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The Influence of Lewiston Dam Releases on Water Temperatures of the Trinity River and Lower Klamath River, CA. April to October, 2012

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Abstract — Water temperatures were monitored at several locations along the Trinity and lower Klamath rivers from April to October 2012 to evaluate the influence of Lewistown Dam releases on downstream water temperatures. We compared observed values to water temperature objectives specified in the Trinity River Record of Decision, including the spring water temperature targets established for smolt production for the lower Trinity River and the Basin Plan objectives for the 64-kilometer reach located downstream of Lewiston Dam to protect holding and spawning adult salmonids. In addition, we document the influence of Lewiston Dam releases on water temperatures in the lower Klamath River downstream of the confluence of the Trinity River. This document is the eleventh consecutive annual water temperature report generated for the Trinity River Restoration Program.

Introduction

Water temperature is one of the most important environmental variables affecting salmonid biology (Carter 2005). Water temperature influences feeding rates and growth (Hicks 1999; USEPA 2003), metabolism (Fry 1971; Beitinger and Fitzpatrick 1979), development (ODEQ 1995), timing of migration (Hicks 1999; USEPA 1999; Beeman et al. 2012), spawning and freshwater rearing (USEPA 2001a, 2003), and the availability of food (Ligon et al.1999). Changes in temperature can also cause stress and lethality (Elliot 1981; Li et al. 1994; USEPA 1999; Myrick and Cech 2001; USEPA 2001b). Water temperatures in the lower Klamath River have been found to block migration (CDFG 2004), stress fish (Barthalow 2005), and create disease problems in juvenile (True et al. 2010) and adult salmonids (Lynch and Risley 2003; Guillen 2003; CDFG 2004). Discharge from Lewiston Dam can play an important role in regulating water temperatures downstream in the mainstem Trinity River. Problems associated with decreased flows on the Trinity River after Trinity and Lewiston Dam construction and other anthropogenic activities, led to restoration efforts by the Trinity River Restoration Program (TRRP; USDOI 2000).

The TRRP was authorized with the signing of the Record of Decision (ROD) of the Final Trinity River Mainstem Fishery Restoration Environmental Impact Statement in December of 2000 (USDOI 2000). Since the signing of the ROD, the TRRP has worked aggressively to achieve the program's over-arching goal of restoring natural production of salmon and steelhead below Lewiston Dam. As part of the TRRP's Adaptive Environmental Assessment and Management (AEAM) process, monitoring is conducted to evaluate progress towards achieving restoration objectives and to improve our understanding of the river's response to differing management actions (e.g. dam releases or gravel

augmentation). A major objective of the TRRP's flow management is to improve thermal regimes for all life stages of anadromous salmonids that use the mainstem Trinity River. Specific temperature targets have been developed for holding and spawning adult salmonids and for outmigrating juvenile salmonids (USFWS and HVT 1999). Additionally, supplemental flows were released in August and September 2012 to improve conditions in the lower Klamath River to decrease the potential for an adult fish kill (TRRP - Fall Flow Subgroup 2012). This report supports the AEAM process in that it briefly describes the influence that Lewiston Dam releases had on the downstream thermal environment during the spring, summer, and fall of 2012 and whether or not the water temperature objectives identified in the ROD were achieved (Table 1).

This report presents the temperature monitoring data collected for April to October during water year (WY) 2012, and beginning of WY 2013, and is the eleventh consecutive year a report of this type has been written for the TRRP. Reports describing the thermal regimes for the years 2002 to 2011 (Zedonis 2003, 2004, and 2005; Zedonis and Turner 2006, 2007, and 2008; Zedonis 2009; Scheiff and Zedonis 2010, 2011, and 2012) are available in electronic format from the TRRP or the Arcata Fish and Wildlife Office (AFWO) of the U.S. Fish and Wildlife Service (USFWS) (http://www.fws.gov/arcata/fisheries).

Study Area

The Trinity River is located in northwestern California and is the largest tributary to the Klamath River (Figure 1). Trinity and Lewiston dams were constructed in the early 1960s (USFWS and HVT 1999). Trinity Dam creates Trinity Reservoir that can store up to 2.45 million acre-feet of water. Lewiston Reservoir is located immediately downstream of Trinity Dam, and is formed by Lewiston Dam, which serves as a re-regulating reservoir for flow to the Trinity River and diversion to the Sacramento River Basin. From Lewiston Dam, the Trinity River flows for approximately 180 river kilometers (rkm) before joining the Klamath River at Weitchpec, CA. From Weitchpec, the Klamath River flows for 70 rkm before entering the Pacific Ocean.

Methods

The influence of Lewiston Dam releases on downstream water temperature was assessed using water temperature data collected by telemetered gauging stations operated by the U.S. Geological Survey (USGS), the California Department of Water Resources (DWR), and from probes deployed by the AFWO, U.S. Bureau of Reclamation (USBR), and the Yurok Tribe's Environmental Program (YTEP; Table 2). Data from telemetered gauging stations were downloaded from the California Data Exchange Center (CDEC) website available at http://cdec.water.ca.gov.

Data obtained from CDEC sites are labeled "preliminary and subject to revision", meaning the accuracy of the data has not been verified by USGS. To correct for possible errors, we conducted graphic evaluations to identify potential erroneous data points that were

Table 1. Water temperature objectives for the Trinity River, California.

Water year type	Target area	rkm	Dates	Temperature objective[1] (°C)
Adult Salmonid Holding and Spawning Temperature Criteria[2]				
All types	Lewiston to Douglas City	178.2-148.5	Jul 01 - Sep 14	≤ 15.6
			Sep 15 - Sep 30	≤ 13.3
	Lewiston to confluence North Fork Trinity River	178.2-118.0	Oct 01 - Dec 31	≤ 13.3
Outmigrant Salmonid Temperature Criteria [3]				
Normal and wetter	Lewiston to Weitchpec	178.2- 0.1	Apr 22 - May 22	≤ 13.0
			May 23 - Jun 04	≤ 15.0
			Jun 05 - Jul 09	≤ 17.0
Dry and critically dry	Lewiston to Weitchpec	178.2- 0.1	Apr 22 - May 22	≤ 15.0
			May 23 - Jun 04	≤ 17.0
			Jun 05 - Jun 15	≤ 20.0

[1] = Average daily water temperature in degrees Centigrade
[2] = Basin Plan for the North Coast Region (Regional Water Quality Control Board 1994; USFWS and HVT 1999)
[3] = Spring-time objectives of the Record of Decision for the Trinity River EIS (USDOI 2000; USFWS and HVT 1999).

subsequently deleted. These "preliminary" labeled data have been used in prior years (2004 thru 2011) as they have generally been shown to be accurate when compared to independent certified thermistors (Zedonis 2003).

AFWO used temperature probes manufactured by Onset Computer Corporation® to collect water temperature data every 30 min from April to October. Prior to and after deployment, each probe was subjected to a performance test to verify it was recording within the manufacturer's accuracy specification of ± 0.2 degrees Celsius (˚C). The instruments proved accurate and reliable for all tests conducted in 2012, and no adjustments to temperature data were necessary due to "probe drift" based on graphical evaluations. A copy of the AFWO quality assurance protocol is available upon request.

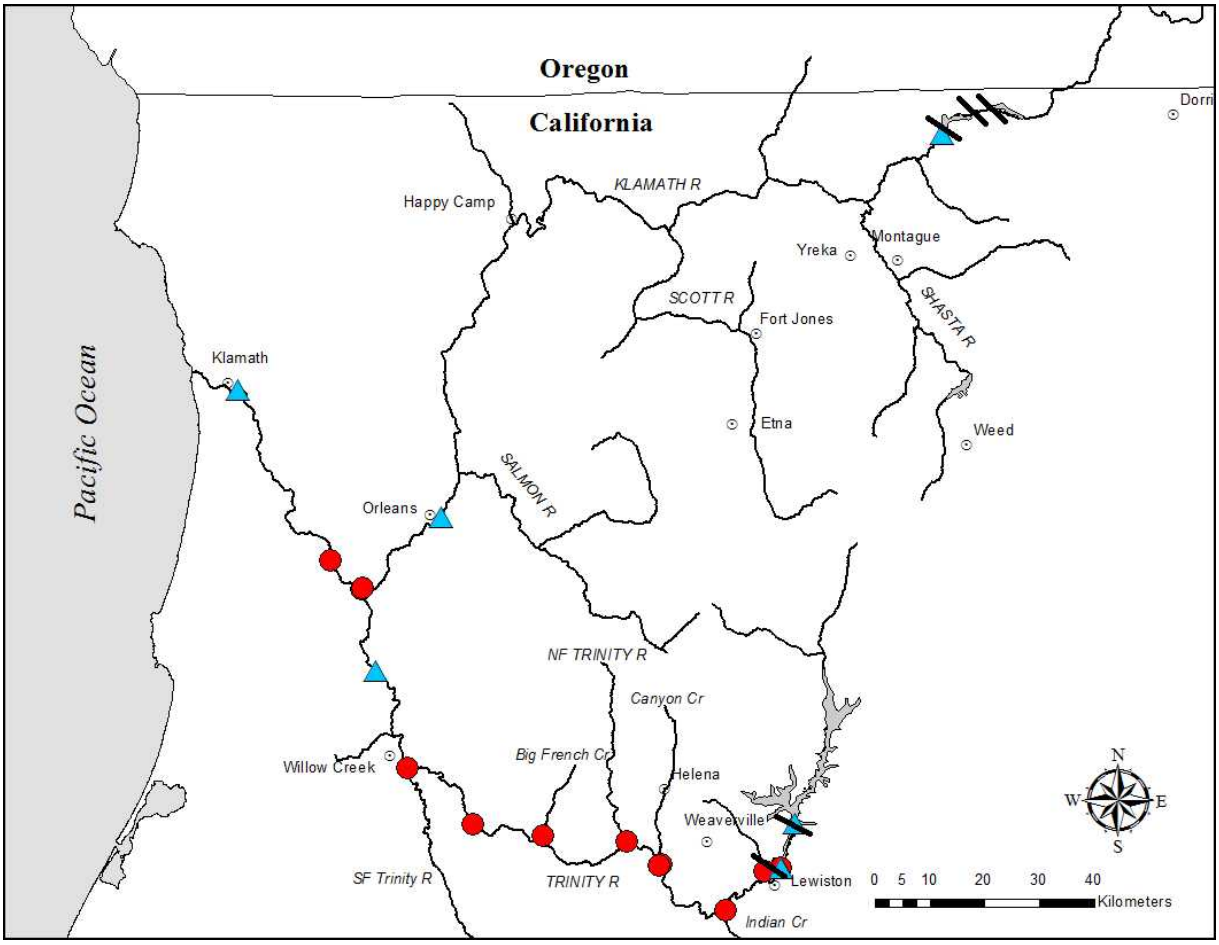

Figure 1. Location of water temperature monitoring sites of the Trinity River and lower Klamath River in 2012. Circles = water temperature sites, Triangles = discharge gauging sites, Bars = dams. Specific site information is presented in Table 2 of this report.

Air temperature data were also obtained from the CDEC. These data were also labeled "preliminary and subject to revision" and were reviewed and corrected using the same standards established for downloaded water temperature data. Estimates of river flow at several sites on the Trinity River at Lewiston (rkm 178.2), Hoopa (rkm 20.0) and on the Klamath River at Iron Gate Dam (rkm 305.5), Orleans (rkm 95.1) and in the lower river near Klamath (rkm 13.0), were obtained from the USGS website (http://water.usgs.gov). Efforts were made to use "final" flow data from USGS, which was dependent on the timing of its release and the timing of completion of this report. In some cases, the only data available at the time of this report were labeled "provisional and subject to change". Although water temperature data were collected from more locations than are presented, only key sampling locations will be discussed in this report.

Table 2. Water temperature monitoring sites of the Trinity River (TR) and the Klamath River (KR) below Weitchpec, 2012. Note: Not all data identified in this table are presented in the report but are available upon request.

