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Central Valley Steelhead Monitoring Plan for the San Joaquin River Restoration Area

2014 Monitoring Results for National Marine Fisheries Service Permit 16608

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Steelhead abundance and distribution in the San Joaquin River (SJR) Basin have substantially decreased, and steelhead are now believed to be extirpated from the Restoration Area. The Central Valley (CV) steelhead distinct population segment (DPS) includes naturally spawned steelhead, and their progeny, from the Sacramento and San Joaquin Rivers as well as their tributaries; because this includes the Restoration Area, the presence of CV steelhead must be monitored. Flows could attract adult steelhead into the Restoration Area and attracted fish would not have access to appropriate spawning habitat due to a number of impassable barriers. The Bureau of Reclamation implemented a steelhead monitoring and detection plan (SMP) for the SJR, upstream of the confluence with the Merced River, that, in the event of a capture, would result in in recording and subsequent transportation of the fish to the mouth of the Merced River. Electrofishing, fyke netting, and trammel netting were used to detect the presence of CV steelhead from River Mile 136 of the Restoration Area to the confluence of the Merced River, including the adjoining sloughs. A 1,184 fish comprising 26 species were captured during SMP activities from January–March 2014. No steelhead were recovered during this time. However, ancillary data that were collected provide information of fish community assemblages for Reach 5 of the San Joaquin River Restoration Program (SJRRP). Four out of 26 (15.4%) fish species captured were native to the SJR, but only comprised 5.1% of total individuals captured. Continued monitoring of potential CV steelhead migration in the Restoration Area is important to provide information regarding the status of the CV steelhead DPS as well as to assess the progress of SJRRP regarding fish assemblages in the Restoration Area.

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by

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ABSTRACT

Steelhead abundance and distribution in the San Joaquin River (SJR) Basin have substantially decreased, and steelhead are now believed to be extirpated from the Restoration Area. The Central Valley (CV) steelhead distinct population segment (DPS) includes naturally spawned steelhead, and their progeny, from the Sacramento and San Joaquin Rivers as well as their tributaries; because this includes the Restoration Area, the presence of CV steelhead must be monitored. Flows could attract adult steelhead into the Restoration Area and attracted fish would not have access to appropriate spawning habitat due to a number of impassable barriers. The Bureau of Reclamation implemented a steelhead monitoring and detection plan (SMP) for the SJR, upstream of the confluence with the Merced River, that, in the event of a capture, would result in in recording and subsequent transportation of the fish to the mouth of the Merced River. Electrofishing, fyke netting, and trammel netting were used to detect the presence of CV steelhead from River Mile 136 of the Restoration Area to the confluence of the Merced River, including the adjoining sloughs. A 1,184 fish comprising 26 species were captured during SMP activities from January–March 2014. No steelhead were recovered during this time. However, ancillary data that were collected provide information of fish community assemblages for Reach 5 of the San Joaquin River Restoration Program (SJRRP). Four out of 26 (15.4%) fish species captured were native to the SJR, but only comprised 5.1% of total individuals captured. Continued monitoring of potential CV steelhead migration in the Restoration Area is important to provide information regarding the status of the CV steelhead DPS as well as to assess the progress of SJRRP regarding fish assemblages in the Restoration Area.

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. After more than 18 years of litigation of this lawsuit, known as *NRDC, et al. v Kirk Rodgers, et al.*, a settlement was reached (NRDC 2006). On September 13, 2006, the Settling Parties, including NRDC, Friant Water Users Authority, and the U.S. Departments of the Interior and Commerce, agreed on the terms and conditions of the settlement, which was subsequently approved by the U.S. Eastern District Court of California on October 23, 2006. The Settlement establishes two primary goals: (1) Restoration Goal – To restore and maintain fish populations in "good condition" in the mainstem San Joaquin River (SJR) below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish, and (2) Water Management Goal – To reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement. These goals will require developing a fisheries management plan that implements an adaptive management approach that includes professional environmental review, review of structural modifications and designs, and technical support to provide the best quality data to define problems, prioritize actions, and increase the confidence in future decisions.

Potential routes to spawning habitats for migratory fish such as the Central Valley (CV) steelhead (*Oncorhynchus mykiss*) are believed to have been historically unhindered in the SJR before completion of the Friant Dam. Although little detailed information on steelhead distribution and abundance in the SJR is available (McEwan 2001, Lindley *et al.* 2006), steelhead in the Klamath River Basin typically overlapped with distributions of Chinook salmon (*O. tshawytscha*) though steelhead may distribute further upstream (Voight and Gale 1998, as cited in McEwan 2001). Therefore, steelhead may have spawned at least as far upstream as the natural barrier located at the present-day site of Mammoth Pool and the upper reaches of SJR tributaries. Modeling of potential steelhead habitat by Lindley *et al.* (2006) suggests that a portion of the upper SJR basin historically supported an independent steelhead population. However, much of the habitat downstream from this population's modeled distribution may have been unsuitable for rearing because of high summer water temperatures. Lindley *et al.* (2006) concluded that suitable steelhead habitat existed historically in all major SJR tributaries, although to a lesser degree than in stream systems in the Cascades, Coast Range, and Northern Sierra Nevada. Additionally, steelhead are historically documented in the Tuolumne and Kings River systems (McEwan 2001).

Steelhead abundance and distribution in the SJR basin have substantially decreased (McEwan 2001), and steelhead have been extirpated from the

Restoration Area of the San Joaquin River Restoration Program (SJRRP) since the construction of Friant Dam. Based on their review of factors contributing to steelhead declines in the Central Valley, McEwan and Jackson (1996) concluded that basin-wide population declines were related to water development and flow management that resulted in habitat loss. Dams have blocked access to historical spawning and rearing habitat upstream, thus forcing steelhead to spawn and rear in the lower portion of the rivers where water temperatures are often high enough to be lethal (Yoshiyama *et al.* 1996, McEwan 2001, Lindley *et al.* 2006). However, steelhead continue to persist in low numbers in the Stanislaus, Tuolumne, and Merced River systems (McEwan 2001, Zimmerman *et al.* 2008). The CV steelhead distinct population segment (DPS) includes naturally spawned populations of steelhead, and their progeny, in the Sacramento and San Joaquin Rivers and their tributaries and is protected under the U.S. Endangered Species Act; 61 FR 4722; http://www.westcoast.fisheries.noaa.gov); 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 2009).

