California Department of Fish and Wildlife

North Central Region

Wallace Weir Fish Trapping and Relocation Efforts

2020 - 2021

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Purpose

The purpose of this document is to summarize the fish salvage efforts during the 2020-2021 trapping season in the Knights Landing Ridge Cut (KLRC) using the Wallace Weir Fish Collection Facility (Facility). The information in this document is intended to 1) provide historical context describing why a permanent fish collection facility was constructed, 2) document fish salvage efforts in the KLRC using the facility, 3) show species composition observed in the facility and 4) compare salvage efforts between the facility and temporary trapping methods (i.e., fyke traps).

Introduction

Non-natal straying is a natural occurrence for adult salmonids and serves to increase genetic diversity among populations of different watersheds (Quinn, 1984). Anthropogenic impacts to natural waterways such as damming of rivers, water diversions, and the creation of artificial waterways have led to increased straying of adult salmonids in the California Central Valley. Adult salmonids can be attracted to the outflow from man-made canals and become entrained in them. These canals are usually not connected to a river upstream and oftentimes have poor habitat and water quality for adult salmonids and can make them vulnerable to predation and poaching. The entrainment of these fish leads to a reduction in the adult spawning population. These losses are especially detrimental to Central Valley winter-run and spring-run Chinook salmon *(Oncorhynchus tshawytscha). S*outhern distinct population segment (sDPS) of North American green sturgeon (*Acipenser medirostris*) have also been rescued as part of these efforts. *These* species are listed as threatened or endangered under the federal Endangered Species Act (ESA) and state of California Endangered Species Act (CESA). To reduce and prevent entrainment losses, the California Department of Fish and Wildlife (CDFW) has implemented salvage efforts in these man-made canals where salmonids have been observed. Beginning in 2013, CDFW has seasonally installed temporary traps in the Colusa Basin Drainage Canal (CBDC), KLRC, and the eastern toe drain of the Yolo Bypass (Toe drain) for salvaging ESA listed anadromous species (Figure 1). Although these efforts may reduce the impacts from artificially augmented straying, they are not a permanent solution.

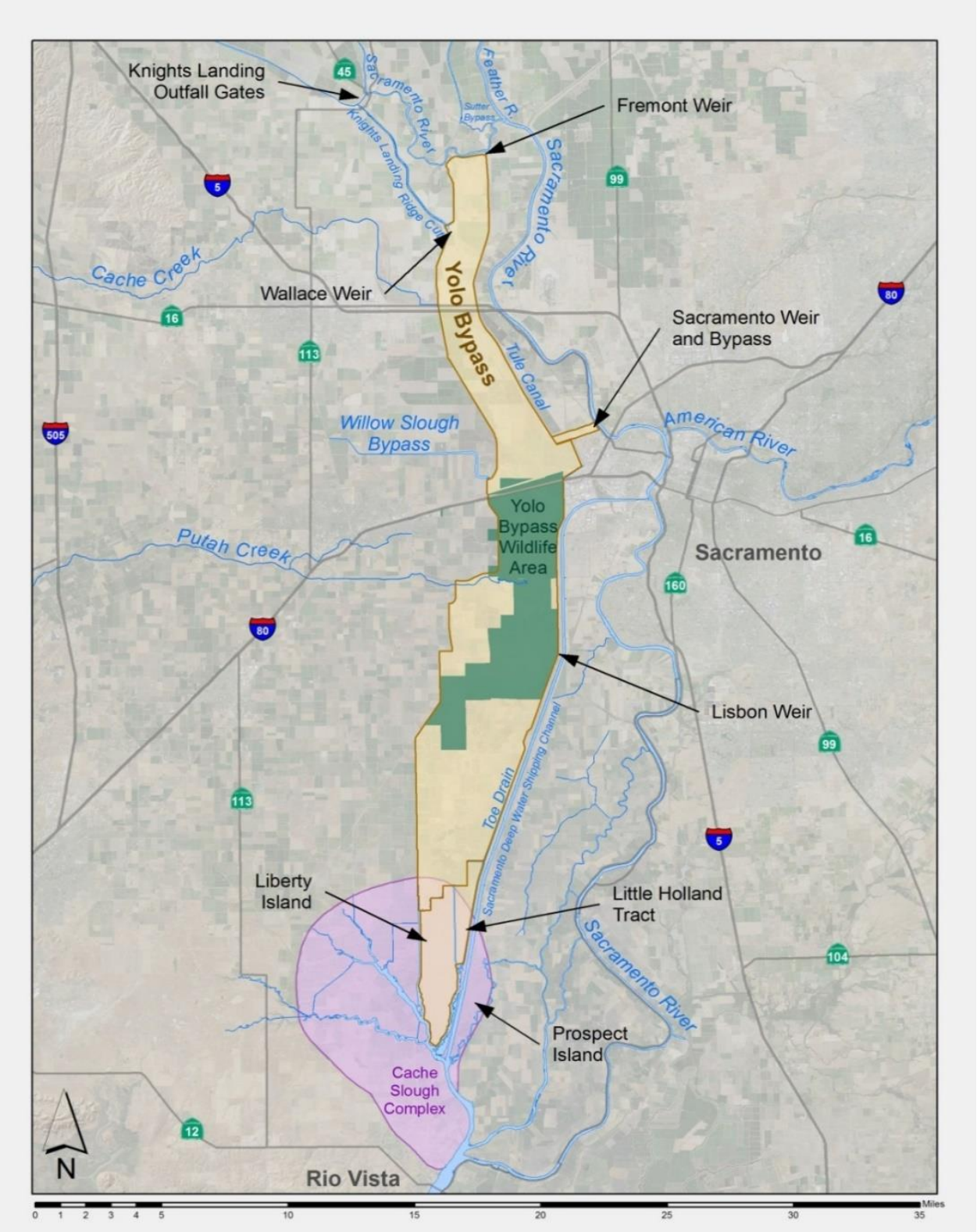

Figure 1. Map of the Yolo Bypass showing the Knights Landing Outfall Gates, Wallace Weir, and the Cache Slough Complex.

