

Summary of Fish Rescues Conducted within the Yolo Bypass, 2018 Water Year
Prepared for the United States Bureau of Reclamation



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**SUMMARY OF FISH RESCUES CONDUCTED WITHIN THE YOLO BYPASS, 2018
WATER-YEAR**

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Purpose

The purpose of this document is to summarize fish rescue efforts conducted within the Yolo Bypass Fremont Weir splash basin, Tule Pond, and Deep Pond during the 2017-2018 water year.

The U.S. Bureau of Reclamation (USBR) operates the Central Valley Project (CVP) in coordination with the State Water Project (SWP), which is operated by the California Department of Water Resources (DWR). Operation of the CVP and SWP alters the hydrology in the Central Valley and San Francisco Bay-Delta and as a consequence, has a significant influence on fish distribution, survival, and available aquatic habitats. The National Marine Fisheries Service (NMFS) evaluated these stressors in their 2009 Biological Opinion on the Long-term Coordinated Operation of the CVP and SWP Biological Opinion (BIOP) and concluded they are likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*; federal and State endangered), Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*; federal and State threatened), Central Valley steelhead *Oncorhynchus mykiss*; federal threatened), and the southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*; federal threatened).

Based on their conclusion, NMFS identified reasonable and prudent alternatives (RPAs) intended to avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the adverse modification of critical habitat. The RPAs include *Action I.7. "Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass."* There are a number of actions already implemented or planned for implementation to address this RPA. In the interim to completion of large-scale improvements addressing Action I.7, USBR has contracted the California Department of Fish and Wildlife (CDFW) to conduct fish rescues within the Yolo Bypass.

Introduction

The approximately 59,000-acre Yolo Bypass is essentially designed to convey floodwaters from the Sacramento River and west side streams and drains around the populated regions of the Sacramento Valley (**Figure 1**). Inundation of the Yolo Bypass primarily occurs when Sacramento River flows overtop the Fremont Weir, located at Sacramento River kilometer (RK) 226 (River Mile 140.4). The Fremont Weir spills on average once every two to three years (USBR and DWR 2012). Inundation of the Yolo Bypass occurs when Sacramento River flows at the Fremont Weir exceeds a stage height of 32.3 feet above mean sea level North American Vertical Datum of 1988 (NAVD 1988) which occurs at a flow of approximately 1,622 cubic meters per second (57,290 cfs) (DWR 2016). Inundation of the Yolo Bypass is augmented by flows from west side tributaries including Cache Creek, Willow Slough, Willow Slough Bypass, Putah Creek, and South Fork Putah Creek (**Figure 2**). Up to 80 percent of the Sacramento River's floodwaters are conveyed for a distance of approximately 50 km (31 miles) through the Yolo Bypass and returned to the Sacramento River via the Cache Slough Complex approximately two miles upstream of

the town of Rio Vista. The Yolo Bypass capacity is 9,713 cubic meters per second (343,000 cfs) (DWR 2010).

The Yolo Bypass serves as a migration corridor for adult and juvenile anadromous fish during overtopping events as well as rearing habitat for juvenile salmonids and other freshwater fish species. The perennially inundated areas of the Yolo Bypass such as the Knights Landing Ridge Cut, Tule Canal, and Toe Drain are habitat for a number of resident native and non-native fish species. Federal and State anadromous listed species including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and the southern Distinct Population Segment (sDPS) green sturgeon are also known to utilize these areas during low flow periods. Flows within the Yolo Bypass can be much greater than flows within the Sacramento River during weir overtopping events, attracting anadromous fish migrating up the Sacramento River into the Yolo Bypass at the Cache Slough complex. Even in years when the Fremont Weir does not spill, west side tributary and drainage canal flows can attract anadromous fish into the Yolo Bypass at the Cache Slough complex, particularly during periods of high tides and low Sacramento River flows. Fish attracted by west side stream and drainage canal flows have been observed migrating upstream through the Toe Drain, Tule Canal, Knights Landing Ridge Cut, and Colusa Basin Drain Canal (CBDC). Similar to fish isolated and stranded during weir spill events, fish attracted into the Yolo Bypass by west side tributary and drainage canal flows are unable to return to the Sacramento River when river flows are not overtopping weirs. CDFW initiated fish trapping and rescue efforts in the CBDC in 2013 and at the Wallace Weir in the Knights Landing Ridge Cut in 2014 to return anadromous fish that migrated upstream after entering the Yolo Bypass at the Cache Slough Complex.

