California Department of Fish and Wildlife

North Central Region

Wallace Weir Fish Trapping and Relocation Efforts

2021 – 2022

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Purpose

The purpose of this document is to summarize the fish salvage efforts during the 2021-2022 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.

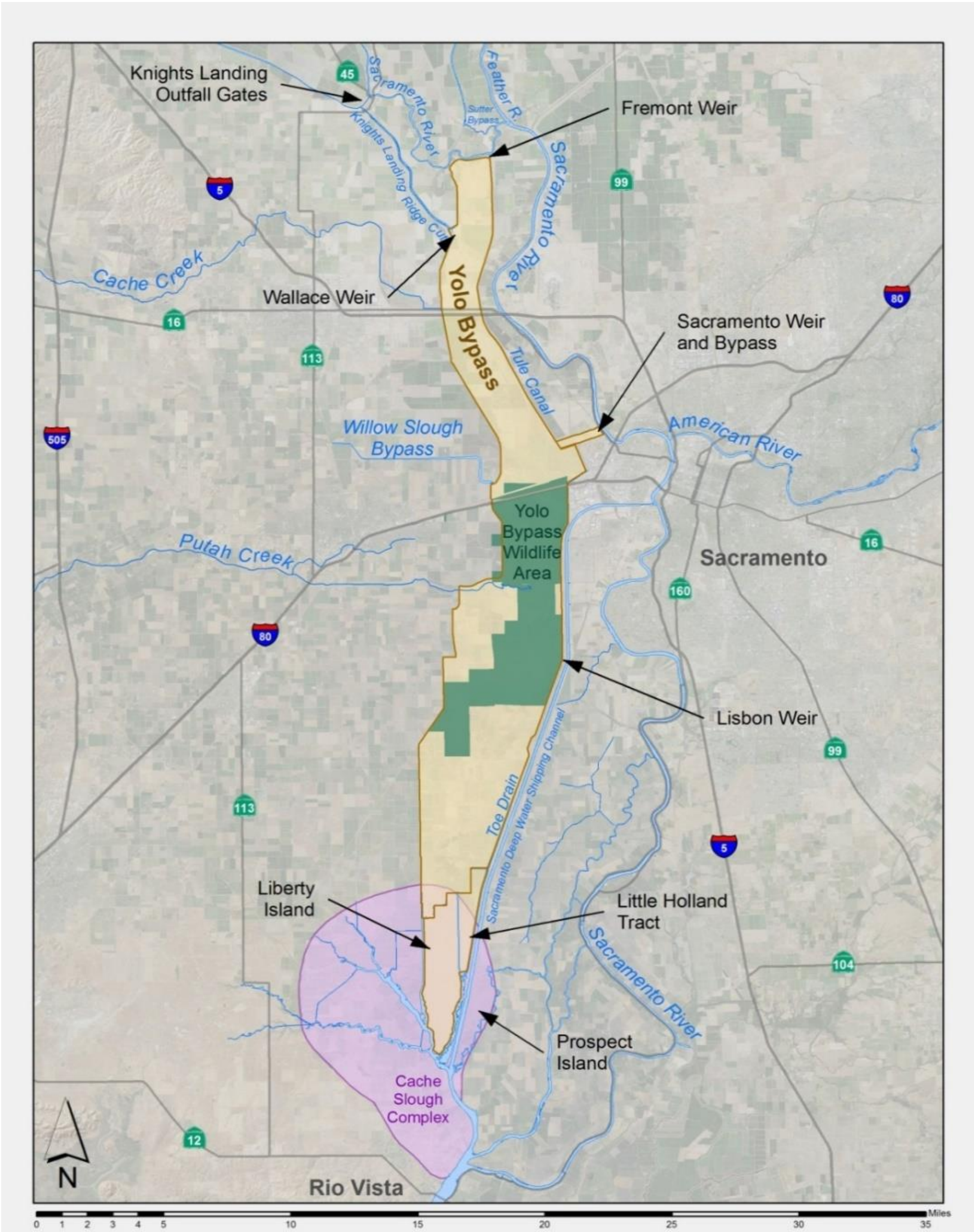

Figure 1. Map of the Yolo Bypass showing the Knights Landing Outfall Gates, Wallace Weir, and the Cache Slough Complex.