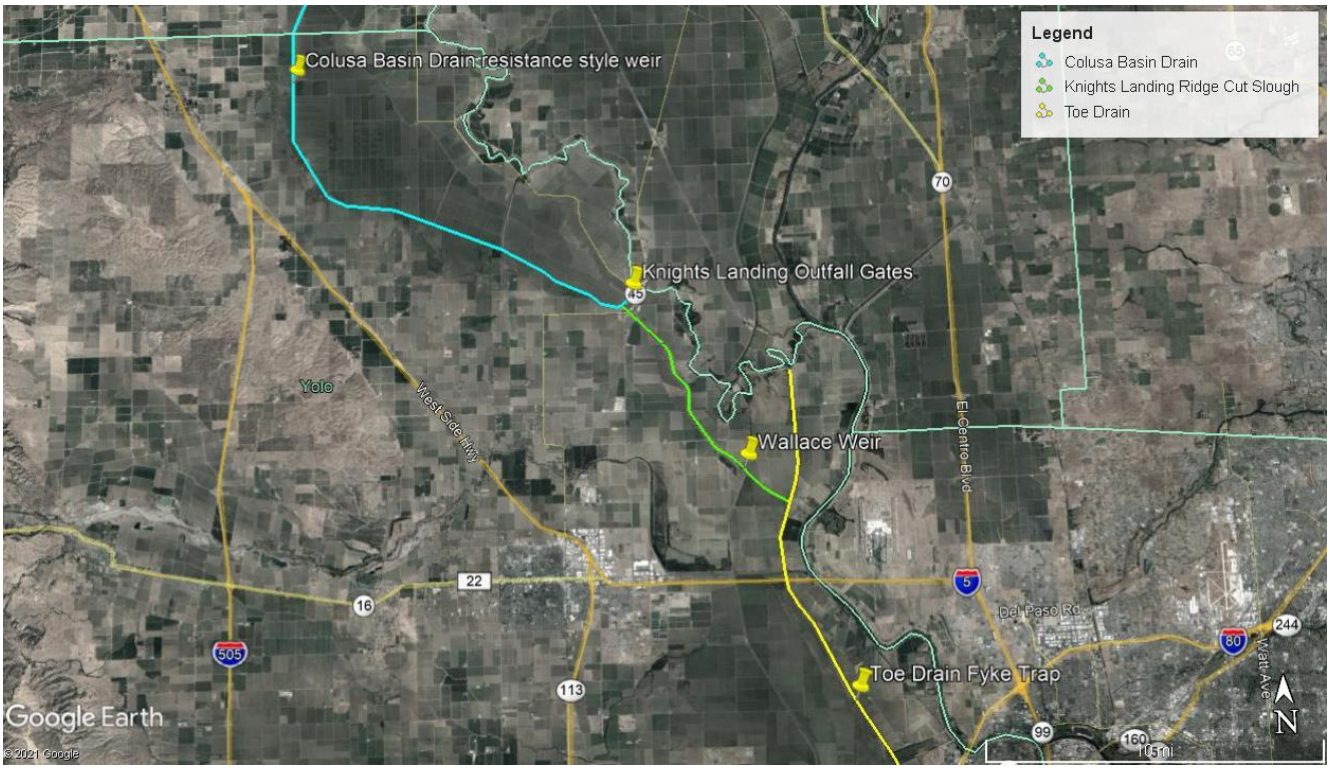

Figure 2. Map showing temporary trap site locations since 2013 in the Colusa Basin Drain (blue), Knights Landing Ridge Cut (green), and the eastern toe drain of the Yolo Bypass (yellow).

Background

During the spring of 2013, the California Department of Fish and Wildlife (CDFW) rescued 312 adult Chinook salmon from the CBDC, a man-made canal that drains approximately one million acres of agricultural land from Glenn, Colusa, and Yolo counties. Genetic and coded wire tag analysis revealed that many of the Chinook salmon rescued were federally listed winter-run and spring-run origin fish. Following this rescue effort, CDFW implemented trapping efforts upstream of two possible entry points into the CBDC: The Knights Landing Outfall Gates (KLOG) and the Cache Slough Complex (CSC) (Figure 1). Multiple years of trapping in these locations has revealed that much of the salmonid entrainment occurs in the KLRCS via the CSC. Conditions allowing for entrainment into the KLRCS occur more frequently throughout the year and under a wider range of water years compared to the number of days KLOG is passable in a given year (Gahan et al., 2016). As such, it was deemed necessary to have a more permanent means of salvaging listed salmon and sturgeon from the KLRC. Trapping efforts in the KLRCS historically took place approximately 200 meters downstream of an agricultural water control structure known as Wallace Weir (Figure 2). The weir consisted of an earthen berm and manually operated culvert with a wooden slide gate. During high flow events in the KLRC and Yolo Bypass, the weir was subjected to overtopping flows and erosion and needed to be repaired after such events. Similarly, the temporary fyke trap used for salvage operations was also subject to severe damage during these high flow events and needed to be removed beforehand. In an effort between CDFW, California Department of Water Resources (CDWR), and Reclamation District 108 (RD108), the weir was modified to be more robust and include a

fish collection facility. Construction on the improved weir and collection facility began in the summer of 2016 and was finished in the summer of 2019.

Wallace Weir

Flow Control Structure – The current Wallace Weir flow control structure consists of a built-up earthen berm armored with rip rap and six concrete box culverts through which water flows. Obermeyer dams are located on the upstream side of each culvert to regulate flow. On the downstream side of each culvert are bottom hinged metal fish screens that prevent fish from swimming upstream of the weir and further into the KLRC and CBDC. Each of the screens are raised and lowered via an overhead hoist and cable system mounted on the downstream end of the retaining walls. The Obermeyer dams and fish screens are controlled through a user interface housed in a control building on the top of the levee west of the weir. Air compressors that regulate the air pressure in each of the bladder dams are also stored in this control building. The fish screens can be programmed to raise and lower at different time intervals. Lowering of the fish screens can also be triggered by the amount of force being applied to the screens. This is to prevent debris build up which could cause a mechanical failure in the hoist system and result in an uncontrolled drop of the screens.

Fish Collection Facility - The Wallace Weir Fish Collection Facility (facility) is a concrete structure adjacent to the improved Wallace Weir water control structure, located in the KLRC, approximately 9.7 kilometers southwest of the town of Knights Landing.

The facility has four major components: the downstream entrance pool, holding pool, facility intake pool, and energy dissipation basins (Figure 3). The entrance pool is where fish enter the facility and leads to the holding pool, where fish are collected. The facility intake pool is at the upstream end of the facility, where water is diverted from the KLRC into the facility. A mechanized trash rack is mounted at the intake of the facility to block large debris from entering. The trash rack is driven by a Rotork actuator. After entering the facility intake pool, water can be diverted into two energy dissipation basins within the facility: one at the upstream end of the holding pool and one running parallel to the west side of the holding pool. Water routed through the western energy dissipation basin drains out to the upstream end of the entrance pool to provide auxiliary attraction or maintenance flow when needed.

