

# SUMMER 2013

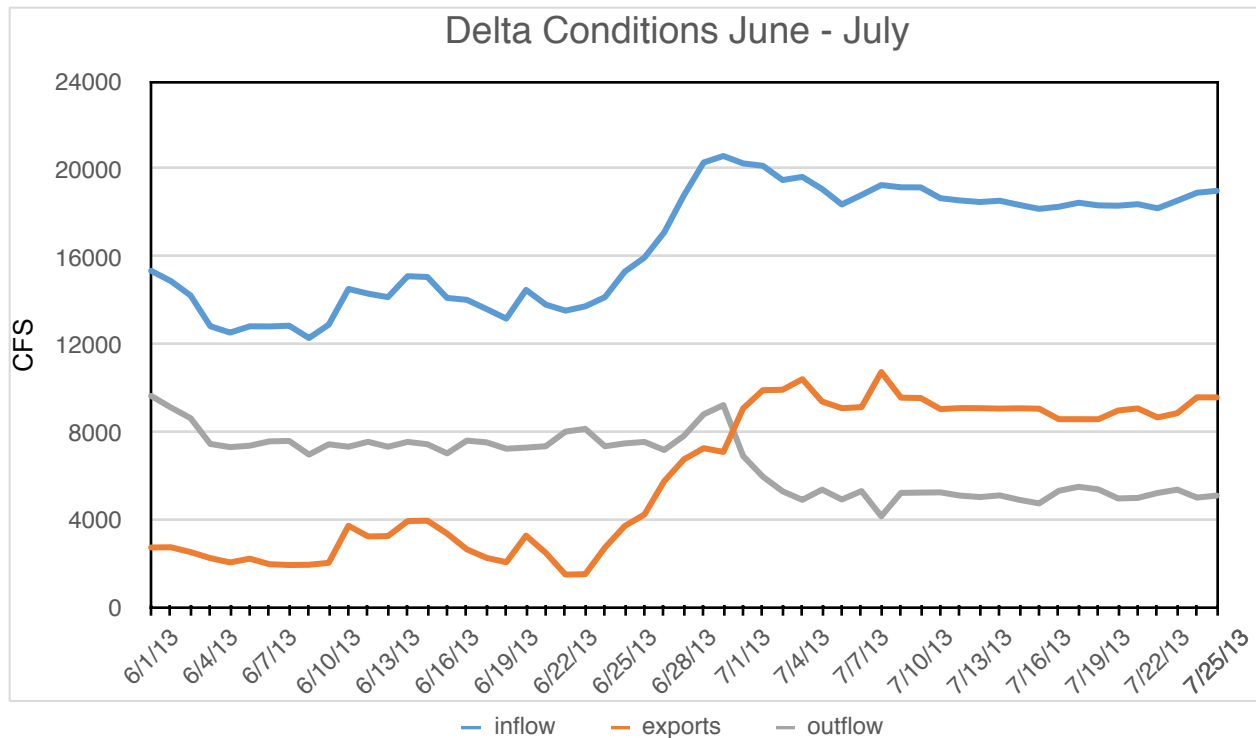
## The demise of Delta smelt under D-1641 Delta Water Quality Standards

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# Summer 2013



## Dry Year Standards Relaxed?

Despite near record low precipitation in the Central Valley in the spring of 2013, the water year remained classified as “dry,” pursuant to D-1641. The “dry year” standards for EC at Emmaton were violated in April, May and June and the EC standard at Jersey Point was violated in June. These standards were established to protect agricultural beneficial uses in the Delta.

The Department of Water Resources and the Bureau of Reclamation, fearing that water exports from the State and Federal Water Projects (Projects) would lead to violations of Delta outflow and western Delta EC standards and depletion of cold water storage in Shasta Reservoir, asked the State Water Resources Control Board on 24 May to reclassify the water year to “critically dry” and requested permission to move the temperature compliance point on the Sacramento River upstream from Red Bluff to Anderson to save the cold-water pool supply in Shasta Reservoir. The Department of Fish and Wildlife, NOAA Fisheries and US Fish and Wildlife Service submitted letters supporting the request.

While the State Board had no authority to arbitrarily change a water year classification, it informed the agencies that it “will not object or take any action if the Bureau and Department operate to meet critically dry year salinity objectives for Western and interior Delta.”

On or about June 22, the Projects began substantially increasing exports and Delta inflows, and shortly thereafter significantly reducing Delta outflow per the Delta Standards.

The D-1641 standards for a dry year (Figure 1) already allowed salinity to encroach into the West Delta at Emmaton and Jersey Point. Earlier violations of those standards in the spring had already exacerbated conditions by summer (it should also be noted that South Delta EC standards were also violated in June and July through August 15).

This report reviews conditions in the summer of 2013, the inadequacy of D-1641 dry year standards and the adverse impacts to Delta smelt caused by violation of those already inadequate standards.

| TABLE 3 (continued)<br>WATER QUALITY OBJECTIVES FOR FISH AND WILDLIFE BENEFICIAL USES |   |  |   |                           |                        |                |
|---|---|--|---|---------------------------|------------------------|----------------|
| COMPLIANCE LOCATION   | INTERAGENCY<br>STATION<br>NUMBER(RK11[1]) | PARAMETER                                | DESCRIPTION<br>(UNIT) [2]                               | WATER<br>YEAR TYPE<br>[3] | TIME<br>PERIOD         | VALUE          |
| <b>DELTA OUTFLOW</b>  |   |  |   |                           |                        |                |
|   |   | Net Delta<br>Outflow Index<br>(NDOI) [7] | Minimum monthly<br>average [8] NDOI<br>(cfs)            | All                       | Jan                    | 4,500 [9]      |
|   |   |  |   | All                       | Feb-Jun                | [10]           |
|   |   |  |   | W,AN                      | Jul                    | 8,000          |
|   |   |  |   | BN                        |                        | 6,500          |
|   |   |  |   | D                         |                        | 5,000          |
|   |   |  |   | C                         |                        | 4,000          |
|   |   |  |   | W,AN,BN                   | Aug                    | 4,000          |
|   |   |  |   | D                         |                        | 3,500          |
|   |   |  |   | C                         |                        | 3,000          |
|   |   |  |   | All                       | Sep                    | 3,000          |
|   |   |  |   | W,AN,BN,D                 | Oct                    | 4,000          |
|   |   |  |   | C                         |                        | 3,000          |
|   |   |  |   | W,AN,BN,D                 | Nov-Dec                | 4,500          |
|   |   |  |   | C                         |                        | 3,500          |
| <b>RIVER FLOWS</b>  |   |  |   |                           |                        |                |
| Sacramento River at Rio Vista   | D-24<br>(RSAC101)                         | Flow rate                                | Minimum monthly<br>average [11] flow<br>rate (cfs)      | All                       | Sep                    | 3,000          |
|   |   |  |   | W,AN,BN,D                 | Oct                    | 4,000          |
|   |   |  |   | C                         |                        | 3,000          |
|   |   |  |   | W,AN,BN,D                 | Nov-Dec                | 4,500          |
| San Joaquin River at Airport Way<br>Bridge, Vernalis                                  | C-10<br>(RSAN112)                         | Flow rate                                | Minimum monthly<br>average [12] flow<br>rate (cfs) [13] | C                         |                        | 3,500          |
|   |   |  |   | W,AN                      | Feb-Apr 14<br>and      | 2,130 or 3,420 |
|   |   |  |   | BN,D                      |                        | 1,420 or 2,280 |
|   |   |  |   | C                         | May 16-Jun             | 710 or 1,140   |
|   |   |  |   | W                         | Apr 15-<br>May 15 [14] | 7,330 or 8,620 |
|   |   |  |   | AN                        |                        | 5,730 or 7,020 |
|   |   |  |   | BN                        |                        | 4,620 or 5,480 |
|   |   |  |   | D                         |                        | 4,020 or 4,880 |
|   |   |  |   | C                         |                        | 3,110 or 3,540 |
|   |   |  |   | All                       | Oct                    | 1,000 [15]     |

Figure 1a. D-1641 EC Water Quality Objectives Table 2.