Site name (abbreviation)	Location (rkm)	Data source	Operator
Mainstem Trinity River Water Temperature Monitoring Sites			
TR @ Lewiston Gauge (LWS)	178.2	CDEC	USGS and USBR
TR above Rush Ck (TRRC1)	173.0	USFWS	USFWS
TR@ Limekiln Gulch Gauge (TLK)	158.7	CDEC	USGS
TR @ Douglas City Gauge (TRDC2)	148.5	CDEC	USGS
TR above Canyon Ck (TRCN1)	127.4	USFWS	USFWS
TR abv N.F. Trinity R. (NFH)	118.0	CDEC	USGS
TR abv Big French Creek (TRBF1)	94.2	USFWS	USFWS
TR @ Burnt Ran. Trans Sta (TRBR1)	76.4	USFWS	USFWS
TR abv S. Fork Trinity R. (TRSF1)	50.6	USFWS	USFWS
TR @ Willow Creek Trap (TRWC1)	34.1	USFWS	USFWS
TR @ Hoopa Gauge (HPA)	20.0	CDEC	USGS/DWR
TR @ Weitchpec (TRWE1)	0.1	USFWS/YTEP/USBR	USFWS/YTEP/USBR
Mainstem Klamath River Water Temperature Monitoring Sites			
KR at Weitchpec (KRWE1) [a]	70.2	YTEP	YTEP
KR below Weitchpec (KBW3)	68.7	YTEP/USFWS	USFWS/YTEP
KR near Klamath (KRTG2) [b]	13.0	YTEP/USFWS	USFWS/YTEP
Trinity River Tributary Water Temperature Monitoring Sites			
Canyon Ck (CNTR1)	127.3 + 0.1	USFWS	USFWS
N. F. Trinity R (NFTR1)	116.7 + 0.1	USFWS	USFWS
Big French Ck (BFTR1)	94.1 + 0.1	USFWS	USFWS
S. F. Trinity R (SFTR1)	50.5 + 0.1	USFWS	USFWS

a = This site is located immediately above the confluence of the Trinity River and refers to the distance from the Klamath River mouth.
b = Data are available from multiple sources

Results and Discussion

Hydrology

Water year 2012 was designated as a Normal WY in the Trinity Basin. A total of 686,559 acre-feet (AF) of water was released from Lewiston Dam to the Trinity River in WY 2012. This total exceeded the prescribed flow of 646,133 AF for a Normal water year due to the increased releases in the fall to prevent a fish kill (TRRP - Fall Flow Subgroup 2012). Notable differences from a standard ROD normal hydrograph included a shorter, higher peak flow, a more rapid initial decrease in flow following the peak followed by a more gradual decrease in flow until the augmented flow from mid-August to late-September occurred (Figure 2). The gradual reduction in flow that occurred from late June to early July was lower than the ROD-prescribed flow bench of 2000 cubic feet per second (cfs). The release from Lewiston Dam was ramped down to a summer base flow of 450 cfs in early August and persisted until mid-August when flows were increased until mid-September to reduce the likelihood of a fish kill by increasing water velocities and water turnover rates in holding areas in the lower Klamath River (TRRP-Fall Flow Subgroup 2012). Other benefits increased flows can provide are improved water temperature, improved fish passage, and provide migration cues to adult salmon (CDFG 2004). Detailed description of the decisions used to establish the flow pattern during the spring and summer period are provided in a Technical Brief titled *Development of the Trinity River Restoration Flow Release Schedule for Water Year 2012* released by the TRRP (2012).

Contributions of flow from Lewiston Dam to the lower Trinity River and Klamath River varied throughout WY 2012 (Figure 3; Appendix A). During early April, the contributions of flow from Lewiston Dam to the total discharge measured at the Klamath gauge were small (e.g. 1 %) due to low base flows (e.g. 300 cfs) from Lewiston and the comparatively high tributary accretions between these gauges. By early May, peak spring flow releases from Lewiston Dam resulted in a greater contribution of flow to the lower Trinity River and lower Klamath River as compared to values for early April. The greatest contributions occurred in early May to mid-July and again in mid-August to mid-September when Lewiston Dam releases comprised up to 40% of the total discharge measured at the Klamath gauge (Appendix A). The large contribution during mid-August to mid-September was due to the augmented fall flows described above.

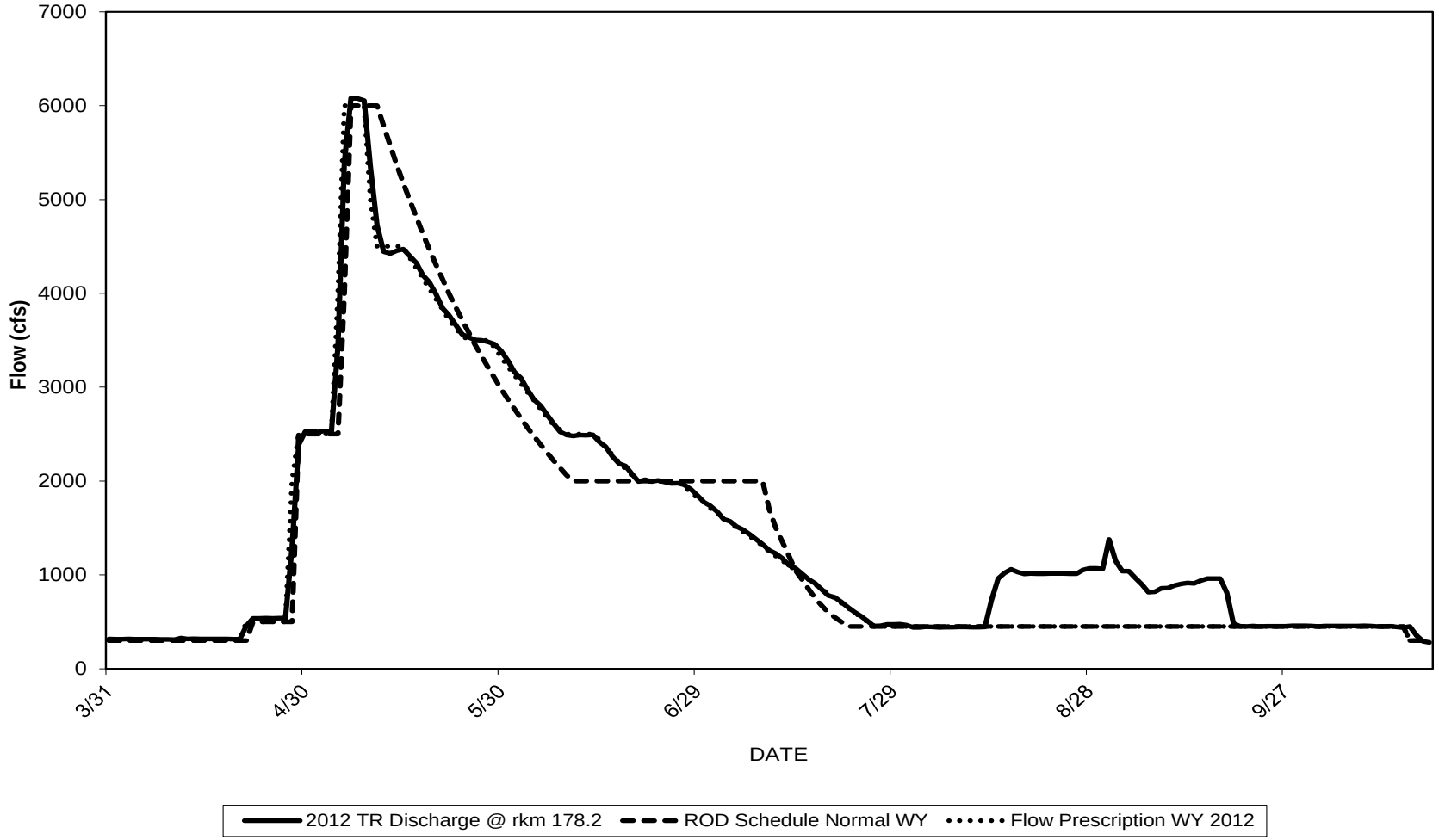

Figure 2. Spring and summer flow releases from Lewiston Dam (rkm 178.2) on the Trinity River (TR) in 2012 compared to the flow schedule for a normal hydrologic water year identified in the Record of Decision (USDOI 2000).

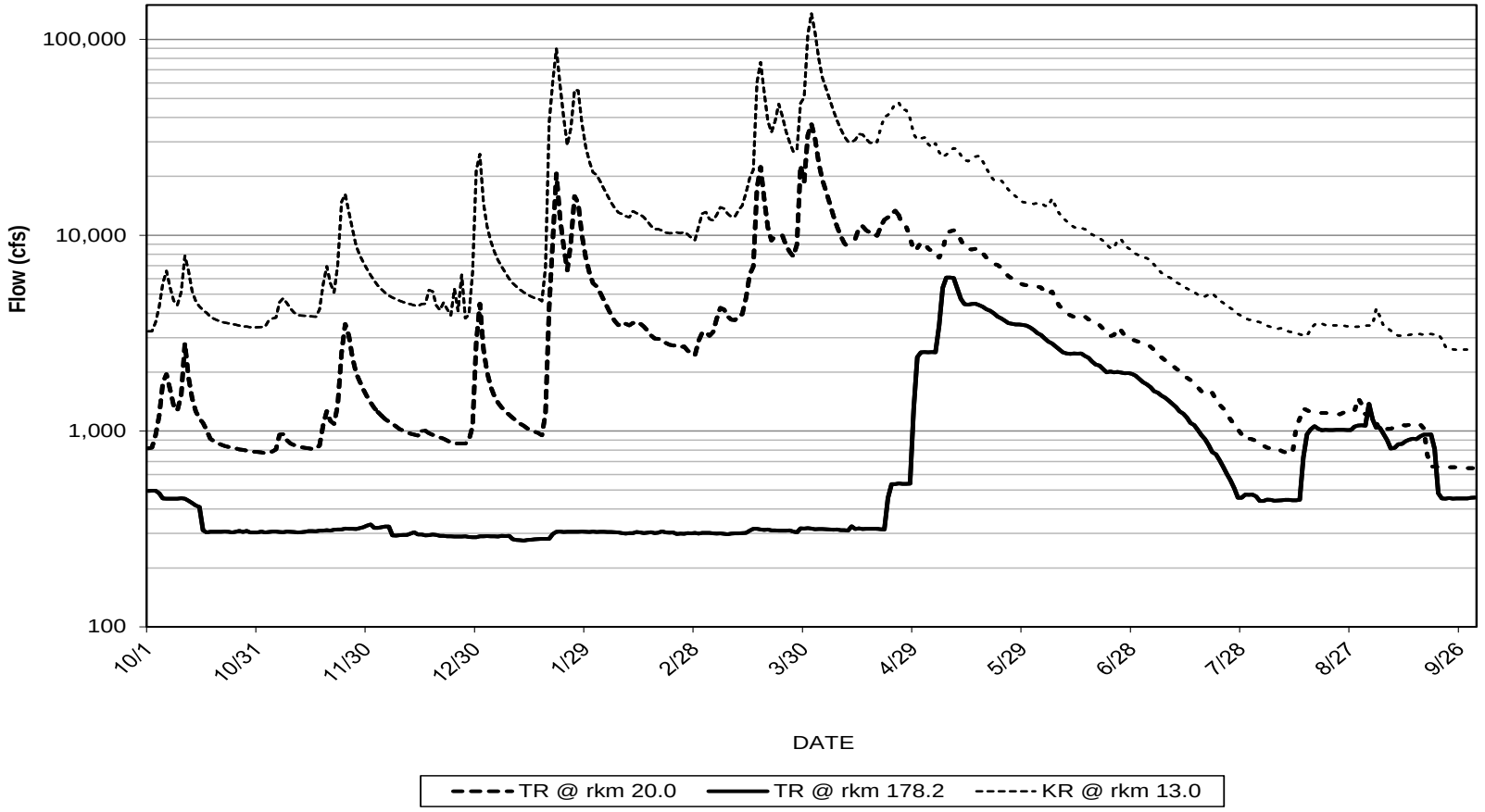

Figure 3. Average daily flow of the Trinity River (TR) at Lewiston gauge (rkm 178.2) and Hoopa gauge (rkm 20.0), and the Klamath River (KR) near Klamath (rkm 13.0), WY 2012. Note that U.S. Geological Survey gauge data are preliminary and subject to revision.

Water Temperatures of the Trinity River

Lewiston Gauge (rkm 178.2)

Average daily water temperatures of Lewiston Dam releases ranged between 8.5 ˚C and 11.9 ˚C between mid-April and mid-October (Figure 4). The warmest release temperatures occurred in mid-April and between late July and mid-August. The mid-April release coincided with low reservoir releases and relatively warm air temperatures. The warm water temperatures in late July to mid-August, coincided with typical warming trends and periods of decreasing discharge from Lewiston Reservoir. In contrast, some of the coldest release temperatures occurred during times of high flow releases and thus, short hydraulic residence times, most notably from early to late May (Figure 4).

Douglas City Gauge (rkm148.5)

Water temperatures at Douglas City ranged between 8.9 ˚C and 15.2 ˚C from mid-April to mid-October (Figure 5). Water temperature remained below the water temperature objectives for the period when Douglas City is the compliance point for the summer/fall water temperature objectives (Table 1). Water temperatures at this site also exhibited an inverse relationship with discharge from Lewiston Dam, most notably during high flow periods from late April to late May and in mid-August.