CV steelhead populations are depressed to the point where monitoring opportunities are limited because sample sizes are too low to use statistical analyses (Eilers *et al.* 2010), and depressed to the point that even determination of presence is difficult. According to Eilers *et al*. (2010), CV steelhead are currently extirpated from all waters upstream of the Merced-San Joaquin River confluence. However, irrigation return and Restoration flows could attract adult steelhead into the Restoration Area. Attracted steelhead would not have access to appropriate spawning habitat due to a number of impassable barriers. Therefore, the Bureau of Reclamation (Reclamation) implemented a steelhead monitoring and detection plan (SMP) for the SJR, upstream of the confluence with the Merced River that in the event of capture would result in recording, transportation, and subsequent release of the fish to the mouth of the Merced River. The SMP spanned January 1–March 15, 2014.

Annual fall flows in the fall could also attract adult steelhead into the Restoration Area. However, during fall flows, the Hills Ferry Barrier (HFB), designed to divert adult Chinook salmon, is in place in the SJR just upstream of the confluence with the Merced River. Ongoing fish monitoring occurs at HFB until its removal in December. Steelhead reaching the HFB could be detected and potentially trapped or deterred from upstream migration. Since 2010, Chinook salmon trap and haul activities have occurred by Reclamation and California Department of Fish and Wildlife biologists to assess the barrier's effectiveness (Portz *et al.* 2011) and translocate salmon to Reach 1of the SJRRP Reach 1 (http://restoresjr.net/flows/MAP/2013_MAP/06_Trap_and_Haul.pdf). The HFB has limited efficacy as some fall-run Chinook salmon were able to pass the barrier during the 2010–13 irrigation-return and interim flows. While no steelhead were detected, the limited efficacy of the HFB could allow steelhead to pass.

Central Valley Steelhead

Steelhead are the anadromous form (*i.e.*, returning from sea to the river in order to spawn) of *O. mykiss*. The CV steelhead DPS was listed as a threatened evolutionarily significant unit by the National Marine Fisheries Service (NMFS; NMFS 1998). Critical habitat for CV steelhead DPS in the SJR Basin includes the Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced River (NMFS 2005). On August 15, 2011, NMFS completed the 5-year status review of CV steelhead DPS and recommended that they remain classified as a threatened species. Currently, CV steelhead DPS critical habitat extends upstream on the San Joaquin River to the confluence with the Merced River (NMFS 2011).

CV steelhead are divided into two types: summer-run and winter-run. Summer-run steelhead are river-maturing fish species that require coldwater pools between 55°F and 70°F for holding and staging (Moyle 2002). According to Lindley *et al.* (2006), summer-run steelhead have been extirpated because suitable summer holding habitats are located above impassable dams. Therefore, ocean maturing winter-run steelhead is the only type found in the Central Valley (Moyle 2002).

Two to three year-old CV steelhead generally migrate to freshwater (Reynolds 1993), and occurrence of adults in the SJR range between July and March of the following year, but peaks between the months of December and January (CDFG 2007) when small streams and tributaries are cool and well- oxygenated (Williams 2006). Unlike other salmonids which can only spawn once before death, a percentage of steelhead population (17.2%) in California streams can return to the ocean and migrate back upstream to spawn again in subsequent years (Shapovalov and Taft 1954).

STUDY AREA

The Restoration Area for the SJRRP includes the SJR between Friant Dam and its confluence with the Merced River (Figure 1). Steelhead monitoring activities were proposed as the area of the SJR below Sack Dam, or to the uppermost contiguous wetted section of the SJR, to the confluence with the Merced River, including the adjoining sloughs. During the 2014 survey period, the confluence of the Eastside Bypass with the SJR was considered the furthest upstream extent for CV steelhead migration because of low water conditions and impassable upstream barriers. A total of approximately 18 river miles along the San Joaquin River were monitored as well as slough tributaries (totaling approximately 19.4 river miles) for a total of approximately 37.4 river miles monitored (Figure 2).