**TABLE 2**  
**WATER QUALITY OBJECTIVES FOR AGRICULTURAL BENEFICIAL USES**

| INTERAGENCY STATION NUMBER (RKI [1])     |                 | PARAMETER                    | DESCRIPTION (UNIT) [2]                                     | WATER YEAR TYPE [3] | TIME PERIOD                   | VALUE                            |
|--|-----------------|------------------------------|--|---------------------|-------------------------------|----------------------------------|
| COMPLIANCE LOCATION                      |                 |                              |  |                     |                               |                                  |
| WESTERN DELTA                            |                 |                              |  |                     |                               |                                  |
| Sacramento River at Emmaton              | D-22 (RSAC092)  | Electrical Conductivity (EC) | Maximum 14-day running average of mean daily EC (mmhos/cm) |                     | 0.45 EC April 1 to date shown | EC from date shown to Aug 15 [4] |
|  |                 |                              |  | W                   | Aug 15                        | ----                             |
|  |                 |                              |  | AN                  | Jul 1                         | 0.63                             |
|  |                 |                              |  | BN                  | Jun 20                        | 1.14                             |
|  |                 |                              |  | D                   | Jun 15                        | 1.67                             |
| C  | ----            | 2.78                         |  |                     |                               |                                  |
| San Joaquin River at Jersey Point        | D-15\ (RSAN018) | Electrical Conductivity (EC) | Maximum 14-day running average of mean daily EC (mmhos/cm) |                     | 0.45 EC April 1 to date shown | EC from date shown to Aug 15 [4] |
|  |                 |                              |  | W                   | Aug 15                        | ----                             |
|  |                 |                              |  | AN                  | Aug 15                        | ----                             |
|  |                 |                              |  | BN                  | Jun 20                        | 0.74                             |
|  |                 |                              |  | D                   | Jun 15                        | 1.35                             |
| C  | ----            | 2.20                         |  |                     |                               |                                  |
| INTERIOR DELTA                           |                 |                              |  |                     |                               |                                  |
| South Fork Mokelumne River at Terminous  | C-13 (RSMKL08)  | Electrical Conductivity (EC) | Maximum 14-day running average of mean daily EC (mmhos/cm) |                     | 0.45 EC April 1 to date shown | EC from date shown to Aug 15 [4] |
|  |                 |                              |  | W                   | Aug 15                        | ----                             |
|  |                 |                              |  | AN                  | Aug 15                        | ----                             |
|  |                 |                              |  | BN                  | Aug 15                        | ----                             |
|  |                 |                              |  | D                   | Aug 15                        | ----                             |
| C  | ----            | 0.54                         |  |                     |                               |                                  |
| San Joaquin River at San Andreas Landing | C-4 (RSAN032)   | Electrical Conductivity (EC) | Maximum 14-day running average of mean daily EC (mmhos/cm) |                     | 0.45 EC April 1 to date shown | EC from date shown to Aug 15 [4] |
|  |                 |                              |  | W                   | Aug 15                        | ----                             |
|  |                 |                              |  | AN                  | Aug 15                        | ----                             |
|  |                 |                              |  | BN                  | Aug 15                        | ----                             |
|  |                 |                              |  | D                   | Jun 25                        | 0.58                             |
| C  | ----            | 0.87                         |  |                     |                               |                                  |

Figure 1b. D-1641 Flow Water Quality Objectives Table 3.

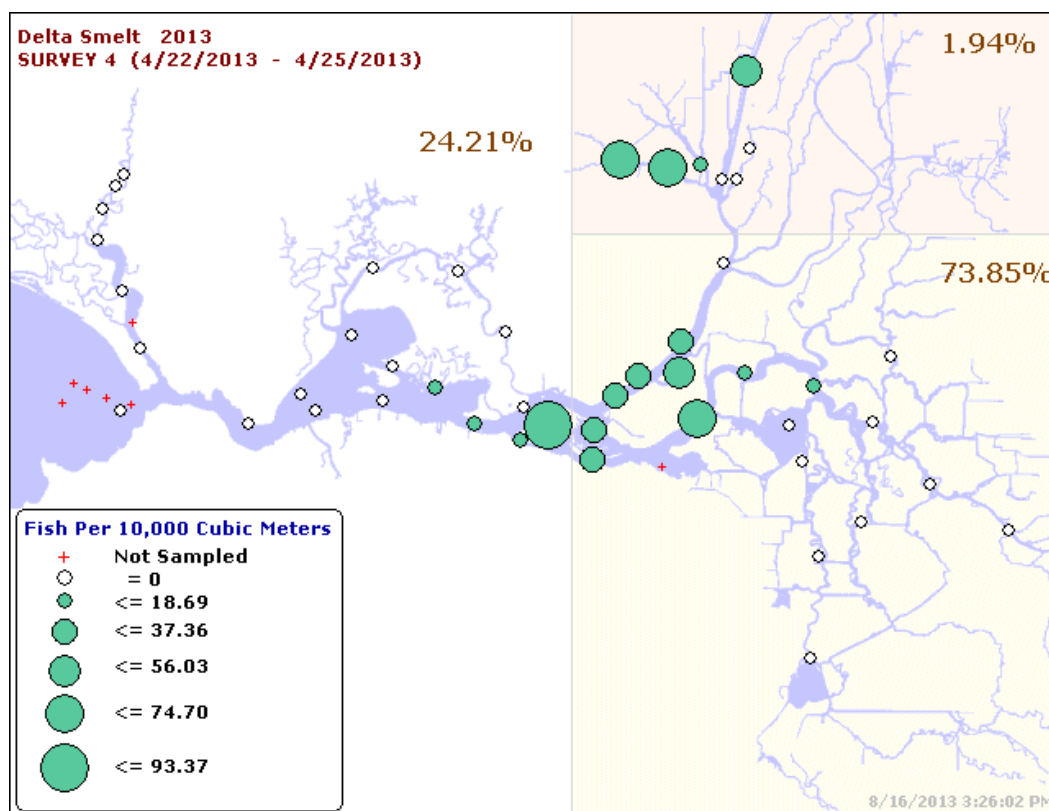


Figure 2. Late-April 2013, 20-mm Smelt Survey results. (Source: <http://www.dfg.ca.gov/delta/data/20mm/>)

## Delta Smelt in April

Although not the subject of this report, spring conditions set the stage for summer. April 2013 was a tough time for smelt. Sacramento River inflow to the Delta dropped to only 6,000 cfs, San Joaquin inflows were 1500-3000 cfs, exports were up to 2,500-3,000 cfs, and outflow was as low as 6,000 cfs. Old and Middle River OMR flows were -1000 to -4000 cfs. The Delta Cross Channel was closed.

Over the past 20 years, the late April – early May period had been under the protection of CVPIA and VAMP (Vernalis Adaptive Management Program) protections, but these protections ended in 2010. This year, without these protections, late April exports climbed to 2,500-3,000 cfs reaching 4,000 cfs in early May (from 1500 cfs cap under VAMP). This increase in exports without the VAMP export cap occurred under lower inflows, outflows, and negative OMR flows. Nearly three quarters of the Delta smelt population was in the Central and Western Delta (20-mm survey, Fig. 2) and thus subject to being exported (especially with negative OMRs with the DCC closed). Most of the smelt were not of salvageable size (they were only 10-25 mm), so they were entrained in the export water likely in large numbers (hundreds of thousands per day were moving into Old River toward pumps).

Despite these horrible conditions many still survived in the western Delta under the modest outflows and thus became subject to summer conditions.

## Delta Smelt in Mid June

In mid June 2013 the small remnant population of delta smelt surviving in the San Francisco Bay-Delta after the below-normal water year of 2012 and poor spring conditions described above were spread through their usual dry-year habitats in the western Delta, eastern Suisun Bay, Montezuma Slough, and the Cache Slough/Bypass/Ship Channel complex in the north Delta (Figure 3).

Other than the north Delta group, most of the smelt were in their summer low-salinity zone (LSZ) home where salinities are low (0.5-5 ppt) and water temperature optimal (about 20C). With the protective dry-year EC standard of 0.45 through June 15, the LSZ was in eastern Suisun Bay west of the Delta.

