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September 14, 2012
File No. 11002A
Electronically Filed

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

SUBJECT: **Drum-Spaulding Project, *Pacific Gas and Electric Company,* Project No. 2310-193 Yuba-Bear Hydroelectric Project, *Nevada Irrigation District*, Project No. 2266-102**

REPLY COMMENTS of Placer County Water Agency on the California Department of Fish and Game's Federal Power Act § 10(j) Recommendations

Dear Secretary Bose:

Pursuant to the Commission's January 19, 2012 Notice Soliciting Motions to Intervene, Protests, Comments, and Recommendations, and the Commission's February 29, 2012 Notice extending time to file motions to intervene and comments, Placer County Water Agency (PCWA) submits comments on the California Department of Fish and Game's (CDFG) § 10(j) Recommendations for Pacific Gas and Electric Company's (PG&E) Drum-Spaulding Project (FERC No. 2310)[1] and Nevada Irrigation District's (NID) Yuba-Bear Hydroelectric Project (FERC No. 2266)[2] filed on July 30, 2012. PCWA's interest in the aforementioned projects and background information are

[1] Response to Notice of Ready for Environmental Analysis FEDERAL POWER ACT SECTION 10(j) and 10(a) RECOMMENDATIONS Drum-Spaulding Hydroelectric Project (Project No. 2310-193) (Jul 30, 2012). eLibrary No. 20120730-5181.

[2] Response to Notice of Ready for Environmental Analysis FEDERAL POWER ACT SECTION 10(j) and 10(a) RECOMMENDATIONS Yuba-Bear Hydroelectric Project (Project No. 2266-102) (Jul 30, 2012). eLibrary No. 20120730-5174.

explained in detail in its letters of intervention, filed with the Federal Energy Regulatory Commission (FERC or Commission) on July 30, 2012[3].

COMMENTS

PCWA's comments jointly address the CDFG's § 10(j) Recommendations for the Yuba-Bear Hydroelectric Project and the Drum-Spaulding Project (as appropriate), as the two projects are hydrologically and operationally interrelated and FERC intends to prepare a multi-project environmental impact statement[4]. In the following, PCWA identifies the appropriate FERC project, measure, and reach associated with each comment.

PCWA has specific comments on five elements of CDFG's § 10(j) Recommendations:

Issue No. 1. CDFG's proposed *Measure No. 2 - Flow Measures, Part 1. Water Year Types* conflicts with United States Department of Agriculture – Forest Service[5] (USDA-FS)/ Bureau of Land Management[6] (BLM) Revised Preliminary § 4(e) conditions and fails to adequately protect PCWA's water supply in Back-to-Back Critically Dry water years. This issue applies to: the Drum-Spaulding Project - all stream reaches[7] and the Yuba-Bear Hydroelectric Project - Bear River below Rollins Reservoir Dam.

Issue No. 2. CDFG's proposed *Measure No. 2 - Flow Measures, Part 2. Minimum Streamflows* is duplicative to USDA-FS Revised Preliminary § 4(e) Condition No. 29 – Flow *Measures, Minimum Streamflows* but is less clear than the USDA-FS provision. This issue applies to: the Drum-Spaulding Project - South Yuba River Below Lake Spaulding Dam in Extreme Critically Dry water year types.

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[3] Motion to Intervene of the Placer County Water Agency under P-2310 (Jul 30, 2012), eLibrary No. 20120730-5131 and Motion to Intervene of the Placer County Water Agency under P-2266 (Jul 30, 2012), eLibrary No. 20120730-5134.

[4] FERC Scoping of environmental issues for new licenses for the Yuba-Bear (FERC No. 2266-096) and Drum-Spaulding (FERC No. 2310-173) hydroelectric projects, and the Rollins Transmission Line Project (FERC No. 2784-003), California. (May 22, 2008). eLibrary No. 20080522-3011.

[5] The US Forest Service's Revised Preliminary Conditions and Recommendations re Pacific Gas and Electric Company's Drum-Spaulding Hydroelectric Project under P-2310 (Aug. 24, 2012). eLibrary 2012824-5005.

[6] Nevada Irrigation District Yuba-Bear Hydroelectric Project, FERC No. 2266-102 The Department of the Interior Revised Preliminary Terms, Conditions, and Recommendations. (Aug. 28 2012). eLibrary 20120828-5023.

[7] Stream reaches with an Extreme Critically Dry water year type.

Issue No. 3. CDFG's proposed *Measure No. 2 - Flow Measures, Part 3. Compliance with Streamflow Requirements* conflicts with BLM Revised Preliminary § 4(e) *Condition 3 - Coordination of the Drum-Spaulding Project and the Yuba-Bear Hydroelectric Project Operation Regarding the Yuba-Bear Hydroelectric Project's Streamflow Requirements in the Bear River Below Rollins Reservoir at YB-196*. This issue applies to the Drum-Spaulding Project - Bear River below the Bear River Canal Diversion Dam.

Issue No. 4. CDFG's proposed block flows for water temperature would reduce habitat for special-status species and increase power generation loss and water supply deficits. This issue applies to: the Drum-Spaulding Project - South Yuba River (*Measure No. 2 – Flow Measures, Part 9*) and the Yuba-Bear Hydroelectric Project - Middle Yuba River (*Measure No. 2 – Flow Measures, Part 8*).

Issue No. 5. CDFG's proposed *Measure No. 7 Terrestrial Protection Measures – Part 6. Bear River Management Through Bear Valley* fails to protect the water supply to PCWA and NID customers in certain conditions and fails to balance water supply, generation, and environmental resource protection. This issue applies to: the Drum-Spaulding Project - Bear River Management through Bear Valley.

Comment on Issue No. 1 – CDFG's Proposed Measure No. 2 - Flow Measures, Part 1. Water Year Types

FERC should reject CDFG's *Measure No. 2 – Flow Measures, Part 1. Water Year Types,* Table 1. The USDA-FS/BLM Revised Preliminary § 4(e) water year type measures provide a more appropriate balance of water supply, generation, and environmental resource interests.

CDFG's water year types measures should be replaced by USDA-FS Revised Preliminary § 4(e) *Condition No. 29 – Flow Measures, Water Year Types* for the Drum-Spaulding Project (all reaches) and BLM Revised Preliminary § 4(e) *Condition 3 – Water Year Types* for the Yuba-Bear Hydroelectric Project (Bear River below Rollins Reservoir Dam). The USDA-FS/BLM Revised Preliminary § 4(e) water year type measures include a water year type modification, whereby the second year of back-to-back Critically Dry water years become an Extreme Critically Dry water year (B2B CD->ECD). As explained below, when there are back-to-back Critically Dry water years, there is a substantially increased threat to PCWA's water supply. Recognizing the second Critically Dry water year as an Extreme Critically Dry water year is necessary to protect the only source of water for many PCWA customers.

The USDA-FS/BLM Revised Preliminary § 4(e) water year type measures are shown below. The red text shows the revised text that is not in the CDFG's Water Year Types Measures.

Drum-Spaulding Project: USDA-FS Revised Preliminary Section 4(e) Condition No. 29 – Flow Measures

<u>Water Year Types</u>

Table 1. Water Year types for the Drum-Spaulding Project.

Water Year Type	DWR Forecast of Total Unimpaired Runoff in the Yuba River at Smartville in Thousand Acre-Feet or DWR Full Natural Flow Near Smartville for the Water Year in Thousand Acre-Feet[1]
Extreme Critically Dry	Equal to or Less than 615 or second year of a back-to-back Critically Dry Water Years (<=900)
Critically Dry	616 to 900
Dry	901 to 1,460
Below Normal	1,461 to 2,190
Above Normal	2,191 to 3,240
Wet	Greater than 3,240
[1] DWR rounds the Bulletin 120 forecast to the nearest 1,000 acre-feet. The Full Natural Flow is provided to the nearest acre-foot, and Licensee will round DWR's Full Natural Flow to the nearest 1,000 acre-feet.	

Yuba-Bear Hydroelectric Project: BLM Revised Preliminary Section 4(e) Condition 3 – Water Year Types

Table 1. Water Year types for the Yuba-Bear Hydroelectric Project.

Water Year Type	DWR Forecast of Total Unimpaired Runoff in the Yuba River at Smartville in Thousand Acre-Feet or DWR Full Natural Flow Near Smartville for the Water Year in Thousand Acre-Feet[1]
Extreme Critically Dry	Equal to or Less than 615 or 2nd year of a back-to-back Critically Dry Water Years (<=900) [2]
Critically Dry	616 to 900
Dry	901 to 1,460
Below Normal	1,461 to 2,190
Above Normal	2,191 to 3,240
Wet	Greater than 3,240
[1] DWR rounds the Bulletin 120 forecast to the nearest 1,000 acre-feet. The Full Natural Flow is provided to the nearest acre-foot, and Licensee will round DWR's Full Natural Flow to the nearest 1,000 acre-feet. [2] Applies only to minimum instream flows in the Bear River below Rollins Reservoir.	

Justification

Operations Modeling results, using the correct PCWA water demands[8] and NID peak-use demands, demonstrate the risk that reservoirs, required to serve PCWA customers, may run dry in the second year of back-to-back Critically Dry water years if flows are not adjusted during that second year. The results for Rollins Reservoir are shown (in Figure 1) to illustrate the effect of back-to-back Critically Dry Water Years on reservoir storage (including other reservoirs in the system such as Bowman and Spaulding reservoirs). Three scenarios, Base Case scenario (existing license conditions), CDFG Recommended model run without B2B CD->ECD, and the USDA-FS/BLM Revised Preliminary § 4(e) conditions model run, which includes B2B CD->ECD are shown in Figure 1. In 1988, under the Base Case scenario, Rollins Reservoir storage (and other reservoirs in the system such as Spaulding and Bowman reservoirs) remains at a level that can meet future minimum flow requirements, provide for water supply, and provide water supply reliability should the following year be drier than normal. However, with the new minimum flows specified in the CDFG § 10(j) Recommendations, Rollins Reservoir is drained and the other reservoirs (e.g., Spaulding and Bowman reservoirs) are at minimum reserve pool levels (water necessary to only meet future minimum instream flow requirements) and cannot be utilized for water supply or to provide water supply reliability. Conversely, by including the second year back-to-back Critically Dry water year type (B2B CD->ECD), USDA-FS/BLM Revised Preliminary § 4(e) conditions, approximately 10,000 ac-ft carryover is maintained in Rollins Reservoir for future water supply. As described in previous filings[9], this consumptive water

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[8] PCWA's existing water demand is incorrectly characterized in PG&E's and NID's Operation Model runs. PCWA's demand should be 100,400 ac-ft in PCWA's Zone 1 and 10,500 ac-ft in PCWA's Zone 3. PCWA previously commented on this issue and provided the supporting data in its response to PG&E's Draft License Application (filed January 27, 2011). In total, approximately 6,260 ac-ft of PCWA demand is not reported in the Operations Model runs. This error causes impacts on PCWA's water supply to be underreported.

[9] For example, see the following PCWA filings: Motion to Intervene of the Placer County Water Agency under P-2310 (Jul 30, 2012), eLibrary No. 20120730-5131; Motion to Intervene of the Placer County Water Agency under P-2266 (Jul 30, 2012), eLibrary No. 20120730-5134; Comments of Placer County Water Agency on Amended License Application for the Drum-Spaulding Project, Pacific Gas and Electric Company, Project No. 2310-193 (Jul 30, 2012), eLibrary No. 20120730-5131; Comments of Placer County Water Agency on Amended License Application for the Yuba-Bear Hydroelectric Project, Nevada Irrigation District, Project No. 2266-102 Jul 30, 2012), eLibrary No. 20120730-5140; Comments of Placer County Water Agency on PG&E's Draft License Application for the Drum-Spaulding Project (FERC Project No. 2310) (Jan. 28, 2011), eLibrary No. 20110128-5024; and Comments of Placer County Water Agency on Nevada Irrigation District's Yuba-Bear Project (FERC Project No. 2266) (Jan. 28, 2011), eLibrary No. 20110128-5023.

supply from the Yuba-Bear/ Drum-Spaulding projects is irreplaceable for the residents of Placer County.

The USDA-FS/BLM Revised Preliminary § 4(e) conditions are protective of aquatic resources in the second year of a back-to-back Critically Dry water year. Minimum flows throughout the Yuba-Bear/Drum-Spaulding projects in Extreme Critically Dry water year (i.e., the second year of a back-to-back Critically Dry water year) are greatly increased from existing conditions. The habitat benefits are shown in Supplement No. 3[10] submitted by NID, Supplement No. 4[11] submitted by PG&E, and in Appendix A. For example, the new minimum flow in the South Yuba River below Spaulding Dam in Extreme Critically Dry water years is 20 cfs during the summer, which is four times greater than the existing minimum flow of 5 cfs and is also four times greater than the unimpaired summer flow. Adult rainbow trout habitat[12] in the South Yuba River Canyon Creek Reach, for example, at the 20 cfs in USDA-FS/BLM Revised Preliminary § 4(e) conditions is 370% greater than the habitat at the existing/unimpaired flow of 5 cfs (3.7 times greater)[13] (Appendix A).

Comment on Issue No. 2 – CDFG's Proposed Measure No. 2 - Flow Measures, Part 2. Minimum Streamflows: Drum-Spaulding Project - South Yuba River Below Lake Spaulding Dam in Extreme Critically Dry Water Year Types

FERC should reject the CDFG's *Measure No. 2 – Flow Measures, Part 2. Minimum Instream Flows* recommendation for the South Yuba River below Lake Spaulding Dam (Table 2). The USDA-FS Revised Preliminary § 4(e) *Condition No. 29 – Flow Measures, Minimum Streamflows* for the South Yuba River below Lake Spaulding (Table 2), provided below[14], is the same as

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[10] Nevada Irrigation District Transmittal of Supplements No. 1, 2, 3, 4, and Attachment 1. for the Yuba-Bear Hydroelectric Project under P-2266. (Aug. 17, 2012). eLibrary No. 20120817-5135.

[11] Supplemental Information: Supplement Nos. 1-5 to PG&E's License Application, as Amended for Drum-Spaulding Project FERC Project No. 2310 et., al. (Aug. 29, 2012) eLibrary No. 20120830-5000.

[12] Adult rainbow trout habitat was the habitat used by CDFG to determine summer flows.

[13] See PG&E and NID. 2010. Technical Memorandum 3-2. Instream Flow. Yuba-Bear Hydroelectric Project (FERC Project No. 2266-096) and Drum-Spaulding Project (FERC Project No. 2310-173). October 2011.

[14] PCWA has corrected a typographical error in the USDA-FS's Table 2 for the South Yuba River in red. PCWA has notified the USDA-FS of the error and has filed a comment with FERC regarding the error (Enclosure 6 included in PCWA's reply comments for the Drum-Spaulding Project, filed on Sept 14, 2012).

CDFG's recommendation but the flow table and associated footnote is clearer and should reduce potential confusion during license compliance.

Drum-Spaulding Project: USDA-FS Revised Preliminary Section 4(e) Condition No. 29 – Flow Measures, Minimum Streamflows

Table 2. Minimum Streamflows in cubic feet per second (cfs) for specified reaches by month and water year type.

Month	Extreme Critically Dry Water Year	Critically Dry Water Year	Dry Water Year	Below Normal Water Year	Above Normal Water Year	Wet Water Year
SOUTH YUBA RIVER – BELOW LAKE SPAULDING DAM (COMPLIANCE POINT: YB-29; USGS STREAMFLOW GAGE 11414250)						
October	10*/20	20	20	25	25	30
November	10*/20	20	20	25	25	30
December	10*/20	20	20	25	25	30
January	10*/20	20	20	25	25	30
February	10*/20	25	25	35	40	50
March	10*/20	25	30	40	55	75
April	10*/20	30	40	60	80	90
May	10*/20	40	60	90	90	90
June 1-14	10*/20	35	40	50	90	90
June 15-30	20	35	40	50	90	90
July	20	25	30	35	40	40
August	20	20	23	25	40	40
September 1-15[12]	10*/20	20	23	25	40	40
September 16 - 30[12]	10*/20	20	20	25	28	30

*In the case where an EC water year (less than 615,000 ac-ft at Smartsville) is preceded by an EC or CD water year, the minimum streamflow shall be 10 cfs from September 1 to June 14.

PCWA has corrected a typographical error in the USDA-FS's Table 2 for the South Yuba River in red.

Justification

The USDA-FS Revised Preliminary § 4(e) Condition No. 29 – *Flow Measures, Minimum Streamflows* for the South Yuba River below Lake Spaulding (Table 2) does not change the flows in or the intent of the CDFG's minimum instream flow recommendation; it makes the intent clearer. The CDFG's Table 2 footnote and flow column for Extreme Critically Dry Water Year types are potentially confusing and could be misinterpreted during license compliance.

Comment on Issue No. 3 – CDFG's Proposed Measure No. 2 - Flow Measures, Part 3. Compliance with Streamflow Requirements: Drum-Spaulding Project - Bear River below the Bear River Canal Diversion Dam

FERC should reject CDFG's *Measure No. 2 – Flow Measures, Part 3. Drum-Spaulding Project compliance with Streamflow Requirements in the Bear River Below the Bear River Canal Diversion Dam at Gage YB-196.* BLM Revised Preliminary § 4(e) *Condition 3 - Coordination of the Drum-Spaulding Project and the Yuba-Bear Hydroelectric Project Operation Regarding the Yuba-Bear Hydroelectric Project's Streamflow Requirements in the Bear River Below Rollins Reservoir at YB-196* is a more appropriate approach for maintaining minimum flows in this reach. The BLM Revised Preliminary § 4(e) condition is provided below with text track changes in red to show the differences from the CDFG's measure.

Drum-Spaulding Project: CDFG § 10(j) Measure No. 2 – Flow Measures

Part 3. Coordination of the Drum-Spaulding Project and the Yuba-Bear Hydroelectric Project Operation Regarding the Yuba-Bear Hydroelectric Project's ~~compliance with~~ Streamflow Requirements in the Bear River Below ~~the Bear River Canal Diversion Dam~~ Rollins Reservoir at Gage YB-196.

Licensee of the Drum-Spaulding Project shall not divert water to the Bear River Canal that Licensee of the Yuba-Bear Hydroelectric Project releases from Rollins Reservoir to meet the Yuba-Bear Hydroelectric Project's Flow Measures in the Bear River below the Rollins Reservoir as measured at Nevada Irrigation District's (NID) YB-196 gage (USGS 11422500). ~~If the Flow Measures are not being met at the YB-196 gage, Licensee of the Drum-Spaulding Project shall not divert water to the Bear River Canal until such time as the Flow Measures at the YB-196 gage are met.~~ Licensee's compliance with this measure will be the act of not diverting water into the Bear River Canal that Licensee of the Yuba-Bear Hydroelectric Project releases from Rollins Reservoir to meet its Flow Measures in the Bear River below Rollins as determined utilizing data from NID's YB-196 gage in Bear

River and PG&E's YB-50 gage in Bear River Canal, and the coordinated operations flow forecasts for water that NID will provide at YB-196 and for water that PG&E will divert to the Bear River Canal. Licensee's Coordinated Operations Plan with the licensee of the Yuba-Bear hydroelectric Project shall specifically require coordination between the two licensees of both projects to effectuate compliance with this measure.

Justification

CDFG's measure inappropriately puts the burden of instream flow releases from Rollins Reservoir (a NID facility), potentially, on PG&E instead of NID. The BLM Revised Preliminary § 4(e) measure is the correct approach.

Comment on Issue No. 4 – CDFG's Proposed Block Flows for Water Temperature in Drum-Spaulding Project - South Yuba River (Measure No. 2 – Flow Measures, Part 9) and Yuba-Bear Hydroelectric Project - Middle Yuba River (Measure No. 2 – Flow Measures, Part 8)

FERC should reject CDFG's block flow for water temperature recommendation for the South Yuba and Middle Yuba rivers (*Measure No. 2 – Flow Measures, Part 9. Block Flows for Water Temperature in South Yuba River [Drum-Spaulding Project] and Measure No. 2 – Flow Measures, Part 8. Middle Yuba River – Supplemental Flow Releases for Water Temperature Management [Yuba-Bear Hydroelectric Project])*. CDFG's temperature criterion of 19^{o}C is inappropriate and if implemented, would result in a reduction in habitat for special-status species[15] - foothill yellow-legged frogs (FYLF) (*Rana boylii)* and hardhead (*Mylopharodon conocephalus*), and could potentially adversely affect western pond turtle (WPT) (*Actinemys marmorata*) and its habitat. CDFG's temperature criterion is focused on a cold water temperature objective that creates a water temperature regime in the reaches downstream of Milton and Spaulding dams far colder than any reasonable reference condition (unimpaired or

[15] FYLF is listed by the USDA-FS as a Forest Service sensitive species, by BLM as a sensitive species, and is a California Species of Special Concern by CDFG. Hardhead is listed by the USDA-FS as a Forest Service sensitive species and the CDFG as a California Species of Special Concern. WPT is listed by the USDA-FS as a Forest Service sensitive species and is a California Species of Special Concern by CDFG. And, a petition has recently been submitted to the USDI FWS to list FYLF and WPT under the Federal Endangered Species Act.

existing) (discussed below). Further, CDFG's recommendation increases power generation losses and water supply deficits.

FERC should accept the USDA-FS Revised Preliminary § 4(e) condition *(Condition No. 29 – Flow Measures, South Yuba River Supplemental Flows)* in place of the CDFG recommendation. The USDA-FS Revised Preliminary § 4(e) condition provides "summer supplemental flow" for the South Yuba River that balances power generation, water supply, and environmental resource interests. The USDA-FS Revised Preliminary § 4(e) condition has lower impacts to power generation and water supply compared to CDFG's recommendation. The USDA-FS condition balances enhancement of rainbow trout habitat while protecting native warmer-water special-status species habitat (FYLF and hardhead). The USDA-FS condition uses a 20^{o}C temperature criterion in the South Yuba River and establishes a monitoring program and Ecological Group to assess the effects of any supplemental flows on habitat and temperature conditions for FYLF and native fish species (e.g. resident trout, hardhead and pikeminnows). Based on monitoring results, the Ecological Group may modify the supplemental flow releases and minimum flows (above normal and wet year) if adverse impacts to native aquatic species are observed. The USDA-FS Revised Preliminary § 4(e) condition is a more environmentally cautious approach, recognizing the potential for adverse effects to FYLF and hardhead, and provides a process for adaptively managing flows to protect sensitive species in the South Yuba River.

Reference Conditions (Existing and Unimpaired)

Summer/fall unimpaired flows in the South Yuba River, Middle Yuba River, and Canyon Creek are relatively very low (Figures 2a-c, 3a-b, and 4; respectively) (NID and PG&E existing and unimpaired flows; Yuba-Bear and Drum-Spaulding Operations Model) because of limited groundwater storage in the granite watersheds. Unimpaired August average monthly flow in the Middle Yuba River (below Milton Diversion Dam) and South Yuba River (below Spaulding Dam at Lang's Crossing) is 7 cfs and 9 cfs (50% exceedance), respectively; the 90% exceedance unimpaired August flows are 3 cfs and 5 cfs, respectively. Existing FERC license minimum flows in the two rivers are the same as the 90% August unimpaired exceedance flows. Unimpaired

August average monthly flow in Canyon Creek is 5.7 cfs (50% exceedance) and 2.6 cfs (90% exceedance) at the mouth.

Unimpaired summer water temperature is generally warmer or the same as existing conditions. Unimpaired water temperature modeling data are available for the South Yuba River for 2008. Unimpaired water temperature is warmer than existing conditions at the top of the South Yuba River where cold water is currently released from Spaulding Reservoir (Figures 5, 6a-b, and 7a-b; Map 1). Downstream, where the cold water warms and reaches equilibrium with air temperature, unimpaired water temperature is the same as existing conditions. Unimpaired conditions would likely not have supported cold water species/habitat (≤20˚C) from Spaulding Reservoir downstream, particularly downstream of the natural barriers, but rather warm/transitional zone species/habitat (hardhead and FYLF) (Figures 6a-b; Map 1) (the only exception may be in extreme wet water years). In the South Yuba River, under existing conditions, the Project releases have created approximately 6.8 miles (RM34 to RM 40.8) of habitat suitable for trout. This habitat was not present under unimpaired conditions (Figures 6a-b).

At present, modeled unimpaired water temperature data are not available for the Middle Yuba River and Canyon Creek, but the same cooling effect at the upstream end of the river reaches from the Project flow releases can be seen on Maps 2a-d (Base Case in Map 2a and 2c). Based on the existing conditions temperature data (Map 2a and 2c; including additional plots presented later), cold water (≤20˚C) likely occurred only in the Middle Yuba River above Wolf Creek and in Canyon Creek above Little Canyon Creek.

The temperature maps (Map 2a-d) also show locations of large natural, total barriers to upstream fish migration (including anadromous species) that are downstream of the project facilities. Barriers occur in the Middle Yuba River beginning at RM34.4, in the South Yuba River beginning at RM35.4, and in Canyon Creek beginning at RM1.18.

The three native special-status aquatic species that exist in the Middle and South Yuba rivers are FYLF, hardhead, and WPT. Both FYLF and hardhead are warm/transitional water temperature species. These two species require warm/transition water temperatures (consistent with unimpaired and existing summer flow conditions), and will be adversely impacted by CDFG temperature criteria. At present, due to data limitations, we do not address potential water temperature effects to WPT. Western pond turtles are present in the South and Middle Yuba rivers and their populations may be affected by decreased water temperature as a result of the CDFG proposed minimum summer flows[16]; however, limited information on their distribution precludes assessment of the effects of decreased temperature at the present.

<u>FLYF and Hardhead/Pikeminnow Temperature Criteria and Existing Distribution</u>

A maximum 30 day average temperature (M30DAT) threshold of ≥19.3˚C in drier water year types is required to protect Sierra FYLF populations (Figures 8a-b; Kupferberg et al. 2012 in Appendix B). Based on the observed abundance and temperature data for Sierra rivers (Figures 8a-b), FYLF abundance is greatly reduced at lower temperatures. The known distribution of FYLF in the South and Middle Yuba rivers and Canyon Creek is consistent with the temperature threshold (Figures 8a-b). The upstream distribution is known based on sampling discrete locations and the actual upstream distribution may extend somewhat upstream of the sampling locations. We conservatively estimate the FYLF upstream distribution extends to the point where M30DAT is 19.3˚C under existing conditions if this temperature occurs upstream of the last known sampling location. The known upstream distribution of FYLF in the South Yuba River is near the Fall Creek confluence at RM35.65; no sampling was conducted farther upstream[17]. Using the M30DAT temperature metric of 19.3˚C, the estimated upstream distribution of FYLF in the mainstem South Yuba River is near Rucker Creek (RM37.0) (Figure 6a-b). FYLFs in Canyon Creek were sampled near Little Canyon Creek (RM1.1); using the M30DAT temperature metric of approximately 19.3˚C, the estimated upstream distribution extends to at least RM2.1

[16] CDFG states in their rationale statement: 'Changes in normal thermoregulatory behaviors may affect several aspects of general life history traits such as growth patterns, age at maturity, and size at maturity, which in turn could affect age- and size-specific reproductive investments and the size at birth of offspring" (page 25 in CDFG's Rational Report for Proposed License Conditions and Recommendations for the Drum-Spaulding and Yuba-Bear Hydroelectric Projects).

[17] PG&E and NID. 2010. Technical Memorandum 3-6. Special-status Amphibians Foothill Yellow-legged Frog Surveys. Yuba-Bear Hydroelectric Project (FERC Project No. 2266-096) and Drum-Spaulding Project (FERC Project No. 2310-173). October 2010.

(Figure 9a-b). The upstream FYLF distribution in the Middle Yuba River is likely somewhere near National Gulch (RM30), near the upstream end of FYLF sampling (Figure 10a-b).

Hardhead are part of the "pikeminnow-hardhead-sucker" native fish assemblage that occurs in warmer water/transition portions of streams and rivers downstream of the cold water "rainbow trout" assemblage[18]. The distribution of hardhead was not identified in Yuba-Bear/Drum-Spaulding fish sampling studies of the Middle or South Yuba rivers[19]. A number of historical sampling studies, however, have clearly identified hardhead in both rivers[20,21,22,23].

Based on recent additional sampling in the South Yuba River[24] and sampling in adjacent watersheds, the upstream end of pikeminnow-hardhead habitat occurs at a M30DAT of 23˚C. In the South Yuba River the upstream end of the pikeminnow-potential hardhead distribution is near Scotchman Creek where the M30DAT is 23˚C (Appendix C; Map 3). The upstream distribution in the adjacent Rubicon River (very similar watershed and river characteristics to the South Yuba) is at the same M30DAT temperature location (M30DAT 23.1˚C, 23.3˚C and 23.0˚C in 2006, 2007, 2008, respectively)[25]. This is also the same temperature where minnows (presumably Sacramento pikeminnow/hardhead) exist in the Middle Yuba River just upstream of the Yuba County Water Agency's (YCWA) Our House Dam[26].

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[18] Moyle, P.B. 2002. Inland fishes of California, updated and revised. University of California Press, Berkeley.

[19] PG&E and NID. 2010. Technical Memorandum 3-1. Stream Fish Populations. Yuba-Bear Hydroelectric Project (FERC Project No. 2266-096) and Drum-Spaulding Project (FERC Project No. 2310-173). September 2010.

[20] Knight, N.J. 1985. Microhabitats and Temperature Requirements of Hardhead (*Mylopharodon conocephalus*) and Sacramento squawfish (Ptychochielus grandis), With Notes for Some Other Native California Stream Fishes. Doctoral Dissertation: UC Davis.

[21] Gast, T., M. Allen, and S. Riley. 2005. Middle and South Yuba Rainbow Trout (*Oncorhynchus mykiss*) Distribution and Abundance Dive Counts August 2004. FINAL DRAFT. August 2005. Appendix G in *Upper Yuba River Watershed Chinook Salmon and Steelhead Habitat Assessment. Submitted to the California Department of Water Resources. Prepared by the Upper Yuba River Studies Program Study Team.*

[22] Gard, M.F. 1994. Biotic and Abiotic Factors Affecting Native Stream Fishes in the South Yuba River, Nevada County, California. PhD Thesis, University of California, Davis. 174pp.

[23] PCWA recently conducted qualitative snorkeling and positively confirmed hardhead in the South Yuba River upstream to near Humbug Creek (see underwater pictures Appendix C; Map 3), and potential hardhead (small mixed minnows) as far upstream to Scotchman Creek (Map 3). Small minnows were present (Sacramento pikeminnow and potentially hardhead). Additional sampling effort would need to occur to determine the extent of the hardhead distribution. Experience suggests that hardhead are often scarce and considerable effort is needed to locate their presence.

[24] *Ibid.*

[25] PCWA. 2011. Application for New License. AQ 2 – Fish Population Technical Study Report (2007–2009). Volume 3, Exhibit E, Book 5, Supporting Document B. Filed with FERC February 23, 2011.

[26] Gast et al. 2005.

The hardhead upstream distribution and corresponding water temperature is consistent with literature. According to Moyle (2002), streams where hardhead occur have temperatures in excess of 20˚C. Knight (1985) states that successful management of native fishes, hardhead/Sacramento pikeminnow, requires maintaining river temperature ≥25˚C. The temperature preference for Sacramento pikeminnow and hardhead was 26 - 28˚C[27,28].

Reduction of Water Temperature

The CDFG recommended <19˚C temperature requirements would result in a large decrease in summer water temperature outside the range of reference conditions. For example, in the South Yuba River the temperature would be 4-5˚C M30DAT colder than the unimpaired or existing reference conditions (Figures 5 and 6a-b). Summer temperatures in the South Yuba River are naturally warm due to the open granite basin/river canyon and the low natural summer flows (Figures 5, 6a, and 7a; Map 1). In Canyon Creek, flows associated with the CDFG recommendation reduce temperatures by more than 2˚C M30DAT (Figures 9a-b and 11a-b; Maps 2a-d) and in the Middle Yuba River temperatures, are approximately 1˚C colder than reference conditions (Figures 10a-b and 12a-b; Maps 2a-d).

CDFG Recommended Block Flow/<19˚C Temperature Criteria and Special-status Species

CDFG's § 10 (j) recommended block flows and <19˚C temperature criteria in the South Yuba River result in further cooling of water temperatures than would occur under USDA-FS Revised Preliminary § 4(e) recommendation. Water temperature would remain below 19˚C in the South Yuba River above Canyon Creek and in the Middle Yuba River above Wolf Creek and would result in the loss of the FYLF habitat in the South Yuba River downstream to and including Canyon Creek (7.5 miles of FYLF habitat in the South Yuba River and Canyon Creek) (Figures 6a-b and 9a-b) and in the Middle Yuba River downstream and including the confluence area at Wolf Creek (4 miles of FYLF habitat) (Figure 10a-b).

[27] Moyle, P.B. 2002.
[28] Knight, N.J. 1985.

Approximately 14 miles of hardhead/pikeminnow habitat could be lost in the South Yuba River (from the current upstream location of approximately RM30 to a future upstream location of approximately RM16) with the CDFG recommended temperature criteria (Figure 6a-b). In the Middle Yuba River, approximately 1 mile of hardhead/pikeminnow habitat immediately upstream of YCWA's Our House Diversion (RM13.1) could be lost.

CDFG did not address the impacts to FYLF in their block flow/<19˚C recommendation and used an apparently incorrect "17˚C" July and August temperature goal to protect FYLF habitat[29] when developing flow and temperature recommendations. Figure 8a-b shows that a M30DAT of 17˚C results in a loss of FYLF habitat.

It does not appear that CDFG accurately evaluated the potential adverse effects of their recommendation on hardhead. CDFG cited a presentation[30] of a study regarding hardhead temperature preference in their rationale that suggests the hardhead preferred temperature is "greater than or equal to 19˚C". The study presentation cited, however, tested hardhead preference over only a very small range of acclimation temperatures ≤18˚C. A later report for this study, Klimley et al. 2010[31], states with respect to the limited test range that "our data fit those of Knight (1985)." Knight's (1985) conclusion from graphical analysis of his much more extensive data set was that hardhead in his study preferred 28.4˚C water temperature. CDFG's analysis suggests that because hardhead prefer temperatures "at or above 19˚C", the CDFG recommendation to keep temperature below 19˚C is not expected to "negatively impact this sensitive species." The CDFG reasoning and criteria do not appear to be supported by the data.

Comment on Issue No. 5 – CDFG's Proposed Measure No. 7 Terrestrial Protection Measures – Part 6: Drum-Spaulding Project - Bear River Management through Bear Valley.

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[29] For example, see page 279 in Enclosure C in Drum-Spaulding Hydroelectric Project and FERC No. 2310 Yuba-Bear Hydroelectric Project FERC No. 2266 Rationale Report for Proposed License Conditions And Recommendations for Proposed License Conditions And Recommendations in CDFG's Response to Notice of Ready for Environmental Analysis FEDERAL POWER ACT SECTION 10(j) and 10(a) RECOMMENDATIONS Drum-Spaulding Hydroelectric Project (Project No. 2310-193) (Jul 30, 2012). eLibrary No. 20120730-5181.

[30] *Ibid.* at Page 298.

[31] Klimley, A.P., J. J. Cech, L.C. Thompson, S.A. Hamilton, D.E. Cocherell, G. Jones, and J. Miranda. 2010. Experimental and Field Studies to Assess Pulsed Water Flow Impacts on the Behavior and Distribution of Fishes in the South Fork American River: Second Year. CEC-500-2009-067. Prepared for California Energy Commission Public Interest Energy Research Program. University California Davis. January 2010.

PCWA recommends that FERC reject CDFG's *Measure No. 7, Part 6. Bear River Management through Bear Valley,* and replace it with the USDA-FS Revised § 10(a) *Recommendation No. 5 – Bear River Management Through Bear River Valley*. The USDA-FS Revised § 10(a) recommendation was developed in consultation with the Licensee, PCWA, and other stakeholders. It contains the following language in red that does not exist in the CDFG Measure and that balances water supply, generation, and environmental resource protection:

> **USDA-FS Revised § 10(a) Recommendation (only the portion related to water supply)**
>
> Emergencies
>
> The operational guidelines in this measure do not apply in emergencies. An emergency is defined as an event that is reasonably out of the control of Licensee and requires Licensee to take immediate action, either unilaterally or under instruction of law enforcement, emergency services, or other regulatory agency staff, including actions to prevent the imminent loss of human life, ~~or~~ damage to property, loss of Project facilities, or water supply delivery infrastructure. An emergency may include, but is not limited to: natural events such as landslides, storms, or wildfires; vandalism; malfunction or failure of Project works; or other public safety incidents. During emergencies any Drum Canal spillway may be used without restriction.
>
> Water Supply Protection
>
> Licensee may exceed the good faith flow limits described in this measure or utilize
>
> Project spillways during planned or unplanned outages to the extent needed to avoid limiting downstream consumptive water deliveries.

Justification

The USDA-FS Revised § 10(a) recommendation is the proper approach for managing flows in the Bear River through Bear Valley. The water supply flows that would otherwise be conveyed in the river during routine operations and emergencies are well within the capacity of the active channel. The Bear River through Bear Valley Meadow (land owned by PG&E) is used for water conveyance during both routine operations by PG&E and during emergency situations, particularly when the Drum Canal system is down. Water supply delivery via the Bear River through the Bear Valley Meadow to the Lower Bear River watershed during emergencies or canal/powerhouse outages is vitally important to PCWA's customers and the residents of Placer County. For example, in 1997 and 1998, during an extended outage at the Drum Powerhouses (caused by storm damage), water diverted from PG&E's facilities on the South Yuba River (e.g., 450 cfs) was conveyed through the meadow and Bear River to provide the water supply needs of the residents of Placer and Nevada counties (via PCWA and NID). Restrictions on PG&E flows through the meadow, during periods when no other option is available to convey water, will result in an irreplaceable loss of water supply to PCWA's customers.

During stakeholder meetings there was concern raised about the potential effects of high flows on the channel and meadow. This appears to be primarily due to assumptions by some stakeholders that current flows are causing scouring and down cutting of the channel. The evidence indicates that those concerns are not merited. The Licensee completed numerous studies to assess the condition of the channel, fishery, vegetation, and meadow. The studies show that the fishery in the meadow area is the highest in terms of number of fish and biomass of any location sampled in the Drum-Spaulding Project. The studies also show that the channel in the meadow is inset and that the riparian vegetation, meadow vegetation, and the channel are functioning properly under the current flow regime. The Proper Functioning Condition (PFC) assessment completed by the Licensee indicated that the riparian corridor and meadow were Functional – At Risk with an upward trend.

PCWA has reviewed the available data, conducted two field trips, reviewed the history of the meadow, collected additional data, and conducted additional analyses (Appendix D). This information shows that the channel and its riparian and meadow conditions are stable and functional under the current flow regime and are recovering following the removal of cattle from the area. There are a couple of very small areas with streambank erosion, but these are not related to current Project operations (discussed further in Appendix D). The inset channel was likely formed in the mid-late 1800s as a result of releasing South Yuba River water into the top of the Bear Valley Meadow to supply gold miners with water. Aerial photographs taken since 1939 show that the channel has remained in the same location. Tree core dating indicates that the active floodplain of the inset channel has been at the present elevation since at least about 1959 – 1980 and perhaps earlier. The existing flow regime is maintaining an ecologically functioning riparian zone. The inset channel vertical incision is constrained by several natural bedrock, coarse substrate, or manmade controls (e.g., road crossing, diversion structure). Because of the bedrock/manmade vertical controls, there appears to be no potential for additional vertical incision of the channel under the existing flow conditions beyond the historic incision that has occurred.

<u>CONCLUSIONS</u>

- FERC should reject CDFG's *Measure No. 2 – Flow Measures, Part 1. Water Year Types,* Table 1; and accept the USDA-FS/BLM Revised Preliminary § 4(e) water year type measures, which better balance the protection of water supply, generation, and environmental resources.
- FERC should reject CDFG's *Measure No. 2 – Flow Measures, Part 2. Minimum Instream Flows,* recommendation for the South Yuba River below Lake Spaulding Dam (Table 2) and accept the USDA-FS Revised Preliminary § 4(e) *Condition No. 29 – Flow Measures, Minimum Streamflows* for the South Yuba River below Lake Spaulding (Table 2).
- FERC should reject CDFG's *Measure No. 2 – Flow Measures, Part 3. Drum-Spaulding Project compliance with Streamflow Requirements in the Bear River Below the Bear River Canal Diversion Dam at Gage YB-196* and replace it with BLM Revised Preliminary § 4(e) *Condition 3 - Coordination of the Drum-Spaulding Project and the Yuba-Bear Hydroelectric Project Operation Regarding the Yuba-Bear Hydroelectric Project's Streamflow Requirements in the Bear River Below Rollins Reservoir at YB-196*.
- FERC should reject CDFG's Block Flow for Water Temperature recommendation for the South Yuba and Middle Yuba rivers (*Measure No. 2 – Flow Measures - Part 9. Block Flows for Water Temperature in South Yuba River [Drum-Spaulding Project] and*

Measure No. 2 – Flow Measures – Part 8. Middle Yuba River – Supplemental Flow Releases for Water Temperature Management [Yuba-Bear Hydroelectric Project]). For the South Yuba River, the USDA-FS Revised Preliminary § 4(e) condition *(Condition No. 29 – Flow Measures, South Yuba River Supplemental Flows)* provides a “summer supplemental flow” condition that has a more acceptable balance of power generation, water supply, and protection of aquatic species habitat.

- FERC should reject CDFG’s *Measure No. 7, Part 6. Bear River Management through Bear Valley,* and replace it with the USDA-FS Revised § 10(a) *Recommendation No. 5 – Bear River Management Through Bear River Valley*, which better balances water supply, generation, and environmental resource protection.

PCWA appreciates the opportunity to comment on CDFG’s § 10(j) Recommendations under the Federal Power Act for the Drum-Spaulding Project and Yuba-Bear Hydroelectric Project. If FERC staff, the CDFG, the Licensees, or Yuba-Bear Drum-Spaulding relicensing participants would like further information on the contents of this filing, please contact me at (530) 823-4889.

Sincerely,

Andrew Fecko
Resource Planning Administrator

Figures

Figure 1. Rollins Reservoir Storage, Guide Curve, and Minimum Pool Under the Modeled Base Case Conditions and the Revised USDA-FS Conditions (Second Year of Back-to-Back Critically Dry Water Year Type Becomes Extreme Critically Dry Water Year Type) and the Storage and Minimum Pool Under the CDFG Recommendation Conditions.

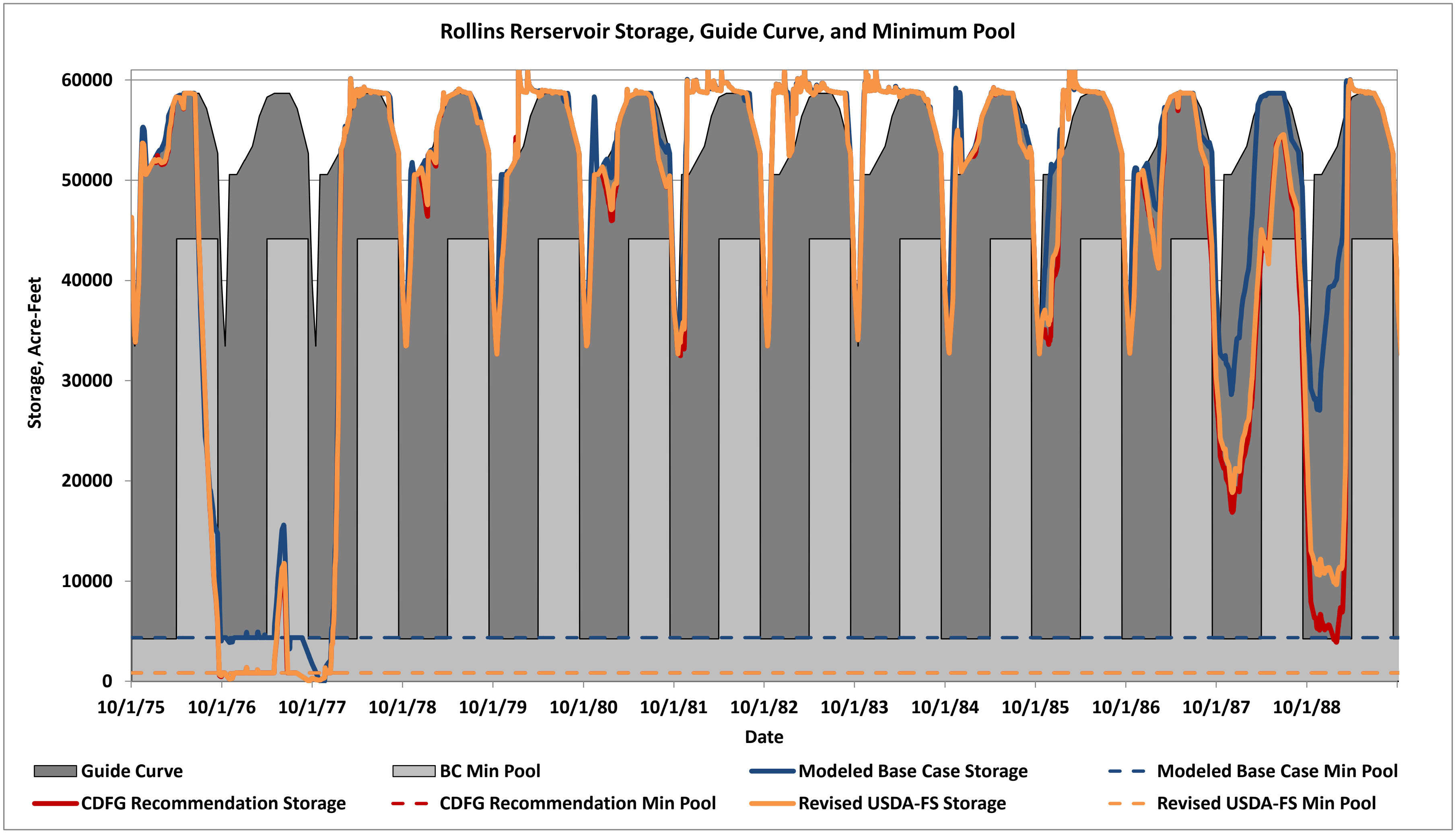
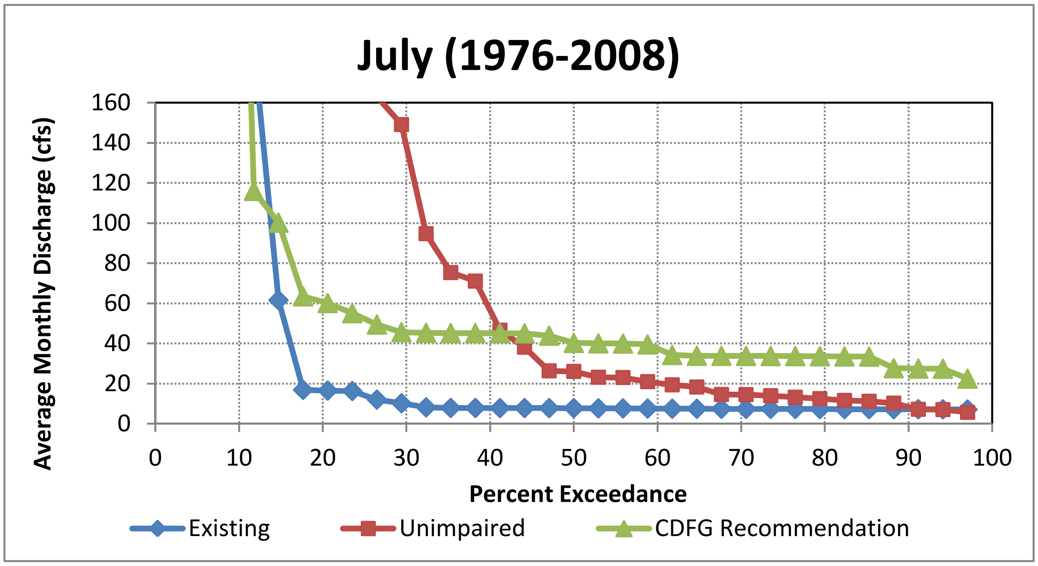
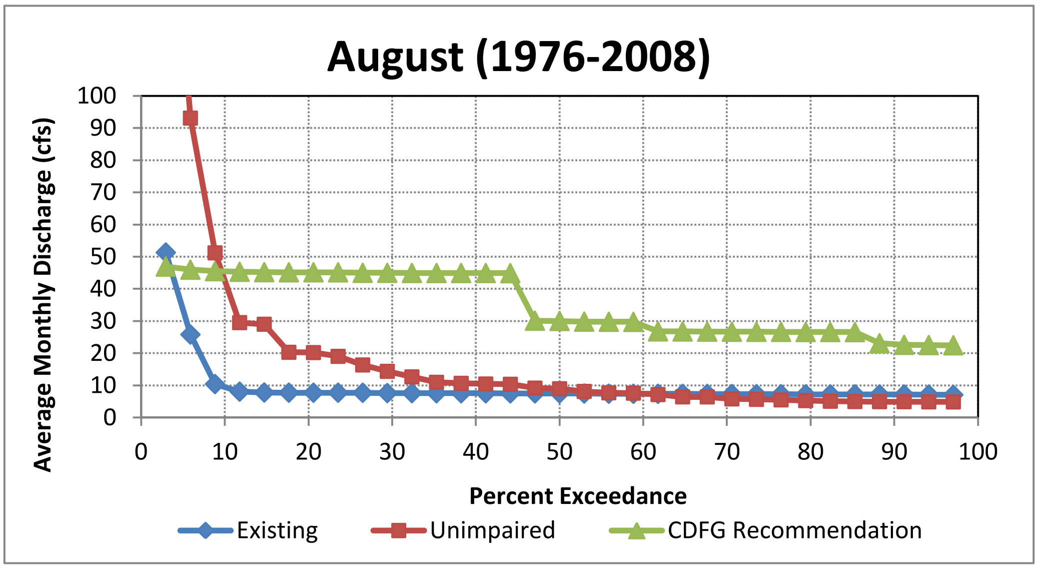


Figure 2a. South Yuba River at Langs Crossing Average July (top), August (middle), and September (bottom) Discharge.