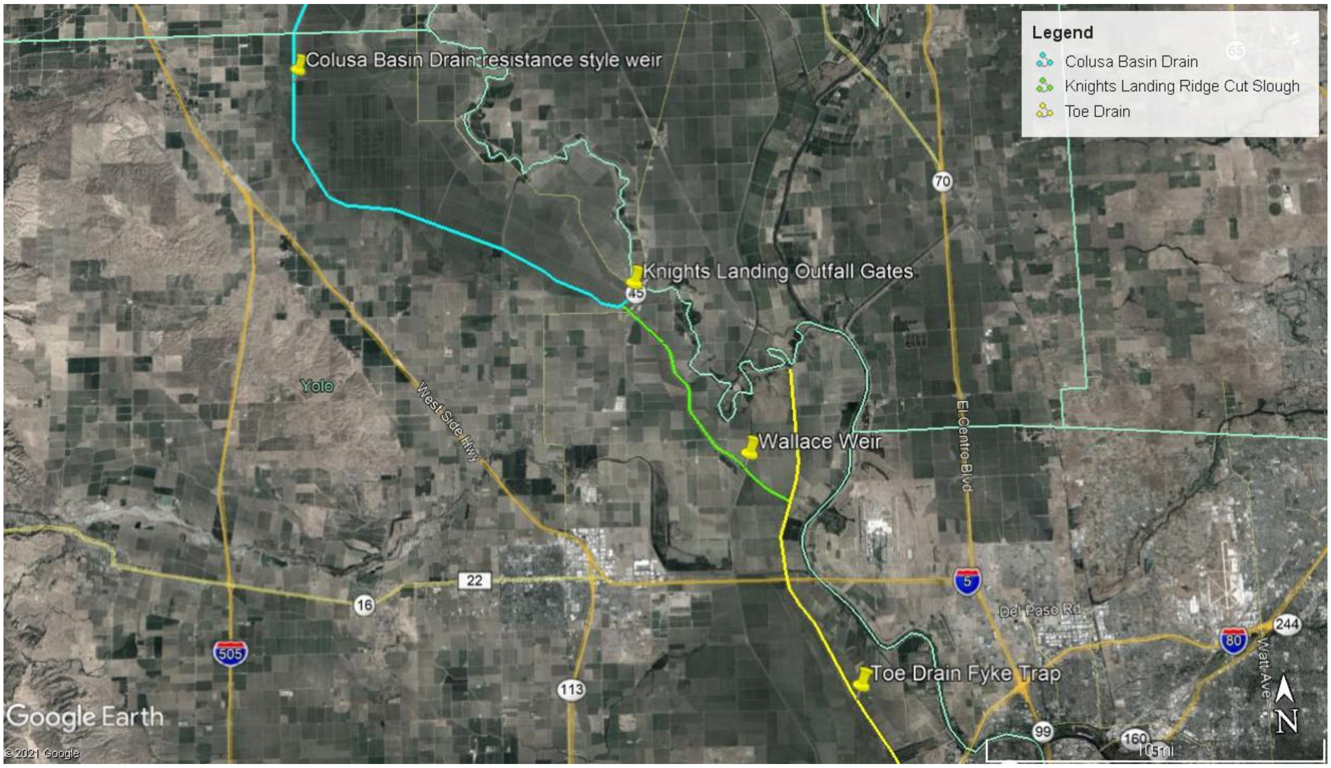

Figure 2. Map showing temporary trap site locations since 2013 in the Colusa Basin Drain (blue), Knights Landing Ridge Cut (green), and the eastern toe drain of the Yolo Bypass (yellow).

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.