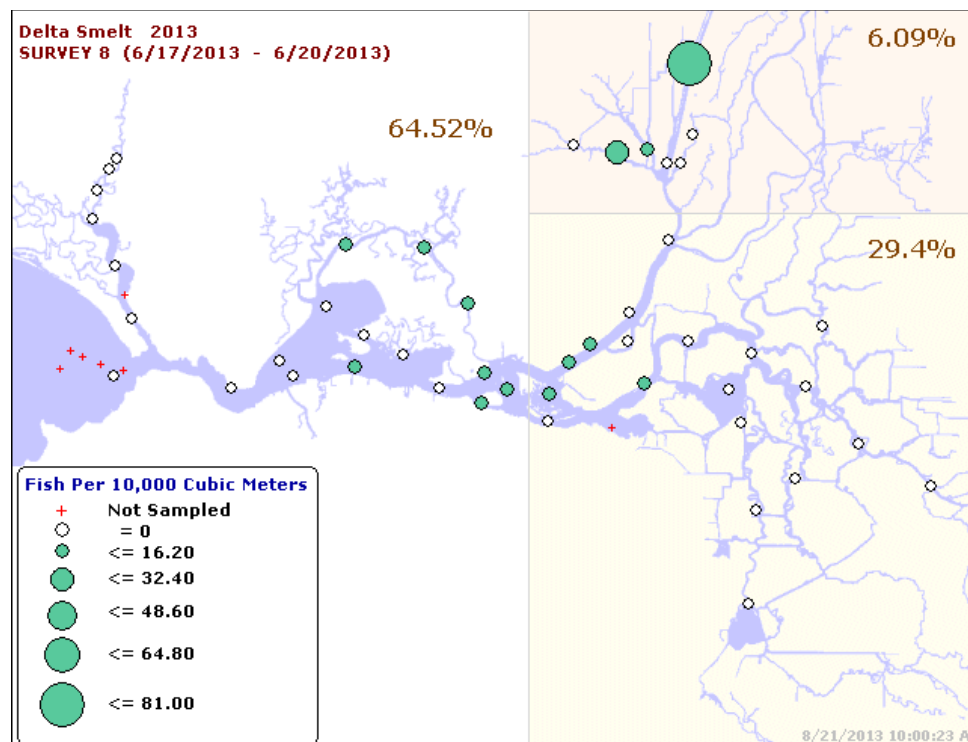


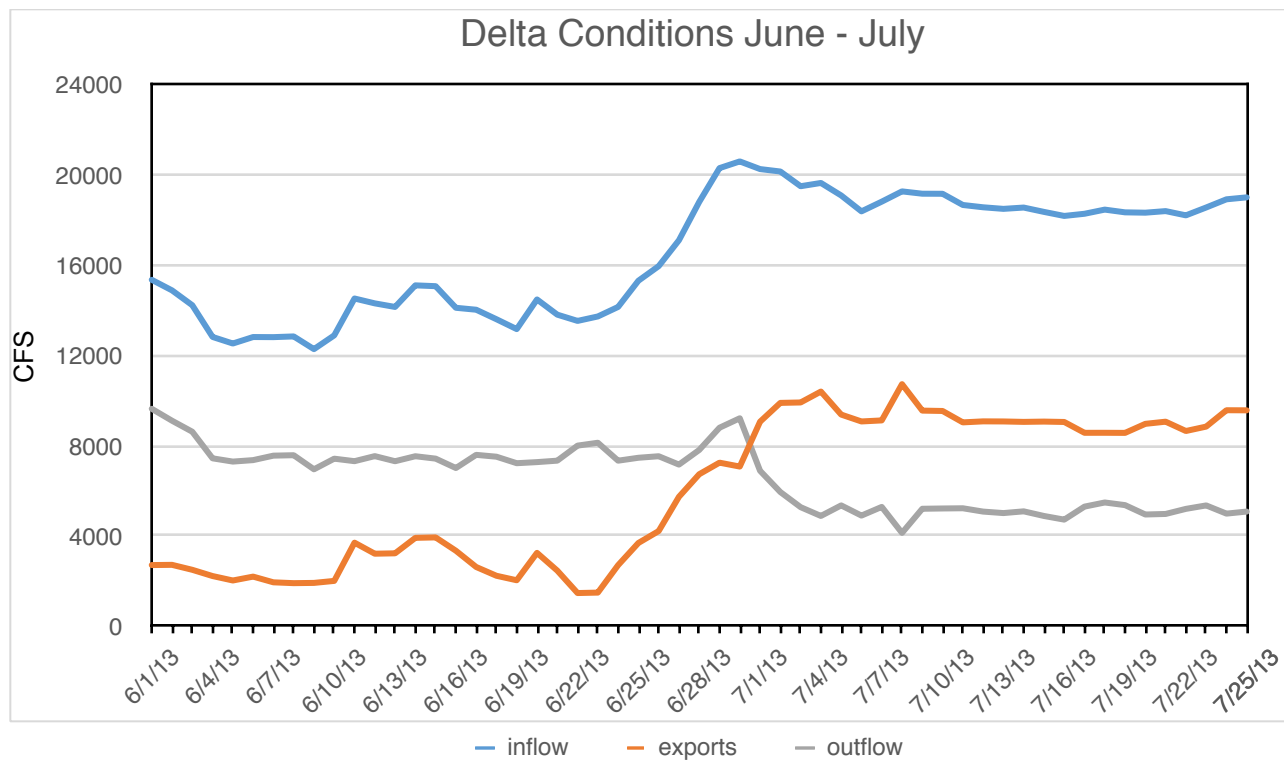
Figure 3. Mid-June 2013, 20-mm Smelt Survey results. (Source: <http://www.dfg.ca.gov/delta/data/20mm/>)

# Summer Flow and Salinity Conditions

Beginning in the third week in June, inflow increase from the 12,000-14,000 cfs level to 20,000 cfs and exports increased from 2,000 to 10,000 cfs (Figure 4). A week later Delta outflow was reduced to 5,000 cfs.

## West Delta

The effect is seen in the EC patterns at Emmaton and Jersey Point in the west Delta (Figures 5a and 5b). As outflow declines, salinities (EC) increase. The LSZ with its 500-6000 EC signature moved upstream into the West Delta with each incoming tide. In contrast, in wet year 2011, outflow was maintained at 8000 cfs and the LSZ did not move upstream into the Delta (Figure



5c).

*Figure 4. June through July 2013 Delta inflow, outflow, and exports. Summer EC standards kick in after mid June.*

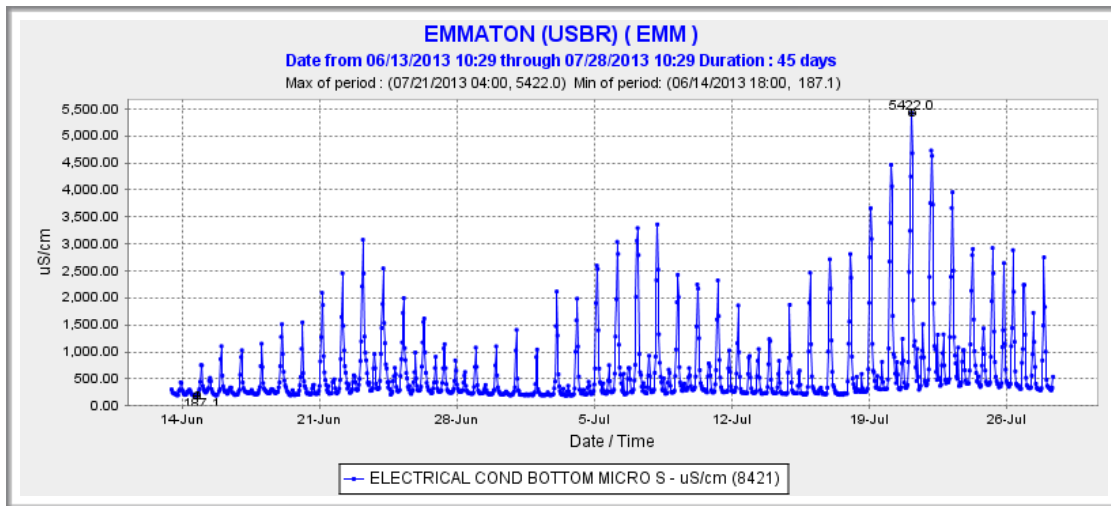


Figure 5a. Conductivity (EC) at Emmaton on lower Sacramento River in West Delta after mid June 2013. (Source: CDEC)

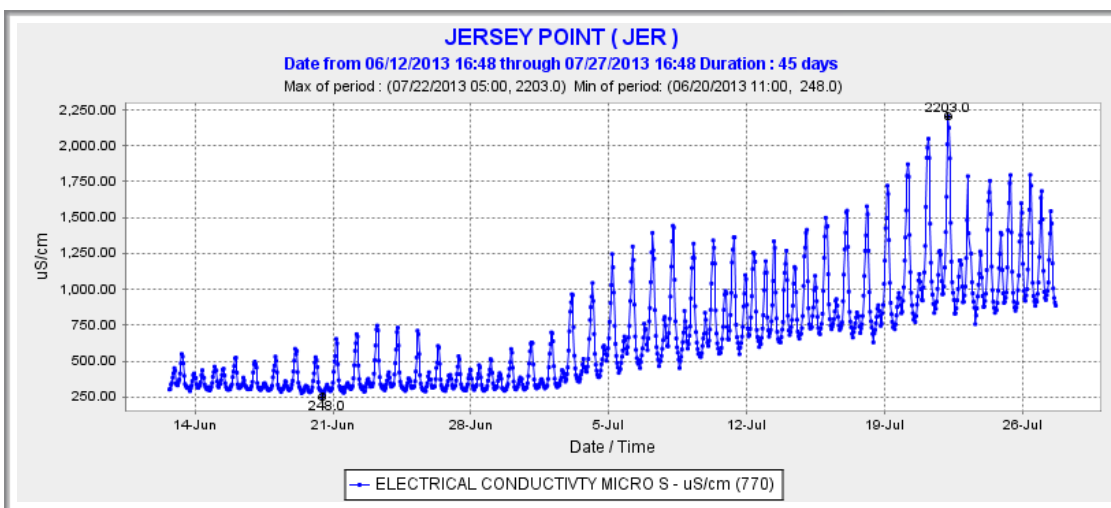


Figure 5b. Conductivity (EC) at Jersey Point on lower San Joaquin River in West Delta after mid June 2013. (Source: CDEC)

