From: Gary Bobker [mailto:bobker@sbcglobal.net]
Sent: Monday, April 11, 2016 9:10 PM
To: Babb, Ryan@Waterboards
Cc: Oppenheimer, Eric@Waterboards
Subject: Fw: protest of USBR TUCP

forwarding to the two of you since I got auto-responses from Rich and Tom indicating they're out of the office.

Gary Bobker
Program Director
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San Francisco, CA 94133
ph: 415-272-6616
email: bobker@bay.org

On Monday, April 11, 2016 9:03 PM, Gary Bobker <bobker@sbcglobal.net> wrote:

Rich and Ron,

attached are the following:

1. protest by TBI, NRDC, Defenders of Wildlife, PCFFA, and IFR of the USBR TUCP dated April 1, 2016

2. appendix to the protest describing the environmental and public trust considerations at issue

3. TBI, NRDC, and Defenders 60 day notice of intent to sue USEPA dated October 29, 2015

4. the Franks 2012 report referenced in the appendix

5. the Jackson et al 2016 paper referenced in the appendix

Please contact me or any of the other protestants if you have any questions.

cheers,

Gary

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State of California
State Water Resources Control Board
DIVISION OF WATER RIGHTS
P.O. Box 2000, Sacramento, CA 95812-2000
Info: (916) 341-5300, FAX: (916) 341-5400, Web: http://www.waterboards.ca.gov/waterrights

PROTEST– PETITION

This form may also be used for objections
PETITION FOR TIME EXTENSION, CHANGE, TEMPORARY URGENT CHANGE OR TRANSFER ON

April 1, 2016, Letter and Enclosures from Ronald Milligan, U.S. Bureau of Reclamation, Regarding Temporary Urgency Change Petition – San Joaquin River Flow at Airport Road Bridge, Vernalis and Dissolved Oxygen on the Stanislaus River.

I (We) have carefully read the notice (state name): Gary Bobker, The Bay Institute; Kate Poole, Natural Resources Defense Council; Kim Delfino, Defenders of Wildlife; Tim Sloane, Pacific Coast Federation of Fishermen's Associations/Institute for Fisheries Research

Address, email address and phone number of protestant or authorized agent: The Bay Institute, Pier 39, Box #200, San Francisco, CA 94133, bobker@bay.org, (415) 272-6616; Natural Resources Defense Council, 111 Sutter Street, 20th Floor, San Francisco, CA 94104, kpoole@nrdc.org, (415) 875-6100; Defenders of Wildlife, 1303 J St., Suite 270, Sacramento, CA 95814, kdelfino@defenders.org, (916) 313-5800; Pacific Coast Federation of Fishermen's Associations/Institute for Fisheries Research, P.O. Box 29370, San Francisco, CA 94129-0370, tsloane@ifrfish.org, 415-561-5080

Attach supplemental sheets as needed. To simplify this form, all references herein are to protests and protestants although the form may be used to file comments on temporary urgent changes and transfers.

Protest based on ENVIRONMENTAL OR PUBLIC INTEREST CONSIDERATIONS (Prior right protests should be completed in the section below):

· the proposed action will not be within the State Water Resources Control Board's jurisdiction ☐
· not best serve the public interest ☒
· be contrary to law ☒
· have an adverse environmental impact ☒

State facts which support the foregoing allegations: See attached

Under what conditions may this protest be disregarded and dismissed? (Conditions should be of a nature that the petitioner can address and may include mitigation measures.): See attached ________

Protest based on INJURY TO PRIOR RIGHTS:

To the best of my (our) information and belief the proposed change or transfer will result in injury as follows:____

____

Protestant claims a right to the use of water from the source from which petitioner is diverting, or proposes to divert, which right is based on (identify type of right protestant claims, such as permit, license, pre-1914 appropriative or riparian right):____

____

List permit or license or statement of diversion and use numbers, which cover your use of water (if adjudicated right, list decree).

____

Where is your diversion point located?_ ¼ of ____ ¼ of Section , T ___, R____, ___ B&M

If new point of diversion is being requested, is your point of diversion downstream from petitioner's proposed point of diversion? ____

The extent of present and past use of water by protestant or his predecessors in interest is as follows:

a. Source ____

b. Approximate date first use made____

c. Amount used (list units)____

d. Diversion season____

e. Purpose(s) of use____

Under what conditions may this protest be disregarded and dismissed?___________________________

All protests must be signed by the protestant or authorized representative:

Signed: ________________________________ Date: April 11, 2016

Signed: ________________________________ Date: April 11, 2016

Signed: ________________________________ Date: April 11, 2016

Signed: ________________________________ Date: April 11, 2016

All protests must be served on the petitioner. Provide the date served and method of service

used:
Email transmitting this form and appendix sent to rsattkowski@waterboards.ca.gov and rmilligan@usbr.gov.

APPENDIX:
ENVIRONMENTAL AND PUBLIC INTEREST CONSIDERATIONS ASSOCIATED WITH THE PROTEST BY THE BAY INSTITUTE, NATURAL RESOURCES DEFENSE COUNCIL, DEFENDERS OF WILDLIFE, PACIFIC COAST FEDERATION OF FISHERMEN'S ASSOCIATIONS, AND INSTITUTE FOR FISHERIES RESEARCH OF THE APRIL 1, 2016, TEMPORARY URGENCY CHANGE PETITION FILED BY THE UNITED STATES BUREAU OF RECLAMATION REGARDING SAN JOAQUIN RIVER FLOW AT AIRPORT ROAD BRIDGE, VERNALIS, AND DISSOLVED OXYGEN ON THE STANISLAUS RIVER

This protest of the April 1, 2016 petition is based on the following environmental and public interest considerations:

1. Weakening the objectives for San Joaquin River inflow at Vernalis and dissolved oxygen (DO) at Ripon will cause unreasonable impacts to fish and wildlife beneficial uses in the Stanislaus River, the lower San Joaquin River, and the south Delta.

2. The State Water Resources Control Board (SWRCB)'s responsibilities to protect the public trust values of the San Joaquin Basin and the Delta and designated uses of their waters under the Clean Water Act have priority over the water supply demand of senior water rights holders with rights to water stored in New Melones Reservoir or of other water rights holders in the San Joaquin River basin that should be contributing to compliance with the Vernalis flow objectives.

3. Weakening the objectives for San Joaquin River inflow at Vernalis and DO at Ripon is not in the public interest.

4. Approving the petition is contrary to law because it would modify adopted water quality objectives without following proper procedure for doing so under the Clean Water Act, including obtaining U.S. Environmental Protection Agency (USEPA) review and approval prior to implementing the modified objectives, and it would appear to violate protections for listed species under the federal Endangered Species Act.

These considerations are addressed in greater detail below.

<u>1. Weakening the objectives for San Joaquin River inflow at Vernalis and DO at Ripon will cause unreasonable impacts to fish and wildlife beneficial uses in the Stanislaus River, the lower San Joaquin River, and the south Delta.</u>

As a result both of insufficient protections in the Bay-Delta Water Quality Control Plan (WQCP) and failure to implement those protections fully, the fish migration beneficial use and other public trust values in the San Joaquin River basin and the Delta have continued to degrade over the last two decades. Estimated natural fall-run Chinook salmon production (i.e., the estimated number of salmon of harvestable age in the ocean that originated from natural spawning) in the San Joaquin's three main tributaries has dropped to less than half of 1967-1991 levels, instead of doubling from those levels as called for in both the WQCP and the Central Valley Project Improvement Act. Relaxations of WQCP objectives for San Joaquin River inflows at Vernalis and of San Joaquin River Basin Plan objectives for DO at Ripon in recent years have significantly exacerbated the adverse conditions affecting migratory fish populations and other public trust resources in the basin and the Delta.

The late October 2015 pulse flow attracted a relatively large return of salmon (greater than 11,000 adults) to the Stanislaus River. Most of these are believed to be hatchery fish that strayed into the Stanislaus because it was the only river in the San Joaquin River basin with anything near adequate releases for fishery attraction flows. Having induced migration of adult salmon into the Stanislaus River, the proposed weakening of Vernalis flow and DO objectives would abandon the juvenile offspring of the 2015 spawning class. Among other negative effects, the conditions proposed in Reclamation's petition will lead to extremely poor survival of fall-run Chinook salmon juveniles, causing a negative effect on an already heavily damaged ocean fishery.

Vernalis flows: There is overwhelming evidence that protection of the fish migration beneficial use and other beneficial uses is positively correlated with base and pulse flows from the San Joaquin River into the Delta. (SWRCB 2010; CDFG 2010a,b; TBI et al 2013). In a letter to the SWRCB, NMFS wrote: "Flow is undisputedly a key driver for [salmonid] survival in the San Joaquin River system. San Joaquin River flows must be augmented significantly from current levels in order to reverse the present trend of salmonid population declines in the basin" (NMFS 2013).

According to the SWRCB's own analysis (SWRCB 2010 at 56):

> Outmigration success of juvenile Chinook salmon is affected by multiple factors, including water diversions and conditions related to flow. … As indicated below in Figure 9, DFG found that more spring flow from the San Joaquin River tributaries results in more juvenile salmon leaving the tributaries, more salmon successfully migrating to the South Delta, and more juvenile salmon surviving through the Delta. (DFG 3, p. 17.) DFG concludes that the primary mechanism needed to substantially produce more smolts at Jersey Point is to substantially increase the spring Vernalis flow level (magnitude, duration, and frequency) which will produce more smolts leaving the San Joaquin River tributaries, and produce more smolts surviving to, and through, the South Delta. (DFG 3, p. 17-18.) DFG indicates that random rare and unpredictable poor ocean conditions may cause stochastic high mortality of juvenile salmon entering the ocean, but that the overwhelming evidence is that more spring flow results in higher smolt abundance, and higher smolt abundance equates to higher adult production. (DFG 3, p.17.)

Recent studies have continued to demonstrate the beneficial effect of higher springtime flow rates and flow variation on success of juvenile Chinook salmon migration from the Stanislaus River (Zeug et al. 2014; Sturrock et al 2015). In particular, higher flow rates enable success of a greater diversity of juvenile Chinook salmon life history types; thus, increased flows during the early rearing and migration season support improved abundance and diversity of the Chinook salmon population – both abundance and diversity are essential elements of salmonid population viability (Lindley et al. 2007; McElhany et al 2000; Satterthwaite et al. 2014).

There is no evidence to indicate that the base and pulse flows proposed by Reclamation in its petition will do anything more than cause very poor survival of emigrating juvenile fall-run and spring-run Chinook salmon. The proposed flows are also likely to be detrimental to adult Chinook salmon that attempt to enter the San Joaquin and Stanislaus River basins during the spring; the presence of spring-running Chinook salmon adults in San Joaquin River tributaries is well-known (Franks *unpublished*, R. Johnson, NOAA, *personal communication*). A number of other species, including migrating steelhead juveniles, white sturgeon, and fish populations in the Delta downstream of Vernalis will also likely be harmed by the proposed flows.

The existing WQCP objective for Vernalis during the current 2016 Dry water year requires base flows of 2280 cfs prior to an April – May pulse flow of 4,880 cfs. These flow requirements are already acknowledged to not be fully protective of the designated beneficial use of the lower San Joaquin River and southern Delta for fish migration by salmon and steelhead juveniles (SWRCB 2010; CDFG 2010b). The flows proposed in Reclamation's petition (1000 cfs base flows followed by a "pulse" flow of <3200 cfs) are much less than those that would occur under either the existing WQCP, let alone the recommended flows in SWRCB 2010 or CDFG 2010b. We are not aware of any scientific basis for the assumption that these flows will support successful Chinook salmon rearing and migration. To the contrary, weakening the current objectives will likely accelerate the continued decline of salmonid fish populations in the San Joaquin basin. Furthermore, base flows of 1000 cfs are associated with violations of the DO objective for the lower San Joaquin River in the Stockton Deepwater Ship Channel and with temperatures in excess of those that support juvenile salmon migration (TBI et al., 2013). These conditions may create a barrier to the migration of anadromous fishes, including Chinook salmon, steelhead, and sturgeon (e.g., Hallock et al. 1970; CVRWQCB and CBDA 2006).

Spring-run Chinook salmon (which migrate into rivers as adults and out of rivers as juveniles during the spring months) will also be negatively affected by the proposed flows. Adult Chinook salmon presence in the San Joaquin basin during the spring has been documented in several recent years and these fish are believed to have spawned successfully in the Stanislaus River (Franks, *unpublished* and sources cited therein). According to the SWRCB, a minimum pulse flow of 3,600cfs at Vernalis for a minimum of 10 days is necessary to ensure adequate migration conditions for fall-run Chinook salmon adults in the San Joaquin River (SWRCB 2010). There is no reason to believe that lower flows levels will support adult spring-run Chinook salmon migration into the San Joaquin River, particularly because the DO objective in the lower San Joaquin River is lower during the spring than it is during the fall-run Chinook salmon migration period. Thus, the proposed pulse and base flows are likely to impair successful adult spring run Chinook salmon migrations into the San Joaquin basin in general and the Stanislaus River in particular; the effect of the proposed flow levels on outmigrating spring-run Chinook salmon juveniles will be negative in the same way and to the same extent as described for juvenile fall run Chinook salmon.

White sturgeon have been documented in the San Joaquin Basin in 2011 and 2012, perhaps in response to pulse flow augmentation to benefit salmon during those years (Jackson et al, 2016). Low river flows and water quality degradation experienced by juvenile sturgeon are believed to be among the most important factors limiting white sturgeon productivity and abundance throughout the Central Valley (Israel et al. 2009). There is no evidence to suggest that Reclamation's proposed springtime flow levels at Vernalis will permit juvenile or adult sturgeon migration in the San Joaquin River or its tributaries.

Finally, lower springtime San Joaquin River flows into the southern Delta will harm fish populations and fish migration in that ecosystem. For example, freshwater flows from the San Joaquin River into the Delta affect orientation and migration success of juvenile salmon and other fish. (e.g., NMFS 2009; SWRCB 2010). Low inflows facilitate the establishment and spread of undesirable organisms, including invasive plants (Kankanamge et al. 2011 as cited in Durand et al. 2016), invasive predatory fish (Mahardja et al. 2016), and harmful algal blooms (Berg and Sutula 2015) that negatively impact fish populations in the Delta and other public trust resources.

Dissolved oxygen: Reclamation's proposed weakening of the objective for DO at Ripon in the San Joaquin River Basin Plan is likely to impair not only migration into the Stanislaus River and subsequent spawning success of adult fall-run Chinook salmon later this year, but also the full range of species that rely on coldwater river habitat in the watershed – and the damage may be long lasting (Davis 1975). There appears to be no basis for Reclamation's continuing assertion that maintaining 5mg/L DO at Ripon will translate into 7mg/L DO at any particular point upstream. There is no regular DO monitoring upstream of Ripon; thus, DO at Ripon cannot be correlated with DO at any other point in the Stanislaus River. Nor has Reclamation provided any evidence regarding how flow and temperature conditions projected to occur throughout 2016 will affect the assumed relationship between DO at Ripon and DO at any point upstream in the Stanislaus River. (See the July 13, 2016, protest filed by TBI, NRDC and PCFFA of the June 23, 2015, USBR petition to weaken DO at Ripon for a more detailed discussion of this and other issues, including a full list of references).

In addition, because Stanislaus River water drains directly into the San Joaquin River, low DO levels at Ripon will lead to or exacerbate low DO levels below the confluence of these rivers; such an effect would impede migration of fall-run Chinook salmon attempting to use the San Joaquin River as a corridor, including those migrating into the Tuolumne and Merced Rivers upstream of the Stanislaus, and potentially the Calaveras river downstream. The lower San Joaquin River is already beset by persistently low DO levels that have impacted fall-run Chinook salmon migration and other aquatic resources in the past (e.g. Hallock et al. 1970; Jassby and Van Nieuwenhuyse. 2005; CVRWQCB and CBDA 2006). Violations are especially frequent during the fall when flows in the Stockton Deep Water Ship Channel fall below 1,000 cfs; this condition continues to occur even after improvements to the City of Stockton's wastewater treatment facility were implemented (TBI 2013, Technical Appendix, Figure 2). If Reclamation's petition is approved, it is extremely unlikely that flows from other sources in the San Joaquin basin will be sufficient to oxygenate water with low DO released from the Stanislaus. In fact, in the late summer and fall, the lower San Joaquin is typically very warm and concentrated with other compounds (reducing its ability to carry DO) including high concentrations of agricultural runoff that generate a high biological oxygen demand (BOD); these substances are a major driver of low DO conditions in the lower San Joaquin. Therefore, reducing DO levels on the Stanislaus is likely to impact adult salmon migrations into other San Joaquin River tributaries.