In 1966, a Denil fish ladder was constructed in the east section of Fremont Weir to facilitate adult fish passage back into the Sacramento River following several observations of stranded Chinook salmon and sturgeon at the weir. Central Valley Flood Protection Board permit number 4899 issued to the California Department of Fish and Game on 1 April 1965 authorized CDFW to operate the fish ladder by removing flashboards on the river side of the structure following an overtopping event. The ladder was essentially a 1.2 meter-wide, zero percent gradient notch structure in the Fremont Weir which facilitated volitional fish passage from the splash basin back into the Sacramento River (**Figure 2**). While installation and operations of the ladder reduced the magnitude of the stranding at the weir, it did not eliminate it. The Denil fish ladder appeared to be mostly ineffective for volitional passage of adult sturgeon, as many as 13 sDPS green sturgeon and 17 white sturgeon were rescued from the splash basin following overtopping events in 2011 (CDFW 2016).

Additionally, as the Fremont Weir consists of two separate sections, the ladder did not address stranding in the west section splash basin or in numerous ponds, scour pools, drainages, and swales in the Fremont Weir Wildlife Area downstream of the weir. Most of the historical observations of stranding and rescue efforts were focused on adult fish, more recent studies and fish rescues have shown juvenile or young-of-year (YOY) anadromous fish also become stranded in the weir splash basin, scour ponds,

drainages, and swales within the Yolo Bypass when floodwaters recede and connectivity to the Sacramento River is lost.