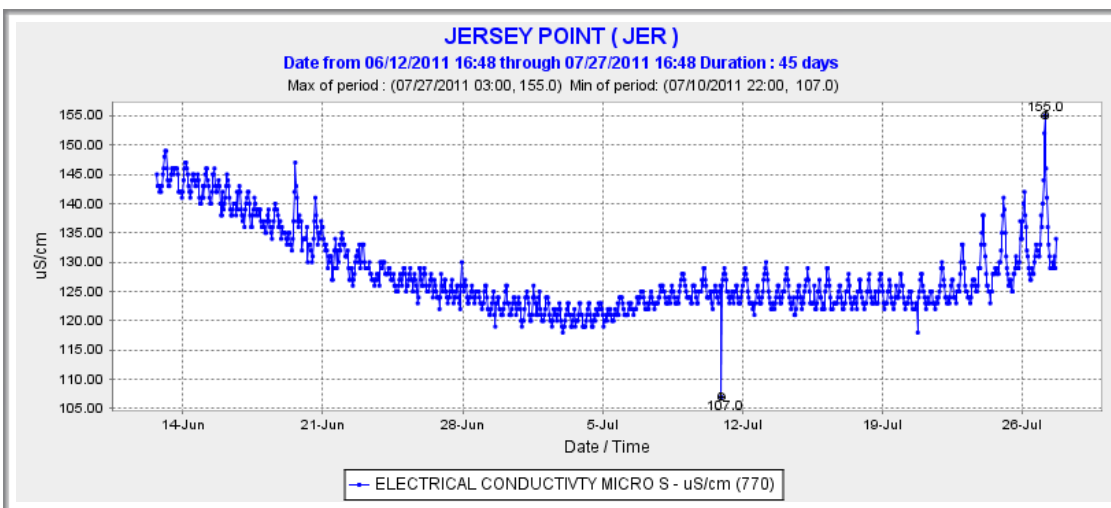


Figure 5c. Conductivity (EC) at Jersey Point on lower San Joaquin River in West Delta after mid June 2011. (Source: CDEC)

## Eastern Suisun Bay

Salinity (EC) in Eastern Suisun Bay at Collinsville on the north and Pittsburg on the south also increased at the beginning of July with the decrease in outflow (Figures 6 and 7). At high tide the LSZ was well upstream of the two locations by early July. The lower end of the LSZ did extend downstream to these locations during low tides through July.

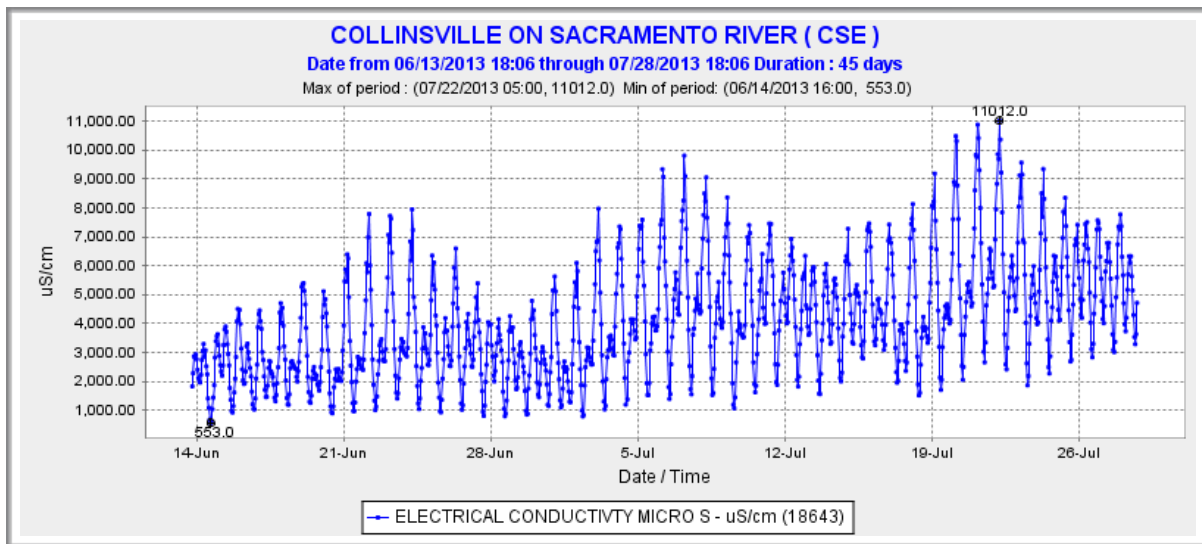


Figure 6. Conductivity (EC) at Collinsville in Eastern Suisun Bay after mid June 2013. (Source: CDEC)

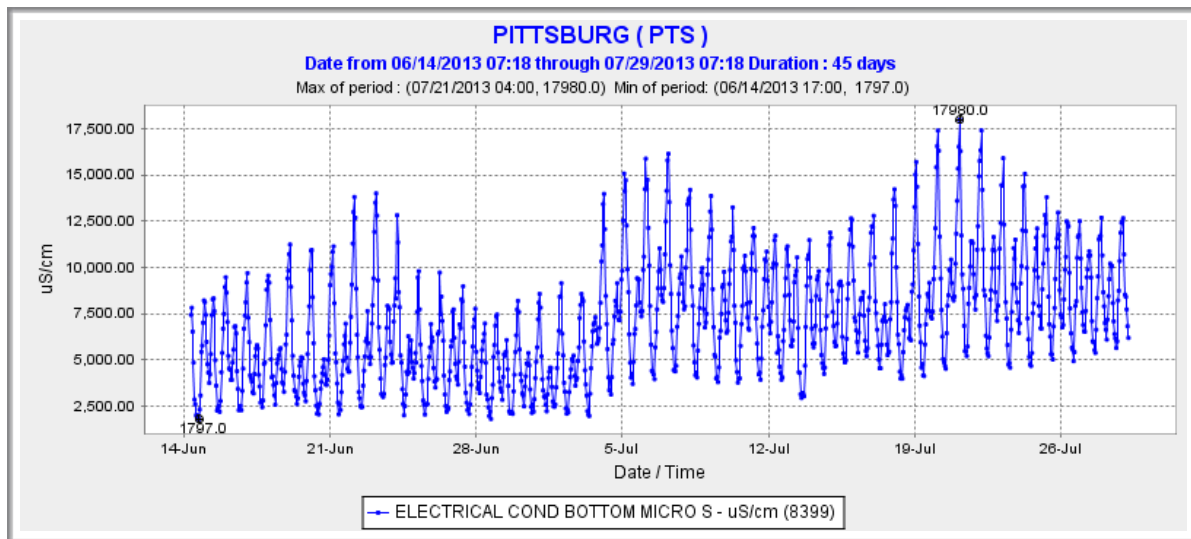


Figure 7. Conductivity (EC) at Pittsburg in Eastern Suisun Bay after mid June 2013. (Source: CDEC)

## Central Delta

Central Delta EC as measured Threemile Slough on the San Joaquin River (Figure 8) and False River (Figure 9) also shows the movement of the LSZ upstream coincident with the reduction in Delta outflow at the beginning of July.

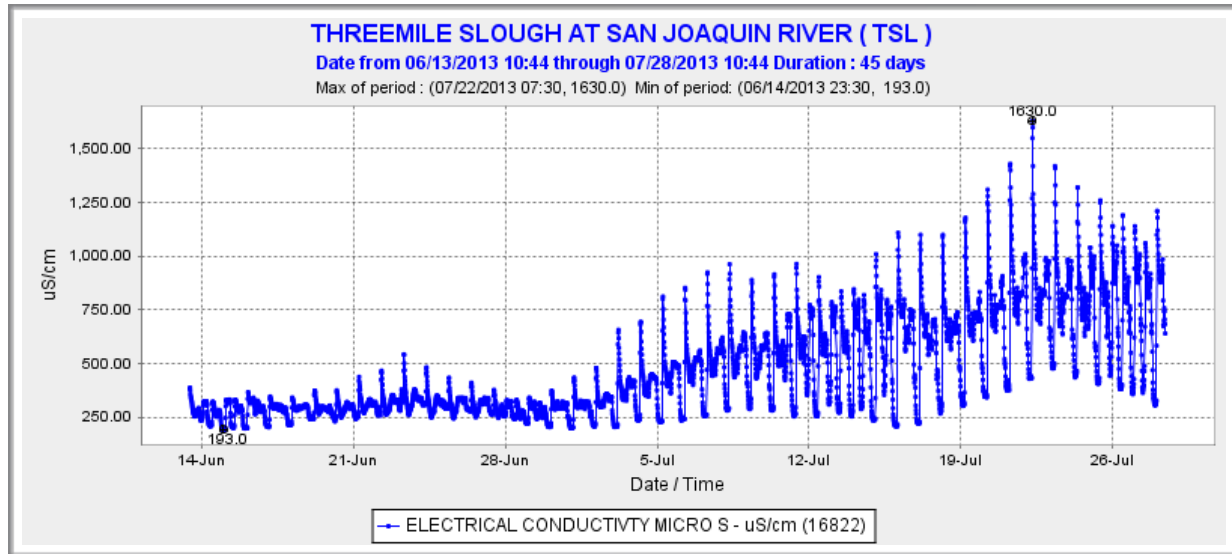


Figure 8. Conductivity (EC) at Threemile Slough in the Central Delta after mid June 2013. (Source: CDEC)