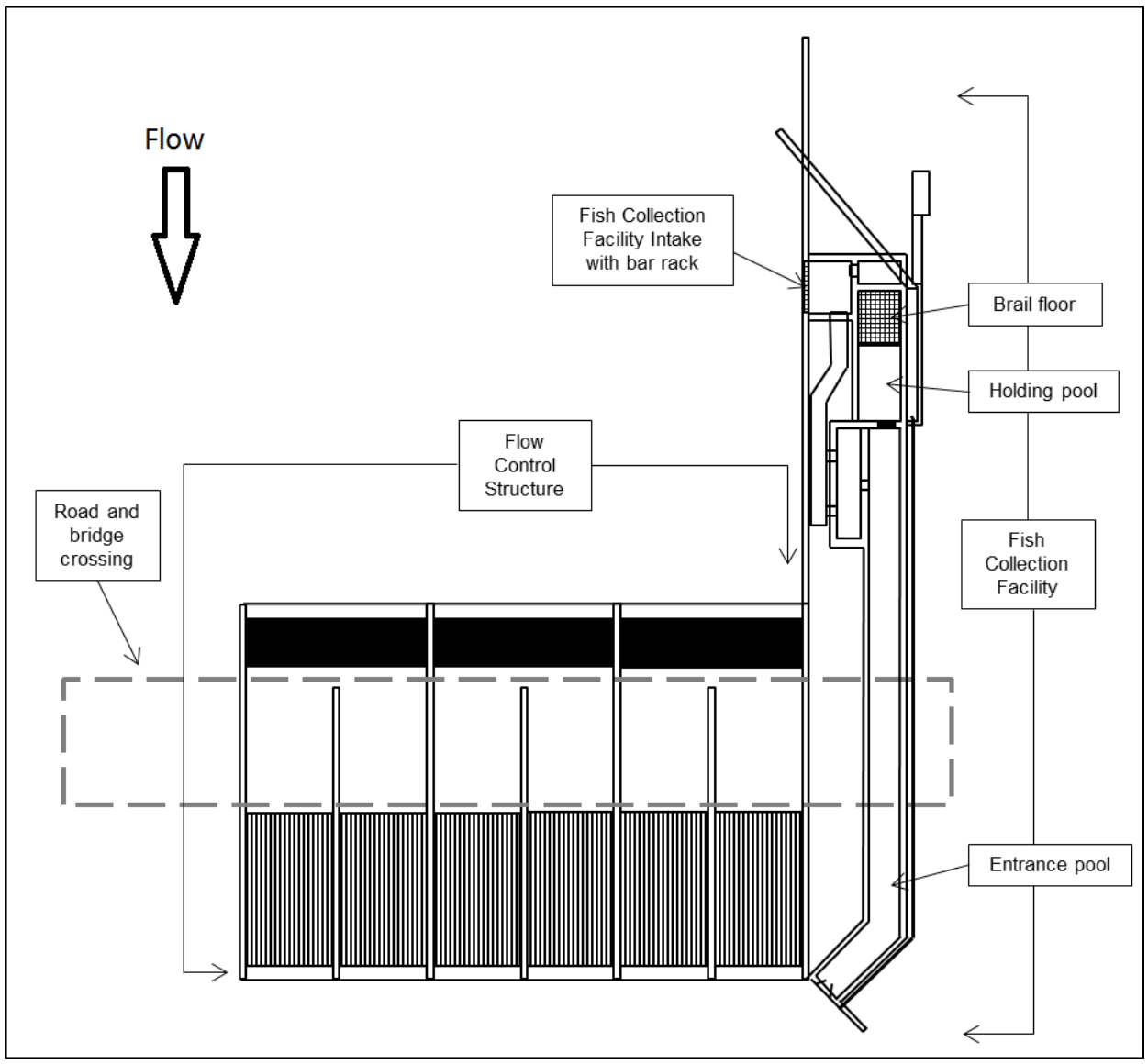

Figure 3. An overhead diagram of the new Wallace Weir including the flow control structure and fish collection facility.

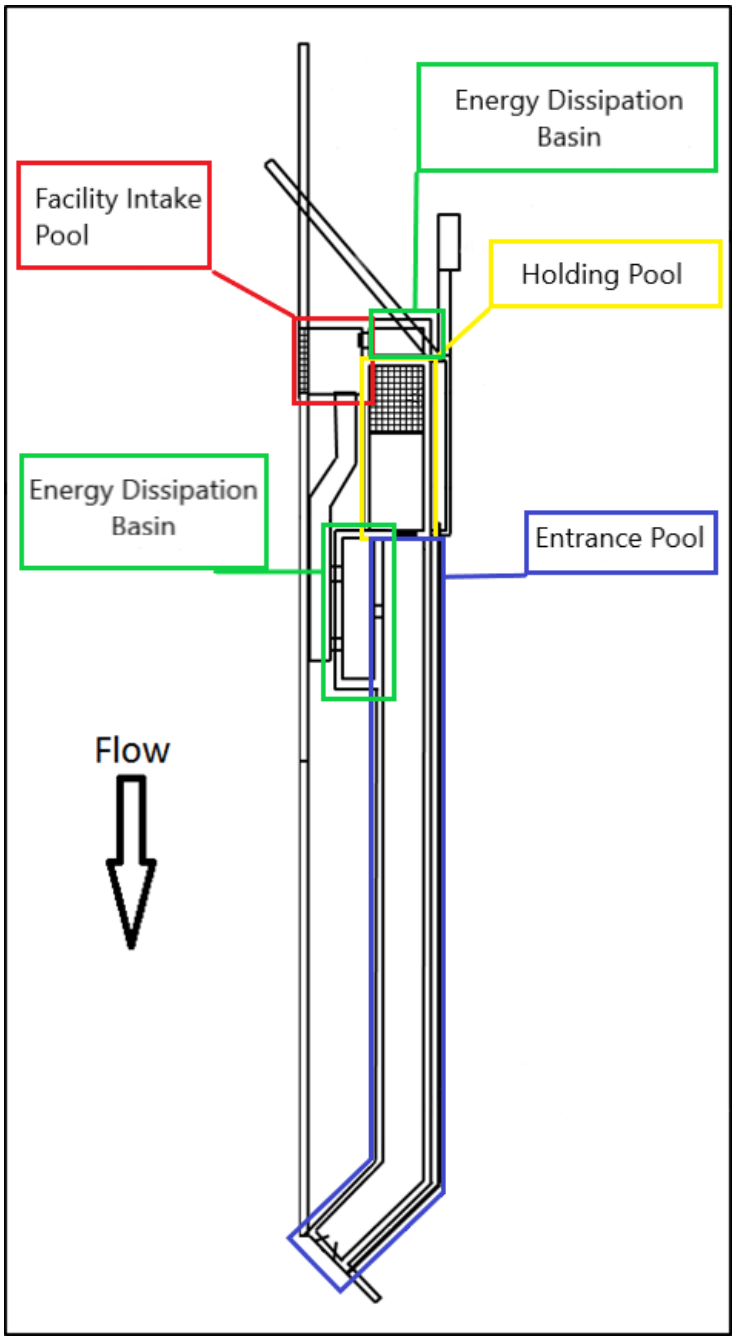

Figure 4. An overhead diagram of the Wallace Weir Fish Collection Facility with the four major components highlighted. The facility intake pool (red), holding pool (yellow), entrance pool (blue) and the energy dissipation basins (green).

