Technical Memorandum ENV-2020-082

San Joaquin River Steelhead Monitoring Plan 2019-20

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EXECUTIVE SUMMARY

San Joaquin River (SJR) Basin Central Valley (CV) steelhead (*Oncorhynchus mykiss*) have been in decline in recent decades, due, in part, to impassable barriers developed in the early-mid twentieth century (McEwan 2001). Instream barriers have led to the reported extirpation of CV steelhead upstream of the SJR-Merced River confluence (i.e., the San Joaquin River Restoration Program (SJRRP) Restoration Area). In accordance with the 2012 SJRRP Record of Decision and National Marine Fisheries Service (NMFS) Biological Opinion (2011/05814:ELS), the U.S. Bureau of Reclamation (Reclamation) annually monitors for presence of CV steelhead in the Restoration Area when Restoration Flows are being released. This is of particular importance, as recent restored flows, reconnecting historically desiccated river sections, as well as spring interim flows, could attract adult CV steelhead into the Restoration Area. Adult steelhead accessing the Restoration Area could be exposed to loss into sloughs and would not have access to appropriate spawning habitat due to a number of impassable in-river barriers. In 2019-20 Reclamation completed the seventh year of the SJRRP Steelhead Monitoring Plan (SMP). A combination of fyke netting/trapping, and raft electrofishing were completed monthly for approximately two weeks between December 2019 and April 2020 in Reach 4 and 5 of the Restoration Area. For the seventh consecutive monitoring effort (2012, 2013, 2014, 2017, 2018, 2019, and 2020) since the inception of the SMP, no steelhead were detected. However, 1,136 fish comprising 25 species, including eight native species (12.2 % of total individuals captured) were captured. Inclusive in the native species captured, was the first recorded Green Sturgeon confirmed within the Restoration Area. Continued monitoring of potential steelhead immigration in the Restoration Area is important to provide information regarding the status of the CV steelhead Distinct Population Segment (DPS), as well as to assess fish assemblages in the Restoration Area, an important metric to evaluate SJRRP progress.

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Table of Contents

Page

Figures

Tables

Page

List of Abbreviations and Acronyms

CDEC	California Data Exchange Center
CDFW	California Department of Fish & Wildlife
cfs	cubic-feet-per-second
CPUE	Catch-per-unit-effort
CV steelhead	Central Valley steelhead
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESBP	Eastside Bypass
FL	Fork Length
NMFS	National Marine Fisheries Service
NRDC	National Resource Defense Council
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Program
SMP	Steelhead Monitoring Plan
TL	Total length

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1.0 Introduction

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and the Central Valley Project Friant Division Long-Term Contractors known as *NRDC*, *et al. v Kirk Rodgers, et al.,* (NRDC 2006). In response, the San Joaquin River Restoration Program (SJRRP) was established, followed successively by a SJRRP Fisheries Management Plan which provides guidance for achieving demands of the lawsuit. During programmatic Endangered Species Act (ESA) consultation with National Marine Fisheries Service (NMFS), the Bureau of Reclamation (Reclamation) contended SJRRP impacts would not adversely affect Central Valley (CV) steelhead (*Oncorhynchus mykiss*) populations, as they were extirpated from SJRRP Restoration Area (confluence of Merced River to Friant Dam) following construction of Friant Dam. Thus, Reclamation did not request ESA coverage for CV steelhead, but proposed to implement a CV Steelhead Monitoring Plan (SMP) to determine whether CV steelhead were using the lower Restoration Area, with the caveat being if steelhead were detected, then Reclamation would reinitiate ESA consultation with NMFS. The Steelhead Monitoring Plan (SMP) was vetted through the SJRRP Fisheries Management Workgroup in response to a request from Reclamation, and is being implemented in accordance with the Record of Decision (ROD) and NMFS Biological Opinion (BO).