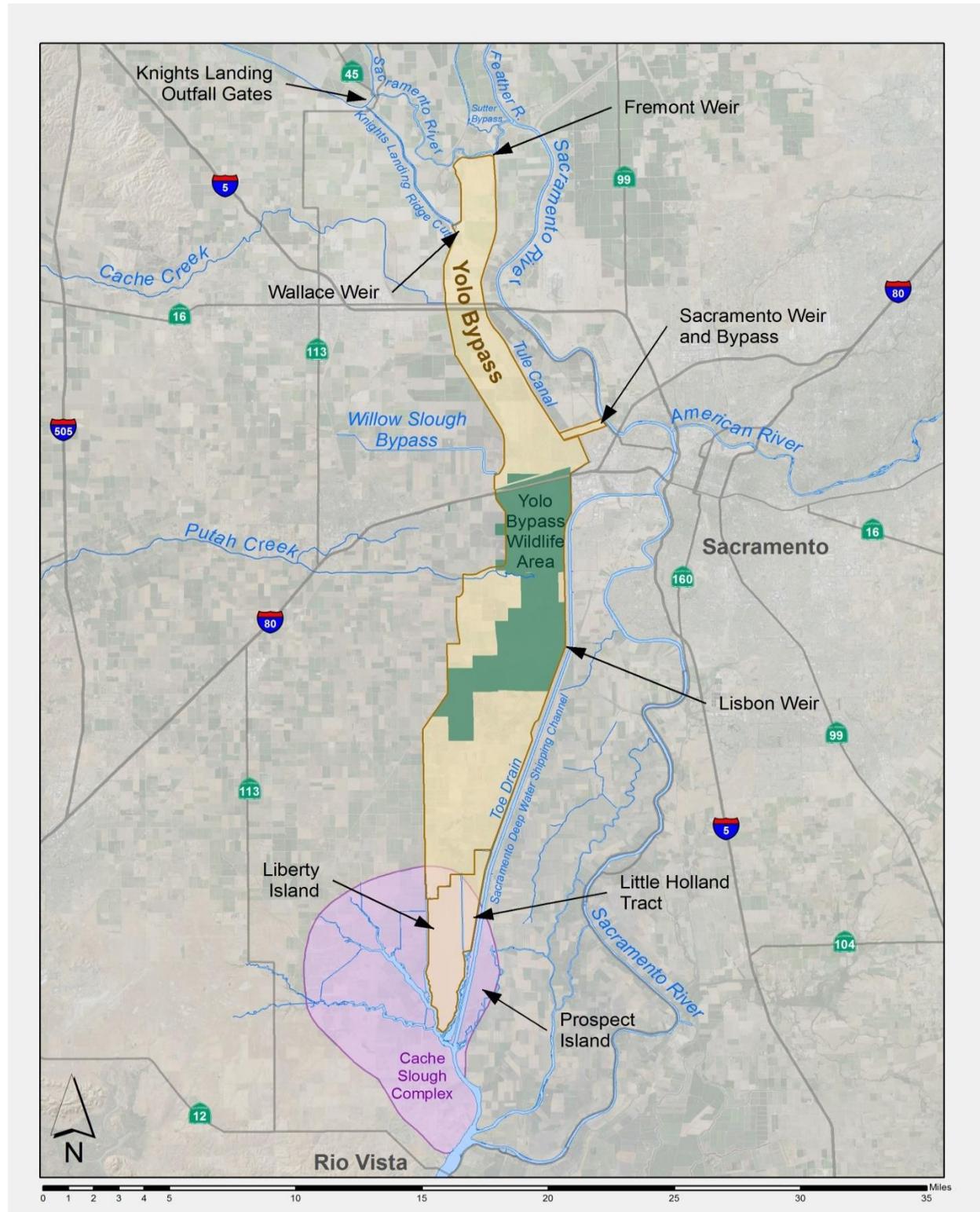


Figure 1. Fremont Weir, Yolo Bypass, Westside Tributaries and Cache Slough Complex



Figure 2. View of Fremont Weir during after cessation of overtopping event in March 2017. Flashboards have been removed to facilitate volitional fish passage to the Sacramento River prior to rescue operations

Methods

CDFW staff monitored the California Data Exchange Center (CDEC) National Weather Service River Forecast Center to determine when Sacramento River stage height at Fremont Weir dropped to approximately 32.0 feet mean sea level (msl) on 12 April 2018. At 32.0 feet msl, flow over the weir essentially ceased, at which point CDFW staff removed the flashboards to facilitate volitional passage of fish stranded in the east section of the splash basin. CDFW staff then conducted a reconnaissance survey of the east and west sections of the splash basin by walking the entire length of the Fremont Weir splash basin to determine fish species present, estimates of numbers of each species if possible; and potential safety issues regarding fish rescue operations. CDFW staff conducted a one-day fish rescue operation at the east and west side weir splash basins on 13 April 2018. Equipment used to conduct fish rescue operations included ¼-inch mesh beach seines, dip nets, and aerated coolers. Fish capture was conducted by seining the weir splash basin with a 50-foot long by 4-foot high ¼-inch mesh beach seine. Upon reaching the end of a haul, the seine was pursed and ¼-inch mesh dip nets were used to collect fish. Fish were then transferred to an aerated cooler for subsequent identification, enumeration, and measurement. Juvenile Chinook salmon were assigned an Evolutionary Significant Unit (ESU) or run designation using length-at-date criteria (Green 1992).



Figure 3. Fremont Weir and Northern Yolo Bypass (Fremont Weir Wildlife Area)

Results

During the 2017-2018 water year, the Fremont Weir experienced one overtopping event beginning 8 April and ending 12 April 2018 at which time the flashboards were pulled by CDFW staff. The maximum flow during the overtopping event was 16,309 cfs on 9 April at 00:00 hours (**Figure 4**) (DWR 2018). Water levels in the weir splash basin decreased rapidly between the time the fishway flashboards were removed on 12 April and the initiation of rescue operations on 13 April. The average depth in the weir basin on the morning of 13 April was less than 0.3 m, and long stretches of the east section of the splash basin had already dried. Because of limited area to survey, fish rescue was completed at both the east and west sections of the Fremont Weir splash basin on 13 April. The water temperature in the east section ranged from 13°C to 20°C during the course of rescue operations (10:15 to 13:00), and 22°C in the west section at the start of rescue operations at 13:40. A total of 546 fish consisting of five native species and eight non-native species were captured, identified, and released in the Sacramento River. Listed fish species rescued included 20 juvenile Central Valley spring-run Chinook salmon as determined by length-at-date (**Table 1**). In instances when large numbers (> 20) of Chinook salmon were captured in seine hauls, subsets of 20 individuals were measured to avoid excessive handling stress. Therefore, it is possible that an additional 19 adipose intact juvenile Chinook salmon rescued from the west splash basin may have been Central Valley spring-run ESU based on extrapolation of the ratio of spring-run to fall-run juvenile Chinook salmon as determined by length-at-date measurements. No other special status fish species were encountered, although one juvenile hatchery-origin Central Valley steelhead was rescued from the west section weir splash basin.