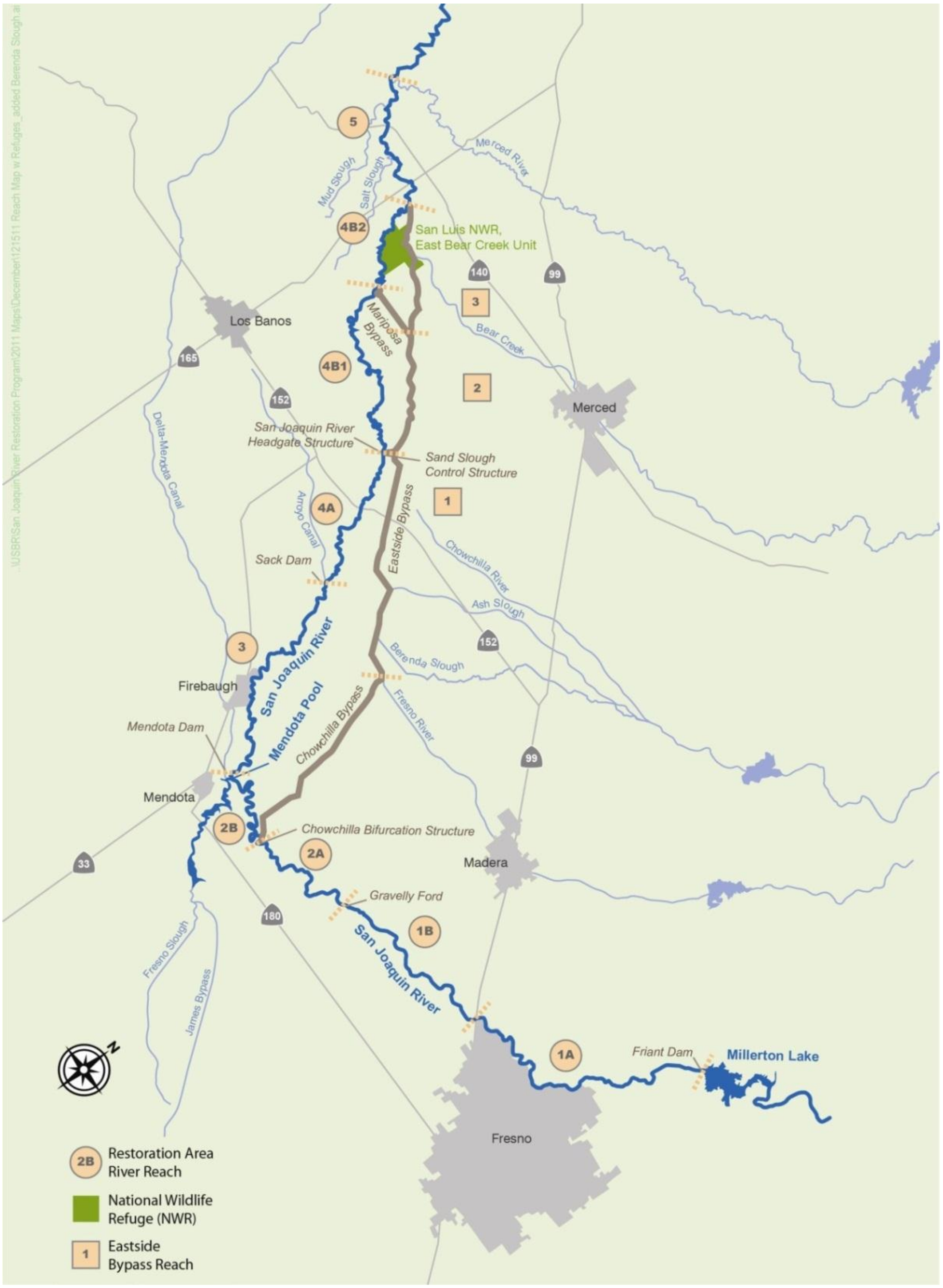

Figure 1.—Reaches within the San Joaquin River Restoration Area, San Joaquin Watershed, Central Valley, California.

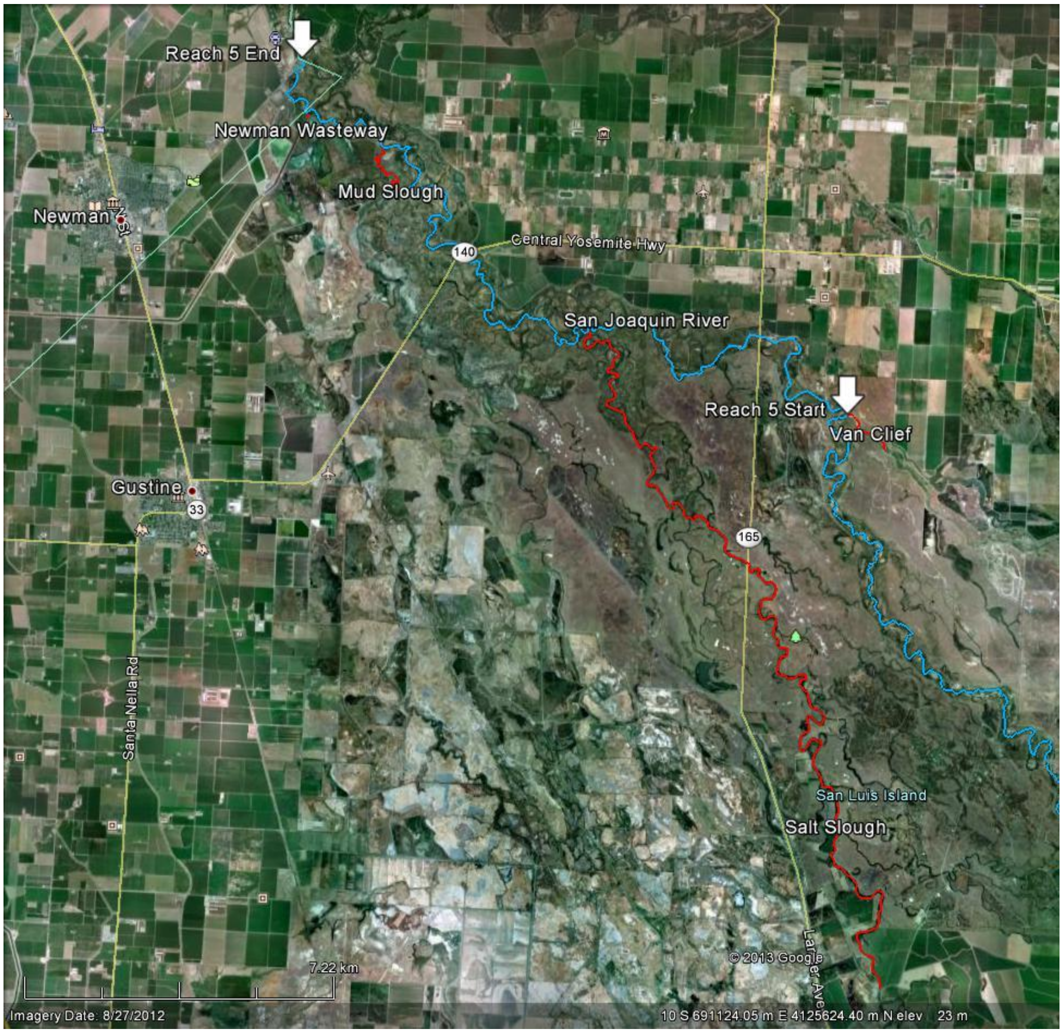

Figure 2.—Overview of Reach 5 of the San Joaquin River Restoration Area (indicated by arrows), and associated waterways. The blue line indicates the mainstem San Joaquin River and the red line indicates associated waterways (*e.g.*, sloughs, wasteways).