1.1 Central Valley steelhead

The CV steelhead Distinct Population Segment (DPS) is protected under the Endangered Species Act; 61 FR 4722 (NMFS 2005), and includes naturally spawning populations, and their progeny, in the Sacramento and San Joaquin Rivers and their tributaries; tributaries include those that drain the western slopes of the Sierra Nevada Mountains (*i.e.,* Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, Fresno, upper San Joaquin, Kings, Kaweah, and Kern Rivers, and Caliente Creek; NMFS 2005). According to Eilers *et al*. (2010), CV steelhead are currently extirpated from all waters upstream of the Merced-San Joaquin River confluence. In 2016 NMFS completed a 5-year CV steelhead DPS status review and recommended they remain classified as a threatened species under the ESA (NMFS 2016).

2.0 Methods

2.1 Study Period and Area

The SJRRP Restoration Area is separated into five distinct reaches and includes the mainstem SJR from Friant Dam (Reach 1) downstream to the Merced River confluence (Reach 5; Figure 1). Steelhead Monitoring Plan (SMP) sampling efforts were completed for 10, 10, 11, 16, and 8 days in December, January, February, March, and April, respectively. Sampling was restricted to Reaches 4 – 5, from Eastside Bypass Control Structure downstream to the Merced River confluence, including adjoining sloughs (Mud and Salt Slough). This was deemed the most accessible upstream location to immigrating salmonids, and was the furthest upstream sections sampled during the 2020 season. During 2019-20 SMP sampling efforts, the river was routed through the Eastside Bypass from the Sand Slough Control Structure to the confluence of Bear Creek and the SJR.