Sturgeon rescue operations were conducted in the Tule Pond on 27 April; 4 and 11 May 2018; and in the Deep Pond on 26 April 2018. A dual frequency identification sonar (DIDSON) survey was conducted to determine the presence and holding locations of sturgeon prior to deploying a 200-foot long x 12-foot high 7-inch mesh size trammel nets from an inflatable vessel. Any sturgeon captured were transported to shore, evaluated for condition, measured, and surgically implanted with VEMCO® V16 acoustic transmitters to provide post-rescue survival and movement data. The sturgeon were then placed in a tank supplied with aeration and transported to the Sacramento River Elkhorn Boat Launch for release.

Two adult white sturgeon were rescued from the Tule Pond; one on 27 April 2018 and one on 4 May 2018. No sturgeon were captured and rescued from Deep Pond and none were observed during a concurrent DIDSON survey. **Table 2** presents data for white sturgeon rescued from the Tule Pond that were tagged and released into the Sacramento River at the Elkhorn Boat Launch. **Table 3** presents a summary of salmonids rescued or salvaged from the vicinity of Wallace Weir during the 2018 water year. Fish were captured in a fyke trap installed downstream of the Wallace Weir Fish Collection Facility or by beach seine when the fyke trap was not deployed. Rescued or salvaged listed fish species included 23 Sacramento River winter-run Chinook salmon, seven Central Valley spring-run Chinook salmon, and one Central Valley steelhead. In addition, 39 fall-run Chinook salmon and two hatchery-origin Central Valley steelhead were rescued or salvaged during the 2018 water year.