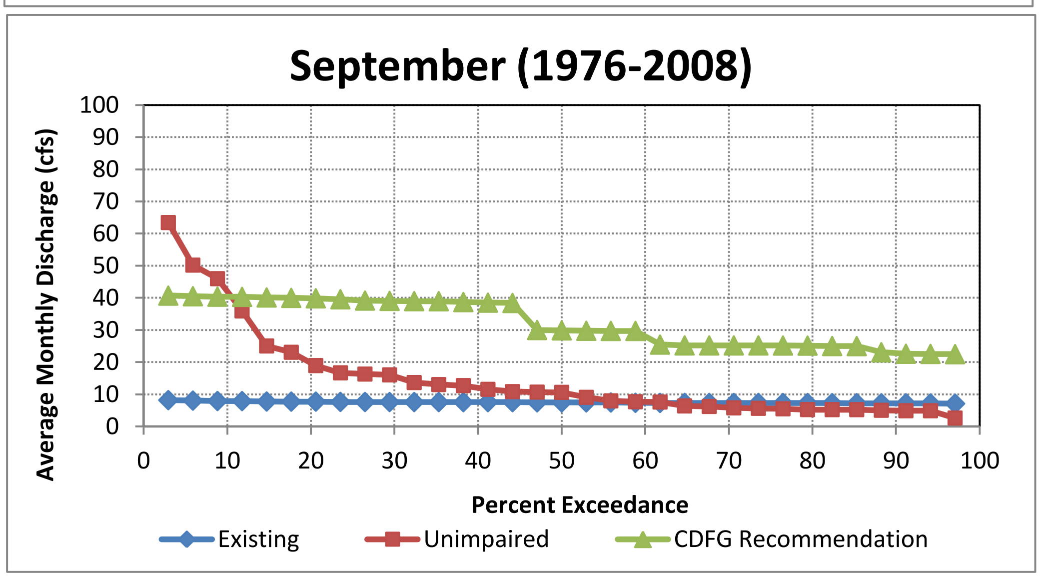
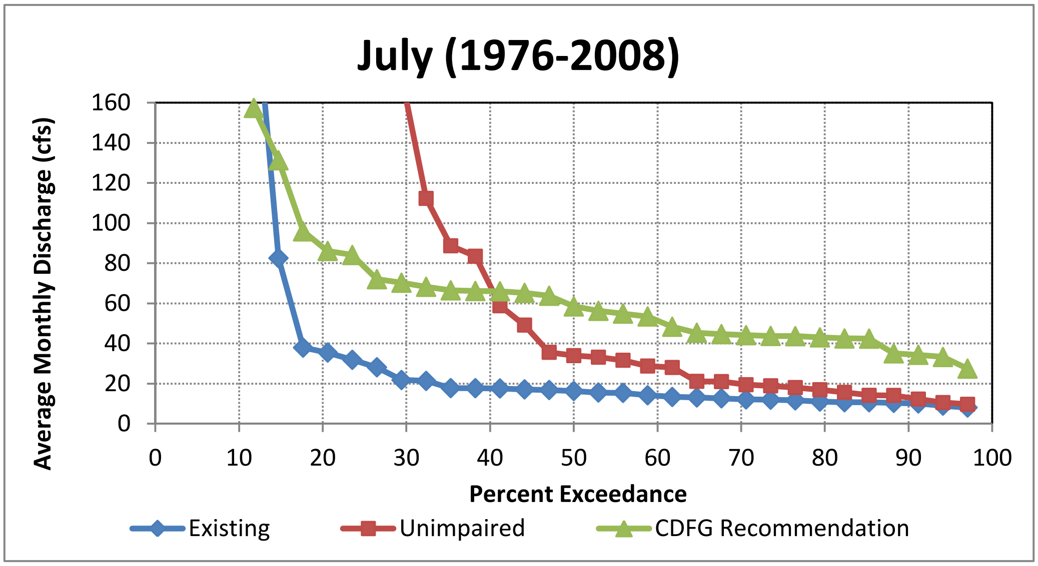
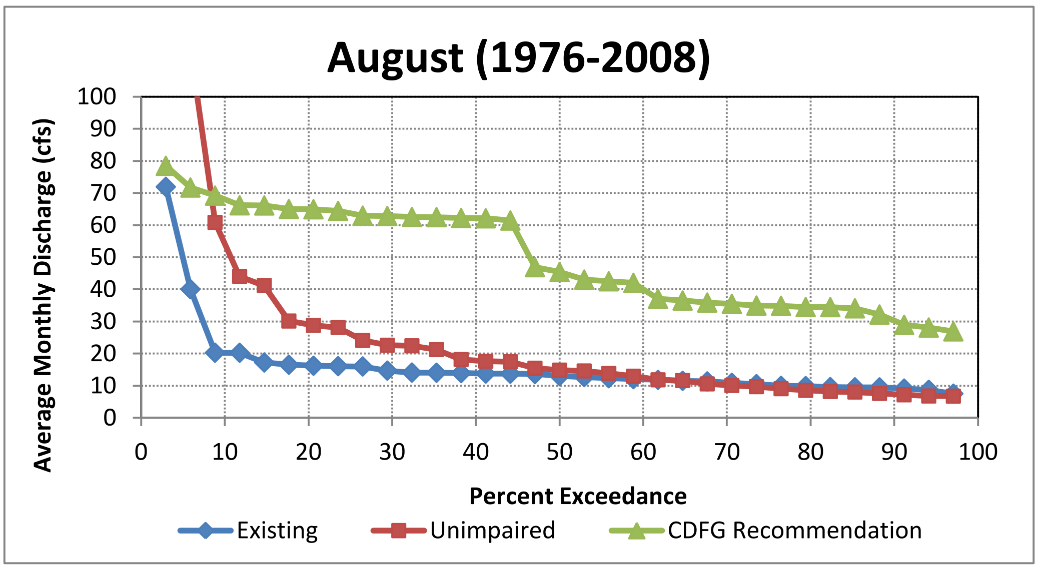


Figure 2b. South Yuba River Above Canyon Creek Average July (top), August (middle), and September (bottom) Discharge.





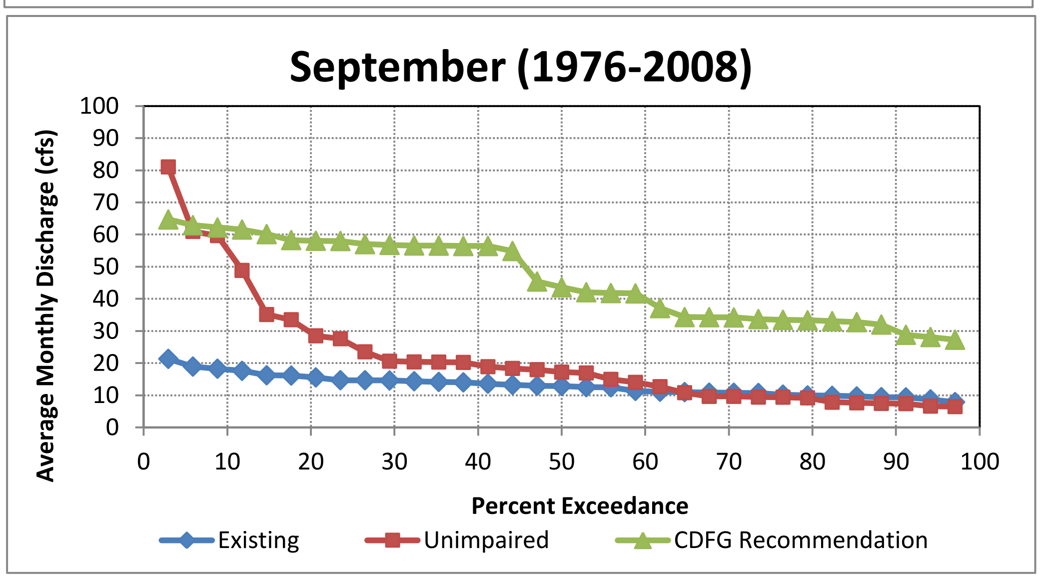
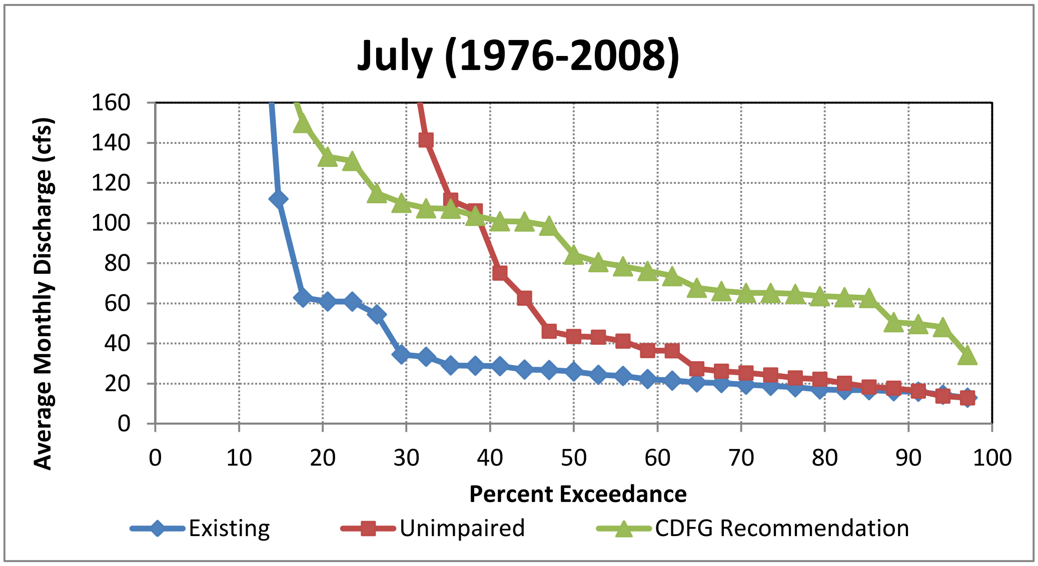
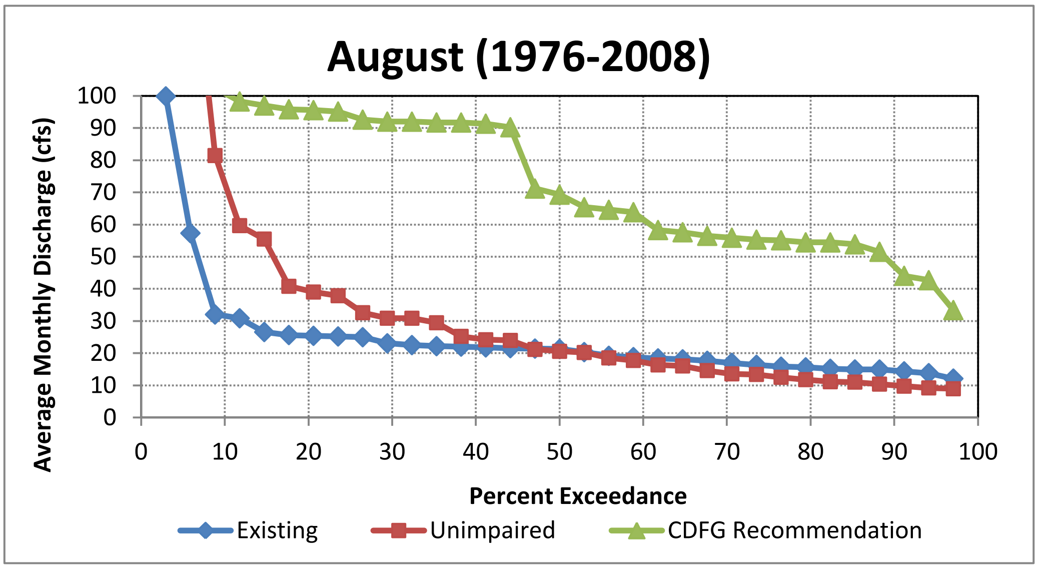


Figure 2c. South Yuba River Below Canyon Creek Average July (top), August (middle), and September (bottom) Discharge.





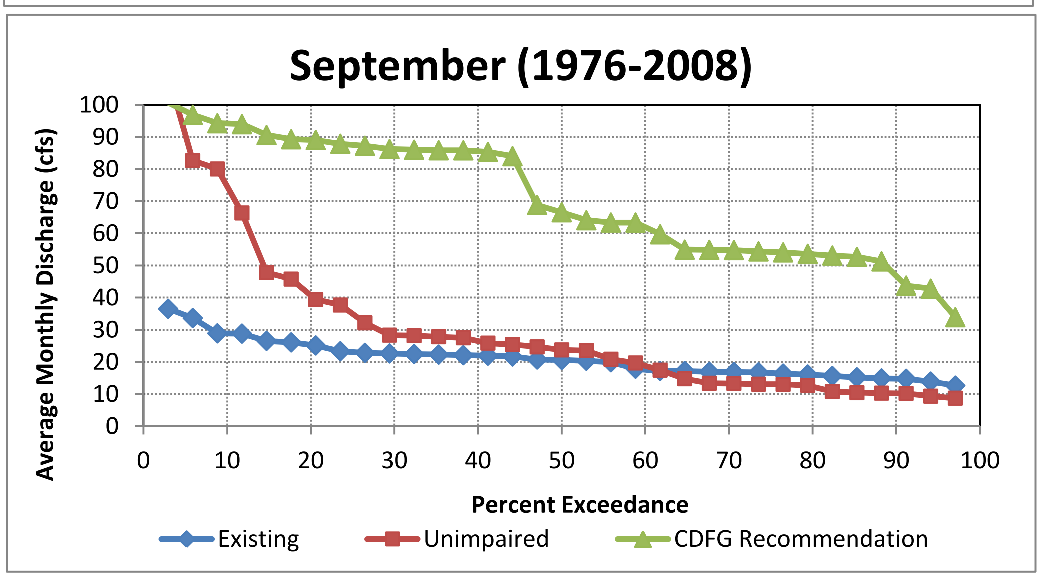
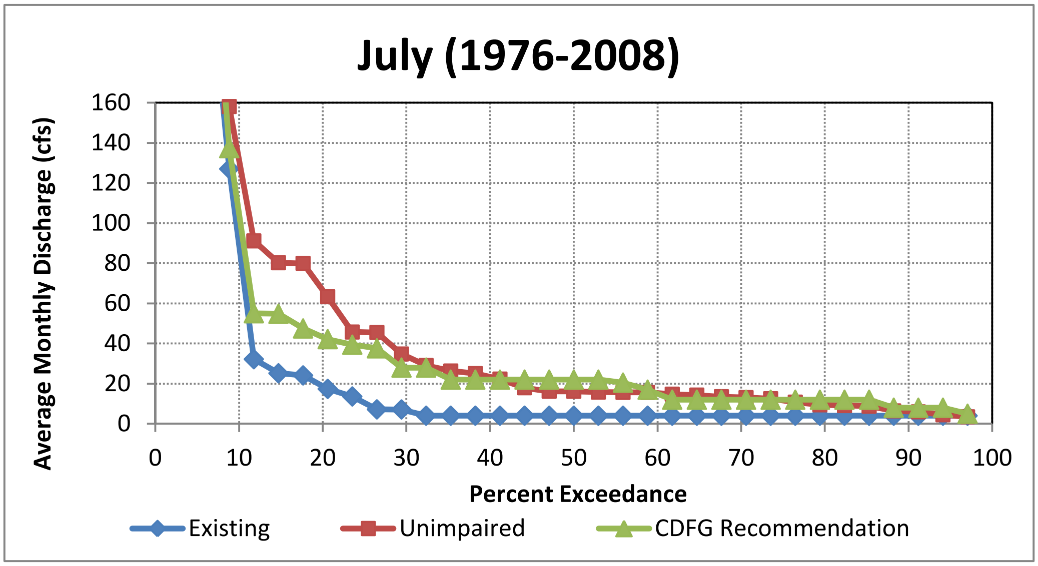
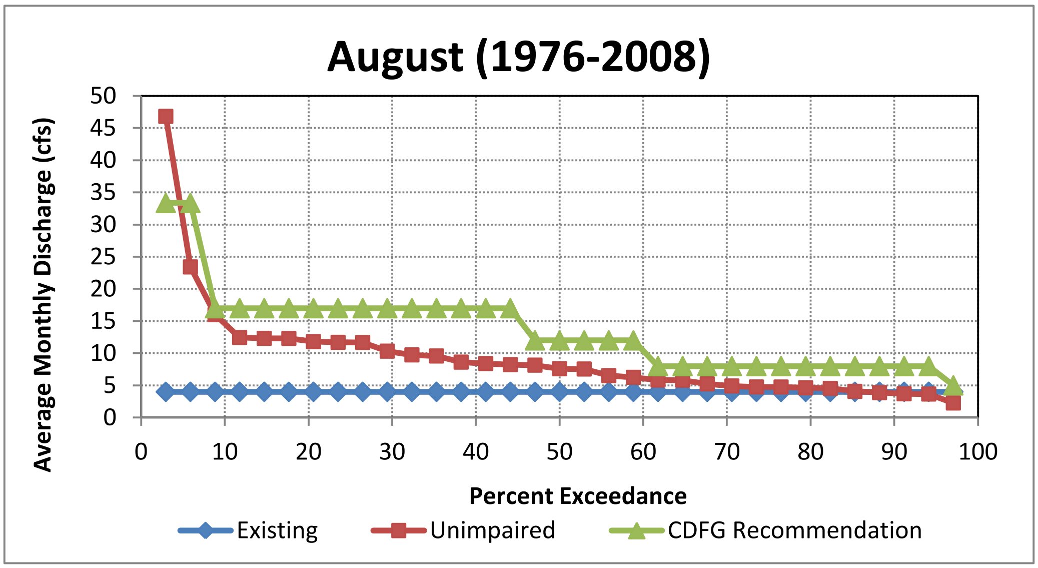


Figure 3a. Middle Yuba River Below Milton Diversion Dam Average July (top), August (middle), and September (bottom) Discharge.





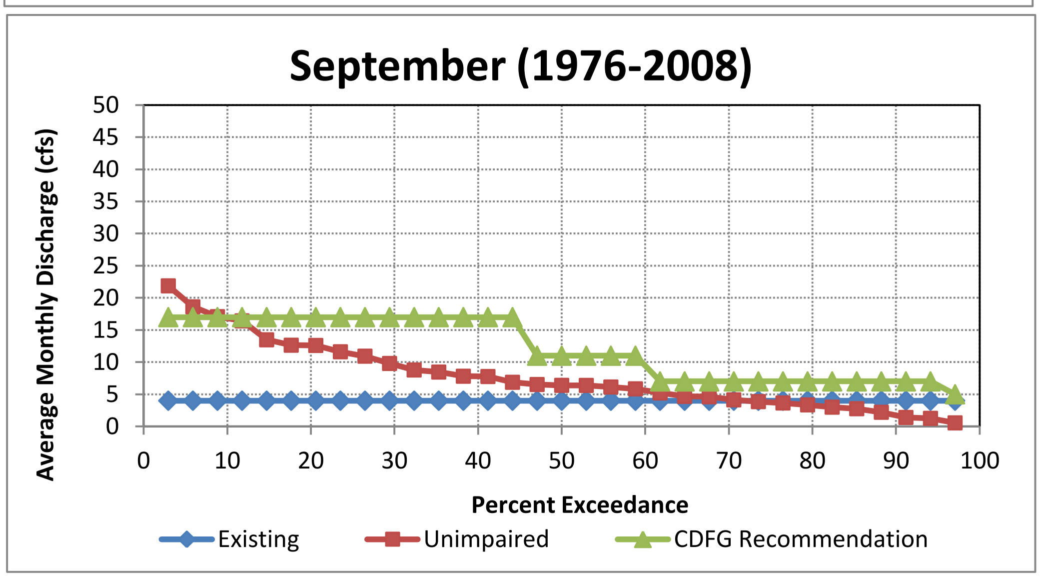
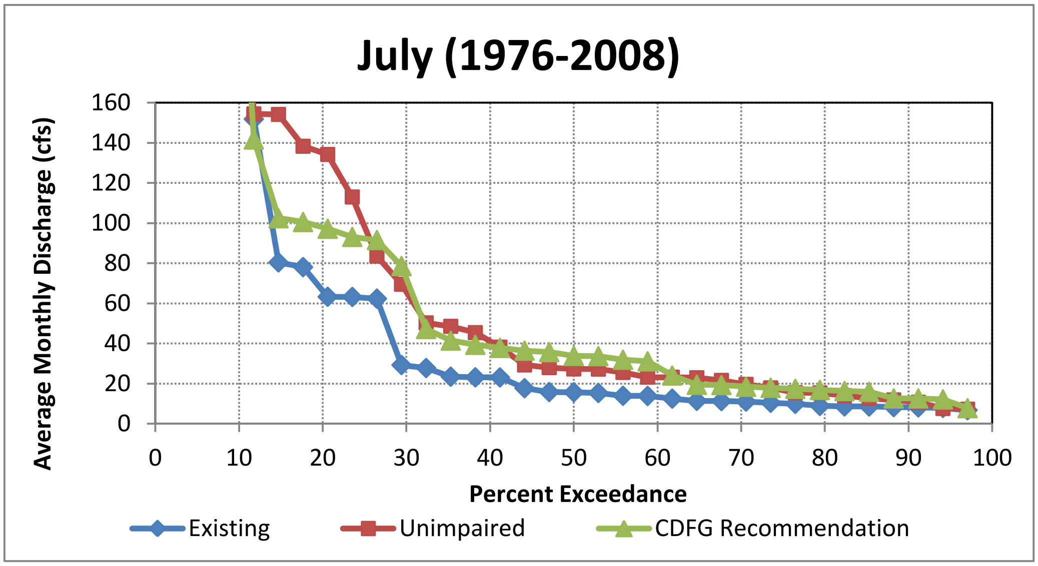
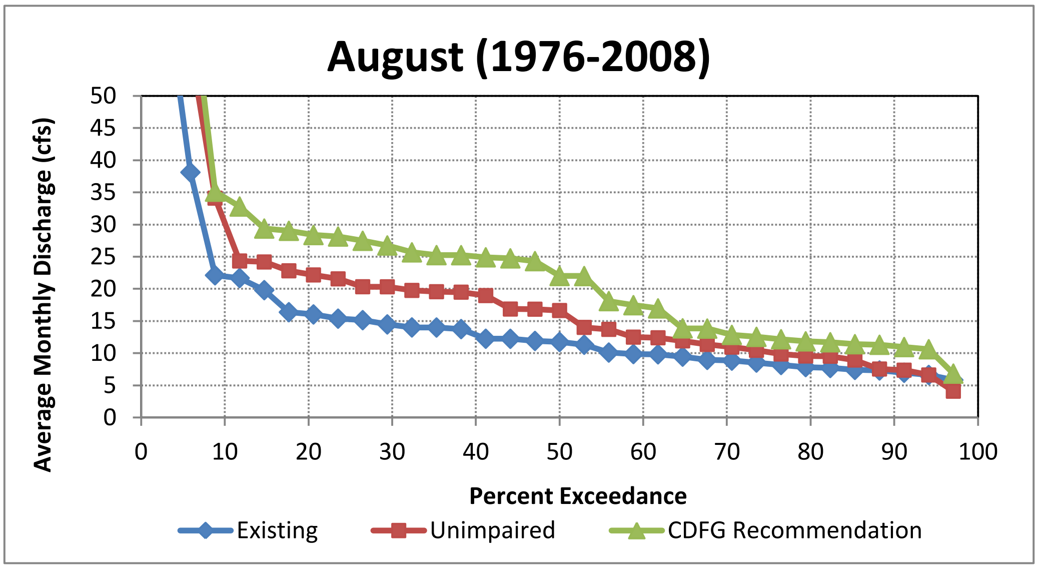


Figure 3b. Middle Yuba River Above Wolf Creek Average July (top), August (middle), and September (bottom) Discharge.





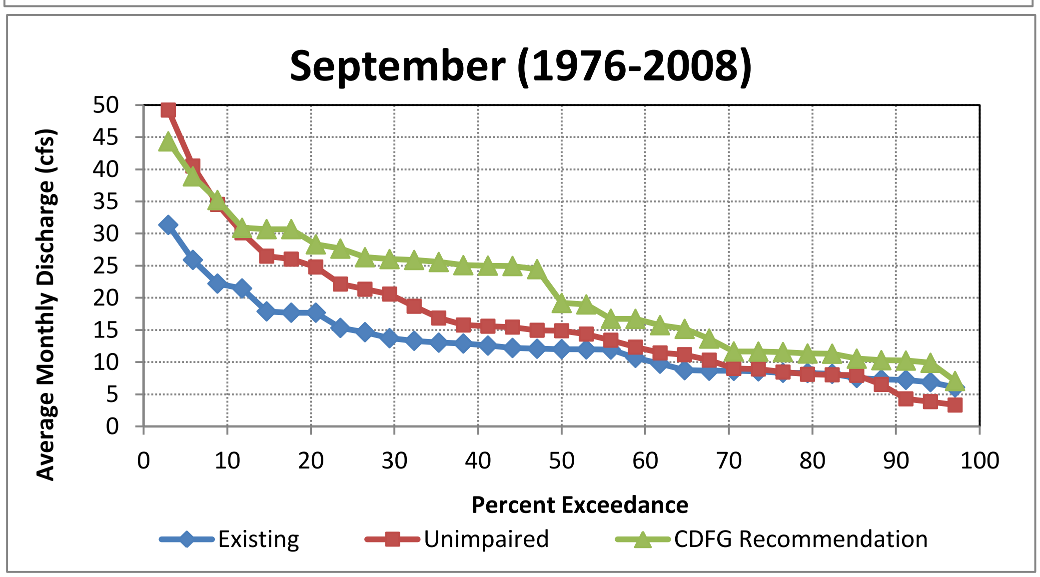
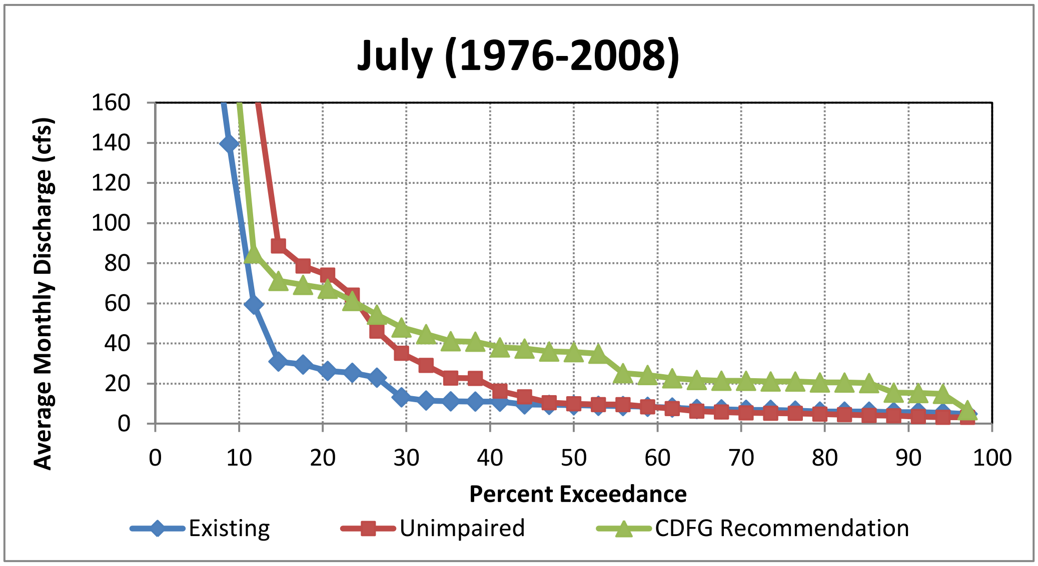
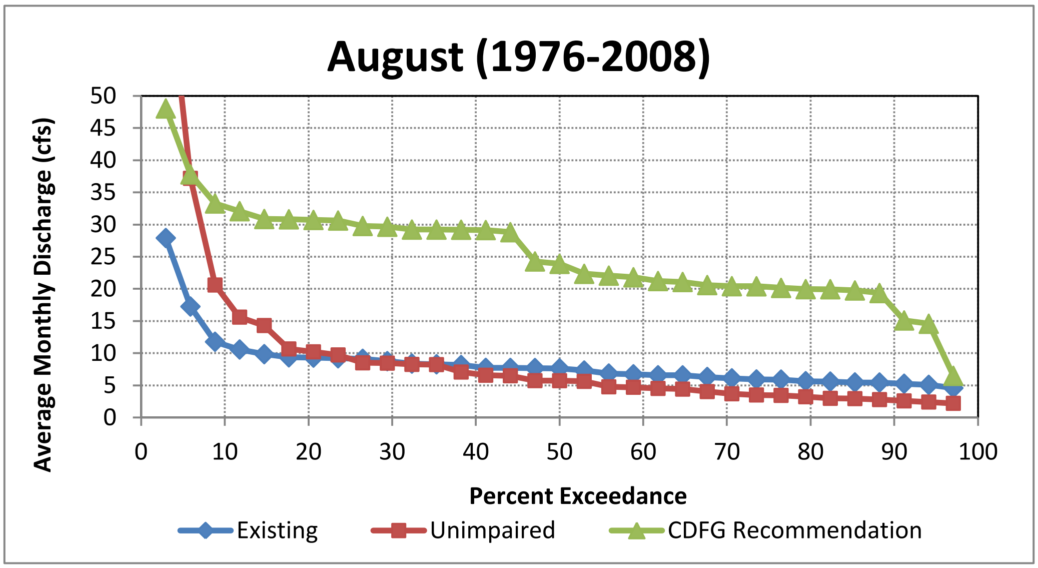


Figure 4. Canyon Creek at the South Yuba River Confluence Average July (top), August (middle), and September (bottom) Discharge.





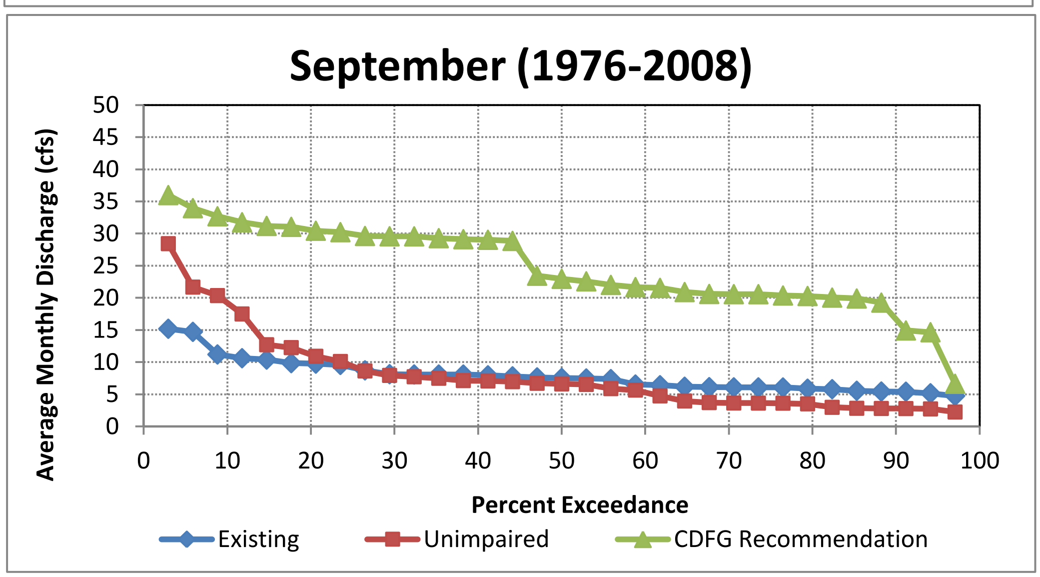


Figure 5. 2008 South Yuba River Unimpaired Flow and Water Temperature.

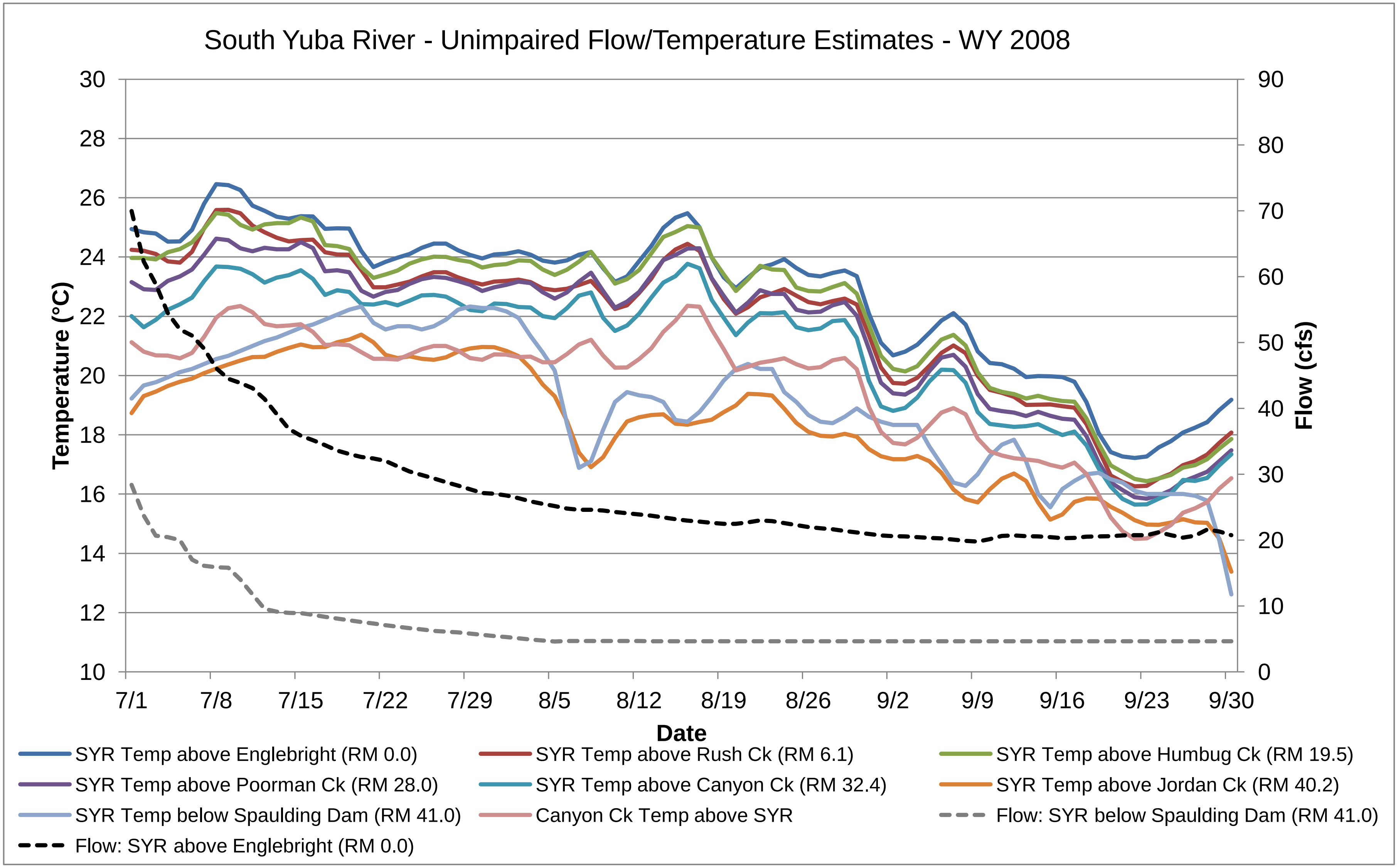


Figure 6a. 2008 South Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case, CDFG Recommendation, and Unimpaired Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog and Hardhead/Pikeminnow Habitat Under the CDFG Recommendation Flows.

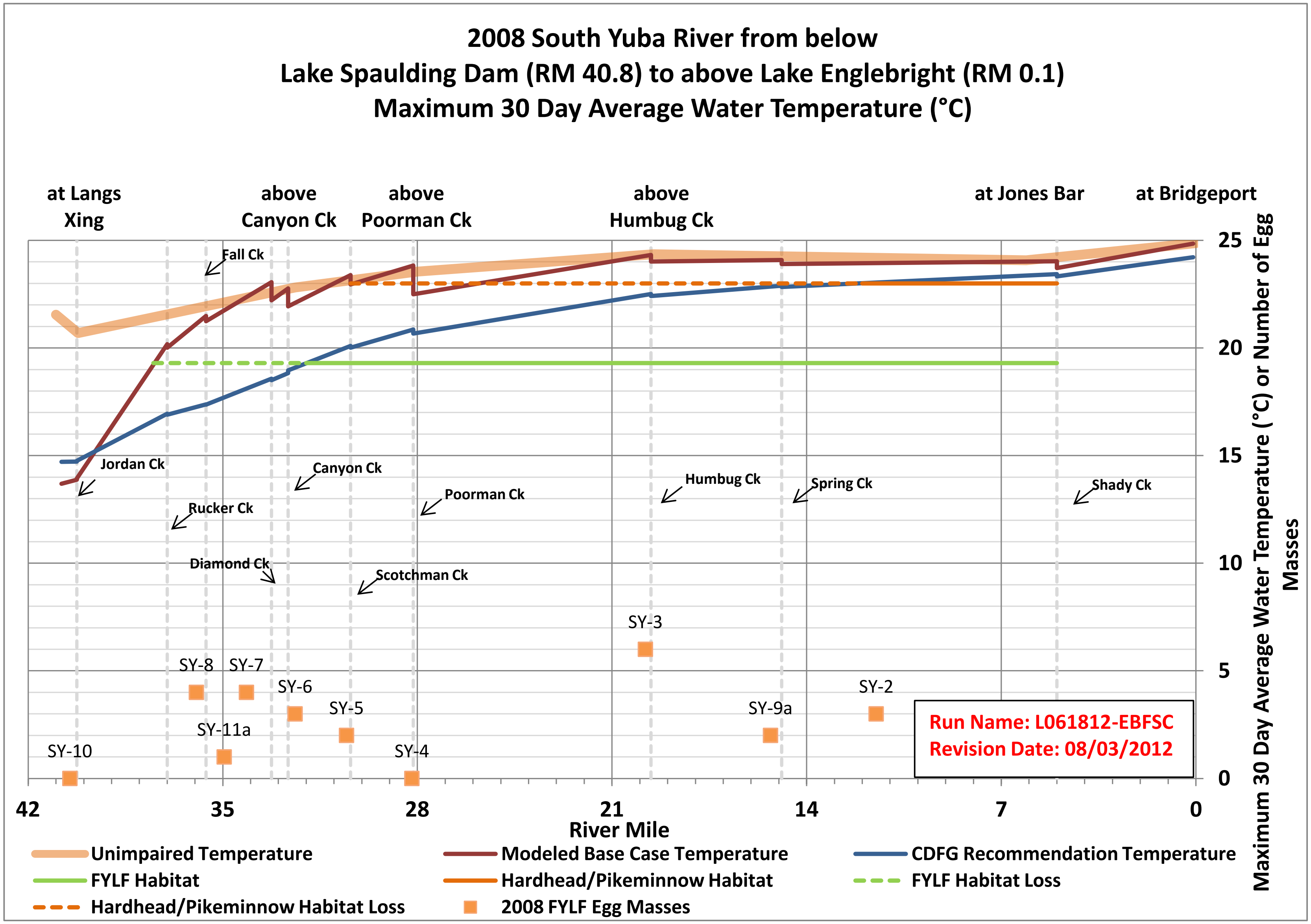


Figure 6b. 2009 South Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and CDFG Recommendation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog and Hardhead/Pikeminnow Habitat Under the CDFG Recommendation Flows.

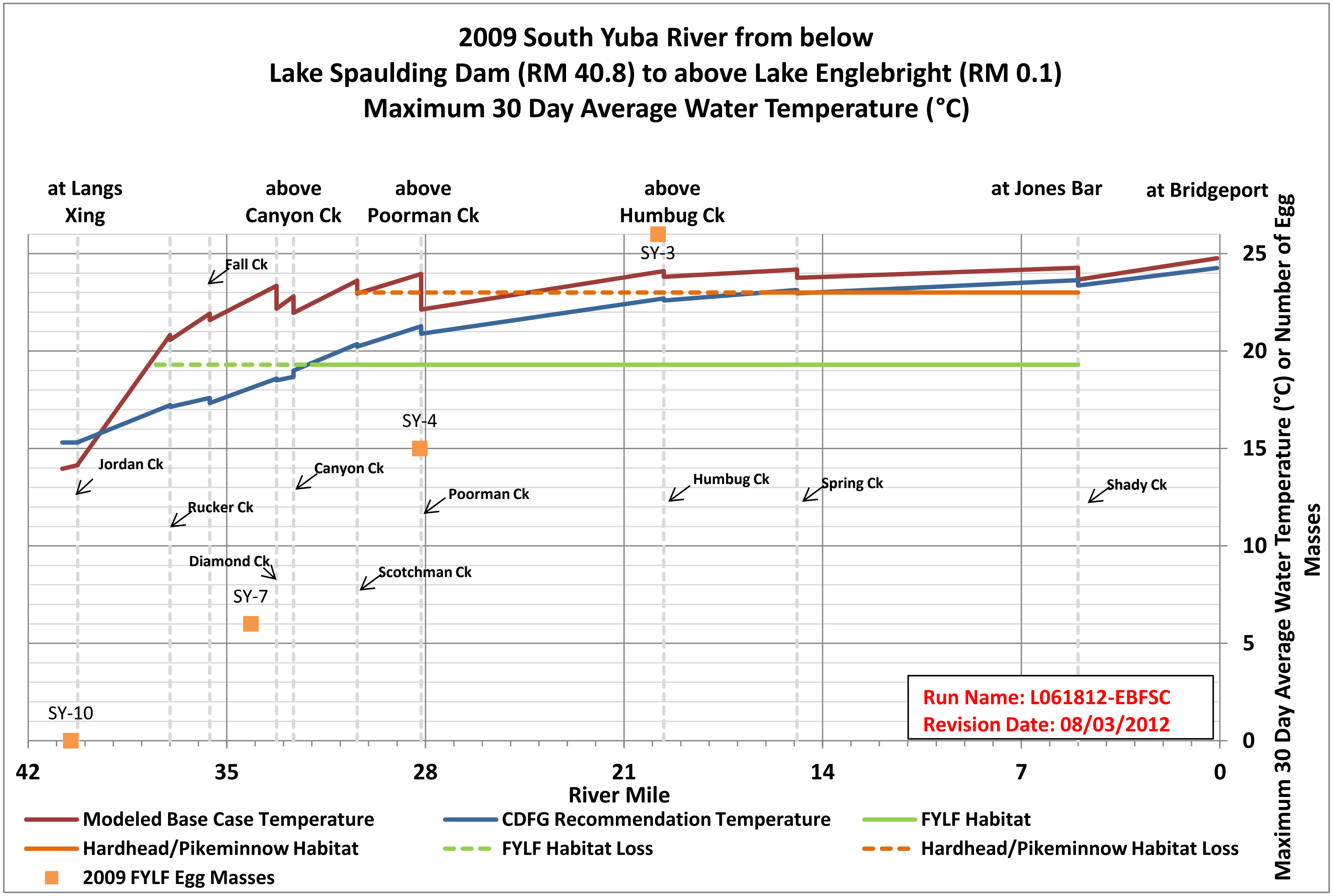
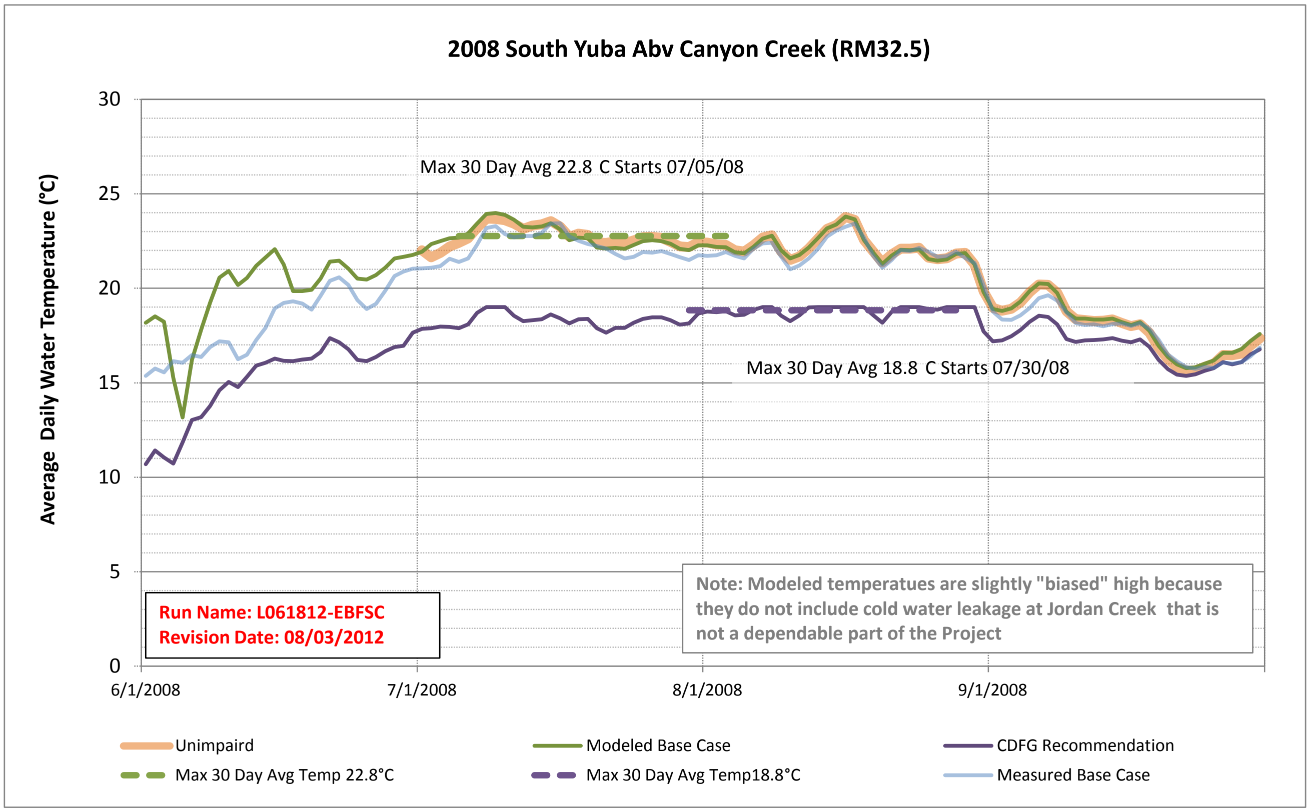


Figure 7a. 2008 South Yuba River Average Daily Water Temperature For Modeled Base Case, CDFG Recommendation, Measured Base Case, and Unimpaired Flows Above Canyon Creek (top) and Modeled Base Case and CDFG Recommendation Flows Above Fall Creek (bottom).



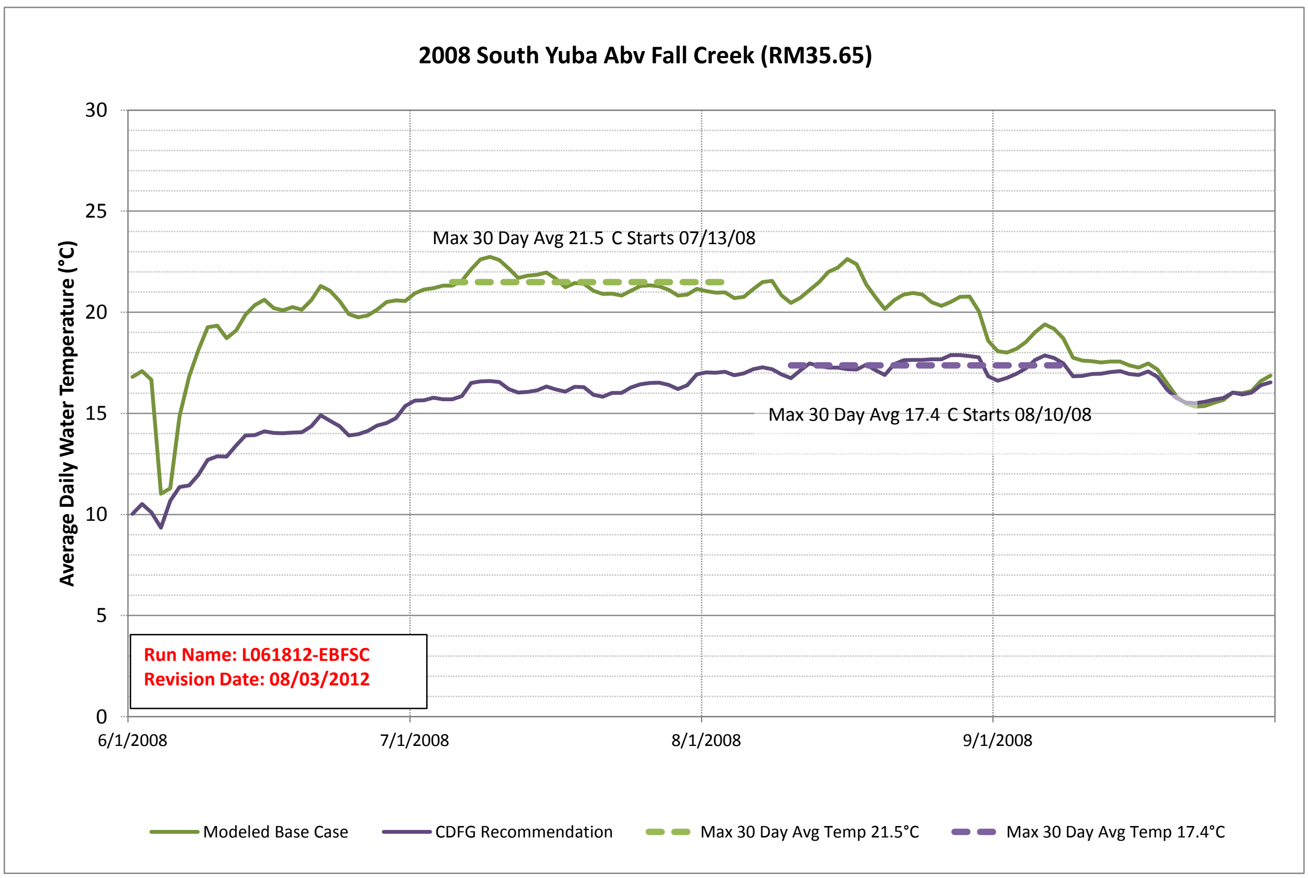
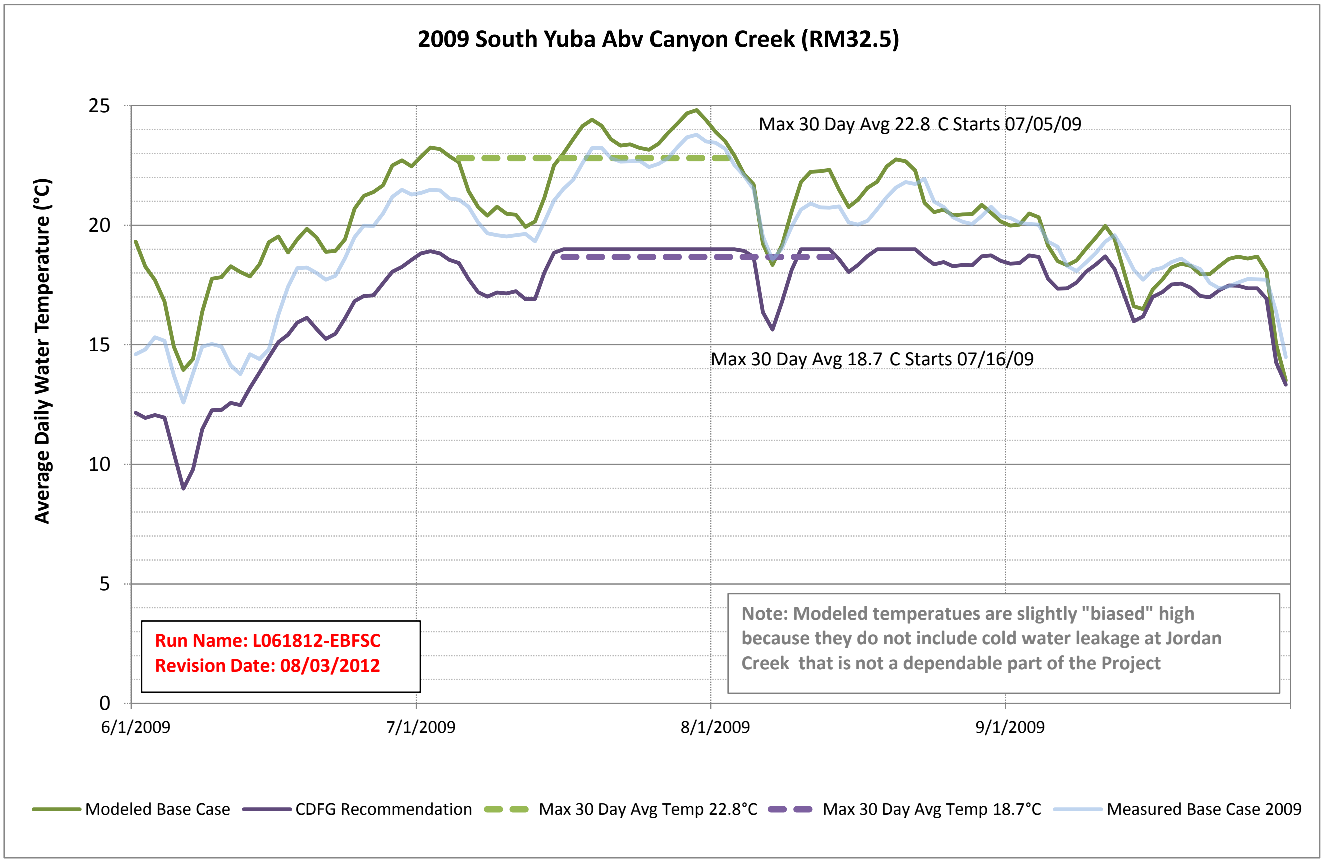


Figure 7b. 2009 South Yuba River Average Daily Water Temperature For Modeled Base Case, CDFG Recommendation, and Measured Base Case Flows Above Canyon Creek (top) and Modeled Base Case and CDFG Recommendation Flows Above Fall Creek (bottom).