Five gates separate the major components of the collection facility: the upstream Waterman gate, western auxiliary Waterman gate, slide gate, screened panel dual leaf holding pool LOPAC gate, and solid panel dual leaf entrance pool LOPAC gate (Figure 4). The upstream Waterman gate regulates flow from the KLRC to the facility intake pool. The western auxiliary gate regulates flow from the facility intake pool to the western energy dissipation bay. The slide gate is a stainless-steel plate used to hydraulically isolate the holding pool from the entrance

pool. The screened panel dual leaf LOPAC gate opens inwards into the holding pool and prevents fish from swimming back out into the entrance pool. These screened panels allow water to flow through even when closed, but block fish passage. The solid panel dual leaf LOPAC gates are used to adjust the head height of the water inside the facility as well as to close the facility.

The holding pool contains two components for collecting fish: a crowder rack and floor brail. The crowder rack is located at the downstream end of the holding pool. The top portion of the crowder rack consists of a platform with four wheels that ride along two metal rails that run lengthwise on the top of the holding pool walls. Metal handlebars mounted to either end of the crowder rack are used to manually push the crowder rack back and forth in the holding pool. The lower part of the crowder rack consists of two screen panels made of metal frames with 1" metal tubing running vertically within the frames. The metal tubes are spaced approximately 1" apart. The bottom of the two panels is raised and lowered mechanically via a chain driven by a Rotork actuator. This allows operators to control when fish pass through or to block them in when crowding in the holding pool occurs. The floor brail is a 10' by 8' metal basket consisting of 1" tubing spaced out approximately 1" apart. The floor brail sits in the upstream half of the holding pool and is raised and lowered by two steel threaded stems that are mechanically driven by a Rotork actuator. The floor brail is used to crowd fish towards the surface of the pool when staff are ready to collect fish and transfer them to a workup tub.

The mechanized components of the collection facility are operated from a control panel mounted in a cabinet located on the northeast corner of the collection facility. The controls are connected to the actuator of the crowder rack, floor brail, and traveling trash rack, providing power and a user interface. The two LOPAC gates and slide gate are operated via corded hand drills. Both LOPAC gates are operated via a drive nut and ball valves. The LOPAC gates open or close depending on which way the drive nut is spun, and which ball valves are opened or closed. The slide gate opens and closes via an operator nut that is rotated with a corded hand drill.

Although the facility is intended to be operated during a wide range of river and bypass flow conditions, the area it is in is still subject to flooding when the Fremont Weir overtops during high Sacramento River flows. As such, several of the components of the facility are removable, including: the Rotork actuators for the crowder rack, floor brail, traveling trash rack, and control cabinet. While these components need to be removed before overtopping events, the rest of the facility can remain in place. This enables trapping to begin quickly after flooding recedes.

The facility's flexibility, and ability to be operated under a wide range of flow conditions, allow for safer and easier fish salvage operations than using temporary trapping methods.

Methods

Facility Procedures – Salvage operations at the facility started on October 2, 2020. The dual leaf solid panel LOPAC gates, screened panel LOPAC gates, slide gate, and crowder rack gate were opened with the floor brail in the fully lowered position. While the facility was fishing, the crowder rack was left on the downstream end of the holding pool with the gate open, allowing fish to swim into the holding pool and access the floor brail. The upstream Waterman gate at the intake pool was fully opened to allow flow through the facility.

Environmental data were measured and recorded prior to checking the facility. Water velocity (cubic feet per second) going into the facility was measured using a Global Water flow probe. Water samples were taken upstream of the facility for measuring turbidity. Water temperature (degrees Celsius) and dissolved oxygen (milligrams per liter) were measured in the holding pool using a YSI temperature/dissolved oxygen meter.

Once environmental data were recorded, staff would close the gate on the crowder rack and push the crowder upstream in the holding pool until it became flush with the downstream edge of the floor brail. This concentrated fish in the holding pool above the floor brail. Once the crowder was pushed into position, the floor brail was lifted until the top of the brail was visible. If fish were present, the screened panel LOPAC gate and slide gate were closed, hydraulically sealing the holding pool from the entrance pool, and blocking any other fish from entering the holding pool. After closing the gates, the holding pool was filled with water using the upstream Waterman gate until the water level in the holding pool equalized with the water level in the KLRCS. Then a diesel-powered water pump was used to fill the holding pool, and the floor brail was raised to the surface to allow for easy capture of fish. Fish were netted out using large D-ringed dip nets and salmonids were transferred to a 150-gallon (568 liter) workup tub to be processed. The workup tub was filled halfway with water from the KLRC and approximately 50 milliliters of API stress coat for every 3.8 liters of water. All bycatch were identified to species, enumerated, and returned to the KLRCS, next to the facility.

Salmonids were identified to species, examined for any external markings or tags (adipose fin clips, Floy tags, etc.), measured to fork length to the nearest 0.5 centimeter, and examined for sex. Two external t-bar anchor tags marked with individual four-digit ID numbers and a contact phone number were implanted into the muscle tissue behind the dorsal fin. A subset of Chinook salmon was implanted with a HDX23 passive integrated transponder (PIT) tag. All salmonids were sampled for genetics via a fin clip from the upper lobe of the caudal fin. Genetic samples were stored on filter paper and placed inside individually labeled sample envelopes. After salmonids were measured, tagged, and sampled for genetics, they were evaluated for Reflex Action Mortality Predictors (RAMP) (Davis, 2010). RAMP scoring has been used by other researchers as an early indicator of stress and predictor of delayed mortality by testing five reflexes:

Tail grab – If fish respond to handlers grabbing the tail by bursting forward. No response gives a score of 1.

Body flex – If fish attempts to struggle free of handlers grip when held out of the water with both hands around the center of the fish's body. No struggling gives a score of 1.

Vestibular-ocular response – If the fish's eye rolls to track the handler when rolled on its side out of the water. Eye not rolling to track handler gives a score of 1.

Head complex – If fish are exhibiting a regular pattern of operculum ventilation when held above the surface of the water. If fish are not ventilating or if ventilation is highly irregular, gives a score of 1.

Orientation – if fish right themselves within 3 seconds after being turned upside down in the water. Fish not rolling over within 3 seconds gives a score of 1.

One point for any of the five reflex tests indicated impairment of that reflex. The higher the score, the more impaired the fish was. Higher scores are also likely to lead to delayed mortality post release. If there was doubt as to whether a reflex was impaired or not, it was assumed that the reflex was impaired, and a point was given. If fish were vigorously struggling to the point where the handler could not control the fish, it was assumed that the fish's reflexes were not impaired and a total RAMP score of 0 was given.