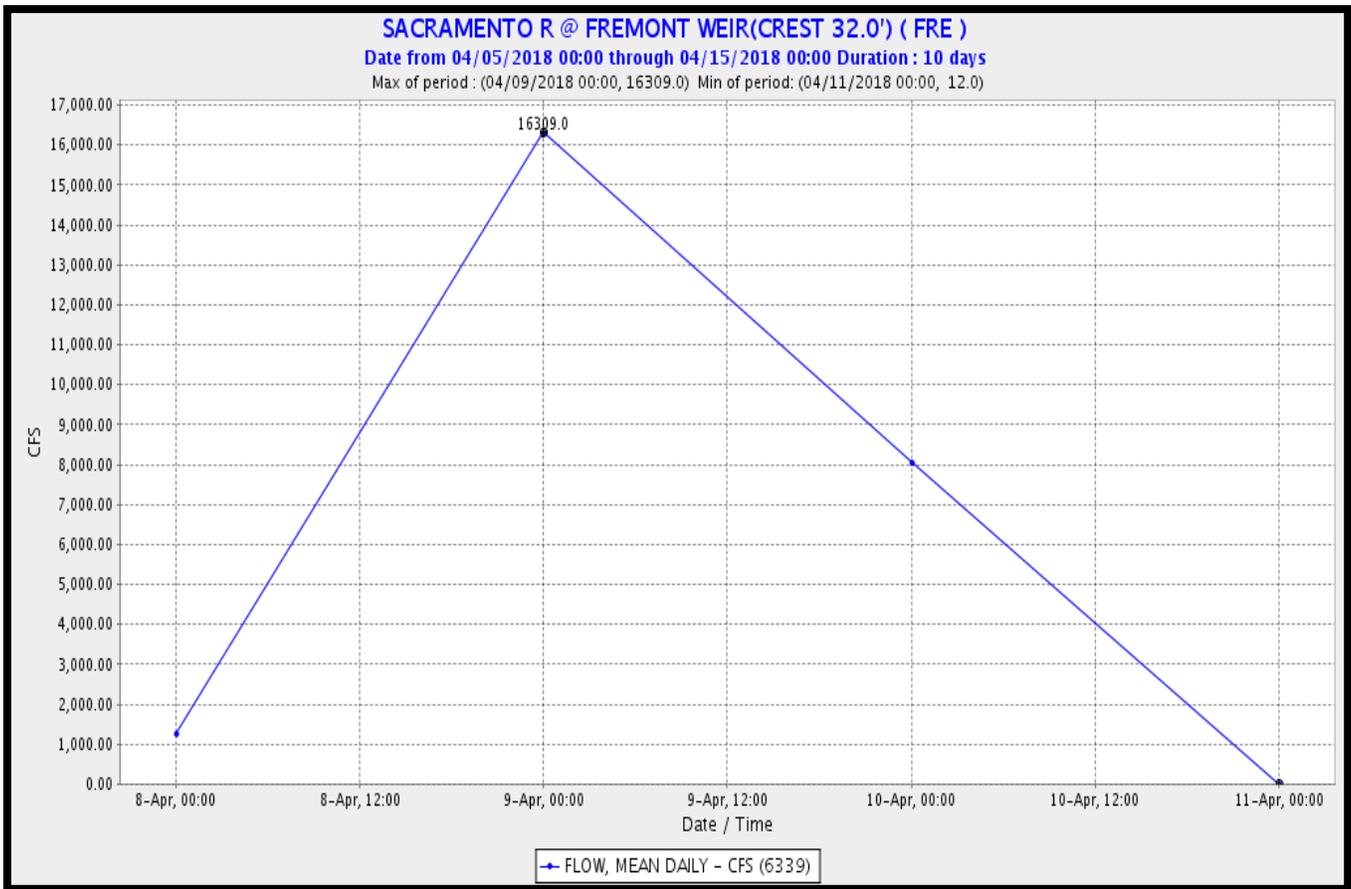


Figure 4. Hydrograph of Fremont Weir 4-day overtopping event, 8 April through 12 April 2018. Mean daily flow during the period was 6,339 (cfs) with a maximum flow of 16,309 (cfs)

Table 1. Fish rescue location, species and numbers rescued from the Fremont Weir splash basin, 13 April 2018

Species/ESU/DPS	Location	Life Stage	Number Rescued
Spring-run Chinook salmon (adipose fin intact)	East section	Juvenile	5
Spring-run Chinook salmon (adipose fin clip)		Juvenile	3
Fall-run Chinook salmon (adipose fin intact)		Juvenile	34
Fall-run Chinook salmon (adipose fin clip)		Juvenile	12
White sturgeon (<i>Acipenser transmontanus</i>) ¹		Adult	1
Sacramento splittail (<i>Pogonichthys macrolepidotus</i>)		Adult	3
Threadfin shad (<i>Dorosoma petenense</i>)		Adult	214
Fathead minnow (<i>Pimephales promelas</i>)		Adult	3
Brown bullhead (<i>Ameiurus nebulosus</i>)		Adult	1
Golden shiner (<i>Notemigonus crysoleucas</i>)		Adult	1
Inland silverside (<i>Menidia beryllina</i>)		Adult	2
Central Valley steelhead (adipose clip)		West section	Juvenile
Spring-run Chinook salmon (adipose fin intact)	Juvenile		10
Spring-run Chinook salmon (adipose fin clip)	Juvenile		1
Fall-run Chinook salmon (adipose fin intact)	Juvenile		28
Fall-run Chinook salmon (adipose fin clip)	Juvenile		2
Chinook salmon (not measured; adipose fin intact)	Juvenile		95
Chinook salmon (not measured; adipose fin clip)	Juvenile		7
Sacramento blackfish (<i>Orthodon microlepidotus</i>)	Adult		1
Largemouth bass (<i>Micropterus salmoides</i>)	Adult		1
Bluegill (<i>Lepomis macrochirus</i>)	Adult		1
Black crappie (<i>Pomoxis nigromaculatus</i>)	Adult		1
Threadfin shad	Adult		114
Golden shiner	Adult		6
Inland silverside	Adult		1

¹ Not tagged due to excessive stress at time of capture; the white sturgeon was found in less than 0.2 m of water and immediately transported to the Sacramento River for release.