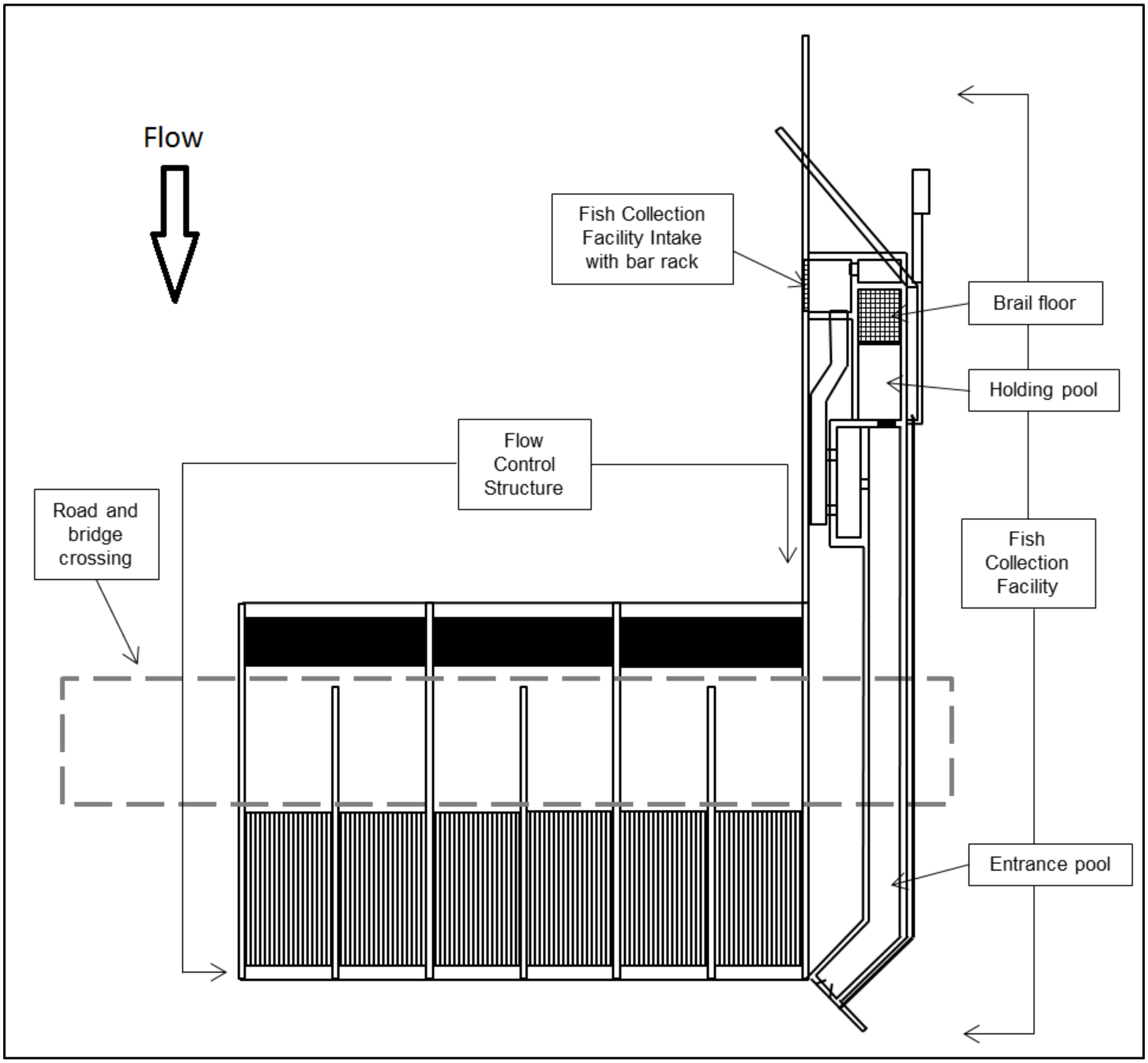

Figure 3. An overhead diagram of the new Wallace Weir including the flow control structure and fish collection facility.

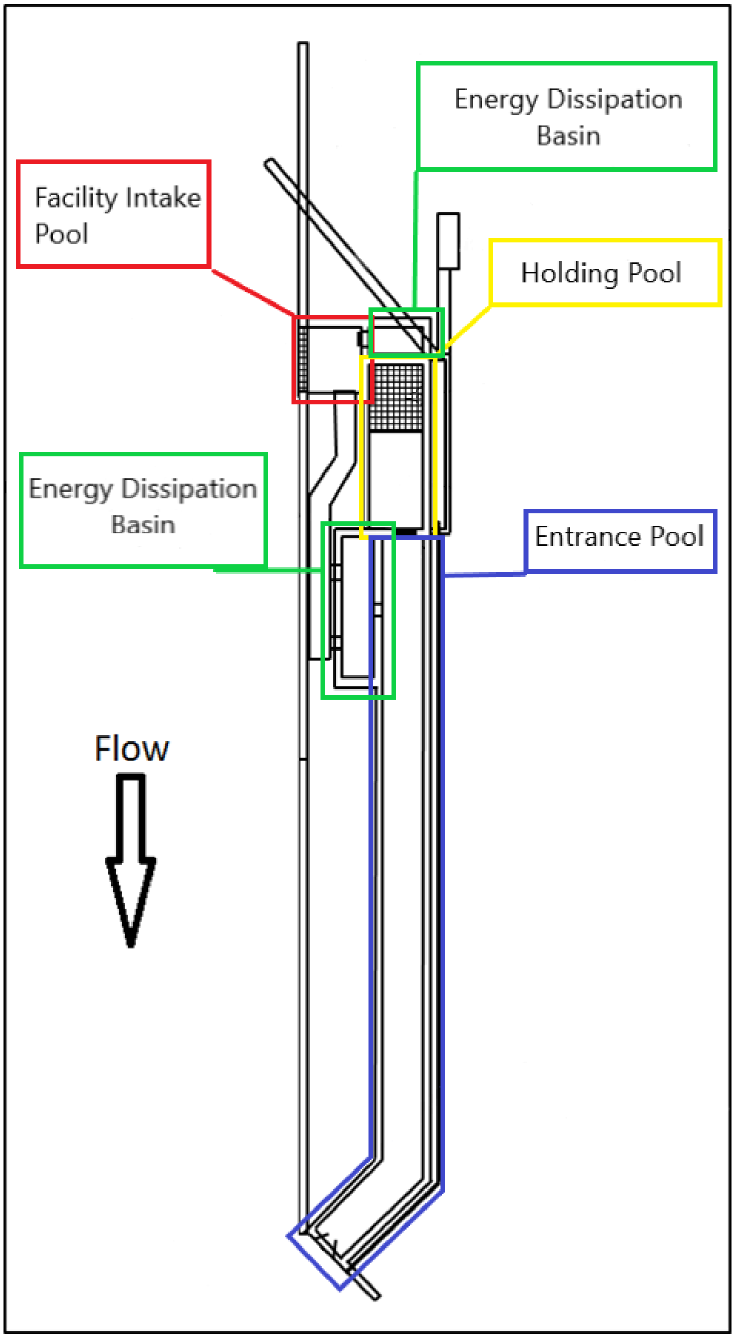

Figure 4. An overhead diagram of the Wallace Weir Fish Collection Facility with the four major components highlighted. The facility intake pool (red), holding pool (yellow), entrance pool (blue) and the energy dissipation basins (green).