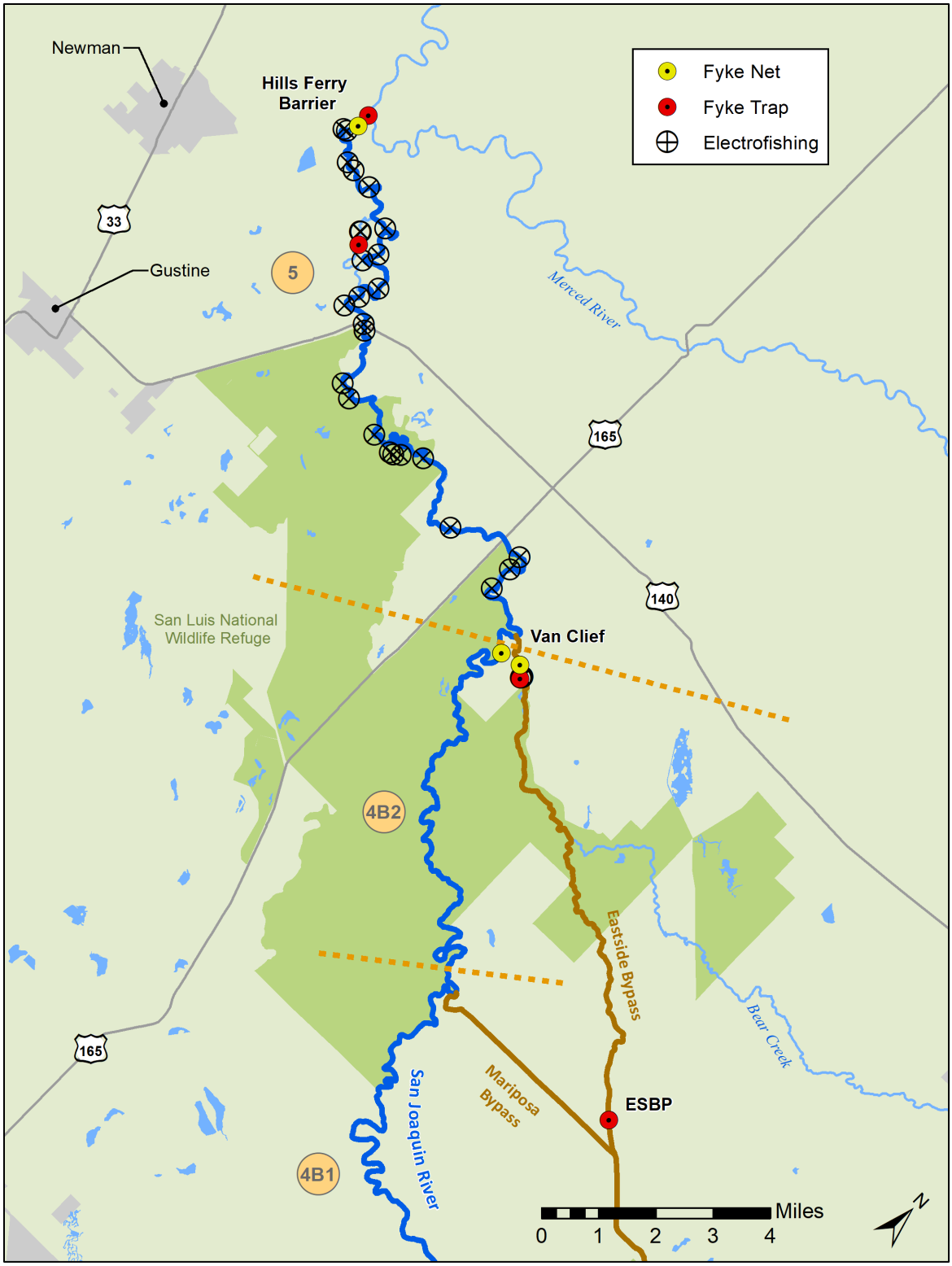

Figure 1. Map of the Reach 4–5 of the San Joaquin River Restoration Area (defined by yellow circles and dashed lines). Electrofishing locations are represented by the upstream end of each transect. The 2019–20 Steelhead Monitoring Plan efforts were constrained to Reach 4–5.

2.2 Fish Capture and Processing Methods

Given the turbid environment common in the lower reaches (4-5) of the SJRRP Restoration Area, methods commonly employed (i.e., snorkel and redd surveys) to monitor for immigrating adult salmonids were not suitable. Therefore, a multiple method sampling regime, including fyke netting, fyke trapping, and electrofishing, was designed and used to actively and passively monitor for steelhead in various habitat types on the SJR.

2.2.1 Fyke Netting/Trapping

Fyke nets are a passive fish sampling gear capable of spanning the full river width, and are, therefore, an efficient and effective tool to capture upstream moving adult fish. SMP fyke nets were constructed of 2.4-cm square #252 knotless nylon netting formed over 5 consecutive 1.2-m hoops and a 1.2-m square welded-conduit frame entrance. The nets contained two throats with a 25-cm diameter opening. Wing walls, attached to the sides of the net opening, were 1.2 m deep and spanned the majority of the river's width (leaving boat passage). The opening of the net faced downstream with the wing walls extending to shore in a v-shaped pattern and were held in place with t-posts (Figure 2).

Fyke traps are similar in design as fyke nets, but do not have wing walls and their construction allows them to be fished at deeper depths and elevated flows. Fyke traps were constructed of 5.0-cm chain link formed over 6 consecutive 3.0-m hoops. The traps contained two throats with the smaller opening of 60-cm. Traps were placed in natural riverine bottlenecks with a minimum depth of 1.5-m. The mouth of the trap faced downstream, and the trap was anchored utilizing t-posts and other readily available anchor points (Figure 3).

During 2019-20 SMP sampling, fykes (inclusive of both fyke nets and fyke traps) were fished in five locations: approximately 0.2 river miles upstream of the SJR and Merced River confluence (Hills Ferry; ~ RM 119), Mud Slough (~RM 121.5), Van Clief (~ RM 136), Van Clief San Joaquin River (~RM 136), East Side Bypass (~ RM 147; Figure 1). Historically fyke monitoring has occurred in Salt Slough, but due to elevated water hyacinth levels access was restricted (Appendix 3). When river conditions (water depth $\leq$ 5 ft.) were suitable, fyke nets were fished continuously during each monthly sampling period. Nets were checked at least once daily to reduce the likelihood of injuring fish. All captured fish were removed, transferred to a trough filled with on-site SJR water, identified to species, measured for length (total and fork length), and released upstream of the sampling location to minimize likelihood of recapture.