Trinity above the North Fork Trinity (rkm 118)

Average daily water temperatures of the Trinity River above the North Fork Trinity were warmer in comparison to the upstream Douglas City site, but followed a similar trend (Figure 6). Similar to the Douglas City site, water temperatures above the North Fork Trinity River were inversely related to flow during the spring and early summer. Average daily temperatures at this site ranged from 9.2 to 18.5 ˚C and peaked on August 6. Temperatures remained below the target of $\leq$13.3 °C (Table 1) objectives except for October 14 when water temperature reached 14.1 °C.

Above Big French Creek to Weitchpec (rkm 94.2 to 0.1)

The peak daily average temperature was 24.1 ˚C at Weitchpec and 20.6 ˚C measured just upstream of Big French Creek at rkm 94.2 (Figure 7). By mid-August water temperature at Weitchpec was as much as 7.7 °C warmer than above Big French Creek, largely due to thermal heating along the mainstem as well as warm water accretion from the South Fork Trinity River. Review of average daily water temperatures from previous years suggest that water temperatures typically peak between 24 ˚C and 25˚C within this reach (Zedonis 2003, 2004, and 2005).

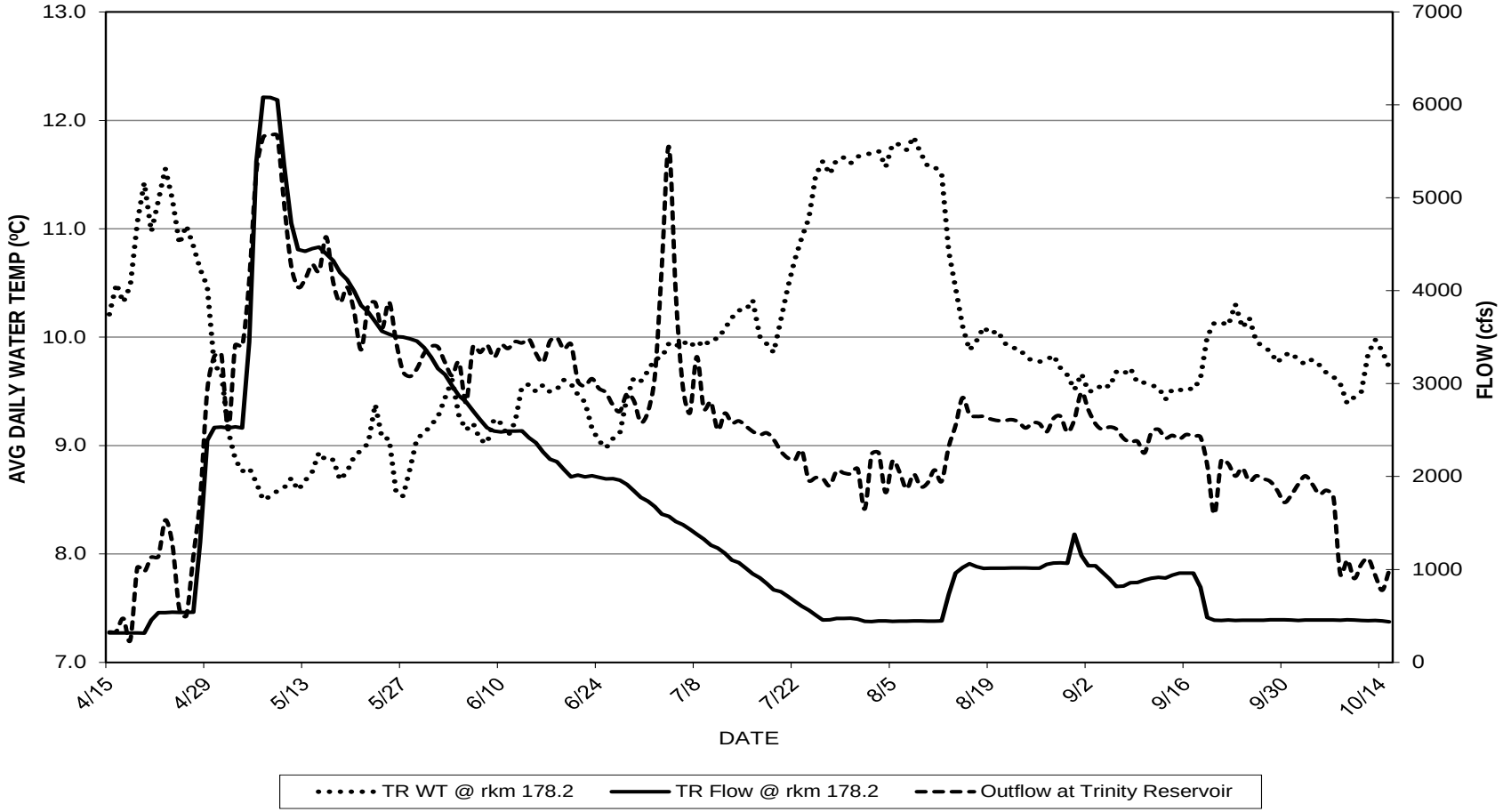

Figure 4. Water temperature (WT) and flow of the Trinity River (TR) at Lewiston (rkm 178.2) and Trinity Reservoir outflow in 2012. Trinity Reservoir outflow supplies water to the Trinity River and diversions to the Sacramento River Basin.

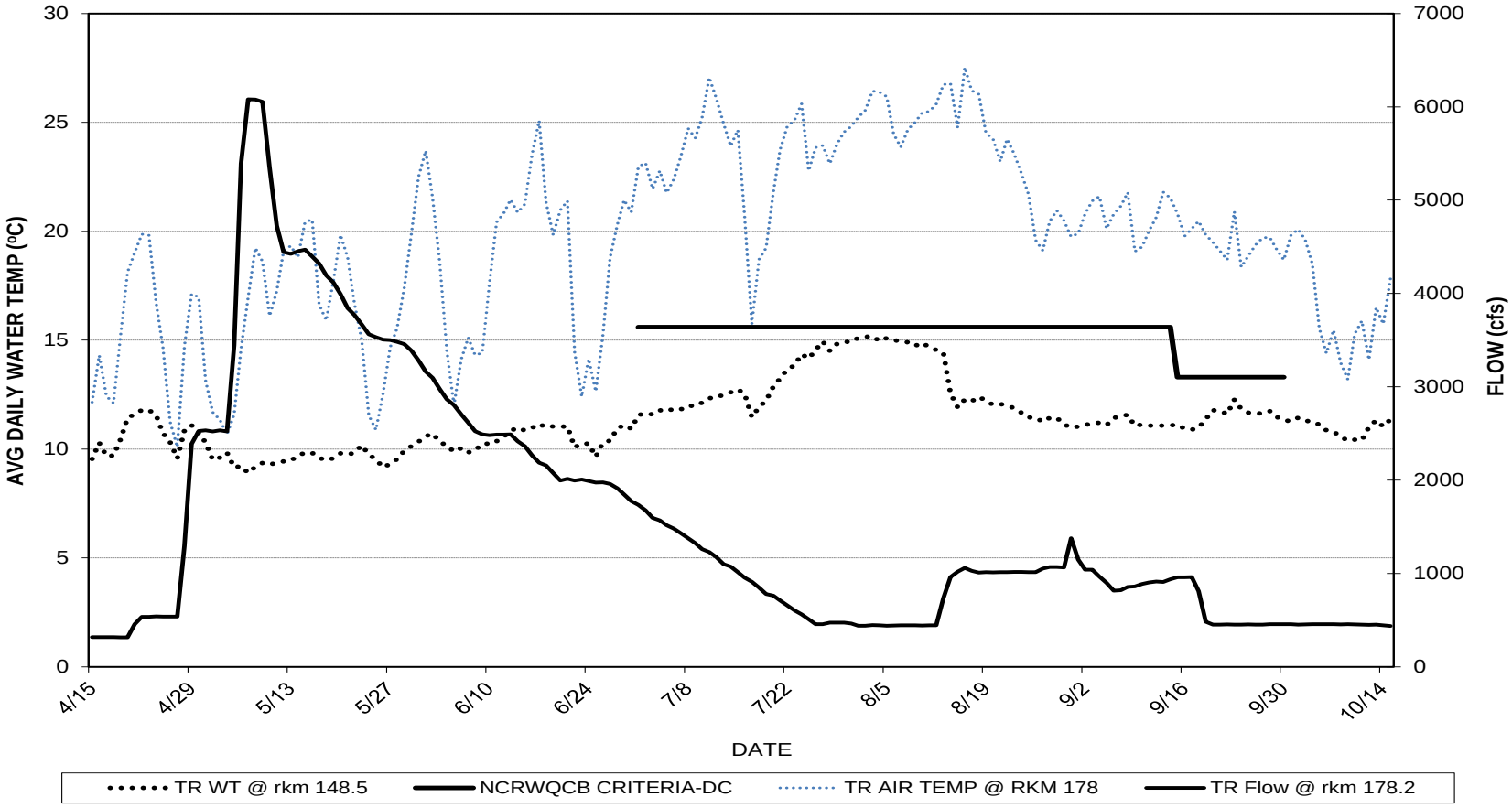

Figure 5. Comparison of average daily water temperatures (WT) of the Trinity River (TR) at Douglas City gauge (rkm 148.5) in 2012 and the water temperature objective of the North Coast Regional Water Quality Control Board (NCRWQCB Criteria-DC). Air temperature (AT) data are from the Lewiston Fish Hatchery (rkm 178).

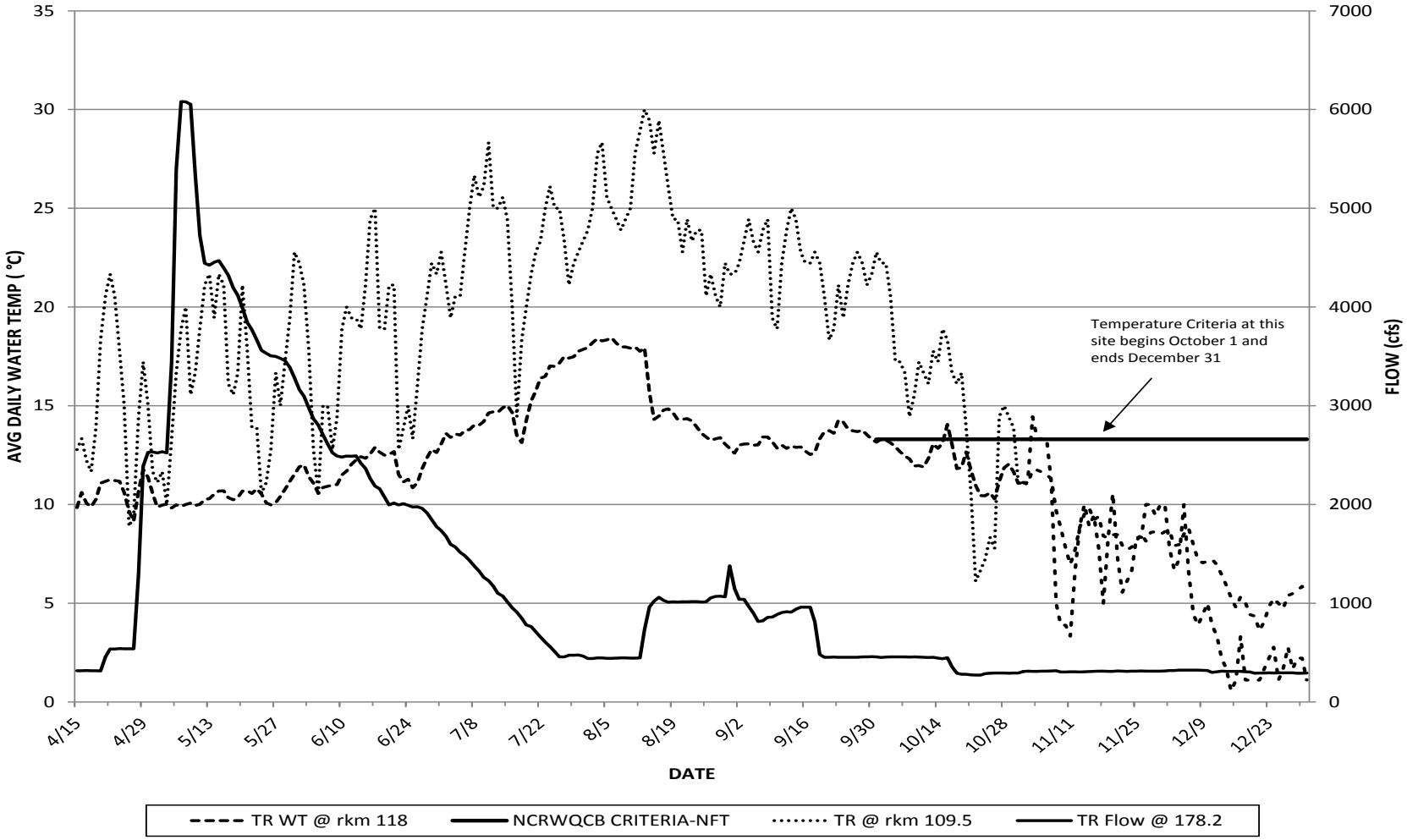

Figure 6. Comparisons of average daily water temperatures (WT) of the Trinity River (TR) above the confluence of the North Fork Trinity River (rkm 118.0) in 2012 and the water temperature objective of the North Coast Regional Water Quality Control Board (NCRWQCB-NFT). Air temperature (AT) data are from the Trinity River at Big Bar (rkm 109.5).