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 15, 2021. 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 4,249 hours during the 2021-2022 season. Trapping operations started on October 15, 2021, and ended on May 19, 2022. Due to mechanical failures on the floor brail, salvage operations using the facility did not occur from March 14, 2022, until April 15, 2022. One of the threaded stems that raises and lowers the floor brail slipped through the Rotork actuator due to stripped threads on a brass nut inside of the actuator that rotates around the stem. The cause of the stripped threading on the nut is unknown at this time, but it is suspected that an earlier operator error may have led to this event. 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 immediately resolved by running the actuators to raise the floor brail. This solved the issue of the bent stems but may have caused additional wear on the nut inside of the actuator that later failed. A temporary fyke trap was installed downstream of the facility while the facility was being repaired. This temporary trap was installed on March 18, 2022, and was removed on April 15, 2022. It was fished for 691.25 hours. A group of approximately 7-10 Chinook salmon was observed downstream of the water control structure of the weir on May 17, 2022. Flows in the KLRC and through the facility were relatively low (Figure 5 & 6). The flows coming out of the facility did not appear to be strong enough to attract the salmon towards the entrance channel as they remained holding downstream of the weir. Flows out of the entrance channel were manipulated using the diesel-powered water pump and the downstream most LOPAC gates to increase attraction flows with no success. As a last resort to capture these salmon, a beach seining effort was conducted on May 18, 2022downstream of the facility. 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.

Environmental Conditions - Mean weekly flows in the KLRC ranged from 2 cfs (week 43) to 961 cfs (week 2) (Figure 5 and Table 1). Mean weekly water temperatures at the facility ranged from 7.9°C (week 53) to 20.7°C (week 21) (Figure 5 and Table 1). Mean weekly dissolved oxygen levels in the facility ranged from 2.4 milligrams per liter (week 45) to 14.1 milligrams per liter (week 6) (Table 1). Mean weekly turbidity ranged from 4.0 NTUs (week 48) to 75.1 NTUs (week 2) (Table 1).

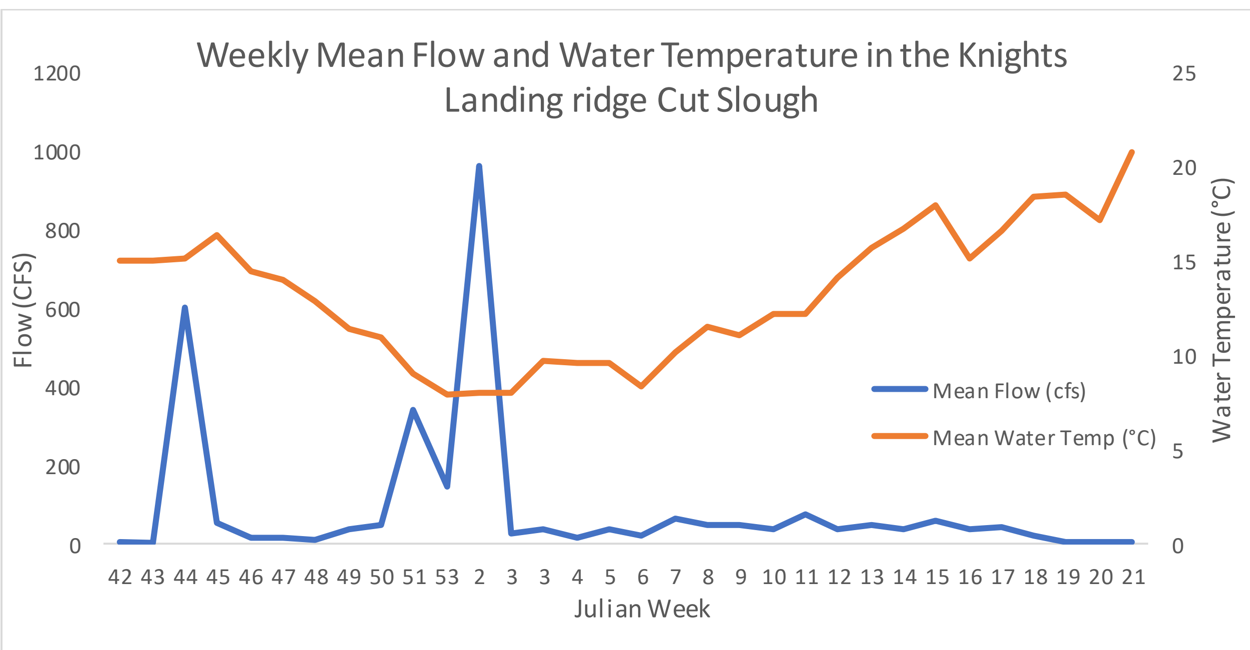

Figure 5. Mean weekly water temperatures (in degrees Celsius) and flow (in cubic feet per second) measured at the Wallace Weir Fish Collection Facility during the sampling season (Julian week 42 to 20). Water flow was reported by CDEC, Ridge Cut Slough (RCS) gage in cubic feet per second.

Table 1. Weekly average turbidity, dissolved oxygen, flow in the KLRCS, and water temperature, measured at the facility.