Figure 2. Deployed fyke net at Hills Ferry Barrier location, Reach 5 of the San Joaquin River Restoration Area. Note opening and v-shape of wing walls facing downstream.

Figure 3. Fyke trap deployed in Eastside Bypass, Reach 4 of the San Joaquin River Restoration Area. Note downstream orientation of the trap opening and riverine bottleneck location.

2.2.2 Electrofishing

Electrofishing is a common method used to monitor steelhead populations *(e.g.,* Mill and Deer creeks, and Feather, American, Mokelumne, Stanislaus, and Merced rivers), and was used during the 2019-20 season to sample mainstem habitats largely inaccessible by other means (Temple and Peasrons, 2007). A Smith-Root™ 5.0 GPP raft-mounted electrofisher (Smith-Root, Vancouver, WA) was used to electrofish the mainstem SJR thalweg and portions of adjacent sloughs while gradually traversing downstream (Figure 1; Appendix 1). This approach allowed efficient coverage of large expanses of river potentially traveled by immigrating steelhead. Voltage range, cyclic frequency and output (pulsed direct current) were determined based on local water conductivity and adjusted to maximize capture efficiency while minimizing electrical exposure. During electrofishing, captured fish were immediately transferred to an onboard live well where they were maintained until each section was sampled. Fish were processed in the same manner as defined in the *Methods: 2.2.1 Fyke Netting* section. A sufficient distance (> 0.25 km) was given between shocking locations to minimize likelihood of resampling the same individuals at downstream locations.

2.2.3 Steelhead Handling and Relocation

A specification of the program NMFS 10(a)(1)(A) permit is to translocate any captured steelhead out of the Restoration Area due to insufficient spawning habitat and the possibility of irrigation canal entrainment. In the event steelhead were captured during monitoring activities, capture location and method would be documented, they would be measured (FL/TL), sexed (if possible), tissue samples would be collected, they would be checked for injuries and presence of identifying tags, and they would be photographed. Additionally, fish would be provided an external spaghetti-type tag (Floy Tag & Mfg., Seattle, WA) and internally tagged with a Passive Integrated Transponder (PIT), each of which has a unique identification number for future identification if recaptured. Captured steelhead would be transported downstream in a 550-L transport tank and released near the SJR confluence with the Merced River.

3.0 Results

Monthly site-specific water quality collected during sampling is reported in Appendix 2. In combination, all sampling methodologies resulted in monitoring spanning approximately 28 river miles of the SJR, as well as adjacent sloughs (approximately 1.3 river miles), totaling approximately 29.4 river miles monitored (Figure 1). For the seventh consecutive monitoring effort (2012, 2013, 2014, 2017, 2018, 2019, and 2020), and since the inception of the SMP, no steelhead were detected. However, across all sampling methods a total of 1,136 fish and 25 different species were captured (Figure 6). Non-native fishes comprised 87.8 % (n=1,015) of the total. Striped Bass (*Morone saxatilis*), Common Carp (*Cyprinus carpio*), and Black Crappie (*Pomoxis nigromaculatus*) were the most abundant species captured, constituting 49 % of all fish captured. Eight species of native fish were captured (12.2 % of total): Sacramento Sucker

(*Catostomus occidentalis*, 89.9 %), juvenile Spring-run Chinook Salmon (*Oncorhynchus tshawytscha,* 2.9 %), Fall-run Chinook Salmon (adult; *O. tshawytscha*, 1.4 %), Green Sturgeon (*Acipenser medirostris*), Sacramento Pikeminnow (*Ptychocheilus grandis*), Sacramento Splittail (*Pogonichthys macrolepidotus)*, Sacramento Blackfish (*Orthodon microlepidotus*), and White Sturgeon (*A. transmontanus*). Of interest, one adult Green Sturgeon was captured twice at Hills Ferry Barrier fyke trap. Green Sturgeon are native to California and are known to be present in the Sacramento – San Joaquin River Delta, however, this is the first individual recorded within the Restoration Area (Root, Sutphin, and Burgess 2020. Draft in Press).

