasta River coho salmon is also relevant to this project.

Justification of Listing for Flow

The U.S. EPA (2010) national impaired waterbodies list includes over 101 rivers, stream segments or estuaries where the recognized source of impairment is flow depletion. Causes for listing include flow alteration, hydromodification, pumping, and diversion. There is also precedent in California for 303d listing for flow impairment on the Ventura River with pumping and diversion recognized as the causes.

The *Shasta TMDL* recognized the linkage of reduced river flows and elevated water temperature and depressed dissolved oxygen; however, recommended increases in flow in the Basin Plan amendment (NCRWQCB 2006b) have not taken place. In addition, there is new information about specific life history patterns of native Shasta River coho salmon juveniles, spring flows and diversions (Chesney 2009, Chesney et al. 2009) that clearly shows an urgent need for action to prevent the last cold water habitat in the basin from being dried up. Section 304 of the Clean Water Act requires that "criteria for water quality accurately reflect the latest scientific knowledge" including impacts on fish and wildlife. Consequently, the SWRCB must consider these new CDFG documents and also the NMFS (Masters 2009) memo regarding "take" of coho salmon juveniles due to diversions at critical springs. These documents are provided as attachments to these comments so they can be fully considered when deciding whether to list the Shasta River as flow impaired.

Low Flow Recognized As Contributing to Impairment of Shasta River

The National Academy of Science (NAS 2004) determined that there was a direct connection between flow depletion and water temperature problems in the Shasta River and that flow augmentation was necessary to remediate the problem:

> "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 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."

Shasta River nutrient pollution has manifested itself in depressed dissolved oxygen (D.O.) levels (Gwynne 1993) for which it has been listed as impaired. Reduced flows increase nutrient concentrations and related problems of algae blooms, elevated pH, depressed dissolved oxygen and potential for increased dissolved ammonia. Consequently, nutrient problems cannot be remedied without increased flow. However, these comments will focus on relationship of flow and water temperature and direct impacts of reduced flow on coho salmon. This is because flow and temperature relationships are established, regional coho water temperature tolerance is known (Welsh et al. 2001) and the relationship of flow and coho salmon juvenile rearing is particularly well studied (Chesney 2009, Chesney et al. 2009). Evidence for flow impairment is presented below by tributary or mainstem channel reach.

<u>Mainstem Shasta River</u>: NAS (2004) stated clearly that reduced flow and increased transit time were leading to warming of the mainstem Shasta River and resulting in unsuitable temperatures in lower reaches for salmonid rearing. The forward looking infrared radar (FLIR) study captured surface water temperature imagery of the Shasta River and its tributaries on July 26, 2003. Results from Dwinnell Dam to the mouth are illustrative of flow and temperature problems (Figure 1). All temperature charts in these comments have reference lines. The lower reference line is at 20 ^{o} C (68 ^{o} F), which is stressful to all salmonids (McCullough 1999, U.S. EPA 2003), and the higher value is 25 ^{o} C (77 ^{o} F), which Sullivan et al. (2001) considered to be lethal for most Pacific salmon species. The U.S. EPA (2003) set a target for Pacific salmon core rearing areas in the middle and upper reaches of streams at 16 ^{o} C/61 ^{o} F. Below Dwinnell Dam, which is below river mile (RM) 42, the water temperature pattern of the Shasta River fluctuates from suitable to stressful for salmonids as springs arise and diversion depletes flows. The river cools somewhat near Louie Road (RM 31.9) where Big Springs Creek and Hole in the Ground Creek converge and remains cool due to continuing spring inputs downstream to road A-12 (RM 21). Water temperatures rises continuously downstream of that point because river water is diverted for irrigation and warm agricultural return flows add to thermal loading. USFWS (2003) provides data indicating that water temperatures exceeded lethal levels for salmonids at the mouth of the Shasta River in 2001 (Figure 2) and 2004 (Figure 3). These were very different water years and low flows are now occurring even in years with normal or above average precipitation. Chesney et al. (2009) monitored coho salmon use of spring water sources in Hole in the Ground Creek and found that diversion of flows decreased coho salmon juvenile carrying capacity there in 2008 (Figure 4). Coho salmon juveniles were seeking refuge in spring areas adjacent to the mainstem and in Parks Creek because Shasta River flows were insufficient and temperatures were too high to support them (Chesney et al. 2009). The SWRCB should list the Shasta River from RM 0 to RM 42 for flow alteration and diversion.

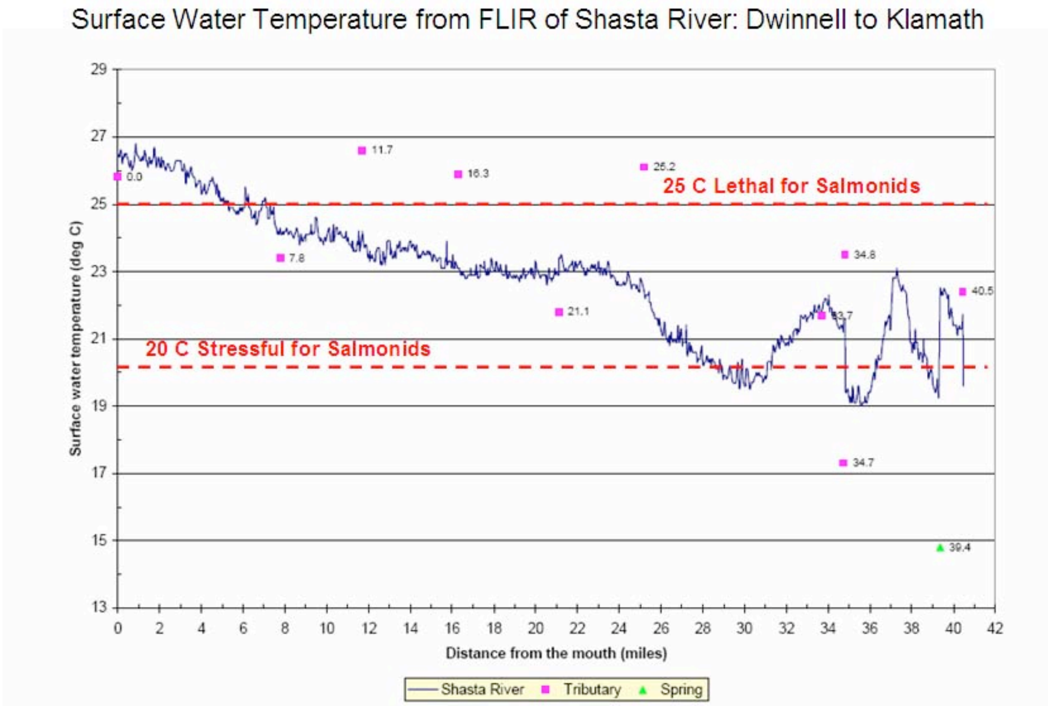


Figure 1. Surface water temperatures of the mainstem Shasta River from Dwinnell Dam (RM 41) to the Klamath River (RM 0) according to 6/26/2003 FLIR survey. Chart from Watershed Sciences (Ltd. 2004) with salmonid reference annotations added.