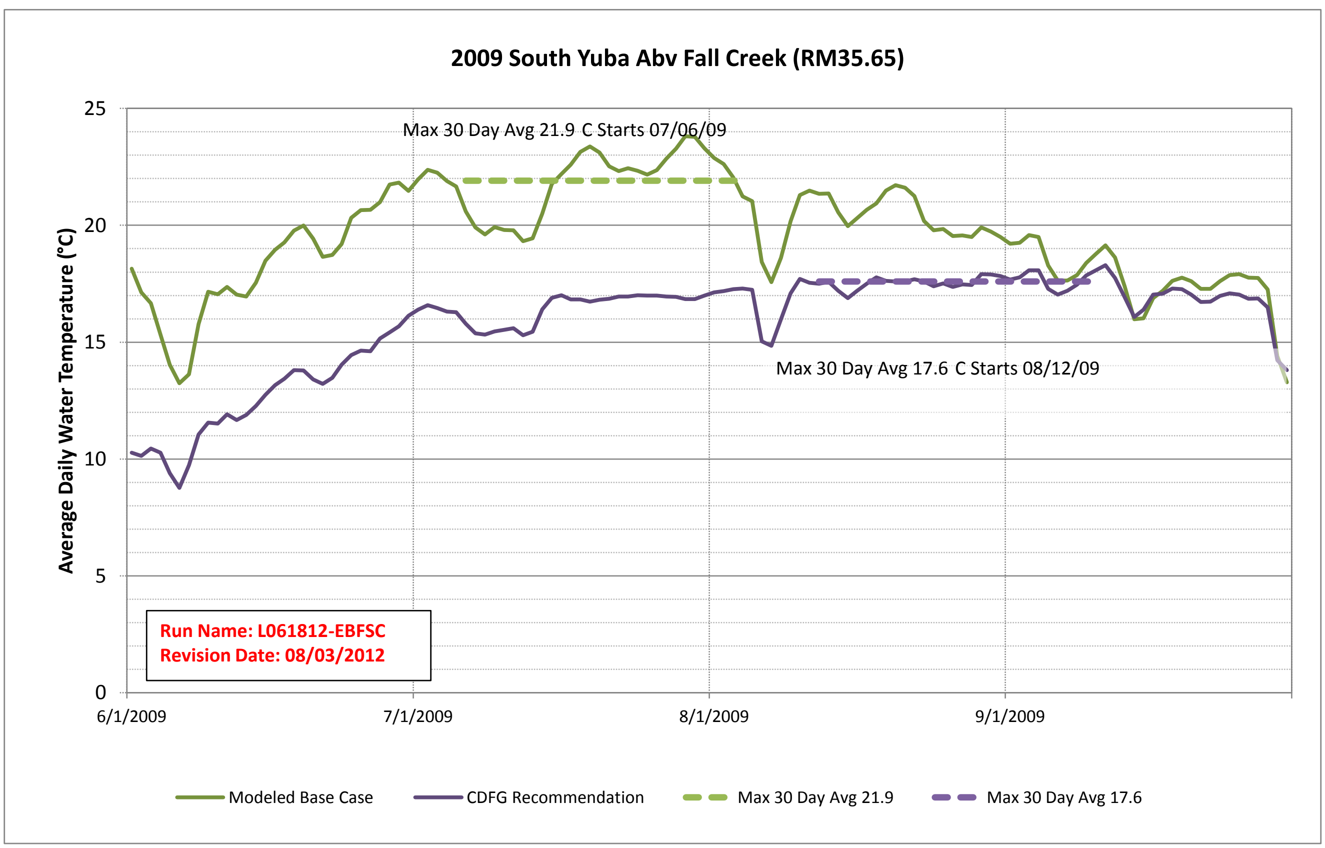


Figure 8a. Foothill Yellow-legged Frog Egg Mass Abundance and Maximum 30 Day Average Temperature.

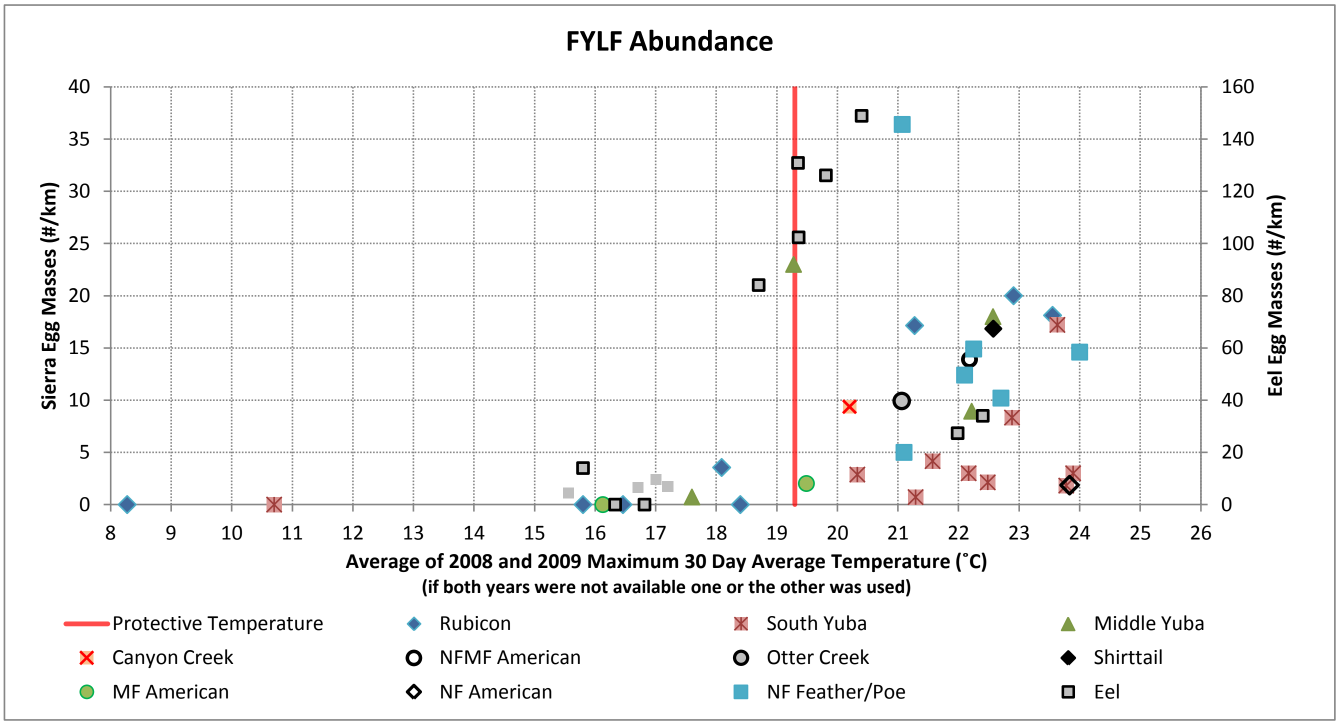


Figure 8b. Foothill Yellow-legged Frog Relative Egg Mass Abundance and Maximum 30 Day Average Temperature.

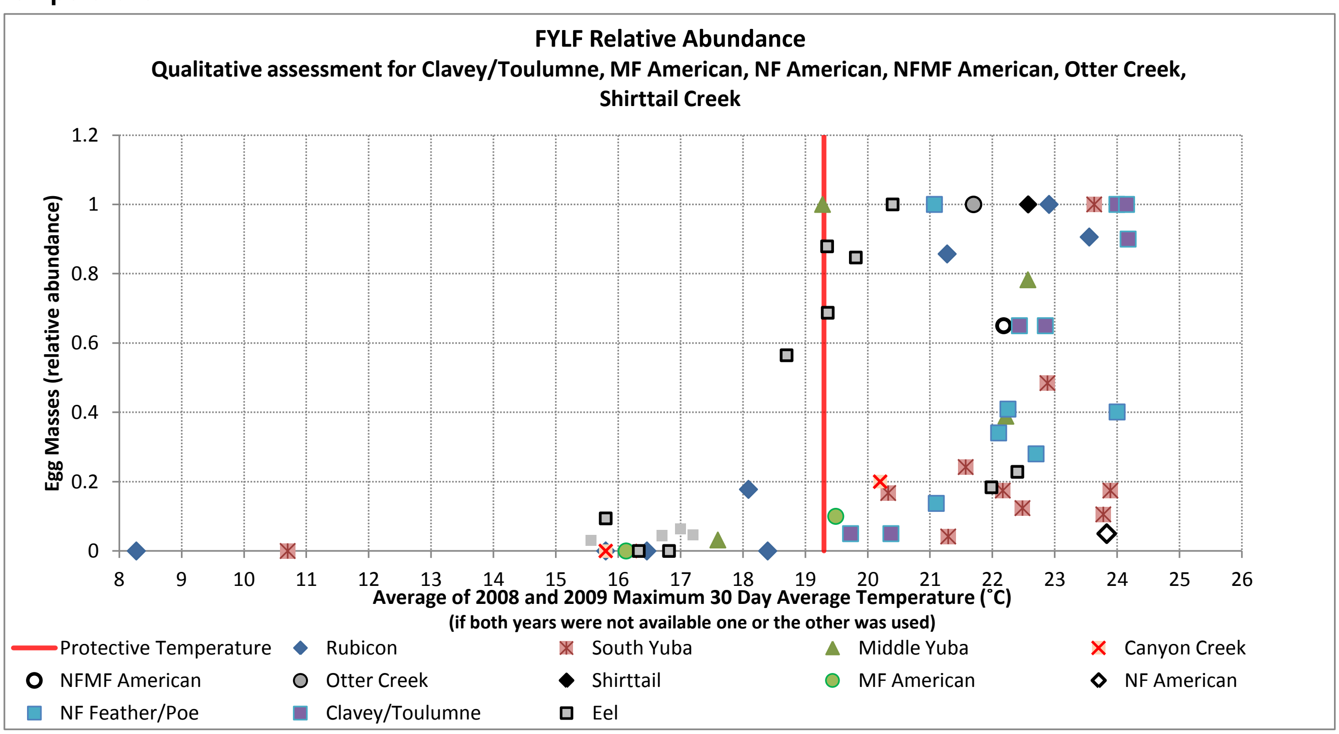


Figure 9a. 2008 Canyon Creek Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and CDFG Recommendation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog Habitat Under the CDFG Recommendation Flows.

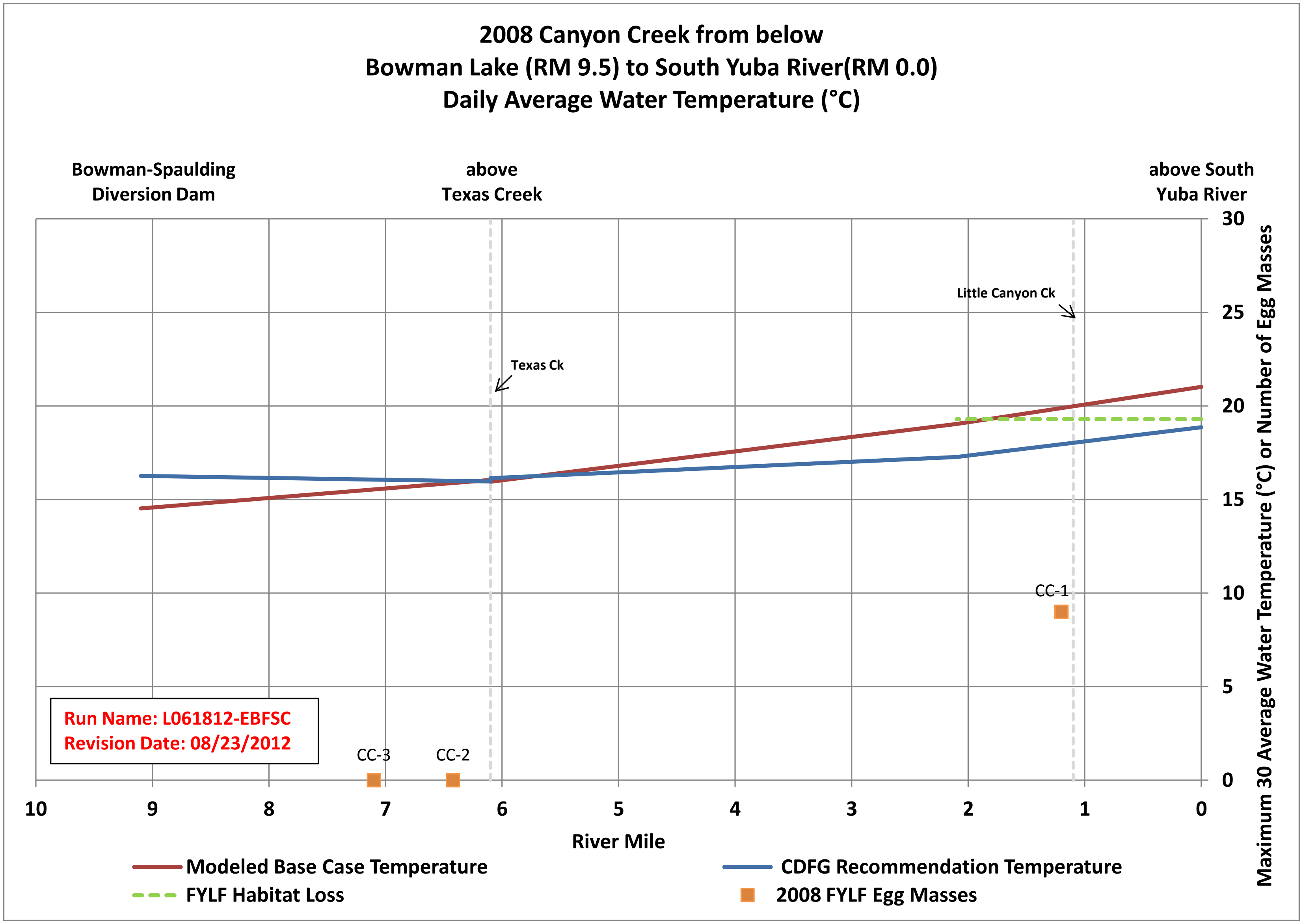


Figure 9b. 2009 Canyon Creek Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and CDFG Recommendation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog Habitat Under the CDFG Recommendation Flows.

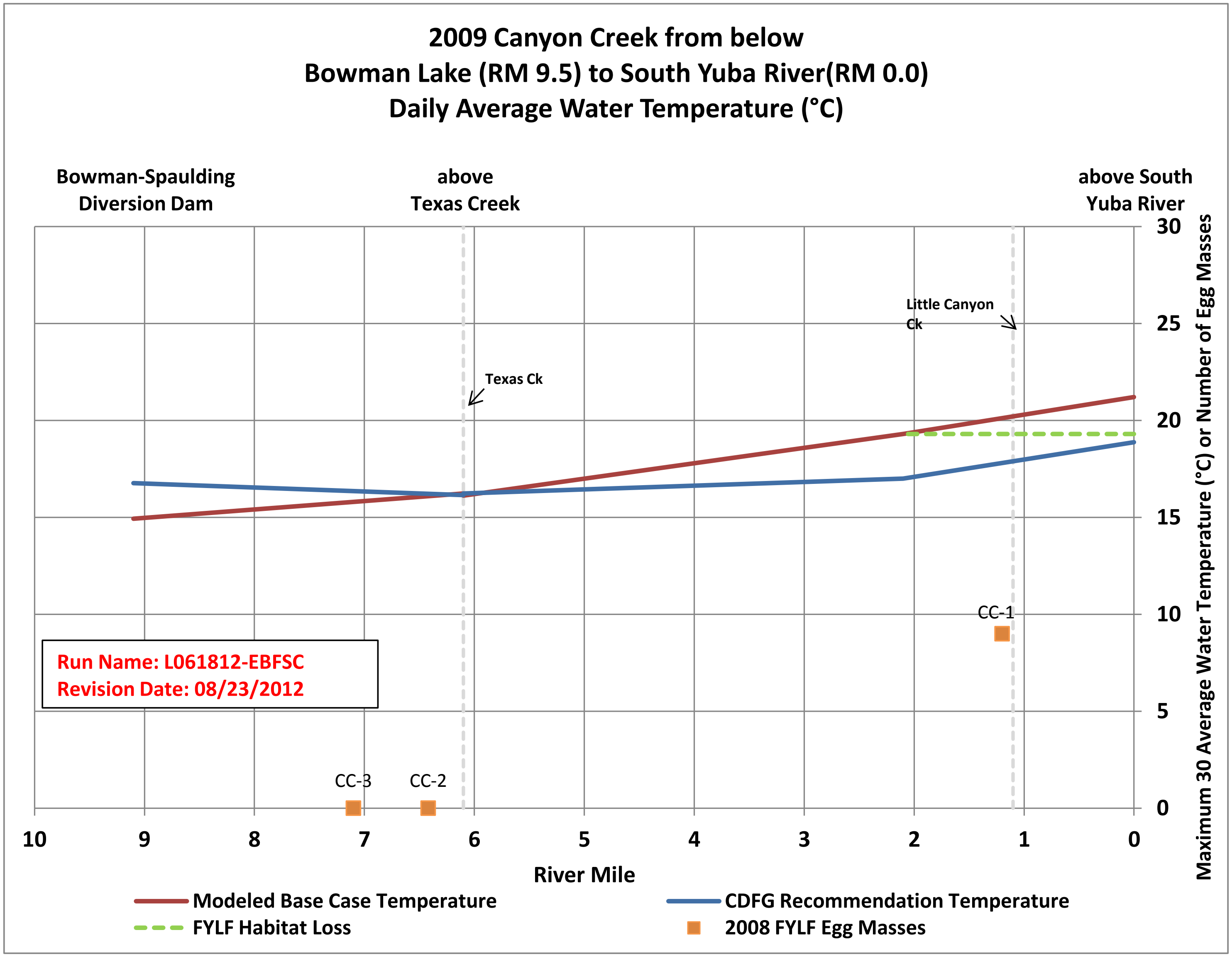


Figure 10a. 2008 Middle Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and CDFG Recommedation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog Habitat Under the CDFG Recommendation Flows.

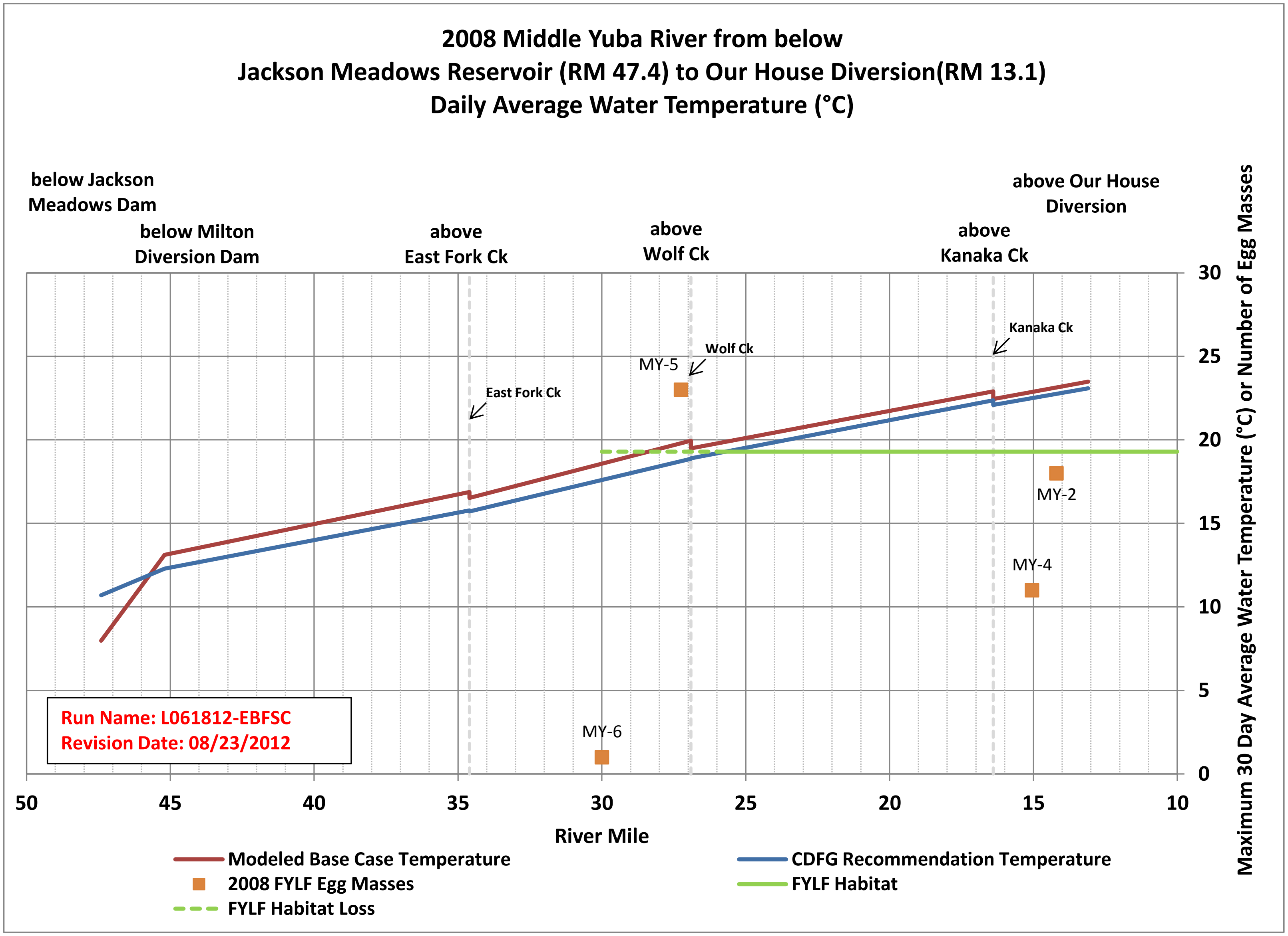


Figure 10b. 2009 Middle Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and CDFG Recommendation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog Habitat Under the CDFG Recommendation Flows.

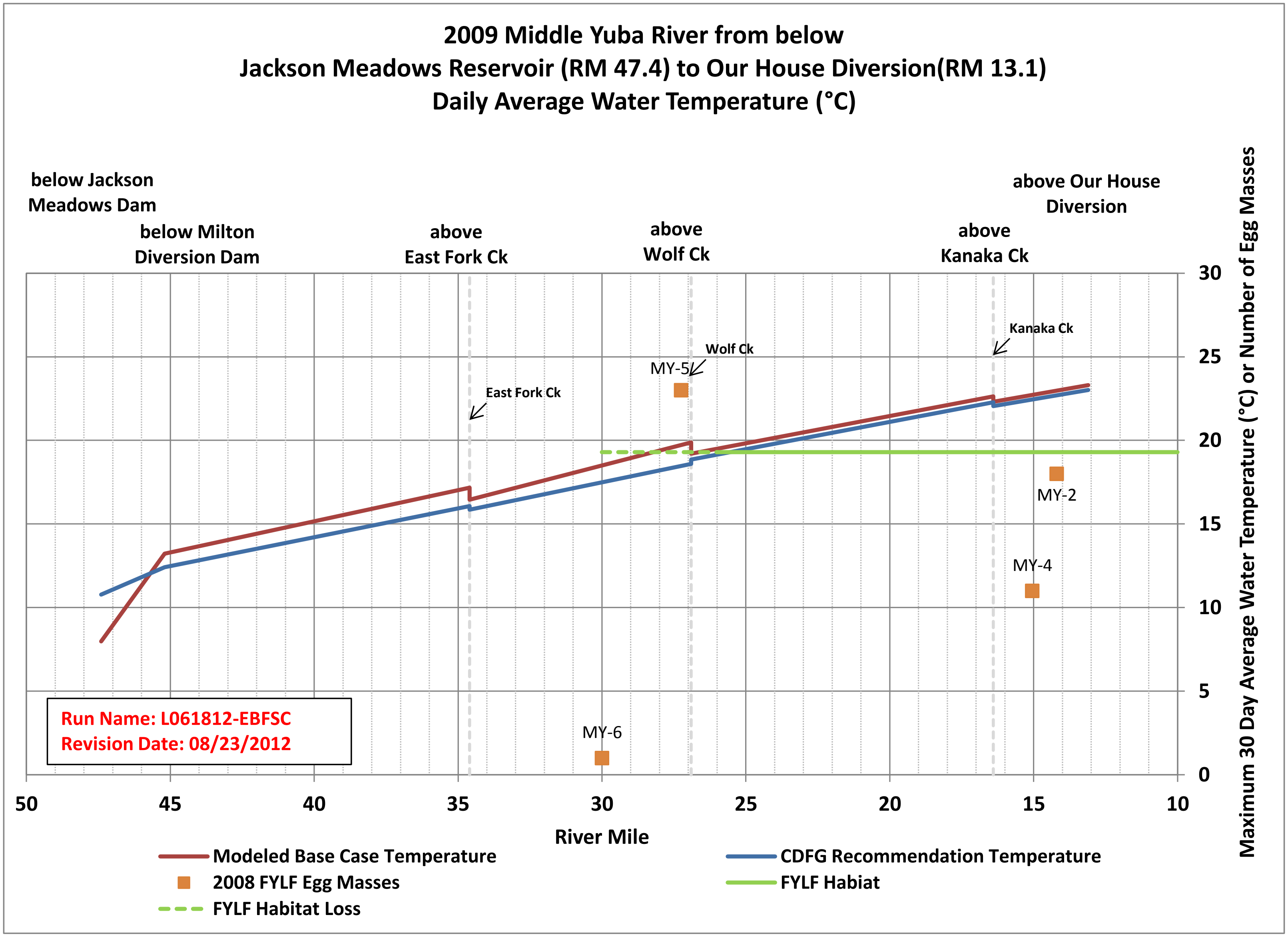
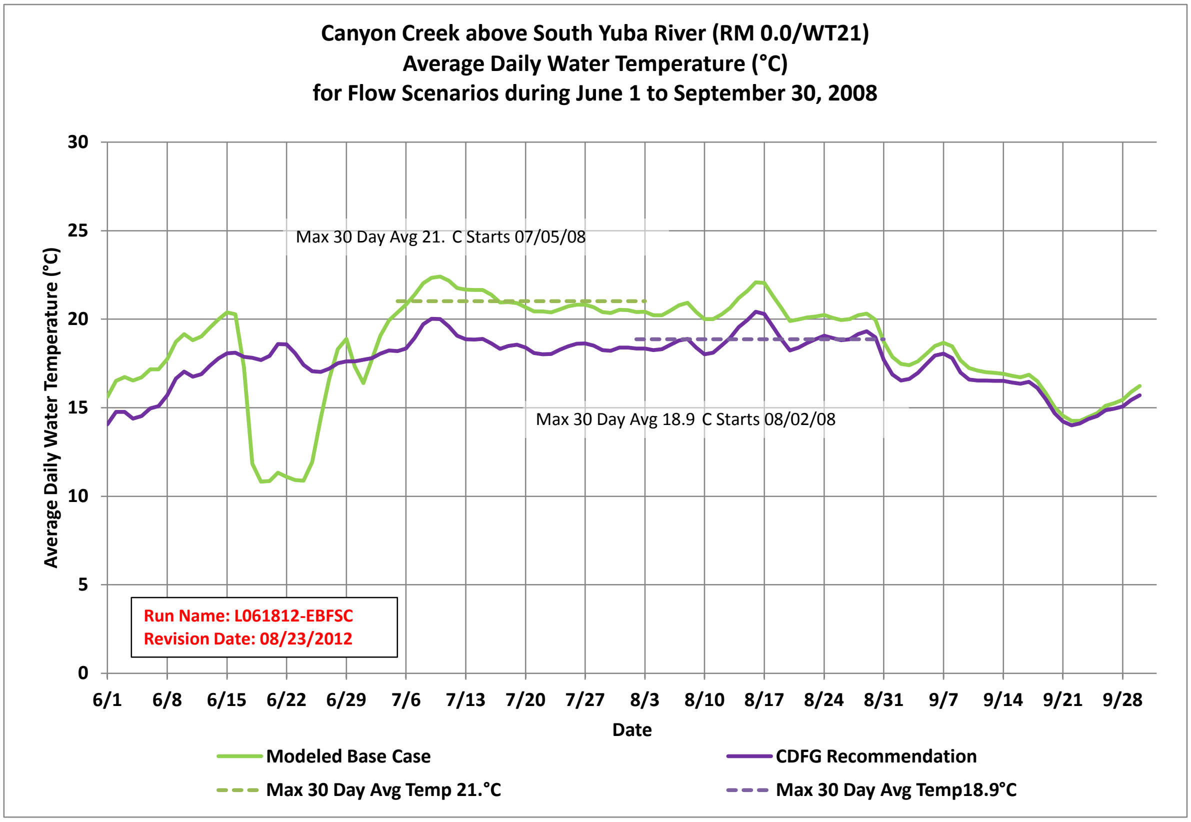


Figure 11a. 2008 Canyon Creek Average Daily Water Temperature For Modeled Base Case and CDFG Recommendation Flows Above the South Yuba River (top) and Above Little Canyon Creek (bottom).



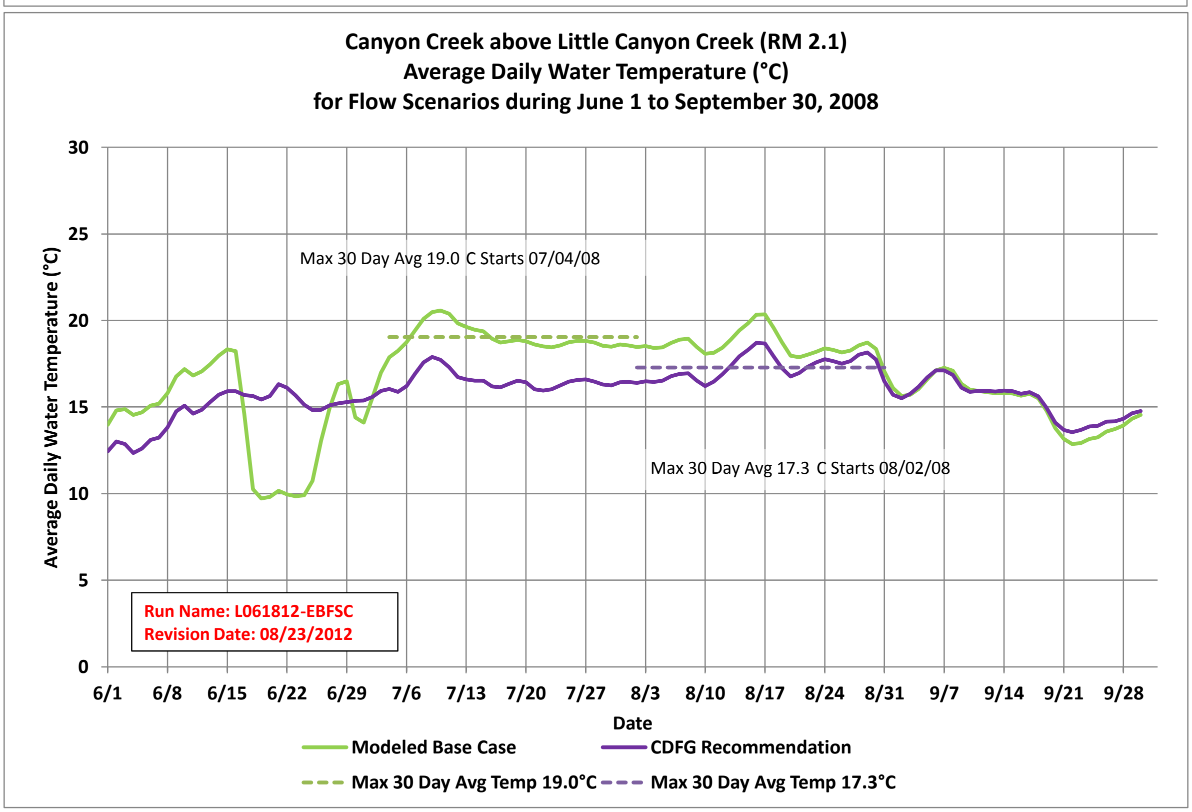
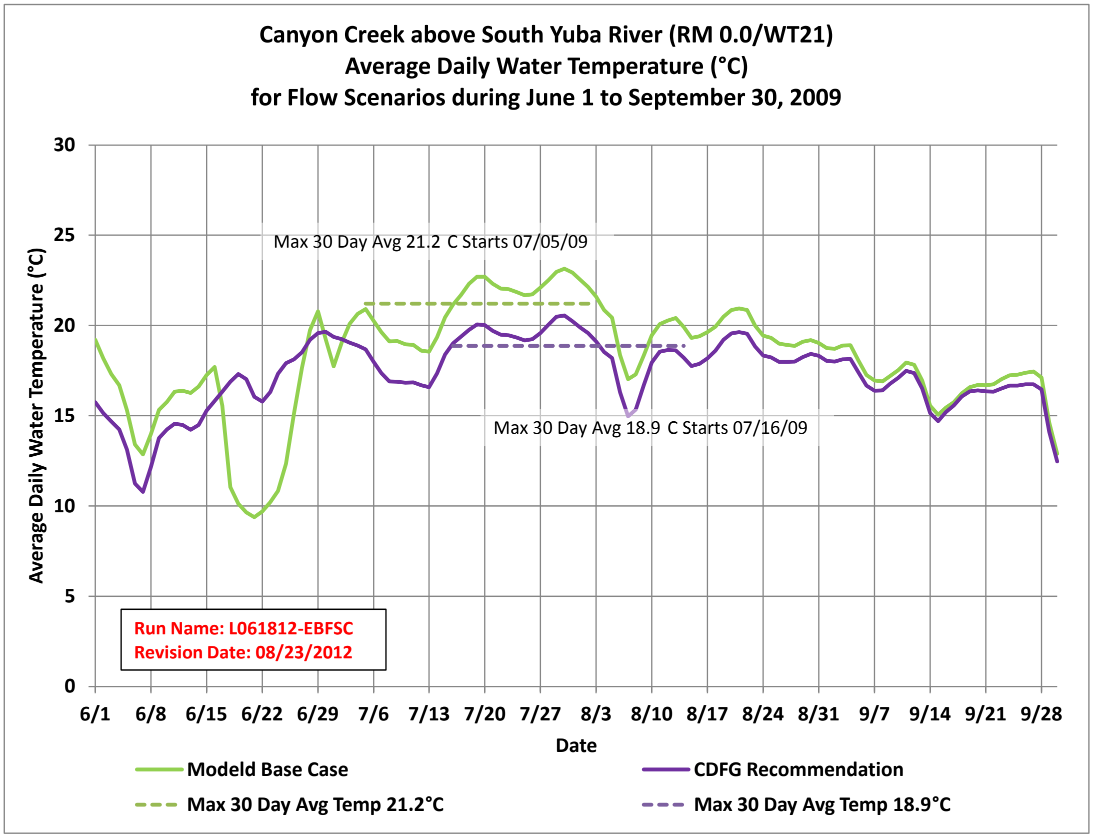


Figure 11b. 2009 Canyon Creek Average Daily Water Temperature For Modeled Base Case and CDFG Recommendation Flows Above the South Yuba River (top) and Above Little Canyon Creek (bottom).



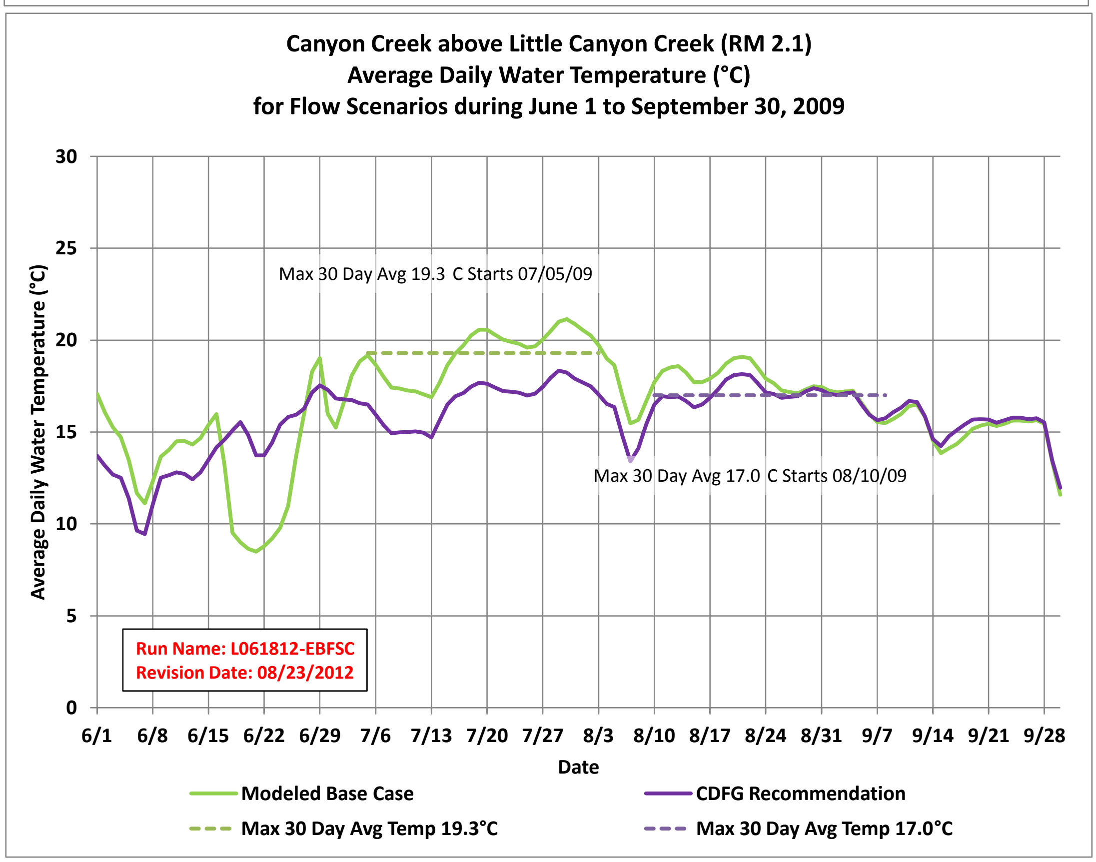


Figure 12a. 2008 Middle Yuba River Average Daily Water Temperature For Modeled Base Case, CDFG Recommendation, and Measured Base Case Flows Above Wolf Creek.

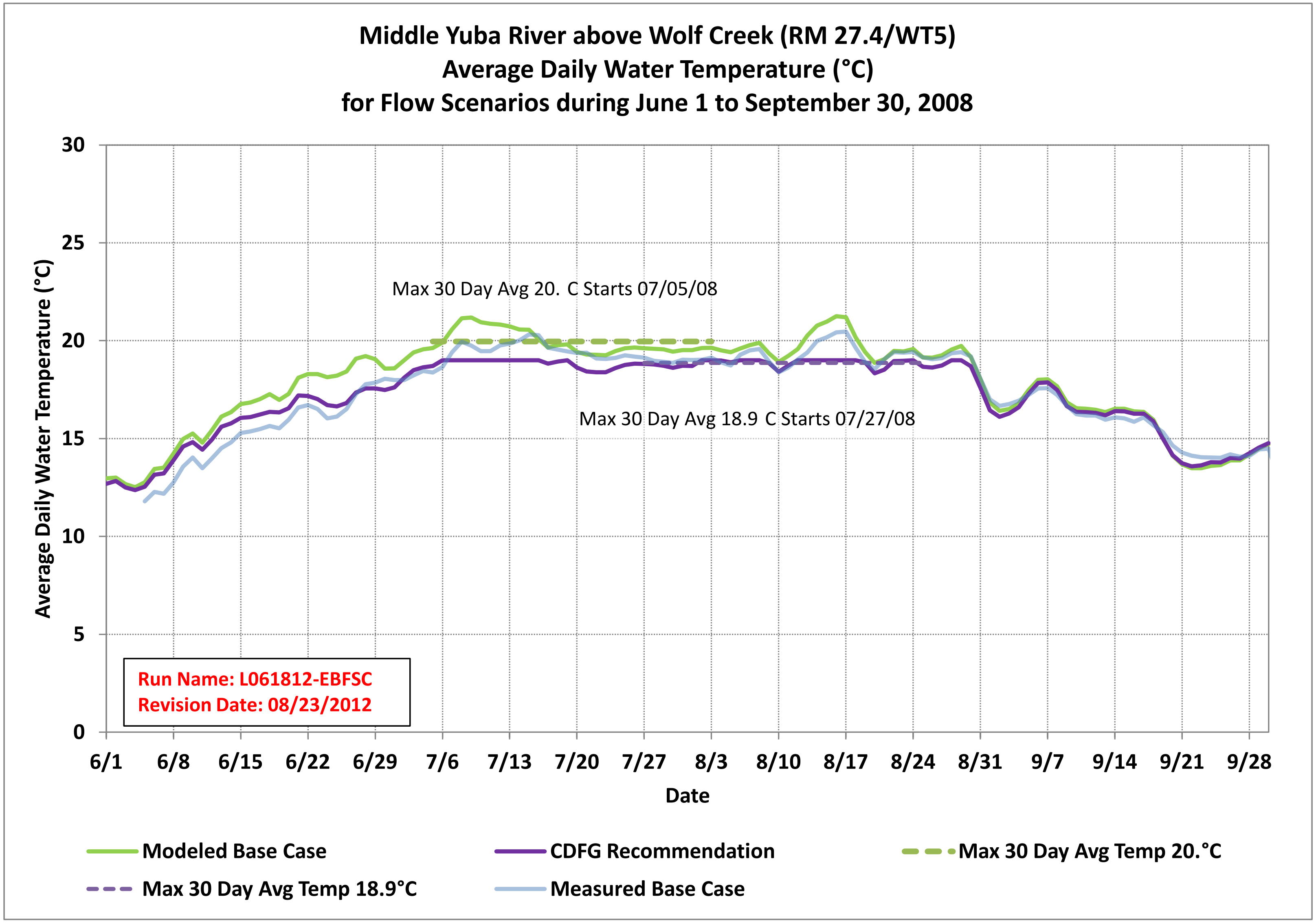
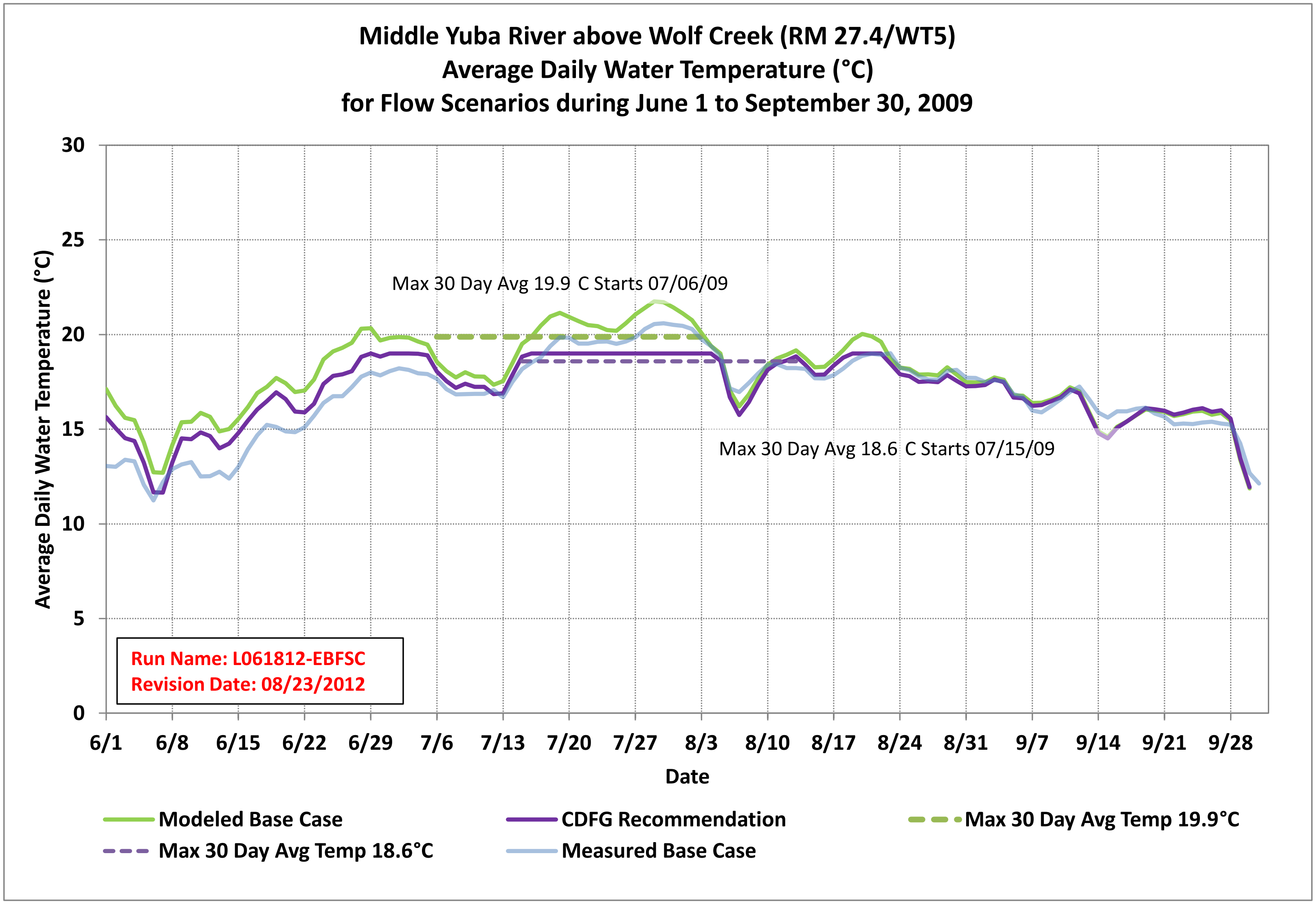
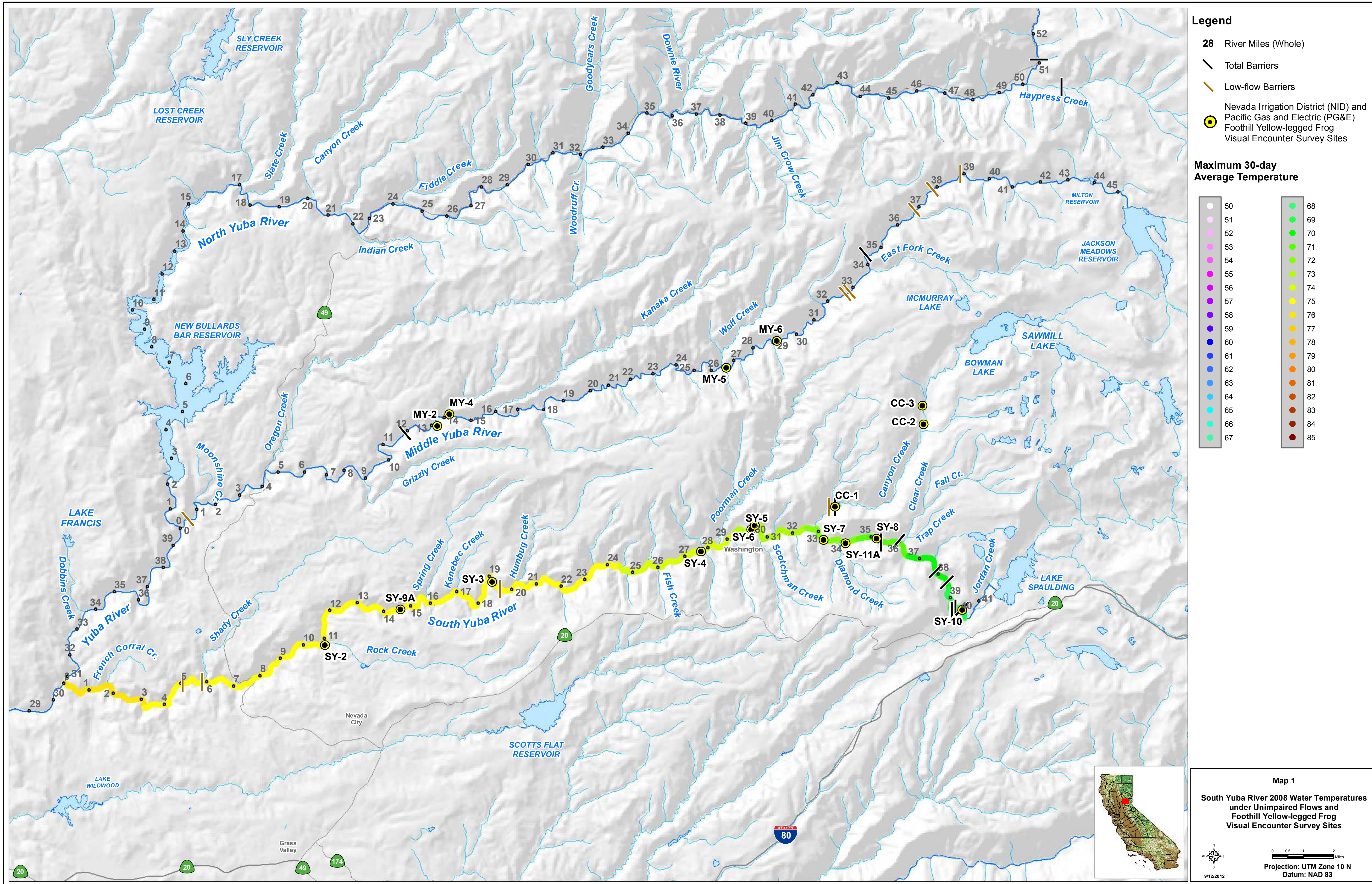


Figure 12b. 2009 Middle Yuba River Average Daily Water Temperature for Modeled Base Case, CDFG Recommendation and Measured Flows Above Wolf Creek.