Julian Week	Beginning Date	Turbidity (NTUs)	D.O. (mg/L)	Flow (cfs)	Water Temp (°C)	Julian Week	Beginning Date	Turbidity (NTUs)	D.O. (mg/L)	Flow (cfs)	Water Temp (°C)
42	10/10/2021	12.7	6.6	3	15	6	1/30/2022	7.0	14.1	20	8.3
43	10/17/2021	14.3	4.4	2	15.0	7	2/6/2022	7.7	12.5	66	10.1
44	10/24/2021	47.3	3.0	602	15.1	8	2/13/2022	19.4	10.1	50	11.5
45	10/31/2021	13.9	2.4	53	16.4	9	2/20/2022	10.4	10.3	45	11.1
46	11/7/2021	8.2	4.3	13	14.5	10	2/27/2022	9.2	10.9	35	12.1
47	11/14/2021	5.7	3.6	15	14.0	11	3/6/2022	13.9	9.9	74	12.2
48	11/21/2021	4.0	6.6	10	12.8	12	3/13/2022	10.52	9.74	38	14.04
49	11/28/2021	5.1	6.5	38	11.4	13	3/20/2021	9.9	8.1	50	15.7
50	12/5/2021	5.0	5.8	49	10.9	14	3/27/2022	17.0	5.5	36	16.6
51	12/12/2021	33.3	8.8	340	9.1	15	4/3/2022	16.1	11.2	61	17.9
53	12/19/2021	28.1	8.8	144	7.9	16	4/10/2022	17.7	7.0	36	15.1
2	12/26/2021	75.1	8.8	961	8.0	17	4/17/2022	17.1	7.0	41	16.5
3	1/1/2022	31.43	9.64	27	8.03	18	4/24/2022	16.8	5.6	20	18.3
3	1/9/2022	22.5	8.5	39	9.7	19	5/1/2022	25.3	4.9	3	18.5
4	1/16/2022	9.6	8.5	13	9.6	20	5/8/2022	35.5	4.9	3	17.2
5	1/23/2022	7.7	13.7	36	9.6	21	5/15/2022	53.7	3.5	3	20.7

Fish catch - During the 2021/2022 season 170 fish were captured during salvage operations in the KLRC. The total catch was comprised of 12 fish species, five of which were native (Table 2).

Table 2. Total catch of all fish species trapped and caught at and below the Wallace Weir collection facility between October 16, 2021, and May 19,2022. *California native fish species.

Common Name	Scientific Name	Number Captured at WW
Chinook Salmon*	*Oncorhynchus tshawytscha*	5
Bass, Largemouth	*Micropterus salmoides*	11
Bullhead, Black	*Ameiurus melas*	4
Common Carp	*Cyprinus carpio*	124
Crappie, Black	*Pomoxis nigromaculatus*	8
Crappie, White	*Pomoxis annularis*	1
Goldfish	*Carassius auratus*	3
Sacramento Blackfish*	*Orthodon microlepidotus*	1
Sacramento Pikeminnow*	*Ptychocheilus grandis*	6
Sacramento Splittail*	*Pogonichthys macrolepidotus*	1
Sacramento Sucker*	*Catostomus occidentalis*	2
Sunfish, Bluegill	*Lepomis macrochirus*	4

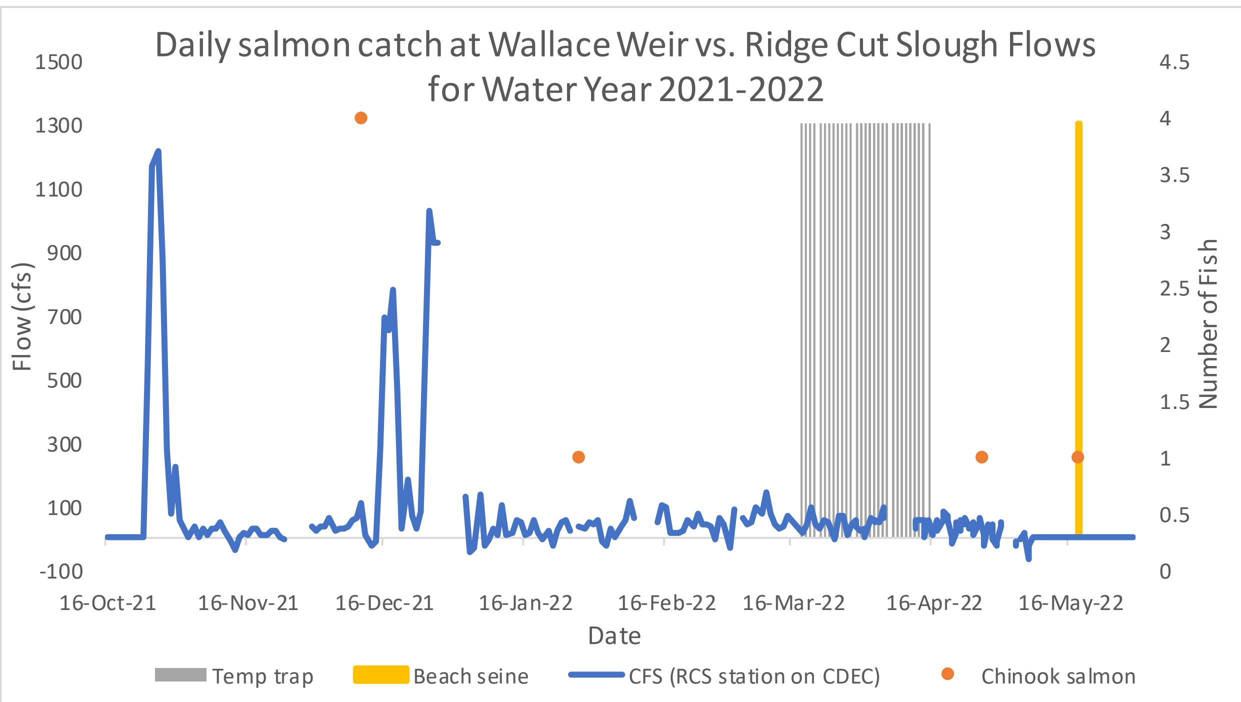

Figure 6. Daily total salmon catch for trapping below Wallace Weir and daily flows recorded on CDEC at time of trap check on the Ridge Cut Slough at Knights Landing gauge for water year 2021-2022. Gray Vertical lines indicate times the fish collection facility was not functioning and the fyke trap was deployed. Yellow lines indicate when beach seining occurred. River flows reported by CDEC, Ridge Cut Slough at Knights Landing (RCS) and reported in cubic feet per second (cfs).