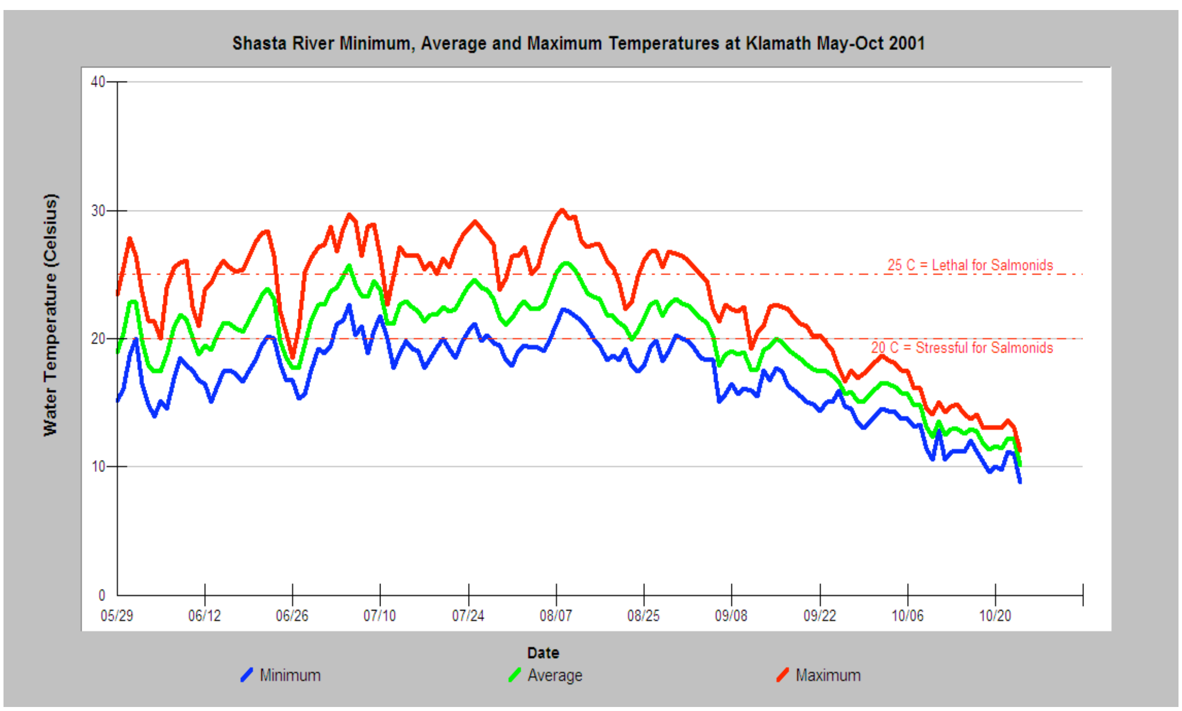


Figure 2. Shasta River minimum, average and maximum daily water temperature above the convergence with the Klamath River shows chronic stressful and lethal conditions for salmonids from late May through mid-September 2003. Data from USFWS (2003).

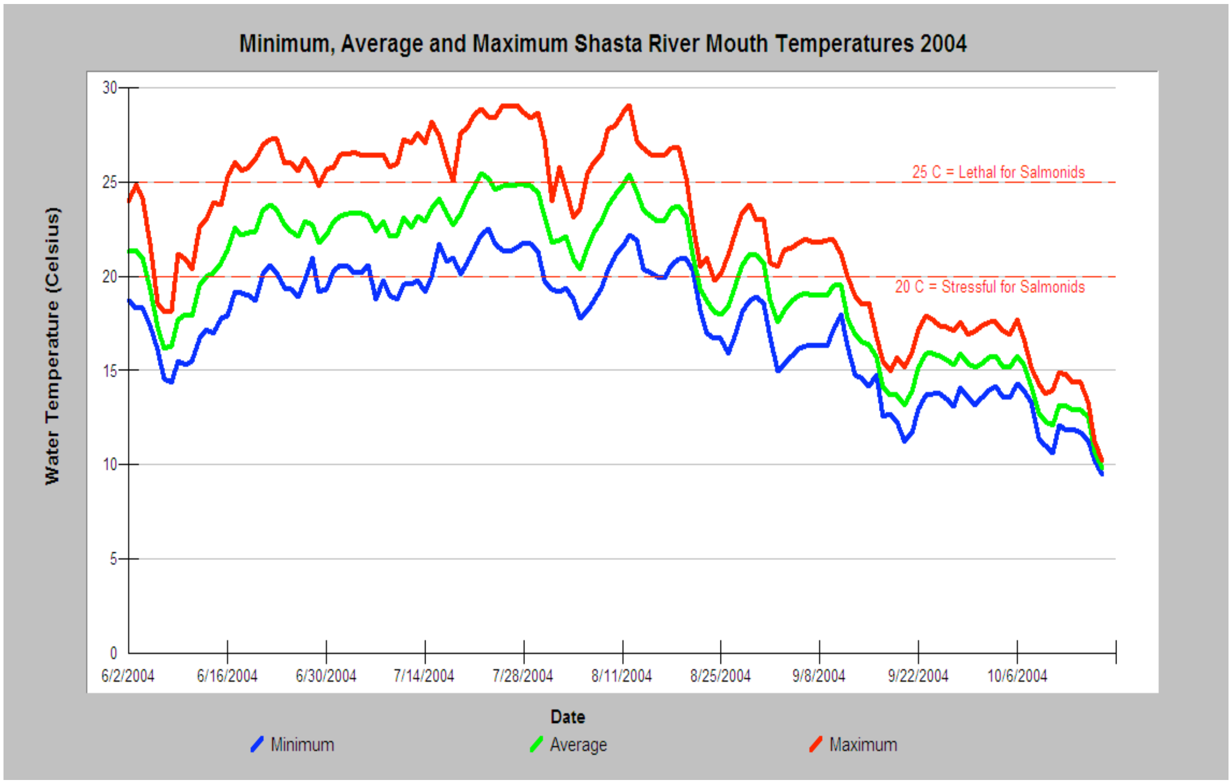


Figure 3. Shasta River minimum, average and maximum daily water temperature above the convergence with the Klamath River shows chronic stressful and lethal conditions for salmonids from mid-June through mid-September 2004. Data from USFWS (2003).

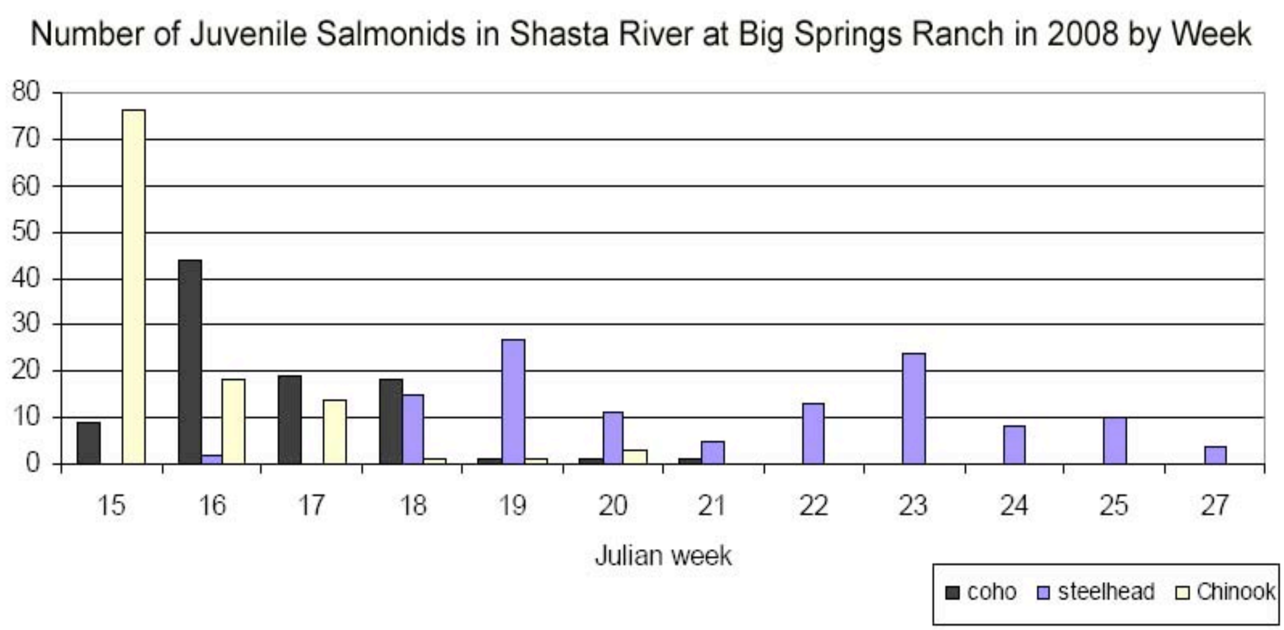


Figure 4. Chart from Chesney et al. (2009) showing the number of coho salmon, Chinook and steelhead juveniles in spring areas near the convergence of the Shasta River and Hole in the Ground Creek by Julian Week (20 = May 1). Flows and temperatures appear to have become unsuitable for coho later in summer.