Salmonids are not the only fish in the San Joaquin and south Delta that may be negatively affected by low DO levels. In fact, members of the sturgeon family (Acipenseridae) are even less tolerant of low DO than are members of the salmon family (Cech and Doroshov 2004). By allowing low DO levels, low flows, and high temperatures in the Stanislaus River, approving the petition will exacerbate water quality conditions (including DO levels that are already problematic) in a manner that could affect a suite of species attempting to use habitats in the lower San Joaquin (including for migration upstream) and southern Delta (for examples, see CVRWQCB and CBDA 2006).

At the April 5, 2016, SWRCB workshop to receive information on Reclamation's petition, the SWRCB staff presentation included estimates of the water "savings" associated with reducing reservoir releases into the Stanislaus River by ~12TAF/month to meet a 5mg/L DO objective at Ripon. In 2015, Reclamation claimed in response to our protest of the agency's petition to weaken the DO objective that there was a "minimal influence of flow on DO" during the July-November period" (Reclamation Response to Objection of Petition for Temporary Changes dated Aug 10, 2015 at 1). It seems clear that, other conditions being equal, flow is positively correlated with DO levels in the Stanislaus River; the SWRCB should review the analysis and modeling that led to the 2016 estimate of the flow required to maintain the 7mg/L DO standard at Ripon and confirm whether Reclamation has corrected its view to acknowledge that there exists a positive relationship between flow and DO at Ripon.

2. The SWRCB's responsibilities to protect the public trust values of the Delta and the Central Valley and designated uses of their waters under the Clean Water Act have priority over the water rights of water rights holders receiving water stored in New Melones Reservoir or of other water rights holders in the San Joaquin River basin that should be contributing to compliance with the Vernalis flow objective.

Reclamation's petition is predicated on the assumption that water currently stored in New Melones Reservoir that is associated with senior water rights holders on the Stanislaus River will not be released to comply with the agency's water permit terms to comply with the WQCP Vernalis flow objectives and Basin Plan DO objectives. This assumption is correct if and only if the SWRCB does not intervene to compel action by the senior water rights holders and other water users in the basin to protect the many public trust resources and designated beneficial uses of San Joaquin River basin and Delta water that are at high risk of being further degraded if Reclamation's petition is approved. The SWRCB has clear authority to do so.

Since 2011, when the San Joaquin River Agreement between Reclamation and senior water rights holders expired, Reclamation has consistently failed to comply with some or all of the WQCP Vernalis objectives. Under its delegated authority to implement the Clean Water Act; its water rights permitting authority; its role as a public trustee; its Constitutional authority to prevent waste and unreasonable use; and/or its authority under the current emergency drought declaration, the SWRCB could and should have required compliance with relevant WQCP objectives by water rights holders throughout the San Joaquin River basin, as it has in other watersheds.[1] It has not. Instead, the SWRCB has generally ignored Reclamation's lack of compliance or indeed even approved previous petitions to weaken WQCP objectives.

Rather than approve the petition, the SWRCB should adopt an order ensuring compliance with the WQCP Vernalis objectives by Reclamation, senior water rights holders on the Stanislaus River with rights to storage in New Melones, and other water rights holders in the San Joaquin basin. Such action would allow for WQCP objectives to be met while preserving adequate

[1] *See, e.g.,* curtailments on diversions that the SWRCB has ordered in Mill, Deer, and Antelope Creeks to ensure adequate minimum flows for fisheries during the drought.
http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/mill_deer_antelope_creeks.shtml

storage for temperature control and carryover. Failure to provide adequate flow and DO conditions yet again in 2016 will lead to yet another failure to protect the fish migration and coldwater habitat beneficial uses in the San Joaquin River basin and the southern Delta.

3. Weakening the objectives for San Joaquin River inflow at Vernalis and DO at Ripon is not in the public interest.

In addition to causing unreasonable effects on fish and wildlife, granting the TUCP is also not in the public interest given the improvements in water conditions in the San Joaquin River basin as compared to prior years and the substantial water diversions that will occur.

First, in contrast to water conditions over the past several years and the statement on page 1 in Reclamation's cover letter, DWR's April 1, 2016 San Joaquin Valley Water Year Type Index classifies 2016 as a Dry water year type under the 50%, 75%, and 90% exceedance forecasts (see: http://cdec.water.ca.gov/cgi-progs/iodir/WSI). Similarly, DWR's Bulletin 120 estimates that total runoff on the Stanislaus River (Goodwin Dam) this water year will be nearly 1.2 million acre feet of water, with an 80% probability range of 1070 taf to 1455 taf (see: http://cdec.water.ca.gov/cgi-progs/iodir_ss/b120). DWR also estimates that Stanislaus River inflow will be 102% of an average water year. *Id*. Despite the low storage at the beginning of the year, runoff and reservoir inflow are likely to be higher than average years, yet Reclamation proposes to cut base and pulse flows far below the minimums required under the WQCP and D-1641.

Second, Reclamation has allocated 600,000 acre-feet of water (a 100% allocation) to senior water rights holders on the Stanislaus River in its initial allocation. (See: http://www.usbr.gov/mp/cvp-water/docs/1-cvp-water-quantities-allocation.pdf). In contrast, Reclamation estimates that meeting the Vernalis pulse flow objective would require 116,000 acre-feet of water. *See* Petition at 2. It is not in the public interest to weaken already insufficiently protective objectives for fish and wildlife beneficial uses while at the very same time allowing senior water rights holders on the river to divert their full allocation.

Third, although Reclamation has increased flow releases from New Melones since April 3, much of that flow has not reached Vernalis. For instance, although daily average outflows from New Melones have exceeded 2,000 cfs on April 3, April 6, and April 8, since April 1 flows at Vernalis peaked at 1,137 cfs on April 10. The SWRCB must do more to ensure that these minimum flows actually reach the Delta.

Finally, Reclamation's petition also proposes to violate the minimum protections necessary to avoid jeopardizing steelhead under the Endangered Species Act, proposing to weaken the requirement for a 2:1 ratio of inflow to exports under RPA action IV.2.1 in the 2009 NOAA biological opinion. *See* Petition at 3. Contrary to statements in Reclamation's petition, the exception procedures allowing for the 1:1 ratio have not been met and use of the 1:1 ratio would violate the Endangered Species Act. The SWRCB should not approve Reclamation's petition and the associated water transfer, both of which are premised on violating Endangered Species Act requirements.

4. Approving the petition is contrary to law because it would modify adopted water quality objectives without following proper procedure for doing so under the Clean Water Act, including obtaining USEPA review and approval prior to implementing the modified objectives, and it would appear to violate protections for listed species under the federal Endangered Species Act.

As TBI, NRDC, and Defenders of Wildlife explained in a 60-day notice of intent to sue the USEPA dated October 29, 2015, and provided to the SWRCB,[2] the federal Clean Water Act requires the SWRCB to obtain review and approval by the USEPA before implementing any revised water quality standard. 33 U.S.C. §1313(c)(2)(A). The revisions to the water quality objectives in D-1641 being proposed here meet USEPA's definition of "new or revised standards," triggering the CWA's section 303(c)(2) – (4) review requirements. The petition should not be granted, not the requested changes implemented, prior to obtaining the requisite USEPA approval. Without first obtaining such approval, granting the petition would be contrary to law.

In addition, as explained above, Reclamation requests a waiver of minimum protections imposed under the Endangered Species Act to protect outmigrating salmonids and steelhead. Granting the petition without meeting these minimum requirements would also be contrary to law.

[2] Included as an attachment to this protest and appendix.

LITERATURE CITED

Anadromous Fish Restoration Program (AFRP). 2005. Recommended streamflow schedules to meet the AFRP doubling goal in the San Joaquin River basin. 27 September 2005.

Berg M and Sutula M. 2015. Factors affecting the growth of cyanobacteria with special emphasis on the Sacramento-San Joaquin Delta. Southern California Coastal Water Research Project Technical Report 869, August 2015.

California Department of Fish and Game. 2010a. Flows needed in the Delta to restore anadromous salmonid passage from the San Joaquin River at Vernalis to Chipps Island. Exhibit #3, Prepared for the Informational Proceeding to Develop Flow Criteria for the Delta Ecosystem Necessary to Protect Public Trust Resources Before the State Water Resources Control Board.

California Department of Fish and Game. 2010b. Quantifiable biological objectives and flow criteria for aquatic and terrestrial species of concern dependent on the Delta: Prepared pursuant to the Sacramento-San Joaquin Delta Reform Act of 2009. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=25987

Cech, J. J., Jr. and S. I. Doroshov. 2004. Chapter 3: Environmental requirements, preferences, and tolerance limits of North American sturgeons. Pages 73–86 in G. T. O. Lebreton, F. W. H. Beamish, R. S. McKinley (eds), Sturgeons and Paddlefish of North America. Netherlands: Kluwer Academic Publishers.

Central Valley Regional Water Quality Control Board and the California Bay-Delta Authority (CVRWQCB and CBDA). 2006. Dissolved oxygen concentrations in the Stockton Deep Water Ship Channel: Biological and ecological effects model. Available at: http://www.sjrdotmdl.org/concept_model/bio-effects_model/lifestage.htm.

Davis, J.C. 1975. Minimal dissolved oxygen requirements of aquatic life with emphasis on Canadian species: a review. Journal of the Fisheries Research Board of Canada 32:2295- 2332.

Franks, S. 2012. Possibility of natural producing spring-run Chinook salmon in the Stanislaus and Tuolumne Rivers. Internal Report to NMFS.

Hallock, R. J., R. F. Elwell, and D. H. Fry, Jr. 1970. Migrations of adult king salmon, Oncorhynchus tshawytscha, in the San Joaquin Delta. California Department of Fish and Game. Fish Bulletin 151.

Israel, J. A., A. M. Drauch, M. Gingras, and M. Donnellan. 2009. Life History Conceptual Model for White Sturgeon (*Acipenser transmontanus*). Final. California Department of Fish and Game Delta Regional Ecosystem Restoration and Implementation Program.

Jackson, Z.J., Gruber, J.J., and J.P. Van Eenennaam. 2016. White sturgeon spawning in the San Joaquin River, California and effects of water management. Journal of Fish and Wildlife Management 7(1): xx-xx; e1944-687X. doi: 10.3996/092015-JFWM-092

Jassby, A. D. and E. E. Van Nieuwenhuyse. 2005. Low dissolved oxygen in an estuarine channel (San Joaquin River, California): Mechanisms and models based on long-term time series. San Francisco Estuary and Watershed Science 2:1–33.

Kankanamge CE, Asaeda T, Kawamura K. 2011. The effect of flow turbulence on plant growth and several growth regulators in Egeria densa Planchon. Flora - Morphol Distrib Funct Ecol Planta;206:1085–1091. Available from: http://www.sciencedirect.com/science/article/pii/S0367253011001319 doi: http://dx.doi.org/10.1016/j.flora.2011.07.014

Lindley, Steven, T. et al. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in The Sacramento-San Joaquin Basin. Vol. 5, Issue 1 [February 2007]. Article 4. http://repositories.cdlib.org/jmie/sfews/vol5/iss1/art4

Mahardja, B. C, J. Louise, L. Lusher, B. Schreier. 2016. Abundance Trends, Distribution, and Habitat Associations of the Invasive Mississippi Silverside (*Menidia audens*) in the Sacramento–San Joaquin Delta, California, USA. San Francisco Estuary and Watershed Science, 14(1). Permalink: http://escholarship.org/uc/item/55f0s462

National Marine Fisheries Service. 2009. Biological opinion and conference opinion on the long term operations of the Central Valley Project. Available at: http://swr.nmfs.noaa.gov/ocap.htm

National Marine Fisheries Service. 2013. Letter to the State Water Resources Control Board from Maria Rea, Supervisor Central Valley Office. Dated May 28, 2013.

Satterthwaite, W.H., S.M. Carlson, S.D. Allen-Moran, S. Vincenzi2, S.J. Bograd, B.K. Wells. 2014. Match-mismatch dynamics and the relationship between ocean-entry timing and relative ocean recoveries of Central Valley fall run Chinook salmon. Marine Ecology Progress Series. 511: 237–248.

State Water Resources Control Board (SWRCB). 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem.

Sturrock AM, Wikert JD, Heyne T, Mesick C, Hubbard AE, Hinkelman TM, et al. 2015. Reconstructing the Migratory Behavior and Long- Term Survivorship of Juvenile Chinook Salmon under Contrasting Hydrologic Regimes. PLoS ONE 10(5): e0122380. doi:10.1371/journal.pone.0122380

The Bay Institute, Natural Resources Defense Council, Planning and Conservation League, Pacific Coast Federation of Fisherman's Associations, Golden Gate Salmon Association, and Merced River Conservation Committee (TBI et al). 2013. Comments re: Draft SED on Changes to Bay-Delta WQCP San Joaquin River Flows and Southern Delta Water Quality.

U.S. Bureau of Reclamation (Reclamation). 2015. Letter from Richard J. Woodley to the State Water Resources Control Board Responding to Objection to the Proposed Temporary Urgency Change in the Stanislaus River Dissolved Oxygen Standard. Dated August 10, 2015.

Zeug, S.C., K . Sellheim, C. Watry, J .D . Wikert, and J . Merz. 2014. Response of juvenile Chinook salmon to managed flow: lessons learned from a population at the southern extent of their range in North America. Fisheries Management and Ecology 2014: 1-14.

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October 29, 2015

Via Certified Mail, Return Receipt Requested

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75 Hawthorne Street
San Francisco, CA 94105

Re: Sixty-day notice of intent to sue for failure to carry out non-discretionary federal review of California water quality standards in violation of Clean Water Act section 303(c)

Dear Administrator McCarthy and Regional Administrator Blumenfeld,

I write on behalf of Natural Resources Defense Council, Defenders of Wildlife, and The Bay Institute ("Noticing Parties") to provide you with notice of their intent to bring suit against you in your official capacities as Administrator and Regional Administrator of the United States Environmental Protection Agency ("EPA"). This suit will redress continuous and intermittent violations of the Clean Water Act ("CWA") for: (1) failing to carry out a non-discretionary duty under 33 U.S.C. §1313(c)(2) – (4) to review and take appropriate action regarding revisions to the water quality standards in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary Water Quality Control Plan ("Bay-Delta Plan") and Water Quality Control Plan for the Central Valley Region, Sacramento River Basin and San Joaquin River Basin ("Central Valley Plan");

and (2) for failing to carry out a non-discretionary duty under 33 U.S.C. §1313(c)(1) to review and take appropriate action regarding the existing standards in the Bay-Delta Plan at least every three years.

Pursuant to 33 U.S.C. §1365(b)(2) and 40 C.F.R. §135.2(c), the Noticing Parties will file suit if these violations are not cured within sixty days of the postmark date of this letter. As required by 40 C.F.R. §135.2(b), a copy of this notice is being sent to the Attorney General of the United States. A copy is also being provided to California's State Water Resources Control Board.

I. STATUTORY FRAMEWORK

The CWA aims "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" and to attain, *inter alia*, "water quality which provides for the protection and propagation of fish, shellfish, and wildlife." 33 U.S.C. §1251(a), (a)(2). Under the CWA, federal and state governments share the responsibility of monitoring and regulating water pollution. *Florida Pub. Interest Research Grp. Citizen Lobby, Inc. v. U.S. Envtl. Prot. Agency*, 386 F.3d 1070, 1080 (11th Cir. 2004) ("*FPIRG*"). The EPA has principal responsibility for regulating point source pollution—pollution which comes from any "discernible, confined and discrete conveyance"—by issuing National Pollutant Discharge Elimination System ("NPDES") permits that mandate technological controls to reduce pollution into the nation's waters. *Am. Wildlands v. Browner*, 260 F.3d 1192, 1193 (10th Cir. 2001). States, on the other hand, have primary responsibility for regulating non-point source pollution by establishing and enforcing water quality standards. *FPIRG*, 386 F.3d at 1073.

There are three basic components to water quality standards: first, states must establish the designated uses of their waterbodies, *see* 33 U.S.C. §1313(c)(2)(A); 40 C.F.R. §131.6(a); second, states must establish water quality criteria sufficient to protect the designated uses, *see* 33 U.S.C. §1313(c)(2)(A); 40 C.F.R. §131.6(c); and, third, states must adopt an anti-degradation review policy enabling states to assess whether the water quality of a particular water body has been diminished, *see* 40 C.F.R. §131.6(d); 40 C.F.R. §131.12(a).