After processing was complete, salmonids were transferred from the workup tub to a trailer mounted 400-gallon transport tank. The transport tank was equipped with two water recirculators and air stones hooked up to oxygen tanks to maintain dissolved oxygen levels while fish were in transit. The transport tanks were filled approximately 3/4 of the way full and API stress coat was added to the water in the same amount as the workup tub. A maximum of 12 fish were loaded into the transport tank at a time. Fish were transported to the Elkhorn Boat Launch on the Sacramento River, approximately 1.8 km downstream of the I-5 bridge. Dissolved oxygen inside the transport tank as well as in the river at the release point were measured and recorded. Temperatures between the transport tank water and river water needed to be within 2 degrees Fahrenheit for fish to be released. If the difference in water temperature was greater than 2 degrees, the water in the transport tank was acclimated to the river water by slowly removing water from the tank and adding river water to the tank. Once the difference between the two water temperatures was less than 2 degrees, the transport tank was backed down the boat ramp into the water and fish were released out of the back of the tank via a slide gate.

Results

Facility Operations – The facility was fished for 4,750 hours during the 2020-2021 season. Trapping operations started on October 2nd, 2020, and ended on May 25th, 2021. A temporary fyke trap was installed downstream of the facility and was operated from October 2nd, 2020, to November 2nd, 2020, and was fished for 760.25 hours (Figure 6). The temporary trap was fished during this time due to repair work at the collection facility. From December 14 to 16, 2020, the floor brail became inoperable. The floor brail motor was running for too long as it was being lowered and as the floor brail reached the bottom of the holding pool, the Rotork actuators continued to push the stems down, causing them to bend. This issue was later resolved by running the actuators to raise the floor brail. A county wide

power outage occurred on January 27, 2021, leaving the motorized components of the facility (floor brail and crowder rack) inoperable (Figure 6). On April 29, 2021, several adult Chinook salmon were observed downstream of the weir, swimming in front of the bays of the water control structure. Increased attraction flows were released from the facility, but were ineffective at drawing these fish in. Two beach seine efforts were conducted downstream of the facility to attempt to capture and relocate these fish. A 10' by 91' beach seine with 1.5" mesh was used. Seine hauls started approximately 300' downstream of the facility and ended at the facility. Beach seining efforts took place on April 29th, 2021, and April 30th, 2021 (Figure 6).

Environmental Conditions – Mean weekly flows in the KLRC ranged from 2 cfs (weeks 44, 45, 46, 21 & 22) to 70 cfs (week 16) (Figure 5. and Table 1.). Mean weekly average water temperatures at the facility ranged from 7.9 °C (week 52) to 24.1 °C (week 43) (Figure 5. and Table 1.). Mean weekly dissolved oxygen levels in the facility ranged from 22 percent (week 20) to 89 percent (week 44) (Table 1). Mean weekly turbidity ranged from 3.4 NTUs (week 52) to 23.6 NTUs (week 21) (Table 1).

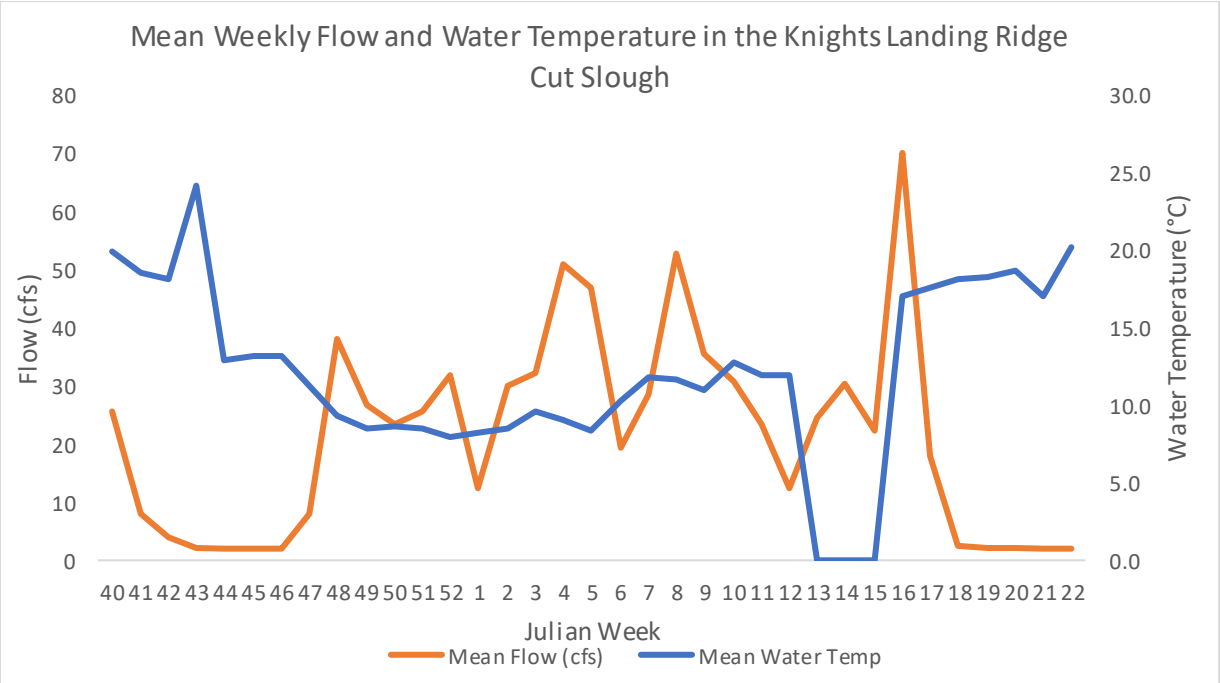

Figure 5. Mean weekly water temperatures (in degrees Celsius) and flow (in cubic feet per second) measured at the Wallace Weir Fish Collection Facility during the sampling season (Julian week 40 to 22). Water flow was reported by CDEC, Ridge Cut Slough (RCS) gage in cubic feet per second.

Table 1. Weekly average values of turbidity, dissolved oxygen measured in percent saturation, flow in the KLRCS in cubic feet per second, and water temperature in degrees Celsius, measured at the facility.