Dwinnell Reservoir: Because of water quality problems in Dwinnell Reservoir (Figure 5), tailwater releases in summer must be restricted to avoid adverse impacts to aquatic life downstream, including coldwater fishes. The NCRWCB and UC Davis (2005) *Lake Shastina Limnology Report* shows that Dwinnell Reservoir has elevated water temperatures and nitrogen fixing blue-green algae that grow to nuisance levels and contribute to increased pH and depressed D.O. Shasta River flows have been shut off by Dwinnell Dam since 1928, in violation of California Fish and Game Code §5937. Also, the dewatering of the mainstem below is a clear case of flow impairment because CWA beneficial uses can't be met when the stream bed is dry. Dwinnell Reservoir should, therefore, be listed for hydromodification and diversion. The Quartz Valley Indian Reservation (QVIR 2008b) petitioned the SWRCB to include Dwinnell Reservoir on the 303d list:

> "Vignola and Deas (2005) identify problems with limnological nuisance algae that thrive in the warm stagnant waters of the Dwinnell Reservoir, including blue-green algae species that fix nitrogen and toxigenic Anabaena flos-aquae. Since these algae create their own nitrogen source from the atmosphere, and phosphorous in Dwinnell Reservoir is not limited because of volcanic formations upstream on the slopes of Mount Shasta, there is no way to prevent this nutrient pollution cycle."

This indicates that the only likely solution to pollution in Dwinnell Reservoir is removal. QVIR (2008b) is also included as an appendix to support this listing request.

Figure 5. Dwinnell Reservoir water is shunted to the east side of the valley while the Shasta River segment below the dam goes virtually dry. The extent of watershed area suitable for spawning in the upper Shasta and Parks Creek is evident in the photo. Photo by Thomas Dunklin with annotation added.

Big Springs Creek: Increased diversion of surface and groundwater has changed the temperature regime of the Shasta River and in Big Springs Creek. Mack (1960) measured flow at Big Springs of 103 cfs, which is very similar to the measurements reported by the California Department of Public Works Division of Water Rights (1925) for the Shasta River adjudication. The California Department of Water Resources (1981) found that Big Springs Creek had the highest concentration of spawning salmon in the Shasta River basin. Sometime after 1991, the Montague Water Conservation District (MWCD) began pumping water from the aquifer immediately upstream of Big Springs and substantially diminished surface flows in the creek (Kier Associates 1999). The land owner at Big Springs, Mr. Busk, took legal action against MWCD, but the court order required only that flows not be reduced to less than 17 cfs. The groundwater extracted by the MWCD is clearly connected to surface flows as there is no other logical explanation for the diminishment of flows to Big Springs Creek. Therefore, MWCD should have acquired an appropriative water right from the SWRCB Water Rights Division, but no such permits have been sought or granted. The diversion of Big Springs by MWCD constitutes a major impairment of Big Springs Creek and justifies listing for pumping.

The rise in temperature caused by diminished flows has turned one of the last salmonid cold water refugia in the Shasta River into marginal habitat. The Watershed Sciences Ltd. (2004) FLIR data for Big Springs Creek further underscores the linkage between flow depletion and temperature impairment (Figure 6). Because of low water volume, the creek begins to warm immediately below the spring source at Big Springs Lake and rises to over 23^{o}-24^{o} C at its convergence with the Shasta River. Water temperatures over 20^{o} C are in the stressful range for all Pacific salmon species (McCullough 1999, U.S. EPA 2003) and exceed suitability for coho salmon (Welsh et al. 2001). Water arising from Big Springs should be 14^{o}-15^{o} C (Stonestrom and Constantz 2004, Pool and Berman 2001) and would remain below 17^{o} C all the way to the Shasta River, if flows were running at 105 cfs. The loss of the cold water volume has an equal or greater impact on the Shasta River downstream, and the FLIR image would show dramatic cooling if there were higher flows.

Kier Associates (1999) reported that Little Springs Creek, a tributary of Big Springs Creek, had been dammed and diverted, causing significant loss of fish habitat. The FLIR imagery from July 2003 (Watershed Sciences Ltd. 2004) does not indicate that flows from Little Springs Creek were restored, as there is no cooling of Big Springs Creek below its convergence. This suggests that the Big Springs sub-basin should be listed as impaired for hydromodification and diversion.

Parks Creek: This stream has its headwaters on U.S. Forest Service (USFS) lands in the Eddy Mountains where there is substantial precipitation. Part of Parks Creek's flow is routed into the China Ditch at the western edge of the Shasta Valley. The remaining flow is then routed into Dwinnell Reservoir leaving Parks Creek's bed nearly dry (Figure 7). If there were perennial flow in Parks Creek and connection to public lands upstream, anadromous fish habitat in the Shasta River basin could be greatly expanded. Below the diversion to Dwinnell, however, there are a number of major springs on private land where coho salmon juveniles rear in summer (Chesney et al. 2009). Unfortunately, water

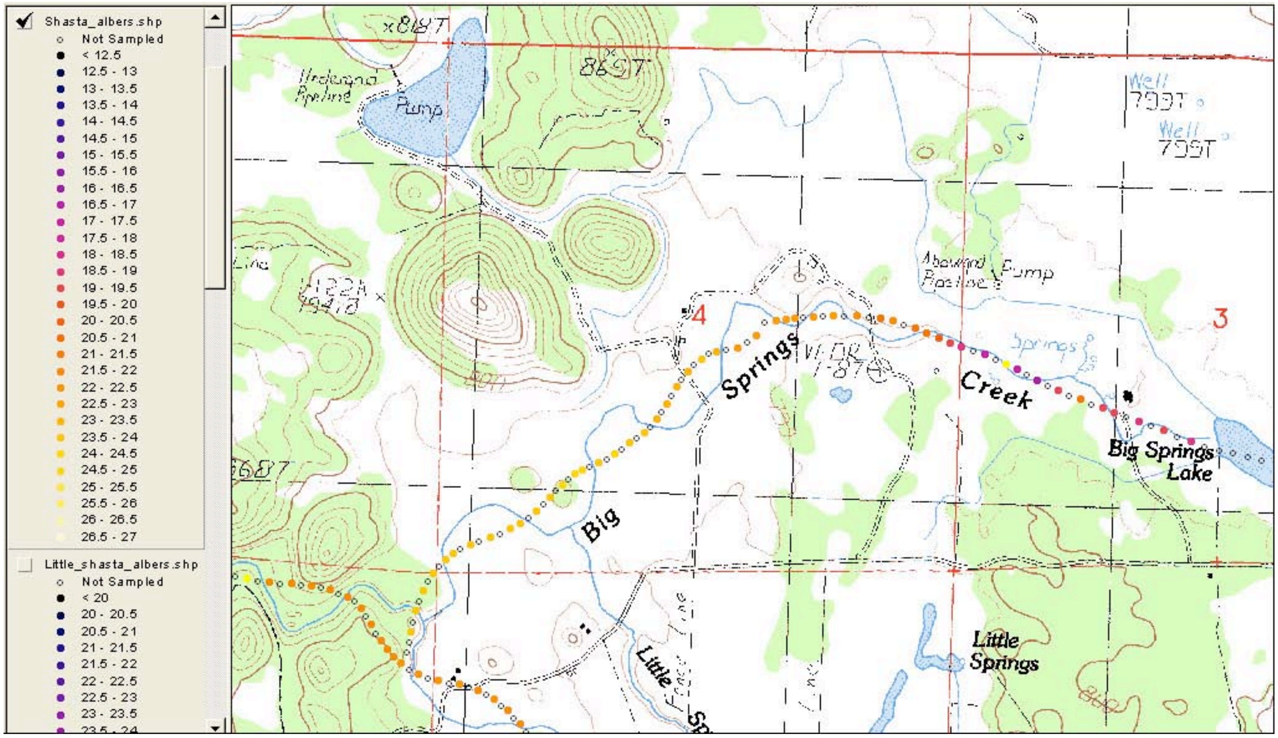


Figure 6. Thermal infrared radar (TIR) map of Big Springs Creek from 6/26/03 shows that the stream warms rapidly as a result of diversion and now is too warm for optimal salmonid rearing. Data from Watershed Sciences (2004).