Although the CWA allows states to promulgate water quality standards, Congress established a system of mandatory federal oversight to ensure that states maintain adequate water quality standards. The CWA provides that "[w]henever the State revises or adopts a new [water quality] standard, such revised or new standard shall be submitted to the Administrator" of the EPA. 33 U.S.C. §1313(c)(2)(A). Although the states are required to submit any new or revised standard for review, the EPA has an affirmative duty to review any new or revised standard regardless of whether the state makes a submission. *FPIRG*, 386 F.3d at 1073 ("While states are primarily responsible for establishing these water quality standards, the EPA, in turn, is required to undertake a review of any new or revised water quality standards adopted by the states."); *Friends of Merrymeeting Bay v. Olsen*, 839 F. Supp. 2d 366, 375 (D. Me. 2012) ("The EPA is under an obligation to review a law that changes a water quality standard regardless of whether a state presents it for review."); *see also* EPA Frequently Asked Questions 2 (EPA-820-F-12-017, Oct. 2012) ("EPA has a mandatory duty to approve or disapprove a new or revised WQS even if the state did not submit such new or revised WQS to EPA for review.").

The EPA must review a new or revised water quality standard to determine whether it complies with multiple requirements, including, *inter alia*: (1) the water quality criteria in the new or revised standard "are consistent with the requirements of the [CWA]"; (2) the water quality criteria "protect the designated water uses"; (3) in adopting or revising the standard, the state followed its own "legal procedures for revising or adopting standards"; (4) that "standards which do not include [fish and wildlife protection or recreational uses] are based upon appropriate technical and scientific data and analyses"; and (5) that the new or revised standard "meets the requirements included in [40 C.F.R.] § 131.6."[1] 40 C.F.R. §131.5. If the standards submitted to the EPA meet each of these criteria, the EPA must approve the standard. *Id.* §131.5(b). Otherwise, the EPA must disapprove the standard and, unless the state submits an acceptable revised standard within ninety days, promulgate a federal water regulation that meets the strictures of the CWA. *Id.*; 33 U.S.C. §1313(c)(4). An existing water quality standard "remains the applicable standard until EPA approves a change, deletion, or addition to that water quality standard, or until EPA promulgates a more stringent water quality standard." 40 C.F.R. §131.21(e); *FPIRG*, 386 F.3d at 1070.

The CWA also requires states to conduct triennial public reviews of water quality standards. 33 U.S.C. §1313(c)(1). Specifically, the CWA provides that states "shall from time to time (but at least once every three year period beginning with October 18, 1972) hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards." *Id.*; 40 C.F.R. §131.20. After each triennial review, the state must submit the results of the review to EPA regardless of whether there has been any revision to the standards. 40 C.F.R. §131.20. The state's submission to the EPA must include "the results of the review, any supporting analysis for the use attainability analysis, the

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[1] The "minimum requirements for water quality standards submission[s]" in 40 C.F.R §131.6 include: "(a) Use designations consistent with the provisions of sections 101(a)(2) and 303(c)(2) of the Act; (b) Methods used and analyses conducted to support water quality standards revisions; (c) Water quality criteria sufficient to protect the designated uses; (d) An antidegradation policy consistent with § 131.12; (e) Certification by the State Attorney General or other appropriate legal authority within the State that the water quality standards were duly adopted pursuant to State law; and (f) General information which will aid the Agency in determining the adequacy of the scientific basis of the standards which do not include the uses specified in section 101(a)(2) of the Act as well as information on general policies applicable to State standards which may affect their application and implementation."

methodologies used for site-specific criteria development, any general policies applicable to water quality standards and any revisions of the standards." *Id.* As with new or revised water quality standards, the EPA is under an affirmative duty to complete review of a state's existing water quality standards at least every three years, regardless of whether the state submits the results of a triennial review to the EPA.

II. FACTUAL BACKGROUND

A. The Bay-Delta Plan

In 1995, California's State Water Resources Control Board ("SWRCB" or "Board") approved the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary ("1995 Bay-Delta Plan"). SWRCB, WR 95-1 (May 1995). The 1995 Bay-Delta Plan, which established water quality standards for the Bay-Delta region, adopted the beneficial uses to be protected from an earlier Bay-Delta plan, including fish and wildlife and agriculture. The 1995 Bay-Delta Plan's objectives included criteria for salinity, flows, exports, and dissolved oxygen. Many of these objectives vary by location, time of year, and the type of water year. The plan also included an objective for how often the Delta Cross Channel ("DCC") gates could be opened during different times of the year.

The 1995 Bay-Delta Plan stated that "most of the objectives in th[e] plan will be implemented by assigning responsibilities to water rights holders because the factors to be controlled are primarily related to flows and diversions." *Id.* at 4. Specifically, the program of implementation for the 1995 Bay-Delta Plan explained that,

> The SWRCB will initiate a water rights proceeding following adoption of this water quality control plan. The water rights proceeding will address the water supply-related objectives in this plan through the amendment of water rights under the authority of the SWRCB. The water supply-related objectives include those for Delta outflow, river flows, export limits, the Delta Cross Channel gates, and salinity control for the protection of municipal and industrial supply, agricultural supply (excluding salinity objectives for protection of southern Delta agriculture, which are discussed in section B.4 of this chapter), and fish and wildlife.

Id. at 27. Accordingly, in 1999, the SWRCB adopted Water Rights Decision 1641 ("D-1641"), which the Board later revised in 2000. SWRCB, WR-2000-02. D-1641 contains terms and conditions for permits under which water rights holders operate to meet the objectives in the 1995 Bay-Delta Plan. *Id.* at 12.

In 2006, the SWRCB approved the current water quality control plan for the Bay-Delta. Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary 4 (Dec. 13, 2006). D-1641 remains the operative SWRCB order regarding water quality standards in the Bay-Delta. As such, for all relevant purposes, the water quality criteria in the Bay-Delta

Plan are the same as the water quality criteria in D-1641. The Board has not conducted timely triennial reviews of the Bay-Delta Plan.

B. Governor Brown's Drought Proclamations And The SWRCB's Orders Approving Petitions To Modify Water Quality Standards

Pursuant to California Water Code §13247, "state offices, departments, and boards" are required to "comply with water quality control plans approved or adopted by the state board unless otherwise directed or authorized by statute." On January 17, 2014, California Governor Jerry Brown issued a Drought Emergency Proclamation suspending section 13247 on the basis that it would "prevent, hinder, or delay the mitigation of the effects of the [drought] emergency."[2] Brown directed the SWRCB to "consider modifying requirements for reservoir releases or diversion limitations, where existing requirements were established to implement a water quality control plan." On April 25, 2014, Brown extended his drought proclamation and the suspension of section 13247,[3] and on December 22, 2014, Brown issued Executive Order B-28-14 extending the suspension of section 13247 through May 31, 2016.[4]

Following the Governor's Drought Proclamations and Executive Order, water users have filed successive petitions requesting changes to the water quality standards in the Bay-Delta Plan, as implemented by D-1641. The California Water Code provides that a permittee may petition the Board for an order changing the terms of its permit or license. Cal. Water Code §1435(a). Upon making specified findings, the Board may issue a change order approving the petition. *Id.* §1435(b). Unless an earlier date is specified, the order automatically expires 180 days from its issuance. *Id.* §1440. The Board may, however, renew the order for successive 180-day periods. *Id.* §1441.

On January 31, 2014, the SWRCB issued an order approving a petition jointly filed by the U.S. Bureau of Reclamation ("Reclamation") and the California Department of Water Resources ("DWR"). The Board's order approved Reclamation and DWR's requests to amend the delta outflow objectives, export requirements, and DCC gate closure requirements in D-1641, thus allowing the agencies to operate the federally owned Central Valley Project ("CVP") and state-owned State Water Project ("SWP") in a manner different from that required by the water quality standards in the Bay-Delta Plan. The Board's order explained that:

> Absent suspension of section 13247, the State Water Board could not approve a petition to modify water right permits and licenses in a way that does not provide

[2] The text of Governor Brown's January 17, 2014 Drought Proclamation is available at: http://gov.ca.gov/news.php?id=18368.
[3] The text of Governor Brown's April 25, 2014 Drought Proclamation is available at: http://gov.ca.gov/news.php?id=18496.
[4] The text of Executive Order B-28-14 is available at: http://gov.ca.gov/news.php?id=18815.

for full attainment of the water quality objectives as specified in the Bay-Delta Plan, even during a drought emergency.

SWRCB Order Approving Temporary Urgency Change 7 (Jan. 31, 2014). The Board did not address compliance with federal law or the Clean Water Act.

The Board issued subsequent orders on February 28, March 18, April 9, 11, and 18, May 2, and October 7, 2014, modifying and/or extending changes to delta outflow and other flow requirements (including San Joaquin River flow requirements), export requirements, and DCC gate closure requirements, all of which are set forth in the Bay-Delta Plan and D-1641.[5] Additionally, the Board's May 2 order moved the salinity compliance location in Table 2 of the Bay-Delta Plan and D-1641 (establishing water quality objectives for agricultural beneficial uses) from Emmaton to Threemile Slough on the Sacramento River, a change that allowed Reclamation and DWR to operate at salinity levels that exceeded the water quality objectives in the Bay-Delta Plan. The EPA did not review nor approve any of the Board's 2014 orders modifying D-1641 to allow water users to operate in violation of the approved Bay-Delta Plan water quality standards.

In 2015, the SWRCB has issued several orders approving modifications to the water quality objectives in D-1641 and the Bay-Delta Plan.[6] On February 3, 2015, the Board approved changes to minimum delta outflow requirements, minimum San Joaquin River flows, DCC Gate closure requirements, and export limits established in the Bay-Delta Plan and D-1641, as follows:

- The Bay-Delta Plan and D-1641 establish a minimum Net Delta Outflow Index ("NDOI") of 7,100 cfs in February and March, calculated as a 3-day running average, or alternate compliance with salinity standards. The NDOI objective is intended to protect estuarine habitat for anadromous fish and other estuarine fish, many of which are listed as endangered or threatened species. The February 3 order changed the minimum NDOI to allow flows of "no less than 4,000 cubic-feet per second (cfs) on a monthly average," and a 7-day running average "not less than 1,000 cfs below the monthly average."

- The Bay-Delta Plan and D-1641 establish minimum flow rates for the San Joaquin River at Airport Way Bridge, Vernalis. This objective is designed to insure that there is adequate downstream freshwater flow to protect fish and wildlife. The objective calls for flows between February 1 and April 14 of 710 or 1,140 cfs in critically dry years,[7] depending on the location of the 2 parts per thousand isohaline. The February 3 order

[5] Most of the SWRCB's 2014 orders are available on the SWRCB website at: <http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml>.
[6] The SWRCB's 2015 orders approving modifications to the water quality objectives in the Bay-Delta Plan, as implemented by D-1641, are available on the SWRCB website at: <http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml>.
[7] 2015 is classified as a critically dry year.

changed the minimum flow rate during the months of February and March to "no less than 500 cfs on a monthly average."

- The Bay-Delta Plan and D-1641 establish requirements for the closure of the DCC Gates. This objective is designed, in part, to protect fish and wildlife, particularly endangered and threatened salmonid species. The Bay-Delta Plan and D-1641 call for the gates to be closed from February 1 through May 20 each year. The February 3 order modified this objective to allow the gates to be open in February and March "as necessary to preserve limited storage in upstream reservoirs and reduce infiltration of high salinity water into the Delta while reducing impacts to migrating Chinook salmon."

- The Bay-Delta Plan and D-1641 establish limits on the quantity of water flowing into the Delta that can be diverted from the South Delta by the SWP and CVP pumping facilities. The objective is designed to protect the habitat of estuarine and anadromous fish species. Generally, the Bay-Delta Plan and D-1641 call for exports to be limited to 35% of delta inflow between February and June. However, when the best available estimate of the Eight River Index for January is less than or equal to 1.0 million acre-feet, as was the case in February 2015, the export limit for February is 45%. The February 3 order set forth a complex modification of the export limits set forth in the Bay-Delta Plan and D-1641 that allowed varying export levels to occur depending on hydrologic circumstances.

On March 5, 2015, the SWRCB revised its February 3 order to allow additional exports from the Delta during the month of March when certain hydrologic conditions are met. On April 6, 2015, the SWRCB extended the changes to delta outflow requirements and export requirements, as set forth in its February 3 and March 5 orders, through the end of June 2015, and extended the changes to the DCC gate closure requirements through May 20, 2015. The SWRCB's April 6 order made the following additional changes to the water quality standards in the Bay-Delta Plan, as implemented by D-1641:

- The Bay-Delta Plan and D-1641 require a pulse flow volume of 3,110 cfs or 3,540 cfs at Vernalis during critically dry years. The April 6 order reduced the required volume to 710 cfs at Vernalis.

- As mentioned above, the Bay-Delta Plan and D-1641 establish minimum flow requirements in the San Joaquin River at Airport Way in Vernalis at 710 cfs or 1,140 cfs, depending on hydrology. The April 6 order reduced the flow requirement following the pulse flow period to 300 cfs until May 31, and to 200 cfs during June 2015.

- As explained above, the Bay-Delta Plan and D-1641 establish a compliance point for the Western Delta agricultural salinity requirement at Emmaton on the Sacramento River. As the Board did in 2014, the April 6 order moved this compliance point to Three-Mile Slough for the period of April-June 2015. Without this change, the water quality objective for salinity compliance at Emmaton (a 14-day running average of under 2.78 mmhos/cm between April 1 – August 15 in critical dry years) would have been violated as of May 1, 2015, when the 14-day running average reached 2.81 mmhos/cm, and thereafter.

On July 3, 2015, the SWRCB extended the change in the salinity compliance point for the Western Delta agricultural salinity requirement until August 15, and made additional changes to the water quality standards in the Bay-Delta Plan and D-1641, including, among other changes:

- The Bay-Delta Plan and D-1641 establish a minimum NDOI in July of 4,000 cfs in critically dry years. The July 3 order reduced the minimum NDOI to 3,000 cfs on a monthly average during the month of July 2015.

- The Bay-Delta Plan and D-1641 establish minimum flows in the Sacramento River at Rio Vista in critically dry years of 3,000 cfs in September and October, and 3,500 cfs in November, based on a monthly average. The Bay-Delta Plan and D-1641 further state that the 7-day running average cannot be more than 1,000 cfs below the monthly average. The July 3 order reduces the minimum flow to 2,500 cfs for the period of September – November 2015, with a 7-day running average of no less than 2,000 cfs.

- The Bay-Delta Plan and D-1641 limit exports from the Delta to 65% of inflow between July and January. The July 3 order replaces the 65% inflow objective with contingency-based export limits Specifically, through November 30, 2015, when water quality objectives designed to protect agricultural and fish and wildlife beneficial uses (Tables 2 and 3 of D-1641) are not being met, the combined maximum exports at the SWP Banks Pumping Plant and the CVP Jones Pumping Plan shall be no greater than 1,500 cfs. Through December 30, 2015, the order requires compliance with D-1641 if the criteria in Table 2 and 3 are being met, but limits SWP and CVP exports above 1,500 cfs to natural or abandoned flow.

Further, on August 4, 2015, the SWRCB approved changes to the dissolved oxygen objective for the Stanislaus River below Goodwin Dam.[8] The Central Valley Plan establishes that,

> For surface water bodies outside the legal boundaries of the Delta . . . [t]he dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time: Waters designated [for warm habitat beneficial uses] 5.0 mg/l; Waters designated [for cold habitat beneficial uses] 7.0 mg/l; Waters designated [for spawning] 7.0 mg/l.

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[8] The SWRCB's August 4, 2015 order is available at: <http://www.waterboards.ca.gov/waterrights/water_issues/programs/compliance_monitoring/stanislaus_river/>.

Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins III-5.00 (Sept. 15, 1998).

Because the Stanislaus River from Goodwin Dam to the San Joaquin River has warm, cold, and spawning freshwater habitat beneficial uses, the more protective minimum 7.0 mg/l objective is the operative objective for DO in the Stanislaus River from Goodwin Dam to the San Joaquin River. D-1641 and Water Rights Decision 1422 ("D-1422") implement the relevant dissolved oxygen objective in the Central Valley Plan. The SWRCB's August 4 order amended D-1641 and D-1422 to allow Reclamation to operate the Central Valley Project to meet a minimum DO level in the Stanislaus River below Goodwin Dam of 5.0 mg/l, instead of the 7.0 mg/l level provided for in the Central Valley Plan. The order is effective through November 30, 2015.

To date, the EPA has not reviewed nor approved any of the Board's 2015 orders modifying water quality standards in the Bay-Delta and Central Valley Plans, as implemented by D-1641 and D-1422.