Figure 4. Reclamation Biologist with a Green Sturgeon *(Acipenser medirostris)* and a White Sturgeon (*A. transmontanus*) captured simultaneously while fyke trapping during Steelhead Monitoring Plan efforts, Reach 5, San Joaquin River, CA.

3.1 Fyke Netting

Across all sample months and inclusive of all six sample locations, fyke traps and nets were fished for 273 days (traps n=194; nets n=79 respectively), resulting in the capture of 657 fish. Of the two trap types, fyke nets had a slightly greater capture per unit of effort (CPUE) of fish CPUE 2.6 (n=208), vs fyke traps (CPUE 2.4; n=449). This is slightly misleading however, as fyke nets include the capture of smaller fish due to the smaller net mesh. Most fish captured during fyke netting/trapping were non-native (n=639, 87.8 %), including the most abundant species: Striped Bass (n=184, 28.0 %), Common Carp (n=155, 23.6 %), and Black Crappie (n=120, 18.3 %). Native fish captured fyke-netting/trapping included fall-run Chinook Salmon (n=2, 0.3 %), Sacramento Sucker (n=9, 1.4%), Sacramento Blackfish (n=1, 0.2 %), Sacramento Splittail (n=2, 0.3 %),

Green Sturgeon (n=1 0.1 %), Sacramento Pikeminnow (n=1, 0.2 %), and White Sturgeon (n=1, 0.2%).

3.2 Electrofishing

Electrofishing efforts produced 479 fish representing 17 different species (Figure 5). Electrofishing efforts were conducted January through March within reach 5.Mean (+/-) shock time per section was 15.7 ± 4.0 minutes (total sections n = 29), with a CPUE of 1.1 fish per minute. Non-native fishes contributed 74.7 % (n=358), whereas native fish contributed 25.2 % (n=121) of the electrofishing total. Of native SJR species captured electrofishing, Sacramento Suckers and juvenile spring-run Chinook Salmon were most abundant, comprising 24.2 % (n=116) and 0.8 % (n=4) of total fish captured, respectively.

Figure 5. Reclamation Biologists G. Nelson and J. Hammon with a Striped Bass *(Morone saxatilis)* captured while electrofishing during Steelhead Monitoring Plan efforts. Reach 5, Mud Slough, San Joaquin River, CA.