Figure 7. Parks Creek running nearly dry during the summer of 2003 below the point where most of its flow is diverted into Dwinnell Reservoir. Copyrighted photo by Michael Hentz.

from these springs is also diverted into irrigation ditches and flows are depleted and subject to warming. Watershed Sciences Ltd. (2004) FLIR imagery (Figure 8) shows that there is flow in lower Parks Creek as it flows toward the Shasta River, then it goes dry. Water flow is re-established just above the Shasta River, but volumes are not sufficient to remain cool. Consequently, it also lacks any ability to improve flow and temperature conditions in the mainstem as well.

Chesney et al. (2009) used pit tags and dive observations to track juvenile coho in lower Parks Creek and found a number of coho juveniles using springs, including Kettle Springs. With no flow in the mainstem Shasta River below Dwinnell Dam and no cold water refuge available in Big Springs or Little Springs Creeks, coho are seeking out the last few cold water sources available. Chesney et al. (2009) found that flows were reduced by diversion late in the season (Figure 9) and that the number of juvenile coho salmon diminished. Water temperature data collected by Chesney et al. (2009) also show effects of diversion, with increased maximum daily water temperatures and also increased fluctuation between maximum and minimums (Figure 10).

Chesney (2009) stressed the importance of maintaining flow in Kettle Springs for the survival of Shasta River native coho salmon:

> "The number of coho affected by the diversion of Kettle Springs in 2009 is small, but that's the point, there are very few left. If the springs are permitted to flow, there is a chance that coho possessing the life history tactic of migrating upstream to cold springs will survive. This tactic is essential to the survival of coho salmon in the Shasta River."

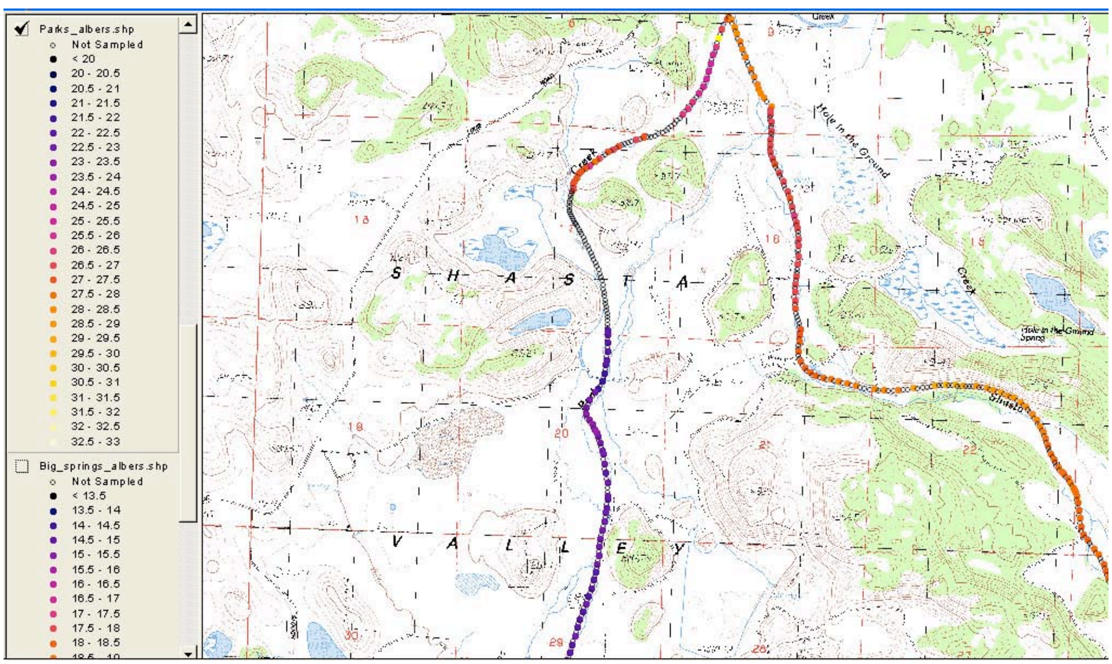


Figure 8. Thermal infrared radar (TIR) map of Parks Creek and the mainstem Shasta River downstream of Dwinnell Reservoir on 6/26/03 show little salmonid suitable habitat. Parks Creek dries up near the center of the image. Data from Watershed Sciences (2004).

Figure 9. Kettle Springs and creek at lower center, but diversion ditch at upper right (red arrow). Wild coho rear downstream when flows are sufficient. Photo from Chesney et al. (2009) taken on 7/7/08.

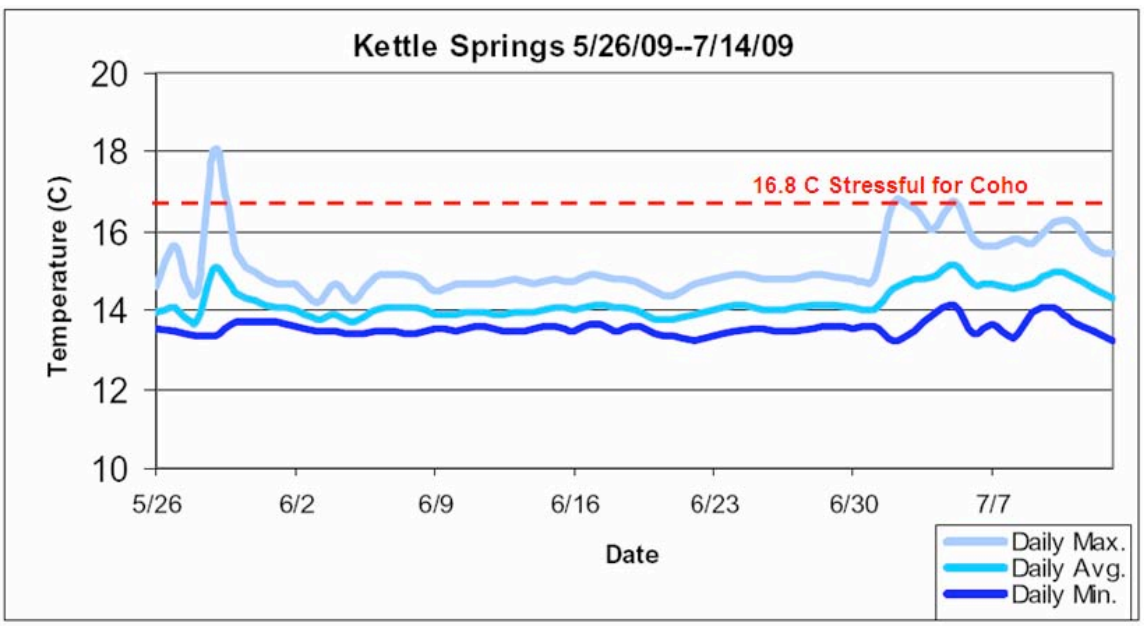


Figure 10. Kettle Springs Creek water temperature remained in the optimal range for coho salmon except briefly in late May and after June 30 when flows were reduced. Chart from Chesney et al. (2009) but reference line is added and reflects Welsh et al. (2001).

The National Marine Fisheries Service (NMFS)(Masters 2009) has indicated that agricultural diversion of spring water sources in lower Parks Creek may constitute a "take" of coho salmon under the federal Endangered Species Act (ESA). Existing mechanisms such as the Watermaster service, the TMDL and CDFG incidental take permits do not seem to be preventing coho salmon extinction. The SWRCB needs to list Parks Creek for altered flow, hydromodification and diversion and take other appropriate actions.

Other Flow Impaired Shasta River Tributaries Below Dwinnell Dam: Three major tributaries of the lower Shasta River all lose surface flow for much of the year because they are completely diverted: Willow Creek (Figure 11), Julien Creek and the Little Shasta River. The FLIR survey of 2003 (Watershed Sciences Ltd. 2003) shows the direct effect of water withdrawals in the Little Shasta River on water temperature (Figure 12). None of these tributaries has the ability to support any life stage of Pacific salmon species except steelhead, intermittently in their headwaters. All deserve consideration for addition to the 2012 303d list for alteration of flow and diversion related impairment.