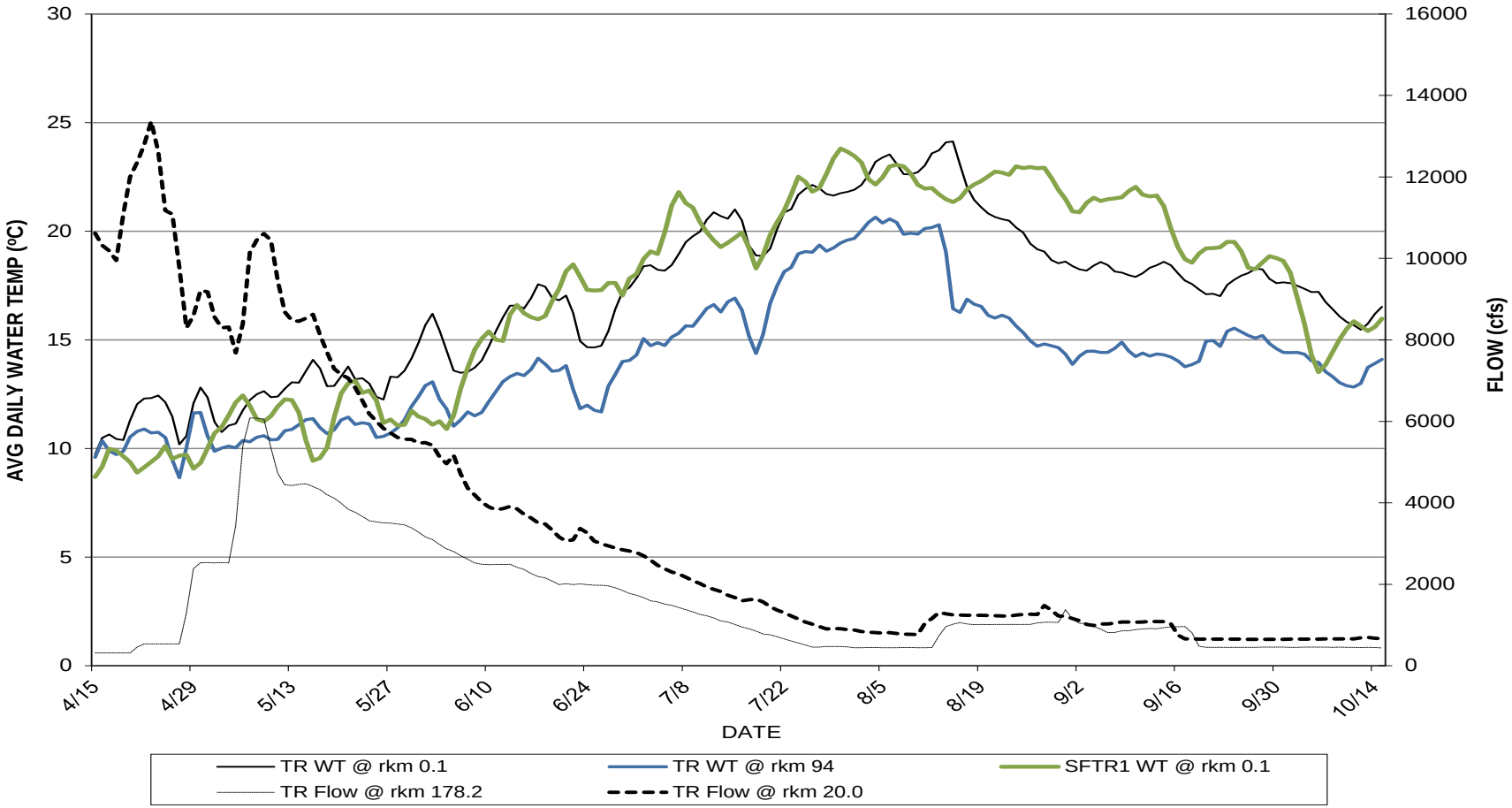

Figure 7. Comparisons of average daily water temperatures of the Trinity River (TR) above Big French Creek (rkm 94.0), South Fork Trinity River (SFTR; rkm 0.1), and Weitchpec (rkm 0.1) and flow at Lewiston (rkm 178.2) and Hoopa Gage (rkm 20.0) in 2012.

Weitchpec- Outmigrant Temperature Objectives

Between mid-April and July 9, 2012, daily average water temperatures recorded in the Trinity River at Weitchpec occasionally exceeded "Optimal" smolt temperatures (OST; Figure 8) specified under the spring-time temperature objectives provided in the ROD (USFWS and Hoopa Valley Tribe 1999, USDOI 2000). Similar to previous years, water temperature in the lower Trinity River climbed into the marginal smolt temperature (MST) range, exceeding the upper threshold temperature value of the OST five times between May 14 and July 9. Periods where the OST threshold was exceeded can be, at least in part, attributed to warming air temperatures coupled with decreasing flow from Lewiston Reservoir (Figure 9). Another factor that likely played a role in exceeding the OST was the reduction in discharge from Lewiston Dam from about 1,852 to 1,328 cfs that occurred in late June and early July (Figure 8). These observed values deviated from the flow schedule for a Normal water year type that specifies a 2,000 cfs release that would extend until July 9 (USFWS and Hoopa Valley Tribe 1999).

Water Temperatures of the Klamath River above and below the Trinity River Confluence

Average daily water temperatures of the Trinity River at Weitchpec were generally cooler than the Klamath River at Weitchpec, except for two time periods (Figure 10, Appendix A). The longest period was from April 16 to May 7 when the Trinity was warmer than the Klamath by as much as 1.6 °C. The other period was from August 13 to 15 when the Trinity River was only 0.3 °C warmer than the Klamath River at Weitchpec. After August 15, the Trinity River was up to 3.8 °C cooler than the Klamath River. This cooling trend was related to the increase in flow from Lewiston Dam, which was intended to reduce the possibility of a fish kill. During this augmented flow, average daily water temperatures of the Trinity River at rkm 0.1 were reduced and the Trinity was on average about 2.0 °C colder than the Klamath River measured upstream of the Trinity River confluence. This temperature reduction was similar to that observed in 2009 and 2011 when peak flow releases from Lewiston Dam occurred for the biennial Hoopa Valley Tribal Boat Dance ceremony (Scheiff and Zedonis 2010 and 2012).

The difference between water temperatures of the Trinity and Klamath rivers during the augmented flow had a noticeable influence on the thermal regime of the Klamath River below the confluence (Figure 10). Flows from Lewiston Dam during augmentation accounted for about 25 to 40% of the total flow of the Klamath River below the confluence. This thermal dilution resulted in water temperature reductions of about 1.0 °C just below Weitchpec (rkm 62.0) and 1.4 °C at Klamath near Klamath, CA (KNK; rkm 13.0), respectively (Appendix A). Following the augmented flow, water temperature differences between Weitchpec (rkm 70.2) and Klamath decreased back to less than 1.0 °C until mid-October.

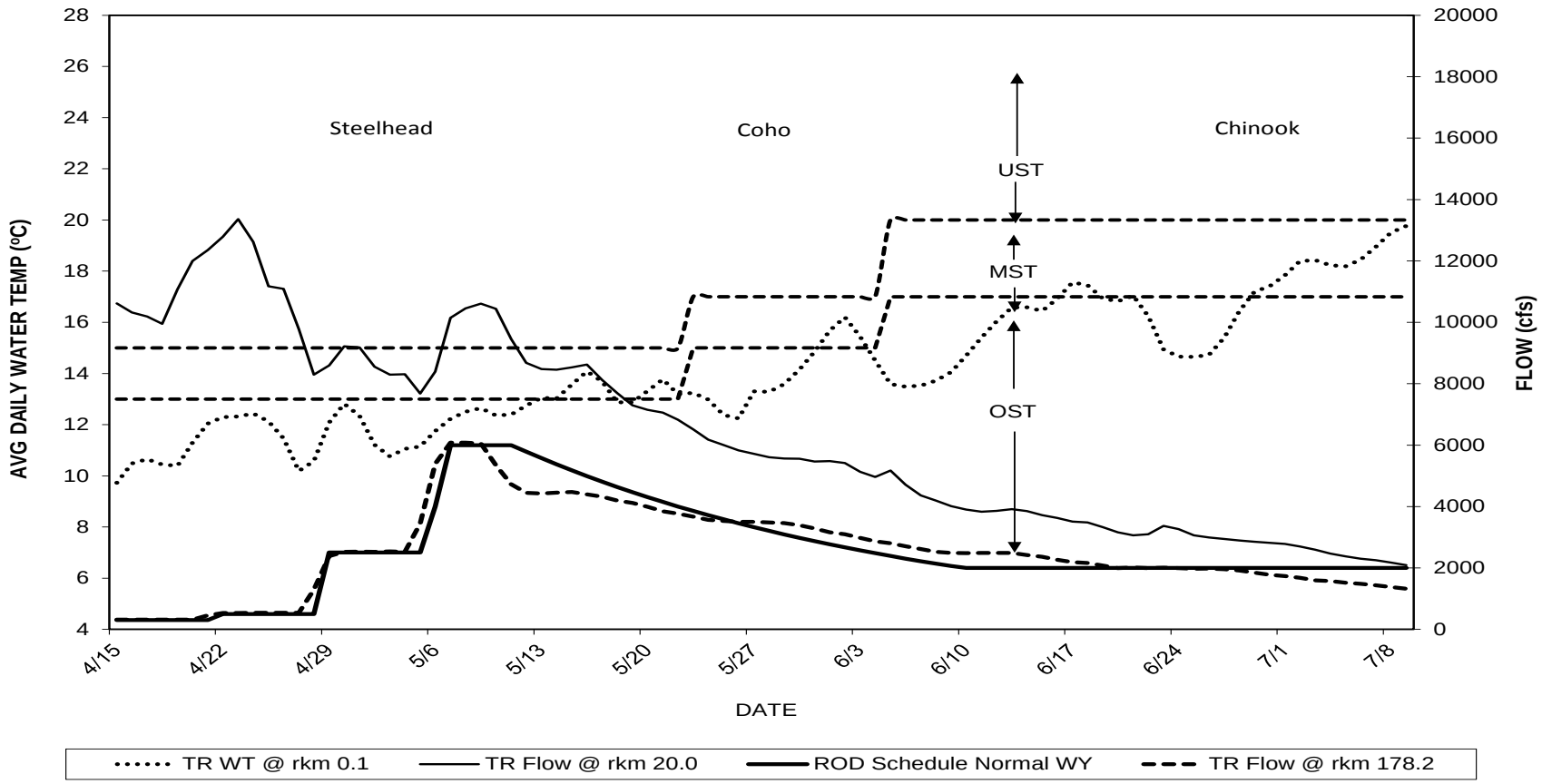

Figure 8. Average daily water temperatures (WT) of the Trinity River (TR) recorded at Weitchpec in 2012, with spring-time temperature objectives established by the Record of Decision (Hoopa Valley Tribe 1999 and USDOI 2000) for steelhead, coho salmon, and Chinook salmon smolts. Smolt objectives: UST = unsuitable smolt temperatures; MST = marginal smolt temperatures, OST = optimal smolt temperatures. Optimal smolt temperatures were sought from April 22 to July 9 in 2012.