METHODS

Migrating adult steelhead are difficult to monitor with commonly used salmonid monitoring techniques (*e.g.,* carcass surveys, snorkel surveys, redd counts) due to their unique life-history traits. Steelhead, unlike salmon, may not die after spawning. Therefore, carcasses may not be available for a mark- recapture survey. In addition, steelhead migrate and spawn during the late-fall, winter, and spring months when rivers have periods of pulse flows (*e.g.*, Vernalis Adaptive Management Plan or VAMP), high flows (*e.g.*, flood releases), and turbid water conditions. However, efforts during the 2014 SMP were reduced due to the critically low water year in California during this time. While discussed whether monitoring should continue during this period, Reclamation suggested reduced sampling during this period to provide some data under these flow conditions (*i.e.*, severe drought). To accommodate a reduced effort while providing the most fish-specific data using previous techniques, electrofishing continued through March, while fyke netting was discontinued after January. Trammel netting, specific to the SMP, did not take place. However, additional sampling during annual fisheries surveys (*i.e.*, SJRRP Fish Assemblage Inventory and Monitoring, I&M), including electrofishing and trammel netting, supplements data collected under the SMP.

Electrofishing

Electrofishing is a common method used in monitoring steelhead populations (*e.g.*, Mill and Deer creeks, and Feather, American, Mokelumne, Stanislaus, and Merced rivers). One potential drawback from electrofishing involves the difficulty in obtaining permits due to the possibility of injuring anadromous salmonids (Eilers 2008). However, electrofishing effectiveness and safety have improved over time (Bonar *et al.* 2009). Design specifications to reduce injury to fish, and a comprehensive review of electrofishing literature can be found in Snyder (2003).

Sampling was done monthly from January–March 2014. Sampling sites were selected at various locations in the survey area (Figure 3). Repeated capture of resident fish was anticipated, thus intervals between sampling periods helped provide recovery time from sampling and handling stress. Electrofishing methods followed the NMFS guidelines for sampling waters with anadromous fish (NMFS 2000). However, stated guidelines were for backpack electrofishing, though SMP biologists were not precluded from boat electrofishing. NMFS were given sufficient documentation that proposed techniques and equipment were necessary for the study, and that listed species were safeguarded, and state scientific collecting permits were obtained for these sampling techniques.

A Smith-Root 5.0 GPP raft-mounted electrofisher (Smith Root, Vancouver, WA) was used on January 22-23, February 20–21, 2013, and March 14–15, 2014 for the SMP (Figure 4). Additionally, sampling data was also provided from I&M surveys on January 12–14, 2014. Pulsed direct current was uses. Voltage range was set at 50-500 V, with a power output range of 10-60%, and cycle frequency from 15–60 Hz. Settings were determined by water conductivity and adjusted to maximize capture efficiency while minimizing electrical exposure (*i.e.*, lowest setting required to elicit response without extended shocking times). All fish captured were placed in a live well aboard the raft. Following an electrofishing period, fish were enumerated, measured (total length, TL, and fork length, FL), weighed, and then released (given that it wasn't a steelhead).

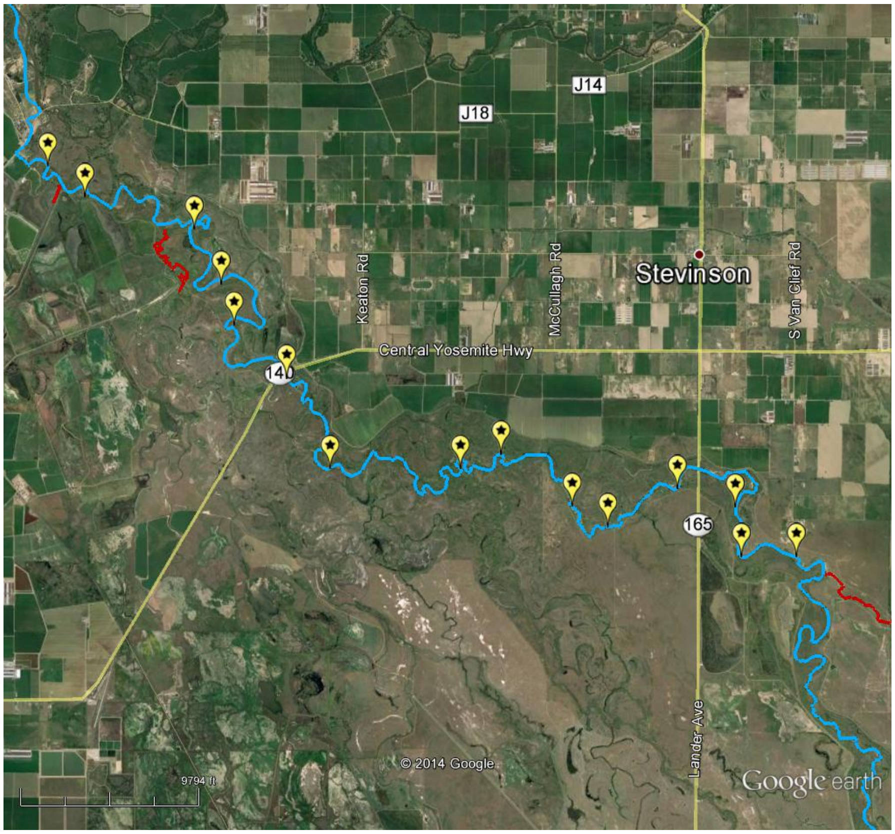

Figure 3.—General starting locations for boat electroshocking in Reach 5 of the San Joaquin River Restoration Area. The blue line indicates the mainstem San Joaquin River while the red lines indicate connecting waterways (*i.e.*, bypasses, sloughs, and wasteways).

Figure 4.—Electrofishing raft and crew. Note extended boom array (ring anodes with vertically hanging cables not visible) and vertical cathode array (attached to the crew deck on the bow).