Julian Week	Beginning Date	Flow (cfs)	Water Temp (°C)	D.O. (% saturation)	Turbidity
40	10/2/2020	26	19.9	51.50	N/A
41	10/6/2020	8	18.5	76.62	7.50
42	10/13/2020	4	18.2	60.38	6.62
43	10/20/2020	2	24.1	26.65	4.76
44	10/27/2020	2	12.9	89.43	6.57
45	11/3/2020	2	13.2	70.99	8.10
46	11/10/2020	2	13.2	74.63	11.42
47	11/17/2020	8	11.3	67.47	9.57
48	11/24/2020	38	9.3	77.98	12.54
49	12/1/2020	27	8.4	59.62	5.14
50	12/8/2020	23	8.6	63.97	6.38
51	12/15/2020	26	8.5	73.86	5.17
52	12/22/2020	32	8.0	65.83	3.40
1	12/29/2020	13	8.3	65.90	3.76
2	1/5/2021	30	8.5	81.00	3.59
3	1/12/2021	32	9.6	86.71	8.57
4	1/19/2021	51	9.0	80.57	8.04
5	1/26/2021	47	8.4	88.09	8.76
6	2/2/2021	19	10.2	68.57	15.17
7	2/9/2021	29	11.8	54.86	10.17
8	2/16/2021	53	11.6	61.14	11.93
9	2/23/2021	35	11.0	80.17	11.14
10	3/2/2021	31	12.8	75.57	8.99
11	3/9/2021	23	12.0	78.57	10.74
12	3/16/2021	13	12.0	87.86	10.07
13	3/23/2021	25	N/A	N/A	9.10
14	3/30/2021	30	N/A	N/A	7.20
15	4/6/2021	22	N/A	N/A	11.09
16	4/13/2021	70	17.1	N/A	5.16
17	4/20/2021	18	17.6	N/A	4.26
18	4/27/2021	3	18.1	N/A	6.83
19	5/4/2021	2	18.3	34.00	10.76
20	5/11/2021	2	18.7	22.71	12.16
21	5/18/2021	2	17.0	34.50	23.65
22	5/25/2021	2	20.2	31.00	N/A

Fish Catch – *A* total of 122 fishes were recovered in the 2020/21 season at Wallace Weir, 56 of which were salmonids. A total of 11 species were represented, including 4 native to California (Table 2).

Table 2. Total catch of all fish species trapped and caught at and below the Wallace Weir collection facility between October 2, 2020, and May 28, 2021. *California native fish species.

Common Name	Scientific Name	Number Captured at WW
Chinook Salmon*	*Oncorhynchus tshawytscha*	55
Steelhead*	*Oncorhynchus mykiss*	1
Bass, Largemouth	*Micropterus salmoides*	21
Bass, UNID	*Micropterus spp.*	2
Common Carp	*Cyprinus carpio*	29
Crappie, UNID	*Pomoxis spp*	1
Goldfish	*Carassius auratus*	3
Sacramento Pikeminnow*	*Ptychocheilus grandis*	3
Sacramento Sucker*	*Catostomus occidentalis*	5
Sculpin, UNID	*Cottus spp.*	1
Sunfish, Bluegill	*Lepomis macrochirus*	1

Salmonids – A total of 55 Chinook salmon were recovered at or below the Wallace Weir facility, as well as one steelhead. Only 8 of the salmon were adipose fin clipped, indicating hatchery origin. The remaining 44 were unclipped. We were unable to determine origin status of three carcasses that were recovered downstream of the facility due to advanced decay. Salmon recovery averaged 5.5 salmon/week, with a minimum of 0 (Weeks 7 & 8), and a maximum of 36 fish (Week 16) total captured per week. There were six Chinook salmon mortalities total. Three of the mortalities were the aforementioned carcasses recovered approximately 100 yards downstream of the facility on December 31, 2020. The three carcasses appeared to have been predated upon by either a terrestrial or avian predator. One of the mortalities occurred in transit from the facility to the boat ramp on April 12, 2021. An adipose in-tact steelhead was captured on that same day and died in transit. The two fish were being transported in an insulated cooler instead of one of the transport trailers, both of which were in the shop for repairs. Proper aeration equipment was not installed in the cooler at the time, so the two fish likely died due to low dissolved oxygen levels. During this time, water temperatures were relatively high (Table 1) which was also likely a contributing factor to the mortalities. Two other mortalities were recovered immediately downstream of the weir in front of the flow control structure bays. Both mortalities occurred on April 30, 2021, when water temperatures at the facility were relatively high (Table 1).

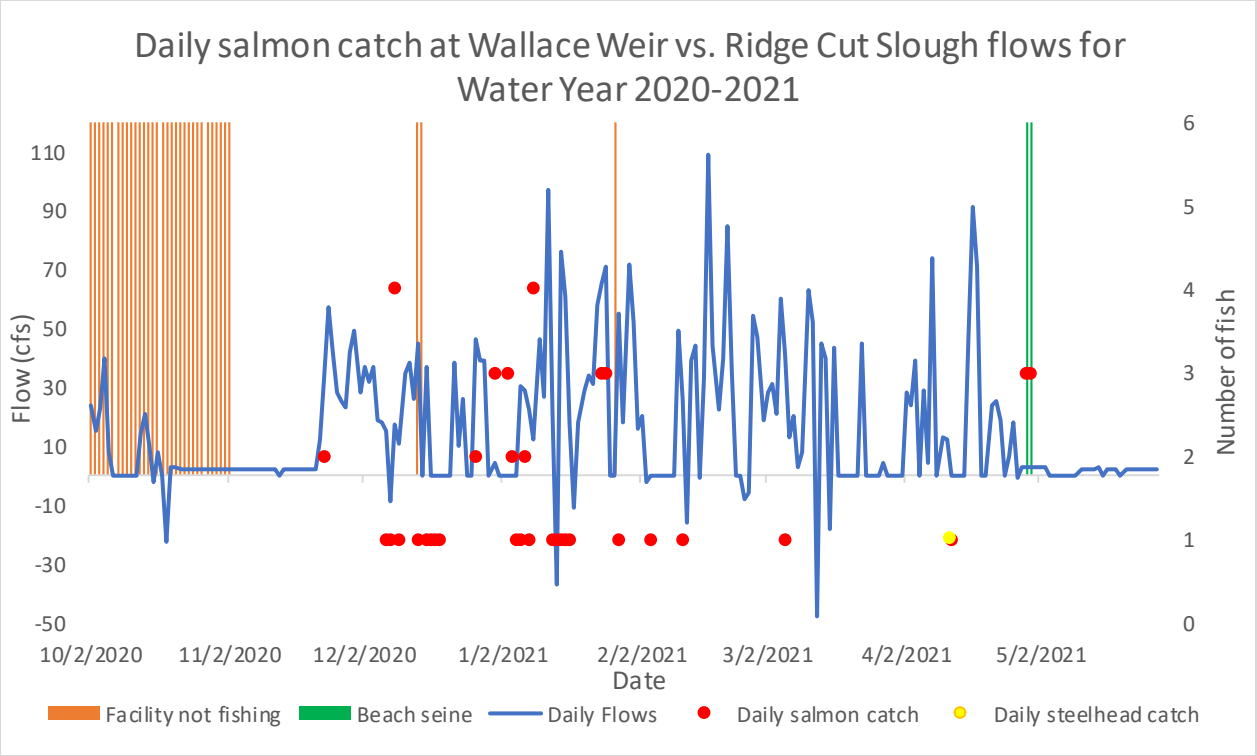

Figure 6. Daily total salmon and steelhead catch for trapping at Wallace Weir and daily flows recorded at time of trap checks on the Ridge Cut Slough at Knights Landing gauge for water year 2020-2021. Orange vertical lines indicate times when a temporary trap was used due to the facility being inoperable. Green vertical lines indicate when a beach seining effort occurred. Flows reported by CDEC, Ridge Cut Slough at Knights Landing (RCS) and reported in cubic feet per second (cfs).