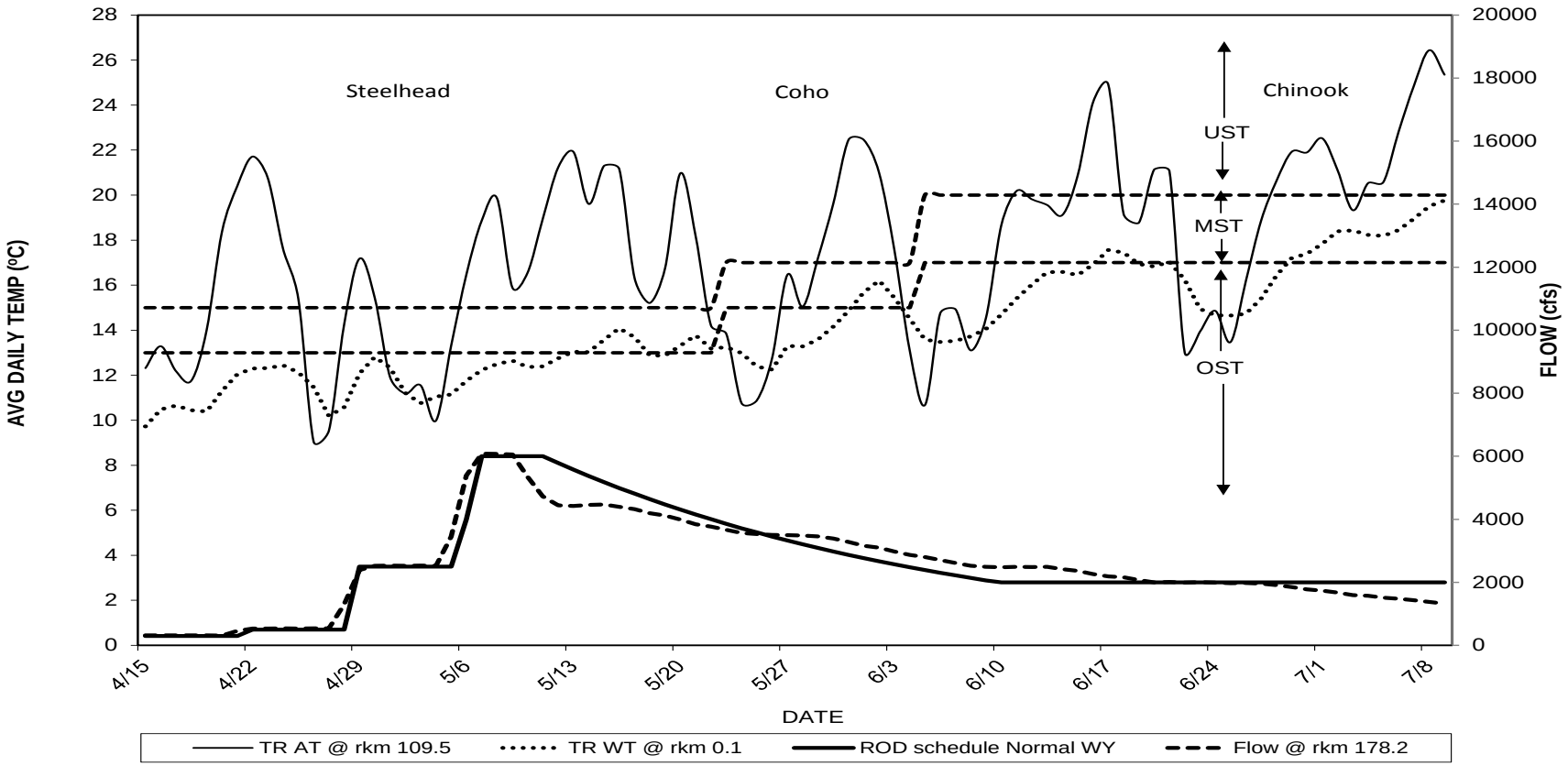

Figure 9. Air temperature (AT) and its influence on water temperature (WT) of the Trinity River (TR) at Weitchpec from April 15 to July 9, 2012, with spring-time water temperature objectives established by the Record of Decision (USFWS and Hoopa Valley Tribe 1999; USDOI 2000) for steelhead, coho salmon, and Chinook salmon smolts. Smolt criteria: UST = Unsuitable temperatures; MST = Marginally suitable temperatures; OST = Optimally suitable temperatures.

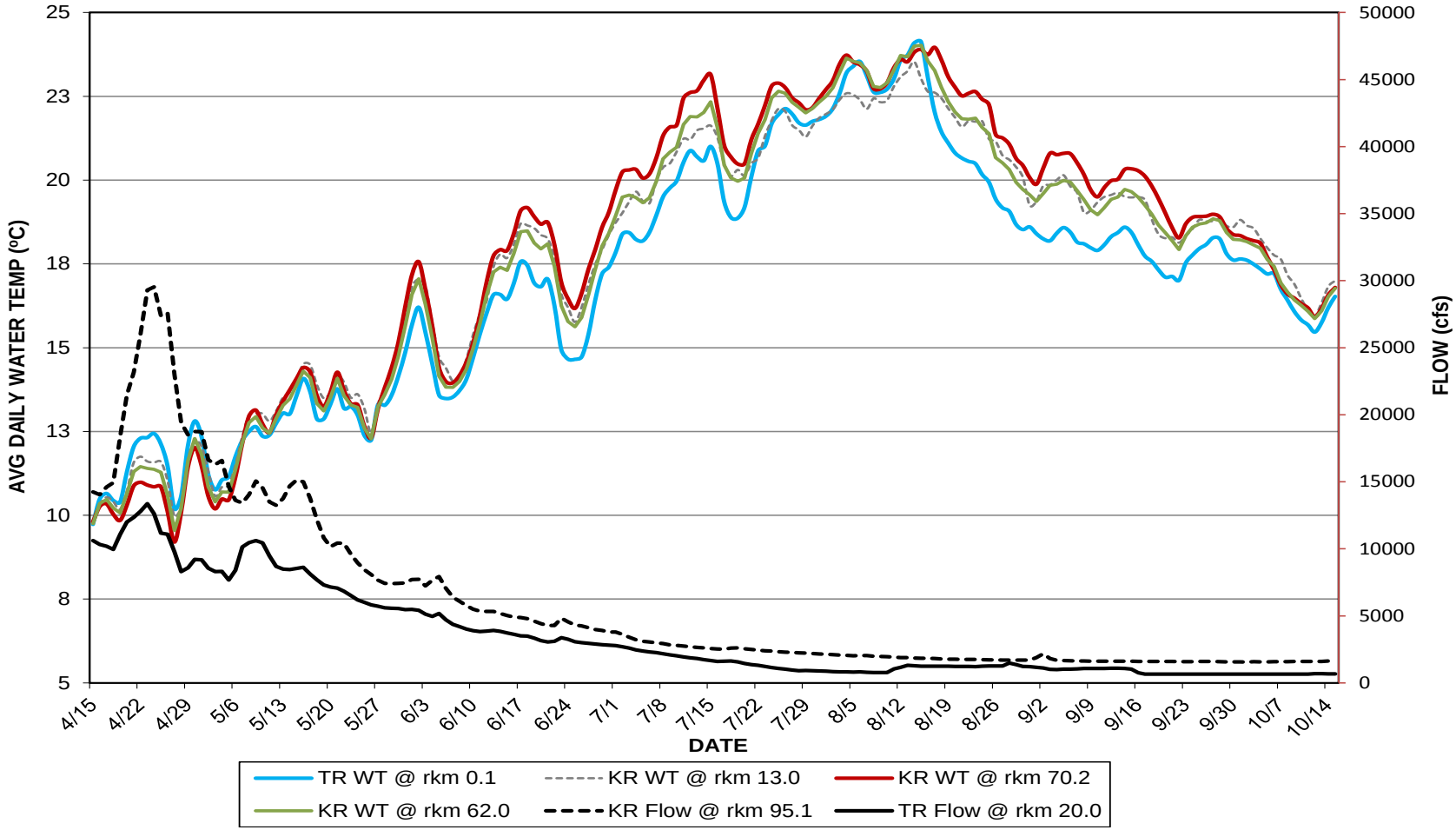

Figure 10. Comparison of water temperatures (WT) of the Trinity River (TR) at Weitchpec (rkm 0.1) and the Klamath River (KR) above (rkm 70.2) and well below (rkm 13.0 near Klamath, CA) the confluence of the Trinity River relative to stream flow in 2012. See Appendix A in this report for daily information.

Summary

Water year 2012 was designated as a Normal WY with a total of 686,559 acre-feet of water released from Lewiston Dam to the Trinity River. This total exceeded the prescribed flow of 646,133AF for a Normal WY due to the additional releases in the fall to prevent a fish kill in the lower Klamath River.

Basin Plan water temperature objectives for adult salmon set by the NCRWQCB (1994) were met for the reach from Lewiston to Douglas City for July 1 to September 30 and generally for Lewiston to the North Fork Trinity River from October 1 to December 31 except for a temperature spike of 14.1 °C on October 14. Spring time objectives set by the ROD for juvenile outmigrant salmonids fell into the marginally suitable range for steelhead smolts two times, coho salmon smolts once, and Chinook salmon smolts twice between April 15 and July 9 at Weitchpec.

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References

Bartholow, J.M. 2005. Recent Water Temperature Trends in the Lower Klamath River, California. North American Journal of Fisheries Management. 25:152-162.

Beeman, J., S. Juhnke, , G. Stutzer, and K. Wright. 2012, Effects of Iron Gate Dam discharge and other factors on the survival and migration of juvenile coho salmon in the lower Klamath River, northern California, 2006–09: U.S. Geological Survey Open-File Report 2012-1067, 96 p.

Beitinger T.L., and L.C. Fitzpatrick. 1979. Physiological and ecological correlates of preferred temperature in fish. American Zool. 19:319-329.

Carter, K. 2005. The effects of temperature on steelhead trout, coho salmon, and Chinook salmon biology and function by life stage: implications for Klamath basin TMDLs:NCRWQCB, August, 2005.

California Department of Fish and Game (CDFG). 2004. September 2002 Klamath River fish-kill: final analysis of contributing factors and impacts. Northern California-North Coast Region. Redding, California.

Elliot, J. 1981. Some aspects of thermal stress on freshwater teleosts. In Pickering, A.D. ed., Stress and Fish: Academic Press, London, p. 209-245.

Fry, F.E.J. 1971. The effect of environmental factors on the physiology of fish. W.S. Hoar and D.J. Randall, editors. Fish physiology. Volume 6. Academic Press, New York.

Hicks, M. 1999. Evaluating Standards for Protecting Aquatic Life in Washington's Surface Water Quality Standards: Temperature Criteria. Preliminary Review Draft Discussion Paper, Washington State Department of Ecology, Olympia, WA, 95 pp.

Li, H.W., G.A. Lamberti, T.N. Pearsons, C.K. Tait, J.L. Li, and J.C. Buckhouse. 1994. Cumulative effects of riparian disturbances along high desert trout streams of the John Day Basin, Oregon. Transactions of the American Fisheries Society. 123:627-640.

Ligon, F.A., A. Rich, G. Rynearson, D. Thornburg, and W. Trush. 1999. Report of the Scientific Review Panel on California Forest Practice Rules and Salmonid Habitat: Prepared for the Resource Agency of California and the National Marine Fisheries Service, Sacramento, California 22 p.+ appendices.

Lynch, D.D., and J.C. Risley. 2003. Klamath River basin hydrologic conditions prior to the September 2002 die-off of salmon and steelhead. U.S. Geological Survey, Water-Resources Investigations Report 03-4099, Portland, Oregon.

Myrick C.A., and J.J. Cech. 2001. Temperature Effects on Chinook Salmon and Steelhead: a Review Focusin on California's Central Valley Populations. Bay-Delta Modeling Forum. Technical Publication 01-1. 57 pp.

North Coast Regional Water Quality Control Board (NCRWQCB). 1994. Basin Plan for the North Coast Region, Santa Rosa, CA.

Oregon Department of Environmental Quality (ODEQ). 1995. Temperature: 1992-1994 Water quality standards review. Final Issue Paper. 122pp.

Scheiff, T., and P. Zedonis. 2010. The Influence of Lewiston Dam Releases on Water Temperatures of the Trinity and Klamath Rivers, CA. April to October, 2009. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2010-17, Arcata, California.

Scheiff, T., and P. Zedonis. 2011. The Influence of Lewiston Dam Releases on Water Temperatures of the Trinity and Klamath Rivers, CA. April to October, 2010. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2011-22, Arcata, California

Scheiff, T., and P. Zedonis. 2012. The Influence of Lewiston Dam Releases on Water Temperatures of the Trinity and Klamath Rivers, CA. April to October, 2011. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2012-24, Arcata, California.

Trinity River Restoration Program (TRRP). 2012. Development of the Trinity River Restoration Flow Release Schedule for Water Year 2012. Technical Report TR-TRRP-2012-3. Trinity River Restoration Program. Weaverville, California.

Trinity River Restoration Program (TRRP) - Fall Flow Subgroup. 2012. Memorandum to Brian Person, Reclamation Northern California Area Manager. 2012 fall flow release recommendation. Available from the Trinity River Restoration Program: www.trrp.net

True, K., J.S. Foott, A. Bolick, S. Benson and R. Fogerty. 2010. FY 2009 Investigational Report: Myxosporean Parasite (Ceratomyxa Shasta and Parvicapsula minibicornis) Incidence and Severity in Klmaath River Basin Juvenile Chinook Salmon, April-August 2009. U.S. Fish and Wildlife Service California-Nevada Fish Health Center, Anderson, CA. http://www.fws.gov/canvfhc/reports.asp.

U.S. Department of the Interior (USDOI). 2000. Record of Decision Trinity River Mainstem Fishery Restoration Final Environmental Impact Statement/Environmental Impact Report, December 2000. 43 pp.