Figure 11. Willow Creek above Callahan-Gazelle Road crossing showing no surface flow and little riparian vegetation, which may indicate dropping of the water table. Photo by Pat Higgins (Oct. 1994).

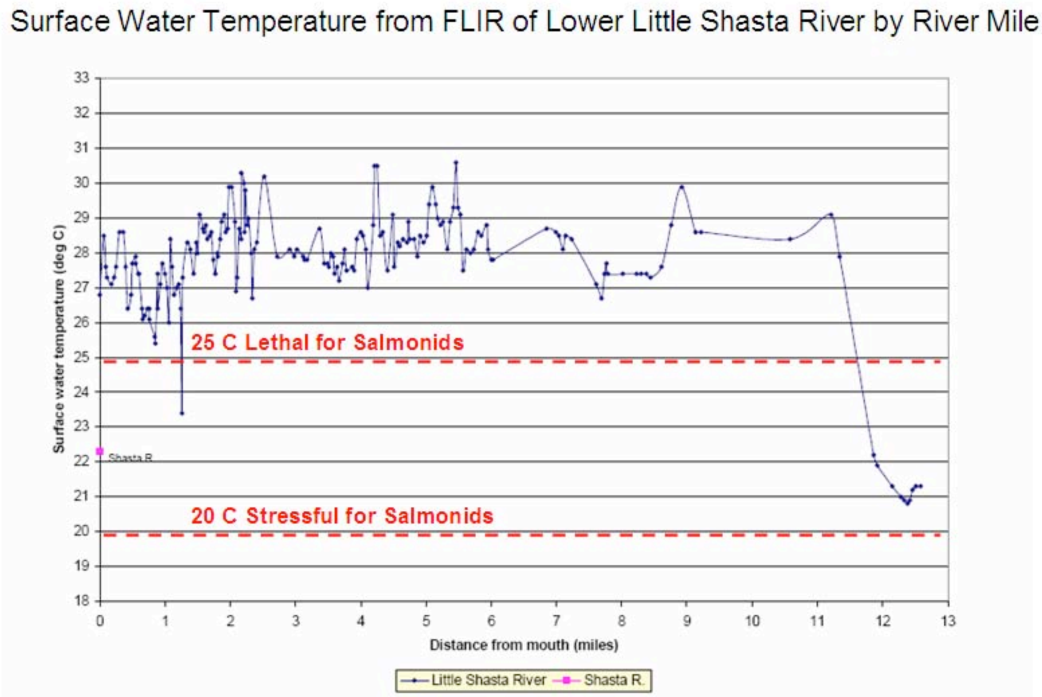


Figure 12. Surface water temperatures of the Little Shasta River from near RM 13 to the mainstem Shasta River (RM 0) according to 6/26/2003 FLIR survey show little possibility for salmonid rearing. Chart from Watershed Sciences Ltd. (2004) with annotation of stressful (McCullough 1999) and lethal (Sullivan et al. 2000) for salmonids added.

Lack of Progress on Increased Flows Proposed by the Shasta TMDL Action Plan

The NCRWQCB and SWRCB may feel that Shasta River flow issues are handled because they were explicitly dealt with in the *Shasta TMDL* (NCRWQCB 2006a) and Basin Plan amendment (NCRWQCB 2006b). While the NCRWQCB recognition of the flow issue and the SWRCB action to specify a specific flow level (45 cfs) is commendable, none of the measures for improving flow have been implemented. Instead flows have dropped to near all time lows since 2006. As a result, water quality problems like high water temperatures have remained acute and coho salmon have slid further towards extinction. The lack of progress on the flow issue on the Shasta River reinforces the need for listing as flow impaired.

The *Shasta TMDL* and Basin Plan amendment (NCRWQCB 2006a, 2006b) both recognize the linkage of decreased surface flows to increased water temperature and depressed dissolved oxygen problems and a number of mechanisms are specified for increasing flow. These will be reviewed below, followed by a discussion of reduced flows and impaired water quality since 2006. The Basin Plan amendment specifies a maximum daily water temperature reduction at specific points along the river of “1.5^{o}C, 1.2^{o} C, and 2.1^{o} C for compliance points at river miles (RM) 24.1, 15.5, and 5.6, respectively.” To meet this objective, water flows were to be increased to 45 cfs at A-12 near Grenada and to be maintained at Montague-Grenada Road at no less than 20 cfs.

Since there is no regulatory mechanism employed for forcing increased flow releases, these targets have not been met.

Irrigators, CRMP and the RCD: Organized water or diversion districts, the Shasta Valley Cooperative Resource Management Planning (CRMP) group and the Shasta Valley Resource Conservation District (RCD) are supposed to report to the NCRWQCB annually about progress on flow improvements:

> "Irrigators should submit annually to the Regional Water Board a written summary of all tailwater return flow management actions taken to help achieve compliance with water quality standards, the TMDLs, and the NPS Policy, either individually or through the Shasta Valley RCD and its CRMP or through the CDFG coho ITP."

> "Within two years, and again within four years, of EPA approval of the TMDL, water diverters shall report in writing to the Regional Water Board, either individually or through the Shasta Valley RCD and its CRMP, on the measures taken to increase the dedicated cold water instream flow in the Shasta River by 45 cfs or alternative flow regime that achieves the same temperature reductions from May 15 to October 15."

The Shasta River incidental take permit (ITP) process for coho salmon sponsored by CDFG has stalled and is currently tied up in court. The annual, bi-annual and fourth anniversary reports envisioned have not been filed.

CDFG ITP Process: The ITP (ESA 2009) does not specify flow levels of 45 cfs at road A-12 and only would insure flow levels of 20 cfs at the bottom of the Shasta Valley in 2015. As pointed out in comments on the ITP (QVIC 2008), this is insufficient to abate water quality problems and too long in attainment. Furthermore, the ITP does not address problems with pumping and loss of flow in Big Springs, diversion of springs in lower Parks Creek or flow and water quality problems caused by Dwinnell Dam.

California Department of Water Resources (DWR): The Basin Plan amendment (NCRWQCB 2006b) assigns responsibility to DWR and its Watermaster service to assist with increased flows:

> "Coordinate and assist water diverters in developing and implementing a monitoring program through a Watermaster service to evaluate and document implementation and effectiveness of the actions taken by the water diverters to increase dedicated cold water instream flows in the Shasta River."

The DWR Watermaster has been unable or unwilling to help with the water supply and illegal diversion crisis, such as the dewatering of Kettle Springs documented by CDFG (Chesney et al. 2009) and the major illegal decrease in flow at Big Springs. In addition, DWR has recently moved to increase fees for their service and legislation has been passed to substitute a private party to serve in this capacity. The failure of existing mechanisms like the Watermaster service to increase flow highlights the need to add flow depletion as a source of pollution and impairment to the California 303d list in 2012.

<u>Potential NCRWQCB Action</u>: Qualifiers in Basin Plan amendment (NCRWQCB 2006b) with regard to flow imply that the NCRWQCB and SWRCB would like to avoid actually dealing with the volatile flow issue:

> "This recommended flow measure does not alter or reallocate water rights in the Shasta or Klamath River watersheds, nor bind the Regional Water Board in future TMDLs, the State Water Board, Division of Water Rights in any water rights decision, or state and federal courts."

None the less, the Basin Plan amendment (NCRWQCB 2006b) sets 2011, the five year anniversary of the TMDL, as the end date for the first phase of effectiveness evaluation of increased Shasta River flow. It also specifies action in the event that provisions are not met:

> "Within five years of EPA approval of the TMDL, water diverters shall provide a final report to the Regional Water Board, either individually or through the Shasta Valley RCD and its CRMP, on documenting dedicated cold water instream flow in the Shasta River in relation to the 45 cfs goal or alternative flow regime that achieves the same temperature reductions from May 15 to October 15."