Salmonids – A total of 7 Chinook salmon were observed in the KLRC during salvage operations, 2 of which were adipose fin-clipped (Table 3). During the beach seining on May 18, 2022, an adipose intact Chinook Salmon was captured downstream of the facility. Due to the elevated temperature and low water levels, the Chinook salmon was briefly examined and transported to the Elkhorn Boat Launch. To reduce handling stress, the salmon was not tagged or measured. On January 28, 2022, a Chinook salmon carcass was recovered from the top of a fish screen in one of the bays of the flow control structure. The status of its adipose fin, sex and fork length could not be determined as the carcass was severely degraded and appeared to have been predated upon by a terrestrial or avian predator. A fin clip was taken for genetic analysis and the head was scanned for a coded wire tag (CWT). No CWT was detected. Genetic analysis from this fish indicated it was of fall-run origin.

Table 3. Total catch and recovery of mortalities of adipose fin intact adipose clipped and unknown status of adipose fin Chinook salmon and steelhead at and below the Wallace Weir collection facility between October 15, 2021, and ended on May 19, 2022.

	Chinook Salmon Total	Chinook Salmon (Adipose Fin Intact)	Chinook Salmon (Adipose Fin Clipped)	Chinook Salmon (Adipose Fin Unknown	Steelhead Total	Steelhead (Adipose Fin Intact)	Steelhead (Adipose fin not intact)
Alive	**6**	4	2	**0**	**0**	0	0
Mortalities	**1**	0	0	**1**	**0**	0	0
Grand Total	**7**	4	2	**1**	**0**	0	0

Table 4. Summary of run-assignments based on genetic analysis of Chinook salmon caught at and below the Wallace Weir collection facility.

Run Assignment	2021/22 Trapping Season
Fall Run	4
Late Fall Run	1
Winter Run	0
Spring Run	2
Total	**7**

Table 5. Chinook salmon captured at Wallace Weir and associated capture dates, release location and biological information.

Date	Species	Fork length (cm)	Ad clip?	Sex	Release location	Mortality
12/11/2021	Chinook salmon	56.0	Yes	Male	Elkhorn Boat Launch	No
12/11/2021	Chinook salmon	74.0	No	Male	Elkhorn Boat Launch	No
12/11/2021	Chinook salmon	66.0	No	Male	Elkhorn Boat Launch	No
12/11/2021	Chinook salmon	65.0	Yes	Male	Elkhorn Boat Launch	No
1/28/2022	Chinook salmon	Unknown	Unknown	Unknown	n/a	Yes
4/27/2022	Chinook salmon	87.0	No	Male	Elkhorn Boat Launch	No
5/18/2022	Chinook salmon	n/a	No	Unknown	Elkhorn Boat Launch	No

RAMP Scores- Out of the seven salmonids recovered, five were able to be evaluated for post-release stress using the RAMP assessment. The most common ramp score was 0, with three fish showing no signs of stress (Table 5). All fish scored 2 or below on the RAMP assessment. The most observed stress indicator was the body flex response, which was noted in two fish. Orientation was the other indicator to be scored.

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	3
1	1
2	1
3	0
4	0
5	0
Grand Total	**5**

Genetics – Genetic analysis of the 7 samples taken showed there were four fall-run, one late fall-run, and two spring-run Chinook salmon (Table 4). No winter-run Chinook salmon were observed in the KLRC salvage efforts for this season.

Discussion

In past trapping seasons at or below Wallace Weir, salmonid catch occurred mostly during the Central Valley fall-run Chinook Salmon migration timing window, from October to December (Yoshiyama, et al., 1998). Salmonid catch at the Wallace Weir Fish Collection Facility this season was lower than in most previous trapping seasons. This was likely due to poor water quality conditions and passage barriers downstream of WW in the eastern toe drain of the Yolo Bypass during the early part of the trapping season. Lower flows and worsening drought conditions throughout the 2021/2022 season likely contributed to the lower Salmonid catch at the facility.

Salvage operations at the facility for the 2021/2022 season started on October 15, 2021, during which time flows in the KLRC were extremely low (Table 1). Later in October, a large rain event swept through the central valley, elevating flows in all the valley rivers, tributaries, and bypasses, including the Yolo Bypass. With these elevated flows, there was a sharp decline in dissolved oxygen levels throughout the bypass, including at the facility (Table 1). Shortly thereafter, a large fish kill was observed in Putah Creek and was likely due to this drop in dissolved oxygen. Over 80 adult chinook salmon carcasses were observed as pre-spawn mortalities in the creek (Rabidoux, et al.). There were no salmon observed at or near the facility during this time. The low number of salmon observed at the facility during the fall-run timing is likely attributed to the dissolved oxygen drop associated with the large rain event.