Maps



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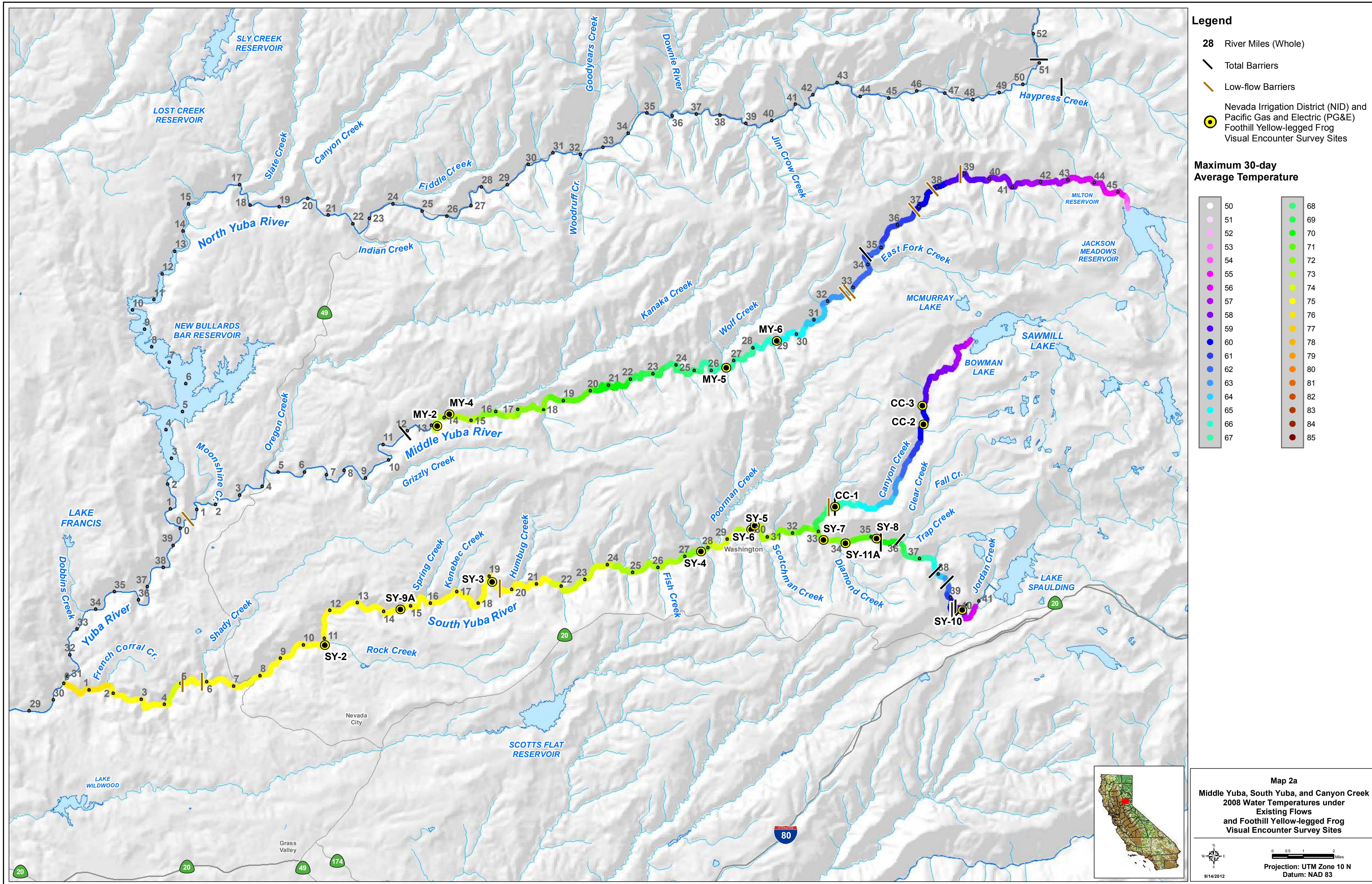

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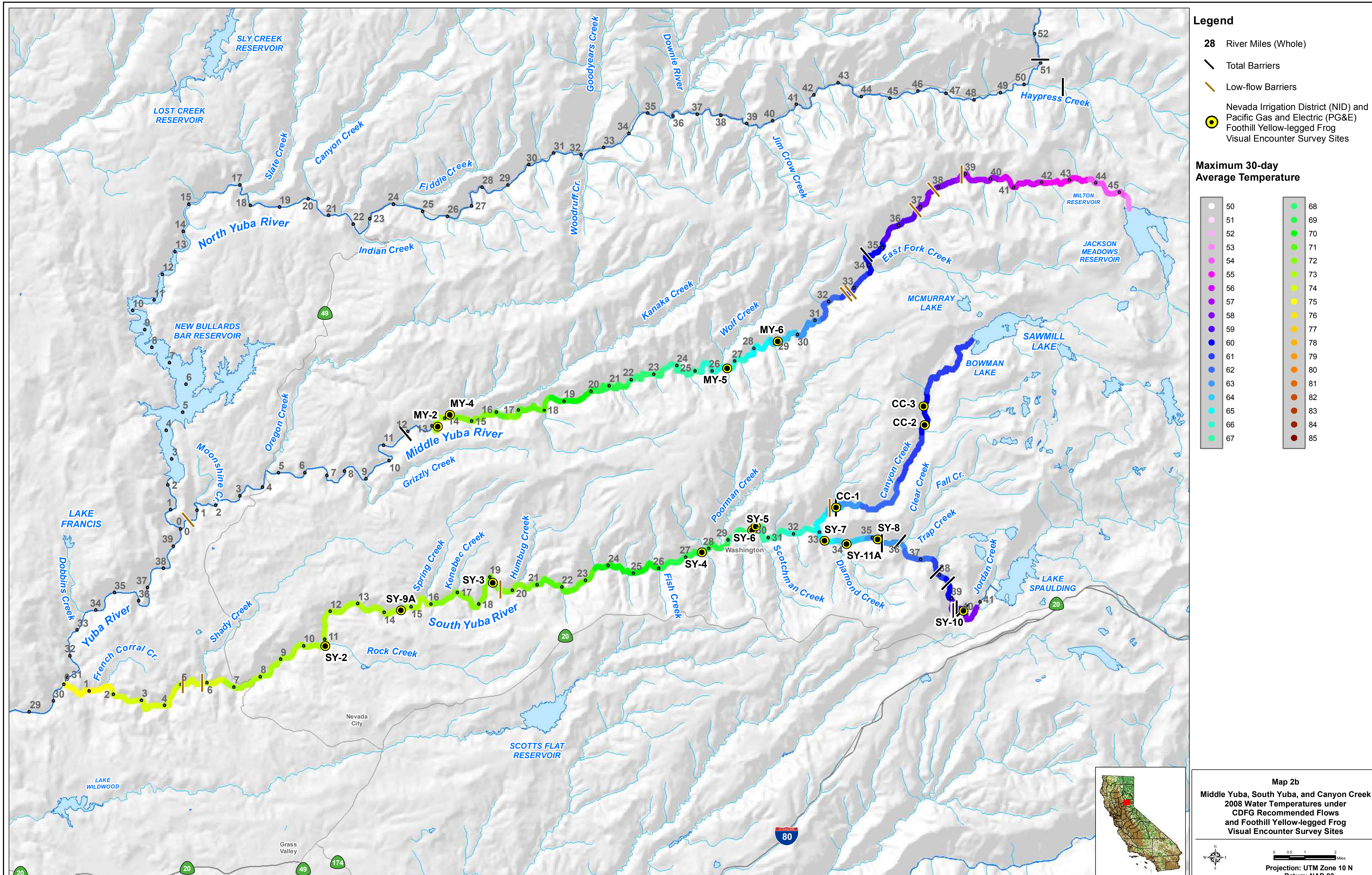
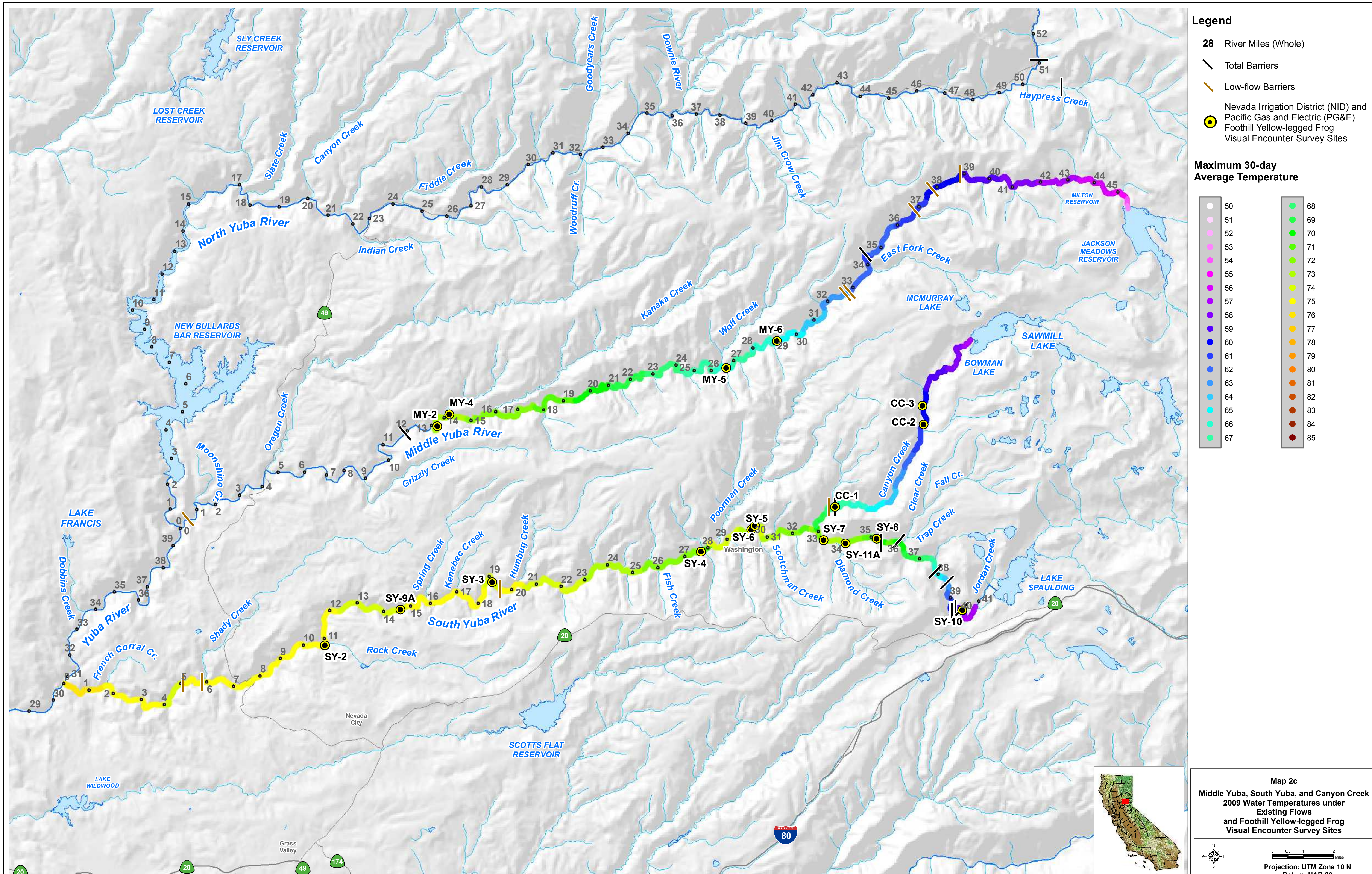


Map 2b
Middle Yuba, South Yuba, and Canyon Creek 2008 Water Temperatures under CDFG Recommended Flows and Foothill Yellow-legged Frog Visual Encounter Survey Sites

9/14/2012

Projection: UTM Zone 10 N
Datum: NAD 83

Z:\GIS\Entrix\31780050_Yuba_Bear\map\M&SYuba_WaterTemps_17i11i_10_Letter_CDFG.mxd



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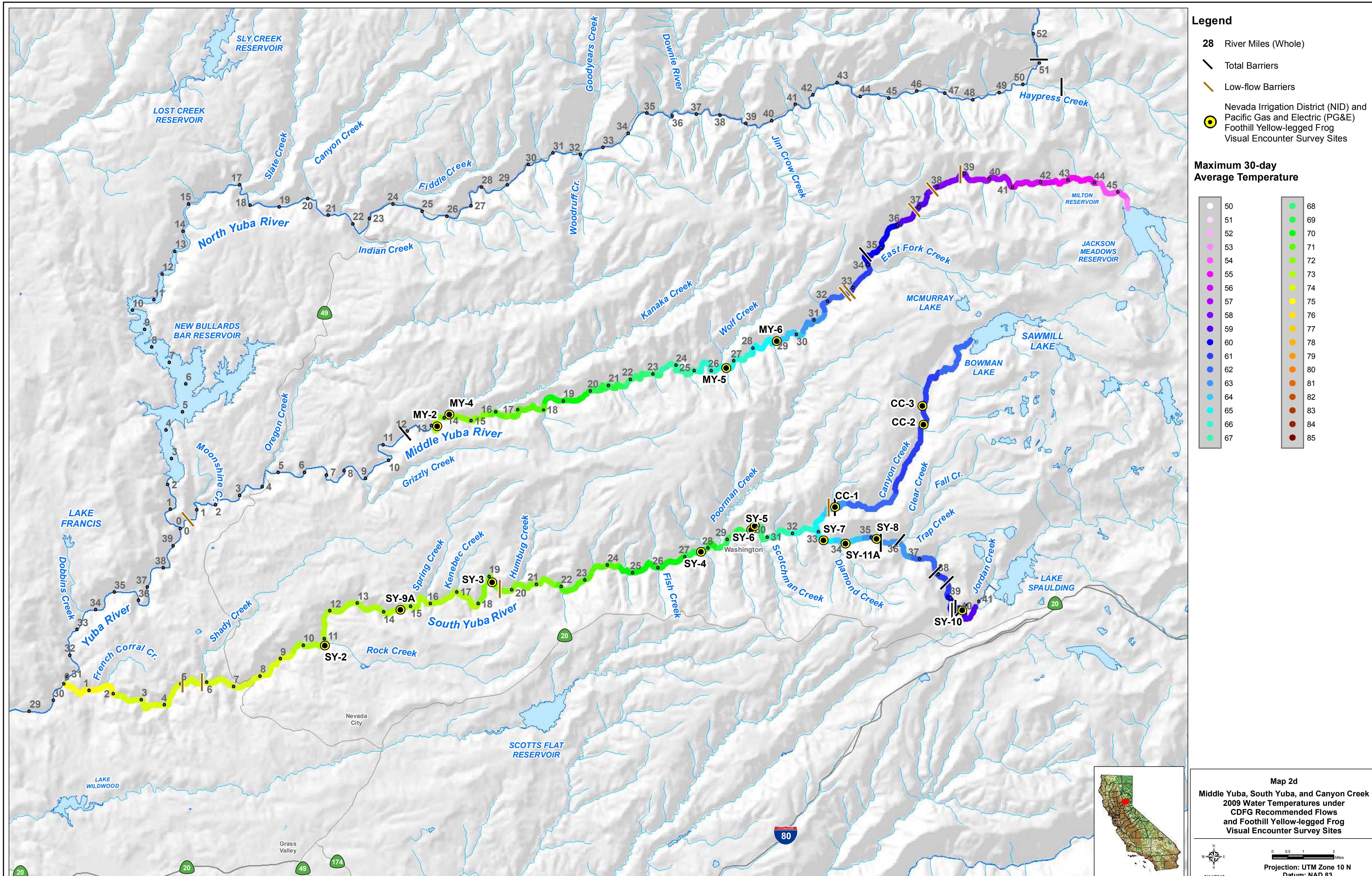

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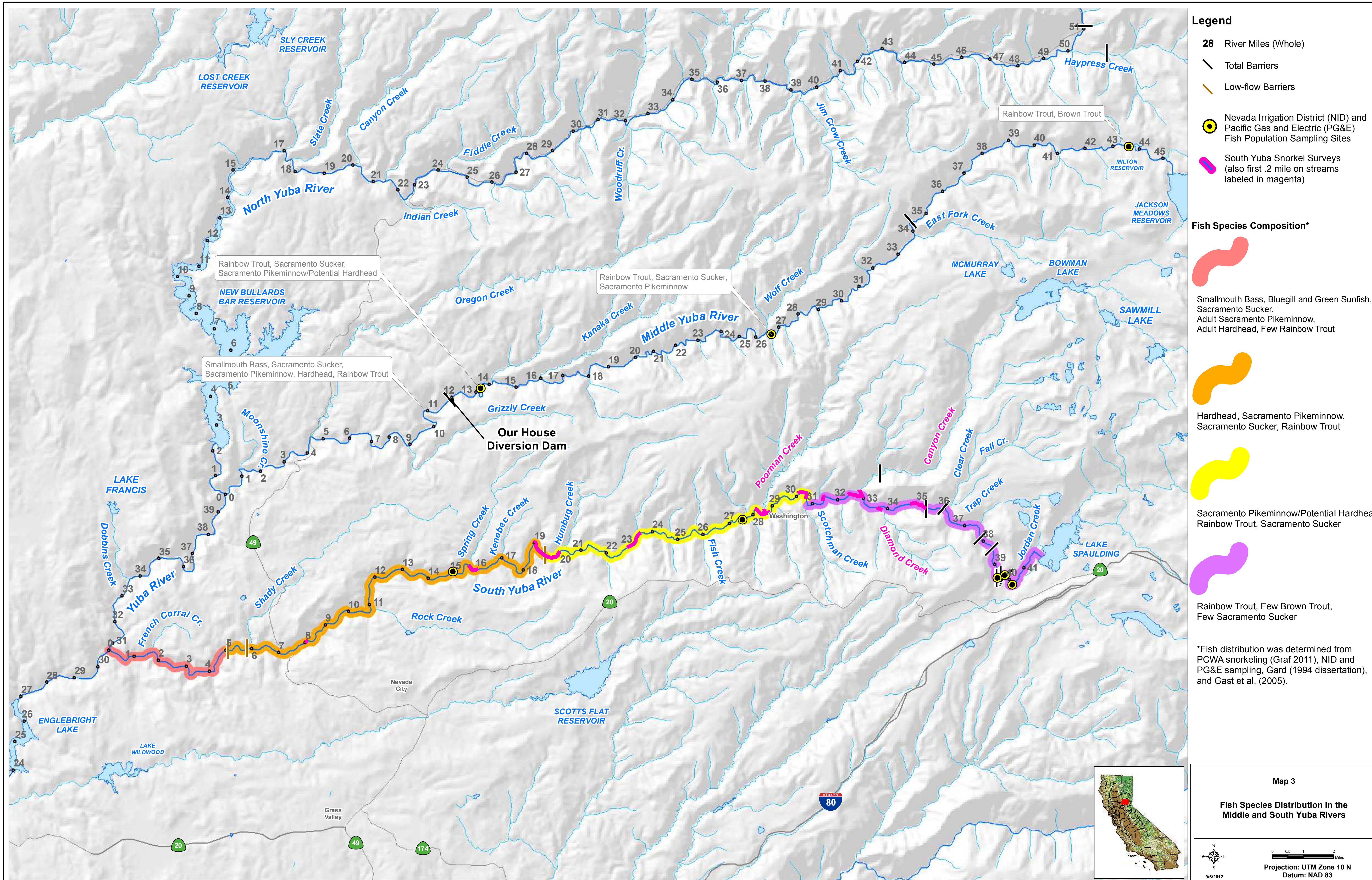

Legend
28 River Miles (Whole)
Total Barriers
Low-flow Barriers
Nevada Irrigation District (NID) and Pacific Gas and Electric (PG&E) Fish Population Sampling Sites
South Yuba Snorkel Surveys (also first .2 mile on streams labeled in magenta)
Fish Species Composition*
Smallmouth Bass, Bluegill and Green Sunfish, Sacramento Sucker, Adult Sacramento Pikeminnow, Adult Hardhead, Few Rainbow Trout
Hardhead, Sacramento Pikeminnow, Sacramento Sucker, Rainbow Trout
Sacramento Pikeminnow/Potential Hardhead, Rainbow Trout, Sacramento Sucker
Rainbow Trout, Few Brown Trout, Few Sacramento Sucker
*Fish distribution was determined from PCWA snorkeling (Graf 2011), NID and PG&E sampling, Gard (1994 dissertation), and Gast et al. (2005).
Map 3
Fish Species Distribution in the Middle and South Yuba Rivers
Projection: UTM Zone 10 N
Datum: NAD 83
9/6/2012
Miles
Rainbow Trout, Sacramento Sucker, Sacramento Pikeminnow/Potential Hardhead
Rainbow Trout, Sacramento Sucker, Sacramento Pikeminnow
Smallmouth Bass, Sacramento Sucker, Sacramento Pikeminnow, Hardhead, Rainbow Trout
Rainbow Trout, Brown Trout
Our House Diversion Dam
North Yuba River
Middle Yuba River
South Yuba River
Yuba River
East Fork Creek
Haypress Creek
SLY CREEK RESERVOIR
LOST CREEK RESERVOIR
NEW BULLARDS BAR RESERVOIR
LAKE FRANCIS
ENGLEBRIGHT LAKE
LAKE WILDWOOD
SCOTTS FLAT RESERVOIR
MCMURRAY LAKE
BOWMAN LAKE
SAWMILL LAKE
JACKSON MEADOWS RESERVOIR
MILTON RESERVOIR
LAKE SPAULDING
Slate Creek
Canyon Creek
Fiddle Creek
Woodruff Cr.
Jim Crow Creek
Indian Creek
Oregon Creek
Kanaka Creek
Wolf Creek
Grizzly Creek
Moonshine Cr.
Dobbins Creek
French Corral Cr.
Shady Creek
Rock Creek
Spring Creek
Kenebec Creek
Humbug Creek
Fish Creek
Poorman Creek
Scotchman Creek
Diamond Creek
Canyon Creek
Clear Creek
Fall Cr.
Trap Creek
Jordan Creek
Washington
Nevada City
Grass Valley

Appendix A

Figure A-1a. South Yuba River Jordan Reach (Lang's Crossing) (Top of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

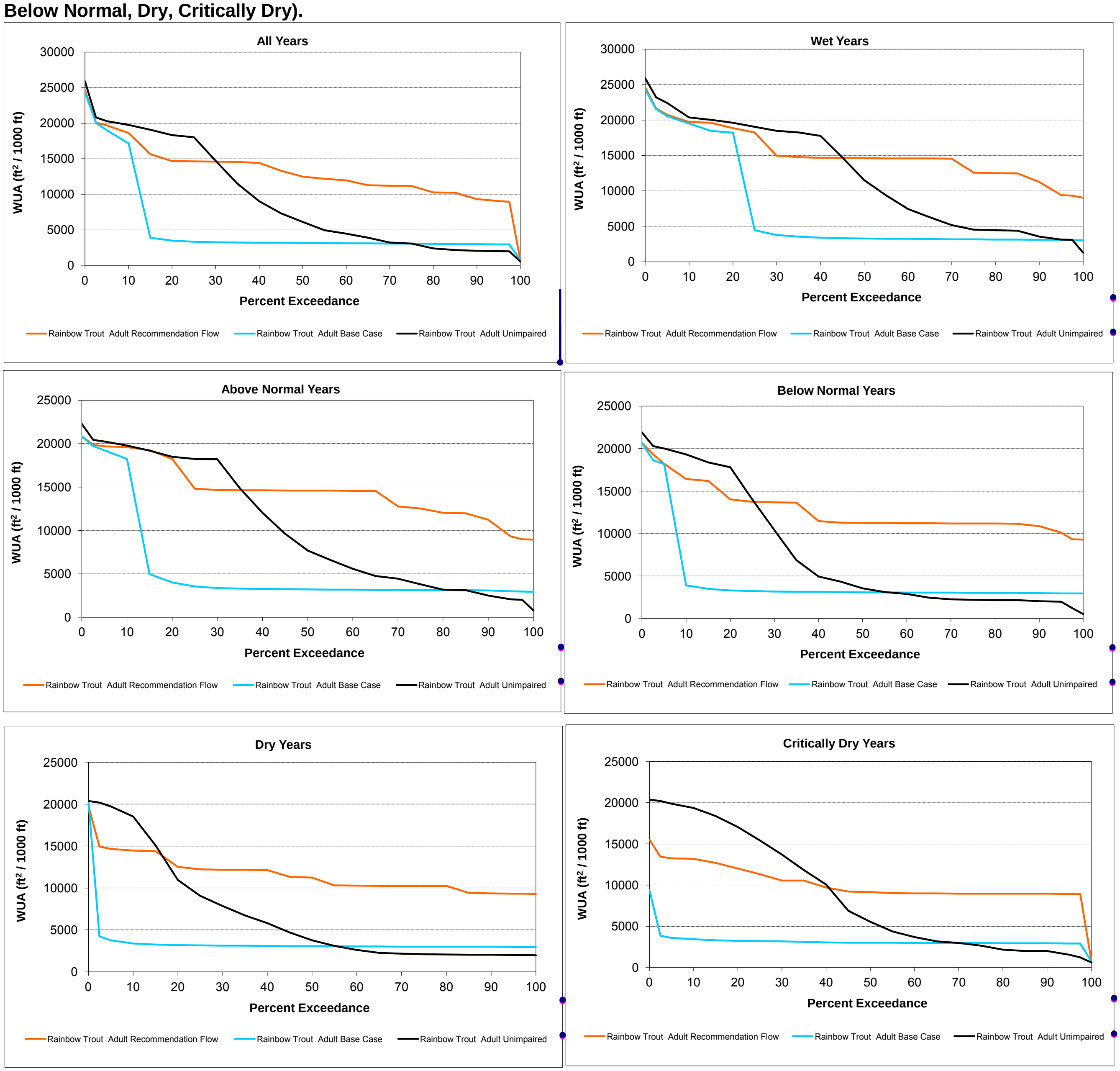


Figure A-1b. South Yuba River Jordan Reach (Lang's Crossing) (Bottom of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

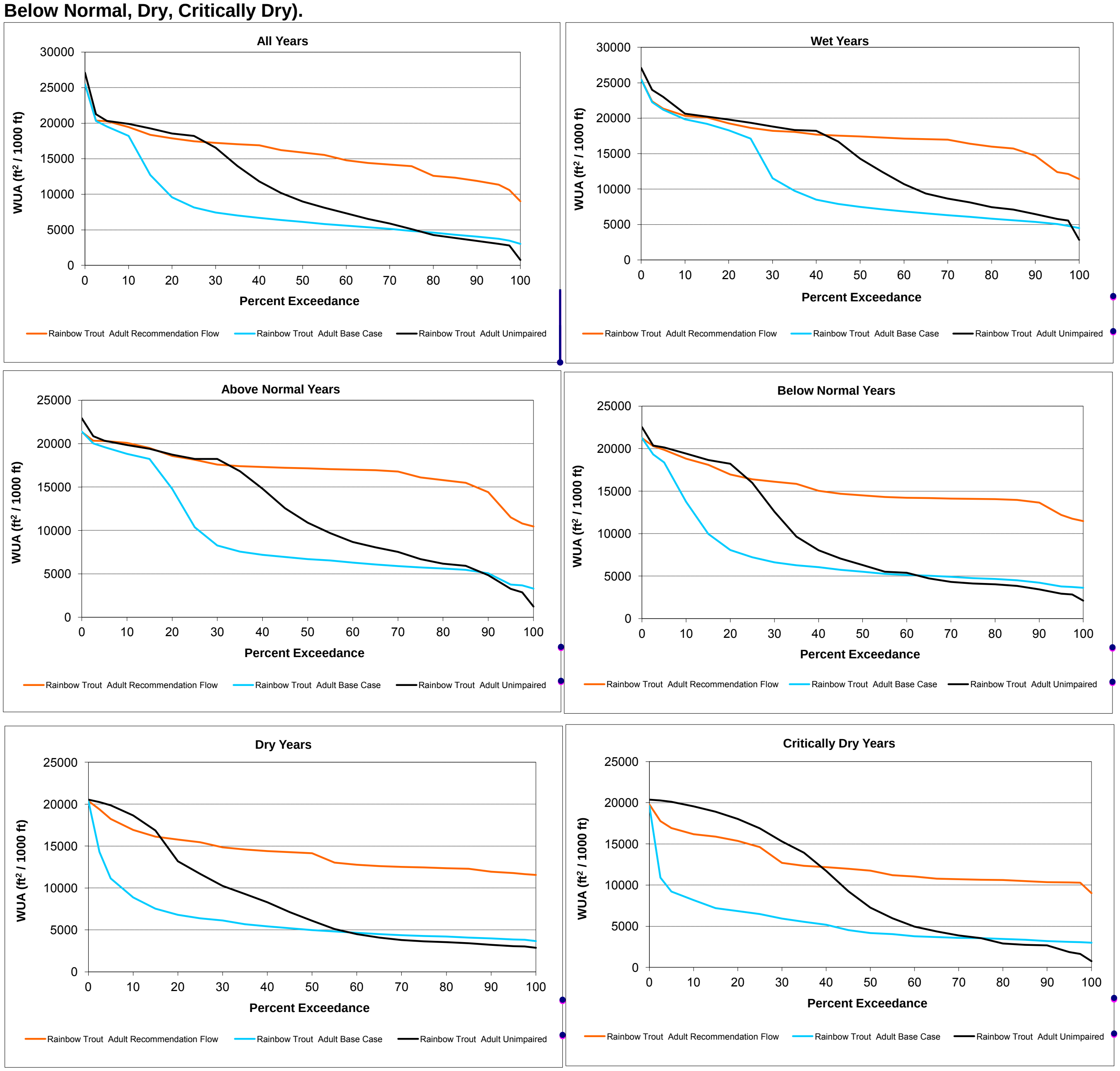


Figure A-1c. South Yuba River Canyon Creek Reach (Top of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

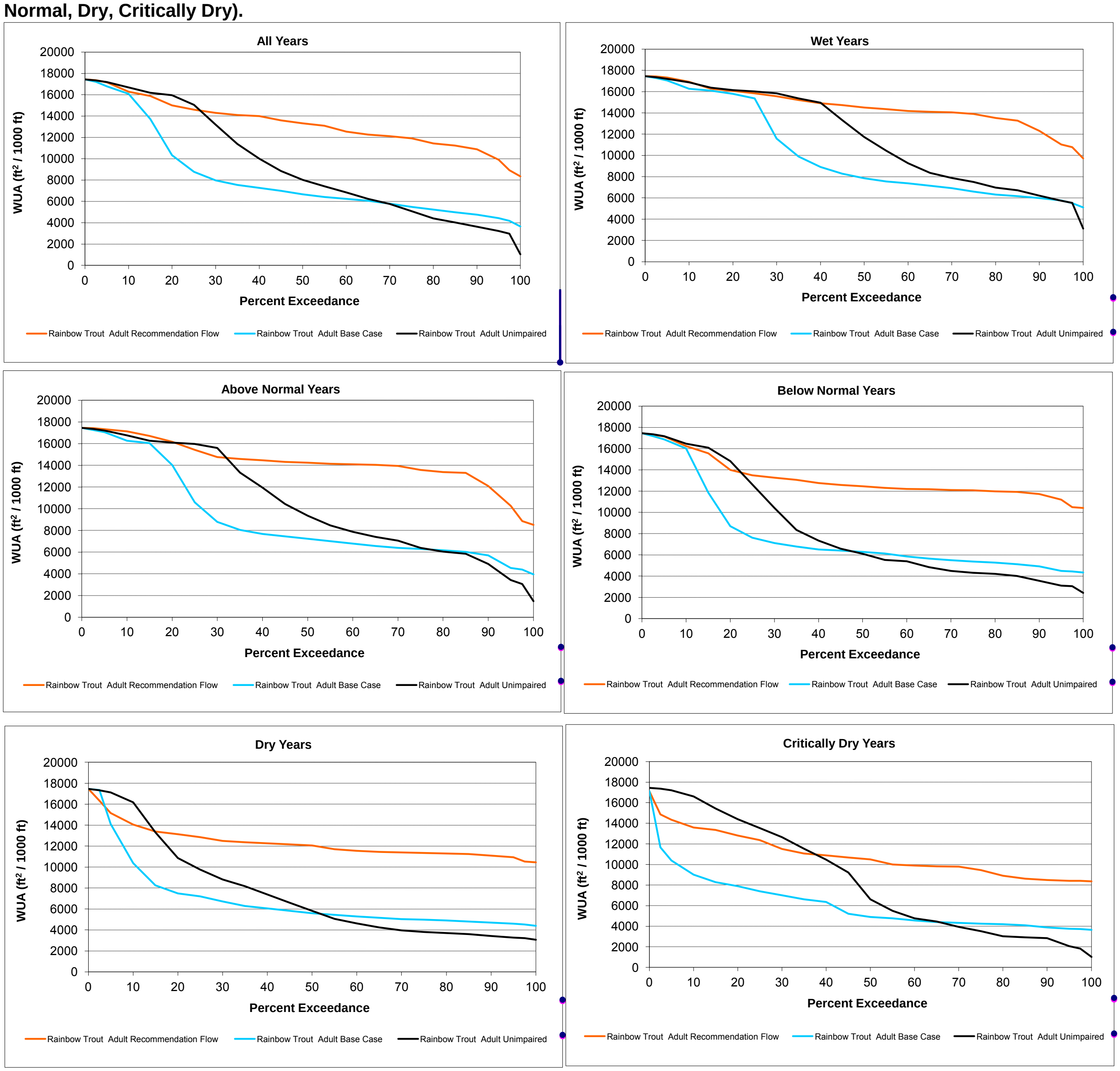


Figure A-1d. South Yuba River Canyon Creek Reach (Bottom of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

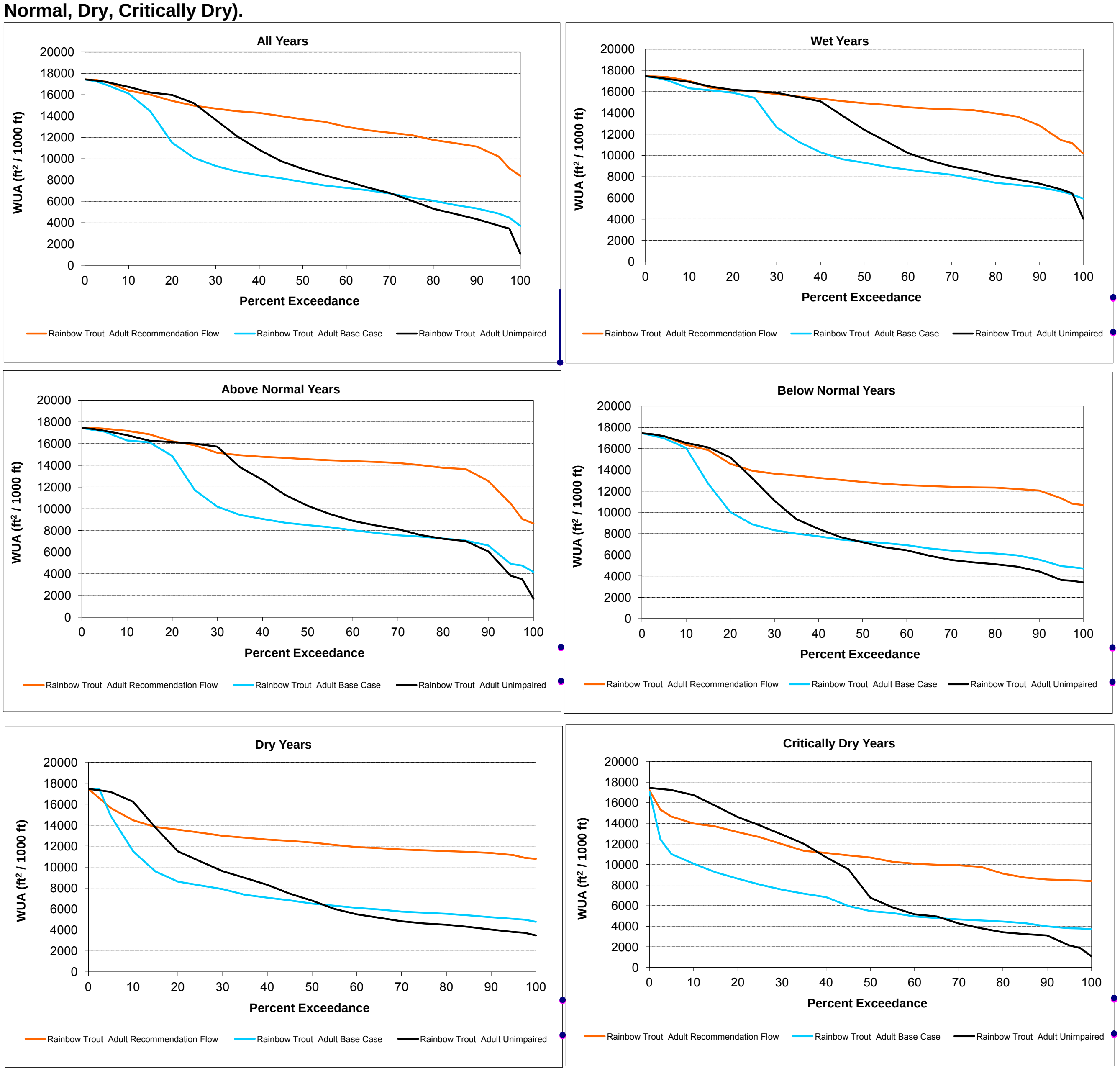


Figure A-1e. South Yuba River Poorman Creek Reach (Top of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

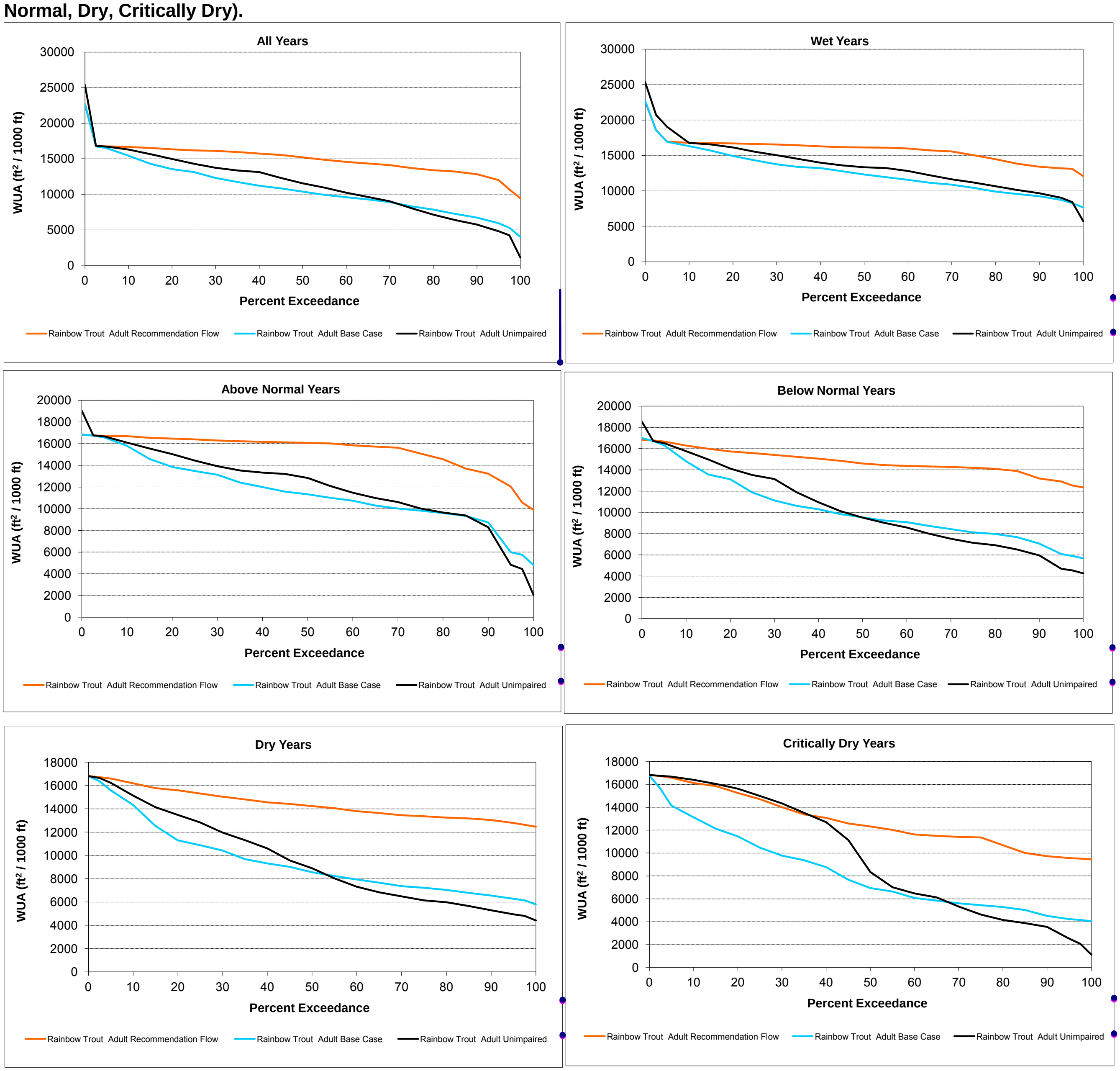


Figure A-1f. South Yuba River Poorman Creek Reach (Bottom of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

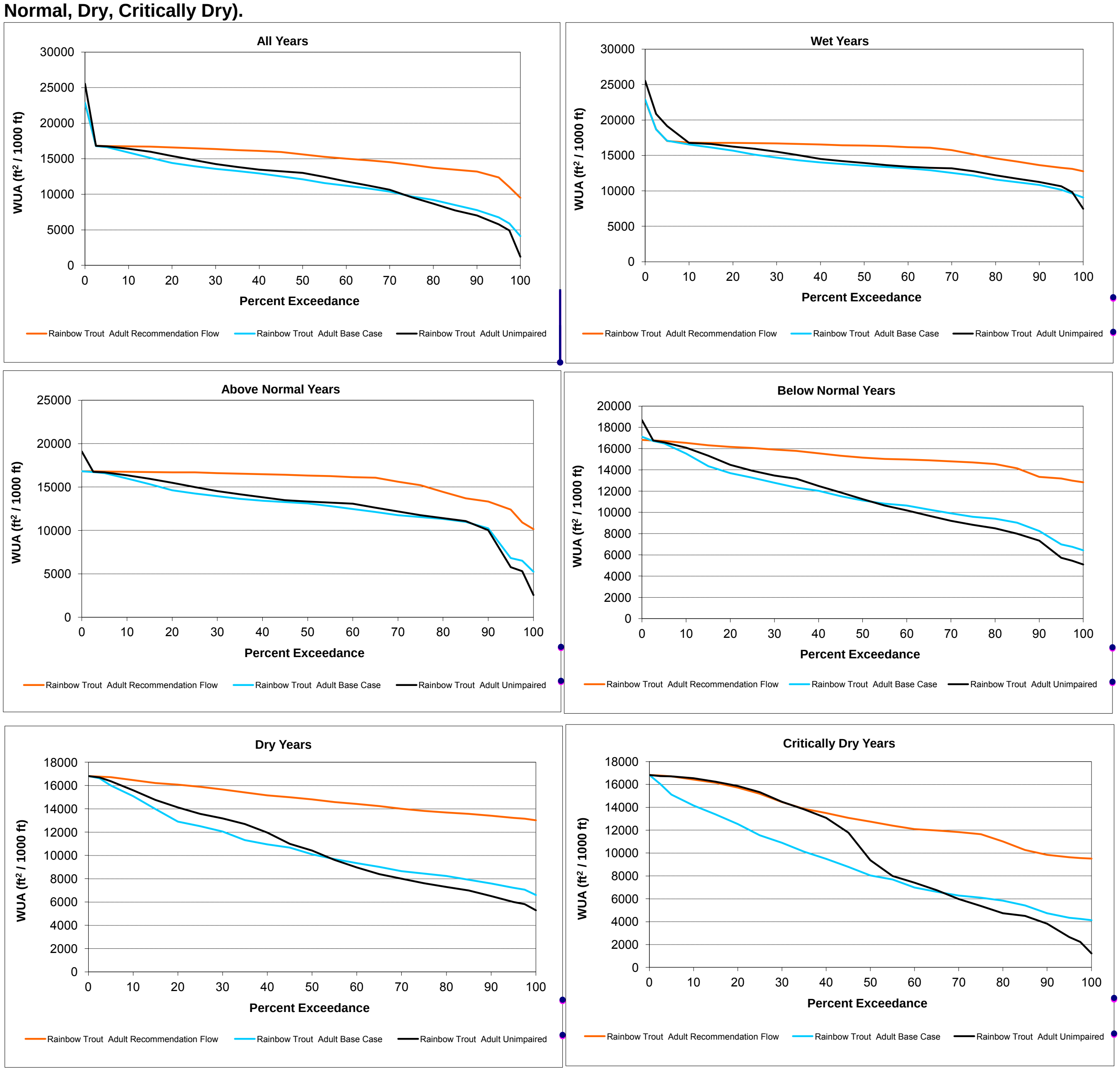


Figure A-1g. South Yuba River Humbug Creek Reach (Top of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

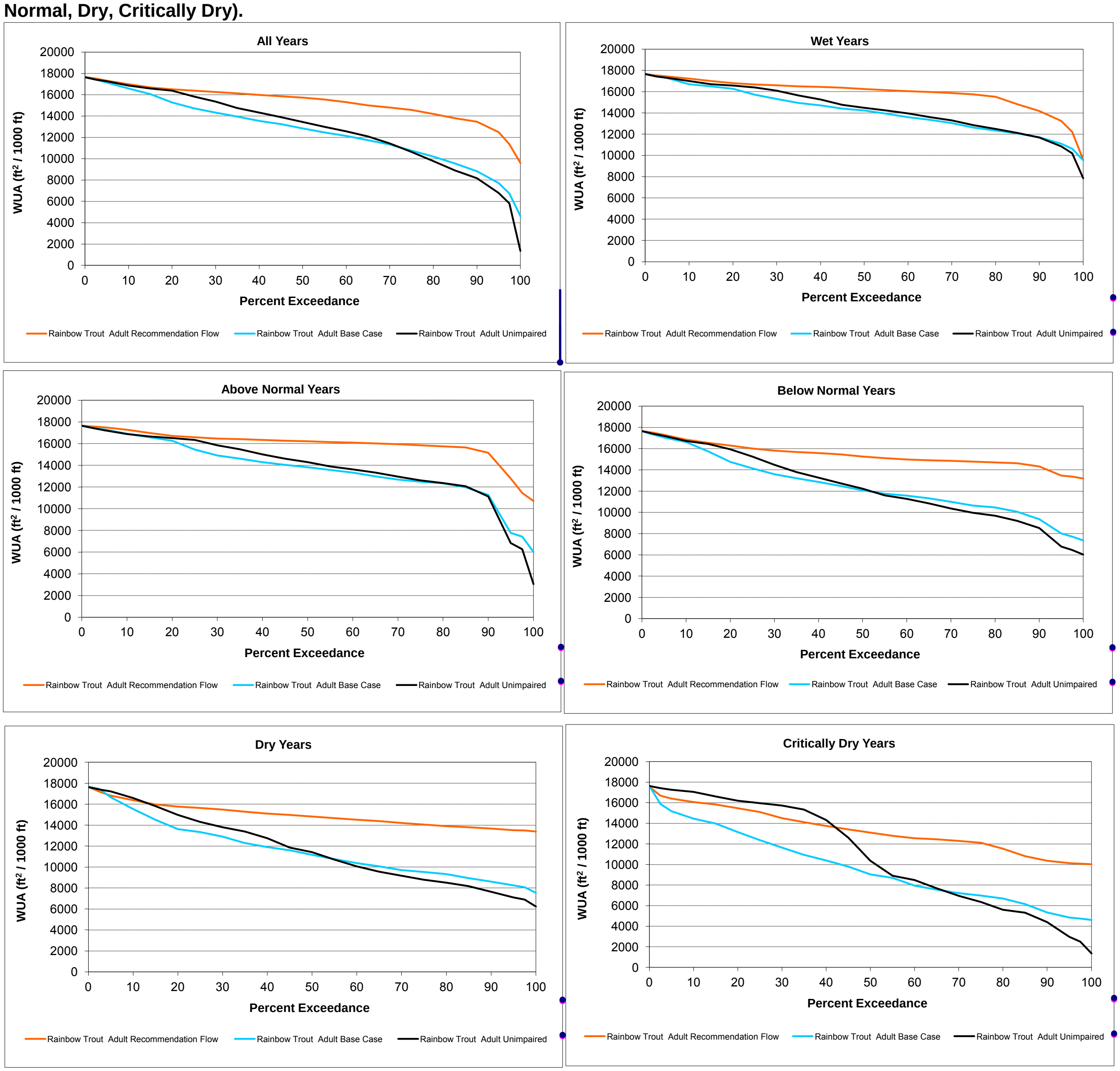


Figure A-1h. South Yuba River Humbug Creek Reach (Bottom of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

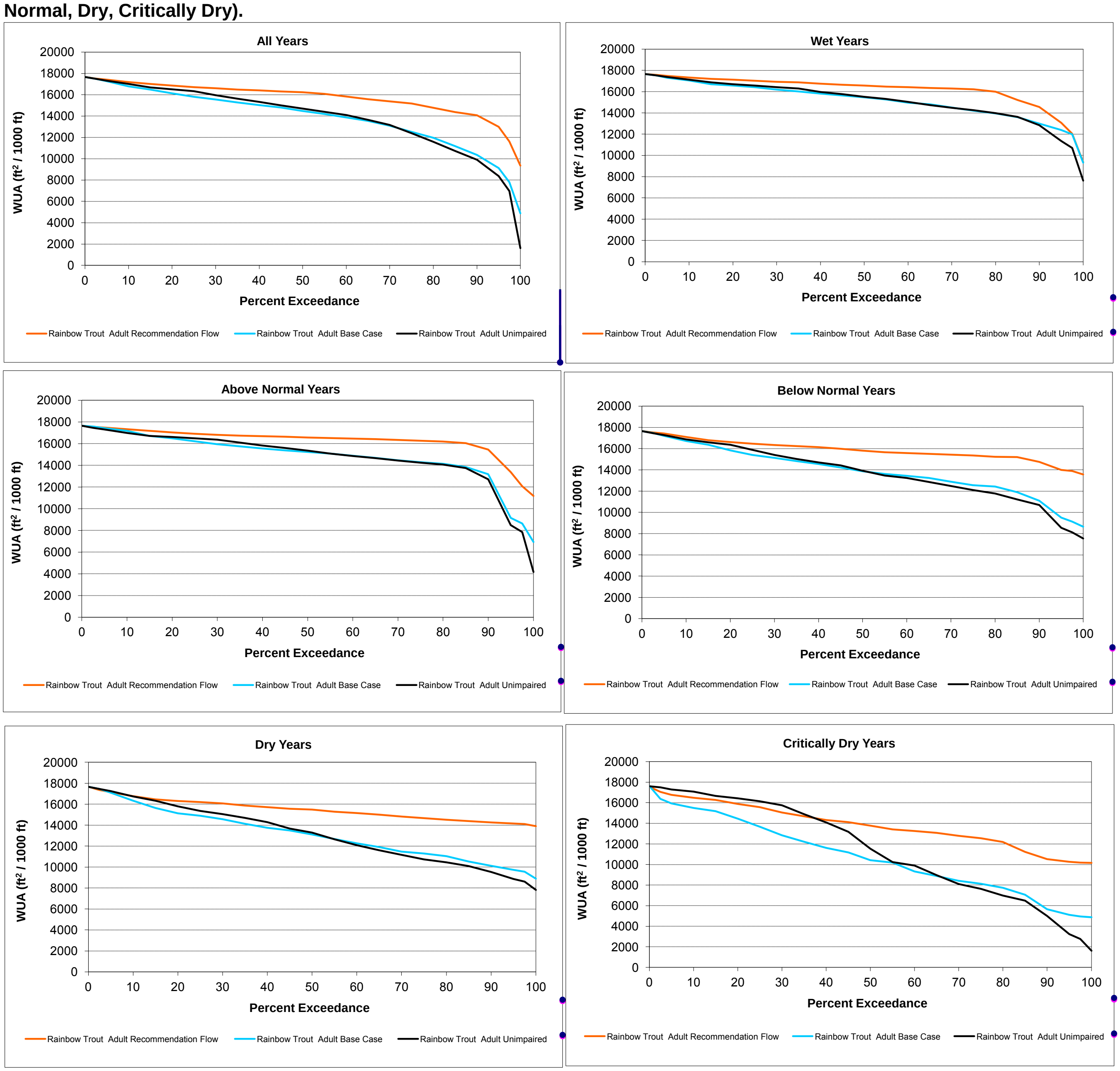


Figure A-2a. Middle Yuba River Milton Reach (Top of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

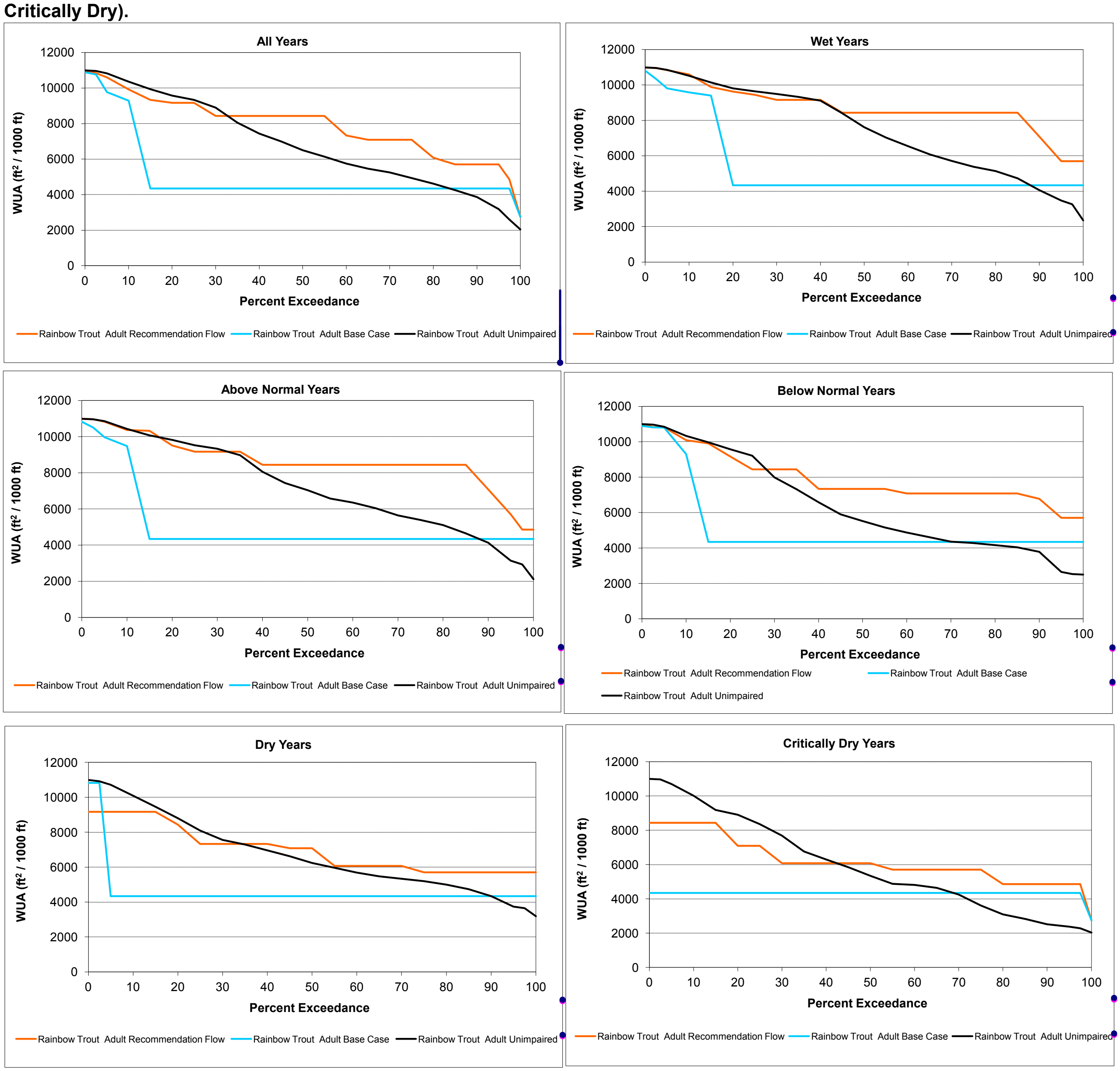


Figure A-2b. Middle Yuba River Milton Reach (Bottom of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