> "If after five years, the Regional Water Board's Executive Officer finds that the above-measures have failed to be implemented or are otherwise ineffective, the Regional Water Board may recommend that the State Water Board consider seeking modifications to the decree (*In re* Waters of Shasta River and its Tributaries, No. 7035 (Super. Ct. Siskiyou County Dec.29, 1932), conducting proceedings under the public trust doctrine, and/or conducting proceedings under the waste and unreasonable use provisions of the California Constitution and the California Water Code."

It is highly likely that the latter provision may need to be invoked and listing of the Shasta River for flow impairment in 2012 is consistent in concert with enforcement action. There are provisions that also call on the NCRWQCB Executive Officer to report to the SWRCB, if they receive "credible evidence that the Shasta River flows are diminishing". We are not aware of any such notice or report, despite a major flow crisis as described by CDFG (Chesney et al. 2009) and below.

<u>Shasta River Flow Conditions and Fisheries Resources</u>: Evidence of decreased Shasta River flow versus historic conditions has been summarized by the Klamath Basin Water Quality Work Group (QVIC 2006a, 2006b, 2008, 2009) and recent USGS flow gauge data confirm continuing flow depletion. Figure 13 shows flows at the USGS gauge in 2001 with frequent drops below 20 cfs from May through August. These flow levels are directly linked to acutely stressful or lethal water temperatures for salmonids near the mouth of the river in the same year (Figure 2).

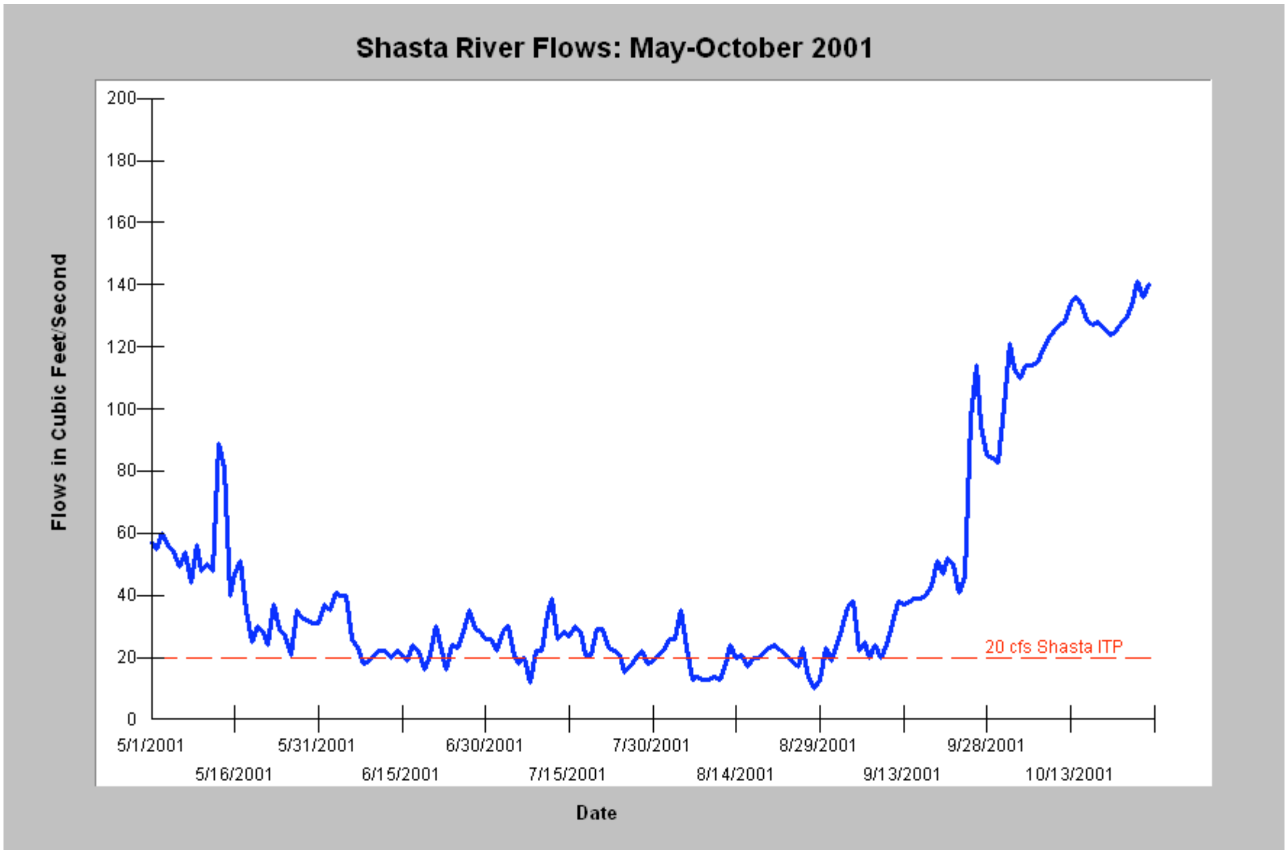


Figure 13. Average daily flow at the USGS Shasta River gauge for May through October 2001 show a pattern of extremely low flows with many days falling below 20 cubic feet per second.

Flows during the summer of 2009 show a similar drop to extremely low levels at the USGS gauge (Figure 14) with a minimum flow of 5 cfs in July. Extremely low flows continued into September, with a low of 9.5 recorded on the 8th and an average of 18 cfs on the 21st. This latter date is problematic since Shasta River spawning historically began on September 15 (Snyder 1931). Figure 15 is a photograph of the lower Shasta River at Montague-Granada Road (RM 15.2) and shows stagnant conditions on August 21, 2009 as a result of flows of 16.8 cfs.

The flow gauge data are average daily flow values, but should be considered conservative because variability during the course of the day could be lower. These transitory fluctuations may be short in duration, but could have catastrophic impact on fish survival if the Shasta River goes dry or nearly so.

Currently irrigation ceases in the Shasta Valley on October 1, except for stock water withdrawals. Unfortunately, this causes the fall Chinook run to hold in the mainstem Klamath River for an additional two weeks from the traditional start of their spawning run on September 15 (Snyder 1931). Klamath River water quality conditions are adverse and there is a likely increase of mortality of adult Chinook salmon as well as reduced fecundity due to stress. Figure 16 shows the timing of the fall Chinook run in 2001 with flow levels annotated to show the relationship of flow releases and run timing.

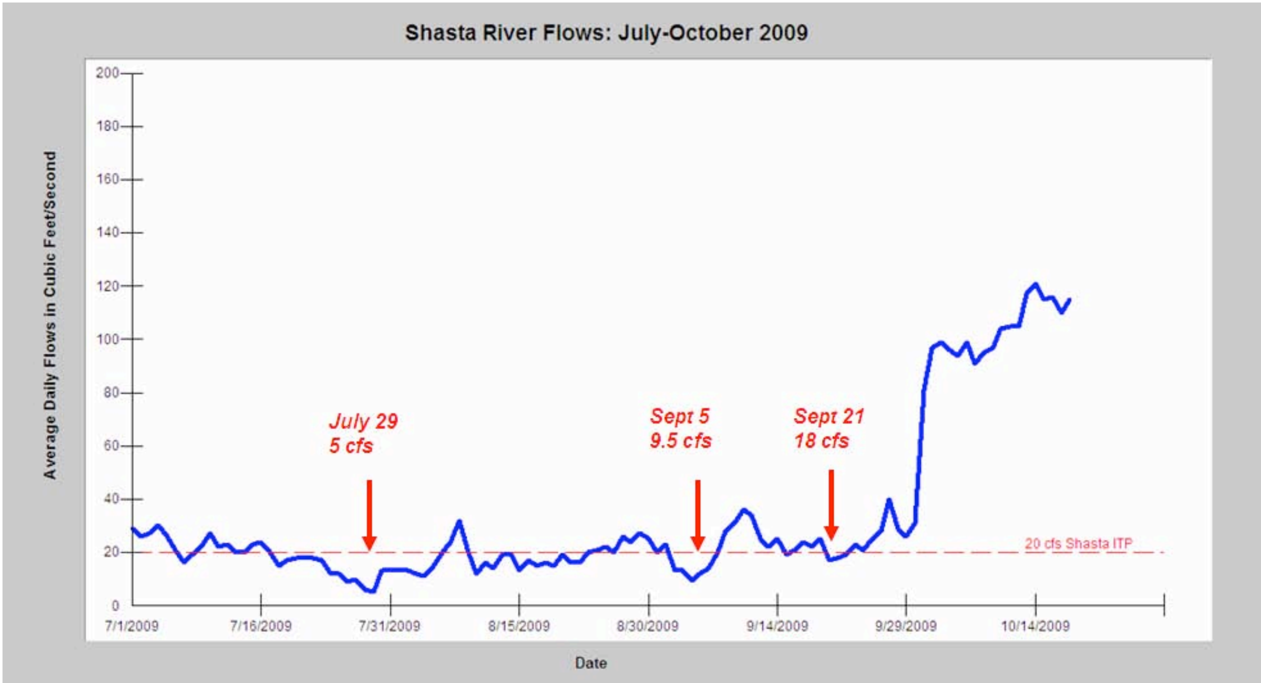


Figure 14. Average daily flow at the USGS Shasta River gauge for July through October 2009 show a pattern of extremely low flows with many specific low flow values labeled.