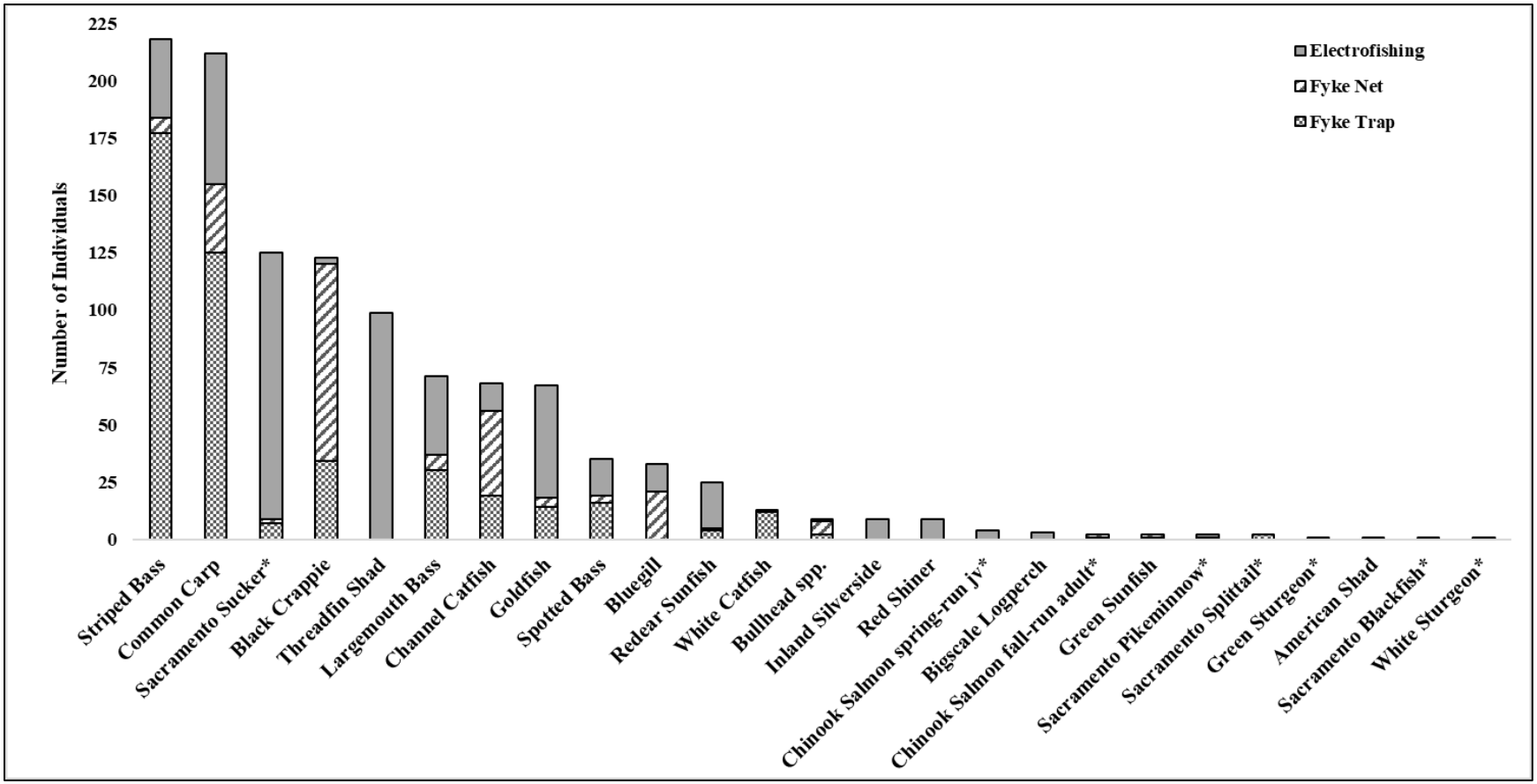

Figure 6. Fish captured (n = 1,136) during 2019-20 Steelhead Monitoring Plan in the San Joaquin River Restoration Area. No Central Valley Steelhead were captured. Native fish are identified with "*"; juvenile = "jv". Columns are stacked to show number of individuals captured by method. Chinook Salmon have also been segregated by age class (adult & juvenile) and run (spring & fall).

4.0 Discussion

Historically, the SJR Restoration Area was a potential migratory pathway for CV steelhead to reach spawning grounds; however, little detailed information on their distribution and abundance is available for these river reaches (McEwan 2001; Lindley et al. 2006). Much of the downstream habitat (Reaches 3-5) is unsuitable for rearing because of high summer water temperatures (Yoshiyama et al. 1996). However, as restoration efforts continue, increasing flows and the connection of upstream to downstream reaches in the Restoration Area may present the opportunity for steelhead to move into the area and access suitable spawning habitat in upper reaches. As a result, and in compliance with the SJRRP ROD and BO, Reclamation will continue to monitor for their presence in the Restoration Area. Though this monitoring does not target non-salmonid species, ancillary data collected are, nonetheless, valuable in providing information regarding fish distributions, and presence absence data, in the Restoration Area. This data, combined with data from other monitoring programs, may provide an indication of SJRRP progress.