U.S. Environmental Protection Agency (EPA). 1999. National recommended water quality criteria, correction. EPA 822-Z-99-001. U.S. Environmental Protection Agency, Washington DC.

U.S. Environmental Protection Agency (EPA). 2001a. Salmonid Behavior and Water Temperature. Issue Paper 1, Prepared as part of EPA Region 10 Temperature water quality criteria guidance development project EPA-910-D-01-001, Environmental Protection Agency Region 10.

U.S. Environmental Protection Agency (USEPA). 2001b. Temperature Interaction. Issue Paper 4, Temperature Water Quality Criteria Guidance Development Project EPA-910-D-01-004, Environmental Protection Agency Region 10.

U.S. Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

U.S. Fish and Wildlife Service (USFWS) and Hoopa Valley Tribe (HVT). 1999. Trinity River Flow Evaluation Final Report. June 1999. 513 pp.

Guillen, G. 2003. Klamath River Fish Die-off September 2002. Causitive Factors of mortality. Report Number AFWO-F-02-03. 1115pp.

Zedonis, P. 2003. Lewiston Dam releases and their influence on water temperatures of the Trinity River, CA, WY 2002. Report AFWO-F-04-03. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, CA 95521. 16 pp.

Zedonis, P. 2004. Lewiston Dam releases and their influence on water temperatures of the Trinity and Klamath Rivers, CA, April to October, 2003. Report AFWO-F01-04. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, CA 95521. 34 pp.

Zedonis, P. 2005. The influence of Lewiston Dam releases on water temperatures of the Trinity and Klamath Rivers, CA, April to October, 2004. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Technical Report Number TR2005-03, Arcata, California. 31 pp.

Zedonis, P. 2009. The Influence of Lewiston Dam Releases on Water Temperatures of the Trinity and Klamath Rivers, CA, April to October, 2008. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2009-15, Arcata, California. 24 pp.

Zedonis, P., and R. Turner. 2006. The influence of Lewiston Dam releases on water temperatures of the Trinity and Klamath Rivers, CA, April to October, 2005. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS2006-08, Arcata, California. 29 pp.

Zedonis, P., and R. Turner. 2007. The Influence of Lewiston Dam Releases on Water Temperatures of the Trinity and Klamath Rivers, CA, April to October, 2006. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2007-01, Arcata, California.

Zedonis, P., and R. Turner. 2008. The Influence of Lewiston Dam Releases on Water Temperatures of the Trinity and Klamath Rivers, CA, April to October, 2007. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2008-01, Arcata, California.

Appendix A. Water temperature and flow comparisons of the Trinity and Klamath Rivers, April 15 to October 15, 2012.Station locations: TR = Trinity River, WE = Klamath River at Weitchpec, KBW = Klamath Below Weitchpec, and KNK = Klamath near Klamath (A = approved data for publication; P = provisional data subject to change).

Date	Flow (CFS)									Average Daily Water Temperatures (°C)				Differences in Water Temps (°C) of the Klamath R. at rkm 70.2 and:		
	Trinity R.		Klamath R.			Contributions of Flow to the Klamath Gage (%)[a]			Trinity R.	Klamath R.			Trinity R.	Klamath R.	
	Lewiston (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	Orleans (rkm 95.1)	Klamath (rkm 13.0)	Lewiston Dam (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	TR (rkm 0.1)	WE (rkm 70.2)	KBW (rkm 68.7)	KNK (rkm 13.0)	TR (rkm 0.1)	KBW (rkm 62.0)	KNK (rkm 13.0)
4/15/12	317 A	10617 A	3047 A	14248 A	31049 A	1	34	10	9.7	9.8	9.8	9.8	0.1	0.1	0.0
4/16/12	317 A	10319 A	3042 A	14030 A	29673 A	1	35	10	10.5	10.3	10.3	10.3	-0.2	-0.1	-0.1
4/17/12	317 A	10188 A	2992 A	14609 A	29711 A	1	34	10	10.6	10.3	10.5	10.5	-0.3	-0.1	-0.2
4/18/12	317 A	9949 A	2866 A	14936 A	30039 A	1	33	10	10.4	10.0	10.2	10.4	-0.4	-0.2	-0.4
4/19/12	315 A	11078 A	2926 A	18392 A	35385 A	1	31	8	10.4	9.8	10.1	10.2	-0.5	-0.2	-0.3
4/20/12	314 A	11997 A	2951 A	21463 A	40047 A	1	30	7	11.3	10.3	10.7	10.7	-1.0	-0.3	-0.4
4/21/12	456 A	12355 A	3370 A	23168 A	41179 A	1	30	8	12.0	10.9	11.3	11.6	-1.2	-0.4	-0.7
4/22/12	536 A	12785 A	3843 A	25972 A	43398 A	1	29	9	12.3	11.0	11.5	11.7	-1.3	-0.5	-0.8
4/23/12	535 A	13364 A	3717 A	29295 A	47301 A	1	28	8	12.3	10.9	11.4	11.6	-1.4	-0.5	-0.7
4/24/12	540 A	12619 A	3802 A	29539 A	47526 A	1	27	8	12.4	10.8	11.4	11.6	-1.6	-0.5	-0.7
4/25/12	537 A	11174 A	3946 A	27388 A	43815 A	1	26	9	12.1	10.9	11.3	11.6	-1.3	-0.4	-0.7
4/26/12	538 A	11088 A	3884 A	27596 A	43564 A	1	25	9	11.5	10.1	10.6	11.0	-1.4	-0.5	-0.9
4/27/12	539 A	9776 A	3864 A	22980 A	39707 A	1	25	10	10.2	9.2	9.5	10.0	-1.0	-0.3	-0.8
4/28/12	1295 A	8294 A	3759 A	19414 A	32916 A	4	25	11	10.6	10.1	10.2	10.3	-0.5	-0.1	-0.2
4/29/12	2387 A	8594 A	3480 A	18490 A	30746 A	8	28	11	12.1	11.4	11.6	11.7	-0.6	-0.2	-0.2
4/30/12	2528 A	9217 A	3246 A	18753 A	31219 A	8	30	10	12.8	12.0	12.3	12.2	-0.8	-0.3	-0.2
5/1/12	2533 A	9181 A	3192 A	18730 A	31580 A	8	29	10	12.3	11.5	11.8	12.1	-0.9	-0.3	-0.6
5/2/12	2523 A	8556 A	3220 A	16634 A	29234 A	9	29	11	11.2	10.6	10.8	11.3	-0.6	-0.3	-0.7
5/3/12	2535 A	8295 A	3194 A	16288 A	28061 A	9	30	11	10.8	10.2	10.4	10.6	-0.6	-0.2	-0.4
5/4/12	2522 A	8312 A	3189 A	16584 A	29457 A	9	28	11	11.1	10.5	10.7	10.8	-0.6	-0.2	-0.4
5/5/12	3448 A	7681 A	3194 A	14648 A	26568 A	13	29	12	11.1	10.5	10.7	10.9	-0.7	-0.2	-0.4
5/6/12	5391 A	8393 A	3196 A	13614 A	25109 A	21	33	13	11.8	11.1	11.4	11.5	-0.6	-0.2	-0.4
5/7/12	6081 A	10143 A	3190 A	13414 A	25860 A	24	39	12	12.2	12.1	12.2	12.3	-0.1	0.0	-0.2
5/8/12	6079 A	10452 A	3183 A	14032 A	26966 A	23	39	12	12.5	13.0	12.8	13.0	0.5	0.2	0.0
5/9/12	6054 A	10610 A	3199 A	15051 A	27857 A	22	38	11	12.6	13.1	12.9	13.0	0.5	0.2	0.1
5/10/12	5346 A	10444 A	3206 A	14550 A	27559 A	19	38	12	12.4	12.7	12.6	13.0	0.4	0.1	-0.3
5/11/12	4726 A	9457 A	3164 A	13505 A	25625 A	18	37	12	12.4	12.5	12.4	12.8	0.1	0.0	-0.3
5/12/12	4443 A	8683 A	3034 A	13243 A	24196 A	18	36	13	12.7	13.0	12.9	13.1	0.3	0.1	-0.1
5/13/12	4424 A	8479 A	2755 A	13747 A	23892 A	19	35	12	13.0	13.4	13.3	13.5	0.4	0.1	-0.1
5/14/12	4453 A	8456 A	2552 A	14677 A	24627 A	18	34	10	13.0	13.7	13.5	13.7	0.7	0.3	0.1
5/15/12	4471 A	8529 A	2377 A	15141 A	25207 A	18	34	9	13.6	14.1	13.9	14.1	0.5	0.2	0.0

Appendix A (Continued). Water temperature and flow comparisons of the Trinity and Klamath Rivers, April 15 to October 15, 2012.Station locations: TR = Trinity River, WE = Klamath River at Weitchpec, KBW = Klamath Below Weitchpec, and KNK = Klamath near Klamath (A = approved data for publication; P = provisional data subject to change).

Date	Flow (CFS)									Average Daily Water Temperatures (°C)				Differences in Water Temps (°C) of the Klamath R. at rkm 70.2 and:		
	Trinity R.		Klamath R.			Contributions of Flow to the Klamath Gage (%)[a]			Trinity R.	Klamath R.			Trinity R.	Klamath R.	
	Lewiston (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	Orleans (rkm 95.1)	Klamath (rkm 13.0)	Lewiston Dam (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	TR (rkm 0.1)	WE (rkm 70.2)	KBW (rkm 68.7)	KNK (rkm 13.0)	TR (rkm 0.1)	KBW (rkm 62.0)	KNK (rkm 13.0)
5/16/12	4396 A	8627 A	2184 A	15004 A	25414 A	17	34	9	14.1	14.4	14.3	14.5	0.3	0.1	-0.1
5/17/12	4322 A	8122 A	2007 A	13749 A	23921 A	18	34	8	13.7	14.3	14.1	14.5	0.6	0.2	-0.2
5/18/12	4195 A	7695 A	1952 A	12175 A	22057 A	19	35	9	12.9	13.6	13.3	13.9	0.7	0.2	-0.3
5/19/12	4118 A	7296 A	1950 A	10808 A	20240 A	20	36	10	12.9	13.2	13.1	13.5	0.4	0.1	-0.2
5/20/12	3993 A	7150 A	1953 A	10150 A	19130 A	21	37	10	13.3	13.7	13.5	13.7	0.4	0.2	0.0
5/21/12	3843 A	7060 A	1979 A	10427 A	19042 A	20	37	10	13.8	14.3	14.1	14.2	0.5	0.2	0.1
5/22/12	3769 A	6824 A	1949 A	10407 A	19077 A	20	36	10	13.2	13.7	13.6	14.0	0.5	0.2	-0.2
5/23/12	3667 A	6515 A	2034 A	9597 A	18161 A	20	36	11	13.2	13.3	13.3	13.5	0.1	0.0	-0.2
5/24/12	3562 A	6181 A	1952 A	8952 A	17110 A	21	36	11	13.0	13.3	13.2	13.6	0.3	0.1	-0.3
5/25/12	3531 A	6001 A	1949 A	8439 A	16401 A	22	37	12	12.4	12.7	12.6	13.2	0.3	0.1	-0.5
5/26/12	3505 A	5825 A	1947 A	8077 A	15810 A	22	37	12	12.2	12.3	12.3	12.5	0.1	0.0	-0.1
5/27/12	3500 A	5715 A	1945 A	7665 A	15278 A	23	37	13	13.3	13.2	13.2	13.3	-0.1	-0.1	-0.1
5/28/12	3481 A	5605 A	1857 A	7428 A	14803 A	24	38	13	13.3	13.8	13.6	13.7	0.5	0.2	0.1
5/29/12	3458 A	5563 A	1729 A	7412 A	14657 A	24	38	12	13.6	14.4	14.1	14.2	0.8	0.3	0.2
5/30/12	3387 A	5556 A	1644 A	7416 A	14553 A	23	38	11	14.2	15.2	14.7	15.0	1.0	0.4	0.2
5/31/12	3284 A	5465 A	1584 A	7450 A	14474 A	23	38	11	14.9	16.2	15.6	15.8	1.4	0.6	0.4
6/1/12	3163 A	5477 A	1576 A	7714 A	14594 A	22	38	11	15.7	17.2	16.6	16.8	1.5	0.6	0.4
6/2/12	3096 A	5413 A	1586 A	7724 A	14679 A	21	37	11	16.2	17.6	17.1	17.0	1.4	0.5	0.5
6/3/12	2977 A	5132 A	1565 A	7241 A	14183 A	21	36	11	15.4	16.7	16.3	16.8	1.3	0.4	-0.1
6/4/12	2868 A	4960 A	1560 A	7656 A	14057 A	20	35	11	14.5	15.6	15.3	15.7	1.1	0.4	-0.1
6/5/12	2804 A	5169 A	1572 A	7926 A	15398 A	18	34	10	13.6	14.4	14.2	14.7	0.8	0.2	-0.3
6/6/12	2706 A	4711 A	1562 A	7057 A	14096 A	19	33	11	13.5	14.0	13.8	14.4	0.5	0.2	-0.4
6/7/12	2615 A	4360 A	1563 A	6400 A	12921 A	20	34	12	13.5	14.0	13.8	14.0	0.4	0.1	-0.1
6/8/12	2524 A	4193 A	1563 A	6081 A	12310 A	21	34	13	13.7	14.2	14.0	14.1	0.4	0.2	0.1
6/9/12	2490 A	4014 A	1564 A	5765 A	11797 A	21	34	13	14.1	14.6	14.4	14.6	0.5	0.2	-0.1
6/10/12	2480 A	3902 A	1565 A	5499 A	11368 A	22	34	14	14.7	15.1	15.0	15.4	0.4	0.2	-0.2
6/11/12	2489 A	3831 A	1573 A	5350 A	10997 A	23	35	14	15.4	16.0	15.7	16.0	0.5	0.2	0.0
6/12/12	2488 A	3858 A	1575 A	5330 A	10841 A	23	36	15	16.0	17.0	16.6	16.4	0.9	0.4	0.6
6/13/12	2492 A	3912 A	1566 A	5337 A	10886 A	23	36	14	16.6	17.7	17.3	17.4	1.2	0.5	0.3
6/14/12	2418 A	3851 A	1561 A	5181 A	10742 A	23	36	15	16.6	17.9	17.4	17.8	1.3	0.5	0.1
6/15/12	2365 A	3718 A	1560 A	5019 A	10394 A	23	36	15	16.4	17.9	17.3	17.7	1.4	0.6	0.2