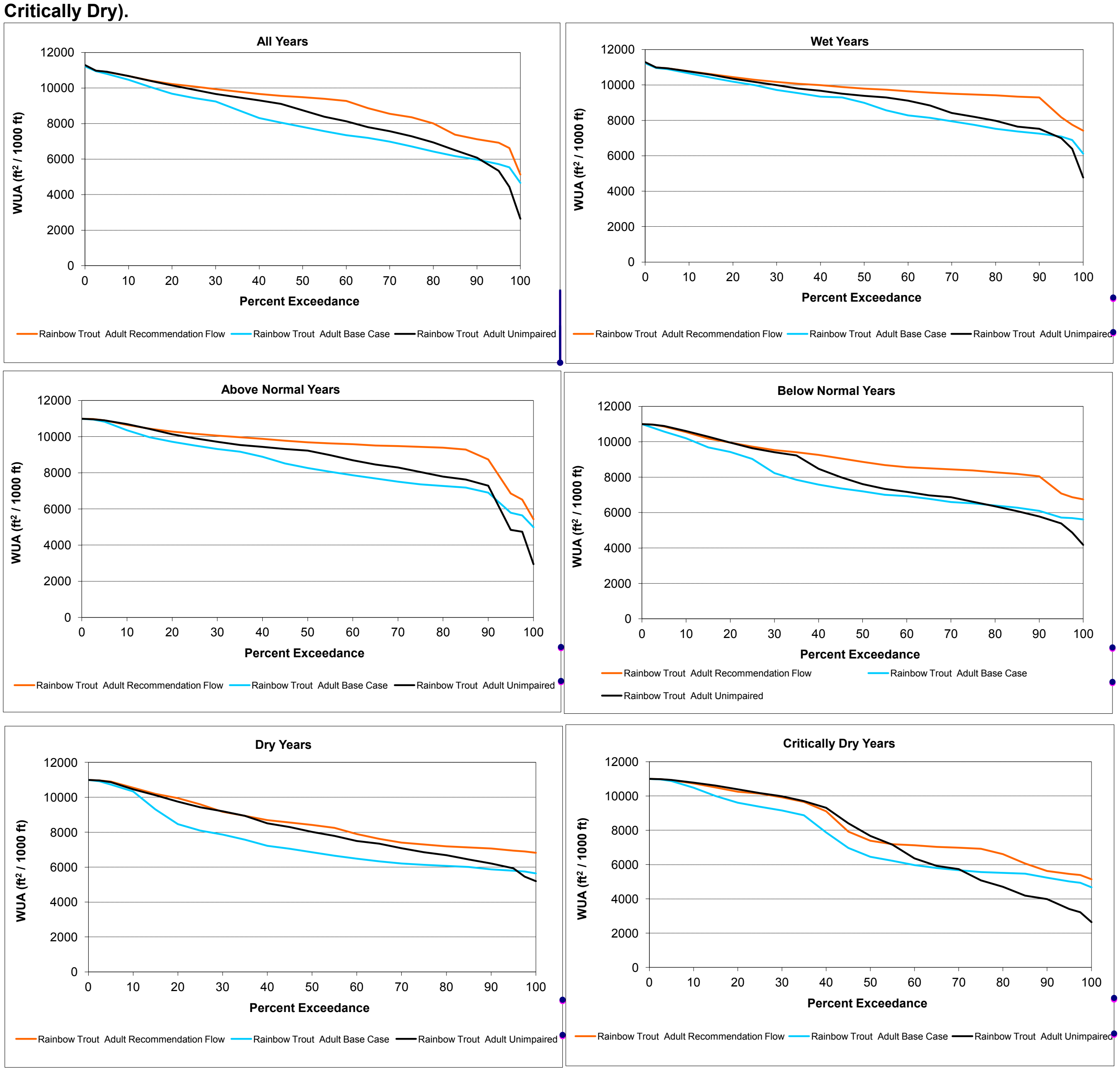


Figure A-2c. Middle Yuba Wolf Creek Reach (Top of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

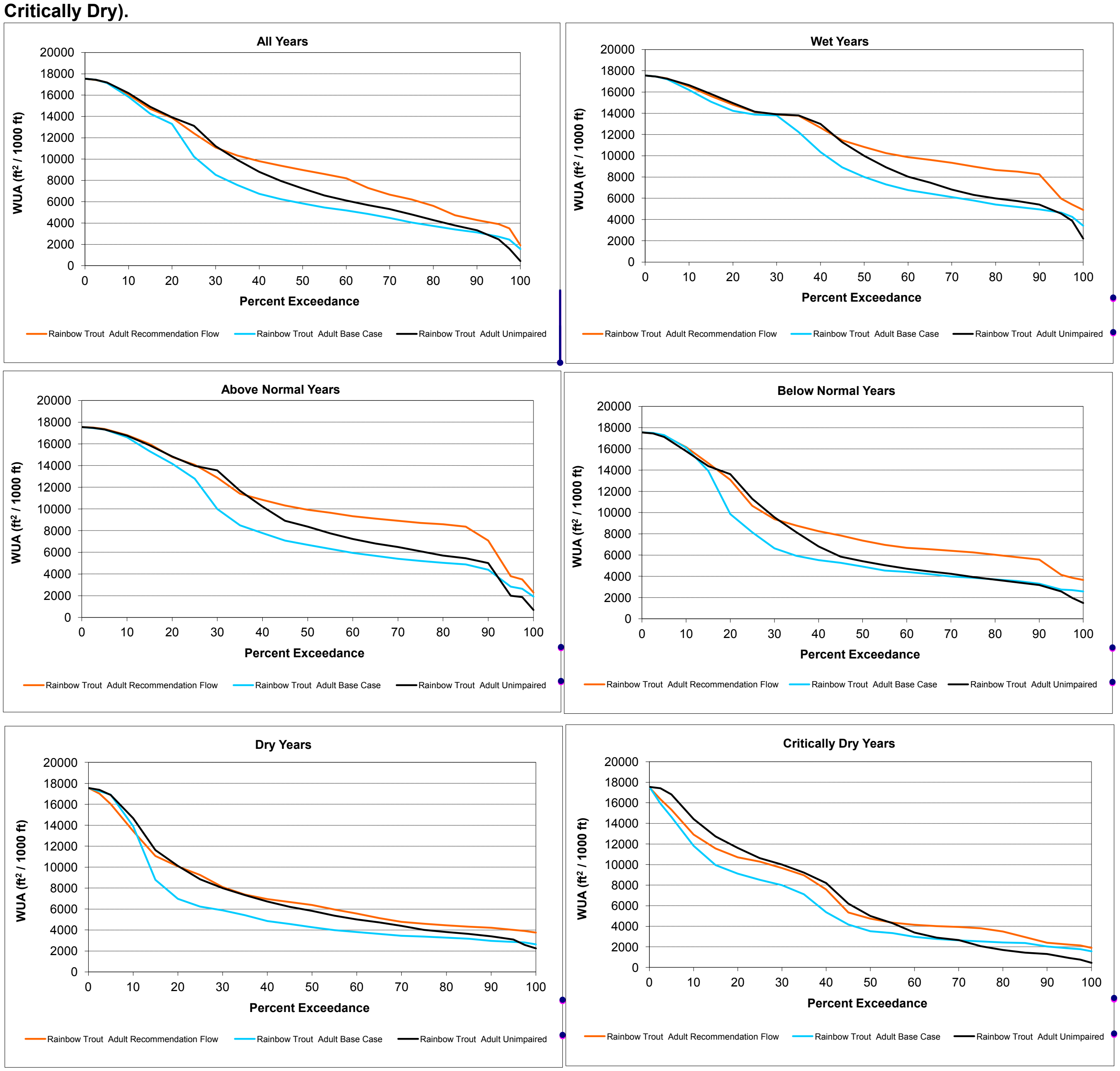


Figure A-2d. Middle Yuba River Wolf Creek Reach (Bottom of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

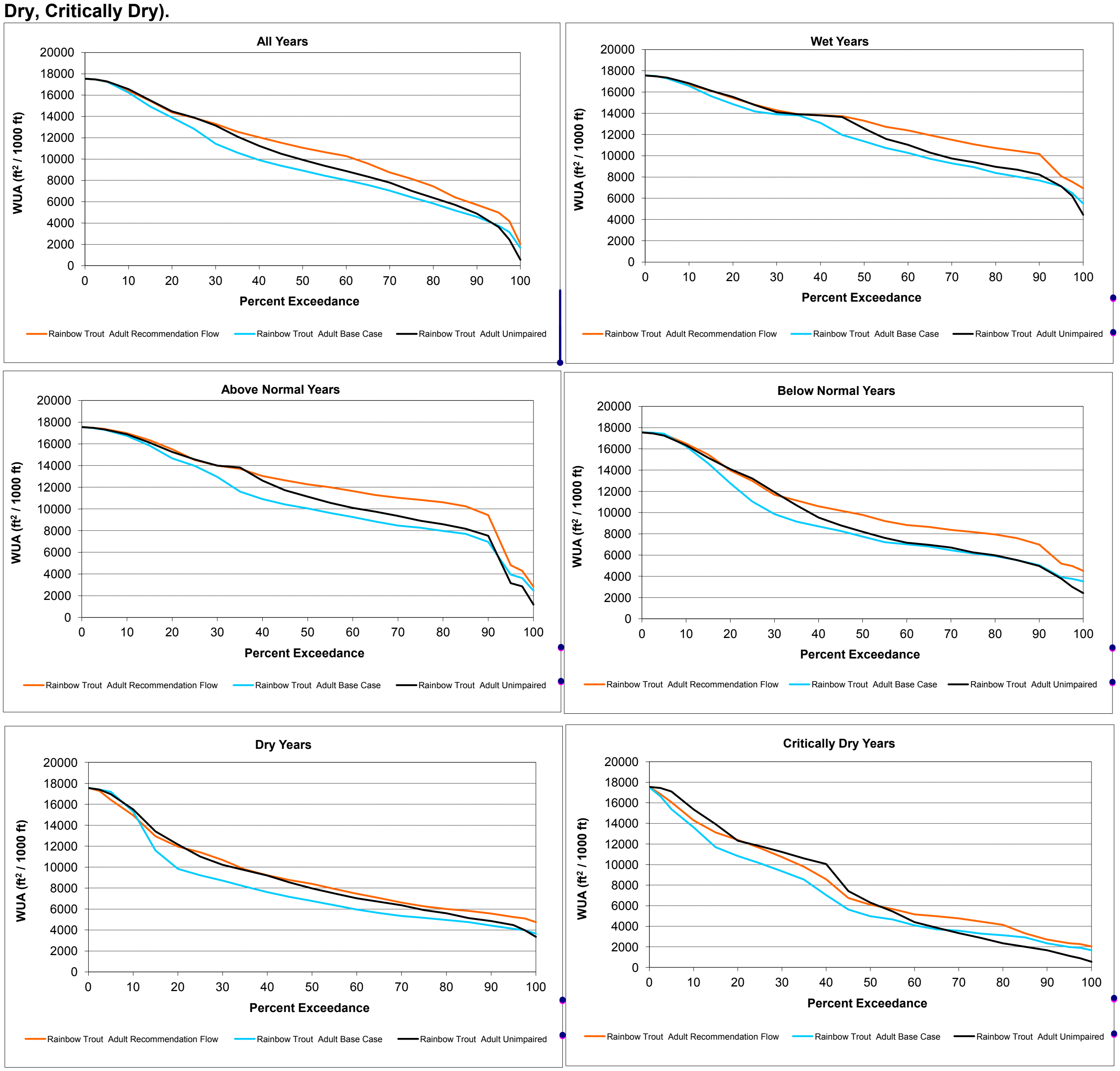


Figure A-2e. Middle Yuba River Kanaka Creek Reach (Top of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

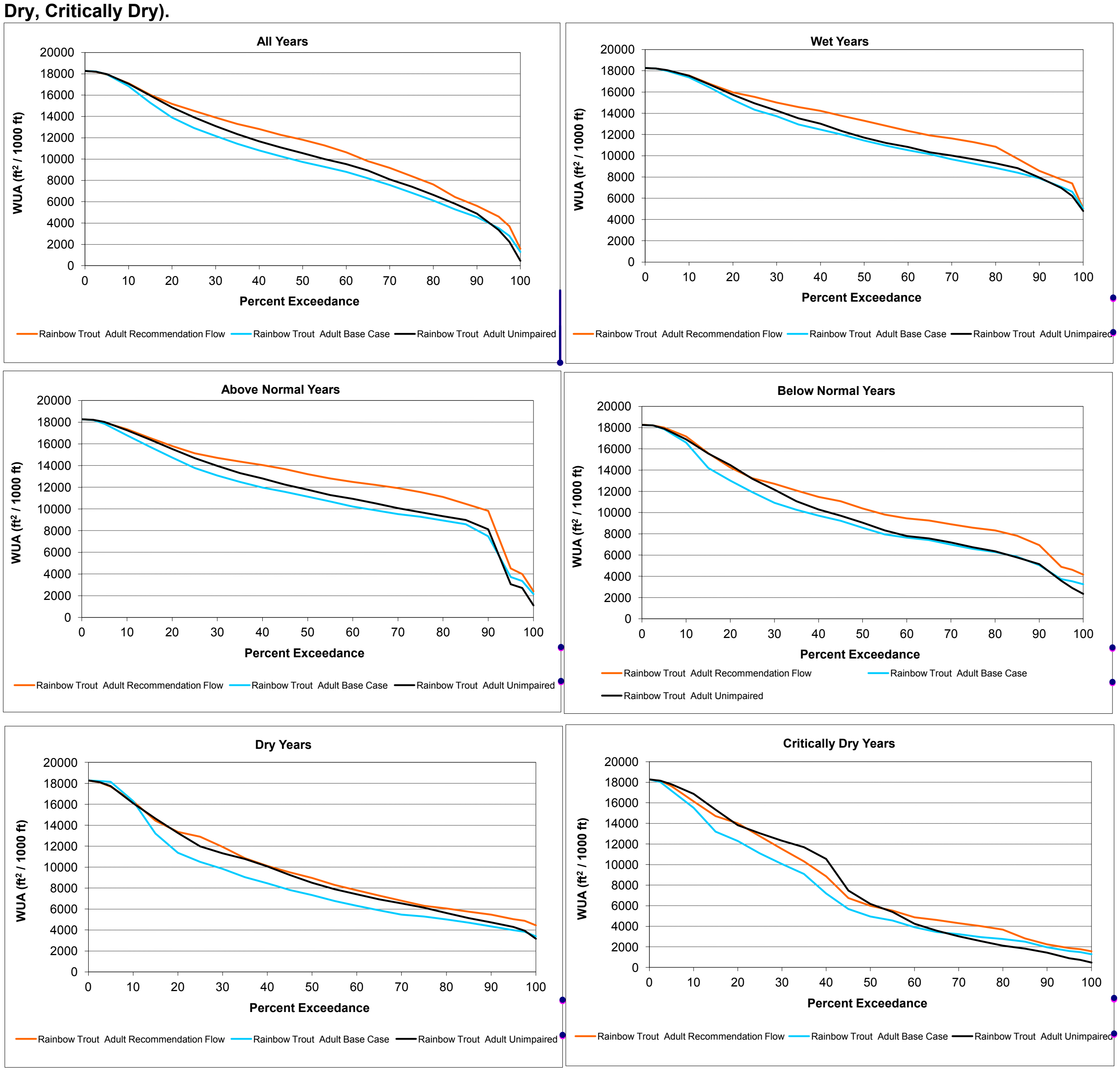


Figure A-2f. Middle Yuba River Kanaka Creek Reach (Bottom of Reach) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).

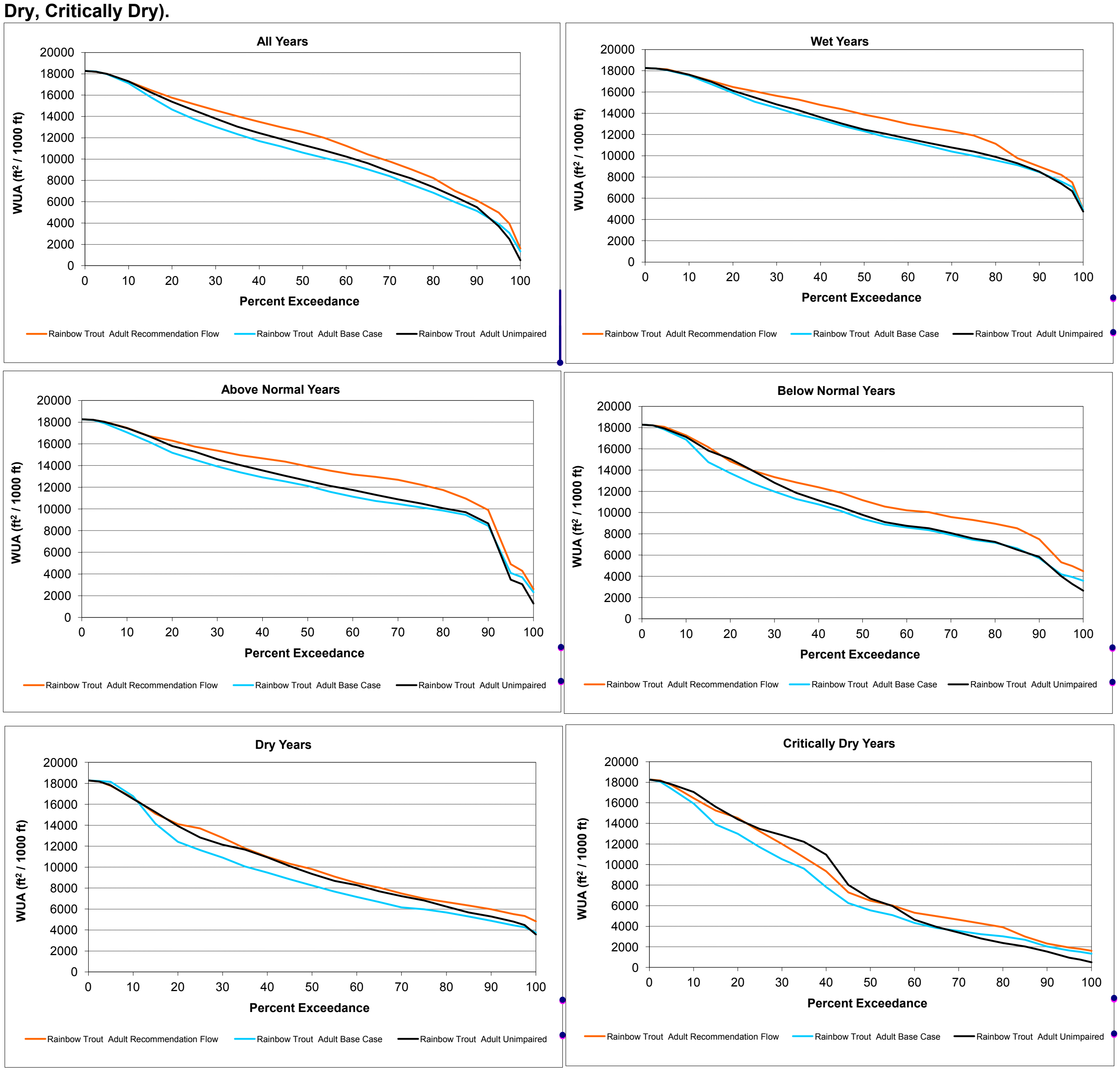
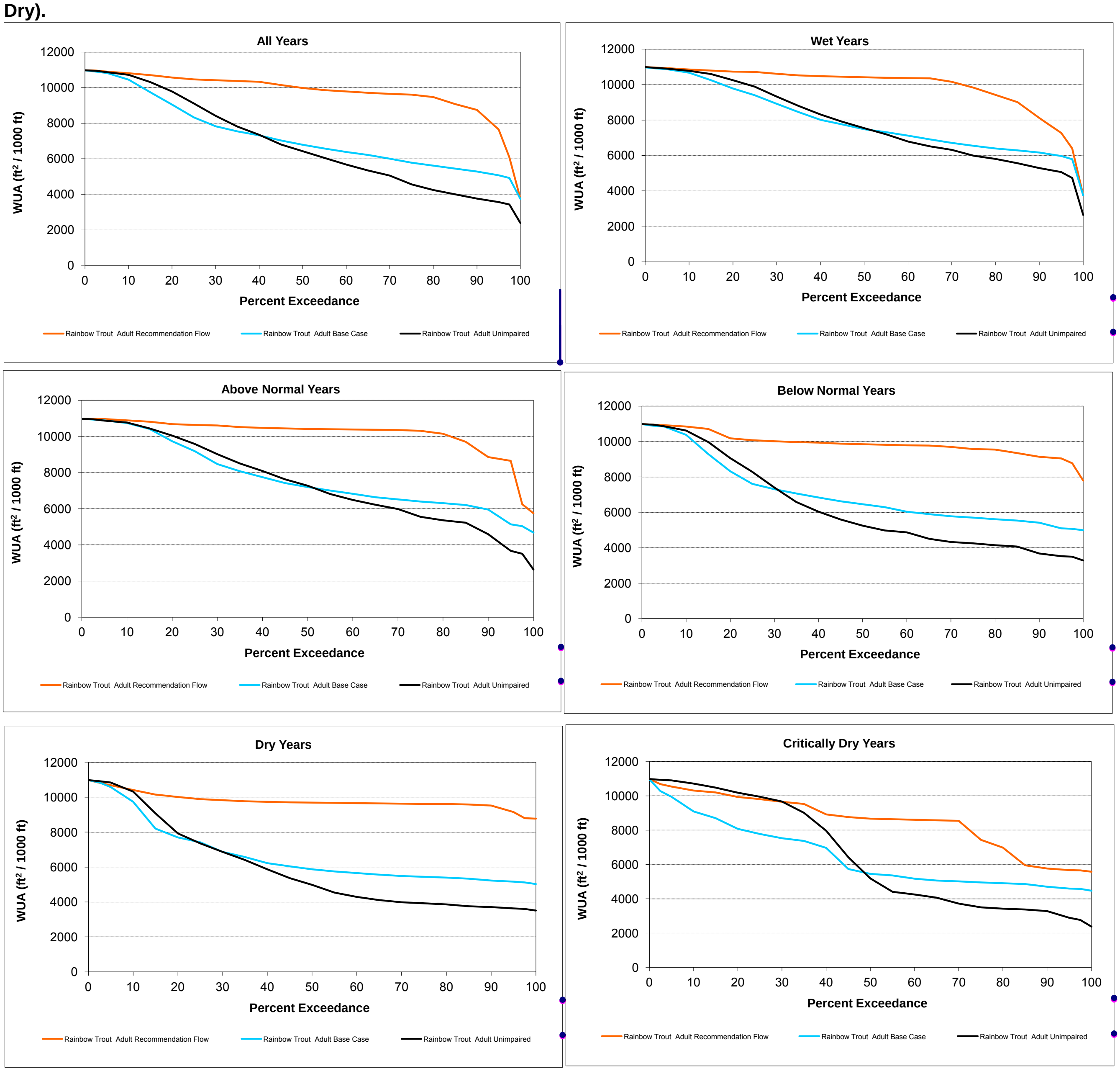


Figure A-3. Canyon Creek (Above South Yuba Confluence) Rainbow Trout Adult Summer Through Fall (June - October) Habitat Exceedance Plots for All Water Years and each Water Year Type Separately (Wet, Above Normal, Below Normal, Dry, Critically Dry).



Appendix B

Water Temperature Effects on Foothill Yellow-Legged Frog and Hardhead

Sarah Kupferberg, Craig Addley, and Peter Graf

I. Introduction.

Predicting a species' vulnerability to an environmental change, such as altered thermal conditions, requires integrating observations of individual ecophysiological and behavioral responses to temperature with broader spatial patterns of distribution along a thermal gradient. In the Yuba River system, proposed water temperature requirements could create cooler water temperatures for a suite of aquatic ectothermic vertebrates including western pond turtles, hardhead, garter snakes, and frogs. The objective of this report is to assess the vulnerability of two in particular, the foothill yellow-legged frog (*Rana boylii*, FYLF hereafter) and hardhead (*Mylopharodon conocephalus*).

We present the idea of thermal niche to provide a framework for integrating what is known about the thermal ecology of FYLF and hardhead at diverse spatial and temporal scales and thus predict the effects of the proposed water temperature requirements. Hutchinson (1957) differentiated the fundamental niche, the multidimensional environmental space where a species could exist, from the realized niche, the subset of this space where the species actually coexists in a community. For ectothermic aquatic vertebrates, temperature is a resource that defines a central axis of the fundamental niche (Magnuson et al. 1979). The fundamental thermal niche is physiologically bounded, controlled at the extremes by low and high lethal temperatures, and more narrowly by the temperatures above and below which growth does not occur even with optimal rations and reproduction does not occur. Preferred temperatures and performance components (e.g., incipient lethal temperature, growth, production) of the thermal niche can be measured in a laboratory setting. A species' field distribution, however, may, or may not, be consistent with laboratory measured preferred temperatures and performance curves. The realized thermal niche in rivers is determined by both abiotic and biotic factors such as food resource abundance, predator avoidance, intra- and interspecific competition, and the availability of suitable habitat such as appropriate water depth and velocity (Shrode et al. 1982). To determine the fundamental and realized thermal niche of FYLF we combine the results of laboratory and field manipulations (previously unpublished results of work conducted by Kupferberg and Catenazzi, California Energy Commission sponsored research conducted 2008-2010) with population censuses and environmental correlations (Entrix / PCWA surveys, Garcia and Associates / PG&E surveys). We show that generally the landscape distribution of FYLF breeding populations is consistent with the water temperatures preferred by tadpoles and that are beneficial to survival, growth, and rapid development of early life stages.

II. Population Biology and Thermal Ecology of FYLF and Hardhead

Fundamental thermal niche relates to algivory and population level processes

A commonality between FYLF and hardhead is that they both have lifestages where a primary food resource is plant based and prefer warm water. Although small hardhead consume primarily mayfly nymphs, caddisfly larvae, and small snails, larger fish feed more on aquatic plants, filamentous algae in particular (Reeves 1964; Moyle 2002), and large invertebrates. Tadpoles of FYLF are scrapers of periphyton, consuming filamentous algae and diatoms. Selecting warm temperatures that are optimal for consumption rate, food conversion efficiency, metabolism, and growth is important across a taxonomically diverse spectrum of vertebrate aquatic ectotherms that are herbivorous, including larval amphibians (Skelly and Golon 2003), marine iguanas, (Wikelski et al. 1993), and tropical marine fishes (Clements et al. 2009). While the benefits of operating at temperatures near an organism's thermal preference include many physiological and biochemical processes (Huey and Stevenson 1979), the benefits may be greater in rapidly developing stages, such as tadpoles, compared to adults. Temperature directly influences differentiation and growth rates, key processes during ontogeny (Berven 1982; Smith-Gill and Berven 1979).

Specifically for FYLF, identifying optimal and preferred temperatures for tadpoles is relevant to our forecasting efforts because persistence of populations in this species is tied to the success of early life stages. A population viability analysis conducted for FYLF illustrated that 30-year extinction probabilities are very sensitive to survival of embryos and tadpoles (Kupferberg et al. 2009a). In addition, thermal conditions that promote growth and large size at metamorphosis may have carryover effects to later life stages. Studies monitoring growth and survival of other Ranid frog species in pens enclosing natural habitats show that size at metamorphosis can often be an important determinant of surviving the first winter (Altwegg 2003, Altwegg and Reyer 2003). The same temperature arguments are generally applicable to juvenile hardhead.

Thermoregulatory behavior in laboratory and field

In a review of temperate freshwater fishes, Magnuson et al. (1979) found that the width of the fundamental thermal niche was 4-5°C when characterized by the mean ± one standard deviation of temperature occupied in a laboratory thermal gradient, and that realized thermal niches were similar in central tendency, but narrower, in comparison to fundamental niches.

Hardhead and Sacramento pikeminnow are part of the “pikeminnow-hardhead-sucker” fish assemblage that occurs in warmer water/transition portions of streams and rivers downstream of the cold water “rainbow trout” assemblage (Moyle 2002). According to Moyle (2002) streams where hardhead occur have temperatures in excess of 20˚C. Similarly, Knight (1985) states that successful management of native fishes, hardhead/Sacramento pikeminnow, requires maintaining river temperature ≥25˚C. Knight’s (1985) observed temperature preference for Sacramento pikeminnow and hardhead was 26˚C and 28˚C, respectively (Knight 1985; Moyle 2002). A recent laboratory study (Klimley et al. 2010) that assessed hardhead temperature preference over a limited range of acclimation temperatures, was consistent with the findings of Knight (1985). Thus, for hardhead, the realized thermal niche is characterized by summer temperatures above 20°C, with fish selecting an even higher optimal range.

Analogously for FYLF, Catenazzi and Kupferberg (manuscript in prep) assayed preferred temperatures by testing tadpoles individually (Gosner (1960) developmental stages 27–42, n=56) in thermal gradients (11.9 –34.7°C) and found that tadpoles spent the majority of time between 16.5–22.2°C, with mean ± 1 SD selected temperature = 19.60 ± 2.5°C. There was no relationship between Gosner stage and mean selected temperature (R^2 = 0.002, p = 0.72). Similarly, there was no relationship between mean selected temperature and body size. Subsequent trials with tadpoles collected from various Sierran locations and transported to the laboratory revealed similar preferenda.

In the field, FYLF tadpoles are also known to actively thermoregulate (Brattstrom 1962), but because they are generally confined to shallow near shore environments in large rivers, selected temperatures are constrained by thalweg temperature and the degree to which local cross-sectional topography allows shallow water to warm relative to the thalweg. Our watershed wide analysis predicting outcomes for frog populations assumes that the thermal conditions in the habitat utilized by tadpoles can be accurately forecast by the output of temperature models which predict the thalweg temperatures as water moves downstream. To illustrate that this is a reasonable assumption, we compare temperatures where tadpoles occurred (observed throughout the day, Figure 1) to temperatures from near-shore benthic sensors as well as a mid-column thalweg sensor. At intervals of 1–2 hr between 8 AM and 8 PM (July 22-28, 2010) we measured the temperature of 20 tadpole locations along a 1-m wide natural thermal gradient from shore to thalweg at three sites on the North Fork Feather River (Figure 1). We found that fixed sensors placed at appropriate depths and velocities closely mirror the operative tadpole temperatures. Although tadpoles were further from shore late in the day and in the early morning with temperatures matching the thalweg, the diurnal series of measured temperatures at precise tadpole locations also illustrates that tadpole temperatures basically mirror thalweg temperatures, with a 1–2 °C warmer offset. Breeding sites at the mouths of cool tributaries represent exceptions, where tadpole temperatures can be cooler than the thalweg (Figure 1).

Performance (growth, development, survival) in relation to temperature.

When tadpoles were reared in flow through enclosures in streams that had maximum 30 day average temperatures (M30DAT) colder (16.06°, 16.9°), warmer (21.83°), or close to the mean preferred temperature (19.94°), survival was highest when M30DAT closely matched thermal preference (Figure 2a). Post-hatching growth and development, however, were most rapid at the M30AT=21.83° (Figure 2b). When considering total production of metamorphs as a performance for tadpoles receiving supplements of high food quality algae, there is a humped shaped (i.e. parabolic) response curve, with the greatest production of metamorphs at M30AT= 19.94C (Figure 2c). At the warmest site (M30AT = 21.83°C) metamorphosis began 4-5 weeks sooner and tadpoles were larger, but because of high mortality during the warmest period, the total production was slightly lower. The causes of mortality in the experiment were not identified, however we believe it was not due to reaching a critical thermal maximum as tadpoles have been observed to successfully metamorphose from isolated sidepools where large diurnal fluctuations in temperature exist, and daily maxima can reach 30°C. When the relationship inferred by the response curve is extended beyond the experimental rearing temperatures, the predicted range of the fundamental thermal niche is 15-24.5°C, broader than the laboratory preferred temperature range 17.1-22.1°C, i.e. the range anticipated by the mean ± 1 SD of thermal preference alone.

Laboratory rearing experiments can also be used to define the lower threshold temperature at which development and growth does not occur with maximum rations. In growth chambers, Furey, Kupferberg, and Lind (manuscript in preparation) reared FYLF tadpoles from the Middle Fork American River on diets of periphyton-covered rocks from: (1) a peaking reach of the MF American where the low food quality invasive diatom *Didymosphenia geminata* is dominant; (2) the Rock Creek reach of the North Fork Feather River which is dominated by native mucilaginous diatoms; and (3) an unregulated stream with high food-quality periphyton (Table 1). Food sources were crossed with temperature, cold (18°C Day and 14° night; 16.3˚C daily mean), or matching tadpole thermal preference (21.5°C day and 18°C night; 20˚C daily mean). Both factors had significant effects on food consumption and tadpole growth. Under cold conditions (16.3°C daily mean) tadpoles gleaned little food and did not grow, even on high food quality algae. At the warmer temperature (20˚C daily mean), tadpoles did not grow on the periphyton from the regulated rivers, despite there being similar or greater biomass of periphyton per unit area on the regulated river rocks. At 20°C mean daily temperature, tadpoles ingested *Didymosphenia* dominated periphyton at a rate similar to tadpoles consuming control periphyton (high-quality periphyton), but did not grow, with a 72 hr relative weight gain of 4.3 ± 5.4%, vs. 30.7 ± 3.4% for controls. For the regulated site dominated by native stalked mucilaginous diatoms, tadpole weight loss was 21.0 ± 9.2 (cold) and 16.6 ± 5.6 % (warm). These results indicate the importance of biotic factors, such as the composition of the periphyton community, to define the realized niche. Despite the presence of preferred thermal conditions, food resources can be limiting.

Temperature, both colder and warmer than preferred, also affects susceptibility to predators and parasites. The smaller size of tadpoles at colder temperatures and longer larval period increases their risk of predation by macroinvertebrates. On the other hand, at warmer temperature locations, non-native predators, such as bass and bullfrogs are more likely to be present (Fuller 2008). Both are known to have negative effects on FYLF populations. Some parasites, such as the copepod *Lernaea cyprinacea*, are thermophilic and become more prevalent in dry years when discharge is low and summer temperatures exceed long term averages (Kupferberg et al. 2009b). For example, at the two warmest Clavey sites where 2009 M30AT was 24.0 and 24.2, copepod infection prevalence was 42% among tadpoles and metamorphs in late August compared to only one infected individual observed in the Rubicon during the same time period. In the lower, warmer reach of the South Yuba River introduced piscivorous smallmouth bass (warm water species) are abundant. Their upstream distribution is limited by a barrier (Gard 1994). The abundance of hardhead and pikeminnow (and the distribution of California roach) are severely limited in the lower river reach due to smallmouth bass predation (Gard 1994; 2004).

III. Landscape scale observations of realized thermal niche.

Methods and Data Sources

There are several Sierran and Coastal locations where temperature monitoring and FYLF surveys have been conducted in which the longitudinal profile of upstream cold to downstream warm summer temperatures provides a basis for predicting changes in thermal suitability in the Yuba River system (see list below). Although populations may be small for any number of reasons, such as lack of post-metamorphic tributary refugia for frogs, absence of appropriate physical habitat, or poor reproductive success when spring or early summer flows fluctuate rapidly and cause eggs to scour or strand, we reason that large populations would not be able to flourish at temperatures that are marginal in terms of preference or performance. Therefore, we compiled temperature data (empirical and modeled output) for the years 2008 and 2009, for any available sites where frog abundance could be reliably estimated. 2008 and 2009 were relatively dry years with relatively warm temperatures; at the sites where temperature data was available in 2010 and 2011, temperatures were up to 3°C colder (Figure 3). We plotted the maximum 30 day average water temperature (2008 and 2009) as the predictor variable and abundance of breeding frogs as the response variable.

Similarly we evaluated the distribution of hardhead in the South and Middle Yuba rivers in terms of the M30DAT index of summer temperature, and made comparisons with the Rubicon River.

Water temperature during relatively dry years was assumed to represent the conditions that allowed population survival at the upstream extent (cold water extent) of population distributions. During wet water years, with colder temperatures, it was assumed that the upstream extent of the hardhead or FYLF distributions may not successfully recruit juveniles or metamorphs into the population due to the limited growing season. For juvenile hardhead, limited growth/size could increase susceptibility to predation or decrease overwinter survival. For frogs, tadpoles might not reach metamorphosis prior to the first fall rains and flooding events or, if they did complete development, they might be too small to survive the winter.

The frog sites and data sources used are as follows:

1. Middle and South Yuba river and Canyon Creek – Egg mass surveys from 2008-2009 by HDR and temperatures from empirical observations (thermographs at breeding sites and interpolated along the length of the river from calibrated temperature model results, as necessary).
2. Middle Fork American River and North Fork of the Middle Fork American River – Egg mass surveys in 2007 conducted for PCWA and temperatures from empirical observations (thermographs at sampling locations and interpolated along the length of the river from calibrated temperature model results, as necessary). Additional temperature data collected in 2010 by Catenazzi.

3. Lower Rubicon River – Egg mass surveys in 2007 conducted for PCWA and temperatures from empirical observations (thermographs at sampling locations and interpolated along the length of the river from calibrated temperature model results, as necessary). Additional temperature data collected in 2010 by Catenazzi.

4. North Fork Feather River – Breeding survey data collected by Garcia and Associates (2009, 2010) averaged over a 5 year period (2006-2010). Egg mass counts were converted to density on a per km basis by dividing the 12 km Poe reach into 1 km segments and placing the surveyed reaches within the appropriate segments. Temperature data collected from thermographs placed within frog breeding sites.

5. Clavey and Tuolumne rivers – Egg mass counts were not done in the Clavey, but tadpole and metamorph surveys were conducted. Egg masses were never found in the Tuolumne, but a few tadpoles were observed (2008-2012). Thus, qualitative estimates of relative abundance on a scale of zero to one were made based on observations at temperature monitoring sites. The Clavey sites offer a relevant comparison with the Yuba because of the largely granitic watershed and similar elevational range where temperatures were monitored (385-784 m). Temperature data collected by Catenazzi and Kupferberg in the Clavey. McBain and Trush, for the San Francisco Public Utility District in the Early Intake reach of the Tuolumne River downstream of O'Shaughnessy Dam.

6. Eel River watershed. In Mendocino Co. Breeding surveys and temperature monitoring were conducted by Catenazzi and Kupferberg in 14 1ocations ranging from 1st to 4th order streams in the South Fork Eel watershed (471-395 m elevation), the mainstem Eel River downstream between Scott Dam (Lake Pillsbury) and Lake Van Arsdale (530-455 m elev), and tributaries flowing into that reach (Bucknell and Benmore Creeks).

Results of Compiled Distribution and Temperature Data.

Empirical observations (Figure 4) of the spatial distribution of FYLF breeding are generally consistent with experimental observations that optimal growth and development of larvae occurs at summer maximum 30 day average temperatures (M30DAT) near or above 20°C. In the Sierra, at the upstream extent, M30DAT ≤ 19.3°C appears to limit the presence of relatively abundant frog breeding populations. This threshold temperature is associated with the FYLF population in Middle Yuba River near confluence with Wolf Ck., where abundance is known only from 2008. All other Sierran sites with relatively abundant frog breeding populations, and sites with longer term frog monitoring records had warmer summer temperatures, 20.3- 24.2 °C dry year M30DAT. In the Eel watershed (coastal climate), the cold limit of abundant populations appears to be lower than the Sierra, perhaps somewhere below 18.8°C (dry year M30DAT). However, a gap in sampled sites with temperature in the 17-18.8°C range exists in the data.

Where M30DAT ≤ 19.3°C in the Sierra, the density of breeding frogs was ≤ 5/km. Although there is uncertainty in determining a minimum viable population size for FYLF, these small populations may not be sustainable when abiotic, biotic, or anthropogenic stressors such as cooler temperatures and mortality due to untimely flow fluctuations decrease recruitment. An empirically derived viability threshold in the absence of anthropogenic stressors could be developed by examining the least dense, yet stable, populations. In the Sierra, there are few unregulated sites with long term monitoring histories, however, the population in Shady Creek has a density of 5.4 clutches/km, based on six years of data (S. Yarnell, pers. comm.). In regulated rivers with long term monitoring, sites where breeding density is lower (approximately 2 clutches/km) appear to be in strong demographic decline (see NF Feather River Cresta reach and Alameda Creek below Calaveras Dam, Kupferberg et al. 2012).

IV. Effect of Temperature on FYLF and Hardhead in the Yuba River

FLYF and Hardhead/Pikeminnow Temperature Criteria and Existing Distribution

Maximum 30 day average temperatures (M30DAT) ≥19.3˚C in drier water year types appear to be required for persistence of sub-populations of FYLF in the Sierra (Figure 4). Summer temperatures warmer than that (20-22˚C) are needed for optimal and rapid growth and development of tadpoles (Kupferberg and Catenazzi data presented Sections II, III above). The known upstream distribution of FYLF in the South Yuba River is near the Fall Creek confluence (RM35.65). Sampling occurred further upstream in the vicinity of Jordan Creek (RM 40.5), in 2008 and 2009, but no FYLF were detected in 5 survey visits. The precise upstream limit for breeding FYLF in the mainstem South Yuba River is unknown, but likely occurs near Rucker Creek (RM37.0) where the existing M30DAT water temperature is approximately 19.3˚C (Figure 5). FYLF breeding in Canyon Creek was confirmed at 20.3˚C M30DAT near Little Canyon Creek (RM1.1), but may exist upstream to at least RM2.1 where the existing M30DAT water temperature is approximately 19.3˚C (Figure 6). The upstream FYLF distribution in the Middle Yuba River is likely somewhere near National Gulch (RM29.55), near the upstream end of FYLF sampling.

The distribution of hardhead was not identified in Yuba-Bear or Drum-Spaulding relicensing sampling of the Middle or South Yuba Rivers (PG&E and NID 2010). A number of historical sampling studies have clearly identified hardhead in both rivers (Knight 1985; Gard 1994; Gast et al. 2005). PCWA conducted qualitative snorkeling surveys and positively confirmed large (adult) hardhead in the South Yuba River upstream to near Humbug Creek (biologist observations and underwater pictures) and potential hardhead, small mixed minnows, as far upstream as Scotchman Creek (RM30.0). At Scotchman Creek the 2008 and 2009 M30DAT water temperature was 23˚C (Figure 5). The upstream distribution for Hardhead in the adjacent Rubicon River (with very similar watershed and river characteristics compared to the South Yuba) is at the same M30DAT temperature location (M30DAT 23.1˚C, 23.3˚C and 23.0˚C in 2006, 2007, 2008, respectively) (PCWA 2011). This is also the same temperature where minnows (presumably Sacramento pikeminnow/hardhead) exist in the Middle Yuba River just upstream of the Our House Dam (Gast et al. 2005). From the observation that the upstream end of pikeminnow-hardhead habitat occurs at a M30DAT of 23˚C, we can estimate the river mile at which this threshold will be reached under the alternative temperature regimes.

Water Temperature Regimes

Two different water temperature regimes are compared to the existing water temperature regime in the South and Middle Yuba rivers and Canyon Creek (2008 and 2009 temperature modeling). One water temperature regime (CDFG) is related to a recommendation by CDFG that would limit water temperature in the South Yuba River above Canyon Creek and in the Middle Yuba River above Wolf Creek to <19˚C. The other temperature regime (NMFS) is related to recommend flow and temperature criteria in the South Yuba and Middle Yuba rivers and recommended flow in Canyon Creek. The NMFS water temperature criteria require maintaining water temperatures <19˚C in the South Yuba River above Poorman Creek and the Middle Yuba River above Plumbago Road crossing (RM26).

CDFG Water Temperature Regime

The CDFG recommended <19˚C temperature requirements would result in summer temperature in the South Yuba River that would be 4-5˚C M30DAT colder than estimated unimpaired or existing reference conditions (Figures 5 and 7). Summer water temperatures in the South Yuba River are naturally warm due to the open granite basin/river canyon and the low natural summer flows (Figures 5 and 7a-b). Canyon Creek temperatures are 2˚C colder (Figures 6 and 8a-b). In the Middle Yuba River water temperatures, would be approximately 1˚C colder than reference conditions (Figures 9 and 10).

NMFS Water Temperature Regime

The NMFS recommended flows cause substantial cooling, 4-6˚C M30DAT, in the summer temperature regime of the South Yuba River (Figures 11 and 12). The South Yuba River water temperature is naturally warm due to the open granite basin/river canyon and the low natural summer flows (Figures 7a, 11, and 12). In Canyon Creek, the flows (Figure 4) reduce temperatures by more than 2˚C M30DAT (Figures 13 and 14a-b). In the Middle Yuba River the resulting temperatures are much colder, 3˚C, than reference conditions (Figures 15 and 16).

Water Temperature Models

Because the temperature modeling slightly over predicts actual water temperature, the absolute cooling of water temperature in the South Yuba and Middle Yuba rivers as a result of the CDFG or the NMFS's water temperature regimes is 0.5˚C and 0.65˚C, respectively, colder than the modeling output[1]. Coldwater leakage flows from Jordan Creek were not included in the South Yuba River temperature modeling (Rick Jones, Pers. Comm.) and Figure 7b show that, for example, at the above Canyon Creek location measured temperatures are 0.5˚C lower than modeled Base Case conditions. In the Middle Yuba River the measured water temperature from Wolf Creek upstream is cooler than the modeled Base Case water temperature (approximately 0.65˚C at Wolf Creek) (Figure 10).

Effects of Water Temperature Regimes on FYLF and Hardhead Habitat

The effects of the CDFG and NMFS temperatures regimes on existing FYLF and hardhead populations and habitat are evaluated using the FYLF (≥19.3˚C) and hardhead (≥23˚C) criteria.

CDFG Water Temperature Regime

The CDFG water temperature regime (<19˚C in the South Yuba River above Canyon Creek and in the Middle Yuba River above Wolf Creek) results in an overall loss of 11.5 miles of FYLF habitat. In the South Yuba River (including the Canyon Creek population), approximately 7.5 miles of FYLF habitat would be lost (Figures 5 and 6). Upstream tributaries populations would also become isolated (e.g., Fall Creek and

[1] The model temperature bias should be similar for all modeling scenarios (Base Case and NMFS Recommended flow) and the relative change in temperature for the modeled Base Case and NMFS Recommended flows should be approximately correct.

Diamond Creek). In the Middle Yuba River 4 miles of FYLF habitat would be lost including the Wolf Creek Confluence area (Figure 9).

Approximately 14 miles of hardhead/pikeminnow habitat would be lost in the South Yuba River (from the current upstream location of approximately RM30 to a future upstream location of approximately RM16) with the CDFG temperature regime (Figure 5). In the Middle Yuba River, approximately 1 mile of hardhead/pikeminnow habitat immediately upstream of YCWA's Our House Diversion (RM13.1) could be lost.

NMFS Water Temperature Regime

NMFS's recommended flows, in total, result in an overall loss of 19.5 miles of FYLF habitat (Figures 11, 13, and 15). In the South Yuba River, approximately 7.5 miles (RM 37 to RM 30) of FYLF habitat would be lost and FYLF populations in two tributaries (Fall Creek and Diamond Creek) would become isolated and the population at Canyon Creek would be lost. In Canyon Creek, approximately 2 miles, the total extent of the habitat, would be lost (Figures 13). In the Middle Yuba River, NMFS's recommendation would result in the loss of approximately 10 miles of FYLF habitat (Figure 15). In addition, the relatively large Wolf Creek FYLF population would be eliminated.

The effects of the NMFS recommendation on FYLF will be greater than identified above. For example, in the South Yuba River the recommended flow regime does not cool water temperatures above Poorman Creek to <19˚C (typically to about 20˚C). Based on the NMFS recommendation, additional cooling of the river would be required and additional loss FYLF habitat would occur at and downstream of the Poorman Creek confluence.

Approximately 25.4 miles of hardhead/pikeminnow habitat (the entire extent of the habitat) would be lost in the South Yuba River (from the current upstream location, RM 30, downstream to the smallmouth bass barrier location, RM 5) with NMFS's recommended flows (Figure 11). In the Middle Yuba River, approximately 1 mile of hardhead/pikeminnow immediately upstream of YCWA's Our House Diversion (RM13.1) would be lost. Although we do not have water temperature modeling below Our House Diversion, it appears likely that NMFS's recommended flows would result in a loss of 4-5 miles of habitat below the diversion.

Water Temperature Timing Shift

In addition to cooler temperatures under the CDFG and NMFS recommended temperature regimes, modeling indicates, there will be a shift in the timing of when peak temperatures are reached, from early to late summer (Figures 7b, 10, 12, and 14). In California's broad and sunlit rivers, algal based food webs reassemble seasonally with the transition between wet and dry seasons when flood probability declines (Power et al. 2008). The seasonal synchrony between stable flow conditions, increasing day light, and warming temperatures allows periphyton, the resource important for FYLF tadpoles and adult hardhead, to bloom. Decoupling the timing of warming with daylength may have unintended consequences on the succession and species composition of the algae and diatoms in the periphyton community, which in turn determines the food quality for consumers (Furey et al. 2012). The temperatures for optimal growth of primary consumers, such as tadpoles, may no longer coincide with the availability of high quality food resources.

The shift in timing also de-couples temperatures when frogs breed from temperatures when tadpoles grow and develop. While water temperature changes may be prominent in late summer, decreases at time of breeding (late May and early June) are not below the range which is suitable for triggering oviposition. Note that in Figures 7b and 10 the base case and modeled scenario thermographs are close together, or even cross, in early June. This has the potential to create an 'ecological trap'. Although FYLF are capable of moving several kilometers between adult home territories in cooler habitats to warmer mainstem breeding sites (Bourque 2008, Gonsolin 2010), we hypothesize that there will be a lack of proximal environmental cues to trigger compensatory changes in migration. Specifically for the South Yuba River, a key question is what late spring or early summer environmental cue would induce frogs from Diamond Creek or Canyon Creek to migrate further downstream to Scotchman and Poorman Creek confluences where summer temperatures would begin to be suitable? If frogs continue to lay eggs at historically used sites because the physical habitat in terms of depths, velocities, substrates, and channel cross-section shape will not have changed, then their offspring may face unfavorable thermal conditions months later. When temperatures do not warm sufficiently later in the summer, tadpole survival will be reduced and metamorph size will be smaller.

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Tables

Table 1. Nutritional analysis of algae used in feeding experiment.

Site	Regulated/Unregulated and Algae	% N (Total)	% Protein	% Crude Fat	% Si (Total)	AFDM (mg/cm2)	% organic material mean (SE)
Alameda Creek	Unregulated, high food-quality periphyton	1.64	10.3	0.39	8.32	3.2 (1.1)	45.7 (4.1)
MF American	Regulated, *Didymosphenia*	0.26	1.6	<0.25	13.51	4.4 (0.7)	10.7 (0.89)
NF Feather	Regulated, native mucilaginous diatoms	0.86	5.4	<0.25	16.21	8.5 (0.6)	20.6 (1.5)

Figures

Figure 1. Tadpole locations (green rectangles) and thermographs from near shore habitat and thalweg at (top) Shady Rest site on the Cresta Reach of the North Fk. Feather River; (middle) downstream of Poe Dam near Flea Valley Creek; and (bottom) near Poe Powerhouse. Mean ± 1 SD temperature (points and error bars) at tadpole locations (n=20 per diurnal sampling time).

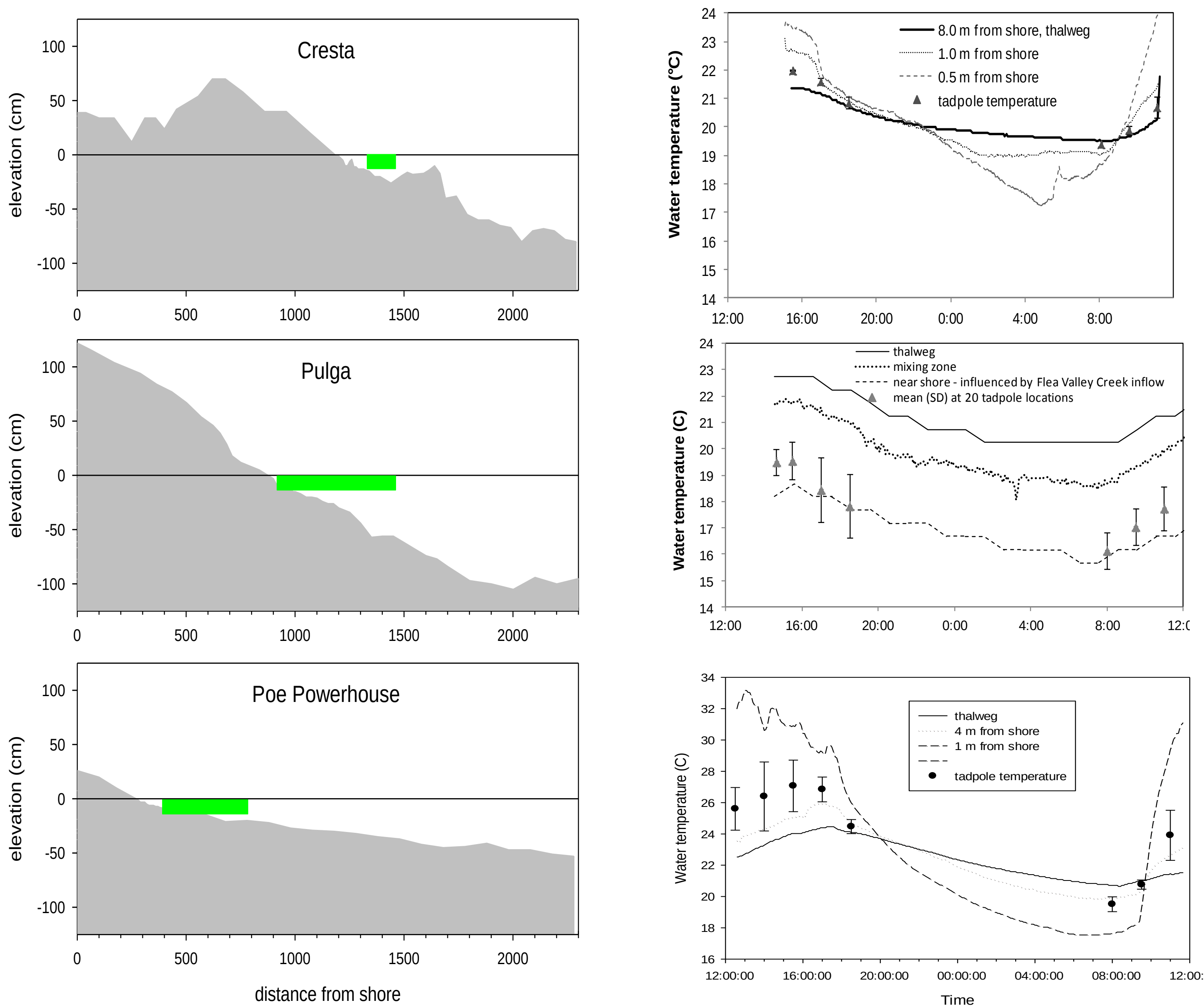


Figure 2. Survival (a), growth and development (b), and total production (c) of FYLF tadpoles in relation to mean daily temperature during the warmest 30 day period of the summer. Colored thermographs indicate minimum and maximum water temperatures measured hourly within the flow-through enclosures where tadpoles were reared from embryo (stage 12) to metamorphosis (stage 42). Closed symbols (a) indicate replicates fed a high quality diet, open indicates ambient periphyton as tadpole diet.