Fyke Nets

Fyke nets were used to survey for upstream migrating CV steelhead (Figure 5). The 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 traps contained 2 throats with a 25-cm diameter opening. Wings walls, attached to the sides of the net opening, were 1.2 m deep and long enough to span the river (max wing length 30.5 m), with small floats spaced every 61 cm on top, and a lead line on bottom. Nets were held in place with anchored t-posts. The opening of the net faced downstream with the wing walls extending to shore in a v-shaped pattern. Fyke nets were placed in four locations during the 2014 SMP (Figure 6): approximately 0.8 river mile upstream from the confluence of the Merced River with the SJR (Casey site), Mud Slough, Salt Slough, and near the confluence of the Eastside Bypass with the SJR (Van Clief site). Fyke netting took place January 16–24, 2014. Marker buoys were placed up- and downstream of each fyke net, and flashing amber lights and visibility tape were affixed to the net and wing walls to alert boaters of the net's presence. The nets were checked daily to reduce the likelihood of injuring fish. Similar data, as with fish collected from electrofishing, were collected for fish recovered from the fyke nets. Fish were released upstream of the net to prevent recapture.

Figure 5.—Reclamation biologist deploying a fyke net in Mud Slough, Reach 5 of the San Joaquin River Restoration Area.

Although California Department of Fish and Wildlife wire fyke traps were available for steelhead collection, fyke nets were used in lieu of wire fyke traps for several reasons: fyke nets were comparably inexpensive and easy to install; the size of the fyke nets used were typically smaller than wire fyke traps, allowing installation in the SJR where water depth may have been insufficient for operation of wire fyke traps; fyke nets, combined with wing walls spanned the entire width of the waterway (except for a small section made accessible to boat passage in the mainstem SJR); were easily replaced if damaged, easily transported, and no permitting was required to transport; while wire fyke traps can catch fish in high flows, it would have required a crane to remove the trap from the water under increased hydraulic pressure and in the event that the trap was partially buried with sediment.

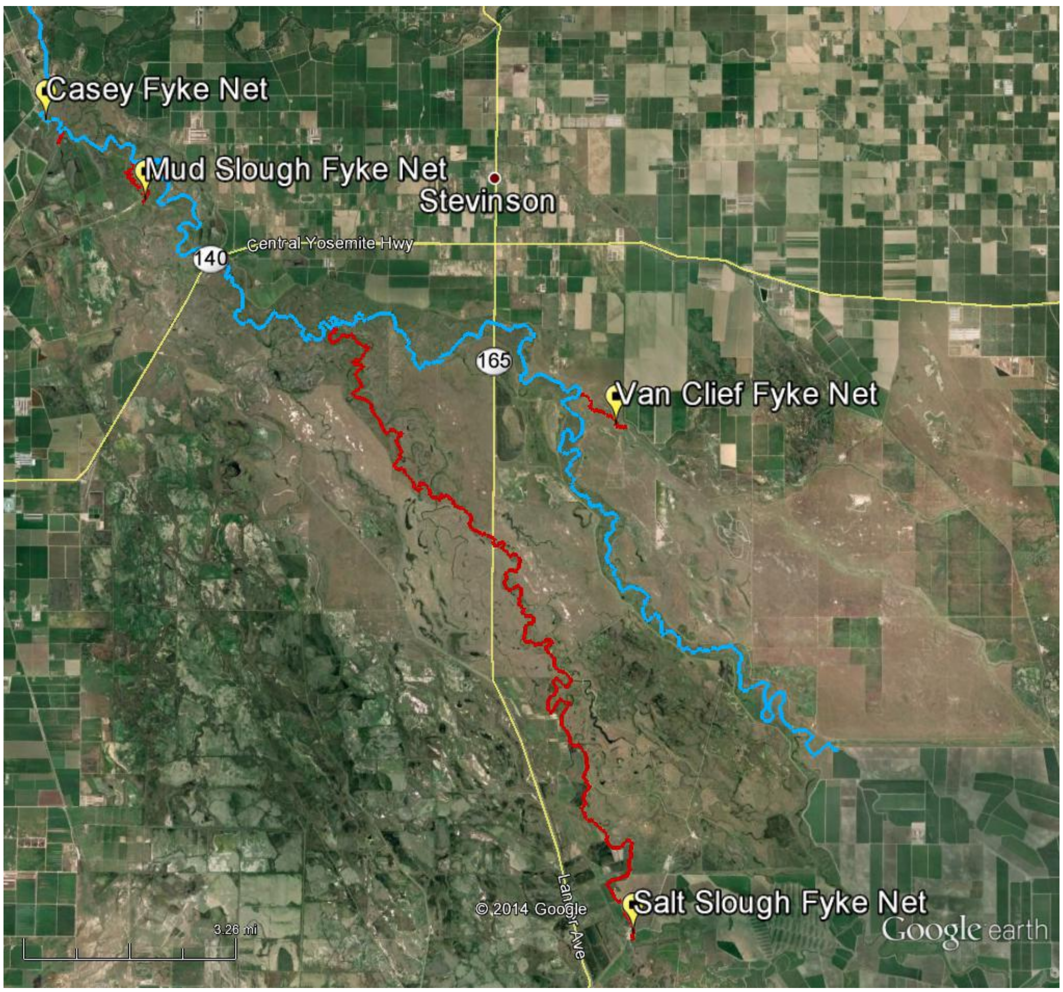

Figure 6.—Locations of four fyke nets used during 2014 Steelhead Monitoring Plan. The blue line indicates the mainstem San Joaquin River. The red lines indicate adjacent waterways (*i.e.*, Eastside Bypass, Salt Slough, Mud Slough, Newman Wasteway).

Trammel Nets

Trammel nets are most commonly used as stationary gear to block off channels with low velocities or no flows. The nets consisted of three parallel vertical layers of netting; the inner net had a smaller mesh size (small hole spacing to prevent steelhead from becoming gilled), while the outer nets had mesh size large enough for fish to pass. The larger and smaller mesh size nets form a pocket when fish try to swim through (Figure 7). A buoyant top line and weighted bottom line keeps the trammel net oriented vertically in the water column. Brightly colored buoys were attached to the terminal ends of the net to alert boaters and other recreationists to the nets and avoid entangling themselves, their boats, or their fishing gear.