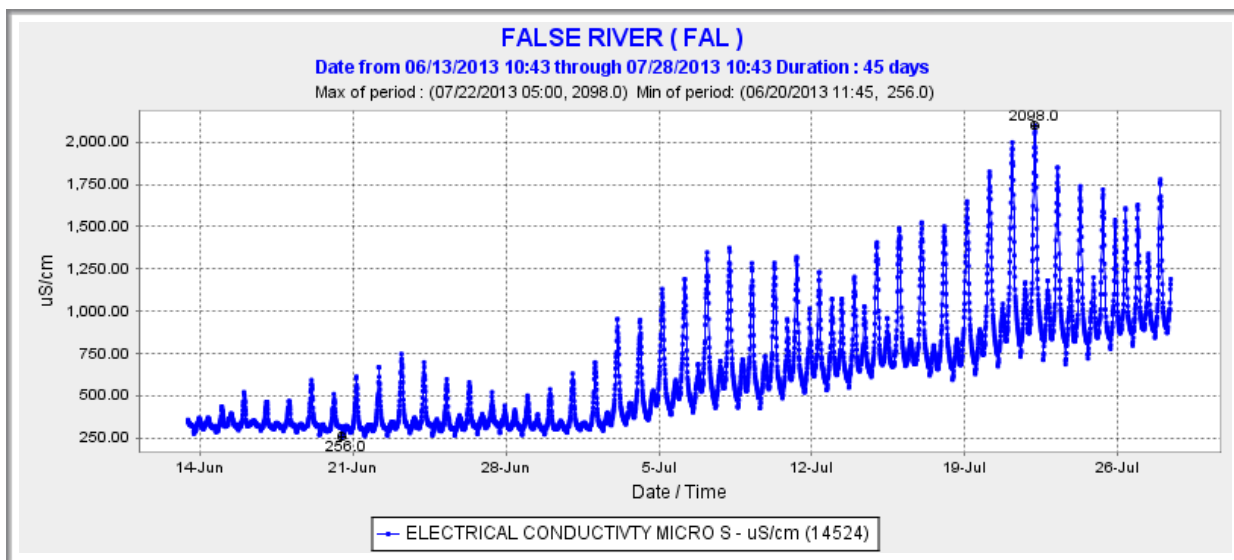


Figure 9. Conductivity (EC) at False River in the Central Delta at Franks Tract after mid June 2013. (Source: CDEC)

## South Delta

South Delta EC also increased as the upper portion of the LSZ was mixed with cross Delta moving freshwater Sacramento River on the way to the export pumps. Salinity gradually increased in Old River as the head of the LSZ actually moved into the South Delta toward the export pumps (Figure 10).

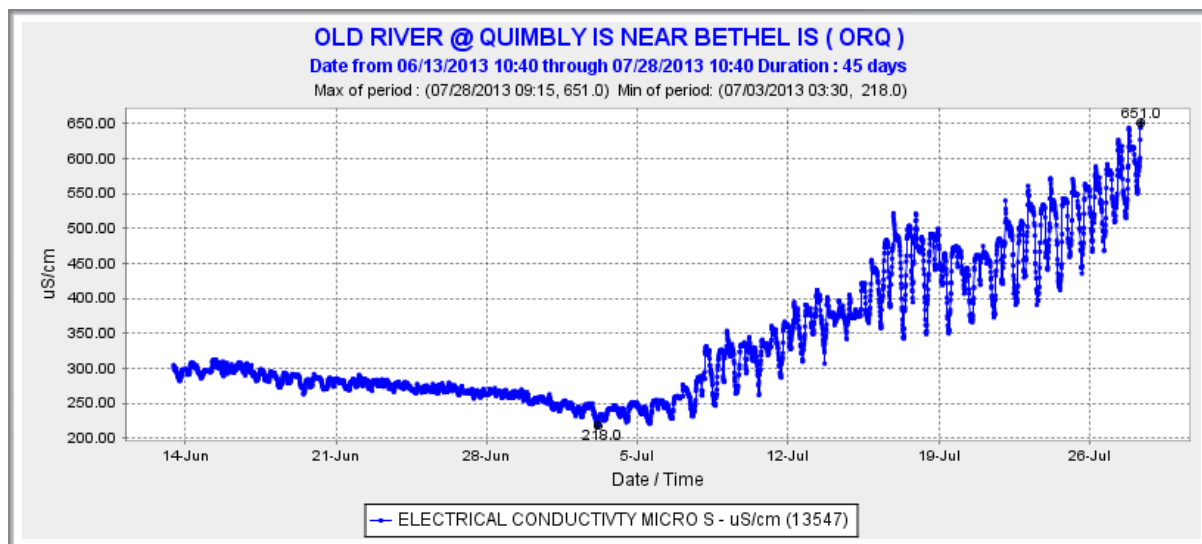


Figure 10. Conductivity (EC) in Old River in the Central Delta near Bethel Is after mid June 2013. (Source: CDEC)

Salinity in Clifton Court Forebay was slightly less as Forebay water is a mixture of Old River, Middle River, and East Delta waters of lower salinity (Figure 11).

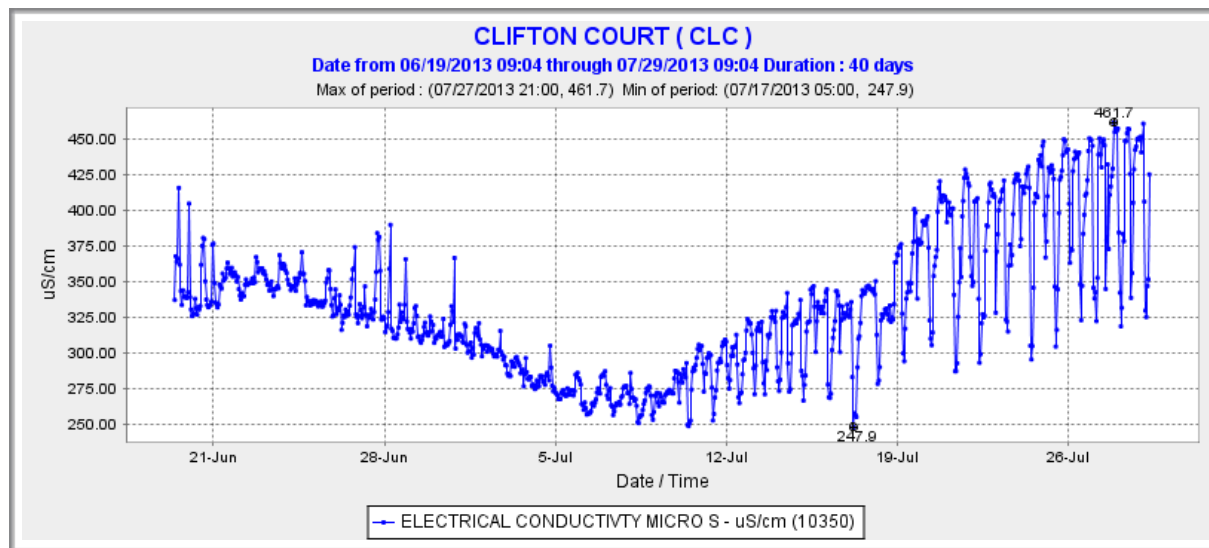


Figure 11. Conductivity (EC) in Clifton Court Forebay after mid June 2013. (Source: CDEC)

# Summer Water Temperatures

## Western Delta

Water temperatures reached near lethal levels for smelt (75-77F) in the western Delta by the beginning of July (Figures 12-14). Water temperatures rose sharply in late June due to the combination of warm air temperatures and sharply higher Delta inflows. Water temperatures declined thereafter through mid July with lower air temperatures, lower Delta inflows, and cooler waters moving upstream from Suisun Bay with lower outflows.

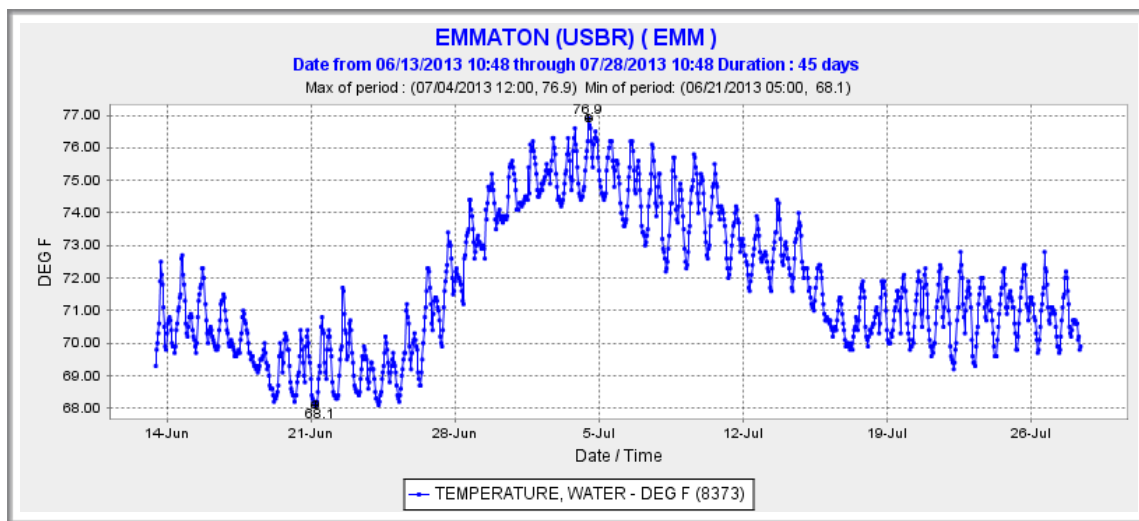


Figure 12. Water temperature at Emmaton mid June through July 2013. (Source: CDEC)