III. FAILURE TO CARRY OUT NON-DISCRETIONARY DUTIES UNDER THE CLEAN WATER ACT

A. Violation of CWA Section 303(c)(2) – (4) For Failure To Review And Take Appropriate Action Regarding SWRCB's Revisions To Water Quality Standards In The Bay-Delta And Central Valley Plans

The CWA's citizen suit provision authorizes suit against "the Administrator where there is alleged a failure of the Administrator to perform such act or duty under this chapter which is not discretionary with the Administrator." 33 U.S.C. §1365(a)(2). Under the CWA, all new or revised water quality standards "shall be submitted to the Administrator" for review. 33 U.S.C. §1313(c)(2)(A) (emphasis added). Applying EPA's own definition of "new or revised standards," the EPA violated the CWA when it failed to review the SWRCB's repeated and ongoing modifications to the water quality standards in the Bay-Delta and Central Valley Plans as required by 33 U.S.C. §1313(c)(2) – (4).

The EPA has interpreted the CWA and its implementing regulations in its Water Quality Standards Handbook ("EPA Handbook"). Chapter 1.5.1, entitled "What Provisions Constitute New or Revised Water Quality Standards Under Clean Water Act Section 303(c)" sets forth a four-part definition for "new or revised water quality standards." If the responses to the following four questions are affirmative, EPA has a non-discretionary duty to review the relevant provision and take appropriate action under CWA section 303(c)(2) – (4):

> (1) Is it a legally binding provision adopted or established pursuant to state or tribal law?; (2) Does the provision address designated uses, water quality criteria to protect designated uses, and/or antidegradation requirements for waters of the United States?; (3) Does the provision express or establish the desired condition (e.g. designated uses, criteria) or instream level of protection (e.g., anti-

> degradation requirements) for waters of the United States immediately or mandate it will be expressed or established for such waters in the future?; (4) Does the provision establish a new WQS or revise an existing WQS? . . . A provision that establishes a new WQS or has the effect of changing an existing WQS would meet this consideration. In contrast, a provision that simply implements a WQS without revising it would not constitute a new or revised WQS."

EPA Handbook 1.5.1. The SWRCB's orders modifying the water quality standards in the Bay-Delta and Central Valley Plans, as implemented by D-1641 and D-1422, satisfy each of these elements.

First, the Board's orders modifying Reclamation's and DWR's permits and licenses such that they do not have to comply with the water quality objectives in the Bay-Delta Plan were issued pursuant to state law and have legally binding effect. The SWRCB utilized its authority to issue a final administrative order approving modifications that effectively changed the water quality standards in the Bay-Delta and Central Valley Plans.

Although the Board's orders did not amend the text of the Bay-Delta and Central Valley Plans themselves, the orders modified the requirements in D-1641 and D-1422 to meet water quality objectives in the Bay-Delta and Central Valley Plans. When the Board decides not to implement a water quality objective, it is making a "de facto amendment to a water quality objective in a water quality control plan," even if it is temporary in duration. *State Water Res. Control Bd. Cases*, 136 Cal. App. 4th 674, 732 (2006). The Board worked a "de facto amendment" to the Bay-Delta and Central Valley water quality standards by modifying the conditions of Reclamation's and DWR's licenses and permits under D-1641 and D-1422 such that they could operate the CVP and SWP in violation of the Bay-Delta and Central Valley Plans.

With respect to the second element of the definition of "new or revised water quality standards," the SWRCB's 2014 and 2015 orders approving modification of Reclamation's and DWR's licenses and permits clearly "address" the water quality criteria in the Bay-Delta and Central Valley Plans, which were promulgated for the purpose of protecting fish and wildlife and other designated uses. The 2014 and 2015 orders allow Reclamation and DWR to operate the CVP and SWP based on water quality criteria other than those in D-1641, D-1422, and the Bay-Delta and Central Valley Plans.

Third, the SWRCB's 2014 and 2015 orders "express and establish a desired condition" both "immediately" and "in the future." The modifications are expressed as changes to the "desired condition" because they change the water quality criteria set forth in D-1641 and D-1422, and by extension, the Bay-Delta and Central Valley Plans. In its Water Quality Handbook, EPA clarifies that a change in water quality criteria establishes and expresses a new "desired condition." EPA Handbook 1.5.1. Additionally, the SWRCB's orders express and establish new water quality criteria "immediately" and "in the future." For instance, the SWRCB's July 3, 2015 order reduced the minimum NDOI for the month of July 2015 to 3,000 cfs, and the Rio Vista flow to 2,500 cfs for the September – November 2015 period.

Finally, the Board's orders have "the effect of changing an existing water quality standard" and are not mere implementation decisions. Several federal courts have applied the "effects test" reflected in EPA's Water Quality Handbook definition to determine whether a state law or regulation is subject to section 303 review. *See, e.g., FPIRG*, 386 F.3d at 1080; *Nw. Envtl. Advocates v. Envtl. Prot. Agency*, 855 F. Supp. 2d 1199, 1209 (D. Or. 2012). Because the modifications to D-1641 allowed Reclamation and DWR to operate the CVP and SWP in a manner that violated the water quality criteria in the Bay-Delta and Central Valley Plans, they had the effect of modifying the Plans' water quality standards. The mandate of section 303 cannot be avoided by amending D-1641 or D-1422 instead of the water quality control plans themselves, particularly where those plans include standards for critically dry years. The allocation of responsibilities in D-1641 and D-1422 is intrinsically intertwined with the water quality standards in the Bay-Delta and Central Valley Plans. By modifying the water users' obligations to implement the water quality criteria, even temporarily, the SWRCB has supplanted or at very least delayed the attainment of these water quality standards.

Nor are the SWRCB's orders mere implementation decisions within the meaning of EPA regulations. Under 40 C.F.R. §131.13, "states may, at their discretion, include *in their State standards*, policies generally affecting their application and implementation, such as mixing zones, low flows and variances." (Emphasis added). Here, the Bay-Delta and Central Valley Plans do not include provisions providing for the modifications in the SWRCB's orders. Nor has the SWRCB defined or described its orders as "variances," or any other type of implementation decision within the meaning of 40 C.F.R. §131.13.

In sum, the SWRCB's 2014 and 2015 orders meet the four elements of EPA's definition for a new or revised water quality standard triggering the CWA's section 303(c)(2) – (4) review requirements. The SWRCB's orders were: (1) made pursuant to state law and have legally binding effect; (2) address water quality criteria; (3) express and establish a desired condition for the Bay Delta; (4) and have the effect of changing existing water quality standards. EPA was, and is, under an affirmative obligation to review the SWRCB's revisions regardless of whether the SWRCB submitted them to the EPA for review. *FPIRG*, 386 F.3d at 1073; *Friends of Merrymeeting Bay*, 839 F. Supp. 2d at 375. The EPA has failed to carry out its mandatory federal oversight role by ignoring SWRCB's ongoing pattern of approving changes to Reclamation and DWR's permits that do not meet the water quality standards in those plans and in D-1641 and D-1422. The EPA thus violated, and continues to violate, CWA section 303(c)(2) – (4) by failing to review the SWRCB's modifications to the Bay-Delta and Central Valley Plans.

After 60 days, the Noticing Parties intend to bring suit for a continuous and intermittent failure to carry out a non-discretionary duty to review and take appropriate action regarding the currently effective revisions to the Bay-Delta and Central Valley Plans discussed in the previous section, and any other revisions in effect after the date of this notice. The Noticing Parties will seek, *inter alia*, injunctive relief requiring that you comply with CWA section 303(c)(2) – (4) by reviewing and taking appropriate action regarding modifications to the Bay-Delta and Central Valley water quality standards, and declaratory relief requiring CWA-compliant review of future modifications to the Bay-Delta or Central Valley Plans.

B. Violation Of CWA Section 303(c)(1) For Failure To Review The Bay-Delta Water Quality Standards At Least Every Three Years

The Bay-Delta Plan was last updated in 2006. Therefore, triennial review of the Bay-Delta water quality standards was required, at minimum, in 2009, 2012, and 2015. The Board has not conducted timely reviews of the Bay-Delta Plan, as required by CWA section 303(c)(1).

The plain text of the CWA and its implementing regulations is mandatory, not permissive: triennial review of water quality standards "shall" occur "at least every three years." 33 U.S.C. §1313(c)(1); 40 C.F.R. §131.20(a). Just as courts and the EPA itself have recognized that the agency has a non-discretionary duty to review new and revised standards under section 303(c)(2) regardless of whether states submit them to the EPA, the EPA has a similar affirmative review obligation under CWA section 303(c)(1). The EPA's failure to take action in the face of California's prolonged inaction is thus a violation of a mandatory duty. *See, e.g.*, *Scott v. City of Hammond,* 741 F.2d 992, 998 (7th Cir. 1984); *Alaska Ctr. for the Envtl. v. Reilly*, 762 F. Supp. 1422, 1424 (W.D. Wash. 1991).

After 60 days, the Noticing Parties intend to bring suit for a continuous failure to carry out a non-discretionary duty to ensure the review of the water quality standards in the Bay-Delta Plan at least every three years. The Noticing Parties will seek, *inter alia*, injunctive relief requiring review of the water quality standards in the Bay-Delta Plan and declaratory relief requiring that such review take place at least every three years.

IV. IDENTIFICATION OF PERSONS GIVING NOTICE AND LEGAL COUNSEL

<u>The persons giving this notice are:</u>

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V. CONCLUSION

For the foregoing reasons, after 60 days from the postmark date of this notice, the Noticing Parties will bring suit if these continuous and intermittent violations of CWA section 303(c) are not cured.

Sincerely,

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Copies Sent Via Certified Mail To:

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Felicia Marcus, Chair, SWRCB (same address)
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Franks, Sierra
NOAA -NMFS
November, 2012
Updated June 2014

Possibility of natural producing spring-run Chinook salmon in the Stanislaus and Tuolumne Rivers

Currently Central Valley spring-run Chinook salmon are listed as threatened under the Endangered Species Act (ESA). This species was first listed in 1999. Historically in the San Joaquin River system spring-run Chinook are thought to have been one of the most viable runs, but were not listed under the original ESA listing as it was presumed by 1950, that the entire run of spring-run Chinook salmon was extirpated from the San Joaquin River (Fry 1961). The former spring run of the San Joaquin River has been described as "one of the largest Chinook salmon runs anywhere on the Pacific Coast" and numbering "possibly in the range of 200,000-500,000 spawners annually" (CDFG 1990).

Analyzing the historic data and information provided specifically on the Tuolumne and Stanislaus rivers, there is high probability based on records coupled with current data that natural (fish that naturally spawned in river systems and whose parents did as well) occurring spring-run Chinook are still present in small numbers. Here it is discussed where spring-run originally used these river systems.

On the Tuolumne River, Clavey Falls (10-15 ft. high) at the confluence of the Clavey River, may have obstructed the salmon at certain flows, but spring-run salmon in some numbers undoubtedly ascended the mainstem a considerable distance. The spring-run salmon were most likely stopped by the formidable Preston Falls at the boundary of Yosemite National Park (~50 mi upstream of present New Don Pedro Dam), which is the upstream limit of native fish distribution (CDFG 1955 unpublished data).

Spring run Chinook also originally occurred in the Stanislaus River. Spring-run probably went up the system considerable distances because there are few natural obstacles (Yoshiyama et al. 1998). Much of the spawning occurred on the extensive gravel beds in the 23-mi. stretch from

Riverbank upstream to Knights Ferry, which is essentially on the Valley floor at approximately 213 feet in elevation. Upstream of Knights Ferry, where the river flows through a canyon, spawning was (historic observations of spring-run) and is (fall-run) concentrated at Two-mile Bar (~1 mi above Knights Ferry) but also occurs in scattered pockets of gravel (Yoshiyama et al. 1998). Historically, the spring run was the primary salmon run in the Stanislaus River, but after the construction of dams which regulated the stream flows (i.e., Goodwin Dam and, later, Melones and Tulloch dams); the fall run became predominant (CDFG 1972 unpublished report).

Recent information suggests that perhaps a self-sustaining (capable of reproducing without hatchery influence) population of spring-run Chinook is occurring in some of the San Joaquin River tributaries, most notably the Stanislaus and the Tuolumne Rivers. Snorkel surveys (Kennedy T. and T. Cannon 2005) conducted between October 2002 to October 2004 on the Stanislaus River identified adults in June 2003 and June 2004 between Goodwin and Lovers Leap. Additionally on the Stanislaus, snorkel surveys also observed Chinook fry in December 2003 at Goodwin Dam, Two Mile Bar, and Knights Ferry, which they interpreted as an indication of spawning occurring in September, which is earlier than when fall-run Chinook salmon would be spawning in the river.

FISHBIO a fisheries consultant has operated a resistance board weir coupled with a Vaki RiverWatcher video monitoring system on the Stanislaus since 2003 and on the Tuolumne since 2009. Information obtained from this monitoring indicates that adult Chinook salmon are passing upstream of these weirs at a time period that would historically indicate a spring-run timing. Looking specifically at the months from February to June almost annually since observation began, some adult Chinook are migrating upstream (Table 1). It should be noted that the weir has not always operated past December due to study design or non-conducive river conditions. For example in 2007, 11 phenotypic spring-run Chinook were observed passing the weir between May and June on the Stanislaus. Future monitoring will determine if these fish are a typical occurrence or an anomaly (Anderson et al. 2007). Further personal observations by fisheries biologist from other agencies (CDFG & USFWS) that are familiar with these systems have accounts of seeing adult Chinook holding in these river systems in summer months (CDFG & USFWS, Personal comm.). If this is the case then genetic testing would be needed to confirm that these fish are in fact naturally producing spring-run Chinook and not hatchery strays*, i.e.*

Feather River. Otolith analysis may be the best way to confirm this by matching chemical signatures specific to each river system. Additionally there is no segregation barrier in place for spring-run and fall-run and it is likely that fall-run are superimposing on spring-run redds (Wikert, Personal Comm.). A further analysis looking at these tributaries rotary screw trap (RST) data helps support the suggestion of self-sustaining spring-run by looking at length at date criteria and comparing it to known spring-run Chinook populations on Sacramento River tributaries. RST data provided by Stockton United State Fish and Wildlife Service (USFWS) corroborates with the adult timing, by indicating that there are a small number of fry migrating out of the Stanislaus and Tuolumne at a period that would coincide with spring-run juvenile emigration (Tables 2 & 3).

Additionally during snorkel and kayak surveys in April, May and June of 2013 with CDFW, USFWS and NMFS staff the author observed a large number of adult Chinook in the upper reaches of the Stanislaus River below Goodwin Dam.

References:

Anderson, J.T, C.B. Watry and A. Gray. 2007. Upstream Fish Passage at a Resistance Board Weir Using Infrared and Digital Technology in the Lower Stanislaus River, California 2006−2007 Annual Data Report. 40pp.

California Department of Fish and Game (CDFG). 1955. Fish and game water problems of the Upper San Joaquin River. Potential values and needs. Statement submitted to the Division of Water Resources at hearings on the San Joaquin River water applications, Fresno, California. 5 April 1955. 51 pp. (Unpublished)

California Department of Fish and Game (CDFG). 1972. Report to the California State Water Resources Control Board on effects of the New Melones Project on fish and wildlife resources of the Stanislaus River and Sacramento-San Joaquin Delta. Region 4, Anadromous Fisheries Branch, Bay-Delta Research Study, and Environmental Services Branch, Sacramento. October 1972.

California Department of Fish and Game (CDFG). 1990. Status and management of spring-run Chinook salmon. Report by the Inland Fisheries Division to the California Fish and Game Commission, Sacramento. May 1990. 33 pp.

Fry, D.H., Jr. 1961. King salmon spawning stocks of the California Central Valley, 1940-1959. California Fish and Game 47: 55-71.

Kennedy, T., and T. Cannon. 2005. Stanislaus River salmonid density and distribution survey report. Fishery Foundation of California.

Tsao, S. 2012. CDFG. Personal communication with Sierra Franks at NMFS.

Wilkert, J.D. 2012. USFWS. Personal communication with Sierra Franks at NMFS.

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley region of California. North American Journal of Fisheries Management 18: 487–521.