Table 3. Total catch and recovery of mortalities of adipose fin intact and adipose clipped Chinook salmon and steelhead at and below the Wallace Weir collection facility between October 2, 2020, and May 28, 2021.

	Chinook Salmon Total	Chinook Salmon (Adipose Fin Intact)	Chinook Salmon (Adipose Fin Clipped)	Chinook Salmon (Adipose Fin Unable to Determine)	Steelhead Total	Steelhead (Adipose Fin Intact)	Steelhead (Adipose Fin Clipped)
Alive	49	41	8	0	0	0	0
Mortalities	6	3	0	3	1	1	0
Total	**55**	**44**	**8**	**3**	**1**	**1**	**0**

Genetics – Genetic samples were taken from all live rescued salmon and processed to determine the run origin. Most of the fish recovered were fall run (n = 39), with minimal representation from the other 3 runs occurring in the region (Table 4). Genetic samples were not taken on 3 carcasses recovered below the facility and were therefore not included in the analysis.

Table 4. Summary of run-assignments based on genetic analysis of Chinook salmon captured at or near the Wallace Weir collection facility.

Run Assignment	2020/21 Trapping Season
Fall Run	39
Late Fall Run	3
Winter Run	4
Spring Run	6
Not Sampled for Genetics	3
Total	**55**

Post release recoveries – Only one Chinook salmon that was captured in the KLRC during 2020/2021 salvage efforts was recovered post release. The recovery occurred on July 21, 2021, during the winter-run Chinook salmon escapement survey on the Upper Sacramento River.

Table 5. Recovery date and location of floy tagged Chinook salmon released at the Elkhorn Boat Launch on the Sacramento River during the 2020/2021 season.

Tag & release date	Recovery Date	Species	Recovery time (days)	Recovery Condition	Spawning Condition	Recovery Location
1/25/2021	7/21/2021	Chinook salmon	178	Dead	Spawned	Upper Sacramento River

RAMP Scores- Out of the 56 salmonids recovered, 49 were able to be transported and evaluated for post-transport stress using the RAMP assessment. The most common ramp score was 0, with 18 fish showing no signs of transport stress (Table #). Over 87% of fish scored 2 or below on the RAMP assessment. Only 2 fish showed increased signs of stress with a score of 4. The most observed stress indicator was lack of vestibular-ocular response, which was noted in 22 fishes.

Table 6. Total count of Reflex Action Mortality Predictor (RAMP) scores of Chinook salmon caught at and below the Wallace Weir collection facility.

Total RAMP Score	Number of Fish
0	18
1	12
2	13
3	4
4	2
Grand Total	**49**

Discussion

Compared to last season's trapping efforts, which was the first season using the facility, salmonid catch decreased greatly. This may be attributed to the worsening drought and poor passage conditions downstream rather than the use of the facility instead of a temporary trap. The number of Chinook salmon recovered after being released from the facility also did not increase compared to previous seasons using temporary trapping methods. Efforts to evaluate post release mortality rates of Chinook salmon released from the facility were made by incorporating the RAMP protocol into fish handling procedures during this season, but the number of Chinook salmon captured was insufficient to draw any conclusions about the facility having any effect on post release mortality rates and the ability of the RAMP scoring protocol to predict such mortalities. Central Valley fall-run Chinook salmon usually make up most of the salmonid catch by a large margin compared to other runs of Chinook salmon. However, during the 2020/2021 season, only 39 of the total 55 salmon caught were genetically identified as fall-run.

A total of 55 Chinook salmon were handled during salvage efforts in the KLRC during the 2020/2021 trapping season. During the previous season, 596 Chinook salmon were handled in the KLRC (Kilgour and Kubo, 2022). The large difference in the number of Chinook salmon between the two seasons is likely due to the differences in flow regimes in the Yolo Bypass between those seasons. During the 2019/2020 trapping season, an experimental pulse flow was conducted using Colusa Basin Drain flows that were routed through the KLRC and Wallace Weir down through the Yolo Bypass and through the Cache Slough Complex. This pulse flow occurred from August 26 to September 21, 2019, during which time flows through Wallace Weir ranged from 456 cfs to 706 cfs (Davis, et al., 2019). The amount of flow during this time likely caused a large attraction flow downstream for adult fall-run Chinook salmon and provided sufficient passage conditions throughout the bypass. The 2020/2021 trapping season did not start until October 2, 2020, and the pulse flow did not occur due to worsening drought conditions throughout the Central Valley. Additionally, passage was blocked in the bypass at a road crossing across the toe drain known as Agricultural Road Crossing 4 (Ag 4) (Figure 7). This road crossing is an earthen berm with three culverts built into it that regulate flow through the crossing. These culverts were completely closed at the start of the 2020/2021 trapping season, which blocks most of the flow through the crossing and restricts fish passage. The culverts were not opened until December 4, 2020. Immediately after the opening of the culverts, 2 Chinook salmon were captured at the facility. In previous trapping seasons most of the Chinook salmon catch in the KLRC during salvage efforts has occurred between October and December. Hence, the block in passage conditions at Ag 4, along with the lower flow conditions likely contributed to the low number of Chinook salmon seen at the facility during the early part of the 2020/2021 trapping season.