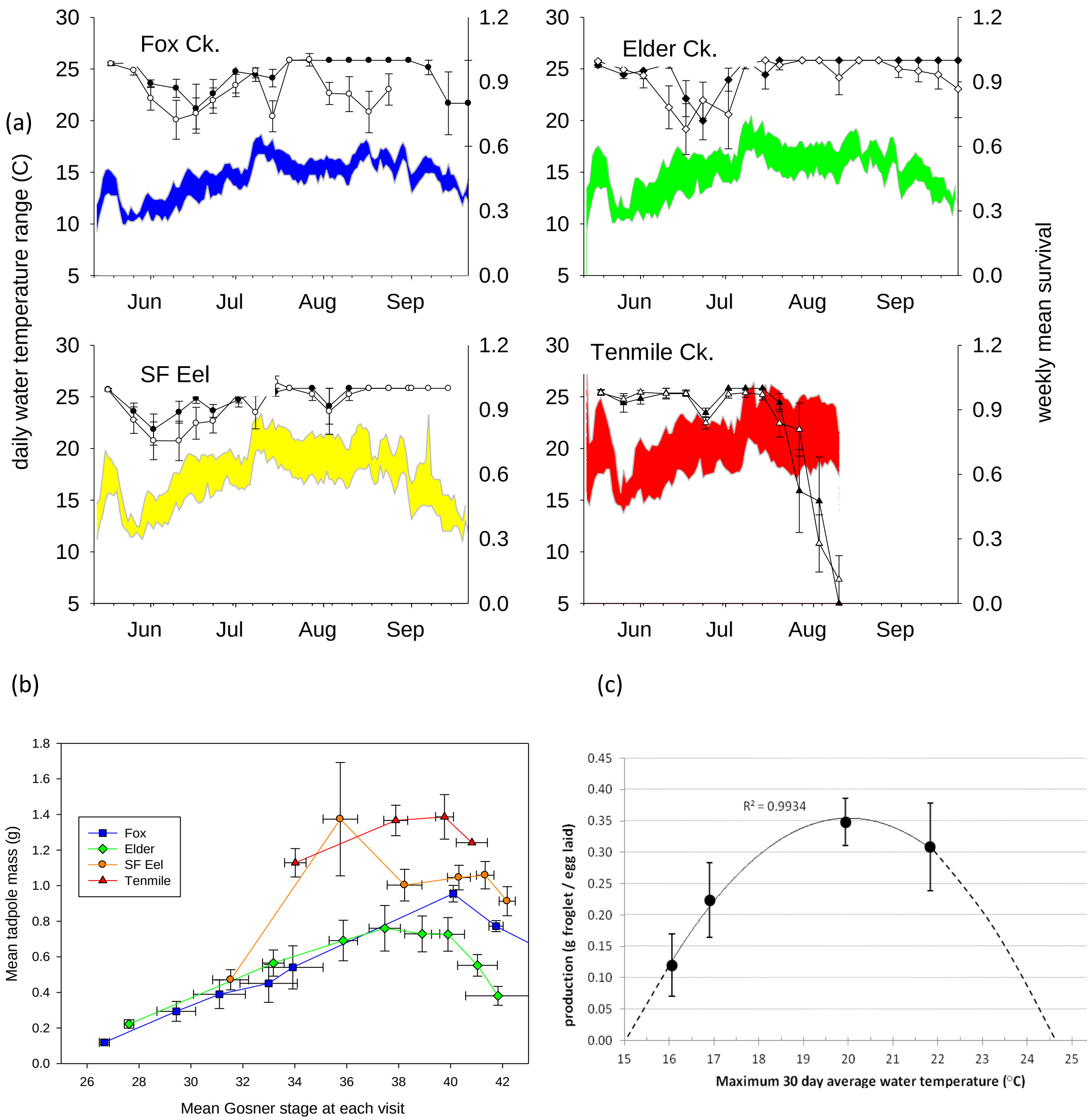


Figure 3. Among year differences in measured maximum 30 day average temperatures (M30DAT). Dotted lines indicate the most upstream observed location for breeding by Foothill yellow-legged frogs. In the Poe reach of the North Fk. Feather River, frogs are present throughout the reach and temperatures are based on monthly means reported by GANDA/PG&E 2009, 2010.

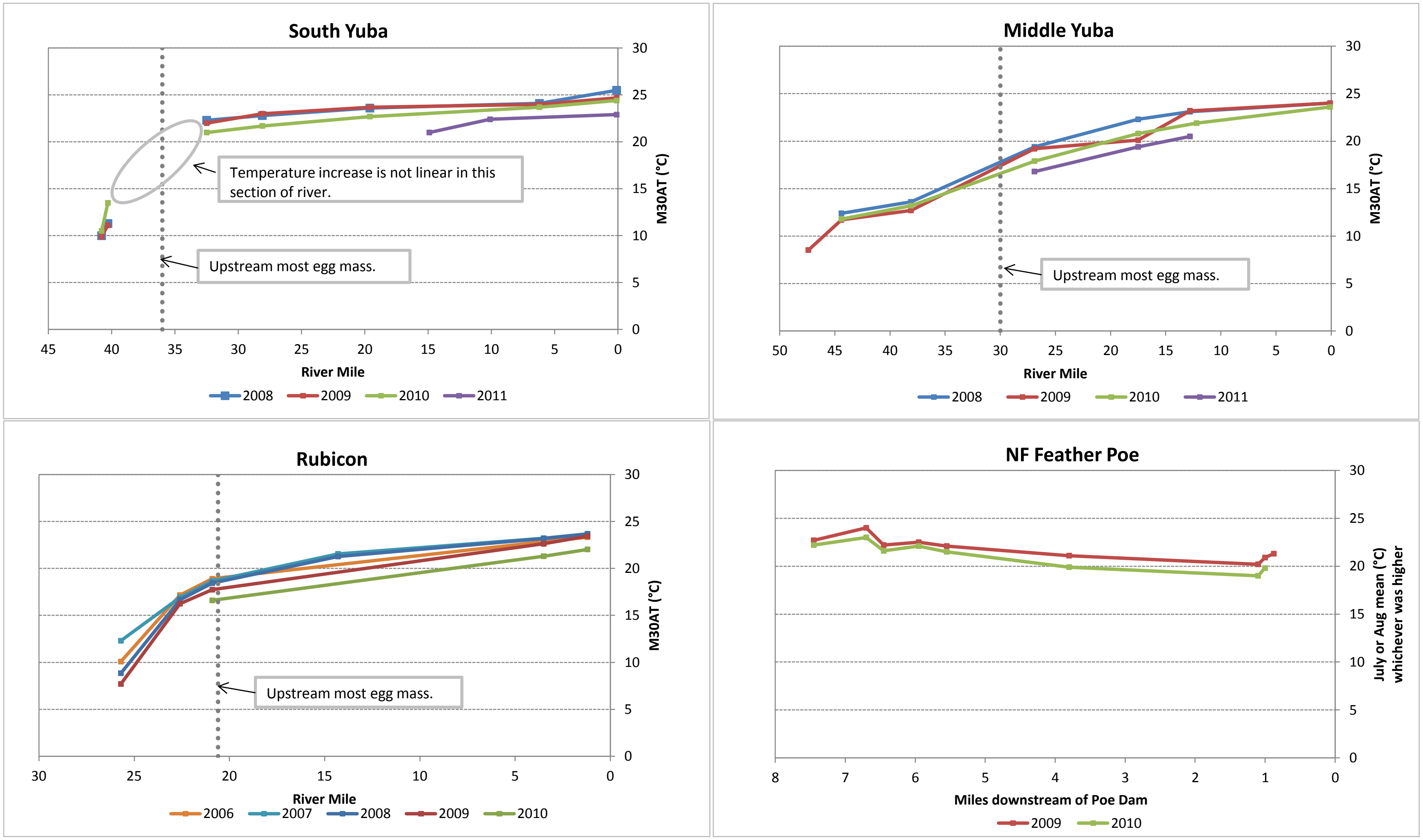
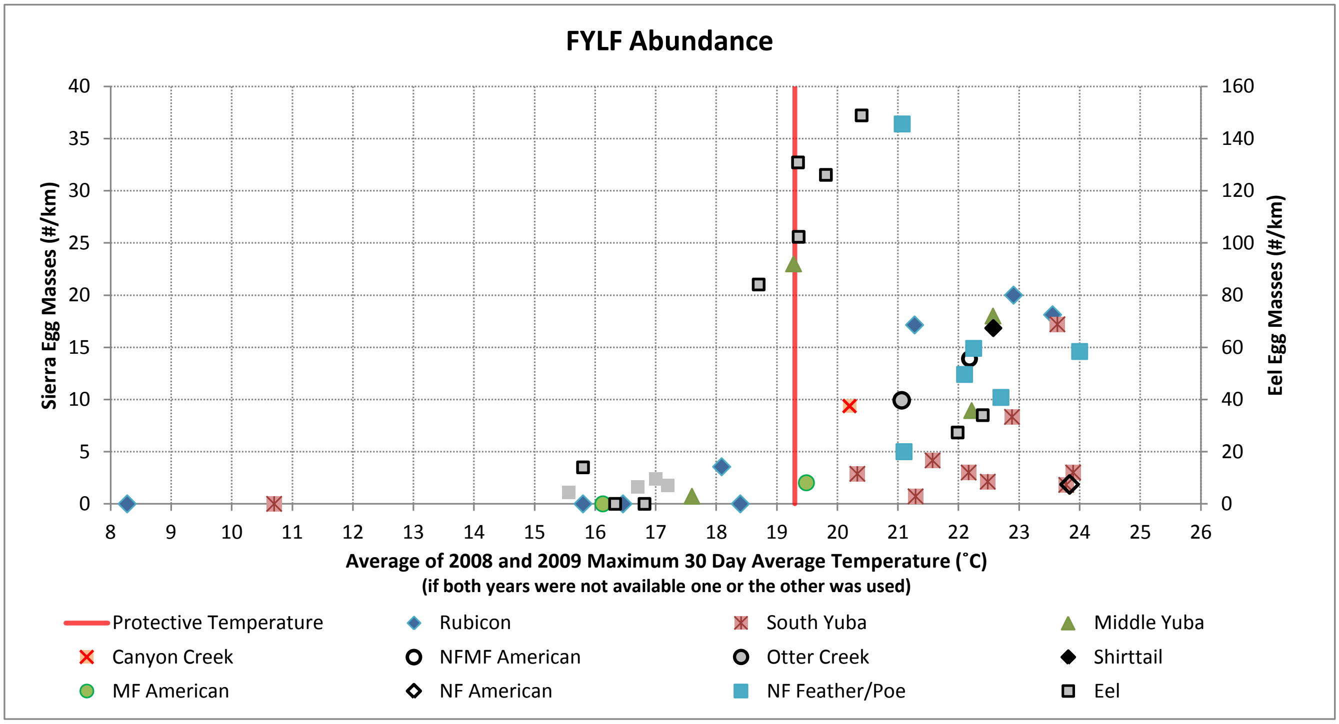


Figure 4. Breadth of summer thermal conditions where FYLF breeding occurs. The number of clutches per river kilometer is used as an index of breeding population size (top) or relative abundance (bottom) in which breeding density is standardized to the most abundant site in that reach or watershed. The index of the thermal regime is the maximum 30 day average water temperature (M30DAT). Markers with black perimeters denote frog population density in free-flowing rivers and those without a border indicate sites experiencing flow regulation. Note that abundance for the coastal Eel River watershed, grey squares, are plotted on a secondary axis with a different scale.



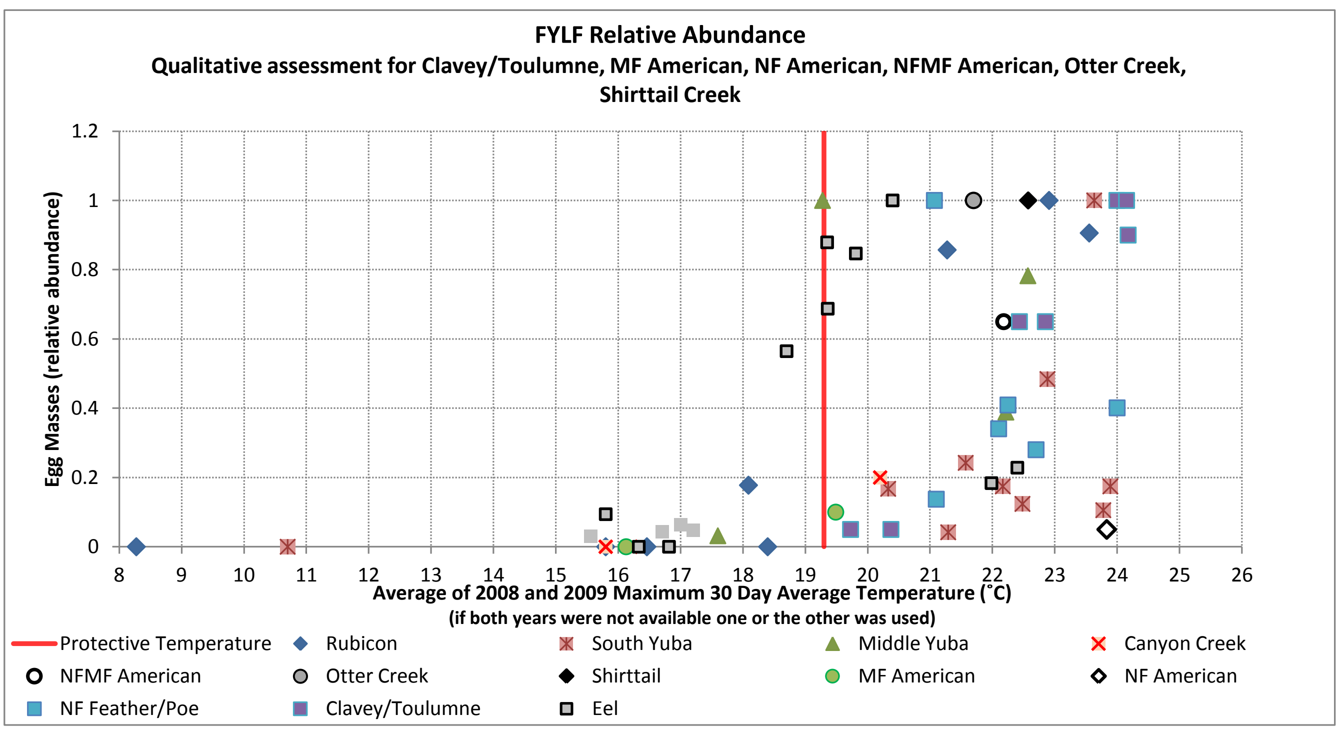
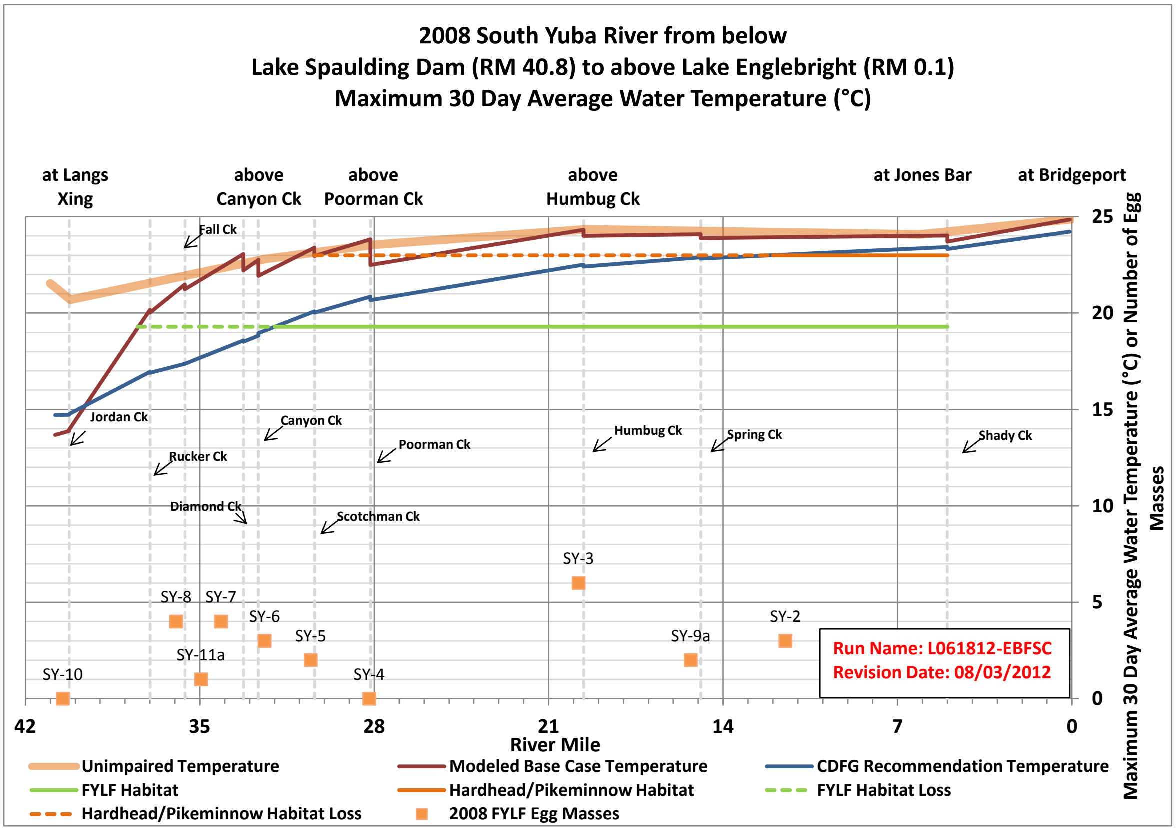


Figure 5. 2008 (top) South Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case, CDFG Recommendation, and Unimpaired Flows and 2009 (bottom) South Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and CDFG Recommendation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog and Hardhead/Pikeminnow Habitat Under the CDFG Recommendation Flows.



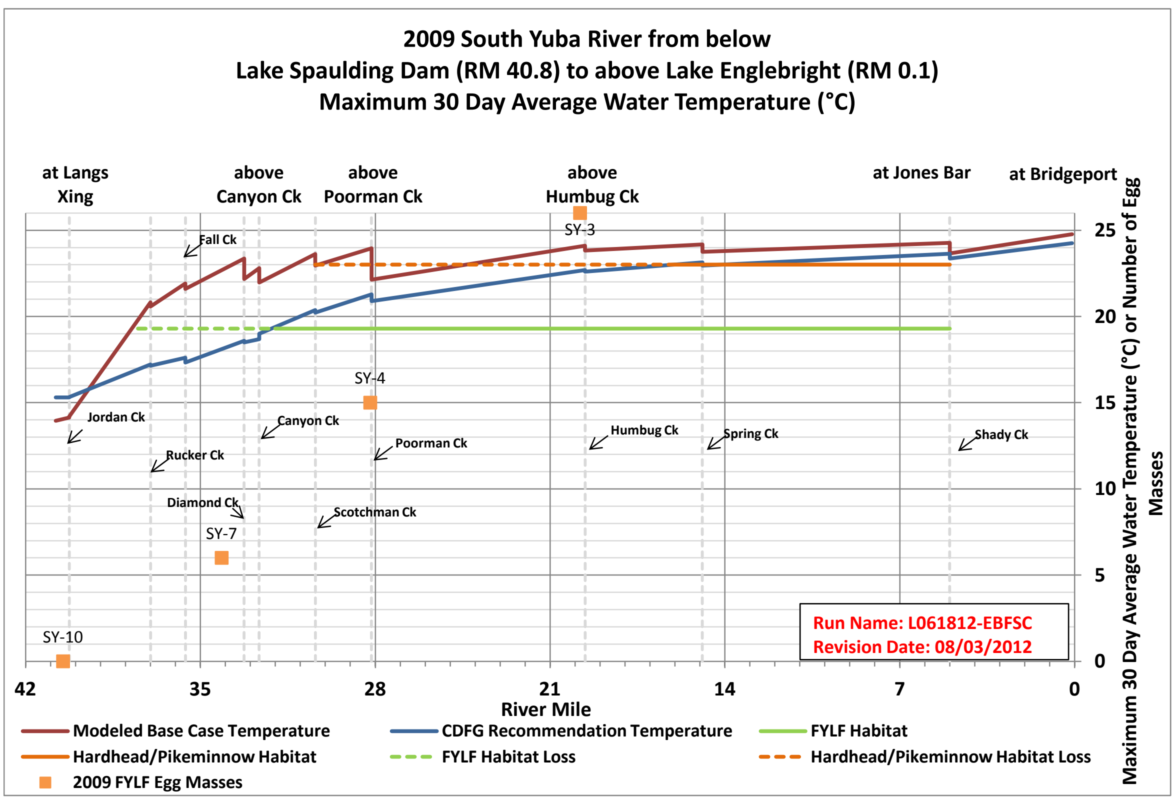
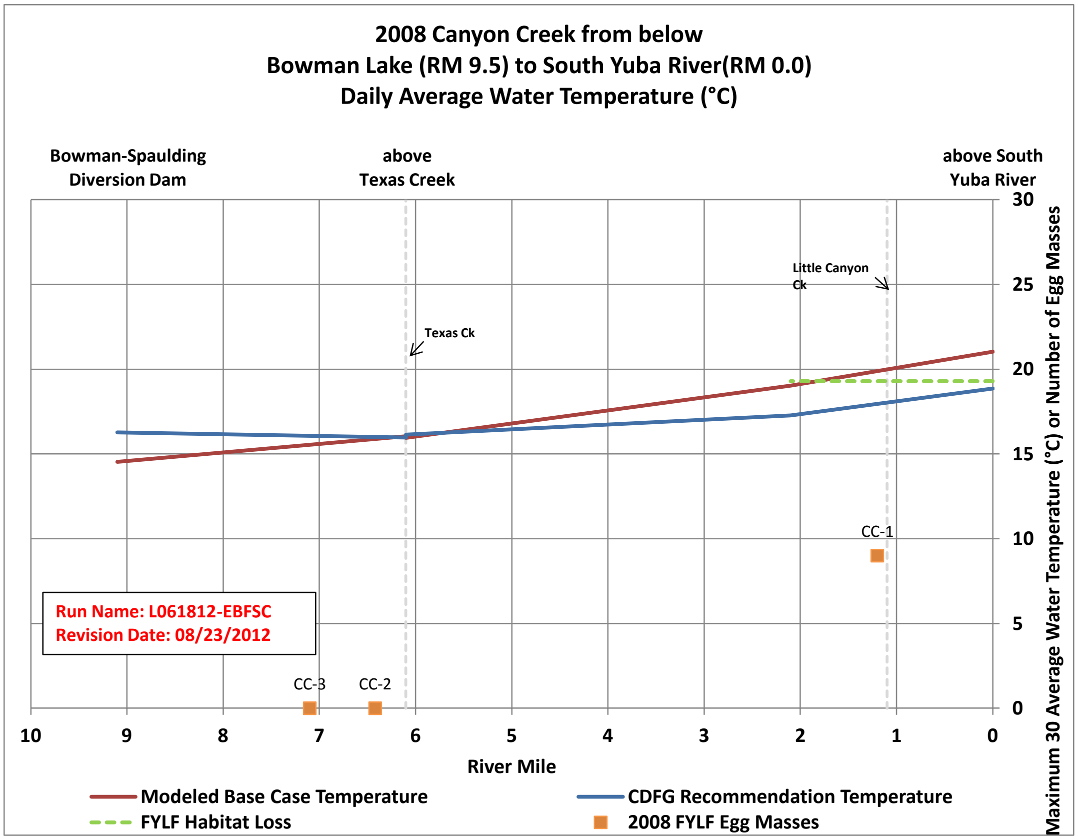


Figure 6. 2008 (top) and 2009 (bottom) Canyon Creek Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and CDFG Recommendation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog Habitat Under the CDFG Recommendation Flows.



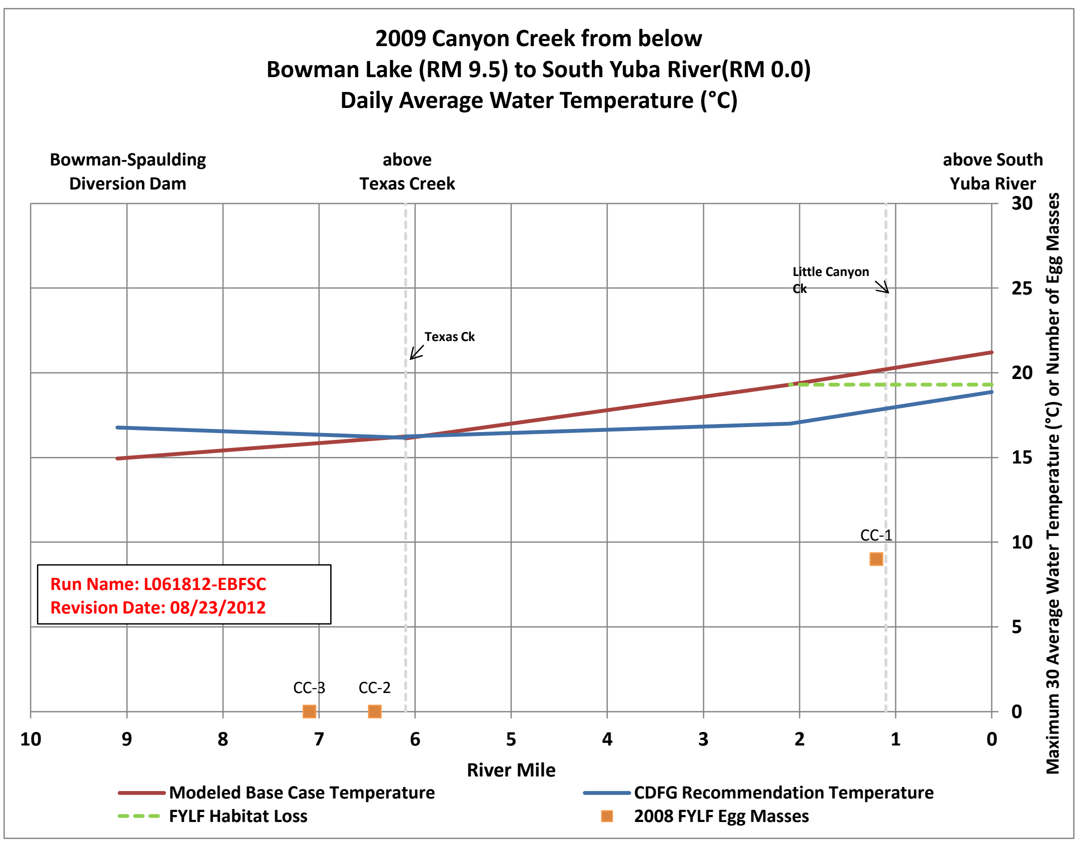


Figure 7a. 2008 South Yuba River Unimpaired Flow and Water Temperature.

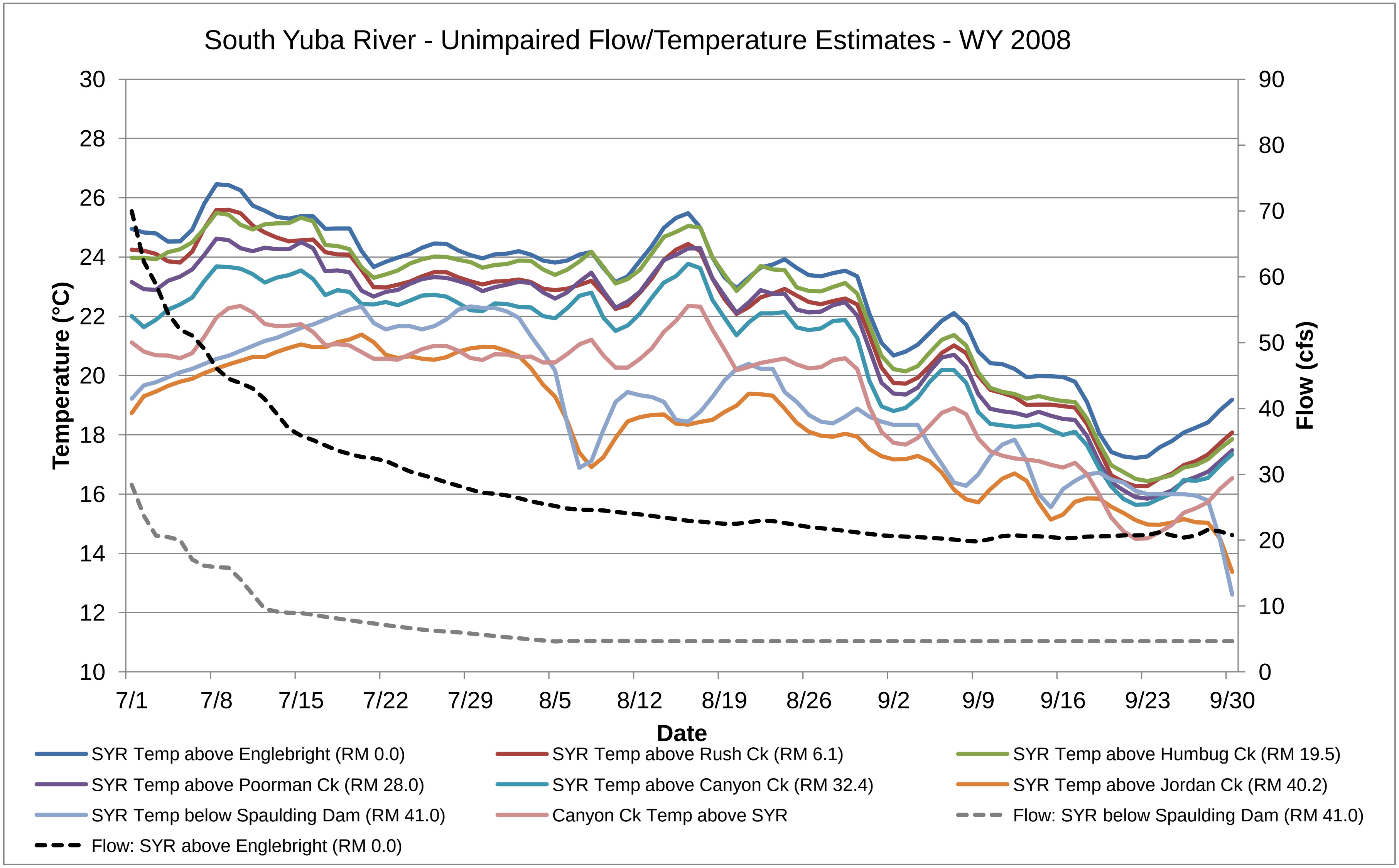
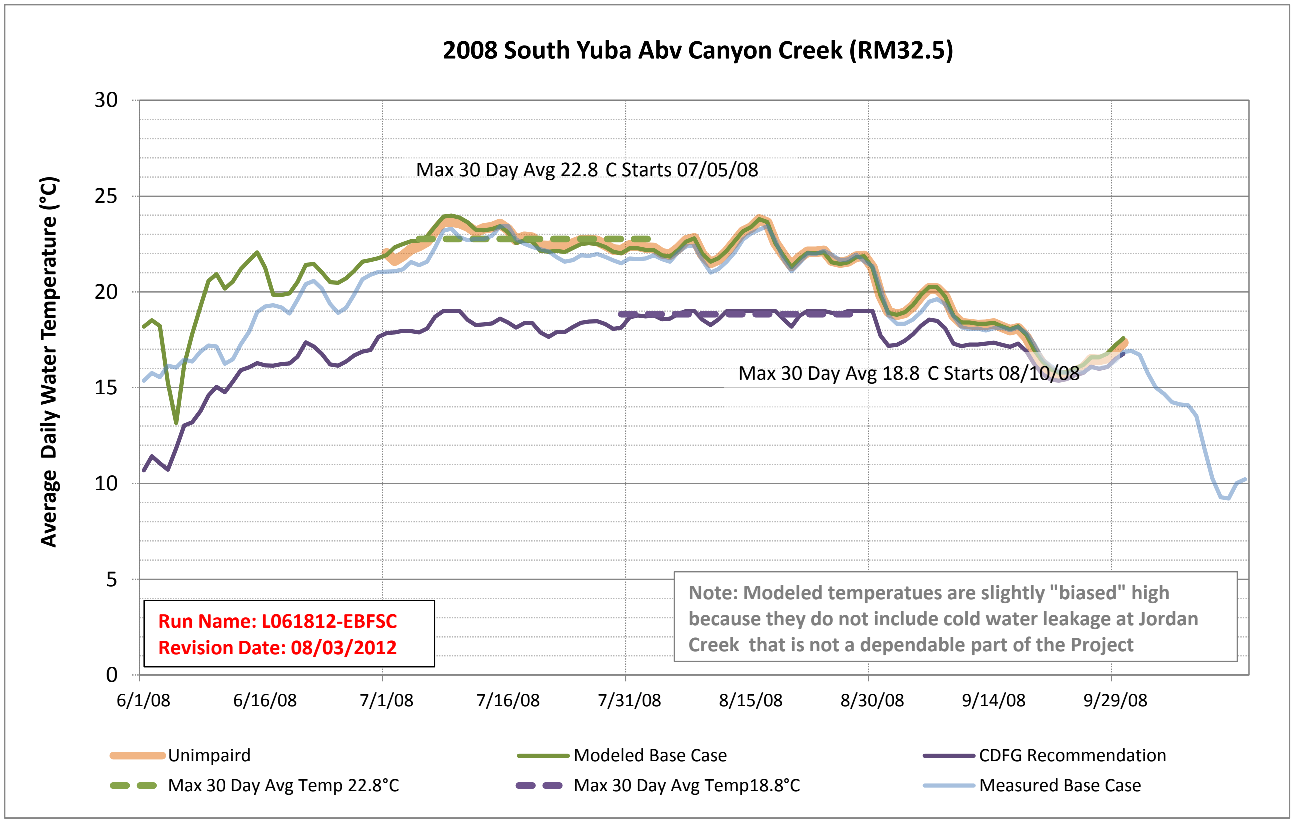


Figure 7b. 2008 (top) South Yuba River Average Daily Water Temperature For Modeled Base Case, CDFG Recommendation, Measured Base Case, and Unimpaired Flows Above Canyon Creek and 2009 (bottom) Modeled Base Case and CDFG Recommendation Flows Above Canyon Creek.



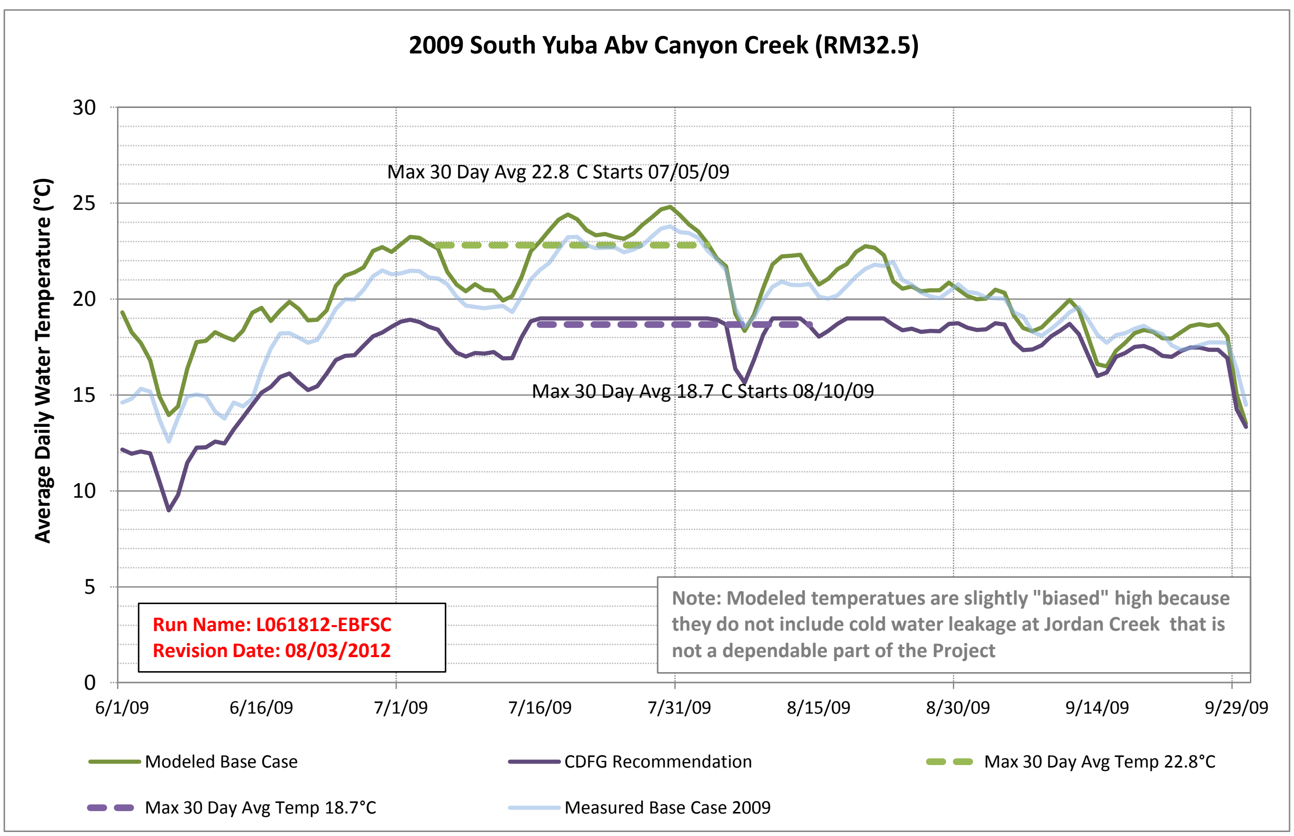
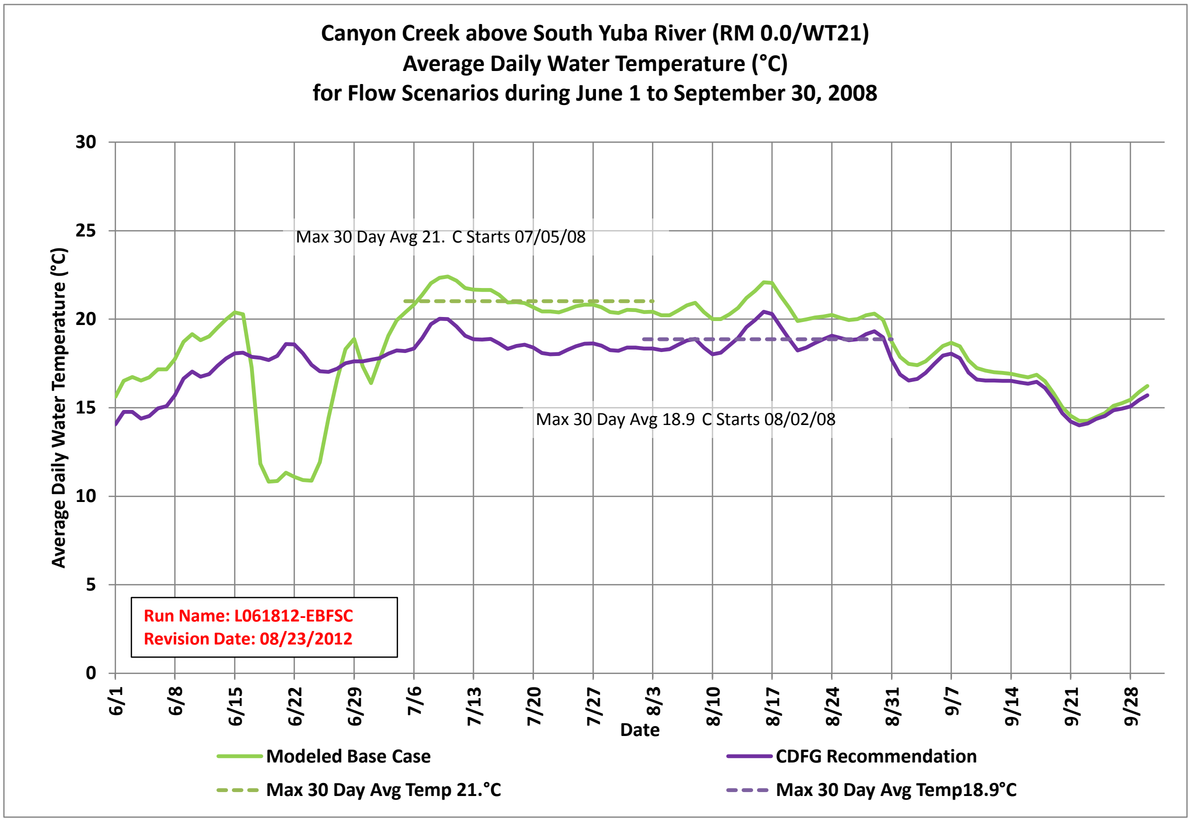


Figure 8a. 2008 Canyon Creek Average Daily Water Temperature For Modeled Base Case and CDFG Recommendation Flows Above the South Yuba River (top) and Above Little Canyon Creek (bottom).



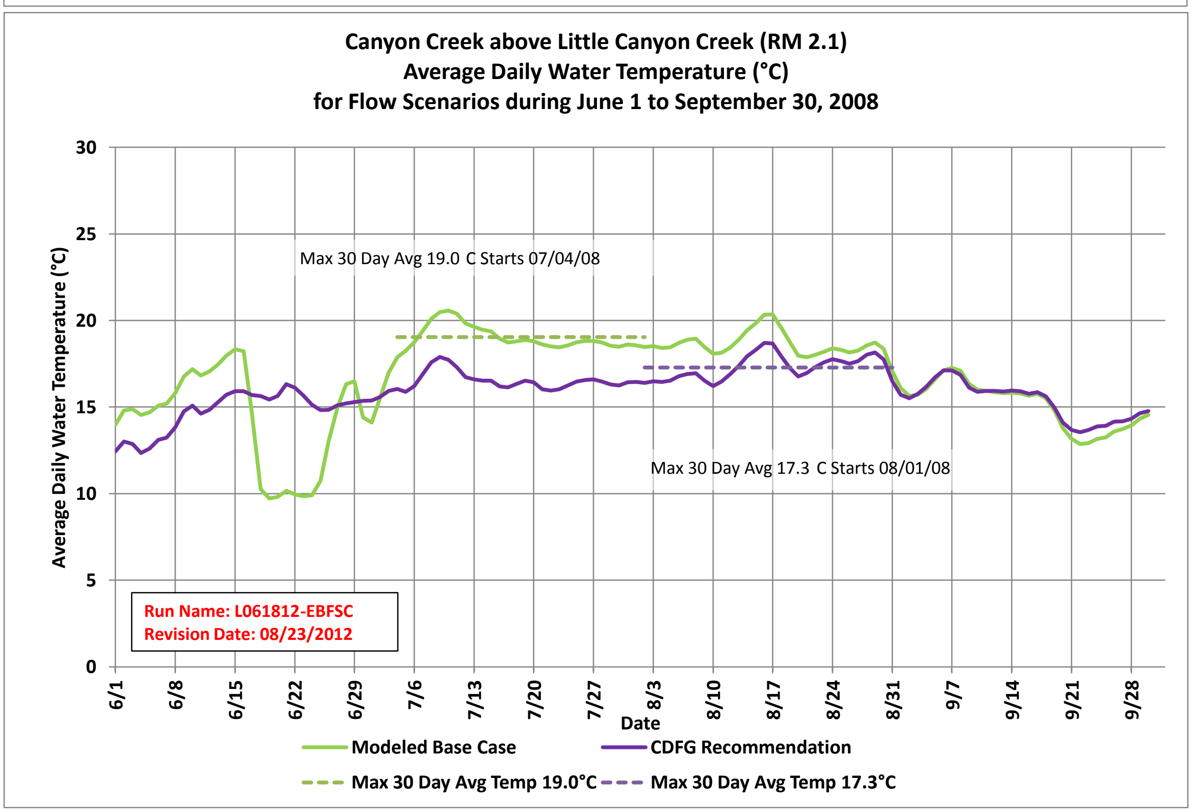
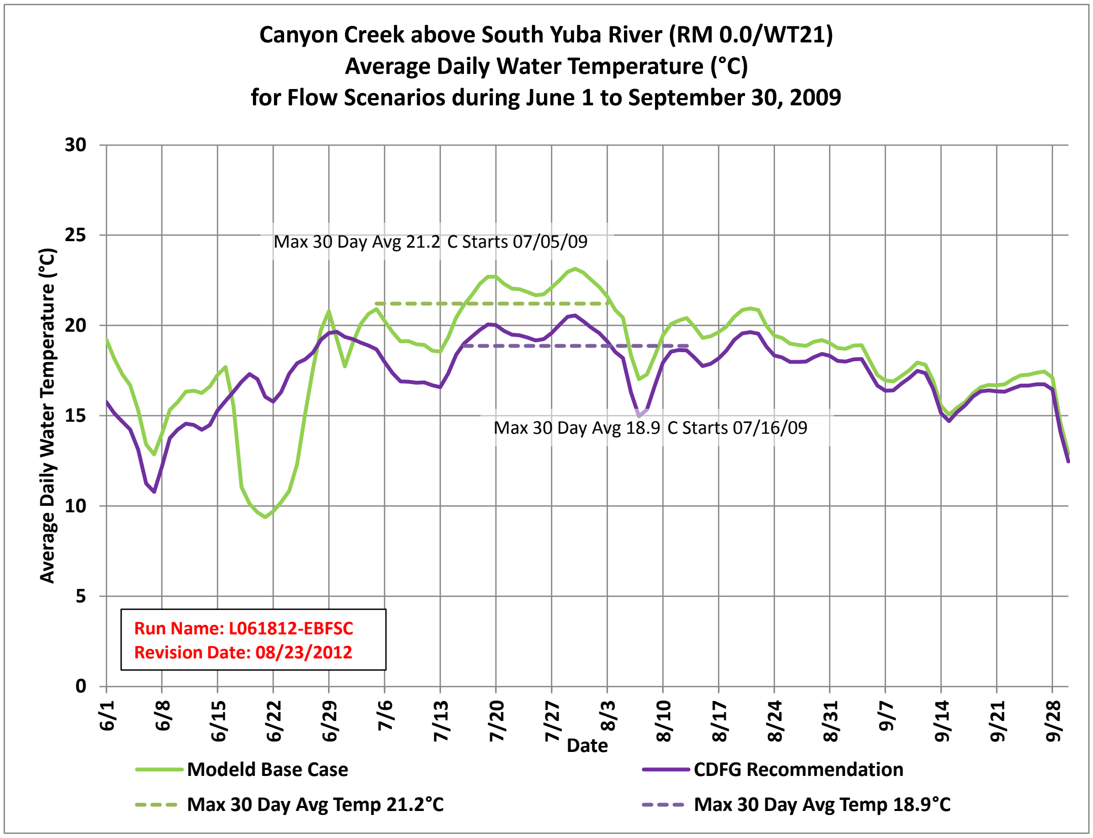


Figure 8b. 2009 Canyon Creek Average Daily Water Temperature For Modeled Base Case and CDFG Recommendation Flows Above the South Yuba River (top) and Above Little Canyon Creek (bottom).



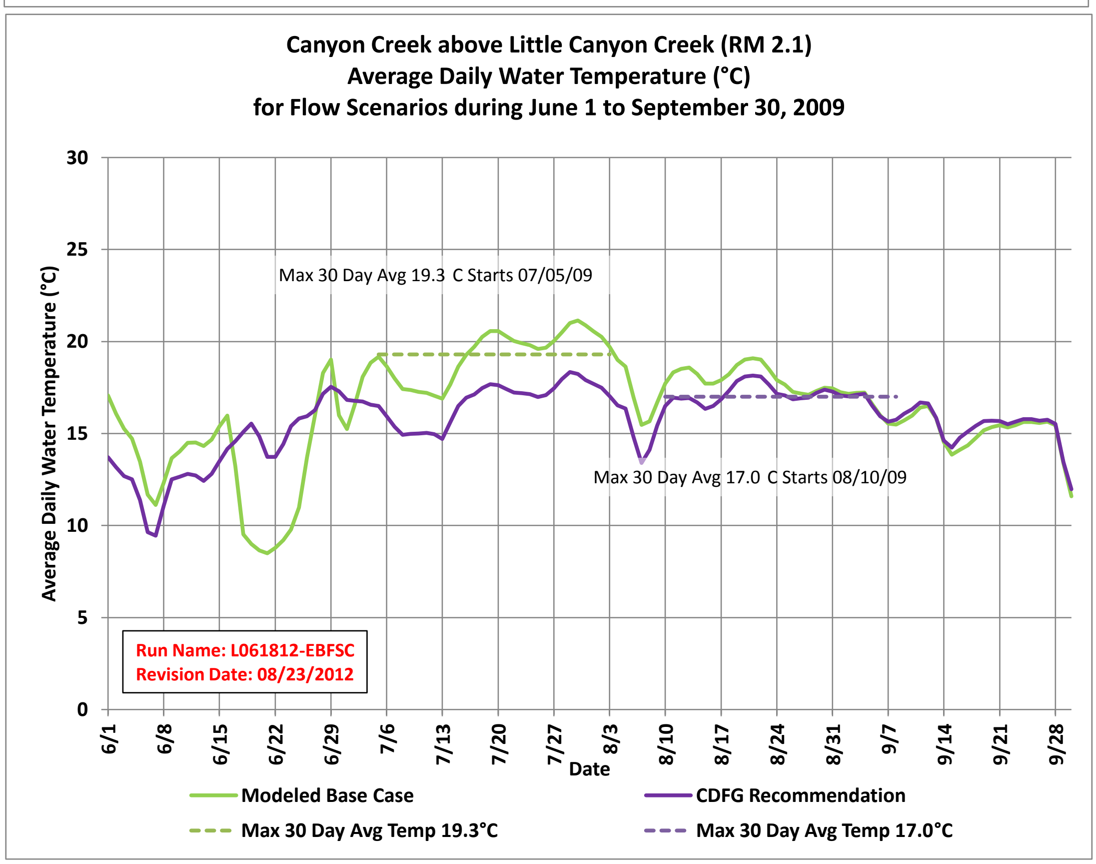
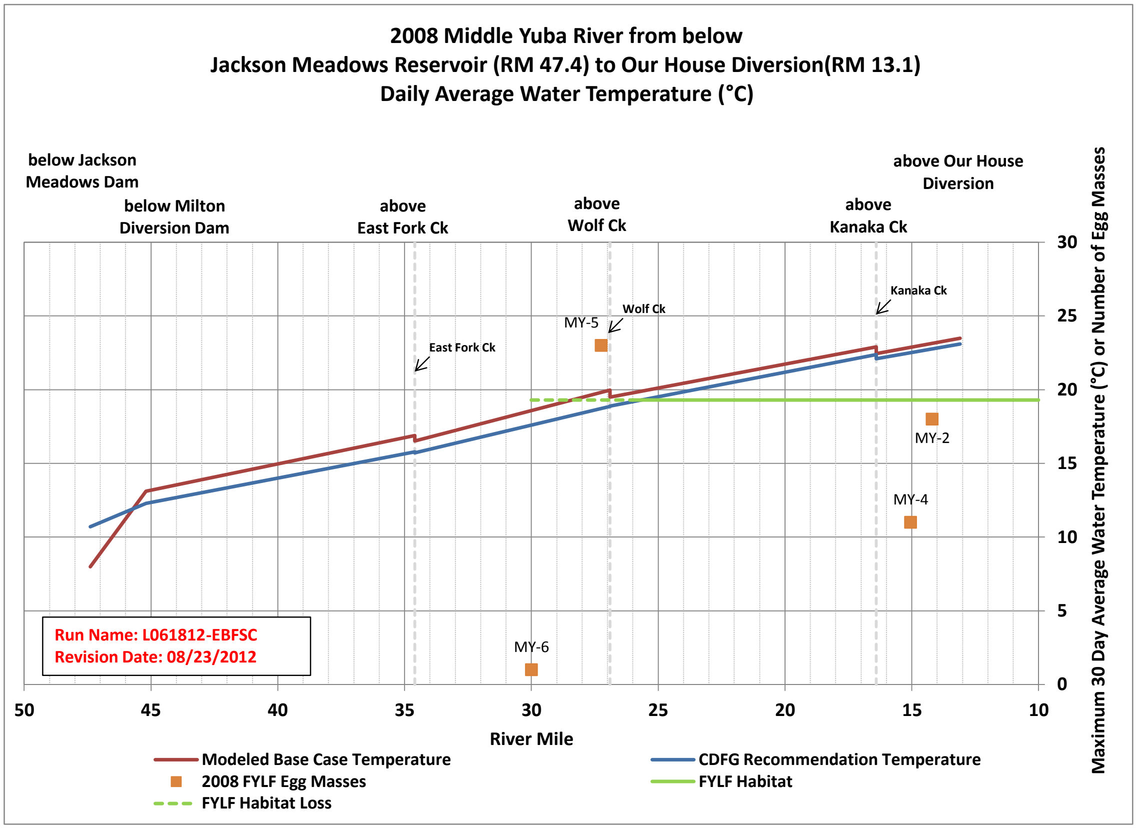


Figure 9. 2008 (top) and 2009 (bottom) Middle Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and CDFG Recommedation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog Habitat Under the CDFG Recommedation Flows.