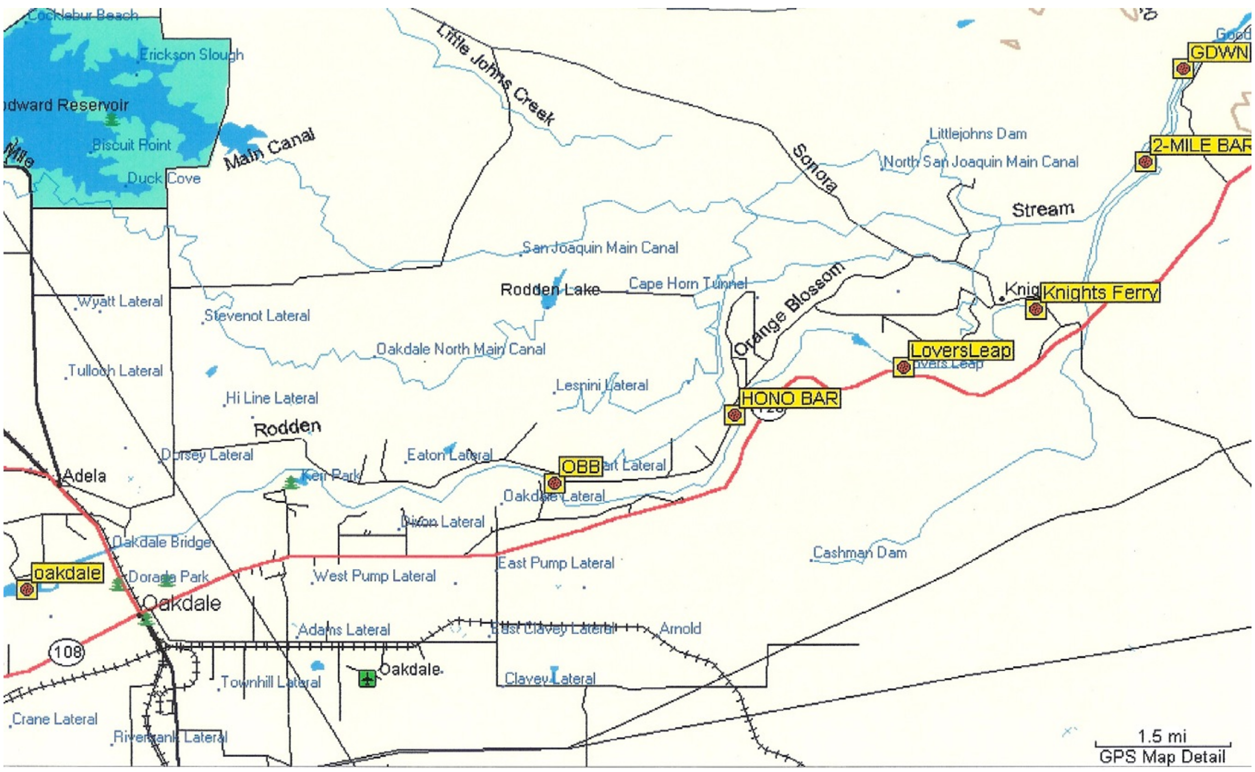

Figure 1. Displaying specific points mentioned in the text on the Stanislaus River, such as Goodwin Dam, 2-Mile Bar and Knights Ferry.

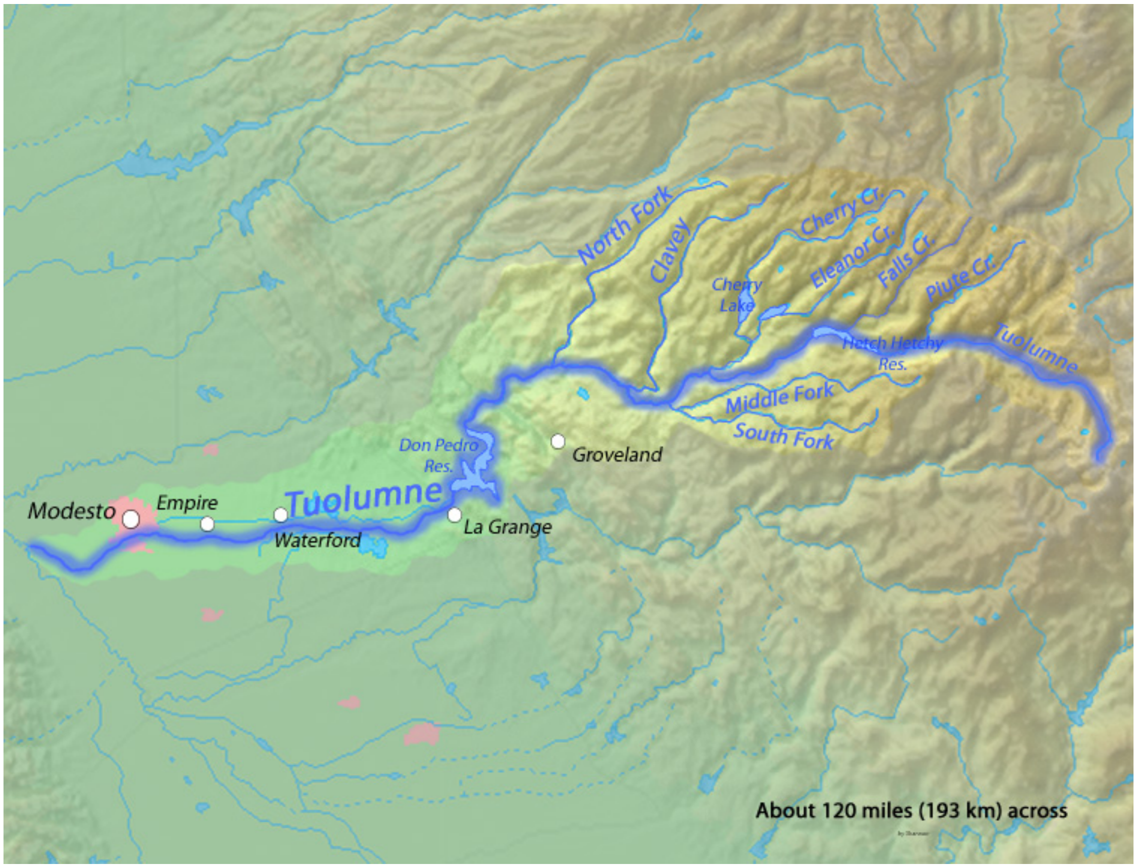

Figure 2. The Tuolumne River

Table 1. **Adult** adipose intact Chinook migrating upstream on the Tuolumne and Stanislaus Rivers (viewed by VAKI RiverWatcher weir: FISHBIO)

Tuolumne (2010, 2012)	Stanislaus (2007, 2009, 2010, 2012)
12 Confirmed adipose intact (*55 total passed)	51 confirmed adipose intact (*68 total passed)

* In 2011 the Stanislaus weir was pulled in mid-March due to flood control releases. The Tuolumne weir was not operating

* 2012 adipose clipped information not available at this time (this includes 38 total fish for the Tuolumne)

Table 2. Tuolumne RST cumulative catch 2000-2011 – matching USFWS length at date criteria for spring-run fry at Mossdale

March	245 Chinook fry -6% of TC
April	761 Chinook fry – 26% of TC
May	736 Chinook fry – 25% of TC
June	7 Chinook fry – 2% of TC

Table 3. Stanislaus (Caswell) RST cumulative catch 2000-2011 - matching USFWS length at date criteria for spring-run fry at Mossdale

March	636 Chinook fry - 9% of TC
April	911 Chinook fry - 12% of TC
May	363 Chinook fry – 6% of TC
June	4 Chinook fry - < 1% of TC

Table 4. Official Water Year Hydrologic Classification Indices from CDWR

	Year Type
2000	Above Normal
2001	Dry
2002	Dry
2003	Below Normal
2004	Dry
2005	Wet
2006	Wet
2007	Critical Dry
2008	Critical Dry
2009	Dry
2010	Above Normal
2011	Wet
2012	Dry

Table 5. Rotary Screw Trap Data on the Tuolumne, cumulative from 2000 – 2011. Data courtesy of Kes Ben, USFWS.

Chinook Salmon Length Range (5 mm intervals) by Month, Tuolumne Rotary Screw Trap Data, 2000-2011.

Length Range (mm)	January	February	March	April	May	June	December
25.1 - 30	41	60	9				2
30.1 - 35	1,835	2,336	1,473	74	17		135
35.1 - 40	2,462	2,900	1,541	37	9		39
40.1 - 45	15	67	38	2	1		
45.1 - 50	1	59	59	6	1		
50.1 - 55	4	58	144	14	1		
55.1 - 60	3	50	179	19	3		
60.1 - 65	3	35	226	58	5	2	
65.1 - 70	3	27	230	144	14	1	
70.1 - 75	7	34	199	333	61	6	
75.1 - 80	15	15	130	605	214	12	
80.1 - 85	22	8	72	658	488	25	
85.1 - 90	26	12	43	495	615	47	
90.1 - 95	12	5	20	266	679	77	
95.1 - 100	6	9	12	126	492	94	
100.1 - 105	4	16	8	26	244	47	
105.1 - 110	5	12	3	16	104	19	
110.1 - 115	2	5	2	6	33	5	
115.1 - 120		4	3	2	10	1	
120.1 - 125	2	4	3			1	
125.1 - 130	4	5	2				
130.1 - 135		3	5				
135.1 - 140	1	4	3				
140.1 - 145							
145.1 - 150			2				
150.1 - 155			1				
155.1 - 160							
160.1 - 165							
165.1 - 170		1					
175.1 - 180							
190.1 - 195							

Table 6. Rotary Screw Trap Data on the Stanislaus, cumulative from 2000 – 2011. Data courtesy of Kes Ben, USFWS.

Chinook Salmon Length Range (5 mm intervals) by Month, Stanislaus Rotary Screw Trap Data at Caswell, 2000-2011.

Length Range (mm)	January	February	March	April	May	June	July	December
20.1 - 25			2					
25.1 - 30	53	105	29					
30.1 - 35	496	967	496	4				4
35.1 - 40	413	1,227	555	6	1			3
40.1 - 45	18	395	507	2	2			
45.1 - 50	4	298	734	21	2			
50.1 - 55		181	924	109	3			
55.1 - 60		110	965	381	10			
60.1 - 65		52	928	799	69	1		
65.1 - 70		14	761	1,280	282	5		
70.1 - 75		2	602	1,509	828	22		
75.1 - 80			358	1,480	1,305	105		
80.1 - 85		1	193	1,040	1,510	162		
85.1 - 90			85	635	1,147	256		
90.1 - 95	1		26	276	677	213	2	
95.1 - 100			11	104	274	100		
100.1 - 105			1	41	89	46		
105.1 - 110				18	24	5		
110.1 - 115		1	1	7	3	2		
115.1 - 120			1		1			
120.1 - 125			3			2		
125.1 - 130			3					
130.1 - 135		1						
135.1 - 140			2					
140.1 - 145		1	1	1				
145.1 - 150	1	1	1	1				
150.1 - 155		1	2					
155.1 - 160			1					
160.1 - 165			4					
165.1 - 170								
170.1 - 175								
175.1 - 180								
180.1 - 185								
185.1 - 190			1					

Notes

White Sturgeon Spawning in the San Joaquin River, California and Effects of Water Management

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Abstract

Inadequate recruitment is a hallmark of declining sturgeon populations throughout the world. Efforts to understand and address the processes that regulate recruitment are of foremost importance for successful management and recovery. San Francisco Estuary white sturgeon (*Acipenser transmontanus*) were previously only known to spawn in the Sacramento River, California. We assessed potential white sturgeon spawning locations by deploying artificial substrate samplers during late-winter and spring of 2011 and 2012 from river kilometer 115.2 to 145.3 of the San Joaquin River. Collections of fertilized eggs, coupled with hydrology data, confirm that white sturgeon spawned within one and four sites in the San Joaquin River during wet (2011; n = 23) and dry (2012; n = 65) water-year conditions. Small pulse flow augmentations intended to benefit juvenile salmonids appear to have triggered white sturgeon spawning within this system. Understanding the effects of water management on spawning and subsequent recruitment is necessary to increase white sturgeon recruitment to the San Francisco Estuary.

Keywords: white sturgeon, egg sampling, spawning habitat, recruitment, San Joaquin River, San Francisco Estuary, Bay Delta, water management

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Short title: White Sturgeon Spawning in San Joaquin River

Introduction

White sturgeon (*Acipenser transmontanus*) are the largest freshwater fish species in North America and are integral to the ecosystem and cultural heritage of the Sacramento-San Joaquin (San Francisco Estuary population), Columbia, and Fraser river systems. Within the San Francisco Estuary, the presence and spawning of both white sturgeon and green sturgeon (*A. medirostris*) have been well documented in the Sacramento River (Kohlhorst 1976; Schaffter 1997; Poytress et al. 2012; DuBois et al. 2014). Although larval and juvenile green and white sturgeons have been sampled within the lower San Joaquin River, these observations have been attributed to movements of sturgeons from the known spawning populations within the Sacramento River (Radtke 1966; Stevens and Miller 1970; Beamesderfer et al. 2004). While several researchers have speculated that sturgeons may spawn within the San Joaquin River during high streamflow conditions (Kohlhorst 1976; Beamesderfer et al. 2004), spawning has not been confirmed through any direct sampling activities and little is known about the spatial and temporal distribution of sturgeons within the San Joaquin River system.

The San Joaquin River has been nicknamed the “hardest working water in the world” due to an extensive system of dams, diversions, and engineering (Kaneshiro et al. 2007). Water management in the San Joaquin River system is primarily focused on water storage for agricultural and municipal use, flood control, and power generation. These goals are fundamentally incompatible with maintaining the natural conditions under which native fishes, including white sturgeon, evolved. Intense water management has altered natural environmental conditions including streamflow, sediment transport, water temperature, floodplain connectivity, and access to upstream habitats. Of particular concern for sturgeon is that diversions in the basin inherently reduce water quantity and generally alter quality (e.g., temperature). Water diversions in the main stem and throughout the San Francisco Estuary may also entrain biologically significant portions of annual juvenile production (Mussen et al. 2014). The natural hydrology of the San Joaquin River system has been altered such that the timing and magnitude of peak runoff has shifted and resulted in a decrease of annual water yield of more than 70% (Cain et al. 2003). Highest monthly unimpaired flow (i.e., natural runoff) in the San Joaquin River during the 1984–2009 period was most commonly May (73%), followed by April (12%) and June (8%), while highest observed flow (i.e., reservoir discharge plus runoff from the watershed below dams) was most common in March (31%), followed by May (27%), February (15%), October (12%), and January (8%; SWRCB 2012).

White sturgeon year class strength is heavily influenced by survival at early life stages (Kohlhorst et al. 1991; Hildebrand et al. 1999; Secor et al. 2002) and recruitment failure is common in most populations (Coutant 2004). Jager et al. (2002) describes many factors influencing white sturgeon recruitment including discharge and temperatures during egg incubation and the downstream export of larvae following hatching. Therefore, gathering information on in-river physical characteristics and environmental conditions that influence white sturgeon recruitment is critical for management of the species. The objectives of this study were to determine if white sturgeon reproduce in the San Joaquin River, and if so, to characterize habitat conditions (e.g., temperature, depth, streamflow) where spawning occurred and describe the spatial and temporal distribution of spawning. Identifying suitable spawning habitat for white sturgeon will help inform future water management decisions and habitat protection and restoration actions needed to increase or maintain the white sturgeon population within the San Joaquin River and San Francisco Estuary.

Study Area

The San Joaquin River originates from the central Sierra Nevada and drains parts of the Sierra Nevada and Diablo Range of California. The river flows through 531 km of California, first west towards the floor of the Central Valley, then north towards the San Francisco Bay Estuary, eventually reaching the Pacific Ocean (Figure 1, Panel A). Friant Dam at river kilometer (rkm) 431 of the San Joaquin River (measuring from its confluence with the Sacramento River) forms a complete barrier to upstream anadromous fish passage. However, a number of physical migration barriers (e.g., dry riverbed, diversion dams, seasonally-installed weir) exist between the Merced River confluence (rkm 187.6) and Friant Dam due to the current state of water management on the San Joaquin River.

Methods

Sampling occurred from rkm 115.2 to rkm 145.3 (Figure 1, Panel B), and sites were selected based on presence of at least two of the following attributes: pool habitat, areas of accelerating velocities, and reported observations of adult-sized sturgeon by anglers and wardens. Artificial substrate samplers (i.e., egg mats) were used to sample for the presence of white sturgeon eggs from April 18 to May 16, 2011 and February 16 to June 1, 2012. The timing of sampling during 2011 was delayed and abbreviated due to a combination of logistic issues (e.g., travel restrictions, permitting). Egg mats were constructed from two 89 x 65-cm rectangular sections of furnace filter material secured back to back within a welded steel framework (McCabe and Beckman 1990; Schaffter 1997; Poytress et al. 2009). The orientation of the furnace filter material allowed either side of the egg mat to collect eggs. Egg mats were held in position by a 2.0-kg anchor attached to the upstream end with two 76-cm lengths of 9.5-mm diameter braided polypropylene line. A labeled float was attached to the downstream end of the egg mat with a 9.5-mm diameter braided polypropylene line. Float line length varied depending on water depth and velocity. Egg mats were set in pairs and predominantly deployed in areas of accelerating velocity (i.e., areas flanking the deepest portions of pools). During 2011, paired egg mats were placed in eight locations between rkm 115.2 and rkm 145.3 (Figure 1). Sampling ceased after limited effort at the rkm 115.2, 120.4, 126.4, 140.8, and 143.7 sites due to sampling difficulty associated with high streamflow conditions. In 2012, paired egg mats were placed in four locations between rkm 115.2 and rkm 139.8 (Figure 1).