Appendix A (Continued). Water temperature and flow comparisons of the Trinity and Klamath Rivers, April 15 to October 15, 2012.Station locations: TR = Trinity River, WE = Klamath River at Weitchpec, KBW = Klamath Below Weitchpec, and KNK = Klamath near Klamath (A = approved data for publication; P = provisional data subject to change).

Date	Flow (CFS)								Average Daily Water Temperatures (°C)				Differences in Water Temps (°C) of the Klamath R. at rkm 70.2 and:		
	Trinity R.		Klamath R.			Contributions of Flow to the Klamath Gage (%)[a]			Trinity R.	Klamath R.			Trinity R.	Klamath R.	
	Lewiston (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	Orleans (rkm 95.1)	Klamath (rkm 13.0)	Lewiston Dam (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	TR (rkm 0.1)	WE (rkm 70.2)	KBW (rkm 68.7)	KNK (rkm 13.0)	TR (rkm 0.1)	KBW (rkm 62.0)	KNK (rkm 13.0)
6/16/12	2265 A	3631 A	1570 A	4912 A	10087 A	22	36	16	16.9	18.4	17.8	18.1	1.5	0.6	0.3
6/17/12	2187 A	3506 A	1568 A	4873 A	9880 A	22	35	16	17.6	19.1	18.5	18.7	1.5	0.6	0.4
6/18/12	2159 A	3481 A	1565 A	4787 A	9668 A	22	36	16	17.5	19.2	18.5	18.6	1.7	0.7	0.5
6/19/12	2076 A	3330 A	1561 A	4595 A	9382 A	22	35	17	16.9	18.9	18.1	18.6	2.0	0.8	0.3
6/20/12	1996 A	3160 A	1555 A	4416 A	8963 A	22	35	17	16.8	18.7	17.9	18.4	1.9	0.7	0.3
6/21/12	2015 A	3059 A	1548 A	4283 A	8592 A	23	36	18	17.0	18.7	18.1	18.3	1.7	0.6	0.5
6/22/12	1995 A	3094 A	1533 A	4284 A	8573 A	23	36	18	16.2	18.1	17.4	17.7	1.8	0.6	0.4
6/23/12	2008 A	3371 A	1527 A	4822 A	9474 A	21	36	16	14.9	17.0	16.2	16.6	2.0	0.7	0.4
6/24/12	1990 A	3261 A	1522 A	4559 A	9531 A	21	34	16	14.7	16.5	15.8	16.2	1.8	0.7	0.3
6/25/12	1975 A	3062 A	1524 A	4315 A	8871 A	22	35	17	14.7	16.2	15.6	15.8	1.5	0.5	0.4
6/26/12	1976 A	2996 A	1496 A	4256 A	8580 A	23	35	17	14.7	16.6	15.9	16.2	1.9	0.7	0.4
6/27/12	1959 A	2943 A	1389 A	4107 A	8358 A	23	35	17	15.4	17.3	16.6	16.9	1.9	0.8	0.5
6/28/12	1914 A	2892 A	1318 A	3976 A	8041 A	24	36	16	16.4	17.9	17.3	17.5	1.5	0.6	0.4
6/29/12	1848 A	2849 A	1206 A	3911 A	7866 A	23	36	15	17.2	18.6	18.0	17.9	1.4	0.5	0.7
6/30/12	1776 A	2816 A	1107 A	3797 A	7717 A	23	36	14	17.4	19.0	18.4	18.4	1.6	0.6	0.7
7/1/12	1735 A	2781 A	1029 A	3792 A	7644 A	23	36	13	17.8	19.7	18.9	18.7	1.9	0.8	1.0
7/2/12	1676 A	2701 A	1029 A	3617 A	7440 A	23	36	14	18.4	20.2	19.5	19.0	1.9	0.7	1.2
7/3/12	1596 A	2595 A	1028 A	3411 A	7078 A	23	37	15	18.4	20.3	19.6	19.4	1.9	0.7	0.9
7/4/12	1570 A	2466 A	1028 A	3215 A	6739 A	23	37	15	18.2	20.3	19.5	19.7	2.1	0.8	0.7
7/5/12	1516 A	2380 A	1024 A	3108 A	6417 A	24	37	16	18.2	20.1	19.3	19.4	1.9	0.7	0.7
7/6/12	1481 A	2300 A	1017 A	3045 A	6256 A	24	37	16	18.4	20.2	19.5	19.3	1.7	0.7	0.9
7/7/12	1431 A	2255 A	1020 A	2983 A	6118 A	23	37	17	19.0	20.7	20.0	20.0	1.7	0.7	0.7
7/8/12	1378 A	2172 A	1020 A	2935 A	5987 A	23	36	17	19.5	21.3	20.6	20.4	1.8	0.7	0.9
7/9/12	1325 A	2089 A	1020 A	2839 A	5774 A	23	36	18	19.8	21.6	20.8	20.5	1.8	0.7	1.1
7/10/12	1261 A	2020 A	1019 A	2801 A	5635 A	22	36	18	20.0	21.6	21.0	20.8	1.7	0.7	0.8
7/11/12	1229 A	1935 A	1018 A	2748 A	5526 A	22	35	18	20.5	22.4	21.7	21.2	1.9	0.8	1.2
7/12/12	1174 A	1878 A	1018 A	2691 A	5349 A	22	35	19	20.9	22.6	21.9	21.2	1.7	0.7	1.4
7/13/12	1101 A	1821 A	1019 A	2649 A	5239 A	21	35	19	20.7	22.7	21.9	21.5	2.0	0.8	1.2
7/14/12	1073 A	1732 A	1019 A	2611 A	5128 A	21	34	20	20.6	23.0	22.0	21.5	2.4	1.0	1.4
7/15/12	1014 A	1674 A	1026 A	2560 A	4974 A	20	34	21	21.0	23.2	22.3	21.6	2.1	0.8	1.5

Appendix A (Continued). Water temperature and flow comparisons of the Trinity and Klamath Rivers, April 15 to October 15, 2012. Station locations: TR = Trinity River, WE = Klamath River at Weitchpec, KBW = Klamath Below Weitchpec, and KNK = Klamath near Klamath (A = approved data for publication; P = provisional data subject to change).

Date	Flow (CFS)									Average Daily Water Temperatures (°C)				Differences in Water Temps (°C) of the Klamath R. at rkm 70.2 and:		
	Trinity R.		Klamath R.			Contributions of Flow to the Klamath Gage (%)[a]			Trinity R.	Klamath R.			Trinity R.	Klamath R.	
	Lewiston (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	Orleans (rkm 95.1)	Klamath (rkm 13.0)	Lewiston Dam (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	TR (rkm 0.1)	WE (rkm 70.2)	KBW (rkm 68.7)	KNK (rkm 13.0)	TR (rkm 0.1)	KBW (rkm 62.0)	KNK (rkm 13.0)
7/16/12	954 A	1596 A	1033 A	2523 A	4850 A	20	33	21	20.5	22.2	21.6	21.3	1.7	0.6	0.9
7/17/12	910 A	1620 A	1026 A	2513 A	4869 A	19	33	21	19.4	21.0	20.4	20.5	1.7	0.6	0.6
7/18/12	849 A	1635 A	1026 A	2602 A	4992 A	17	33	21	18.9	20.7	20.1	20.1	1.8	0.6	0.6
7/19/12	780 A	1568 A	1023 A	2620 A	5065 A	15	31	20	18.9	20.5	20.0	20.3	1.6	0.5	0.2
7/20/12	762 A	1450 A	1033 A	2550 A	4842 A	16	30	21	19.2	20.5	20.1	20.1	1.3	0.4	0.4
7/21/12	711 A	1368 A	1036 A	2490 A	4657 A	15	29	22	20.1	21.2	20.8	20.5	1.1	0.4	0.7
7/22/12	658 A	1304 A	1036 A	2441 A	4524 A	15	29	23	20.9	21.7	21.4	20.7	0.8	0.3	1.0
7/23/12	605 A	1221 A	1039 A	2397 A	4366 A	14	28	24	21.0	22.2	21.8	21.3	1.2	0.4	0.9
7/24/12	561 A	1149 A	1035 A	2376 A	4250 A	13	27	24	21.7	22.8	22.5	21.8	1.1	0.4	1.0
7/25/12	509 A	1074 A	1032 A	2325 A	4109 A	12	26	25	22.0	22.9	22.7	22.1	0.9	0.2	0.8
7/26/12	456 A	1022 A	1034 A	2293 A	3966 A	12	26	26	22.1	22.8	22.6	22.0	0.6	0.2	0.7
7/27/12	457 A	962 A	1035 A	2268 A	3871 A	12	25	27	22.0	22.5	22.3	21.6	0.5	0.1	0.8
7/28/12	473 A	902 A	1036 A	2241 A	3770 A	13	24	27	21.7	22.3	22.2	21.5	0.6	0.1	0.8
7/29/12	473 A	917 A	1037 A	2224 A	3710 A	13	25	28	21.6	22.1	22.0	21.3	0.5	0.1	0.8
7/30/12	474 A	907 A	1021 A	2192 A	3694 A	13	25	28	21.8	22.2	22.1	21.6	0.4	0.0	0.5
7/31/12	464 A	890 A	1020 A	2159 A	3642 A	13	24	28	21.8	22.4	22.3	21.9	0.6	0.1	0.6
8/1/12	440 A	877 A	1021 A	2140 A	3594 A	12	24	28	21.9	22.7	22.5	22.0	0.8	0.2	0.7
8/2/12	440 A	842 A	1020 A	2109 A	3531 A	12	24	29	22.1	23.0	22.8	22.1	0.8	0.2	0.9
8/3/12	447 A	822 A	1020 A	2079 A	3461 A	13	24	29	22.6	23.5	23.2	22.4	0.9	0.2	1.1
8/4/12	446 A	815 A	1020 A	2056 A	3404 A	13	24	30	23.2	23.7	23.6	22.6	0.5	0.1	1.1
8/5/12	441 A	806 A	1020 A	2024 A	3359 A	13	24	30	23.4	23.5	23.5	22.5	0.1	0.0	1.0
8/6/12	443 A	816 A	1020 A	2033 A	3329 A	13	24	31	23.5	23.4	23.5	22.4	-0.1	-0.1	1.1
8/7/12	444 A	792 A	1021 A	2032 A	3353 A	13	24	30	23.1	23.2	23.3	22.1	0.1	0.0	1.1
8/8/12	445 A	779 A	1021 A	1995 A	3293 A	14	24	31	22.6	22.7	22.8	22.4	0.1	-0.1	0.3
8/9/12	445 A	771 A	1020 A	1973 A	3227 A	14	24	32	22.6	22.7	22.8	22.3	0.1	0.0	0.4
8/10/12	443 A	764 A	1020 A	1947 A	3196 A	14	24	32	22.7	22.9	22.9	22.4	0.2	0.0	0.5
8/11/12	444 A	1036	1020 A	1913 A	3164 A	14	33	32	23.0	23.4	23.3	22.8	0.3	0.1	0.6
8/12/12	446 A	1157	1020 A	1894 A	3123 A	14	37	33	23.6	23.6	23.7	23.1	0.0	-0.1	0.5
8/13/12	733 A	1307 A	1022 A	1884 A	3081 A	24	42	33	23.7	23.5	23.7	23.3	-0.2	-0.1	0.3
8/14/12	961 A	1279 A	1020 A	1857 A	3055 A	31	42	33	24.1	23.8	24.0	23.5	-0.3	-0.2	0.3
8/15/12	1020 A	1251 A	1020 A	1838 A	3321 A	31	38	31	24.1	23.9	24.0	23.0	-0.2	-0.1	0.9

Appendix A (Continued). Water temperature and flow comparisons of the Trinity and Klamath Rivers, April 15 to October 15, 2012. Station locations: TR = Trinity River, WE = Klamath River at Weitchpec, KBW = Klamath Below Weitchpec, and KNK = Klamath near Klamath (A = approved data for publication; P = provisional data subject to change).