Figure 15. Shasta River at Montague Road Bridge on Aug 21, 2009. River flow is at 16 cfs. Photo used with permission of Klamath Riverkeeper.

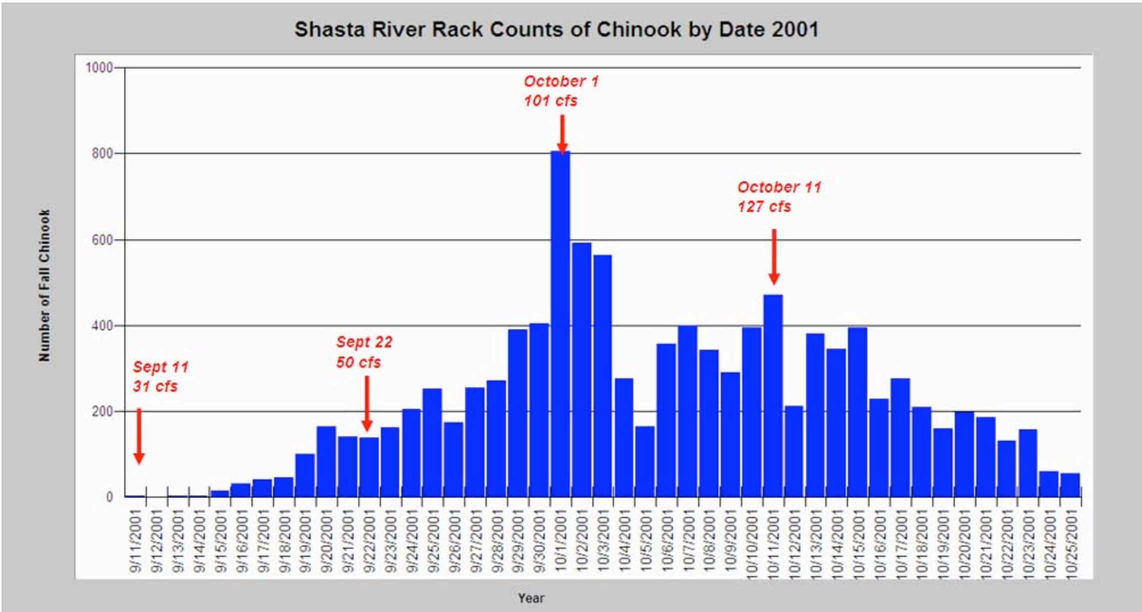


Figure 16. Fall Chinook counts at the Shasta Rack just above the mouth of the Shasta River in 2001 show that some fish entered the river at the time of historical spawn timing on September 15, but the bulk of the run came after flows began to exceed 100 cfs on October 1. Data from CDFG.

Coho Population Will Be Lost Without Prompt Action to Increase Flows

CDFG staff (Chesney et al. 2009) did an excellent job of tracking juvenile coho salmon survival in the Shasta River. They provide evidence that two year classes have failed and the third, which is the one returning in 2010, is in jeopardy if agricultural diversion practices in lower Parks Creek continue. NMFS (Masters 2009) has concurred with CDFG with regard to the impact of these activities. Chesney et al. (2009) provide the following:

> "Based on the number of adults returning in 2008 and 2009, the observed juvenile production in 2008 and the projected smolt to adult survival, we expect that Cohorts A and C will continue to decline and are functionally extinct. Cohort B is the last remaining cohort with viable numbers of adults projected to return. We estimate that 5,000, 1+ coho emigrated from the Shasta River in 2009. If smolt to adult survival is average at 2.9%, we expect that 148 adults will return in the fall of 2010."

Rieman et al. (1993) point out that at-risk animal populations may experience substantial loss of genetic diversity and diminished prospects of long term survival when their numbers drop below 500, and that a minimum of 50 individuals is needed to avoid immediate inbreeding depression. Since the 148 adults expected in 2010 is the strongest year class, returns in 2011 and 2012 will likely be less. The reason that coho salmon are slipping inexorably towards their extinction is the continuing loss of habitat due to flow depletion, including illegal water use and complete blocking of stream flows in violation of Fish and Game Code § 5937:

- Dwinnell Dam blocks access to spawning habitat and shuts off flows to the mainstem,
- Parks Creek is dewatered to help fill Dwinnell Reservoir and springs are dried up in its lowest reaches,
- Tributaries such as the Little Shasta River and Julien and Willow creeks are dewatered and stream courses disrupted and channelized, and
- Flows in Big Springs Creek have been reduced by 80% from historic levels with disastrous impacts to all Pacific salmon because of the loss of this important refugia and ripple impacts to the mainstem Shasta River downstream.

Uncontrolled Groundwater and Riparian Extraction Could Confound Flow Improvements

CDFG (Ricker 1997) pointed out that the number of new wells in the Shasta Valley continues to increase. Groundwater extraction may reduce spring flows and seeps that feed cold water into the Shasta River and its tributaries, as described at Big Springs. It may also cause a reversal of flow direction and surface water from streams may be sucked into the groundwater, if wells are near a stream (Winter et al. 1998, USFS 2007). The NCRWQCB and SWRCB need to request the assistance of the U.S. Geologic Survey in fully analyzing groundwater use in the Shasta River and impacts to stream flows. The final revisiting of the Shasta River adjudication must restrict use of groundwater and also limit riparian water rights, if flows for fish and water quality standards are to be achieved. It is also logical that the SWRCB recognize pumping and diversion as causes of Shasta River basin-wide impairment on the 2012 updated version of the California 303d list.

Abatement of Klamath River Water Quality Problems Also Requires Improved Flows in Shasta and Scott Rivers

Discussions regarding abatement of mainstem Klamath River water quality typically revolve around flow releases from the Upper Klamath and nutrient pollution caused by Upper Basin agriculture and Klamath Hydroelectric Project reservoirs. However,, flows from the Shasta and Scott rivers profoundly impact mainstem Klamath River health. These rivers once cooled the Klamath by providing copious amounts of cold water and major refugia for migrating salmon and steelhead. Instead of contributing cold, nutrient poor water to the Klamath River, the Shasta River now runs over 29^{O} C and has a warming influence on the mainstem Klamath (Figure 17). McIntosh and Li (1998) used forward looking infrared radar (FLIR) to characterize the pattern of temperature problems in the mainstem Klamath River. Their July 1998 FLIR image of the lower Shasta River indicates it has a warming influence on the mainstem Klamath River. The high concentration of nutrients in the Shasta River is also likely to exacerbate mainstem