Environmental and sample effort data were recorded during both the deployment and retrieval of egg mats (Table S1, *Supplemental Material*). Depth and GPS coordinates were recorded using a Lowrance depth finder (Model StructureScan HDS 10-m). Hourly streamflow and water temperature data were obtained from the U.S. Geological Survey gaging station near Vernalis (rkm 111.8) for the rkm 115.2 site, and from the California Data Exchange Center gaging stations at Maze Road Bridge (rkm 120.2) for the rkm 120.4 and 126.4 sites, and the San Joaquin near Patterson (rkm 154.9) for the rkm 137.4–145.3 sites (Figure 1). Sample effort consisted of the time between gear deployment and retrieval and is standardized into wetted mat days (wmd; i.e., one egg mat set for 24 hours).

Egg mats were visually inspected for eggs at least twice per week at each site during each sample season. To achieve this, mats were retrieved, placed on the deck of the boat in a custom-made mat carrier, and initially inspected on both sides by at least two field crew members. Mats were rinsed to remove debris and then inspected again. Rinse water and debris were filtered by a removable 3.2-mm mesh net placed within the mat carrier below each mat to capture any dislodged eggs. After a second inspection of the egg mats, mesh nets, and rinsate, the egg mats were redeployed.

Eggs were identified down to family in the field. Suspected sturgeon and unidentified eggs were placed in vials of 95% ethanol for species confirmation and evaluation of developmental stage and viability in the laboratory (Table S2, *Supplemental Material*). In the laboratory, eggs were identified as white sturgeon based upon coloration, size, and chorion thickness, as they are darker, smaller, and have a thicker chorion than green sturgeon eggs (Van Eenennaam et al. 2008). Egg development stage was based on Dettlaff et al. (1993). Eggs were classified as "not viable" if they were crushed during collection and handling, covered in fungus or algae, or had mottled pigmentation with white streaks. We measured the length and width of white sturgeon eggs (± 0.001 mm, rounded to 0.01) using a dissecting scope (Wild M5-A) with camera lucida and a digital image analyzing tablet (Nikon Microplan II). Estimated spawn date and time for each egg was back-calculated, using an exponential function, based on water temperature and stage of embryonic development described for white sturgeon (Wang et al.

1985; Wang et al. 1987). Minimum number of spawn events was based on rkm, date of egg collections, calculated fertilization time, and the assumption it takes up to 21 hours to complete oviposition (Van Eenennaam et al. 2012) following the methods described in Poytress et al. (2015). A spawning event was defined as any viable fertilized eggs collected within a 10-km distance and within a 21-hour oviposition period. Incubation period was defined as the time between the estimated time of spawning through egg collection. We report the data as a minimum number of spawning events, as it is possible that more than one female was spawning in an area at the same time and location.

Results

2011

Egg mats were deployed at river depths ranging from 4.3 to 12.3 m for a total of 183.2 wmd among eight sample sites (Table 1). High river flows and limited staff availability focused our sampling efforts (68.6%; *n*=125.6 wmd) at three (rkm 137.4, 138.1, and 145.3) of the seven sample sites (Table 1). Twenty-three white sturgeon eggs were collected from mats deployed at depths ranging from 8.2 to 10.5 m (Table 1). All eggs, likely representing a single spawning event, were collected at rkm 138.1 over a four-day period (April 25–April 28, 2011; Figure 2; Table 2). One egg was lost during field handling and was not included in Table 2. Eighty-six percent (*n* = 19) of the eggs were classified as viable and mean egg length and width was 3.26–3.57 mm, and 3.02–3.34 mm, respectively (Table 2). San Joaquin River streamflow and water temperature ranged from 154.5 to 767.4 m^3/s and 13.9 to 18.2 ^oC, respectively, throughout the 2011 sample period (Table 1; Figure 2). Streamflow and water temperature averaged 346.7 m^3/s and 15.3 °C, respectively, at rkm 138.1 during the incubation period in 2011 (Table 1).

2012

Egg mats were deployed at river depths ranging from 0.4 to 9.3 m for a total of 670.9 wmd among four sites (Table 1). Eighty-two percent (552.3 of 670.8 wmd) of the total sampling effort was expended uniformly across three of the four sample sites (rkm 115.2, rkm 126.4, and rkm 137.6; Table 1). Mats were added at rkm 139.8 during the sixth week of sampling, due to observations of sturgeon in the area, accounting for 17.7% of total effort (118.5 wmd; Table 1). Sixty-five white sturgeon eggs were collected among all sampling sites from egg mats deployed at depths ranging from 1.6 to 9.1m between March 22 and May 14, 2012, representing at least six spawning events (Table 1; Table 2). Forty-six eggs (71%) were viable and determined to be in various stages of post-fertilization embryonic development (Table 2). Eight eggs were collected on April 2, 2012 from the upper sites (rkm 137.6 and 139.8); however, due to missing site discrimination data, it is not possible to tell which eggs and how many were collected at each site. Nineteen eggs (29%) were not viable, many of which were covered in fungus. It could not be determined if the non-viable eggs were fertilized eggs that died during embryogenesis or were unfertilized eggs. Mean egg length and width was 3.46–3.64 mm, and 3.34–3.46 mm, respectively (Table 2). San Joaquin River streamflow and water temperature ranged from 12.7 to 127.4 m^3/s and 10.4 to 26.7 °C, respectively, throughout the 2012 sample period (Table 1; Figure 2). Streamflow and water temperature during the incubation period ranged from 19.2 to 127.4 m^3/s and 14.2 to 26.7 °C (Table 1; Figure 2). Hourly temperatures during the incubation period of egg collections on April 19 (rkm 137.6) and May 10 (rkm 137.4; rkm 139.8) ranged from 18.6 to 20.9 °C and 19.9 to 22.1 °C, respectively (Figure 2).

Discussion

Schaffter (1997) stated “identification and protection of spawning habitat is vital for the maintenance of the (white sturgeon) population and the sport fishery”. While our study did set out to identify spawning locations and habitat characteristics (e.g., water temperature, streamflow) in the San Joaquin River, we are unaware of any actions implemented since 1997 with a stated purpose of spawning habitat protection. The collection of white sturgeon eggs in 2011 and 2012 provided the first evidence of white sturgeon spawning in the San Joaquin River. The eggs collected were likely part of at least seven separate spawning events based upon capture location, date of capture, water temperature, stage of development, and the estimation that it takes a female up to 21 hours to complete oviposition (Van Eenennaam et al. 2012). The number of spawning events is likely conservative as the recovery of eggs from a single spawning event was quite rare in this study. Until genetic analyses can be completed on individual eggs, it remains unknown whether multiple eggs collected during a single sampling event could have been from more than one female. The fecundity of a female white sturgeon ranges from 64,000 to 469,000 (Chapman et. al. 1996), yet only 3–5 eggs were collected from half of the 2012 spawning events. Sampling gear efficiency, insufficient numbers of deployed egg mats, losses during retrieval, and predation of eggs are probably leading factors contributing to the scarcity of eggs collected. Additionally, the extent of the time lapse between the occurrence of a spawning event and egg mat retrieval likely resulted in increased egg loss. Caroffino et. al (2010) replaced mats with all lake sturgeon (*A. fulvescens*) eggs attached after counting, and then recovered and recounted them 24 hours later and reported that egg loss rate varied 20–100%. At 24 hours post-deposition for Gulf sturgeon (*A. oxyrinchus desotoi*) eggs, Sulak and Clugston (1998) reported nearly 100% loss of eggs. Although we likely experienced egg loss before mat retrieval, our results provide critical evidence of spawning activity in an area thought to be rarely, if ever, used.

Researchers (e.g., Kohlhorst 1976; Schaffter 1997) have speculated that the presence of white sturgeon in the San Joaquin River was a result of fish on a spawning migration during years with high runoff (i.e., wet water-year types). Spawning surveys in 2011 and 2012 occurred during two drastically different water year types. Mean daily streamflow in the San Joaquin River during early 2011 was as much as four times higher than mean daily streamflow for water years 1993 to 2012. As speculated, streamflow levels of this magnitude may have triggered white sturgeon to enter and spawn within the San Joaquin River. However, streamflow levels in 2012 were generally half or less than the 20-year average. Despite much lower than average streamflow during early 2012, at least six spawning events were observed demonstrating that spawning also occurs in dry years.

An increase in streamflow is believed to be an important cue for migration and spawning of white sturgeon within various watersheds (Hildebrand et al. 1999; Paragamian and Wakkinen 2011). During the drought year of 1991, Schaffter (1997) documented white sturgeon spawning in the Sacramento River 1–3 days after an increase in streamflow of approximately 40 m^3/s. Increases in spawning activity of lake sturgeon was observed concomitant with a change in water management operations on the Sturgeon River, Michigan from a peaking operation to releasing near run-of-river flows (Auer 1996). The change in operations resulted in, among other things, 74% more fish observed and an estimated 68% increase in the number of females present (Auer 1996). In the present study, white sturgeon spawning was documented in the San Joaquin River in 2011 as flood flows receded. However, it remains unknown if spawning had occurred during the peak in streamflow at the end of March since sampling did not commence until April 18. In comparison, white sturgeon spawning was observed at all four sampling locations in association with short-duration streamflow pulses during low streamflow conditions of 2012. Two March and early-April streamflow pulses (~18 to 25 m^3/s) were the result of rainfall, while one streamflow pulse (mid-May) was the result of reservoir releases on the Tuolumne and Merced rivers. Both rivers are tributaries to the San Joaquin River in the vicinity of the study area, and the reservoir releases were intended to increase survival of emigrating juvenile salmonids. Such flow augmentations appear to be providing unintended benefit to white sturgeon.

Twenty-three eggs were collected over a four-day period at rkm 142 in 2011. Water temperatures during the incubation period ranged from 14.6 to 15.8 °C and were consistent with optimal white sturgeon spawning temperatures observed on the Columbia and Sacramento rivers, 10 to 18 °C and 14 to16 °C, respectively (Kohlhorst 1976; Parsley et al. 1993; McCabe and Tracy 1994). However, mean daily water temperatures in our study area during 2012 began to surpass 18.0 °C in mid-April. Egg collections on April 19 (rkm 137.6) and May 10 (rkm 137.4; rkm 139.8) occurred when recorded hourly water temps during the incubation period were 18.6 to 20.9 °C and 19.9 to 22.1 °C, respectively. Wang et al. (1985) reported white sturgeon hatching rates decrease at 20 °C and complete arrest of embryonic development at 23 °C in laboratory experiments. Although embryos were exposed to unfavorable temperatures during the spawning and incubation period in 2012, there were no obvious signs of deformities at the stages of embryonic development observed in any viable eggs that were collected. One may question whether the observed non-viable eggs could be related to the elevated temperatures; however, most of these non-viable eggs were found early in the spawning season when temperatures were within the optimal range, and 75% of the collected eggs were viable. A number of factors other than temperature may be causing or contributing to embryo mortality, including contaminants, sampling-related damage, and substrate type (Lemly 1996; Parsley and Kofoot 2013). Additionally, non-viable eggs may simply have not been fertilized. Considering the high fecundity of white sturgeon it is conceivable that some eggs might not be fertilized and that there were too few eggs sampled to make any definitive conclusions regarding the effect of elevated temperatures.

Sturgeon spawning habitat is generally associated with depths greater than 4 m (Parsley and Beckman 1994; Chapman and Jones 2010; Paragamian 2012). Deep pool habitat is limited on the San Joaquin River during most years. Flood conditions during 2011 resulted in elevated river stage and egg samples were collected at depths varying from 8.2 to 10.5 m. In contrast, eggs were collected during 2012 at depths varying from 1.6 to 9.1m, and 43.9% of eggs were collected at depths less than 2.0 m (25 of the 57 eggs of known origin). Paragamian (2012) suggested that white sturgeon spawn in areas of highest available velocities and depth. The limited availability of sites with depths greater than 4 m and adequate velocities (Z. J. Jackson, unpublished) may be influencing fish to select shallow spawning sites with suitable velocities over deeper sites lacking adequate velocities.

Both rain events and San Joaquin River basin water management decisions resulting in increased streamflows preceding documentation of white sturgeon spawning. In wet years, this may take the form of elevated streamflow managed for flood control purposes and in dry years, small-magnitude, short-duration increases in streamflow appeared to initiate spawning. Continued efforts should be made to restore a natural hydrologic regime and provide sturgeon spawning flows (streamflow increases ≥40 m^3/s) within the San Joaquin River during March–May. Ongoing regulatory and management processes (e.g., restoration of flow and habitat in the main stem river by the San Joaquin River Restoration Program, minimum flow requirements mandated by the Federal Energy Regulatory Commission and State Water Resources Control Board) may result in the desired hydrology and temperature needed to increase white sturgeon recruitment in the San Joaquin River. Future research should be implemented to evaluate the results of new management actions.

Current monitoring efforts include describing available habitat (e.g., depth, substrate, velocity) within the San Joaquin River (Jackson, unpublished). Our research suggests that increases in streamflow during the March–May period are important drivers of spawning activity, perhaps more so than other important habitat features. However, additional research is needed to refine our understanding of the relationship between streamflow, velocity, water temperature, depth, and substrate on spawning initiation and success throughout the range of the species. Additional and more intensive egg sampling (i.e., more mats and more frequent mat retrieval), in conjunction with acoustic tracking of adults should also focus on further evaluating the effects of salmonid-focused flow augmentations on white sturgeon spawning and recruitment. Larval sampling should be conducted in various water year types and across various water management scenarios in order to inform evaluation of the quantity and suitability of available spawning and rearing habitat and verify hatching success. Demonstrating additional benefit from spring flow augmentations may result in added support for continuing efforts to partially mimic natural hydrologic conditions. Additionally, salmonid-focused habitat restoration actions should consider white sturgeon spawning and rearing habitat needs to improve instream habitat for both important resources. Documentation of environmental conditions associated with successful recruitment of white sturgeon is of utmost importance for informing future water management actions in California and throughout their range.

Supplemental Material

Table S1. Table of sampling location (river kilometers; rkm), sampler identification number (Float #), sampler deployment and retrieval dates, times, and river depths (meters), and the presence (eggs) and number of eggs (Total Eggs) collected during 2011 and 2012 San Joaquin River white sturgeon (*Acipenser transmontanus*) spawning surveys on the San Joaquin River, California.

Table S2. Data are presented for identified white sturgeon (*Acipenser transmontanus*) eggs collected during 2011 and 2012 San Joaquin River spawning surveys, California. Data includes sampling date and location (Rkm), minimum (min) and maximum (max) egg diameter measurements, calculated spawning date and time (hour), the estimated number of spawning events (events), and egg developmental stage assignments.

Reference S1. Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller, and D. Demko. 2004. Historical and current information on Green Sturgeon occurrence in the Sacramento and San Joaquin rivers and tributaries. Report by S.P. Cramer & Associates to State Water Contractors, Sacramento, California.

Reference S2. Cain, J. R., R. P. Walkling, S. Beamish, E. Cheng, E. Cutter, and M. Wickland. 2003. San Joaquin Basin ecological flow analysis. Natural Heritage Institute, Berkeley, California.

Reference S3. DuBois, J., M. D. Harris, and J. Mauldin. 2014. 2013 Sturgeon fishing report card: preliminary data report. California Department of Fish and Wildlife, Stockton, California.

Reference S4. Parsley, M. J., and E. Kofoot. 2013. Effects of incubation substrates on hatch timing and success of white sturgeon (*Acipenser transmontanus*) embryos. U.S. Geological Survey Scientific Investigations Report 2013-5180, Seattle.

Reference S5. Poytress, W. R., J. J. Gruber, D. A. Trachtenbarg, and J. P. Van Eenennaam. 2009. 2008 Upper Sacramento River green sturgeon spawning habitat and larval migration surveys. Annual Report to U.S. Bureau of Reclamation, Red Bluff, California.

Reference S6. Poytress, W. R., J. J. Gruber, and J. P. Van Eenennaam. 2012. 2011 Upper Sacramento River green sturgeon spawning habitat and larval migration surveys. Annual Report to U.S. Bureau of Reclamation, Red Bluff, California.

Reference S7. SWRCB (State Water Resources Control Board). 2012. Technical report on the scientific basis for alternative San Joaquin River flow and southern Delta salinity objectives. Sacramento, California.