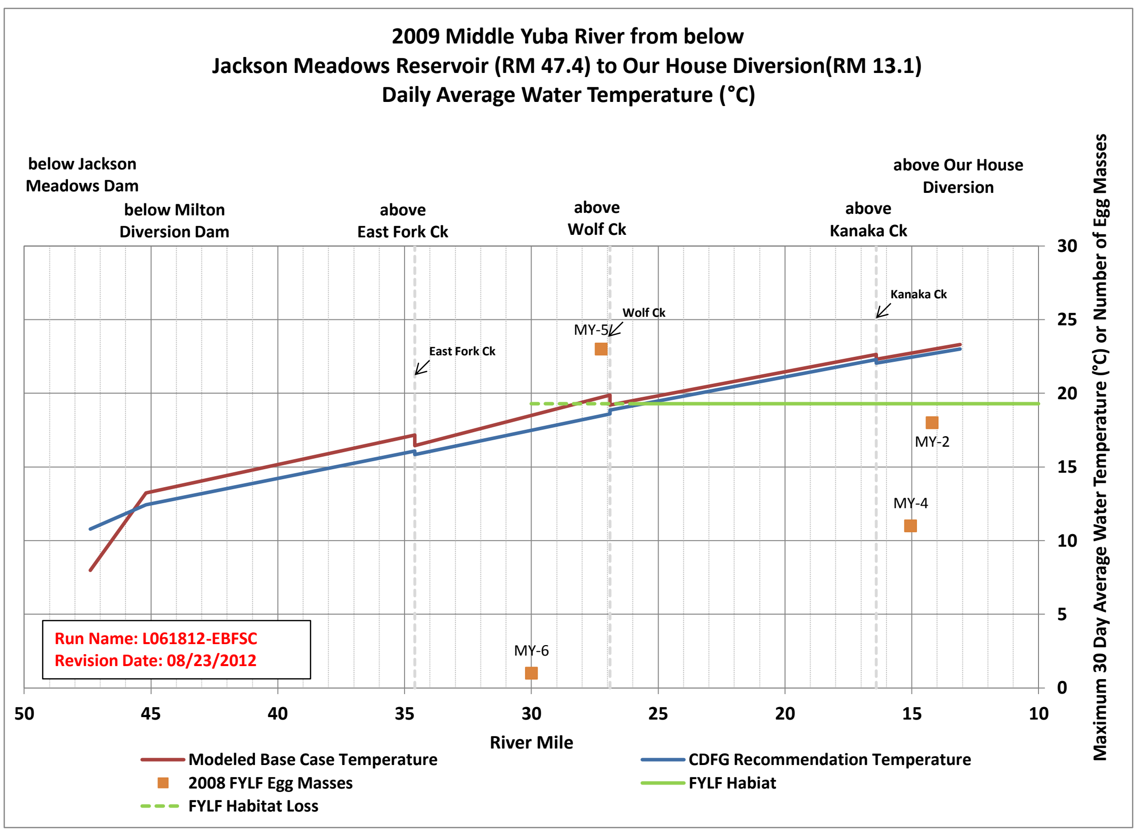
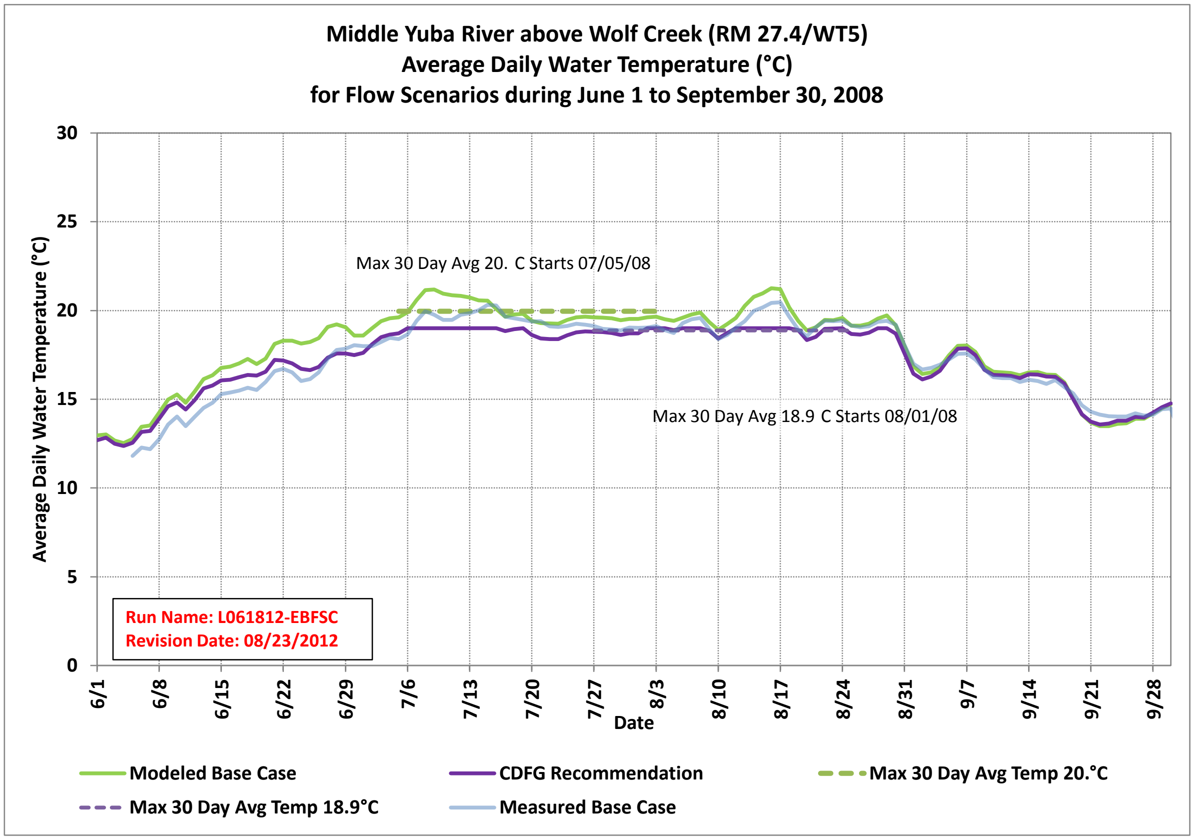


Figure 10. 2008 (top) and 2009 (bottom) Middle Yuba River Average Daily Water Temperature For Modeled Base Case, CDFG Recommendation, and Measured Base Case Flows Above Wolf Creek.



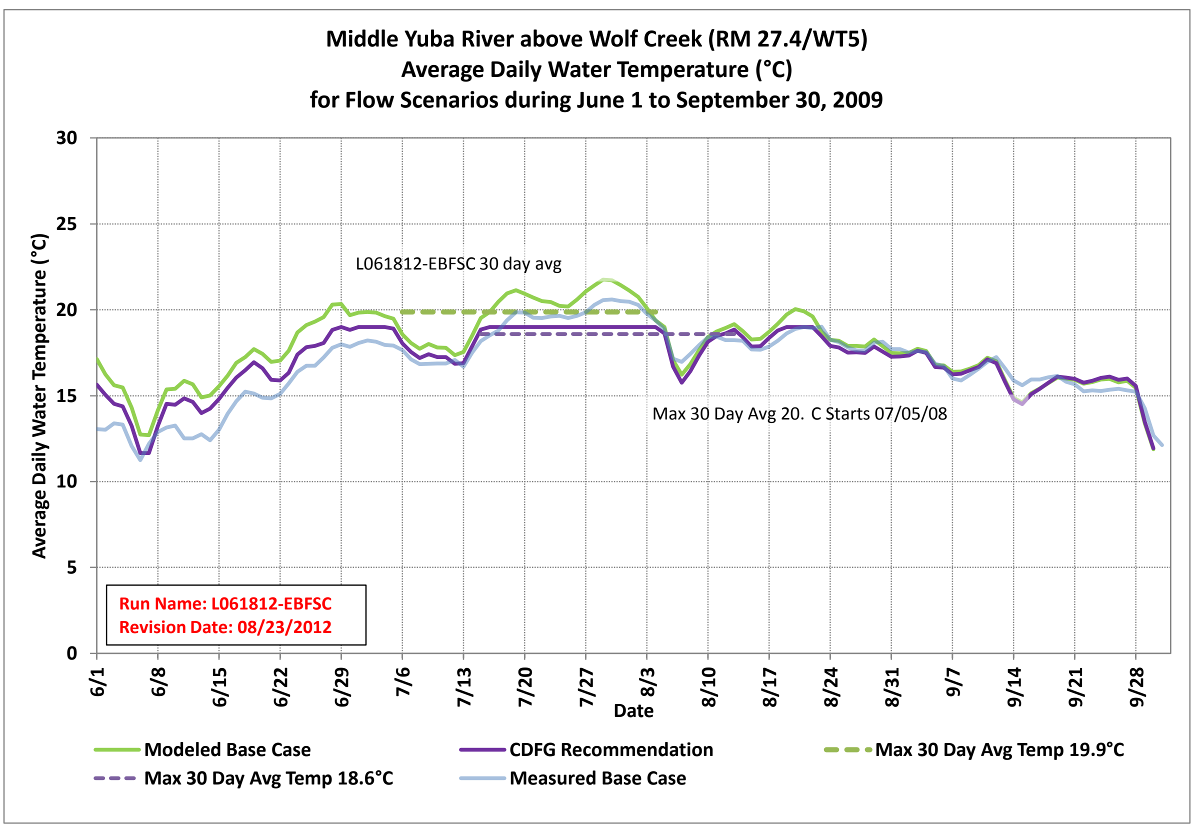
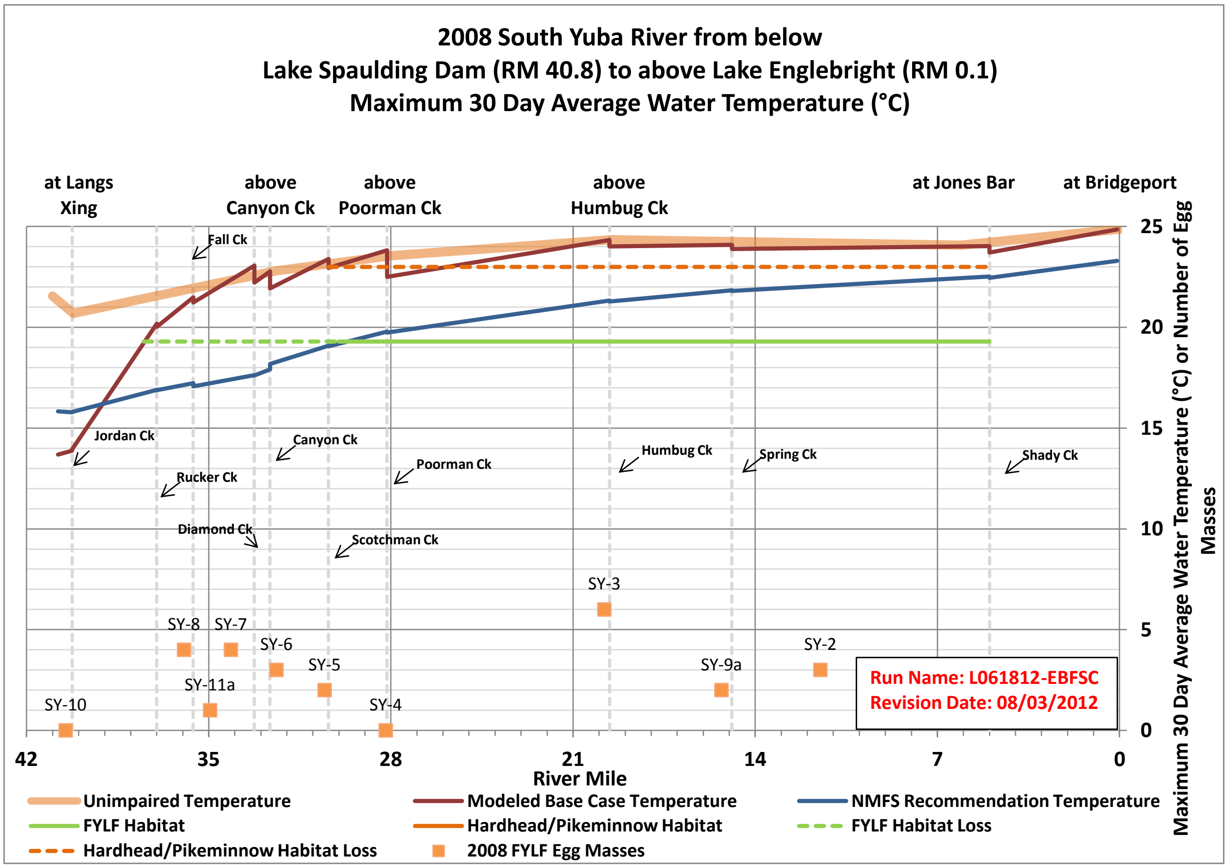


Figure 11. 2008 (top) and 2009 (bottom) South Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case, NMFS Recommendation, and Unimpaired Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog and Hardhead/Pikeminnow Habitat Under the NMFS Recommendation Flows.



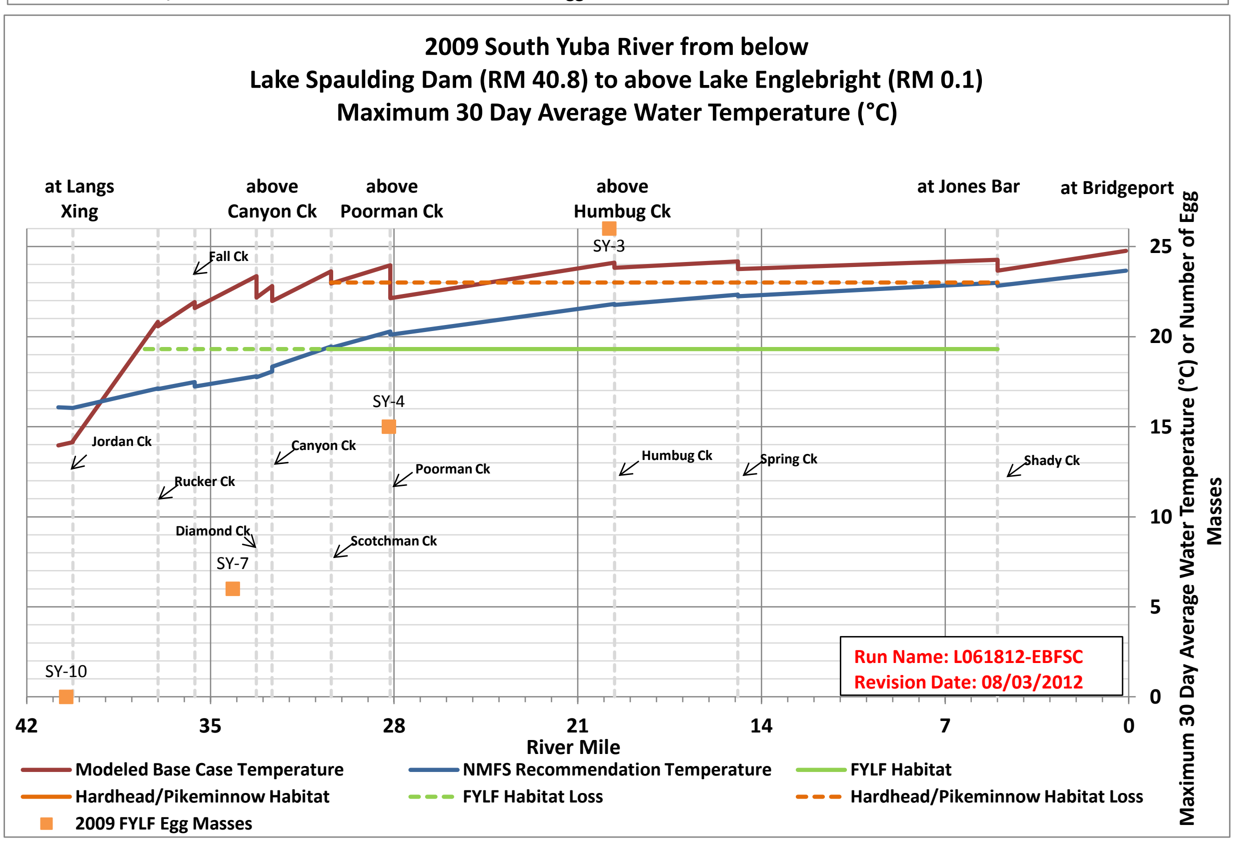
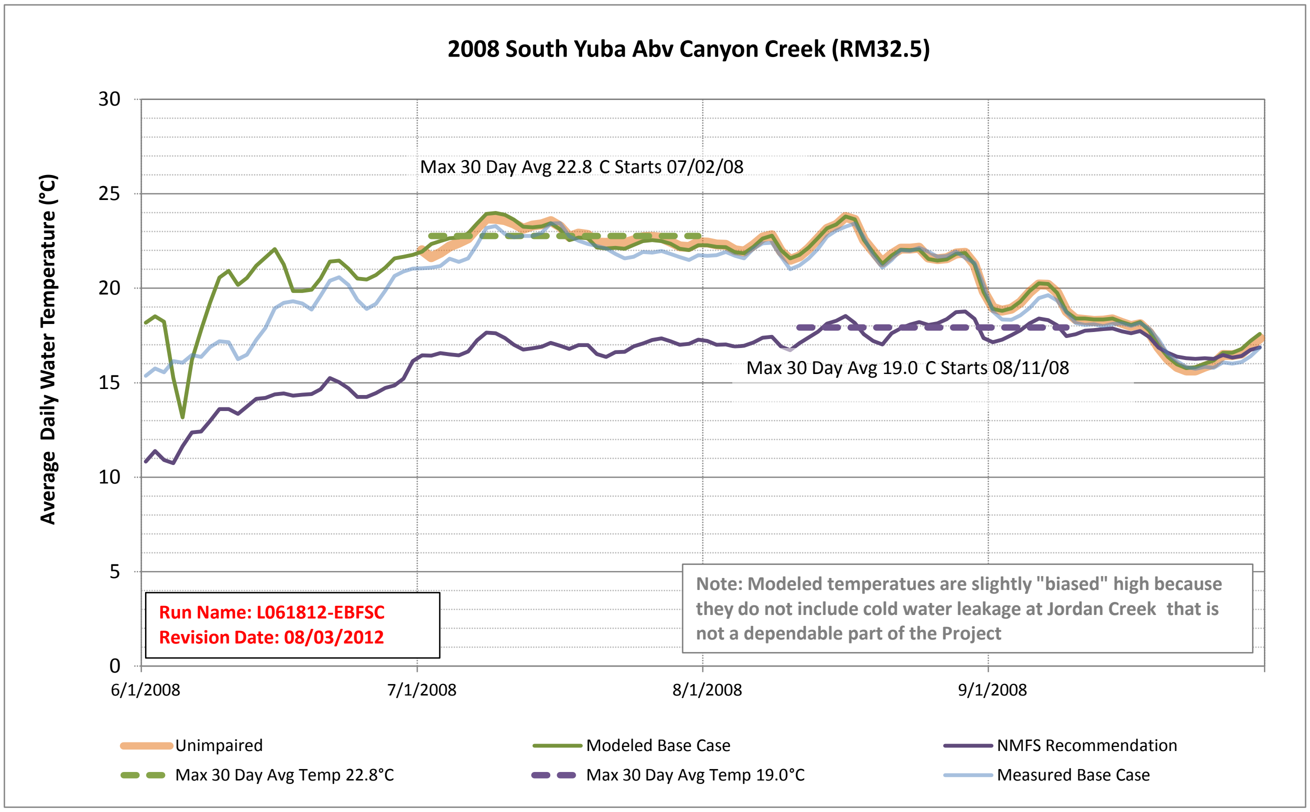


Figure 12. 2008 (top) South Yuba River Average Daily Water Temperature For Modeled Base Case, NMFS Recommendation, Measured Base Case, and Unimpaired Flows Above Canyon Creek and 2009 (bottom) South Yuba River Average Daily Water Temperature For Modeled Base Case and NMFS Recommendation Flows Above Canyon Creek (bottom).



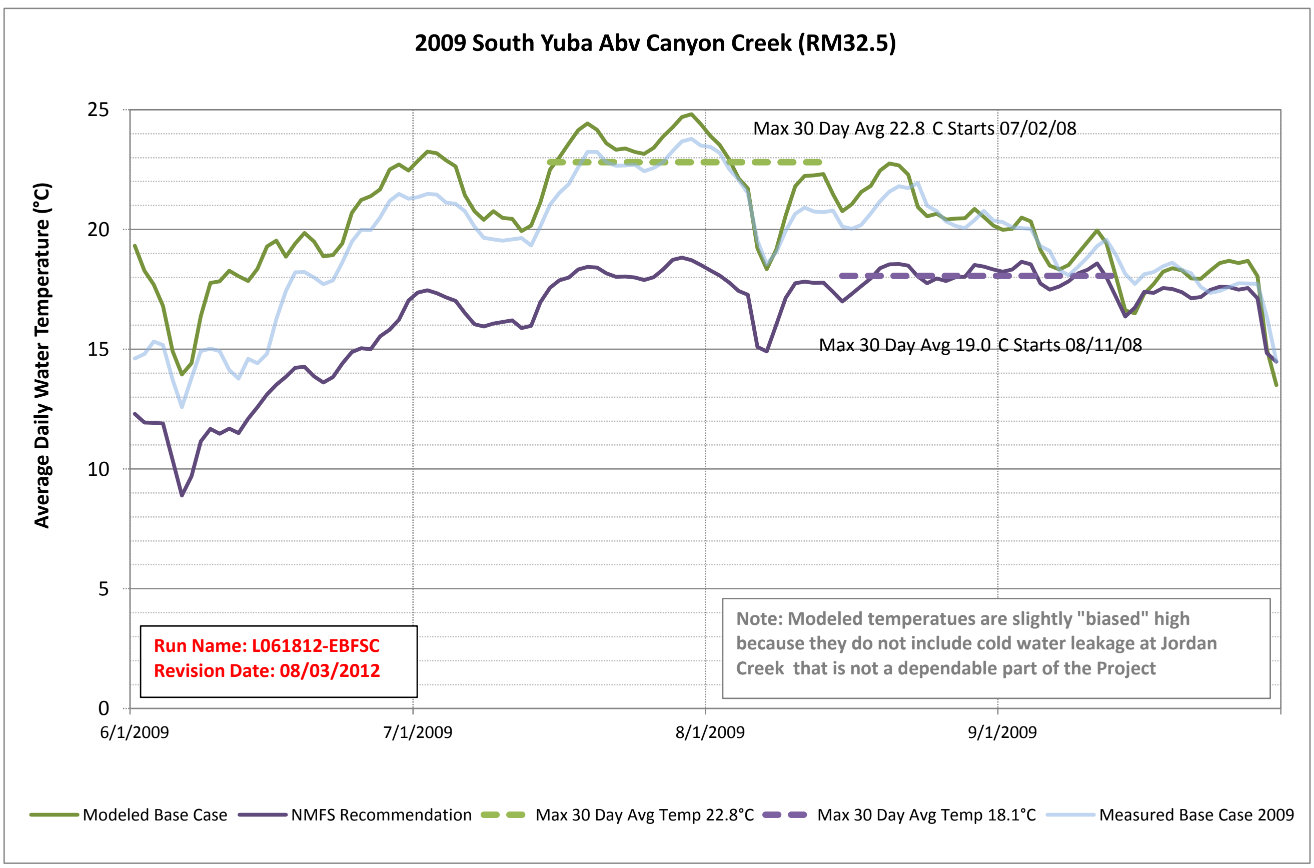
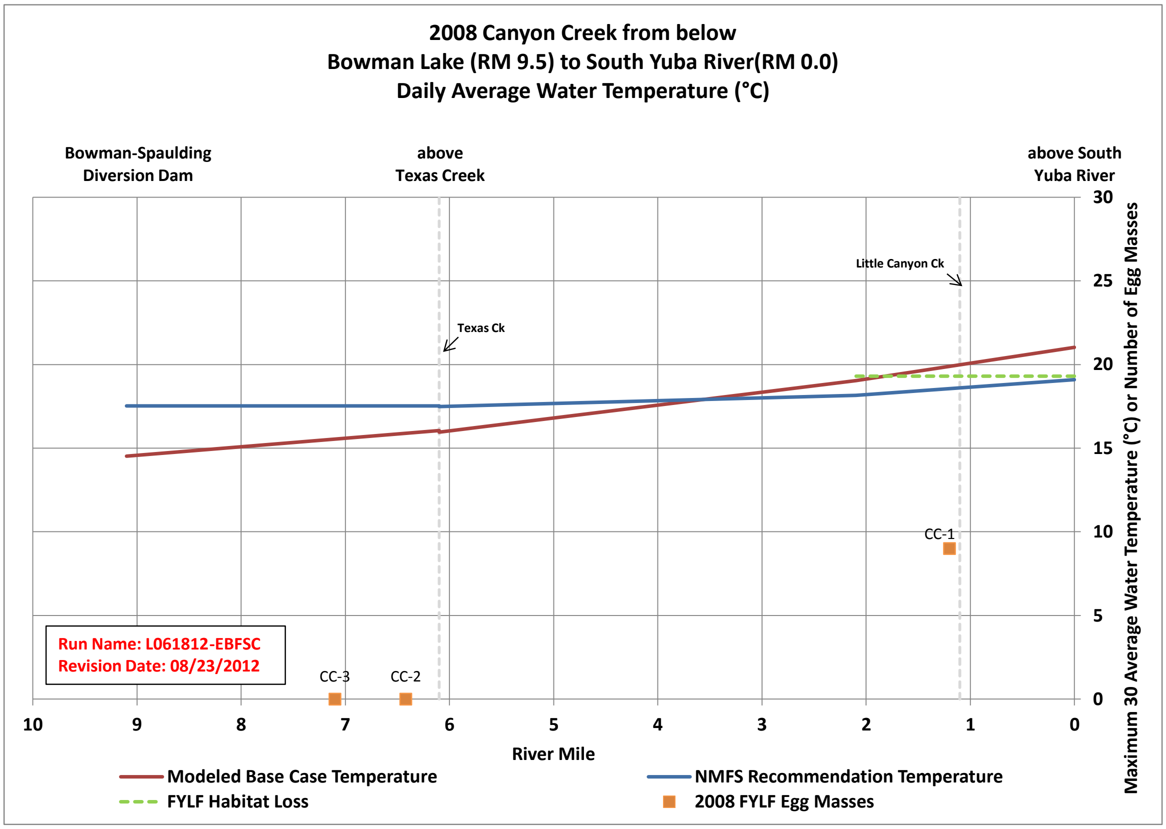


Figure 13. 2008 (top) and 2009 (bottom) Canyon Creek Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and NMFS Recommendation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Yellow-legged Frog Habitat Under the NMFS Recommendation Flows.



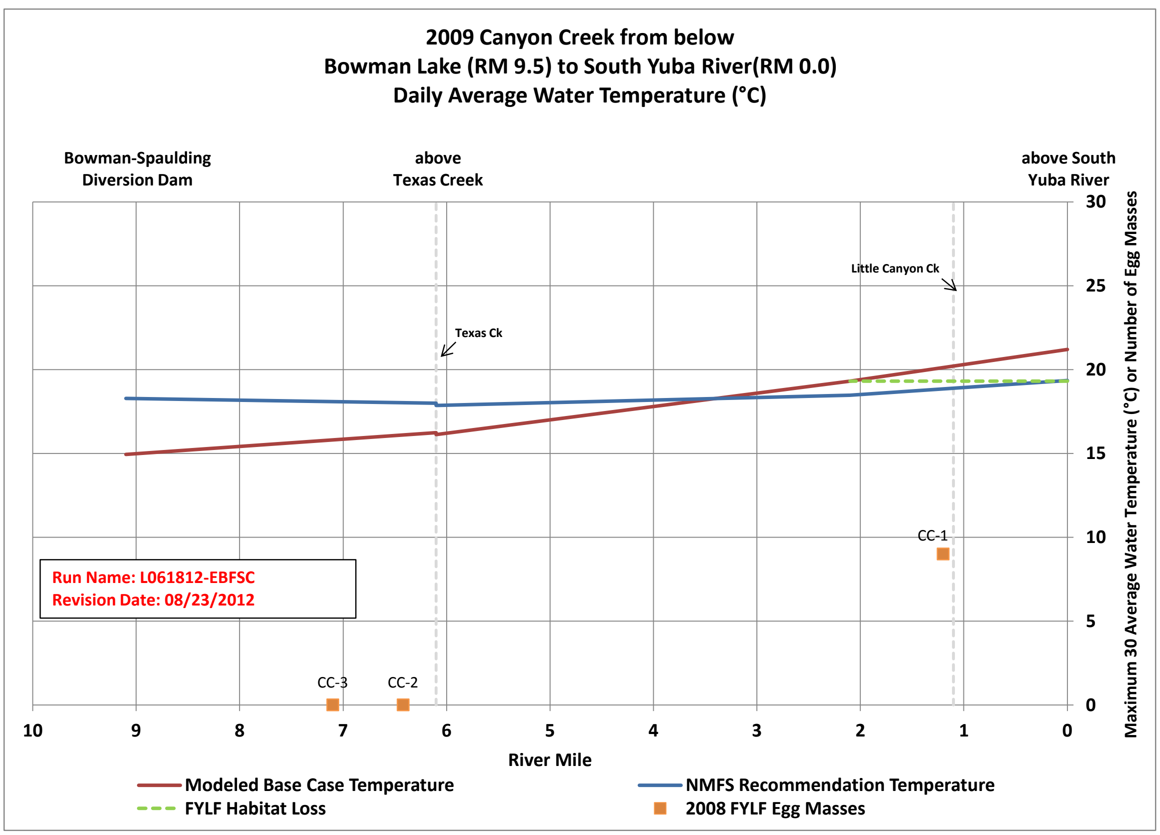
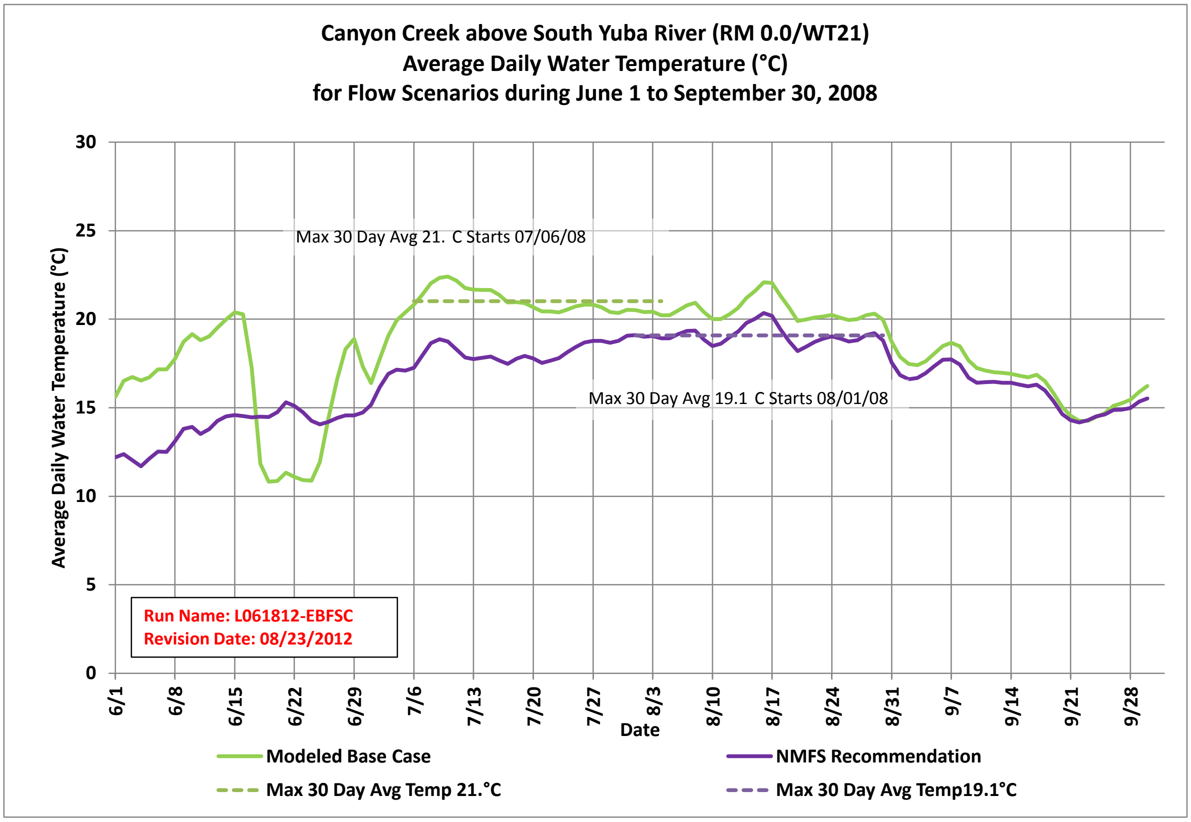


Figure 14a. 2008 Canyon Creek Average Daily Water Temperature For Modeled Base Case and NMFS Recommendation Flows Above the South Yuba River (top) and Above Little Canyon Creek (bottom).



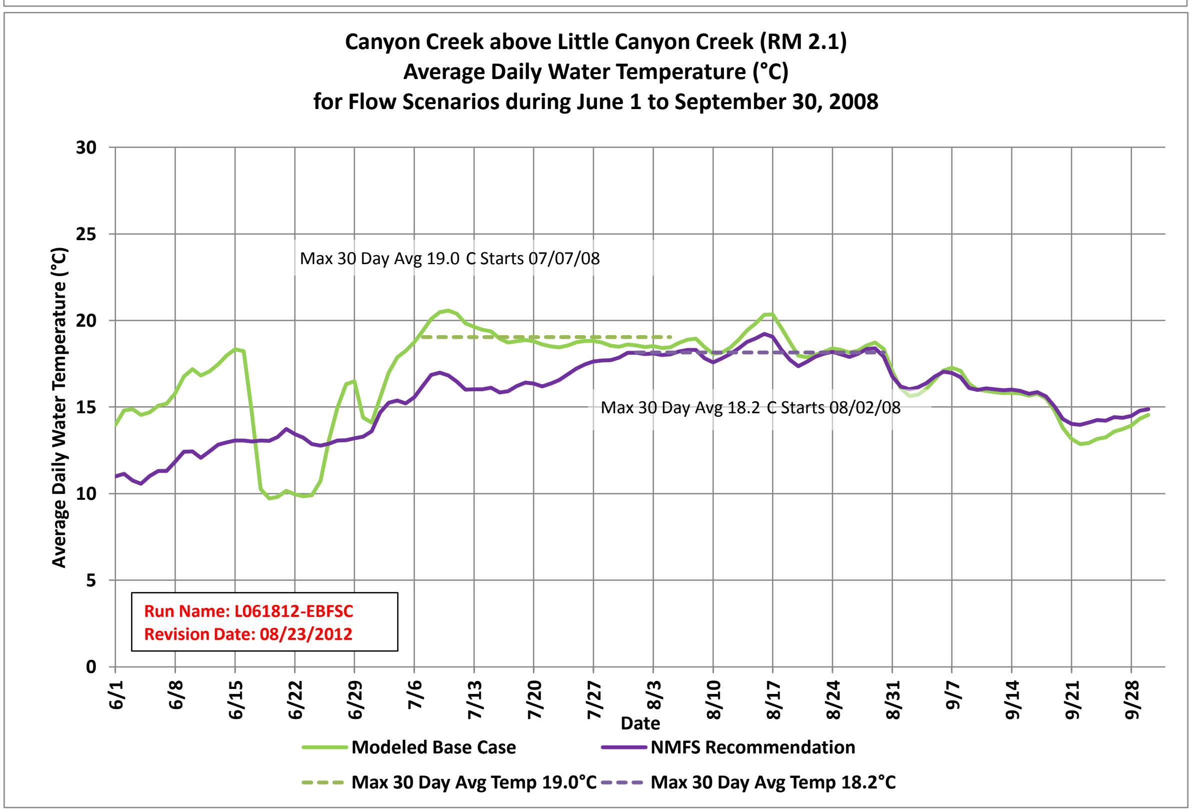
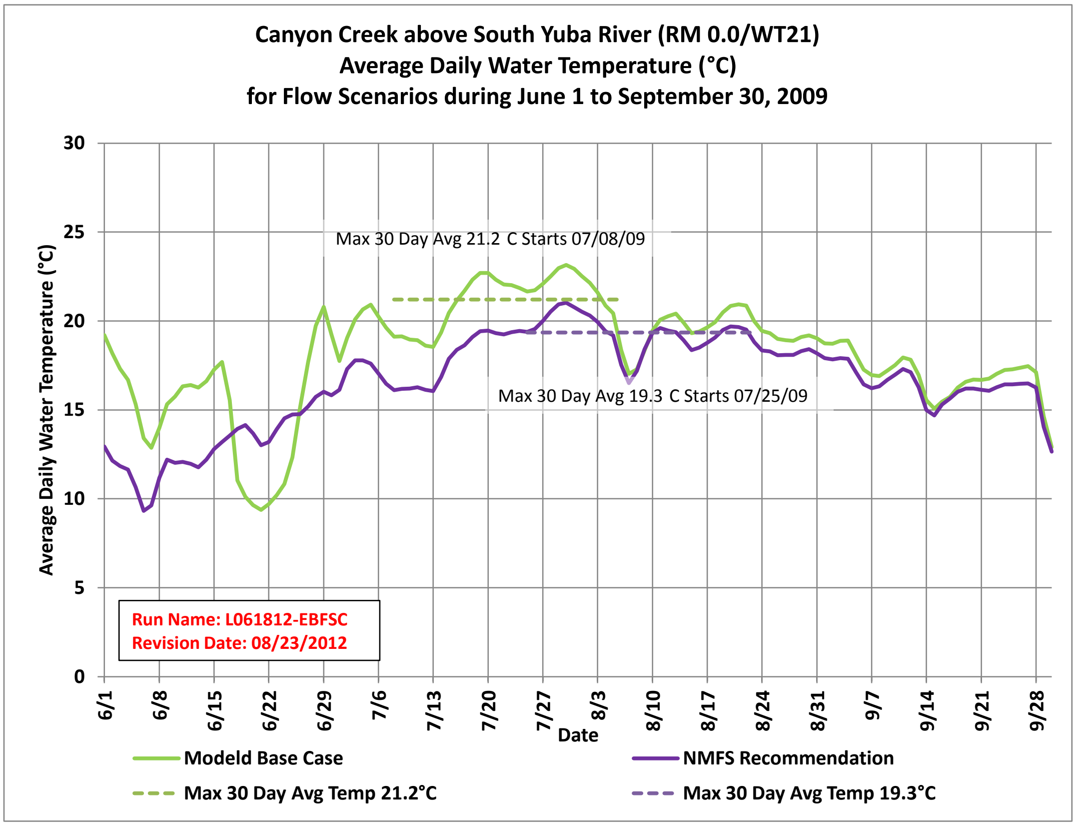


Figure 14b. 2009 Canyon Creek Average Daily Water Temperature For Modeled Base Case and NMFS Recommendation Flows Above the South Yuba River (top) and Above Little Canyon Creek (bottom).



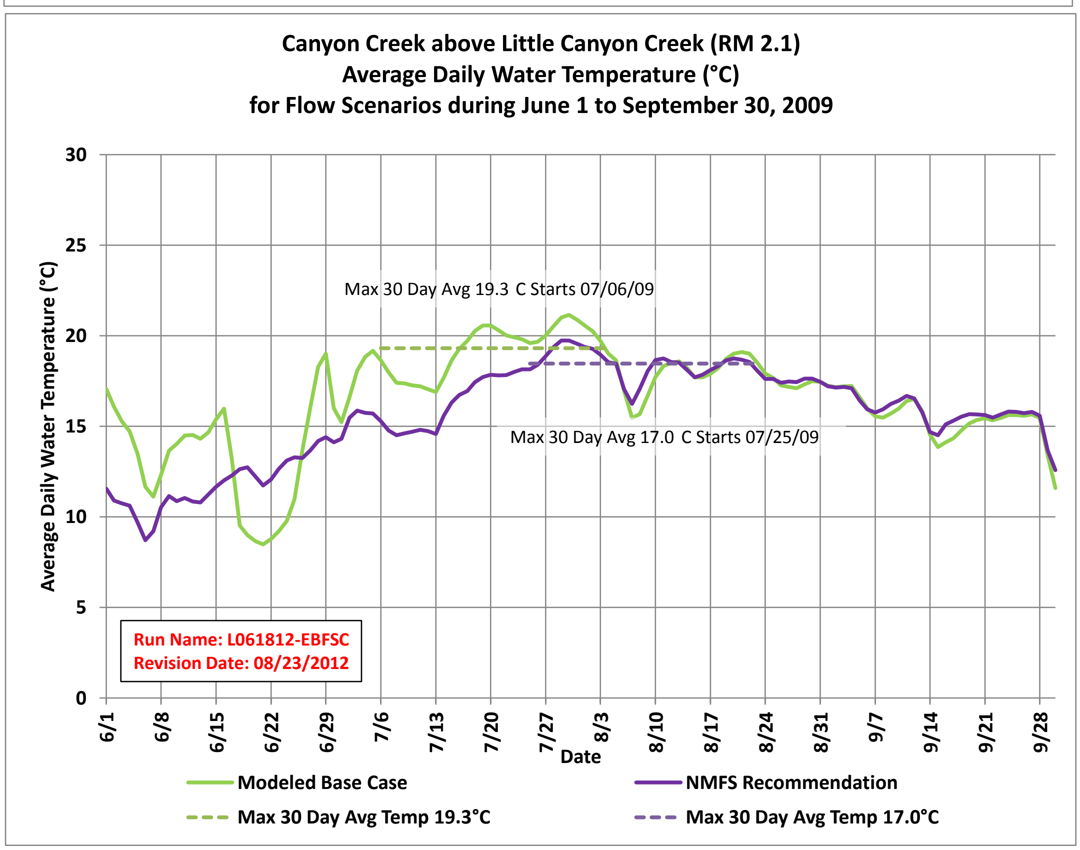
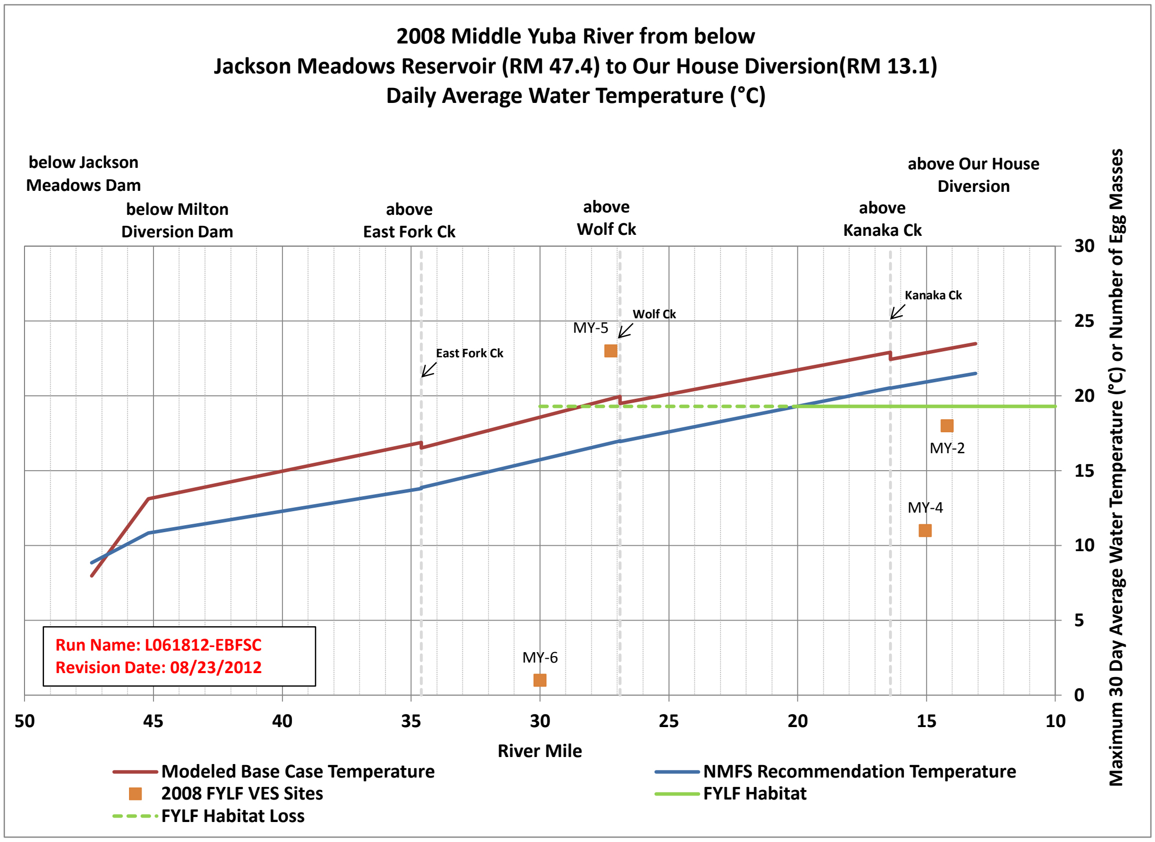


Figure 15. 2008 (top) and 2009 (bottom) Middle Yuba Longitudinal Maximum 30 Day Average Water Temperature For Modeled Base Case and NMFS Recommendation Flows and the Number of Foothill Yellow-legged Frog Egg Masses at VES Sites and Potential Lost Foothill Yellow-legged Frog Habitat Under the NMFS Recommendation Flows.



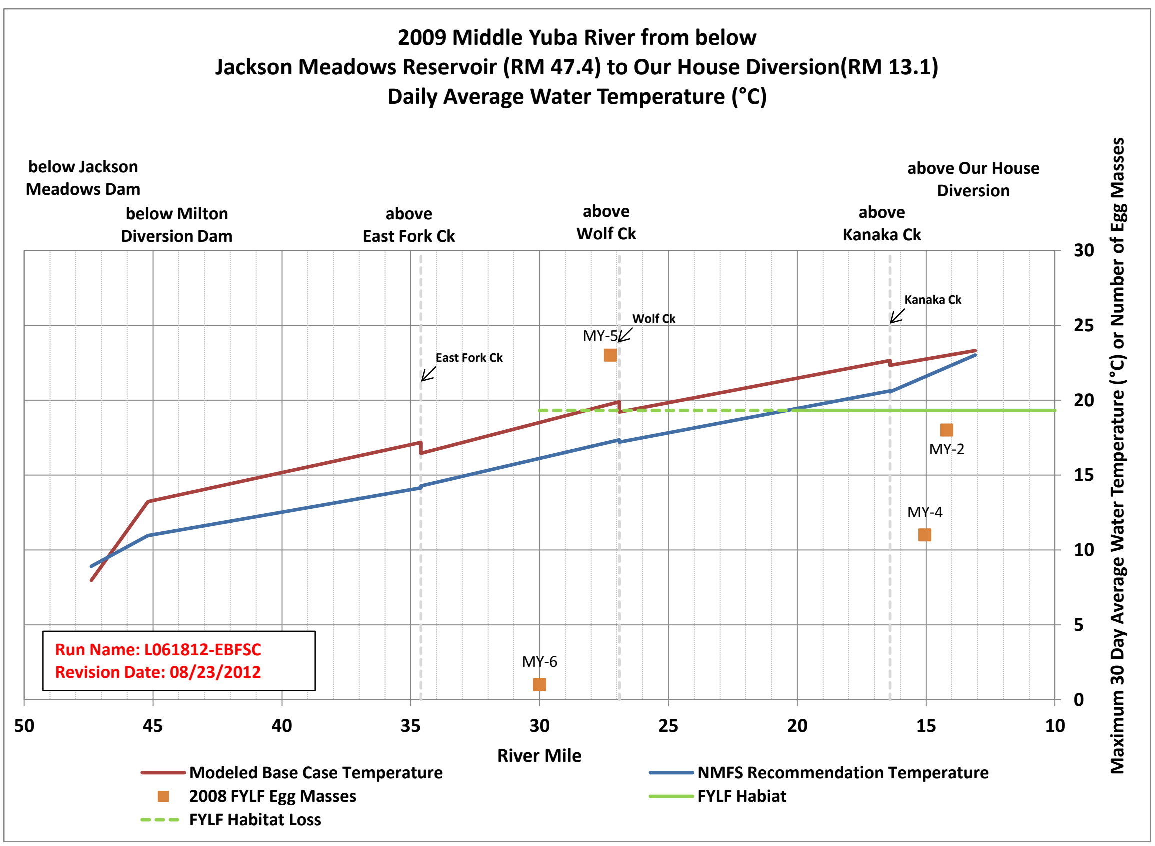
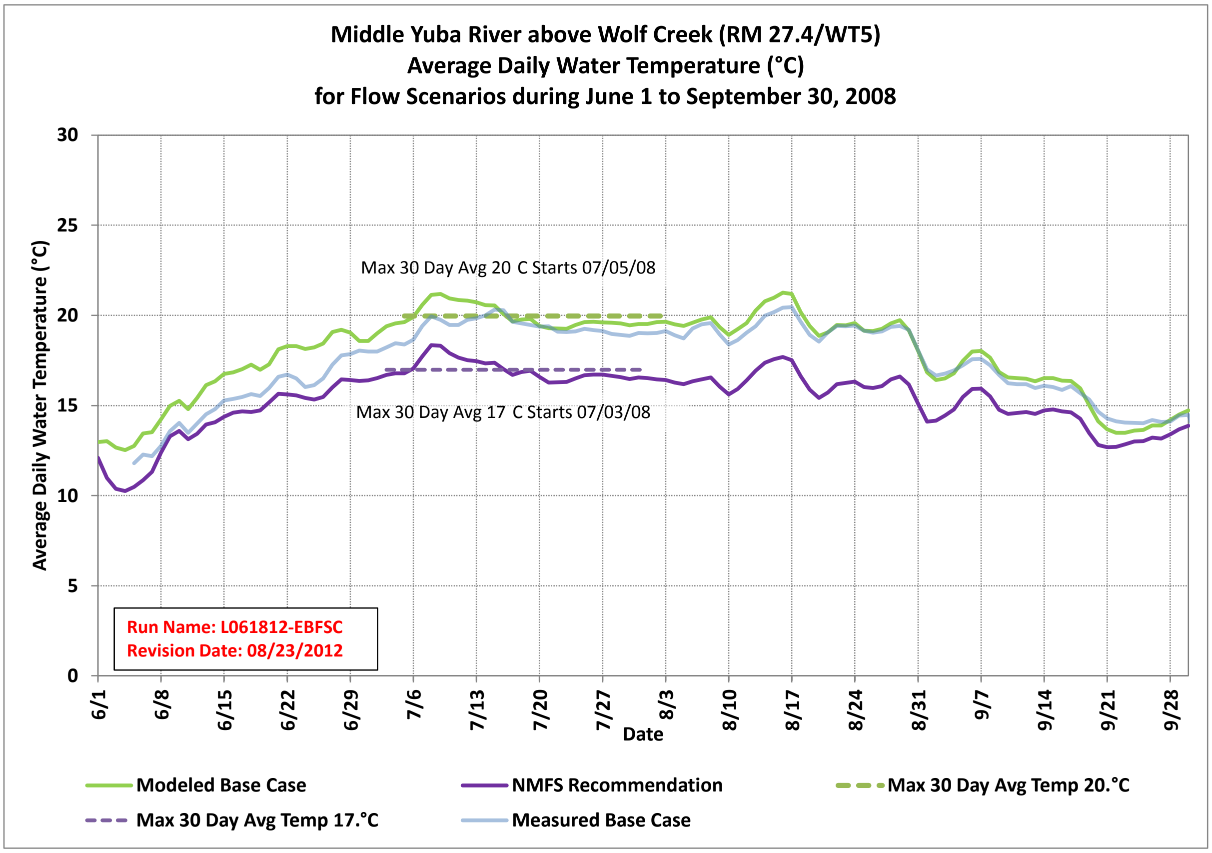
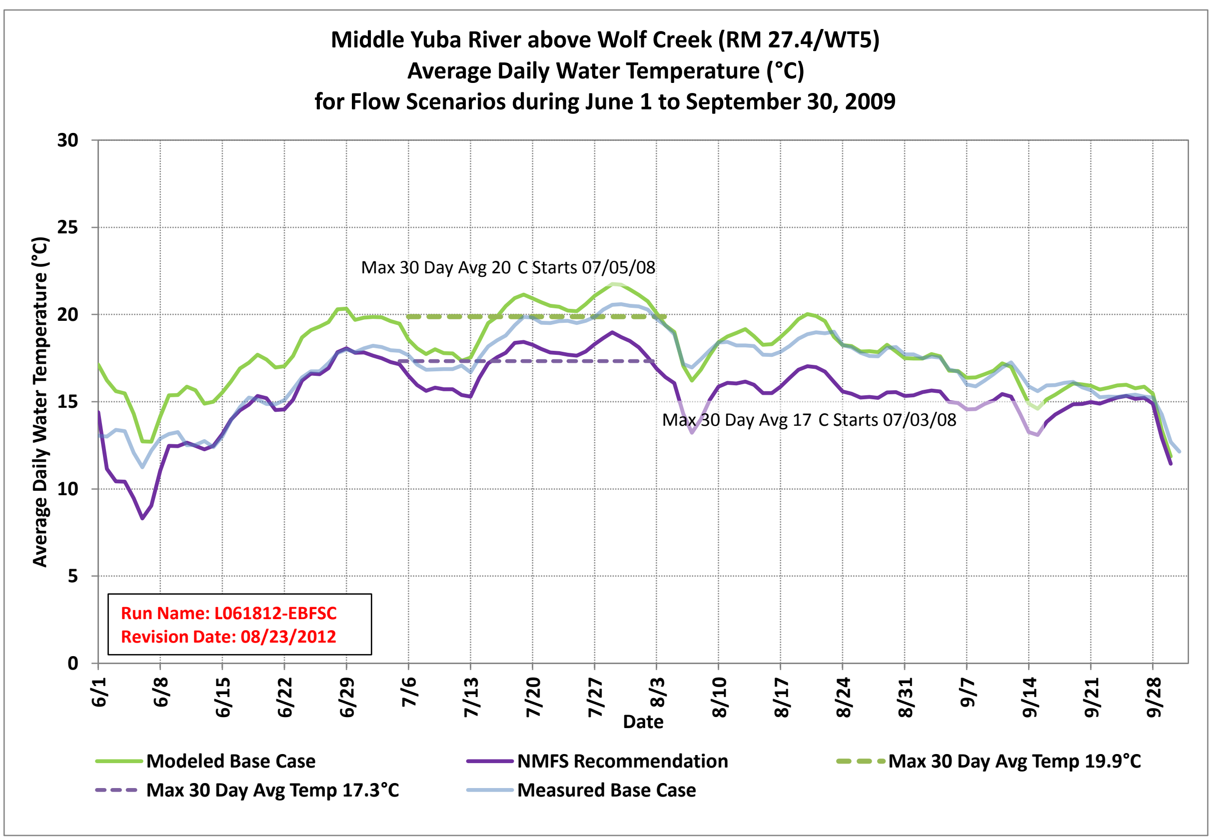


Figure 16. 2008 (top) and 2009 (bottom) Middle Yuba River Average Daily Water Temperature For Modeled Base Case, NMFS Recommendation, and Measured Base Case Flows Above Wolf Creek.