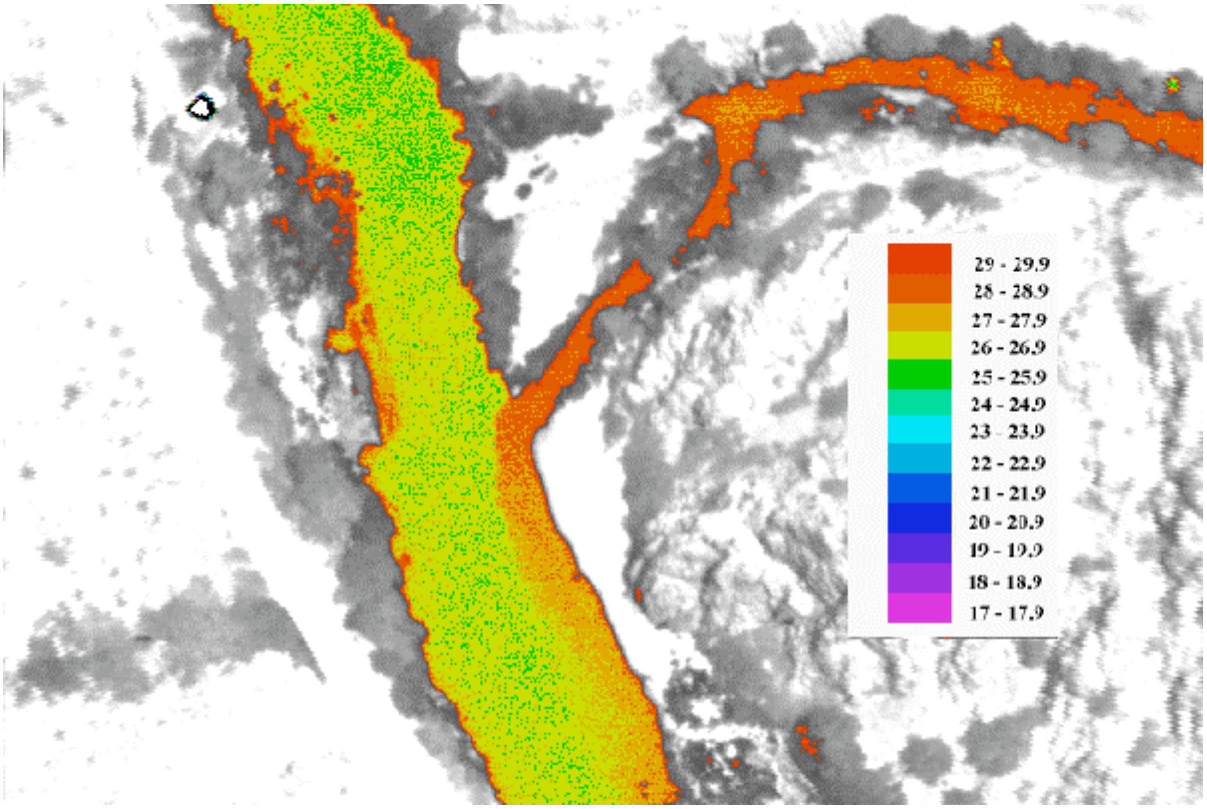


Figure 17. Thermal Forward Looking Infrared Radar Image (FLIR) in July 1998 showing the confluence of the Klamath River (flowing from the top of the image to the bottom of the image) and the Shasta River (flowing right to left in the image). The Shasta River is approximately 29 degrees C and a warm water plume is observed in the Klamath River below. From McIntosh and Li (1998).

Klamath River nutrient enrichment problems, as opposed to moderate them as it would have in its historic condition and will once again after flows are restored.

The 70,000 adult salmon Klamath Fish Kill of September 2002 was strongly linked to flow releases at Iron gate Dam of 750 cfs (CDFG 2002, Guillen 2002, 2003). Salmon were unable to cross riffles in the lower Klamath River, became stressed in warm water temperatures and succumbed to disease. What if the Shasta and Scott rivers were contributing 100 cfs each of cold water? Instead on the date of the mass mortality the Shasta River was flowing at 28 cfs (Figure 18).

The SWRCB must recognize the integral relationship of Shasta and Scott River flow restoration and abatement of mainstem Klamath River water quality problems. Consequently, the SWRCB should move to list both the Shasta and Scott rivers as flow impaired on the 2012 revised California 303d list and the SWRCB Water Rights Division (WRD) should take immediate actions to restore flows in both basins to avoid mainstem Klamath River ecological collapse.

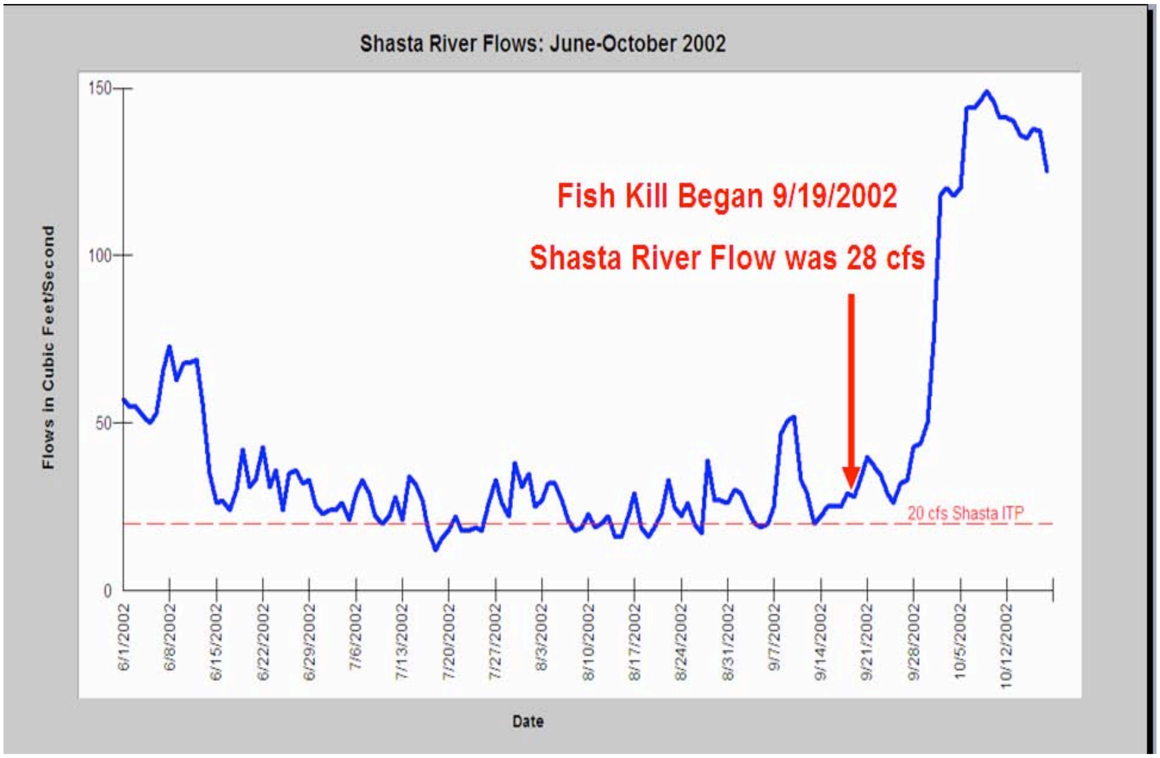


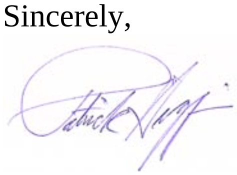
Figure 18. USGS Shasta River flow data for June to October 2002, which includes data from the time of the Klamath Fish Kill.

Conclusion

The SWRCB needs to recognize the Shasta River as flow impaired on the California 2012 updated 303d list and should include all categories for which there is precedent: flow alteration, hydromodification, pumping and diversion. The support for such action is clearly justified above and it is abundantly clear that Shasta River water quality problems cannot be abated nor beneficial uses guaranteed under the Clean Water Act restored without increasing cold water flows.

Evidence from CDFG (Chesney et al. 2009) provide a compelling case that, unless the SWRCB takes immediate action to increase flows and prevent widespread stream desiccation, the ability to restore coho salmon in the future as a COLD beneficial use will be irretrievably and irreversibly lost. The clearest need is for the SWRCB WRD to enforce the law in the Shasta River, particularly with regard to Dwinnell Dam removal, stopping illegal diversion at Big Springs and protecting the last refugia for coho salmon juveniles in lower Parks Creek from being dried up. Please fell free to call me, if you have questions.

Sincerely,



Patrick Higgins

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