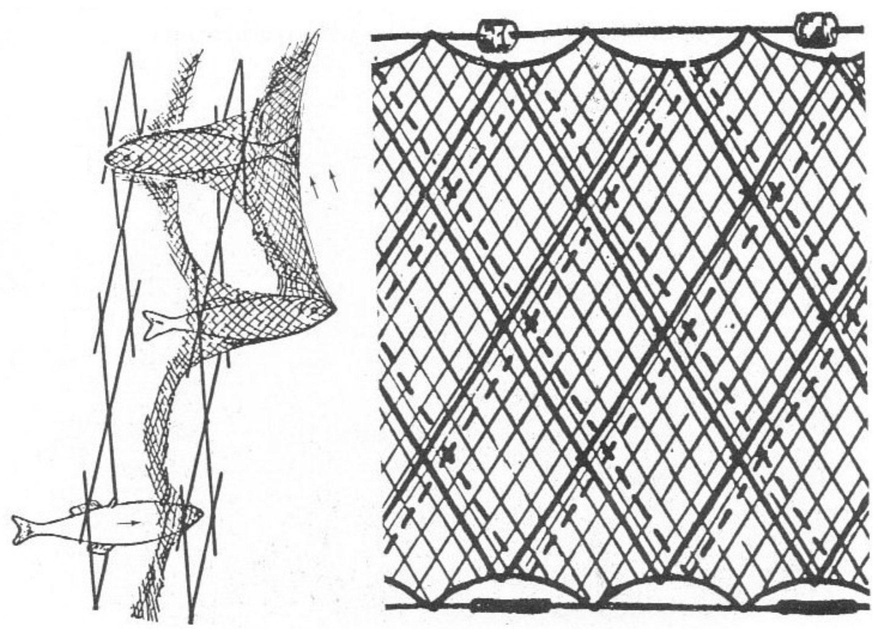

Figure 7.—Depiction of trammel net design and an illustration of the pockets that are created by entangled fish.

Trammel nets ranged in size from 0.9-1.8 m (3-6 ft.) tall and 11.4-30.5 m (37.5–100 ft.) long. Trammel nets were set for a nominal period of 24 h. While no trammel netting occurred under the SMP, data is included from January 13–15, 2014 I&M efforts because sampling locations and the time interval between the two studies overlap. Trammel nets were set at 15 locations in Reach 4B and Reach 5 of the Restoration Area, encompassing the area of the SMP (Figure 8).

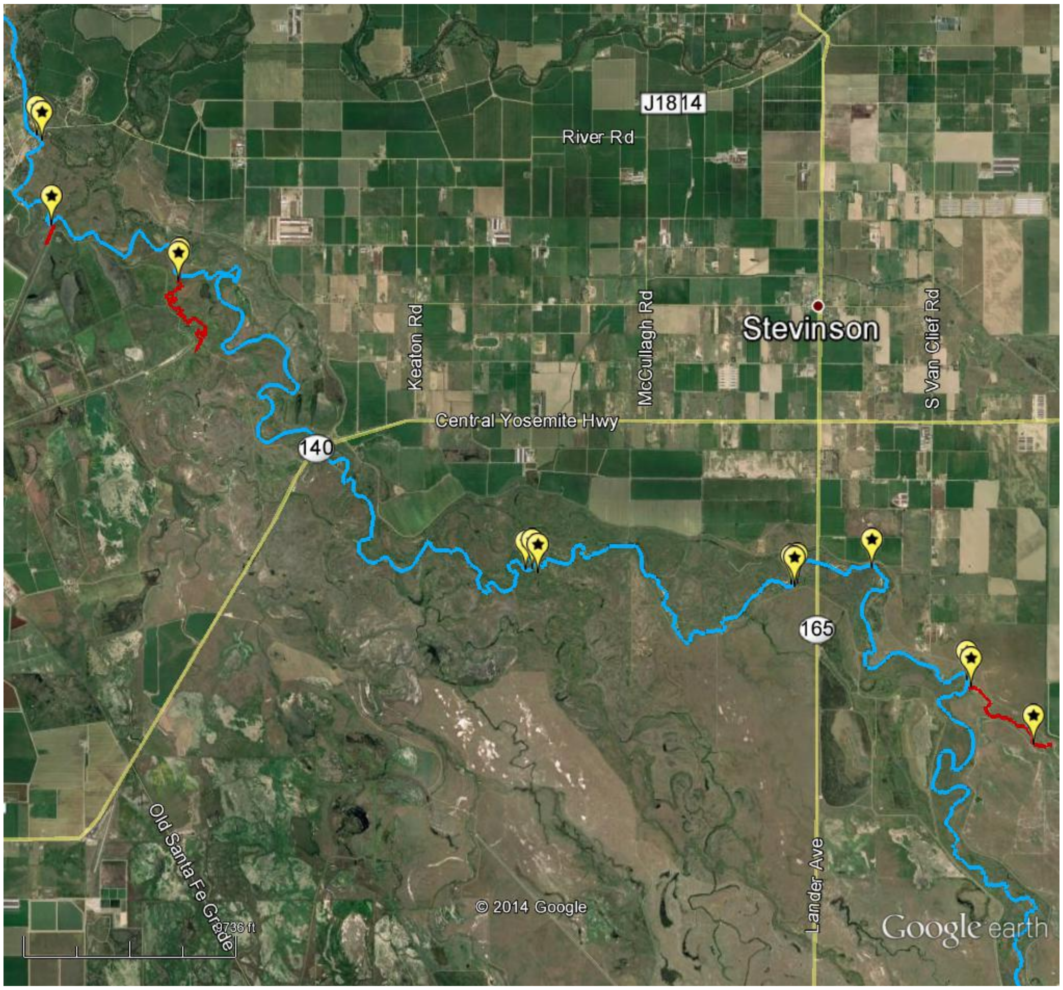

Figure 8.—Locations of trammel nets used during 2014 Steelhead Monitoring Plan. Note at several sites, multiple trammel nets are set in relative close proximity to one another in order to sample water features within an area (*e.g.*, pools, tributaries entering the mainstem river, proximity to physical barriers).