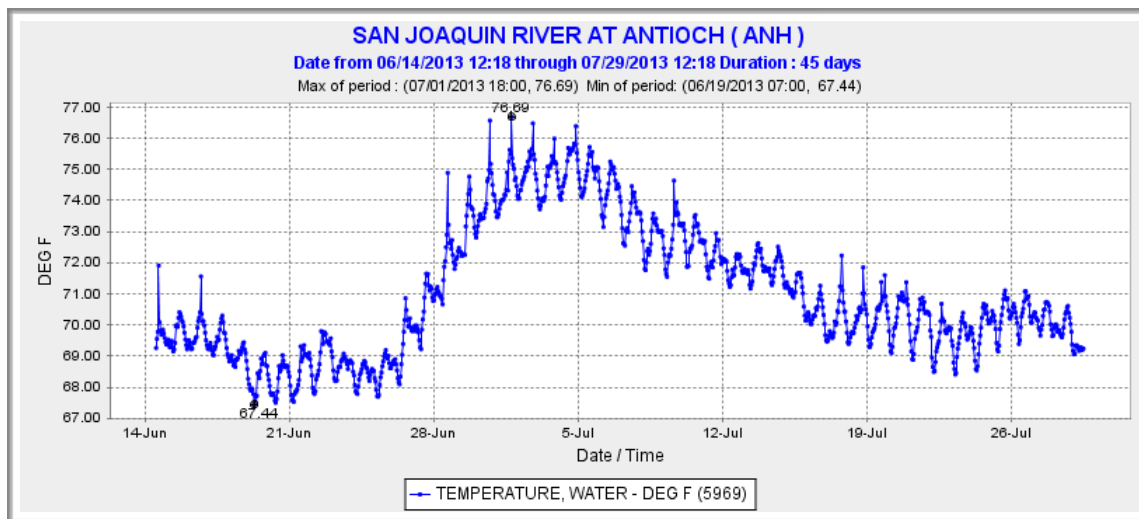


Figure 13. Water temperature at Antioch mid June through July 2013. (Source: CDEC)

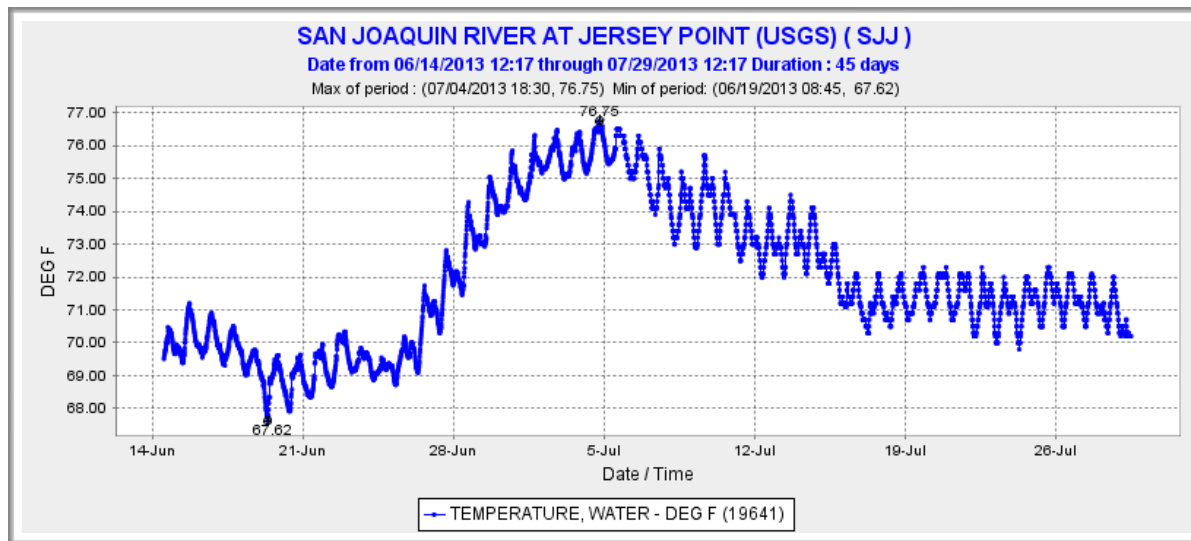


Figure 14. Water temperature at Jersey Point mid June through July 2013. (Source: CDEC)

## Central Delta

Water temperatures reached near lethal levels for smelt (75-77F) in the Central Delta by the beginning of July (Figures 15 and 16). Water temperatures rose sharply in late June due to the combination of warm air temperatures and sharply higher Delta inflows. Water temperatures declined thereafter through mid July with lower air temperatures, lower Delta inflows, and cooler waters moving upstream from The West Delta with lower outflows.

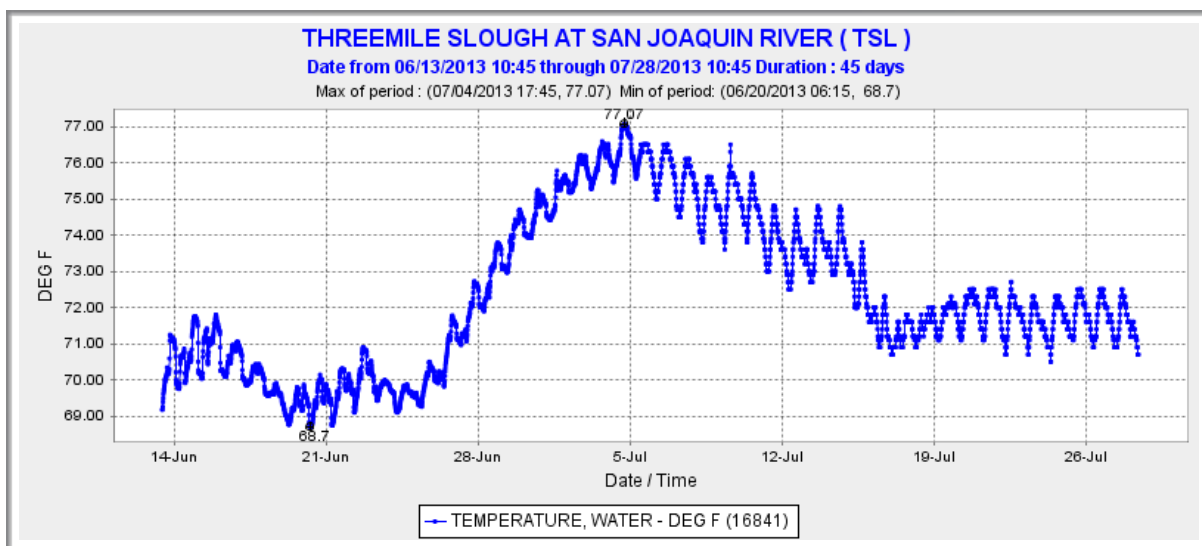


Figure 15. Water temperature at Threemile Slough mid June through July 2013. (Source: CDEC)

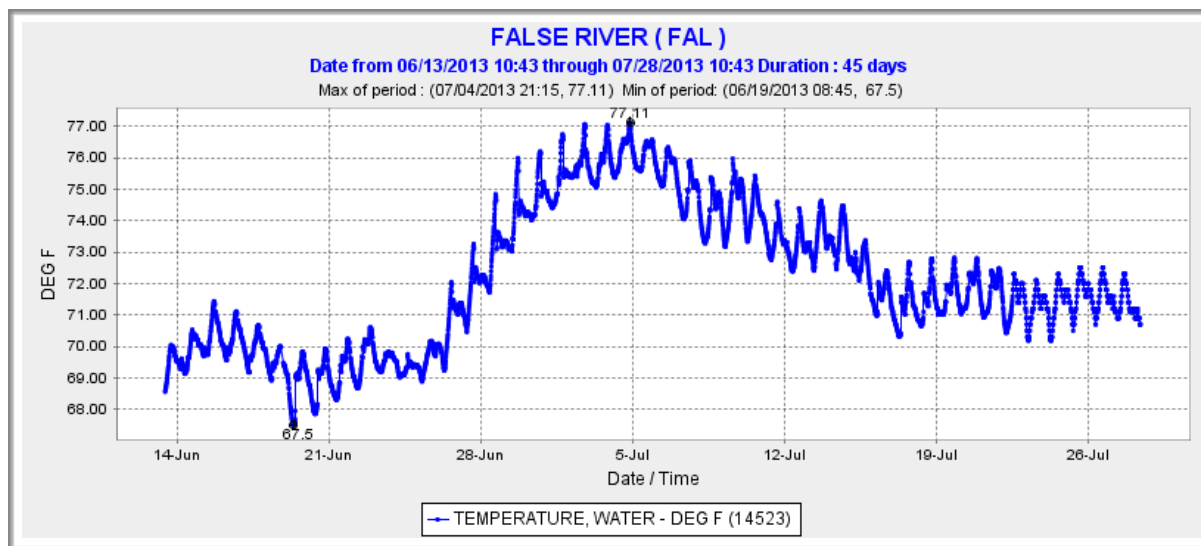


Figure 16. Water temperature at False River mid June through July 2013. (Source: CDEC)

## South Delta

Water temperatures reached lethal levels for smelt (78-80°F) in the South Delta by the beginning of July (Figures 17-18). Water temperatures rose sharply in late June due to the combination of warm air temperatures, sharply higher Delta inflows, and higher exports drawing warm water into the South Delta. Water temperatures declined thereafter through mid July with lower air temperatures, lower Delta inflows, and cooler waters moving into the South Delta from the western and central Delta with lower outflows.