Table 2. Tag ID and metadata for sturgeon rescued from the Yolo Bypass Tule Pond during the 2018 water year

Species	Rescue date	Fork length (cm)	Tag ID
White sturgeon	4/27/2018	155	A69-9001-15841
White sturgeon	5/4/2018	110	A69-9001-15829

CDFW also conducted salvage of adult salmonids downstream of the Wallace Weir fish collection facility. Methods are described in a separate report (in preparation). A summary of salmonids captured including ESU as determined by genetic analysis is provided in **Table 3**.

Table 3. Adult salmonids rescued or salvaged at Wallace Weir, 2017-2018 water year

Date range	Species	ESU ¹ /DPS	Number of natural origin (no ad-clip) ²	Number of hatchery origin (ad-clip)
2/20/2018 – 6/01/2018	Chinook salmon	Winter	7 (+ 1 mortality)	16
3/04/2018 – 5/30/2018	Chinook salmon	Spring	5 (+ 1 mortality)	1
11/14/17 – 12/01/2017	Chinook salmon	Fall	3	0
9/25-2018 – 9-25-2018	Chinook salmon	Fall ³	10 (+ 23 mortalities)	3
2/20/2018 - 3/04/2018	Steelhead	Central Valley	1 mortality	1 (+ 1 unknown)

¹ Determined by genetic analysis.

² Since only 25% of hatchery-origin fall-run Chinook salmon are adipose fin-clipped, it is likely that the majority of these fish were of hatchery origin.

³ Results of genetic analysis not yet available; ESU designation based on run timing.

Discussion

Fish rescue efforts conducted at and around the Fremont Weir during the 2017-2018 water year prevented 546 fish from perishing from factors such as desiccation, poor water quality conditions, increased predation, stress, and poaching. Of these, at least 20 fish were federally or State listed fish species including Central Valley spring-run Chinook salmon and Central Valley steelhead.

Both white sturgeon rescued from the Tule Pond were subsequently detected by 69 kHz receiver arrays as determined through queries of the HYDRA and BARD databases conducted 8 October 2019. The white sturgeon rescued on 27 April was detected at the I-80 Tower Bridge array on 29 April, the Decker Island array on 30 April, and the Chipps Island array on 1 May, providing evidence to suggest that this fish survived and made a fairly rapid downstream migration after release. The white sturgeon rescued on 4 May was detected at the only at the I-80 Tower Bridge array on 11 May, one week after rescue.

While fish rescues do provide benefits in terms of saving listed fish species and preventing indirect mortality associated with CVP, SWP, and flood control operations, there are potential drawbacks associated with fish rescues. generally considered better to address the issue causing the stranding than relying on fish rescues. Stranded fish are in are often subjected to stressful conditions and the rescue effort itself is stressful to fish, having the potential to result in injury and possibly delayed mortality from capture and handling. For salmonids, the loss of slime coat and scales observed during capture and

handling could increase the risk of infection from various fish pathogens. The majority of the Sacramento River winter-run Chinook salmon rescued at Wallace Weir experienced significant delays during migration. Many of these fish were subjected to considerable thermal stress as water temperatures at Wallace Weir after late April were typically in excess of 20° C and were not tagged to minimize additional stress.

Therefore, it is generally considered better to take a proactive approach and address the issue causing the stranding than relying on fish rescues. The implementation of the Yolo Bypass Fish Passage Project in 2018 and ultimately the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project should result in a significant reduction in the stranding and loss of listed fish species. Upon completion of the aforementioned projects, monitoring for fish stranding after weir overtopping events should continue to help determine the overall effectiveness of the improvements designed to increase volitional fish passage to the Sacramento River in addition to observing how the new equipment operates and in identifying areas within the Yolo Bypass that remain problematic for fish stranding. In addition, completion of the Wallace Weir Fish Collection Facility in summer 2019 will increase fish salvage efficiency within the Knights Landing Ridge Cut and also should reduce stress to fish during capture and handling.

References

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