Fish Handling and Relocation

In the event that CV steelhead were captured during monitoring activities, fish would have been subjected to the following handling and transporting procedures: Steelhead would be documented, measured (FL/TL), sexed (if possible), scale and tissue samples collected, and checked for injuries and presence of identifying tags. Additionally, fish would be Floy tagged with a unique identification number for future identification. Captured steelhead would be transported downstream, near the SJR and Merced River confluence in a 550-L transport tank. Immediately prior to transport, the tank would be filled with river water near the area of capture. Salt (NaCl) would be added to the transport water to decrease the cellular-holding water ionic gradient as a means to minimize stress. Steelhead would then be transferred from the river to the transport tank with a water-to-water transfer to reduce handling stress and loss of slime. Oxygen would be supplied via compressed cylinder and micro-bubble diffusers to maintain dissolved oxygen levels near saturation. In the instance of extended transport duration (*i.e.*, >30 min), an inspection of the fish and transport equipment would occur after the first 30 minutes, and each hour thereafter. Captured steelhead would be acclimated to receiving water conditions (*i.e.*, temperature and chemical gradients) at the release location.

RESULTS

No CV steelhead were observed during the 2014 SMP in the SJR Restoration Area.

Combined Sampling Results

A total of 1,184 fish comprising 26 species were captured during the entire sampling period (Figure 9). Non-native fishes were 94.9% (n = 1124) of all fish captured. Bluegill (*Lepomis macrochirus*), goldfish (*Carassium auratus*), and common carp (*Cyprinus carpio*) made up 58.9% of all fish captured. Of the native fish captured (5.1% of total), Sacramento sucker (*Catostomus occidentalis*) were most abundant (50.0%), followed by Sacramento blackfish (*Orthodon microlepidotus*, 30.0%), Sacramento splittail (*Pogonichthys macrolepidotus*, 11.7%), and Chinook salmon (8.3%).

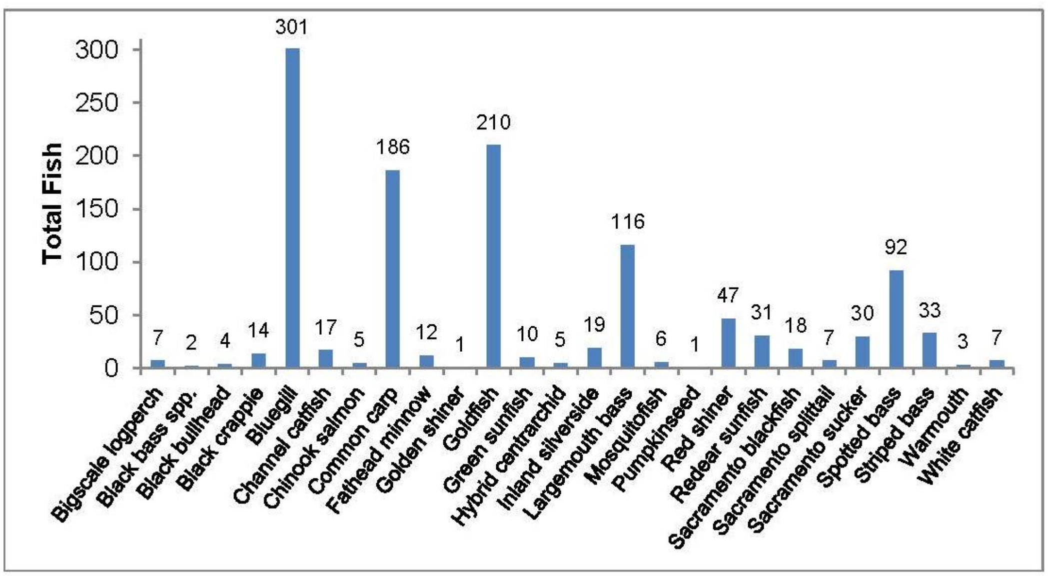

Figure 9.—Total fish captured (n = 1184), by species, from all sampling efforts during the 2014 Steelhead Monitoring Plan period (January 1–March 15).

Electrofishing

Combined raft electrofishing from SMP and I&M efforts produced 1,110 fish comprising 24 species (Figure 10). Of the total fish caught across the three methods, 93.8% were caught from electrofishing. Of the fish captured during electrofishing, 62.4% (n = 693) were caught during SMP electrofishing efforts and 37.6% (n = 417) were caught from I&M efforts. Non-native fishes made up 95.5% (n = 1060) of individuals captured using this method and native fish comprised only 4.5% (n = 50). Between SMP and I&M efforts, a total shock time of 704.8 min was recorded (569 min during SMP efforts and 135.8 min during I&M efforts). Given a total catch of 1,110 fish, the resulting catch per unit effort (CPUE) was 1.58 fish/min.