Appendix C

APPENDIX C

Hardhead (*Mylopharodon conocephalus)* and Sacramento pikeminnow (*Ptychocheilus grandis*) distribution in the South Yuba River was assessed by snorkel surveys in the summer of 2012. Surveys were conducted by two or three fish biologists with experience identifying hardhead and Sacramento pikeminnow. Surveyors generally snorkeled in a line, moving upstream or downstream paying particular attention to deep water and cover habitat. To document the presence of hardhead underwater photographs were taken at Edward's Crossing (easily accessed location). The river segments surveyed and species observed are provided in Table 1. Underwater photographs of hardhead and Sacramento pikeminnow at Edward's Crossing are shown in Figure 1a-c. Illustrations of hardhead and Sacramento pikeminnow are shown in Figure 2.

Table 1. Surveyed River Segments and Species Observations.

River Miles	Species Present	General Area Description
8.0 – 8.1	Hardhead, Sacramento pikeminnow	Highway 49 Crossing
15.7 – 16.1	Hardhead, Sacramento pikeminnow, rainbow trout, Sacramento sucker	Edward's Crossing
19.0 – 20.2	Hardhead, Sacramento pikeminnow, rainbow trout, Sacramento sucker	Humbug Creek
22.9 – 23.6	Rainbow trout, Sacramento sucker	Missouri Bar
28.2 – 28.8	Rainbow trout, Sacramento pikeminnow (potentially hardhead[1]), Sacramento sucker	Poorman Creek
30.1 – 30.6	Rainbow trout, Sacramento pikeminnow (potentially hardhead[1]), Sacramento sucker	Downstream of Scotchman Creek
31.4 – 31.6	Rainbow trout, Sacramento sucker	Upstream of Scotchman Creek
32.4 – 33.0	Rainbow trout, Sacramento sucker	Canyon Creek
34.8 – 35.4	Rainbow trout, brown trout, Sacramento sucker	Glory Hole

[1]Small minnows were observed. Additional survey effort would be required to document the presence of hardhead.

Figure 1a. Hardhead and Rainbow Trout.

Figure 1b. Hardhead.

Figure 1c. Sacramento Pikeminnow and Rainbow Trout.

Figure 2. Illustrations of Hardhead (top) and Sacramento Pikeminnow (bottom).

Appendix D

General and Historical Description

Bear River valley in the vicinity of the Bear Valley Meadow was created by glacial processes. There are at least 2-3 different glacial advances that are apparent in the valley topography. The upper portion of the Bear River valley/drainage (127 mi^2) at some point historically (likely during glaciations) was captured by the adjacent South Yuba drainage (see South Yuba Gorge area, Figure D-1) (James 1995). As a result, the valley in the vicinity of the meadow is a large U shaped canyon that, currently, has extremely limited upstream drainage area (1.62 mi^2) (Figure D-1). The Bear Valley Meadow begins near the top of the drainage (near the headwater capture) and ends at the terminus of a glacial advance. The valley floor in the meadow area is filled with very fine erodible glacial/alluvial sediment several meters deep. The fine sediment deposit is covered on the surface with meadow vegetation and underneath is bedrock. The Bear River (stream) runs through the meadow (Figure D-1).

At some point historically, enough flow has been present in the Bear River to erode an inset channel into the meadow/glacial fine sediment deposit. The active floodplain of the inset channel ranges from something on the order of about $15\text{-}20^{+}$ feet below the meadow floor at its maximum depth in the upper meadow (just downstream of the Emigrant Trail crossing at a bedrock channel control) to just a few feet below the meadow surface in the lower meadow (Figure D-2).

The inset channel vertical incision is constrained by several natural bedrock, coarse substrate, or manmade controls (e.g., road crossing, diversion structure) (Figure D-3). Because of the bedrock/manmade vertical controls, there appears to be no potential for additional vertical incision beyond the historic incision that has occurred.

Tree core dating indicates that the active floodplain of the inset channel has been at the present elevation since at least about 1959 – 1980 (i.e., the age of a sub-set of trees on the floodplain of the inset channel in the meadow) (Figure D-4).

Historical aerial photographs from 1939, 1966, 1983, and 2005 show that the channel has not migrated laterally by any appreciable amount since at least 1939, the date of the earliest photograph (Figure D-5). A small amount of channel movement can be observed between the 1939 and 1966 photographs at one area in the mid-lower meadow (see discussion below regarding the historic Bear Valley Reservoir/Lake alluvial fan). The inset channel banks and the active floodplain of the inset channel throughout the meadow are well protected with vegetation (grasses, trees, alders, willows) or in some cases coarse substrate (Figure D-2). There are a few exceptions that will be discussed later.

The meadow vegetation is primarily supported by snowmelt, groundwater, and seeps/springs and not surface water or groundwater from the Bear River. This is apparent from the long-term persistence of the meadow vegetation (Figure D-5) and the fact that the valley/meadow floor rises in elevation continuously and relatively quickly on either side of the Bear River channel (Figure D-6).

It is possible that the origin of the inset channel is natural. Post glacial melt/runoff may have created the inset channel and it may have been maintained by infrequent, but natural high flow events since or by a natural cycle of high flow hydrology such as occurred in the late 1890s and early 1900s that created arroyo down cutting throughout the southwest may have occurred historically. It is not possible at present to substantiate or discount natural events without evidence, for example, photographs dating to pre-European human disturbance (1850).

Assuming, however, that the inset channel occurred as a result of post-European human disturbance (since 1850), the Bear River and the meadow have an extensive land use history (mid 1800's to early 1900's) that can readily explain the inset river conditions (Mead 1901; Van Norden 1903; Fowler 1923; Pagenhart 1969; Ray 2011):

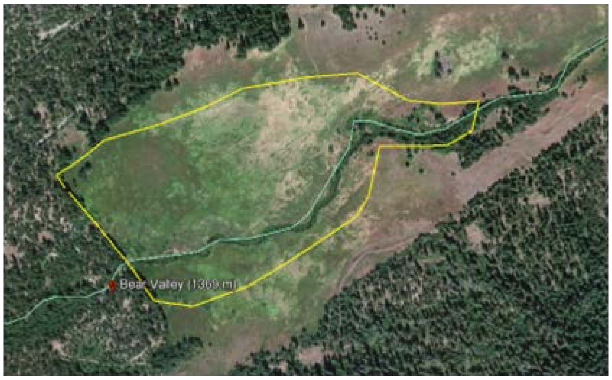
- As early as 1852-3 the original Spaulding Reservoir/Main South Yuba Canal with a capacity of 212.5 cfs (Ray 2011) was constructed that diverted water from the South Yuba River to the head of the Bear Valley Meadow and then over the hill to Nevada City. The canal had a dump gate to release water down the Bear River at the top of the Bear Valley Meadow. Images of the Main South Yuba Canal and a table of capacity from Mead (1901) are shown below:

HERE IS THE HEAD OF THE SOUTH YUBA DITCH IN NEVADA COUNTY

DISTRIBUTING SYSTEM OF THE SOUTH YUBA WATER SYSTEM.

Name of Canal.	Length in Miles	Daily Capacity in Gallons.
Main to Bear Valley	3	136,000,000
Main, entire	16	102,000,000
Dutch Flat	25	68,000,000
Chalk Bluff	[illegible]	[illegible]

- By 1864 the Dutch Flat Canal (later renamed the Boardman Canal) was constructed with a capacity of 105 cfs from the bottom of the meadow to take water from the Main South Yuba Canal 24 miles to Dutch Flat/Secret City for mining operations. At the bottom of the Bear Valley Meadow a reservoir was created to store South Yuba River and Bear River water and distribute the water to canals. The reported size of the reservoir ranged from 60 to 100 acres. The reservoir consisted of two dams. One was 35 feet tall and 140 feet in length and the other was 15 feet tall and 160 feet in length. The reservoir was built prior to 1893, possibly as early as in the 1850's. It was decommissioned in the 1920's. A 30-ft high dam with a reservoir of approximately 70-80 acres would have inundated an area approximately like the area outlined below. The top of the reservoir (upstream end), where an alluvial fan would have developed, lines up directly with the portion of the channel that meandered in the 1939 photograph and appeared slightly active in the 1966 photograph (Figure D-5).



- Several powerhouses were built and operating beginning in 1898 through 1902 (Newcastle, Auburn, and Alta powerhouses [still existing] pg 187 Fowler), which affected the amount of water moving through the Bear River from the South Yuba River (Mead 1901; Van Norden 1903; Fowler 1923).
- The Drum Canal/powerhouse began operation in 1913, which reduced the amount of water flowing from the South Yuba River into the Bear Valley Meadow (Fowler 1923, pg. 188):

> capacity is 80 second-feet. Before Drum canal was constructed about 40 per cent of the water from the lakes and reservoirs in the drainage basins of Bear River and the South Fork of the Yuba above Lake Spaulding was spilled into Bear River below Lake Spaulding, diverted at Boardman head dam, and carried to Alta power house. Most of the water passing Lake Spaulding is now carried in through Drum canal, only surplus water and the minimum required by established rights being diverted through South Yuba and upper Boardman canals. Water was formerly carried from Alta power

- A narrow gage rail was run through the valley in 1880s-1900.
- Extensive grazing occurred in the Bear Valley Meadow from the 1880s until the 1990s.
- Highway 20 was constructed prior to 1966 and traverses both the Bear River and Bear Valley.

Current Conditions

The current conditions in the Bear River and Bear Valley Meadow with respect to bankfull discharge, sediment transport, fish populations, bank erosion, riparian community, Proper Functioning Condition assessments, and hydrology are reviewed below.

Estimated bankfull discharge in the meadow reach is 110 to 122 cfs. This is based on calculating the 1.5 year return interval on the 1987 – 2011 hydrology that has been corrected and reviewed by the PG&E hydrologist (1.5 year return interval is 122 cfs) and based on averaging the three bankfull estimates from the field at the Technical Memo study sites (68, 185,78 = Average 110 cfs). Bankfull estimates for the meadow are also contained in the Technical Memo in Table 3.2-1. Our review indicates, however, that there are problems with the estimates in the Table 3.2-1. The hydrology used for the bankfull statistical estimate was the 1976 – 2008 period, but the data from the 1976 – 1986 portion of that record are not reliable (the 1987 – 2011 data set is the appropriate data set to use[1]). The field-based bankfull estimate in the table was derived from a section of stream immediately upstream of the Highway 20 crossing (Kathi Peacock, Pers. Comm.). While there is a rating curve (gage) at this location, the channel does not have good bankfull indicators and appears to be in disequilibrium because of the road crossing. Based on our site visit review and conversations with Kathi Peacock, the three bankfull estimates at the meadow study sites are more representative of bankfull elevations within the reach.

A reach-averaged sediment transport analysis has not yet been completed for the meadow. Data are forthcoming that will include shear stress at all cross-sections in the reach, which can then be used for reach-averaged sediment transport calculations. This analysis will be conducted once the data are available. It is sufficient to identify at this point that there are clean gravels present in the channel. The active channel is sized to match the flow regime and there is no anomalous degradation or aggradation of the active channel. There are some sediment calculations in the Technical Memo; however, we do not recommend use of these data. The data are reconnaissance level, calculated at an individual cross-section in each study site (which in our review caused obvious analysis problems due to backwater effects at one of the cross-sections), and were not calibrated with empirical sediment transport measurements.

Fish density in the meadow was the highest in the entire Drum-Spaulding Project during sampling in 2008 and 2009 (3,200 - 4,000 fish per mile). Biomass was also the highest in the meadow compared to all sites in the Drum-Spaulding Project (70-85 kg/ha). The population consists of nearly 100 percent brown trout. Steeper gradient reaches above and below the meadow had fewer fish and were dominated by rainbow trout. Because brown trout that were stocked historically are so dominant in the meadow, it is hard to envision a scenario where rainbow trout could successfully compete in the meadow without physical removal of brown trout and/or dramatic reductions in flow in the fall that would make brown trout spawning unsuccessful.

Very limited bank erosion was documented throughout the reach during field surveys as indicated below:

- Overall, active erosion was observed along approximately 345 feet of the 2.3 mile reach (3% of the reach) (FLA; pages E6.1-36 – 37).
- Site-specific localized erosion was present in a couple of locations (e.g., Figure D-9). For example, a larger slump is located on the river left just downstream of the Emigrant Trail bridge. Flow shoots out of a bedrock constriction toward the slump location and an accumulation of woody debris is directing the flow into the bank. This can be addressed through specific bank stabilization measures, as proposed in the Amended Application (DS-TR4 River Management Through Bear Valley Meadow).

[1] Also note that the Upper Boardman Canal was taken out of service in 1986 and PG&E operations changed such that water that was historically delivered to PCWA via the Bear River through the meadow and Upper Boardman Canal were routed down the Drum and Towle canals.

Field visits along the channel downstream of the meadow in the steeper gradient section of the river that crosses USFS property indicate that no unnatural bank erosion is occurring.

Bank erosion and depositional surfaces are important for creation of new sites for potential riparian recruitment. An active channel should have lateral scour and deposition. Particularly in the lower meadow, extensive channel margin vegetation, including sod-forming sedges and alder and willow shrubs provide dense ground cover and root structure that reduce the potential for bank erosion. Currently the vegetation may be preventing the channel from migrating in some locations. Some of the willows in the lower portion of the meadow that are very dense were planted by an angler group.

The riparian community and meadow have the following characteristics (based on data presented in the Technical Memos, Final License Application, and field observations):

- The riparian community is compositionally diverse, and some recent recruits of riparian species (e.g., willows and alders) were observed on depositional surfaces in all three meadow reaches.
- It contains alder trees, alder and willow shrubs, sedges, and other herbaceous plants, including twenty-nine wetland indicator species, indicate a diverse riparian-wetland community.
- The meadow is comprised of eight plant associations that occur within the wetland and include: sedge, rush, white alder, bulrush (*Scirpus* sp.), broadleaf cattail (*Typha latifolia*), willow, wet meadow, and dry meadow. The wetland system occurring in the study site is palustrine.
- Sources of water for this meadow include snowmelt, seeps, springs, seasonal inflow from streams that drain the adjacent uplands. The upper meadow slopes towards the stream channel, and is supported by seeps and springs. Water from the Bear River provides a source of water for the meadow only in a portion of the lower meadow.

There is a Proper Functioning Condition (PFC) assessment by the Licensee that indicated that the riparian and meadow were Functional - At Risk with an upward trend. This was based on the existing inset channel, and that the functional condition of the riparian vegetation has been improving since 1939 and the relatively recent removal of cattle grazing. There is also a alternative assessment by CDFG senior engineering geologist Kris Vyverberg that states that the meadow reach is nonfunctional based on the inset channel, little bank vegetation/high bank erosion hazard, and channel confinement.

Based on site visits and a review of the history of the meadow it is clear that the meadow and riparian vegetation currently are both stable and functional under the current flow regime (Figures D-2 through D-6). Perhaps both assessments above could be viewed as accurate from the perspective of the individual authors, but the differences in interpretation are primarily based on interpretation of baseline conditions. The inset channel most likely occurred more than 100 years ago, prior to the existence of PG&E. Based on the times series of aerial photographs, the size of the meadow has remained stable over time and supports a diversity of wetland plant species (Figure D-5) and the inset active floodplain vegetation functions properly (e.g., compositionally diverse; recent recruitment of riparian species) (Figure D-2). The evidence shows that the channel is not currently incising and that the river is not excessively or unnaturally eroding channel banks or migrating (Figure D-5).

A period of high flow hydrology occurred in the in 1997 and 1998 when the Drum Powerhouse was shut down due to storm damage. Water supply was released down the Bear River during the summer (Figure D-7). Based on aerial photographs, the high flow period did not change the channel location. We do not have available to us close-up pictures of the channel prior to the high flow event or after the event to assess the potential for local scour occurring during this period.

Base flow hydrology in the Bear River has been augmented because of project operations. Figure D-8 shows an exceedance plot of the available data. The Bear River is maintained as a trout fishery as a result of project operations. Flows would have been too low under unimpaired hydrology to sustain a substantial fishery. Figure D-8 also shows that regulated flows are higher than unimpaired in the range of flows that form the channel. As mentioned previously, the bankfull flow is approximately 120 cfs. Minimum instream flows in the existing license and proposed in the amended application have been/will be based on the existing channel and be in proportion to the existing channel dimensions.

Conclusions

The channel/riparian/meadow conditions are stable and functional under the current flow regime. The inset channel most likely occurred in the mid-late 1800s as a result of the release of South Yuba River water into the top of the Bear Valley Meadow. The ages of trees established on the floodplains within the inset channel reach show that the channel has not incised since the 1960-80s for certain, and perhaps earlier. Review of the channel downstream of the meadow on USFS property indicates that there is no unnatural erosion for a river channel.

PG&E has been asked by the Resource Agencies and NGOs to limit high flow releases through the meadow. This appears to be primarily under the assumption that continued scouring and down cutting of the inset channel is occurring as a result of the flows. Based on the available evidence, that is not the case; nevertheless, PG&E has proposed a monitoring and management measure that would reduce, based on a good faith effort, operational flow releases to 200 cfs during winter operations, implement a ramping rate of 0.4 ft/hr on flow releases, and limit flow into Bear Valley when the two Dutch Flat powerhouses are at capacity. The measure also would survey, monitor, and potentially repair site-specific erosion areas such as shown in Figure D-9.

A review of the measure indicates that it is a good approach to managing flows in the Bear Valley Meadow. The proposed flows are well within the capacity of the active channel. Ramping rates will also be beneficial for riparian recruitment processes. Care should be taken to monitor stream gravels that they do not become silted due to a reduction in high flows and to monitor the riparian vegetation that it does not encroach the channel. Removal of grazing and reduction of high flows could result in a channel that is heavily vegetated and encroached and that is unable to efficiently handle high flow events in the case they must be released for water supply (e.g., emergency such as occurred in 1997-98) or as a result of a large storm event.

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Pagenhart, T.H. 1969. Water Use in the Yuba and Bear River Basins, California. Dissertation. University of California, Berkeley.

Ray, Joseph R. 2011. Letter from PG&E to State Water Resources Control Board on May 11, 2011, regarding temporary change in place of diversion or rediversion of various pre-1914 water rights associated with the Bear River Canal in Placer County (SWDU Numbers 953, 955 and 957).

Van Norden, Rudolph W. 1903. The Journal of Electricity, Power and Gas. Vol. XIII, pgs. 57-79.

Figure D-1. Showing Bear Valley Meadow, the South Yuba Gorge headwater capture, and the historic Bear Valley Reservoir Dam site.

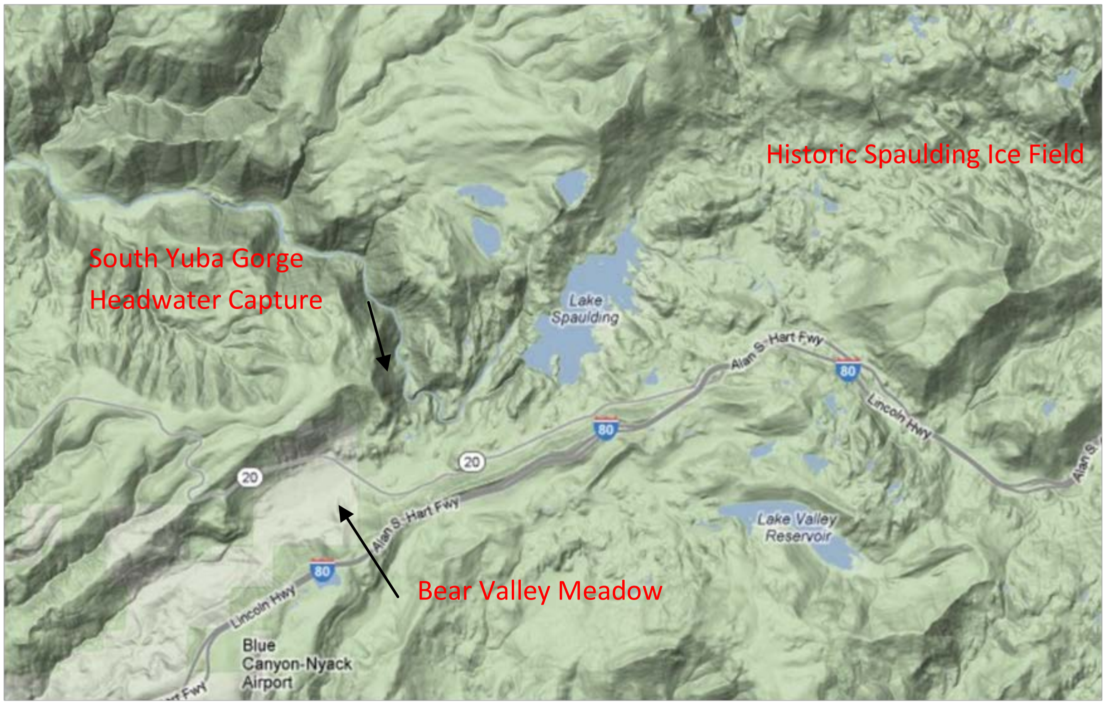


Figure D-2. Images of the inset Bear Valley Meadow channel. The top image is some of the deepest inset channel, which occurs between the Highway 20 crossing and the Emigrant Trail, the middle image is moderate depth inset channel near the Highway 20 crossing, and the bottom image is minimal to no inset near the bottom of the meadow.

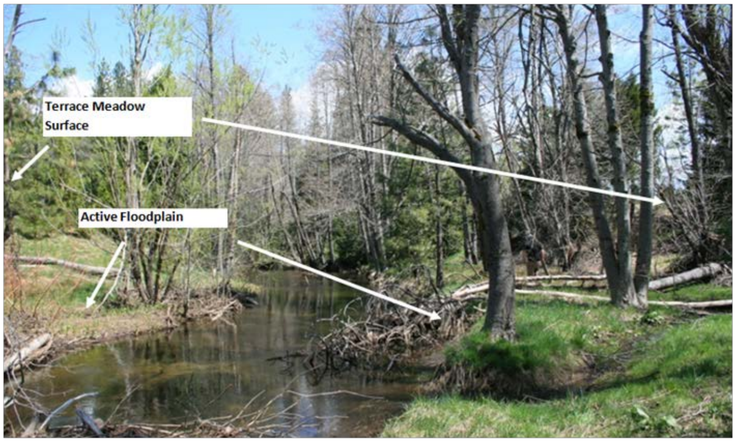
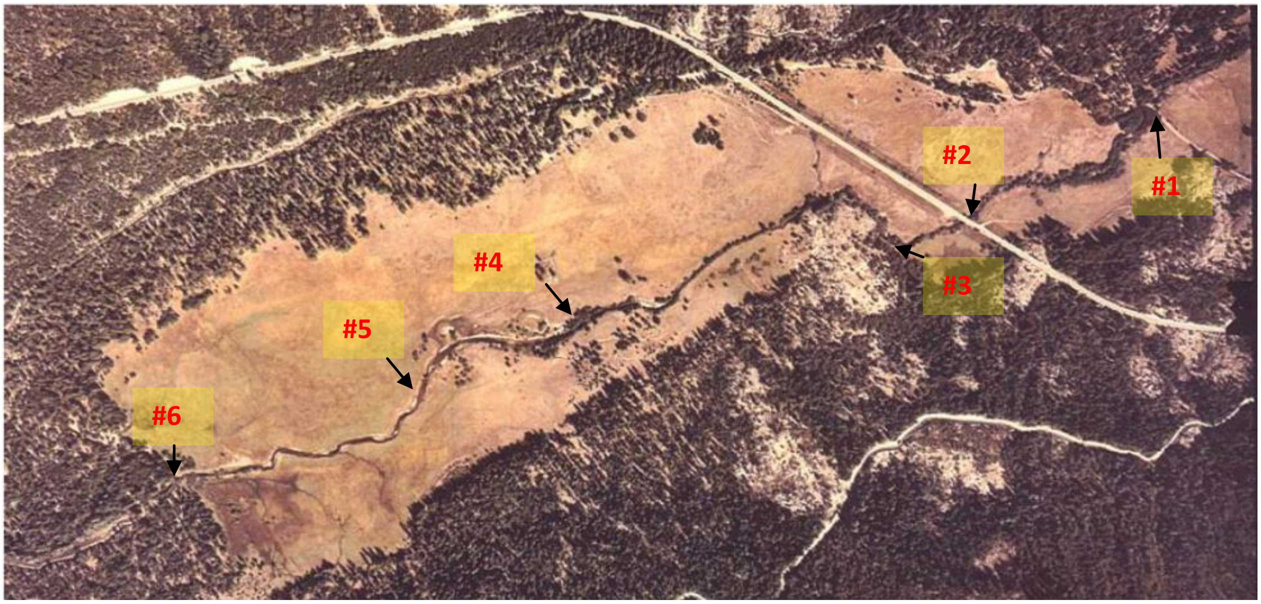


Figure D-3. Approximate location of vertical channel controls in the Bear Valley Meadow Reach (note: locations 4 and 5 are approximate and their locations should be verified).

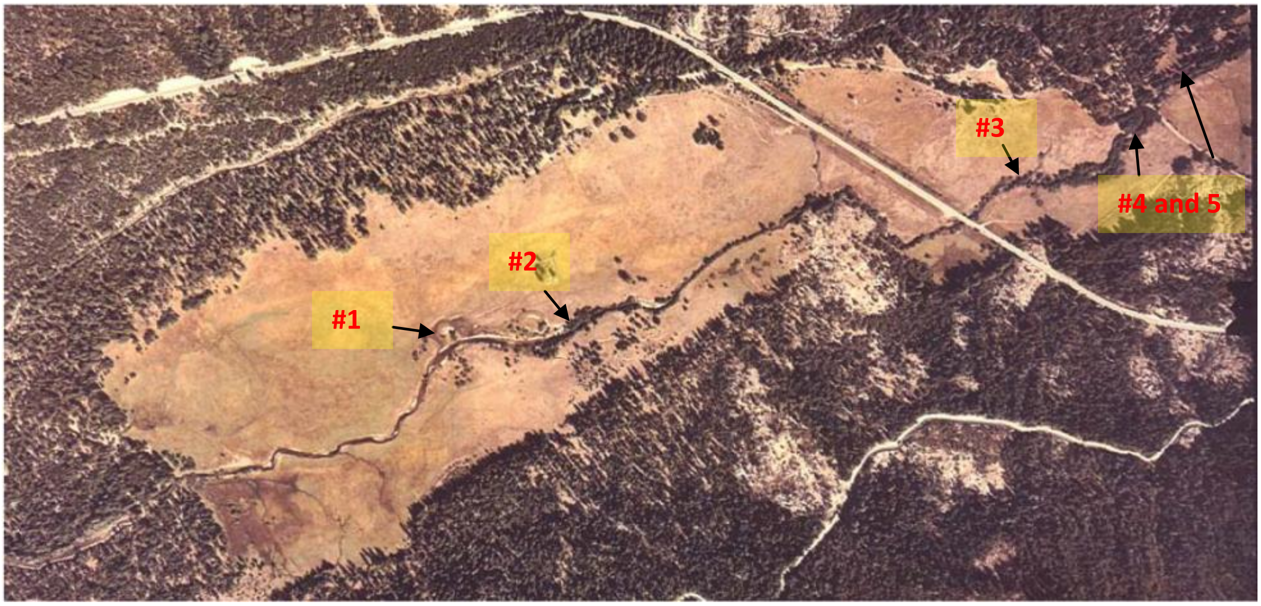


Vertical channel controls occur at the following locations within the reach:

1. Emigrant Trail -- Bedrock
2. Highway 20 -- Concrete
3. Downstream of road at sharp right bend -- Bedrock
4. Near big rock in the meadow – Various coarse substrate controls
5. Below old meander – Coarse substrate control
6. Diversion structure at end of meadow -- Concrete

Figure D-4. Bear River alluvial surface and tree core aging.

Meadow Tree Core Sampling Location Overview



Tree cores were obtained at five surfaces adjacent to the stream:

1. Top of Lower Meadow in old channel scar – Surface present since at least 1975.
2. Middle Meadow in active floodplain near Channel Morphology Site –Surface was present in at least 1980.
3. Upper Meadow above Highway 20 in active floodplain (inset channel) -- Surface was present in at least 1964.
4. Upper Meadow below Discovery Trail in active floodplain (inset channel) -- Surface was present in at least 1959.
5. Upper Meadow above Discovery Trail in active floodplain (inset channel) -- Surface was present in at least 1959.

Figure D-5. The Bear Valley Meadow in 1939, 1966, 1983 and 2005. The channel is in nearly the same location for the entire period. There is a small amount between the 1939 and 1966 photographs at the location where the top of the historic Bear Valley Lake (reservoir) was likely located (see arrows).

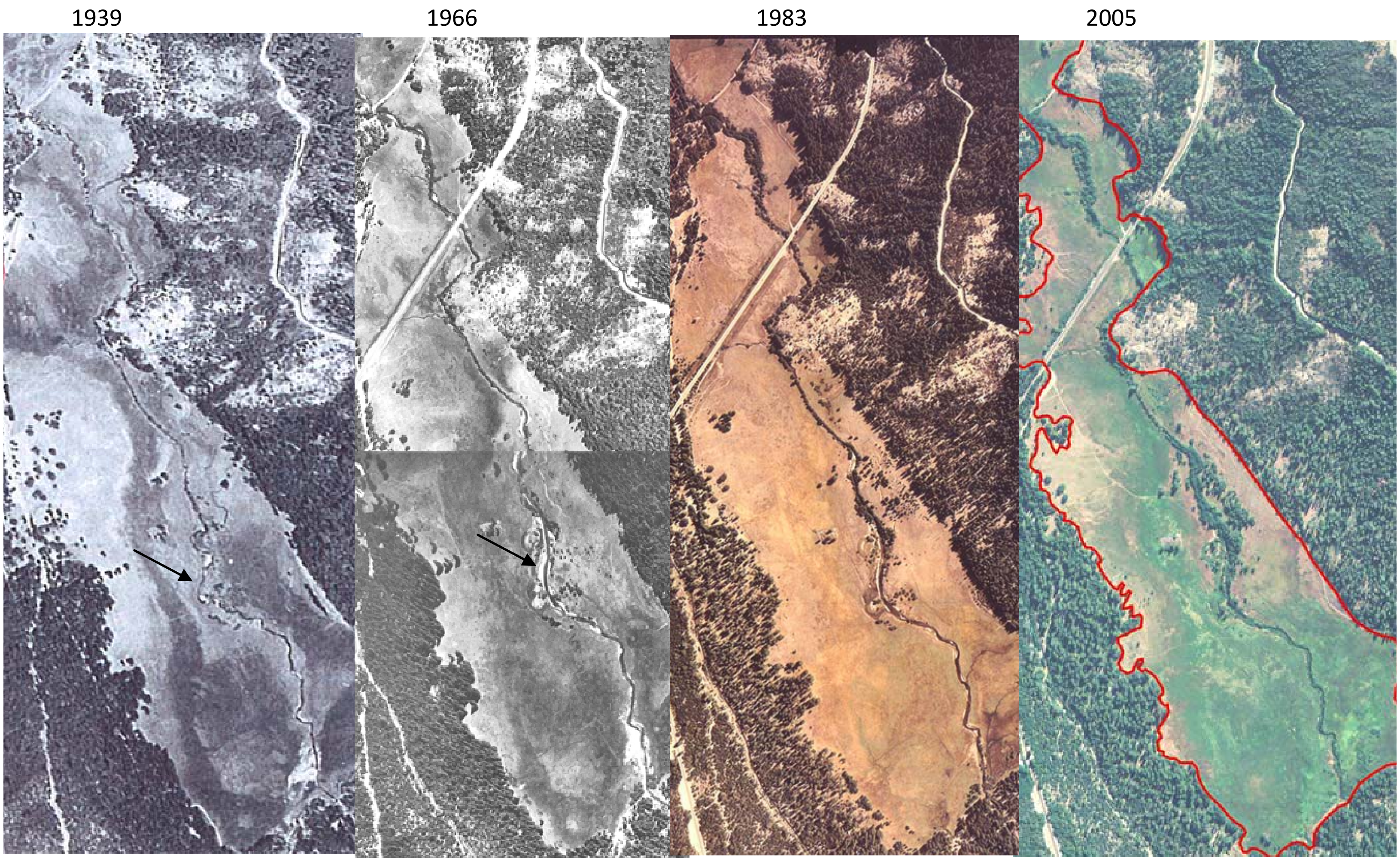
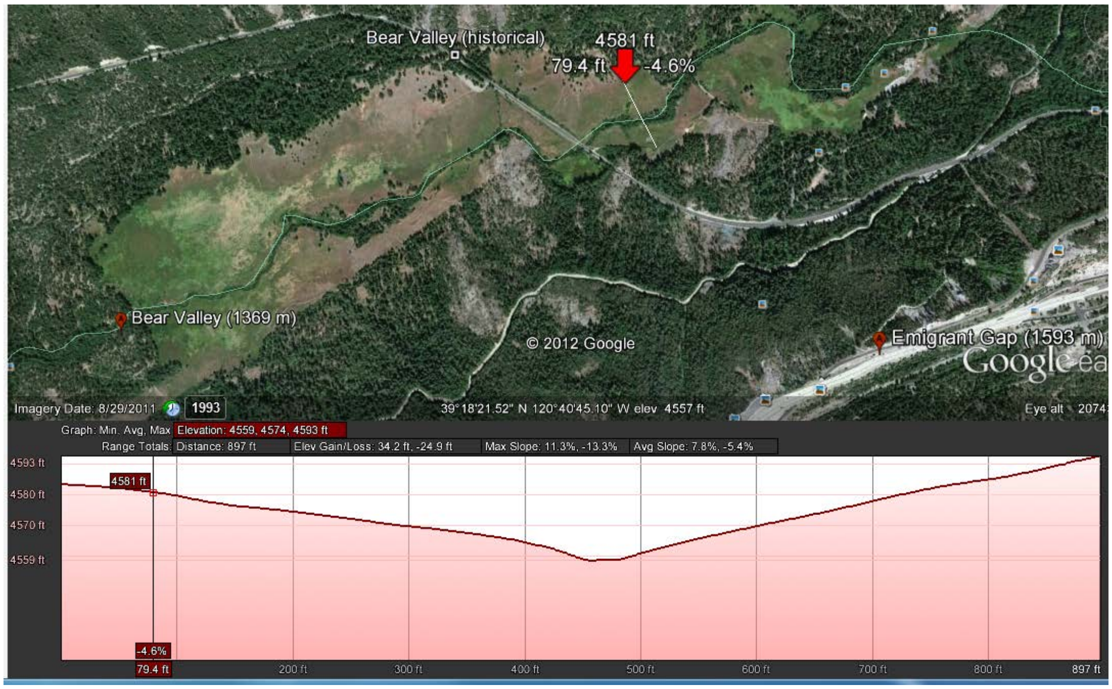


Figure D-6. Elevation profiles throughout the meadow showing a valley floor that rises relatively steeply away from the river channel.



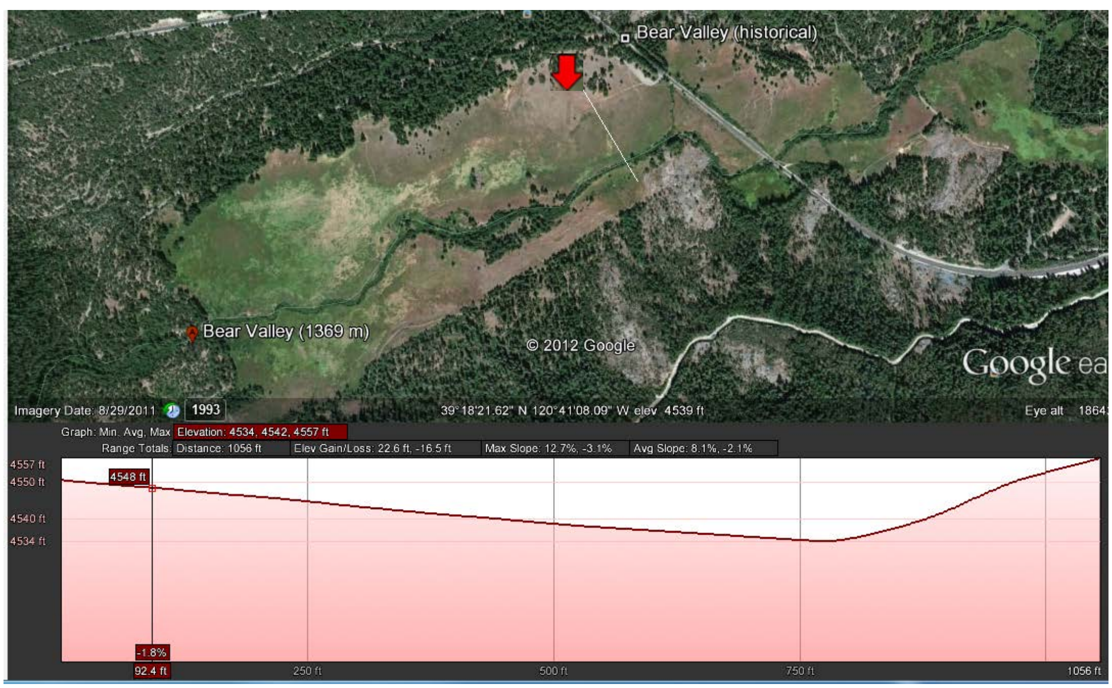
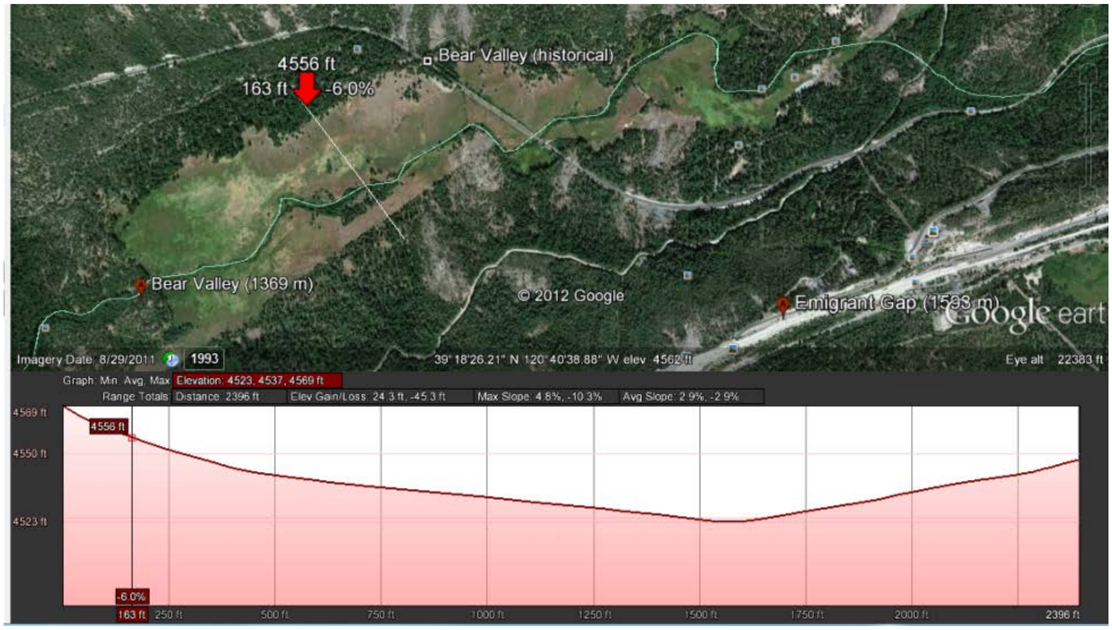


Figure D-6 (continued). Elevation profiles throughout the meadow showing a valley floor that rises relatively steeply away from the river channel.



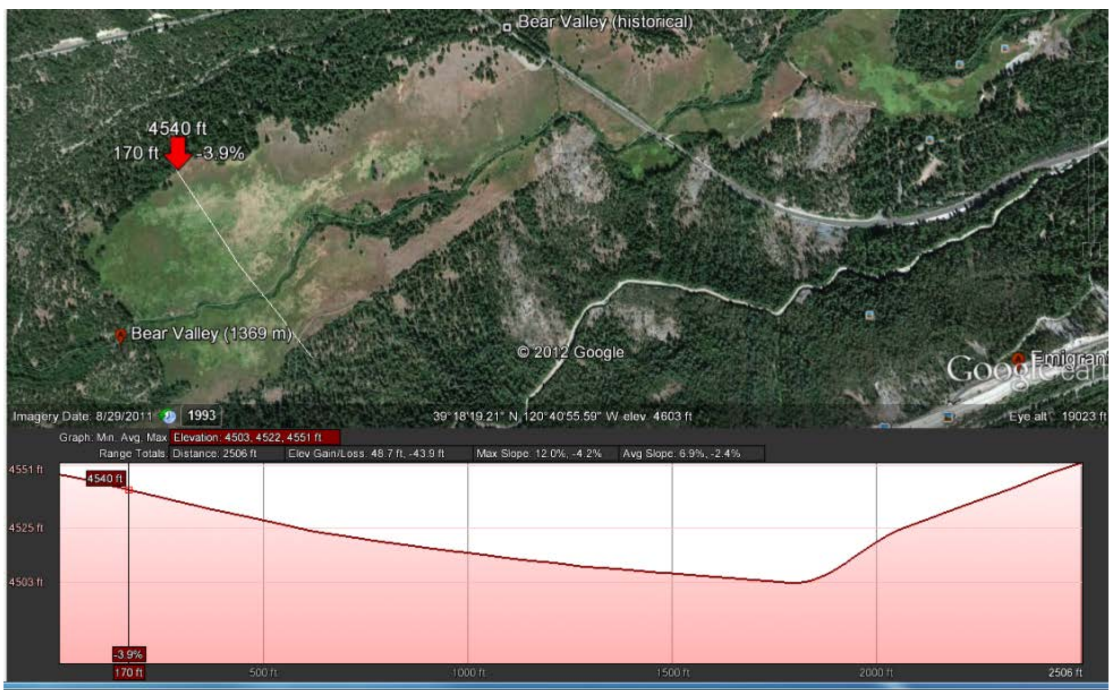


Figure D- 7. Project Hydrology for the Bear River at Bear Valley Meadow. Accurate hydrology prior to 1987 does not exist.

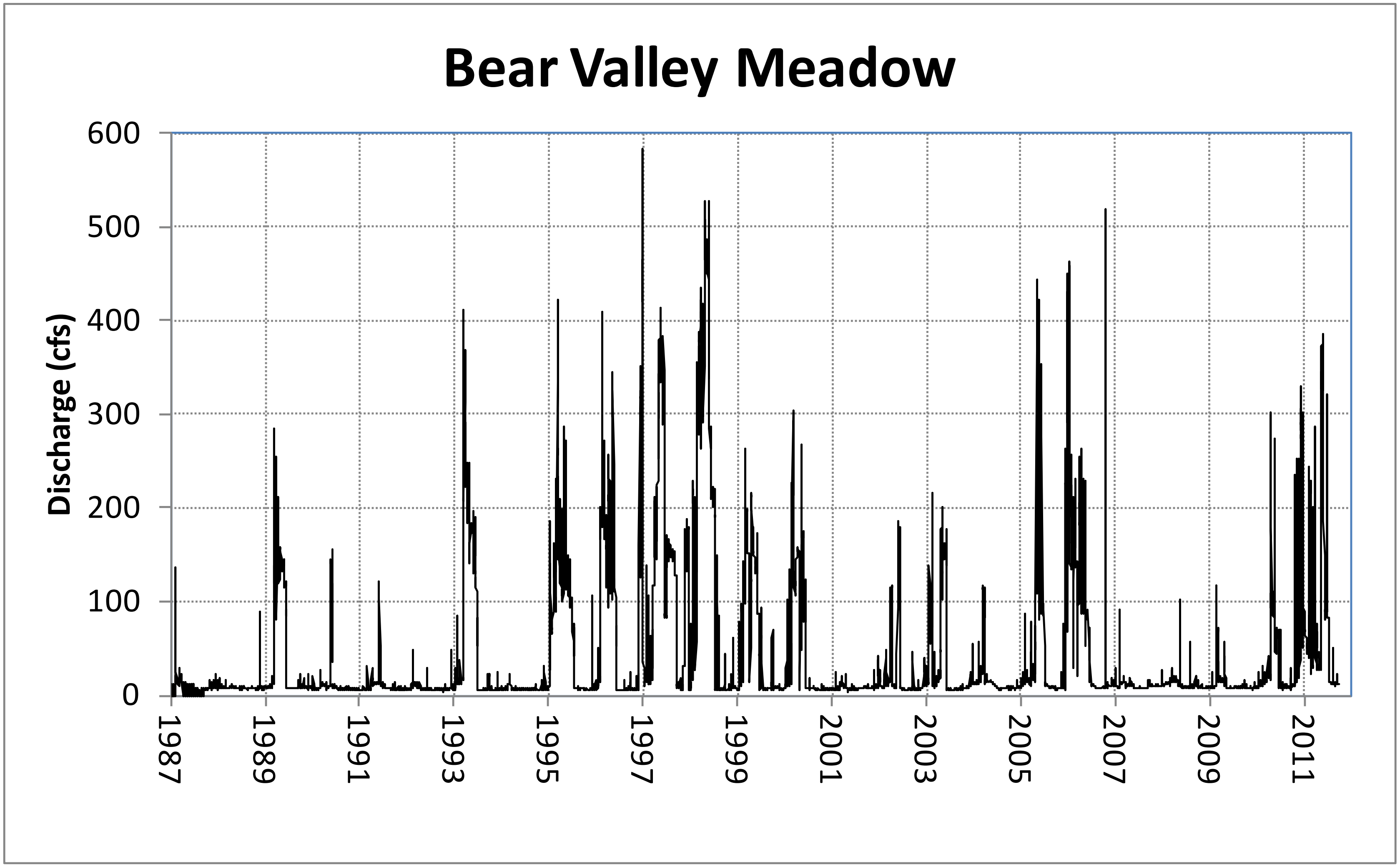
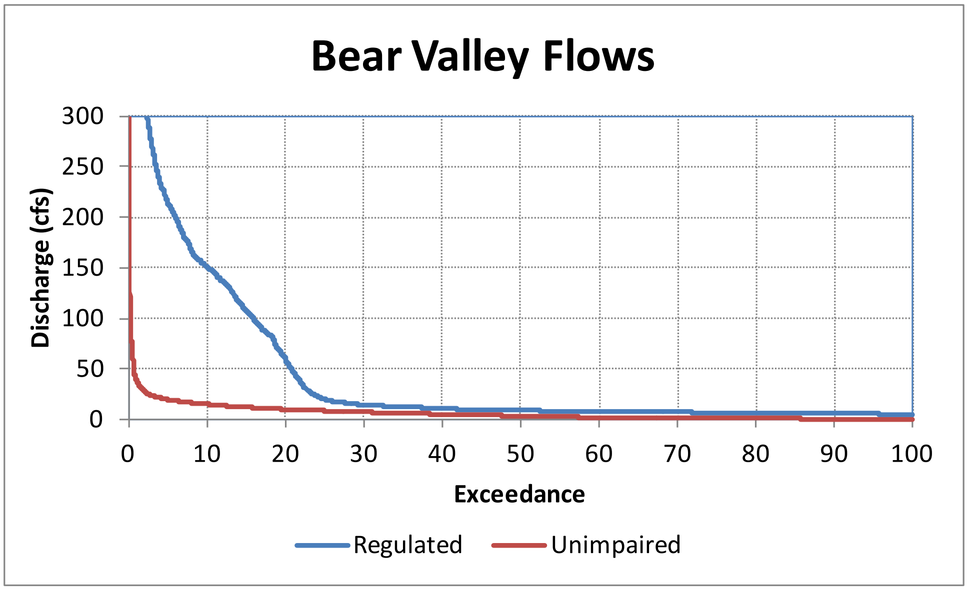


Figure D-8. Regulated (1987-2011) and Unimpaired (1976-2008) Hydrology



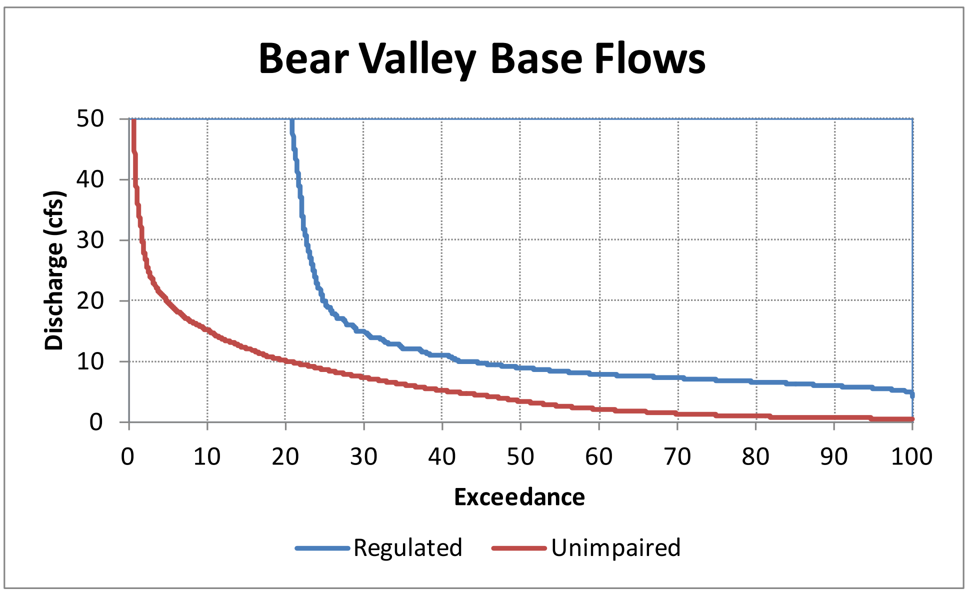


Figure D-9. There are a few erosion scars from the terrace down to the inset active floodplain. The one shown in the photograph below is a small stream of water on the terrace near the Hwy 20 crossing. There is one larger slump up near the Emigrant Trail. Several old "erosion scars" have naturally vegetated.