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conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

References

Auer, N. A. 1996. Response of spawning lake sturgeons to change in hydroelectric facility operation. Transactions of the American Fisheries Society 125:66–77.

Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller, and D. Demko. 2004. Historical and current information on Green Sturgeon occurrence in the Sacramento and San Joaquin rivers and tributaries. Report by S.P. Cramer & Associates to State Water Contractors, Sacramento, California (see *Supplemental Material*, Reference S1).

Cain, J. R., R. P. Walkling, S. Beamish, E. Cheng, E. Cutter, and M. Wickland. 2003. San Joaquin Basin ecological flow analysis. Natural Heritage Institute, Berkeley, California (see *Supplemental Material*, Reference S2).

Caroffino, D. C., T. M. Sutton, R. F. Elliott, and M. C. Donofrio. 2010. Early life stage mortality rates of lake sturgeon in the Peshtigo River, Wisconsin. North American Journal of Fisheries Management 30:295–304.

Chapman, C. G., and T. A. Jones. 2010. First documented spawning of white sturgeon in the lower Willamette River, Oregon. Northwest Science 84:327–335.

Chapman, F. A., J. P. Van Eenennaam, and S. I. Doroshov. 1996. The reproductive condition of white sturgeon, *Acipenser transmontanus*, in San Francisco Bay, California. Fishery Bulletin 94:628–634.

Coutant, C. C. 2004. A riparian habitat hypothesis for successful reproduction of white sturgeon. Reviews in Fisheries Science 12:23–73.

Dettlaff, T. A., A. S. Ginsburg, and O. I. Schmalhausen. 1993. Sturgeon Fishes: developmental biology and aquaculture. New York: Springer-Verlag.

DuBois, J., M. D. Harris, and J. Mauldin. 2014. 2013 Sturgeon fishing report card: preliminary data report. California Department of Fish and Wildlife, Stockton, California (see *Supplemental Material*, Reference S3).

Hildebrand, L., C. McLeod, and S. McKenzie. 1999. Status and management of white sturgeon in the Columbia River in British Columbia, Canada: an overview. Journal of Applied Ichthyology 15:164–172.

Jager, H. I., W. Van Winkle, J. A. Chandler, K. B. Lepla, P. Bates, and T. D. Couniham. 2002. A simulation study of factors controlling white sturgeon recruitment in the Snake River. Pages 127–150 *in* W. Van Winkle, P. J. Anders, D. H. Secor, and D. A. Dixon, editors. Biology, management and protection of North American sturgeon. American Fisheries Society, Symposium 28, Bethesda, Maryland.

Kaneshiro, J., F. Kintzer, M. L. Piek, R. Yoshimura, D. Van Horsen, G. Korbin, K. Lovelie, J. Carfrae, R. McManus, and C. Ovalle. 2007. Reliability assessment, repair, and replacement of historic water tunnels and their contribution to California's sustainability. Pages 1897–1906 *in* J. Bartak, I. Hrdina, G. Romancov, and J. Zlamal, editors. Underground space – the 4^{th} dimension of metropolises. CRC Press, Prague.

Kock, T. J., J. L. Congleton, and P. J. Anders. 2006. Effects of sediment cover on survival and development of white sturgeon embryos. North American Journal of Fisheries Management 26:134–141.

Kohlhorst, D. W. 1976. Sturgeon spawning in the Sacramento River in 1973, as determined by distribution of larvae. California Fish and Game 62:32–40.

Kohlhorst, D. W., L. W. Botsford, J. S. Brennan and G. M. Cailliet. 1991. Aspects of the structure and dynamics of an exploited central California population of white sturgeon

(*Acipenser transmontanus*). Pages 277–283 *in* P. Williot, editor. Acipenser: Actes du premier colloque international sur l'esturgeon, CEMAGREF, Bordeaux, France.

Leland, H. V., L. R. Brown, and D. K. Mueller. 2001. Distribution of algae in the San Joaquin River, California, in relation to nutrient supply, salinity and other environmental factors. Freshwater Biology 46:1139–1167.

Lemly, A. D. 1996. Assessing the toxic threat of selenium to fish and aquatic birds. Environmental Monitoring and Assessment 43:19–35.

McCabe, G. T., and L. G. Beckman. 1990. Use of an artificial substrate to collect white sturgeon eggs. California Fish and Game 76:248–250.

McCabe, G. T., and C. A. Tracy. 1994. Spawning and early life history of white sturgeon, *Acipenser transmontanus*, in the lower Columbia River. Fishery Bulletin 92:760–772.

Mussen, T. D., D. Cocherell, J. B. Poletto, J. S. Reardon, Z. Hockett, A. Ercan, H. Bandeh, M. L. Kavvas, J. J. Cech Jr., and N. A. Fangue. 2014. Unscreened water-diversion pipes pose an entrainment risk to the threatened green sturgeon, *Acipenser medirostris*. PLoS (Public Library of Science) ONE [online serial] 9(1). DOI: 10.1371/journal.pone.0086321

Paragamian, V. L., and V. D. Wakkinen. 2011. White sturgeon spawning and discharge augmentation. Fisheries Management and Ecology 18:314–321.

Paragamian, V. L. 2012. Kootenai River white sturgeon: synthesis of two decades of research. Endangered Species Research 17:157–167.

Parsley, M. J., and L. G. Beckman. 1994. White sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management 14:812–827.

Parsley, M. J., L. G. Beckman, and G. T. McCabe Jr. 1993. Habitat use by spawning and rearing white sturgeon in the Columbia River downstream of McNary Dam. Transactions of the American Fisheries Society 122:217–227.

Parsley, M. J., and E. Kofoot. 2013. Effects of incubation substrates on hatch timing and success of white sturgeon (*Acipenser transmontanus*) embryos. U.S. Geological Survey Scientific Investigations Report 2013-5180, Seattle (see *Supplemental Material*, Reference S4).

Poytress, W. R., J. J. Gruber, D. A. Trachtenbarg, and J. P. Van Eenennaam. 2009. 2008 Upper Sacramento River green sturgeon spawning habitat and larval migration surveys. Annual Report to U.S. Bureau of Reclamation, Red Bluff, California (see *Supplemental Material*, Reference S5).

Poytress, W. R., J. J. Gruber, and J. P. Van Eenennaam. 2012. 2011 Upper Sacramento River green sturgeon spawning habitat and larval migration surveys. Annual Report to U.S. Bureau of Reclamation, Red Bluff, California (see *Supplemental Material*, Reference S6).

Poytress, W. R., J. J. Gruber, J. P. Van Eenennaam, and M. Gard. 2015. Spatial and temporal distribution of spawning events and habitat characteristics of Sacramento River Green Sturgeon. Transactions of the American Fisheries Society 144:1129–1142.

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin estuary as measured by tagging. California Fish and Game 58:94–101.

Schaffter, R. G. 1997. White sturgeon spawning migrations and location of spawning habitat in the Sacramento River, California. California Fish and Game 83:1–20.

Secor, D. H., P. J. Anders, W. Van Winkle, and D. A. Dixon. 2002. Can we study sturgeons to extinction? What we do and don’t know about the conservation of North American sturgeons. Pages 127–150 in W. Van Winkle, P. J. Anders, D. H. Secor, and D. A. Dixon, editors. Biology, management and protection of North American sturgeon. American Fisheries Society, Symposium 28, Bethesda, Maryland.

Stevens, D. E., and L. W. Miller. 1970. Distribution of sturgeon larvae in the Sacramento-San Joaquin river system. California Fish and Game 56:80–86.

Sulak, K. J., and J. P. Clugston. 1998. Early life-history stages of gulf sturgeon in the Suwannee River, Florida. Transactions of the American Fisheries Society 127:758–771.

SWRCB (State Water Resources Control Board). 2012. Technical report on the scientific basis for alternative San Joaquin River flow and southern Delta salinity objectives. Sacramento, California (see *Supplemental Material*, Reference S7).

Sytina, L. A., and V. G. Shagaeva. 1987. Thermotolerance of progeny of Sevryuga, *Acipenser stellatus*, spawners from different periods of the spawning migration. Journal of Ichthyology 27:12–21.

Van Eenennaam, J. P., J. Linares-Casenave, X. Deng, and S. I. Doroshov. 2005. Effect of incubation temperature on green sturgeon embryos, *Acipenser medirostris*. Environmental Biology of Fishes 72:145–154.

Van Eenennaam, J.P., J. Linares-Casenave, J. Muguet, and S. I. Doroshov. 2008. Induced spawning, artificial fertilization, and egg incubation techniques for green sturgeon. North American Journal of Aquaculture 70:434-445.

Van Eenennaam, J. P., J. Linares-Casenave, and S. I. Doroshov. 2012. Tank spawning of first generation domestic green sturgeon. Journal of Applied Ichthyology 28:505–511.

Wang, Y. L., F. P. Binkowski, and S. I. Doroshov. 1985. Effect of temperature on early development of white and lake sturgeon, *Acipenser transmontanus* and *A. fulvescens*. Environmental Biology of Fishes 14:43–50.

Wang, Y. L., R. K. Buddington, and S. I. Doroshov. 1987. Influence of temperature on yolk utilization by the white sturgeon, *Acipenser transmontanus.* Journal of Fish Biology 30:263–271.

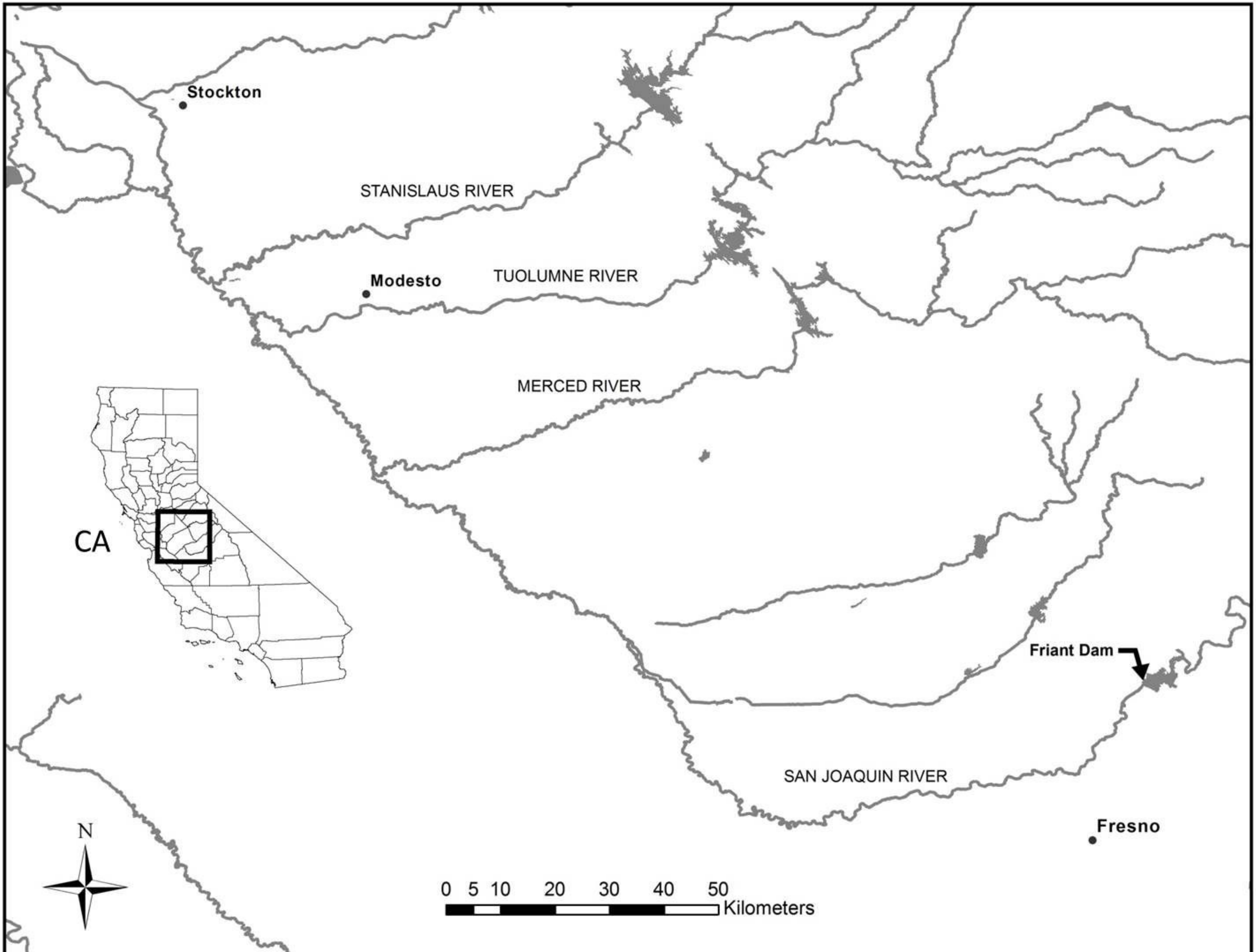
Figure captions

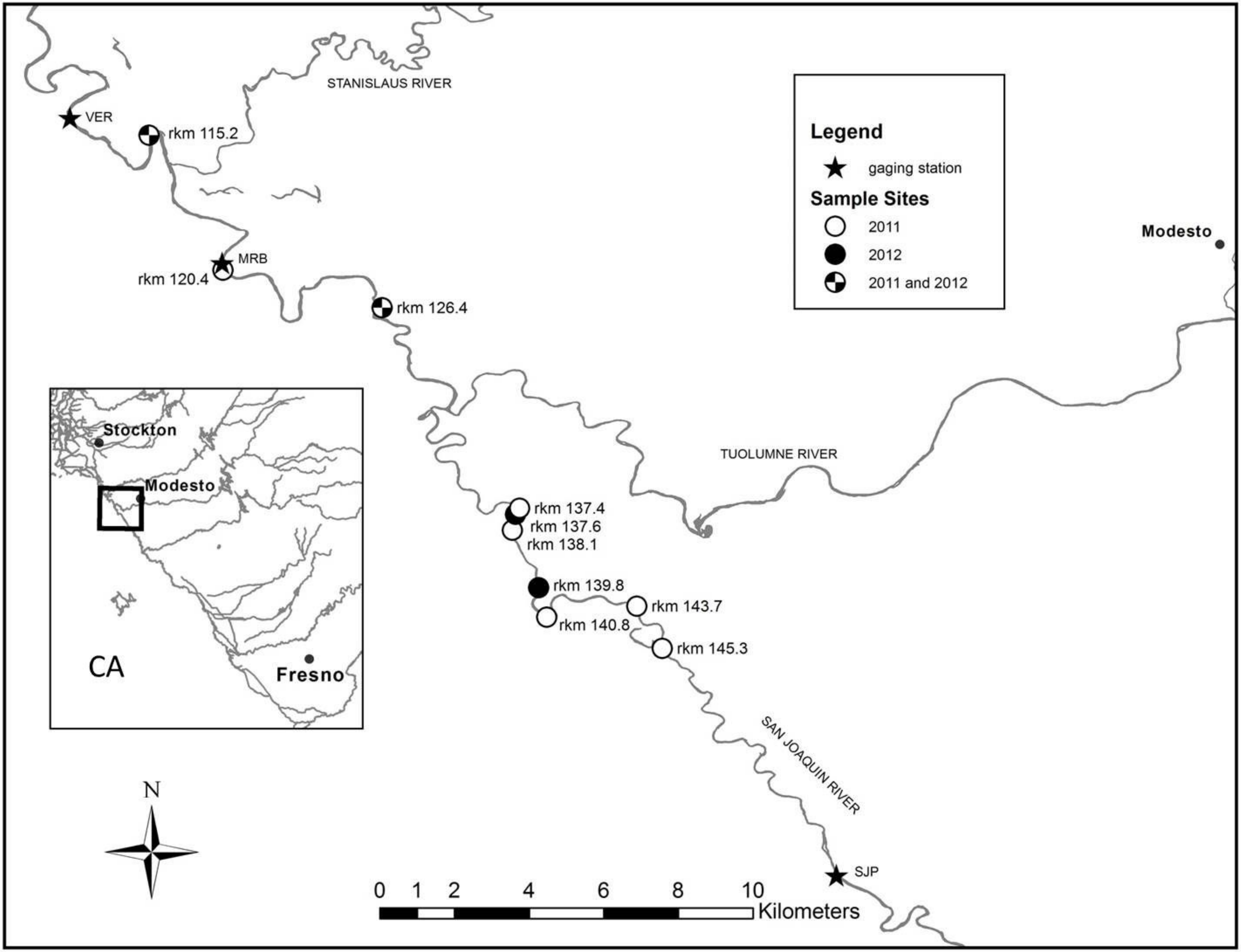
Figure 1. Panel A shows the northern San Joaquin Valley of California and the main tributaries to the San Joaquin River. Panel B depicts the white sturgeon (Acipenser transmontanus) spawning study area, sampling locations, and associated river gaging stations (U.S. Geological Survey gaging station at Vernalis, California (VER; USGS 11303500) and California Data Exchange Center gaging stations at Maze Road Bridge (MRB) and San Joaquin near Patterson, California (SJP)).