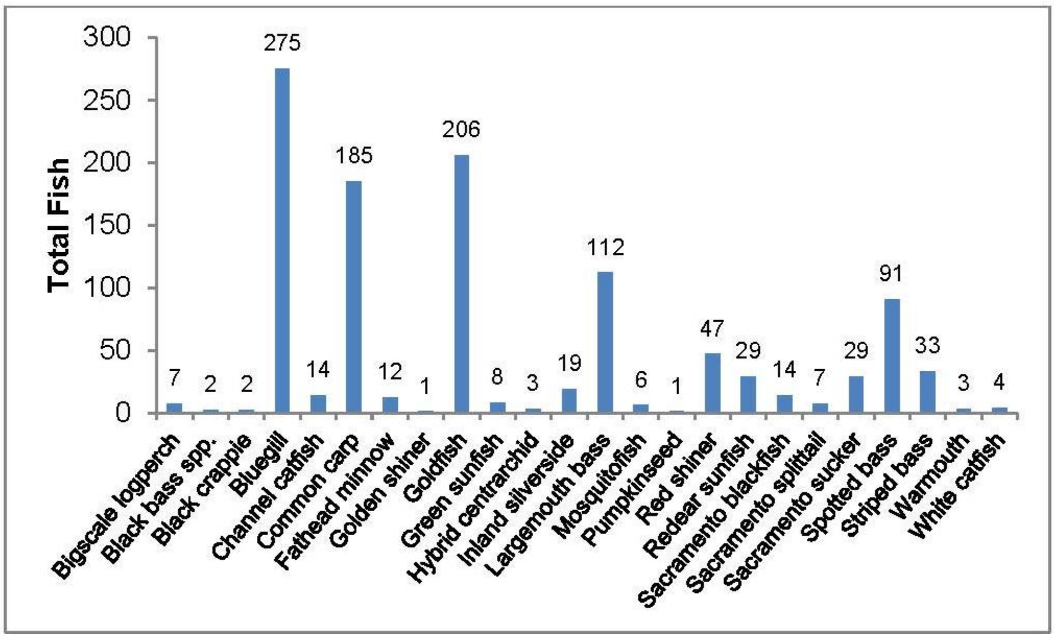

Figure 10.—Total fish captured (n = 1110), by species, from all raft electrofishing efforts during from Steelhead Monitoring Plan and Fish Assemblage Inventory and Monitoring efforts during January 1–March 15.

Fyke Nets

Eleven fish were captured from fyke netting efforts at four locations. This included five black crappie (*Pomoxis nigromaculatus*), three bluegill, two goldfish, and a Chinook salmon. Fyke netting was discontinued after this time to accommodate the reduced sampling efforts during the critically low water year, and because of the comparatively low catch from this period. Between the four fyke nets, there was a total fishing time of 30.24 d over the time period referenced. The resultant CPUE from these efforts was 0.36 fish/day.

Trammel Nets

During January I&M trammel netting, 63 fish comprising 15 species were captured (Figure 11). No other trammel netting occurred during the 2014 SMP period. Non-native fishes were 85.7% (n = 54) of the catch and native fish comprised only 14.3% (n = 9) of fish captured with this method.

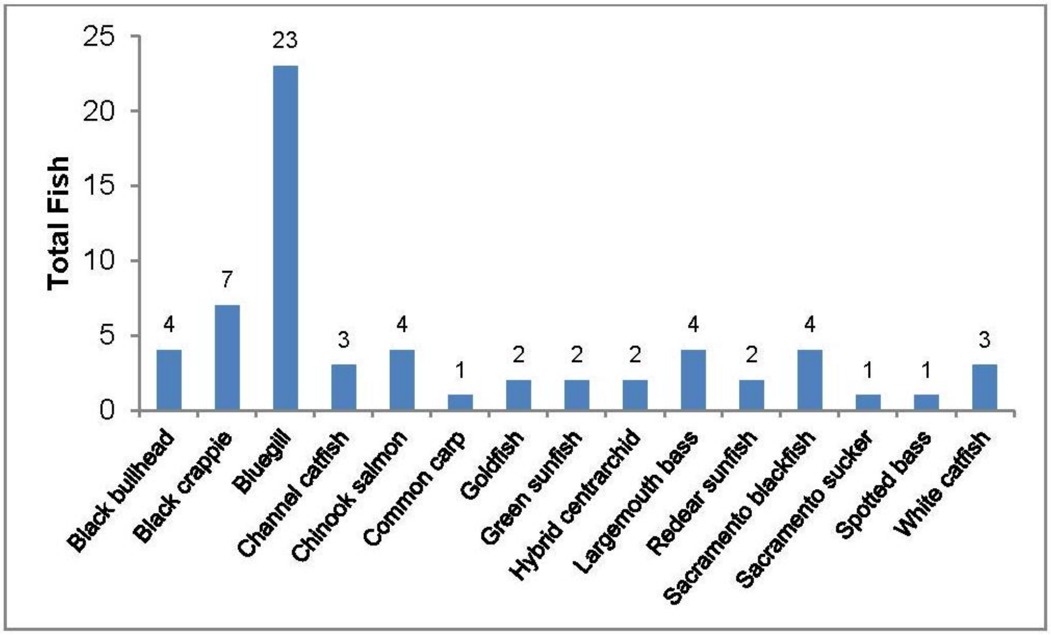

Figure 11.—Fish captured (n = 63) during 2014 Steelhead Monitoring Plan using trammel nets.

During January I&M trammel netting, a total of 15 net deployments with varying sizes occurred within the steelhead monitoring area. The total fishing time of all nets was 14.4 d. However, because nets were not the same size and individual net fishing time differed somewhat from the nominal 24 h, and from each other, total fishing time was standardized as a function of net area and time fishing. A total of 436.6 m^2 days (total area of net, m^2, as a function of a 24-h period) were fished between nets deployments. Total CPUE for trammel nets during January 2014 was 0.144 fish/m^2/d.

DISCUSSION

Historically, the SJR Restoration Area was a potential migratory pathway for CV steelhead to reach their spawning grounds. However, little detailed information on their distribution and abundance is available for these river reaches. The upper SJR basin may have historically supported a steelhead population but much of the downstream habitat is unsuitable for rearing because of high summer water temperatures (Lindley *et al.* 2006). Suitable steelhead habitat existed historically in all major SJR tributaries and there is potential for this fish to return. Attracted steelhead would not have access to appropriate spawning habitat due to a number of impassable barriers. However this is thought to be relatively unlikely because CV steelhead are currently extirpated from all waters upstream of the Merced-San Joaquin River confluence (Eilers *et al*. 2010).

No steelhead were captured during the SMP. However, ancillary data that were collected are valuable in providing foundational baseline information of fish community assemblages and native fishes for Reach 5 of the SJRRP. Four of 26 fish species captured were native to the SJR, though captured fish represented a smaller proportion of individuals; only 5.1% of total individuals captured were native to California waters. Although no CV steelhead were detected or captured during this sampling period, the continued monitoring of adult CV steelhead migration in the Restoration Area provides important information regarding the progress of the SJRRP. Monitoring population abundance trends, rare and native species occurrences, and fish community assemblages will provide a biological indication of SJRRP's success.

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