Date	Flow (CFS)									Average Daily Water Temperatures (°C)				Differences in Water Temps (°C) of the Klamath R. at rkm 70.2 and:		
	Trinity R.		Klamath R.			Contributions of Flow to the Klamath Gage (%)[a]			Trinity R.	Klamath R.			Trinity R.	Klamath R.	
	Lewiston (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	Orleans (rkm 95.1)	Klamath (rkm 13.0)	Lewiston Dam (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	TR (rkm 0.1)	WE (rkm 70.2)	KBW (rkm 68.7)	KNK (rkm 13.0)	TR (rkm 0.1)	KBW (rkm 62.0)	KNK (rkm 13.0)
8/16/12	1060 A	1244 A	1020 A	1836 A	3498 A	30	36	29	23.1	23.7	23.6	22.6	0.7	0.2	1.1
8/17/12	1029 A	1237 A	1020 A	1816 A	3568 A	29	35	29	22.0	24.0	23.3	22.6	1.9	0.7	1.4
8/18/12	1010 A	1239 A	1020 A	1793 A	3544 A	29	35	29	21.4	23.6	22.8	22.4	2.1	0.8	1.1
8/19/12	1014 A	1236 A	1020 A	1773 A	3477 A	29	36	29	21.1	23.1	22.3	22.1	2.0	0.7	0.9
8/20/12	1012 A	1231 A	1019 A	1764 A	3470 A	29	35	29	20.8	22.8	22.0	21.9	2.0	0.7	0.9
8/21/12	1013 A	1231 A	1020 A	1755 A	3468 A	29	35	29	20.7	22.5	21.8	21.6	1.9	0.7	0.9
8/22/12	1015 A	1225 A	1020 A	1756 A	3469 A	29	35	29	20.6	22.6	21.8	21.8	2.0	0.8	0.8
8/23/12	1015 A	1217 A	1020 A	1746 A	3469 A	29	35	29	20.5	22.6	21.8	21.7	2.1	0.8	0.9
8/24/12	1015 A	1243 A	1020 A	1731 A	3454 A	29	36	30	20.2	22.4	21.6	21.8	2.2	0.8	0.7
8/25/12	1013 A	1262 A	1018 A	1725 A	3433 A	30	37	30	19.9	22.3	21.4	21.2	2.3	0.9	1.0
8/26/12	1013 A	1267 A	1012 A	1712 A	3415 A	30	37	30	19.4	21.4	20.7	21.2	1.9	0.7	0.2
8/27/12	1053 A	1262 A	1020 A	1703 A	3407 A	31	37	30	19.2	21.3	20.5	20.7	2.1	0.7	0.5
8/28/12	1069 A	1476 A	1022 A	1706 A	3410 A	31	43	30	19.1	21.1	20.3	20.6	2.0	0.8	0.5
8/29/12	1070 A	1366 A	1565 A	1700 A	3467 A	31	39	45	18.7	20.6	19.9	20.4	2.0	0.7	0.3
8/30/12	1065 A	1221 A	1443 A	1698 A	3459 A	31	35	42	18.5	20.4	19.7	20.1	1.9	0.7	0.4
8/31/12	1378 A	1211 A	1044 A	1696 A	3458 A	40	35	30	18.6	20.1	19.6	19.2	1.5	0.5	0.8
9/1/12	1148 A	1159 A	1023 A	1889 A	3495 A	33	33	29	18.4	19.9	19.4	19.4	1.5	0.5	0.5
9/2/12	1040 A	1104 A	1025 A	2168 A	4223 A	25	26	24	18.2	20.4	19.6	19.8	2.1	0.8	0.5
9/3/12	1040 A	1014 A	1023 A	1821 A	3847 A	27	26	27	18.2	20.8	19.8	19.9	2.6	1.0	0.9
9/4/12	967 A	992 A	1023 A	1676 A	3449 A	28	29	30	18.4	20.8	19.9	20.0	2.3	0.9	0.8
9/5/12	900 A	1026 A	1023 A	1671 A	3364 A	27	31	30	18.6	20.8	20.0	20.1	2.2	0.8	0.7
9/6/12	815 A	1028 A	1024 A	1656 A	3259 A	25	32	31	18.4	20.8	19.9	19.8	2.3	0.8	1.0
9/7/12	821 A	1048 A	1025 A	1640 A	3148 A	26	33	33	18.1	20.5	19.7	19.6	2.4	0.8	0.9
9/8/12	857 A	1074 A	1022 A	1629 A	3069 A	28	35	33	18.1	20.2	19.4	19.0	2.1	0.8	1.1
9/9/12	860 A	1075 A	1023 A	1621 A	3070 A	28	35	33	18.0	19.7	19.1	19.1	1.7	0.6	0.6
9/10/12	886 A	1069 A	1034 A	1614 A	3080 A	29	35	34	17.9	19.5	19.0	19.3	1.6	0.5	0.2
9/11/12	904 A	1076 A	1039 A	1618 A	3098 A	29	35	34	18.1	19.8	19.2	19.5	1.7	0.6	0.3
9/12/12	914 A	1092 A	1039 A	1613 A	3130 A	29	35	33	18.3	20.0	19.4	19.6	1.7	0.6	0.4
9/13/12	908 A	1086 A	1036 A	1614 A	3130 A	29	35	33	18.4	20.0	19.5	19.6	1.6	0.5	0.4
9/14/12	938 A	1084 A	1032 A	1621 A	3127 A	30	35	33	18.6	20.3	19.7	19.5	1.7	0.6	0.8
9/15/12	960 A	1030 A	1033 A	1613 A	3107 A	31	33	33	18.4	20.3	19.7	19.5	1.9	0.7	0.9

Appendix A (Continued). Water temperature and flow comparisons of the Trinity and Klamath Rivers, April 15 to October 15, 2012. Station locations: TR = Trinity River, WE = Klamath River at Weitchpec, KBW = Klamath Below Weitchpec, and KNK = Klamath near Klamath (A = approved data for publication; P = provisional data subject to change).

Date	Flow (CFS)										Average Daily Water Temperatures (°C)				Differences in Water Temps (°C) of the Klamath R. at rkm 70.2 and:		
	Trinity R.		Klamath R.			Contributions of Flow to the Klamath Gage (%)[a]			Trinity R.	Klamath R.			Trinity R.	Klamath R.	
	Lewiston (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	Orleans (rkm 95.1)	Klamath (rkm 13.0)	Lewiston Dam (rkm 178.6)	Hoopa (rkm 20.0)	Iron Gate Dam (rkm 305.5)	TR (rkm 0.1)	WE (rkm 70.2)	KBW (rkm 68.7)	KNK (rkm 13.0)	TR (rkm 0.1)	KBW (rkm 62.0)	KNK (rkm 13.0)
9/16/12	960 A	754 A	1038 A	1606 A	3140 A	31	24	33	18.1	20.3	19.5	19.5	2.2	0.8	0.8
9/17/12	961 A	660 A	1039 A	1598 A	3130 A	31	21	33	17.7	20.1	19.3	19.4	2.4	0.9	0.7
9/18/12	810 A	658 A	1021 A	1600 A	3115 A	26	21	33	17.6	19.8	19.0	18.8	2.2	0.8	1.0
9/19/12	482 A	655 A	1030 A	1601 A	3119 A	15	21	33	17.3	19.4	18.7	18.4	2.1	0.8	1.1
9/20/12	453 A	653 A	1030 A	1602 A	2948 A	15	22	35	17.1	19.0	18.4	18.3	1.9	0.6	0.7
9/21/12	451 A	653 A	1030 A	1594 A	2696 A	17	24	38	17.1	18.6	18.2	18.3	1.5	0.4	0.3
9/22/12	455 A	653 A	1030 A	1586 A	2618 A	17	25	39	17.0	18.3	17.9	18.1	1.3	0.4	0.1
9/23/12	451 A	653 A	1030 A	1588 A	2612 A	17	25	39	17.5	18.7	18.3	18.3	1.2	0.3	0.4
9/24/12	452 A	653 A	1030 A	1583 A	2600 A	17	25	40	17.8	18.9	18.6	18.5	1.1	0.3	0.3
9/25/12	453 A	653 A	1031 A	1591 A	2599 A	17	25	40	18.0	18.9	18.7	18.8	1.0	0.2	0.1
9/26/12	453 A	649 A	1030 A	1596 A	2606 A	17	25	40	18.1	18.9	18.7	18.8	0.8	0.2	0.2
9/27/12	453 A	647 A	1031 A	1591 A	2607 A	17	25	40	18.3	19.0	18.8	18.8	0.7	0.1	0.2
9/28/12	457 A	647 A	1030 A	1579 A	2588 A	18	25	40	18.2	18.9	18.8	18.8	0.7	0.1	0.1
9/29/12	457 A	647 A	1010 A	1573 A	2569 A	18	25	39	17.8	18.6	18.4	18.6	0.8	0.1	-0.1
9/30/12	458 A	648 A	1008 A	1568 A	2559 A	18	25	39	17.6	18.4	18.2	18.6	0.8	0.1	-0.2
10/1/12	456 A	649 A	1002 A	1563 A	2553 A	18	25	39	17.6	18.3	18.2	18.8	0.7	0.1	-0.5
10/2/12	451 A	653 A	1005 A	1555 A	2544 A	18	26	39	17.6	18.3	18.2	18.6	0.6	0.1	-0.4
10/3/12	455 A	654 P	1006 A	1580 P	2540 A	18	26	40	17.5	18.2	18.1	18.6	0.7	0.1	-0.4
10/4/12	456 A	655 P	1007 A	1574 P	2546 A	18	26	40	17.3	18.1	18.0	18.3	0.8	0.1	-0.1
10/5/12	456 A	654 P	1004 A	1571 P	2536 A	18	26	40	17.2	17.7	17.6	18.0	0.5	0.1	-0.3
10/6/12	456 A	654 P	1005 A	1580 P	2549 A	18	26	39	17.2	17.3	17.4	17.8	0.1	-0.1	-0.4
10/7/12	456 A	658 P	1006 A	1588 P	2576 A	18	26	39	16.7	16.9	16.9	17.6	0.1	0.0	-0.8
10/8/12	454 A	659 P	1003 A	1591 P	2595 A	17	25	39	16.4	16.6	16.7	17.2	0.2	-0.1	-0.6
10/9/12	457 A	658 P	1004 A	1603 P	2609 A	18	25	38	16.1	16.5	16.4	16.9	0.4	0.1	-0.4
10/10/12	455 P	659 P	1004 A	1606 P	2629 A	17	25	38	15.8	16.3	16.3	16.5	0.5	0.1	-0.2
10/11/12	451 P	658 P	1007 P	1600 P	2636 A	17	25	38	15.7	16.2	16.1	16.1	0.5	0.1	0.1
10/12/12	449 P	687 P	1005 P	1603 P	2630 A	17	26	38	15.5	15.9	15.9	15.9	0.5	0.1	0.0
10/13/12	452 P	696 P	1005 P	1607 P	2672 A	17	26	38	15.7	16.2	16.1	16.3	0.4	0.1	-0.2
10/14/12	445 P	673 P	1008 P	1630 P	2689 A	17	25	37	16.2	16.6	16.5	16.8	0.4	0.1	-0.3
10/15/12	437 P	664 P	1004 P	1642 P	2730 A	16	24	37	16.5	16.8	16.8	17.0	0.3	0.0	-0.2

[a] The percent contribution estimates are most accurate during periods of stable flow. The calculated percent contribution of dam-released flow to the total flow of the Klamath River at Klamath is predicated assuming an instantaneous response of dam-released flow to the Klamath gage (rkm 17). During periods of varying flows, however, the accuracy of the estimates are diminished since it takes time (up to a few days) for a change in dam-released flow from either Lewiston or Iron Gate Dam to reach the USGS Gage at Klamath. As such, estimates of dam-release contributions presented here may be in error during period of highly variable flows.