In addition to the dissolved oxygen drop, there were blockages to fish passage in the toe drain of the bypass at Agricultural Road crossing 4 (Ag 4), and a Union Pacific railroad bridge. Ag 4 is an earthen berm that spans all the way across the toe drain and is used for vehicle access by local landowners. The berm has three pipe culverts, one six feet in diameter and two four feet in diameter. Aside from flows overtopping the crossing, the culverts are the only means of adult fish passage above the crossing. Blockages can occur when large amounts of debris accumulate on the upstream side of the culverts after high flow events or when the landowner is diverting flows from the toe drain to adjacent canals and rice fields. Gates are installed upstream of the culverts to impound water, increasing the water surface elevation allowing for a sufficient upstream water supply for the landowner to draw from. The railroad bridge consists of wooden abutments, some of which are located within the toe drain and can also accumulate debris, blocking fish passage. Both features are in the eastern toe drain of the Yolo Bypass (Figure 7). Ag 4 is approximately 6.6 miles south of the Interstate 5 causeway and the Union Pacific railroad bridge is approximately 0.7 miles downstream of Ag 4. After the October rain event and subsequent high flows in the bypass, large amounts of debris, including tree trunks, branches, and aquatic vegetation, were caught up at both Ag 4 and the railroad crossing, creating a fish passage barrier. The debris on Ag 4 was not cleared off until December 10, 2021, and the railroad crossing was cleared sometime later between February and March. A future project to modify Ag 4 and install new screened water pumps further downstream of the current crossing is scheduled to occur within the next 2 years. The crossing modification includes removing the current earthen berm structure and installing a concrete bridge. This design will allow for a more open design that is conducive to fish passage. Although it was unclear when the railroad crossing was cleared, CDFW have since established a direct line of communication with Union Pacific, who owns the crossing. Having a direct line of communication with the railroad company will help future issues with debris blockages getting cleared faster.

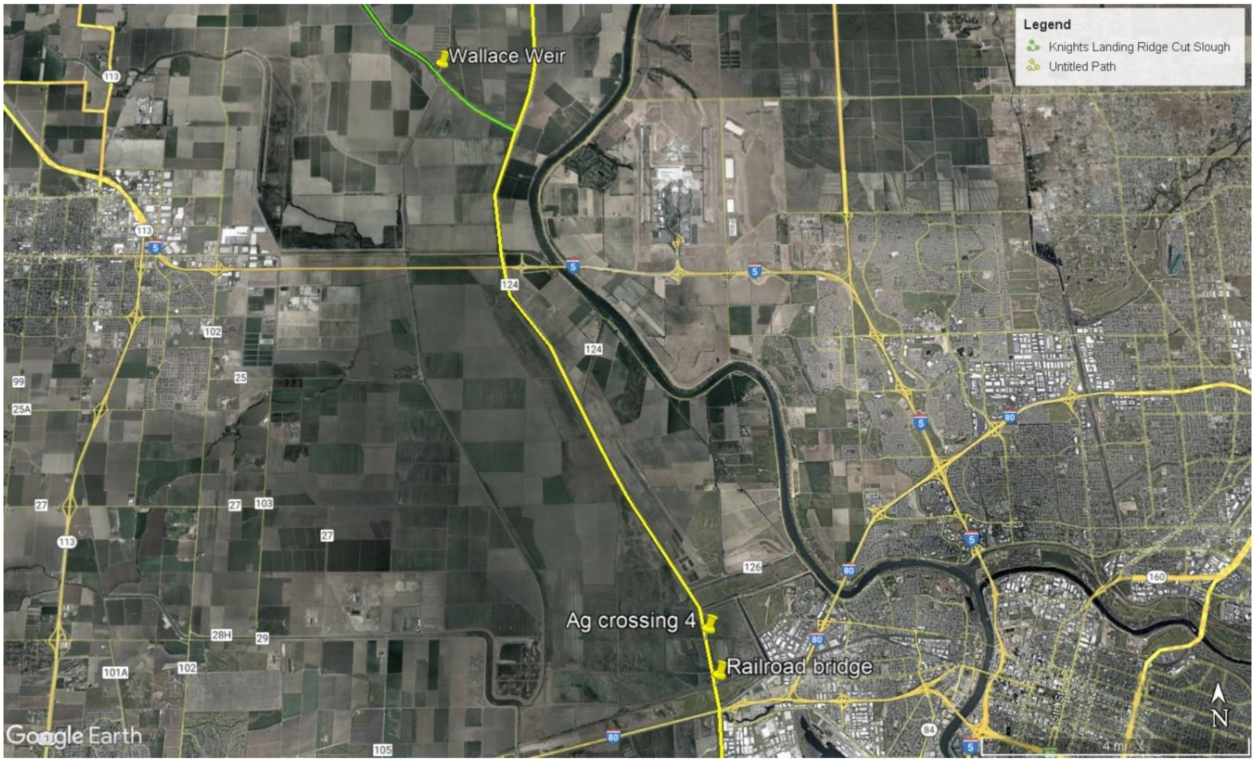

Figure 7. Map of Agricultural Road crossing 4 and the Union Pacific railroad bridge in relation to Wallace Weir.