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6.0 Appendices

6.1 Appendix 1: Fishing Locations 2019-20

Table A1.1. Fyke Trapping Locations

UTM	Easting	Northing
10S	679246	4135297
10S	681679	4132777
10S	693536	4127345
10S	704085	4120327

Table A1.2. Fyke Netting Locations

UTM	Easting	Northing
10S	679327	4135317
10S	693534	4127384
10S	692654	4127493

Table A1.3. Electrofishing Locations and Data

Date:	Site:	UTM	UTM Start		UTM End		Minutes
1/6/2020	Van Clief to Fremont	10S	693542	4127416	692936	4127712	11.1
1/6/2020	Van Clief to Fremont	10S	691167	4128565	691148	4129293	12.4
1/6/2020	Van Clief to Fremont	10S	689147	4128956	688364	4129270	21.0
1/6/2020	Salt Slough	10S	686701	4129418	686181	4129719	21.5
1/6/2020	Van Clief to Fremont	10S	684124	4129681	683693	4131089	25.9
1/7/2020	Fremont to Butch's Levee	10S	683503	4131166	682883	4131413	12.1
1/7/2020	Fremont to Butch's Levee	10S	682736	4131726	683020	4131996	13.8
1/7/2020	Fremont to Butch's Levee	10S	682275	4132961	682046	4133649	15.9
1/7/2020	Mud Slough	10S	681439	4133046	681337	4133663	19.2
1/7/2020	Fremont to Butch's Levee	10S	680100	4134147	679107	4134767	24.8
2/4/2020	Van Clief to Fremont	10S	693530	4127373	692889	4127853	15.3
2/4/2020	Van Clief to Fremont	10S	691107	4129740	690439	4129776	10.8
2/4/2020	Van Clief to Fremont	10S	687219	4129792	686859	4129701	18.7
2/4/2020	Salt Slough	10S	686434	4129249	686408	4129582	14.6
2/5/2020	Fremont to Butch's Levee	10S	683360	4131291	682558	4131427	18.6
2/5/2020	Fremont to Butch's Levee	10S	682942	4132281	682752	4132782	10.1
2/5/2020	Fremont to Butch's Levee	10S	681883	4133611	681409	4133833	19.3
2/5/2020	Fremont to Butch's Levee	10S	679822	4134191	679571	4134537	13.0
2/5/2020	Fremont to Butch's Levee	10S	679181	4134795	679293	4135168	11.6
3/6/2020	Fremont to Butch's Levee	10S	682603	4131264	682603	4131334	15.0
3/6/2020	Fremont to Butch's Levee	10S	682070	4132519	682036	4132595	15.4
3/6/2020	Mud Slough	10S	681462	4133063	681403	4133572	15.6
3/6/2020	Fremont to Butch's Levee	10S	680743	4134119	679872	4134161	17.5
3/6/2020	Fremont to Butch's Levee	10S	679076	4134757	679225	4135252	10.0
3/7/2020	Van Clief to Fremont	10S	693541	4127401	692909	4127855	12.3
3/7/2020	Van Clief to Fremont	10S	691154	4129299	691060	4129743	14.9
3/7/2020	Salt Slough	10S	686538	4129273	686408	4129583	13.4
3/7/2020	Van Clief to Fremont	10S	685772	4129291	685207	4129854	15.6
3/7/2020	Van Clief to Fremont	10S	684553	4129506	684142	4129988	16.6

6.2 Appendix 2: Water Quality 2019-20

Table A2. Mean monthly water quality (± SD) at fyke netting/trapping locations.