Figure 2. Mean daily average streamflow (m3/s) and water temperature (°C) observed from February 1–July 1, 2011 and 2012 on the San Joaquin River, California at the white sturgeon (Acipenser transmontanus) spawning survey sampling sites: 1) downstream of the Stanislaus River (rkm 115.2; top panels); 2) between the Stanislaus and Tuolumne rivers (rkms 120.4 and 126.4 in 2011 and rkm 126.4 in 2012; middle panels); and 3) upstream from the Tuolumne River (rkms 137.4, 138.1, 140.8, 143.7, and 145.3 in 2011 and rkms 137.6 and 139.8 in 2012; bottom panels). Streamflow and water temperature

data were obtained from the United States Geological Survey gaging station at Vernalis, California (VER; USGS 11303500) and California Data Exchange Center gaging stations at Maze Road Bridge (MRB) and San Joaquin near Patterson, California (SJP). Shaded areas represent the timing of sampling activities for each respective sampling area. Triangles represent estimated spawn timing and are coded by sample location (A=rkm 115.2; B= rkm 126.4; C=rkm 137.6; D=rkm 138.1; E=rkm 139.8).

Figure 3. San Joaquin River mean daily streamflow (m3/s) during January–June, 1993–2012 measured at the U.S. Geological Survey gaging station at Vernalis, California (USGS 11303500). These data are presented to demonstrate streamflow conditions observed during the 2011 and 2012 San Joaquin River white sturgeon (Acipenser transmontanus) spawning surveys with average streamflow conditions observed over a twenty-year period ending in 2012.


Stockton
STANISLAUS RIVER
Modesto
TUOLUMNE RIVER
MERCED RIVER
CA
Friant Dam
SAN JOAQUIN RIVER
Fresno
N
0 5 10 20 30 40 50
Kilometers


STANISLAUS RIVER
VER
rkm 115.2
MRB
rkm 120.4
rkm 126.4
Legend
gaging station
Sample Sites
2011
2012
2011 and 2012
Modesto
Stockton
Modesto
CA
Fresno
TUOLUMNE RIVER
rkm 137.4
rkm 137.6
rkm 138.1
rkm 139.8
rkm 143.7
rkm 140.8
rkm 145.3
SAN JOAQUIN RIVER
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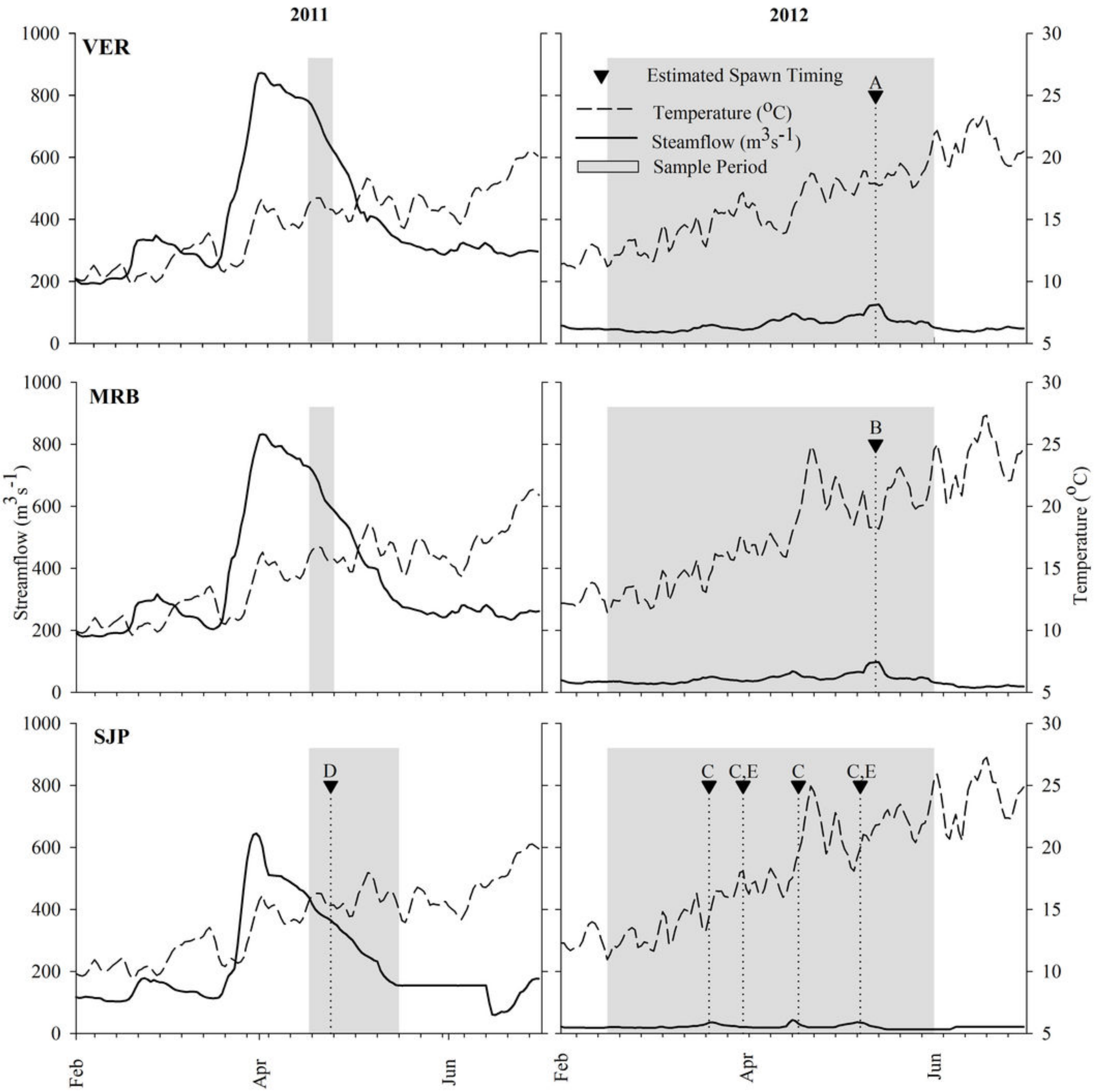
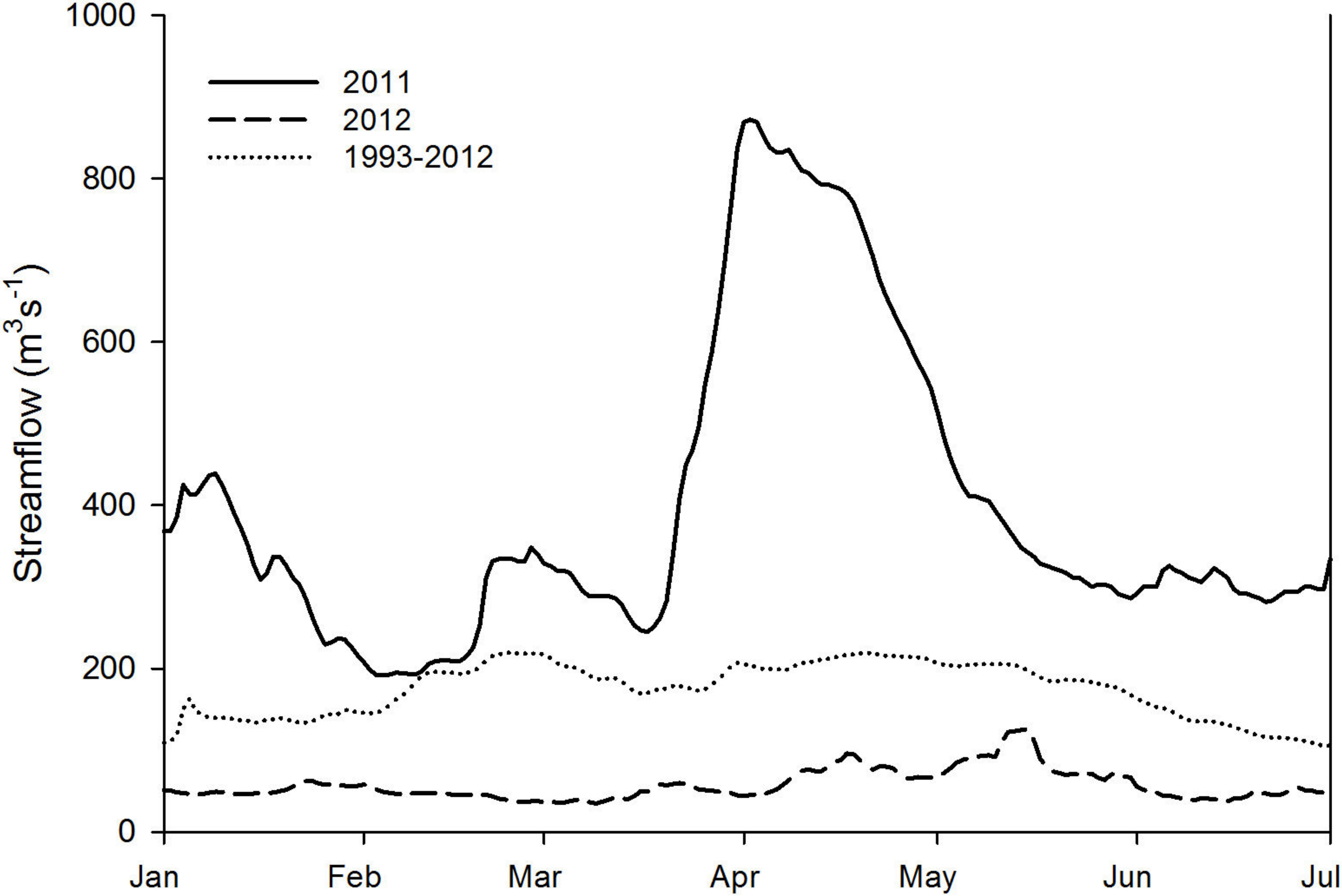
SJP
0 1 2 4 6 8 10
Kilometers



2011
2012
VER
MRB
SJP
Estimated Spawn Timing
Temperature (oC)
Steamflow (m3s-1)
Sample Period
A
B
C
C,E
C
C,E
D
Streamflow (m3s-1)
Temperature (oC)
Feb
Apr
Jun



2011
2012
1993-2012
Streamflow (m3s-1)
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul

Location	Sampling dates	Sample effort		River depth (m)		Streamflow (m^3/s)		Temperature (°C)	
		Wetted mat days	% Effort	Range	Mean	Range	Mean	Range	Mean
				2011					
rkm 115.2	Apr 18–25	10.5	5.8%	9.2–12.3	10.3	620.1–767.4	690.3	15.2–17.3	16.3
				(-)	(-)	(-)	(-)	(-)	(-)
rkm 120.4	Apr 18–25	13.6	7.4%	6.3–10.1	8.1	584.1–713.4	640.7	15.0–17.3	16.2
				(-)	(-)	(-)	(-)	(-)	(-)
rkm 126.4	Apr 18–25	13.7	7.5%	5.5–10.1	7.1	584.1–713.4	640.7	15.0–17.3	16.2
				(-)	(-)	(-)	(-)	(-)	(-)
rkm 137.4	Apr 18–May 16	37.2	20.3%	4.6–9.2	7.3	154.5–420.6	283.2	13.9–18.2	15.9
				(-)	(-)	(-)	(-)	(-)	(-)
rkm 138.1	Apr 21–May 16	48.7	26.6%	4.8–11.1	8.2	154.5–385.3	270.3	13.9–18.2	16.0
				(8.2–10.5)	(9.6)	(325.2–367.2)	(346.7)	(14.6–15.8)	(15.3)
rkm 140.8	Apr 21–25	14.2	7.7%	5.4–7.8	6.0	154.5–385.3	270.3	13.9–18.2	16.0
				(-)	(-)	(-)	(-)	(-)	(-)
rkm 143.7	Apr 25–28	5.5	3.0%	6.6–7.4	7.0	325.2–359.6	341.0	13.9–18.2	16.0
				(-)	(-)	(-)	(-)	(-)	(-)
rkm 145.3	Apr 25–May 16	39.7	21.7%	4.3–12.2	7.1	154.5–359.6	250.7	13.9–18.2	16.0
				(-)	(-)	(-)	(-)	(-)	(-)
				2012					
rkm 115.2	Feb 16–Jun 1	188.6	28.1%	1.3–9.3	5.5	33.7–127.4	63.6	10.4–22.0	15.8
				(5.8–9.1)	(7.1)	(125.2–127.4)	(126.4)	(17.1–18.6)	(17.8)
rkm 126.4	Feb 16–Jun 1	181.7	27.1%	0.9–9.0	4.5	25.9–99.1	45.5	10.9–26.0	17.4
				(4.2–4.2)	(4.2)	(96.1–99.1)	(98.1)	(17.6–18.7)	(18.2)
rkm 137.6	Feb 16–Jun 1	182.0	27.1%	1.1–3.9	2.7	12.7–44.3	21.7	10.5–26.7	17.7
				(1.6–3.8)	(2.6)	(19.2–44.3)	(25.1)	(14.2–26.7)	(18.7)
rkm 139.8	Mar 22–Jun 1	118.5	17.7%	0.4–2.1	1.4	12.7–44.3	21.7	14.9–26.7	19.9
				(1.6–1.6)	(1.6)	(19.2–44.3)	(24.5)	(14.9–26.7)	(19.3)

Table Caption:

Table 1 Summary of white sturgeon (*Acipenser transmontanus*) spawning survey sampling effort and corresponding environmental conditions on the San Joaquin River, California, during the 2011 and 2012 sampling seasons. Data include sampling location given as river kilometer (rkm), dates and effort by site (wetted mat days and percent of total annual effort), and river depth (meters), streamflow (cubic meters per second), and temperature (Celsius) range and mean values are displayed for the sampling and incubation (i.e., estimated spawn timing until time of collection; in parentheses) periods.

Sample date	Rkm	# Eggs	% Viable	Egg diameters (mm) L	Egg diameters (mm) W	Spawning events	Estimated timing of fertilization	Developmental stage
Apr 25, 2011		15	100%	3.26± 0.18	3.02± 0.18			
Apr 27, 2011	138.1[a]	3	100%	3.34±0.18	3.21±0.05	1	Apr 24, 1300–Apr 25, 0300	9–27
Apr 28, 2011		4	25%	3.57±0.02	3.34±0.01			
Mar 22, 2012	137.6	26	62%	3.56±0.12	3.44±0.12	1	Mar 20,1800–Mar 21, 0100	18–19
Apr 2, 2012	137.6, 139.8[b]	8	63%	3.51±0.12	3.44±0.12	1	Mar 31	22
Apr 19, 2012	137.6	5	60%	3.46±0.02	3.34±0.16	1	Apr 18, 0300	22
May 10, 2012	137.6	3	100%	3.64±0.10	3.42±0.05	1[c]	May 8, 1900	26
May 10, 2012	139.8	13	69%	3.55±0.10	3.46±0.11		May 8, 1300	28
May 14, 2012	126.4	5	100%	3.58±0.09	3.42±0.07	1	May 13, 0600	18
May 14, 2012	115.2	5	100%	3.46±0.05	3.35±0.08	1	May 13, 1500–May 14, 0800	4–14

[a]Based on development stage and estimated time of fertilization, these eggs could be from one female spawning over at least 14 hours.

[b]Eggs collected at both the rkm 137.6 and 139.8 sites on April 2, 2012 were pooled due to missing site discrimination data.

[c]The May 10th spawning event could be one female that moved between rkm 137.6 and 139.8, within that approximate six hour time period, or could be from multiple females.

Table Caption:

Table 2 White sturgeon (*Acipenser transmontanus*) egg data from 2011 and 2012 San Joaquin River spawning survey collections. Sample date and location (Rkm), the number of collected eggs (Egg #), percent of collected eggs that were viable upon collection (% viable), length (L; mean ± SD) and width (W; mean ± SD) of eggs, number of spawning events, estimated timing of fertilization, and developmental stages represented by each egg collection are presented. Developmental stage based on Dettlaff et al. (1993), and estimated time of fertilization was back calculated using mean daily water temperatures and developmental stage. Minimum number of spawn events (Spawning Events) was based on rkm, date egg mats were retrieved, calculated fertilization time, and the assumption it takes up to 21 hours to complete oviposition (Van Eenennaam et al. 2012) following the methods of Poytress et al. (2015).