Outside of the rain event in October and an additional storm later in December of 2021 that increased bypass flows, the KLRC experienced relatively low flows for the rest of the season (Figures 5 and 6, Table 1). Along with the lack of rain fall, water temperatures began to rise starting in March of 2022 (Figure 5, Table 1). As water temperatures rise and flows in the bypass decrease, there is less attraction flow in the Cache Slough Complex and less favorable water quality conditions for salmonids to reside in. These poor water quality conditions, low flows, and passage barriers may have contributed to the lower salmonid catch at the facility for the 2021/2022 season.

Due to the scale and complexity of the equipment at the facility, repairs can be lengthy, complex, and expensive. At one point during the season, the Rotork actuators that raise and lower the floor brail were run past the point where the floor brail reached the bottom of the holding pool. This caused the actuators to continue driving the stems of the floor brail downward until they bent and forcibly stopped the actuators. This issue was quickly resolved by driving the actuators up, which straightened the stems immediately. Later in the season, the floor brail suffered a mechanical failure that is thought to be connected to the stems being bent out of alignment. After being raised to the top of the holding pool, one of the stems of the floor brail began to slip through its actuator, leaving the floor brail uneven and inoperable. This fix took a month to resolve, leaving the department staff to rely on a temporary trap until repairs could be made. The facility and its components are meant to be able to handle a wide range of environmental conditions, but it is still vulnerable to mechanical failures.

On May 17, 2022, several live Chinook salmon adults were observed downstream of the weir. at the time, flows through the facility were low (Table 1 and Figure 5). The salmon observed below the weir were schooling on the opposite side of the channel from where the entrance pool meets the downstream side of the KLRC. The attraction flows coming from the facility did not seem sufficient to pull fish towards the facility. Flows were adjusted using the downstream most LOPAC gates as well as the diesel-powered water pump to try to increase attraction toward the facility. By the time the flow adjustments were made the fish may have been too stressed to attempt to swim into the facility. It is unknown exactly how long those fish had been in the KLRC or how long their migration took from the CSC. Environmental conditions were not as favorable for passage or holding. The mean weekly water temperatures exceeded 20 degrees Celsius, mean weekly dissolved oxygen levels were well below 4 mg/L and the mean weekly flow was 3 cfs (Table 1). Given these conditions, passage conditions were also likely not favorable for salmonids (Richter and Kolmes, 2005). The facility is designed to handle a wider range of flow and environmental conditions compared to temporary traps. However, it does not necessarily seem to be more efficient or effective at capturing salmonids during low flows, compared to temporary fyke traps.

Fall, late fall, and spring-run Chinook salmon were identified in the genetic analysis of the fin clips taken this season (Table 4). Despite the high flows observed in the bypass following heavy rainfall in December of 2021, no winter-run Chinook salmon were observed at the facility. The debris build-up at Ag 4 and the Union Pacific railroad bridge may have blocked passage through the Toe Drain and into the KLRC during peak winter-run migration timing. If fish were present at this time, they may have not been able to migrate past these points and either turned around or perished in the canal.

None of the fish captured and released from this season's trapping efforts were reported as recoveries. The last salmon captured for the season, on May 18, 2022, was not tagged, measured, or evaluated for a RAMP score. This was to reduce handling stress due to high water temperatures at the time of capture (greater than 20 degrees Celsius). As for the other fish, it is possible that they avoided detection post release, shed their tags, or died shortly after release. RAMP scores were evaluated for the other fish, but with so few fish captured and evaluated, it is difficult to determine what exactly lead to the lack of post-release recoveries. Hopefully in future seasons, additional fish can be captured and evaluated to provide additional data on this issue.

Due to mechanical failures, the facility was inoperable for 31 days of the 2021/2022 trapping season. Although the facility is meant to be safer and easier to operate than temporary traps, it is still vulnerable to mechanical failures that are complicated and costly to fix. The facility also requires more ongoing maintenance and repair than temporary traps. Worsening drought conditions may provide another challenge for operating the facility as it does not seem to be effective in attracting fish during low flows. As these conditions have persisted for the last few years, salmonid capture at the facility has greatly decreased and events such as the dissolved oxygen drop in October 2021 may become more prevalent in the bypass and possibly throughout the valley. Passage barriers downstream of the facility, especially during low flows, also reduce salmonid catch due to debris build up or water diversion operations. Infrastructure improvement projects are scheduled to take place within the next one to two years, such as the replacement of Ag 4 with a concrete bridge. Such projects should help alleviate issues with debris build up and water diversions causing passage issues for fish in the bypass. With so few fish captured at the facility in the past few seasons, it has been difficult to determine the reason behind the lack of post release recoveries. Further study is needed to fully analyze why there is such a lack of detections post release. Although the facility continues to provide a more stable and permanent means of salvage for the Department, it is not a permanent solution to the issue of adult salmonid and sturgeon entrainment in the bypass. Fish that reach the facility have already taken an approximately 40-mile detour from the delta, via the CSC, and into the KLRC. Volitional passage back to the river is not possible at this point, so human intervention is required. The detour and handling associated with capture and relocation from Wallace are additional stressors that would otherwise not be present had these fish not strayed into the bypass.

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