Month	Temperature (°C):	Disolved Oxygen (mg/L):	Conductivity (µS/cm):	Turbidity (NTU):
December	12.1 ± 0.9	NA	742.0 ± 241.6	58.7 ± 15.9
January	9.1 ± 0.4	10.1 ± 1.1	934.3 ± 276.7	56.8 ± 9.3
February	11.5 ± 1.3	10.3 ± 1.4	1124.6 ± 176.6	62.1 ± 13.6
March	15.3 ± 1.4	9.9 ± 0.8	1345.2 ± 130.3	67.7 ± 8.7
April	20.2 ± 2.6	9.5 ± 1.1	1560.8 ± 410.4	102.7 ± 54.1
Mud Slough				
Month	Temperature (°C):	Disolved Oxygen (mg/L):	Conductivity (µS/cm):	Turbidity (NTU):
December	12.5 ± 0.6	NA	1064.0 ± 28.7	46.6 ± 10.0
January	9.5 ± 0.5	9.6 ± 1.3	1268.8 ± 428.9	48.2 ± 12.2
February	11.7 ± 1.5	10.5 ± 1.2	1591.6 ± 334.7	70.8 ± 18.3
March	15.2 ± 1.5	9.1 ± 0.7	1797.3 ± 211.0	68.3 ± 18.7
April	21.0 ± 2.5	9.9 ± 1.3	2965.5 ± 299.7	89.7 ± 47.0
Van Clief				
Month	Temperature (°C):	Disolved Oxygen (mg/L):	Conductivity (µS/cm):	Turbidity (NTU):
December	12.6 ± 0.4	NA	248.0 ± 36.2	70.2 ± 8.9
January	9.1 ± 3.0	10.5 ± 3.8	302.7 ± 101.4	56.5 ± 10.9
February	10.6 ± 1.4	11.0 ± 1.1	350.5 ± 34.2	63.8 ± 9.9
March	14.7 ± 1.4	9.6 ± 0.7	474.3 ± 110.5	57.2 ± 14.8
April	20.3 ± 2.2	9.3 ± 1.0	524.2 ± 130.4	93.2 ± 45.9
VC SJR				
Month	Temperature (°C):	Disolved Oxygen (mg/L):	Conductivity (µS/cm):	Turbidity (NTU):
December	12.7 ± 0.8	NA	900.1 ± 93.3	23.4 ± 8.0
January	10.1 ± 3.4	10.5 ± 4.1	715.9 ± 283.3	26.3 ± 4.6
February	11.5 ± 1.2	11.7 ± 1.2	910.4 ± 64.5	29.8 ± 5.1
March	15.2 ± 1.4	9.5 ± 3.4	1016.1 ± 70.8	28.2 ± 6.4
April	20.6 ± 2.1	10.6 ± 1.8	1379.5 ± 128.5	43.4 ± 21.1

Table A2 (Cont.). Mean monthly water quality (± SD) at fyke netting/trapping locations.

Eastside Bypass				
Month	Temperature (°C):	Disolved Oxygen (mg/L):	Conductivity (µS/cm):	Turbidity (NTU):
December	NA	NA	NA	NA
January	NA	NA	NA	NA
February	10.1 ± 1.4	11.6 ± 1.1	330.4 ± 25.4	65.4 ± 10.0
March	14.5 ± 1.7	10.5 ± 0.5	400.5 ± 25.4	64.8 ± 13.1
April	19.6 ± 2.3	9.1 ± 1.0	512.0 ± 53.0	90.5 ± 48.0

6.3 Appendix 3: Photo's 2019-20

Figure A-1. Reach 4B2, Salt Slough, San Joaquin River, CA. Elevated water hyacinth restricted access, and likely fish passage, and monitoring was not completed at this location during 2019-20 Steelhead Monitoring Plan.

Figure A-2. Fyke trap monitoring, 2019-20 Steelhead Monitoring Plan, Mud Slough, Reach 5, San Joaquin River, CA.

Figure A-3. Overlapping fyke trapping and netting during the 2019-20 Steelhead Monitoring Plan at Van Clief, Reach 4B2, Bear Creek, CA.

Figure A-4. Fyke netting during the 2019-20 Steelhead Monitoring Plan at Van Clief SJR. Reach 4B2, San Joaquin River, CA.

Figure A-5. Sacramento Sucker (*Catostomus occidentalis*) captured while electrofishing, Reach 5, San Joaquin river, CA.

Figure A-6. Hatchery released juvenile Spring-run Chinook Salmon (*Oncorhynchus tshawytscha*) captured while electrofishing, Reach 5, San Joaquin river, CA.

Figure A-7. Largemouth Bass (*Micropterus salmoides*) captured while fyke trapping, Eastside Bypass, Reach 4B1, San Joaquin River, CA.