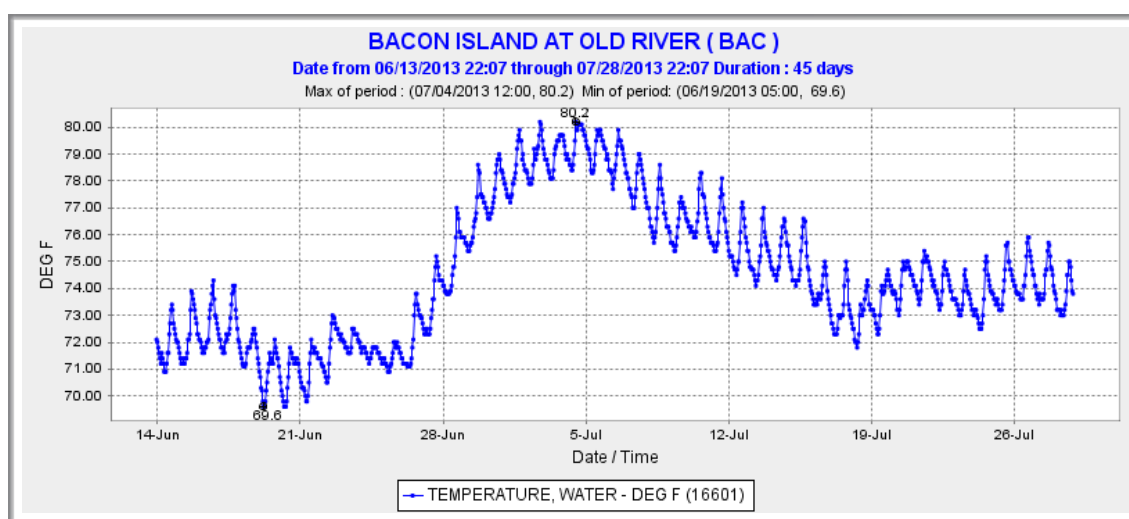


Figure 17. Water temperature in Old River near Bacon Is mid June through July 2013. (Source: CDEC)

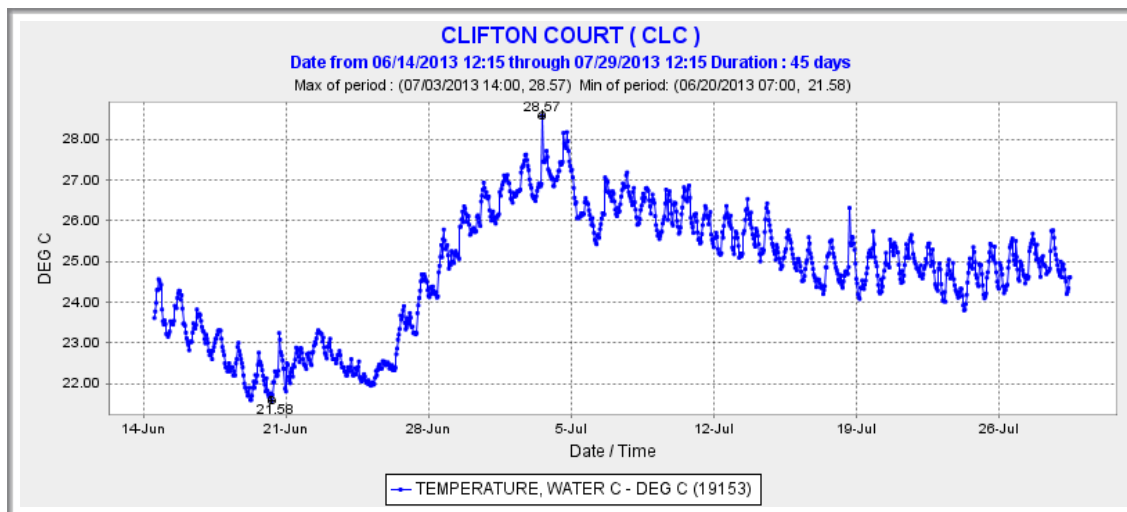
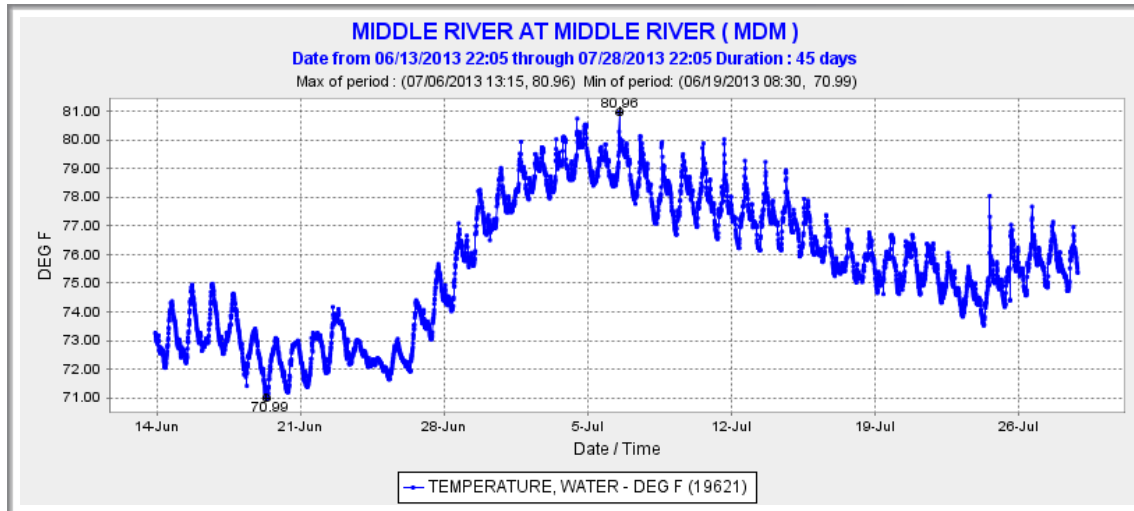


Figure 18. Water temperature in Clifton Court Forebay near Byron mid June through July 2013. (Source: CDEC)

## Eastern Delta

Water temperatures in the eastern Delta also reached lethal levels of 80-81F (Figures 19 and 20).

Figure 19. Water temperature in Middle River mid June through July 2013. (Source: CDEC)



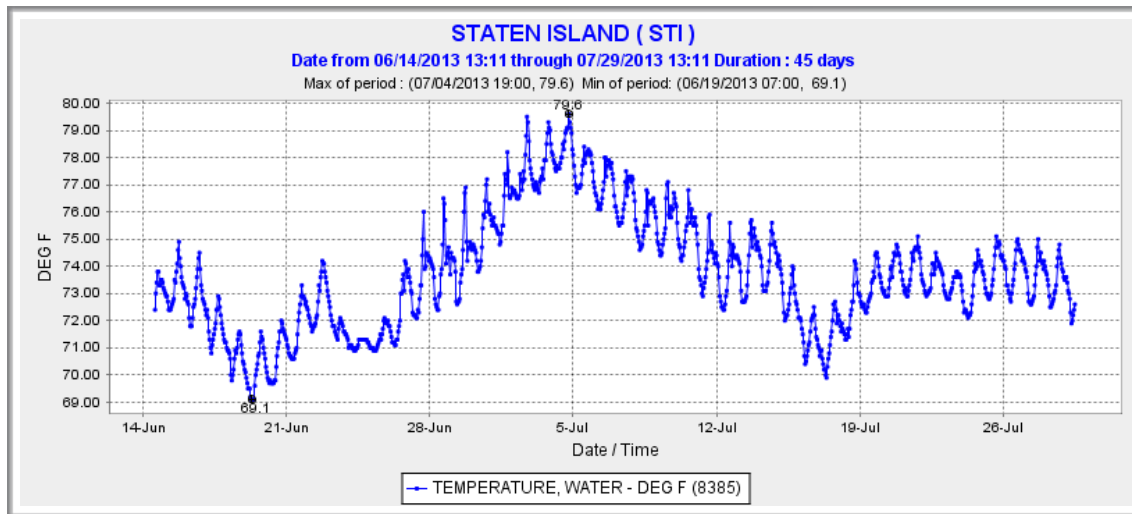


Figure 20. Water temperature near Staten Island mid June through July 2013. (Source: CDEC)

# Delta Smelt Vulnerable

With the LSZ reaching into the Central and South Delta at high tides at a greater frequency through July than in wetter years it begs the question as to why were not more smelt salvaged. Clearly small salvage events occurred through mid June coincident with small pulses of exports (Figure 21). But, why not after mid June?