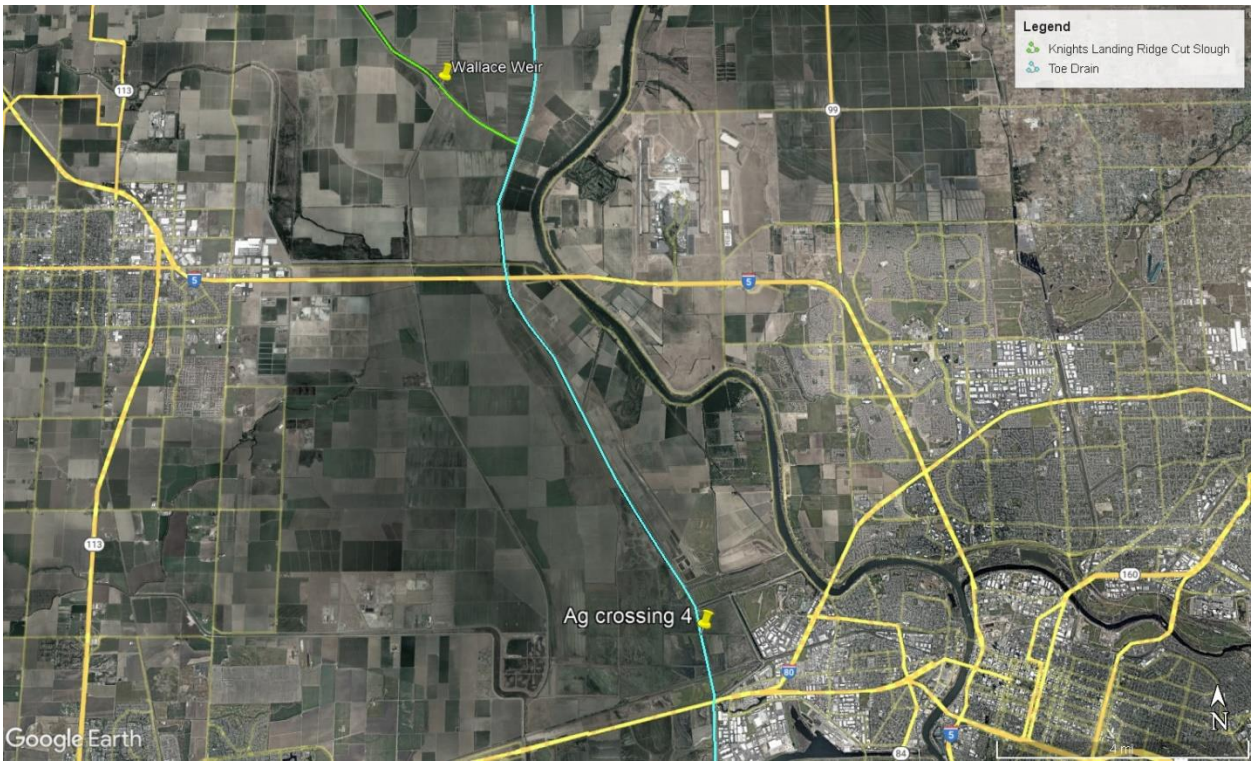

Figure 7. Map of Agricultural Road crossing 4 in relation to Wallace Weir.

Only one tagged Chinook salmon was recovered at upstream spawning grounds on the Sacramento River post release out of the 55 (~1.8%) Chinook salmon observed in the KLRC during the 2020/2021 season (Table 5). During the 2019/2020 trapping season, a similar percentage of recovered fish was observed (~1.9%), with floy tags from seven of the 596 observed salmon in the KLRC having been recovered and 5 PIT tags detected post release (Kilgour and Kubo, 2022). Prior to the use of the facility for salvage efforts in the KLRC, recovery rates of fish captured from the KLRC ranged from 0.7% to 5.6% of the total fish observed in the KLRC (unpublished data). More research is needed to see if this is a result of post release mortality (and if so, why?) or lack of detection or recovery of tagged fish.

The 2020/2021 season was a low water year with periods of time where flow through the facility was low or not flowing at all and had minimal inundation. Such conditions were observed at the facility during the first seven and last five weeks of the trapping season (Figure 5 and Table 1). Salmonid catch during these times was low (Figure 6). Part of the low catch rate for the first seven weeks of the season can likely be attributed to the closure of Ag 4, but also likely due to the low flow conditions. During Julian week 18, flows through the facility were minimal and water temperatures were relatively high, with weekly temperatures above 17 degrees Celsius (Table 1). During this time, several Chinook salmon were spotted downstream of the facility, holding below the bays of the flow control structure. Their behavior was observed before any seining attempts were made to see if they would be attracted to any auxiliary flows that could be pumped through the facility using the diesel-powered pump and adjusting the LOPAC gate configurations, which had no effect. Although there may be enough flow in the Cache Slough Complex and passage through the bypass to attract salmonids up to the facility, there seem to be times when there is not enough flow through the facility or water quality conditions are not suitable for attraction into the facility. The facility was designed to withstand a wider range of environmental

conditions, most notably higher flows, than previous temporary trapping methods. However, the facility does not seem to be more effective at capturing salmon during baseline or low flow conditions.

The RAMP scoring protocol was implemented to further evaluate post release mortality. Most of the fish evaluated using the RAMP scoring protocol showed a score of zero (Table 6), indicating no impairment to any reflexes and therefore a low probability of mortality post release. The one Chinook salmon that was recovered post release from the facility had a score of three, indicating a relatively high probability of post release mortality according to the RAMP scoring. The one Chinook salmon and steelhead that died in transit from the facility to the boat ramp both scored zero. During this time, these two fish had to be transported in an insulated cooler due to the transport trailers being in the shop for repairs. The proper aeration equipment was not equipped in the cooler, so the fish likely perished due to low dissolved oxygen levels. That instance of the RAMP scores not aligning with the condition of the fish post release was likely due to the circumstances of their mode of transportation rather than any inaccuracy of the scoring protocol. Catch this season was much lower than previous seasons so fewer datapoints were available to effectively test this protocol and evaluate post release survival. More study fish are needed for a larger dataset to fully evaluate post release mortality of salvaged fish captured at the facility and provide further insight into this issue.

Due to the robustness and complexity of the equipment at the facility, repairs can be extensive and costly to perform. Since the facility relies on power drawn from local PG&E power lines, it is also susceptible to outages, which leave the facility inoperable. Due to various mechanical issues and necessary repairs that occurred, the facility was inoperable for 34 days of the trapping season. As a result, for the first month of trapping (October 2 to November 2, 2020), a temporary fyke trap was installed downstream of the weir to facilitate salvage operations while repairs were being made. A power outage revealed a vulnerability of the facility's power source. To mitigate this vulnerability, a backup generator has been acquired for future outages. Although the facility is a more robust platform for performing fish salvage operations compared to temporary traps, it is prone to mechanical failures that may require lengthy, complex, and costly repairs.

The facility creates a more permanent means of fish salvage in the KLRC but is still susceptible to mechanical failures and power outages that can leave it inoperable and may require lengthy repair times. Upgrades to the facility to ensure the longevity of the components, improve the user interface and secure a more reliable power source are scheduled to occur. There are also times when flows can be too low to attract salmon into the facility. There is still more research needed to determine the minimum flow thresholds for attraction into the facility. Although trapping efforts using the facility are safer and logistically easier for staff, this does not necessarily translate to higher catch rates or increased survival of fish post release. Future post release survival studies have been planned but a larger sample size is needed to properly conduct such studies. Though the facility is an improvement on previous trapping conditions, it should not be considered a long-term solution to the issue of adult salmonid and sturgeon stranding in the bypass. Project such as the current Fremont Weir Adult Fish Passage Project and the upcoming Big Notch Project will hopefully provide volitional passage opportunities out of the bypass and into the Sacramento River in the future.

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