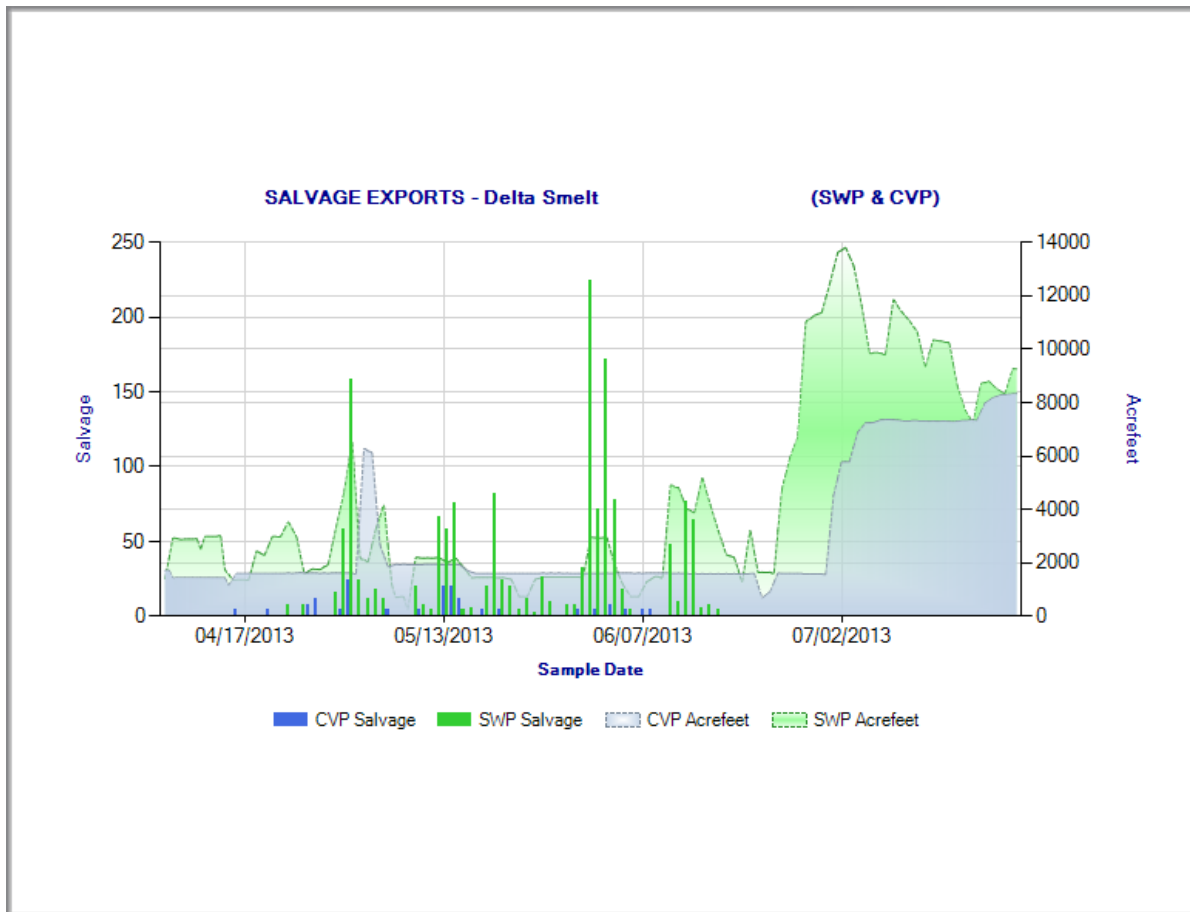


Figure 21. Delta exports and smelt salvage In spring and summer 2013. (Source: USBR MP)

First, the high inflows, low exports and high outflows kept the LSZ away from the influence of the pumps toward the end of June. Until about 8 July export demand was satiated by the pool of freshwater left over in the Delta from prior high inflows as observed in Clifton Court Forebay EC (Figure 11). But soon thereafter evidence of the LSZ being drawn to the pumps was apparent.

So why were no smelt salvaged after exports picked up and the LSZ entered the Central Delta? The answer is high water temperatures by early July. No smelt were able to survive passage to the

South Delta export salvage facilities because of lethal water temperatures in the Central and South Delta.

The high exports and high inflows at the end of June and beginning of July not only pulled the LSZ upstream into the Central Delta and under influence of the South Delta pumps at Clifton Court Forebay, but it also lead to a sharp increase in water temperature throughout much of the LSZ that was lethal to delta smelt (77-80F or 25-27C). Warm weather occurred at the beginning of July throughout the Delta (but reaching over 100F to the north and east), along with nearly a week of 20,000 cfs inflow (from the north and east) with high ambient water temperature, and near 10,000 cfs exports resulted in near lethal or lethal water temperatures in the North, Central, West, and South Delta. Smelt were able to survive only in the western portion of the LSZ of eastern Suisun Bay and extreme western Delta (Figure 22) where water temperatures remained sub-lethal at 22-24C.

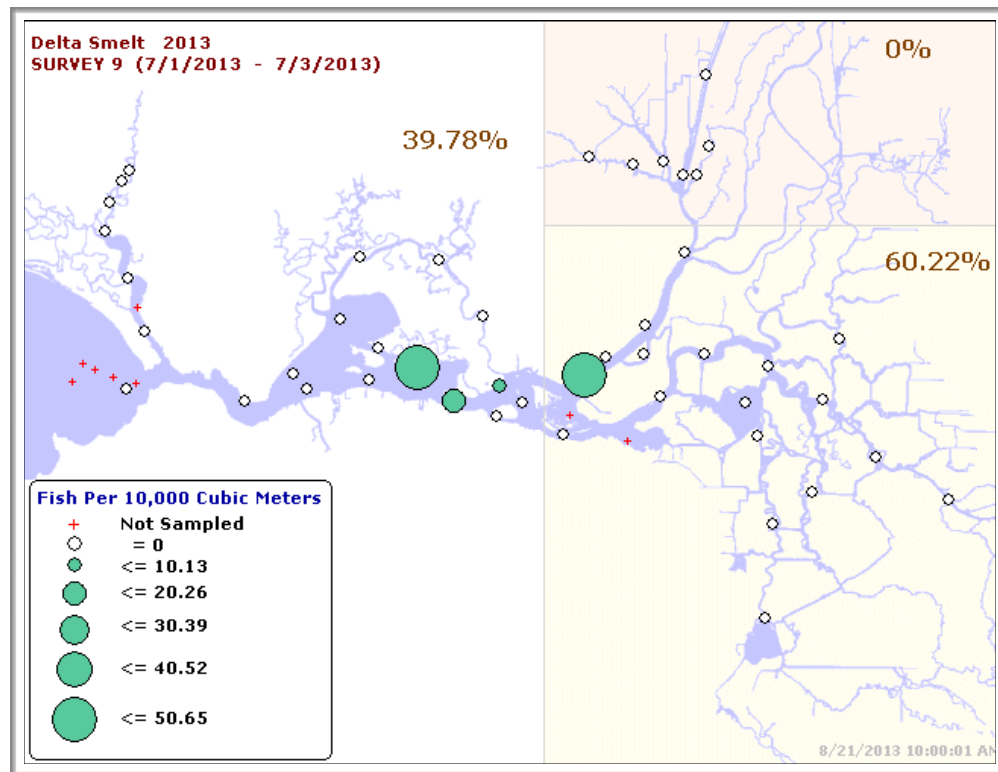


Figure 22. Early July 20-mm Smelt Survey results. (Source: <http://www.dfg.ca.gov/delta/data/20mm/>)

This ninth and last of the Department of Fish and Wildlife's 2013 20-mm Survey shows that the majority of smelt were in the Delta at the beginning of July. The Summer Townet Survey that began in mid June (unpublished CDFW data) has provided a Delta smelt abundance index based upon its first two surveys (weeks of June 10 and 24). The preliminary 2013 index is 0.7, down from last year's 0.9. The results from the remaining Summer Townet Survey and the Fall Mid-

Water Trawl Survey will help reveal the full extent to which Delta smelt were harmed by Project operations this summer. Based upon my decades of experience, I suspect that summer 2013 parallels the conditions during the Pelagic Organism Decline (POD) and record low smelt indices early in the last decade.

## Solution

The problem remains that neither the D-1641 Water Quality Objectives for the Delta or the OCAP Biological Opinions have protections for Delta smelt after June. The demise of VAMP's limit on exports in the late spring has exacerbated the problem. The D-1641 dry and critical year standards for outflow are simply too low to protect delta smelt and their important habitats. Even with higher outflows, excessive exports remain a problem. The inflows necessary to sustain high exports reduce reservoir storage and cold-water pools, and bring warmer, low-productive reservoir water into the Delta and LSZ. Cooler, more productive, more turbid water, critical to delta smelt growth and survival is first exported from the Delta and then replaced with warm, low turbidity, low productivity reservoir water. Higher summer outflow and reduced exports (and a minimum of inflow necessary to sustain reduced exports) in drier years are fundamentally necessary for delta smelt recovery. A minimum of inflow and exports will increase residence time and productivity, allow higher productivity waters and smelt to remain in the Delta, and allow Delta waters to remain cooler to sustain smelt.