

Memorandum

DATE: 10 June 2021

TO: Roland Sanford, Chris Lee, and Rich Marovich, Solano County Water

Agency (SCWA)

FROM: Tim Salamunovich, TRPA Fish Biologists

RE: Results of October 2020 Lower Putah Creek Fish Surveys

TRPA Fish Biologists staff have been sampling the fish fauna of lower Putah Creek using tote barge electrofishing since August 1991. Students from the University of California at Davis (UCD) have been regularly sampling the creek near campus using a combination of boat/backpack electrofishing, seining, and gill netting each fall since 1978. Following the May 2000 Putah Creek Accord, TRPA continued surveying multiple sites along the creek each October as part of an annual fish monitoring program under the aegis of the Lower Putah Creek Coordinating Committee (LPCCC). The Accord requires a schedule of maintenance flows below the Putah Diversion Dam (PDD) to maintain a live stream in the 14.8-mile-long section of stream downstream to the U.S. Interstate 80 Bridge (Table 1). The Accord also requires two additional seasonal supplemental flow releases. The first supplemental flow release in late fall is required to attract anadromous fish into lower Putah Creek to spawn. A second elevated period of flow (if it does not occur naturally) is required in the late winter or early spring to enhance native fish spawning opportunities in the lower basin.

Table 1. Mean daily flow requirements for Putah Creek at Interstate 80 Bridge.

Month	Minimum Flow Requirement (cfs)
October	5
November/December	10
January/February	15
March	25
April	30
May	20
June/July	15
August	10
September	5



A database containing all the raw fish monitoring data for the entire period of record is managed by TRPA and is regularly updated and provided to both the Solano County Water Agency (SCWA), UCD personnel, and the LPCCC. The data through 2008 was the focus of a scientific publication (Kiernan et al. 2012) that demonstrated the recovery of native fishes in the upper 12.5 miles of the creek (upstream of Pedrick Road [County Road 98]) following the prolonged low-flow drought that occurred in the late 1980's and early 1990's and the native fish rearing and spawning flows instituted under the Accord.

A TRPA crew sampled seven sites along 19 miles of the lower creek between PDD and Mace Boulevard (County Road 104; Figure 1) on 19-30 October 2020. This memo report will present the results of this sampling effort. The annual sampling at the Alpha Phi Omega Pool and the 1 Kilometer Sites was not conducted in the fall of 2020 due to pandemic restrictions.

The objective of fish monitoring surveys is to determine the distribution and relative abundance of fish populations in lower Putah Creek. At two of the sites (Mace Blvd. and Old Davis Road) biologists captured fish using a Smith-Root gas powered generator and pulsator (model 5.0 GPP) operated out of a small pram. Two biologists wading alongside the pram (aka tote barge) used electrofishing probes to attract and stun fish. Two additional biologists netted and captured stunned fish and transferred them to buckets located in the front of the pram. A fifth person rowed or pulled the pram and was responsible for shutting off the electric current in the event of a mishap. During the 2020 survey, moisture in the junction box and shorting in the control box prevented continued sampling with the tote barge. Instead, fish were captured at the remaining five sites using two battery-powered Smith-Root backpack electrofishers (combination of models LR-24, 12B, and 11A).

Sampling effort emphasized the margins of the creek around instream cover and overhead vegetation, and additional effort was allocated to open water portions of the creek. Total effort expended at each site was made approximately equal by a combination of measurements of stream area and shocking seconds. The use of backpack electrofishers limited sampling to waist-deep water and two of the regularly sampled sites with extensive areas of moderately deeper water (Dry Creek Site and Russell Ranch Site) were not included in the 2020 surveys. Additionally, the backpack electrofisher wading depth restrictions limited the sampling at the



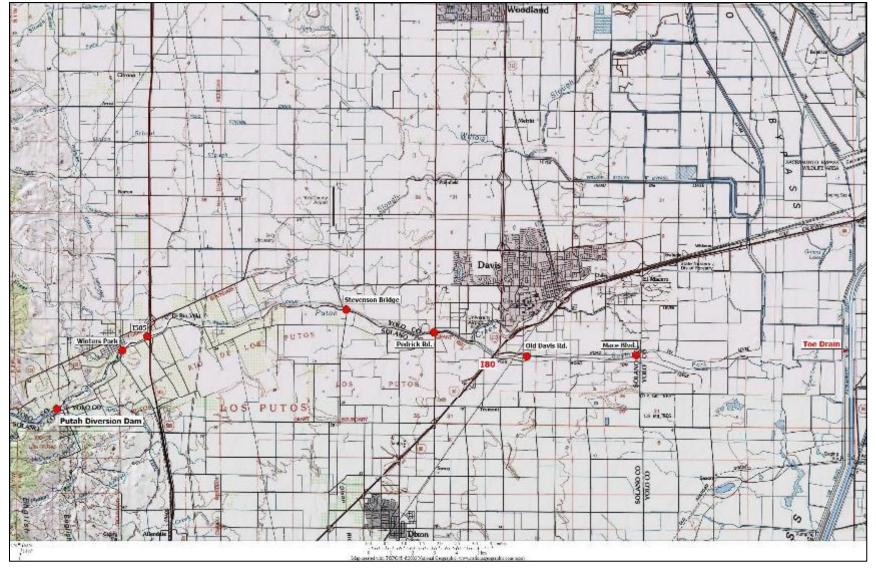


Figure 1. Map showing the seven TRPA locations (red circles) surveyed along lower Putah Creek in October 2020. Locations of the U.S. Interstate 80 Bridge and the Toe Drain are shown in red text.



Winters Putah Creek Park Site to about 400 feet of habitat, with most effort located near the downstream rock weir and the car bridge areas.

All stunned fish were netted and held in 5-gallon buckets of creek water equipped with small bait-bucket aerators. Captured fish were periodically transferred to a live cart until the completion of sampling. Fish were identified and measured to the nearest millimeter using either fork length (FL) or total length (TL). All rainbow trout (*Oncorhynchus mykiss*) captured during the surveys were weighed to evaluate condition factor. Condition factor is a commonly used measure of the trout population health. The condition factor compares the length and weight relationship of individual fish to assess their physical condition (Everhart et al. 1975). Higher condition factors indicate heavier fish for a given length. Trout were anesthetized in weak CO₂ solution with the addition of API® Stress Coat+ prior to handling to reduce movement and injury during the measurement and weighing process. Stress Coat is reported to protect and heal fish by replacing electrolyte loss and by the formation of a synthetic slime coating on the skin of fish and by replacing the natural secretion of slime that is typically interrupted by handling. After handling, all trout recovered in an aeration bucket until fully mobile prior release back into the creek.

Mean daily flow in lower Putah Creek measured at the PDD release point during the 2020 Water Year (WY) is shown in Figure 2. WY 2020, which ended three weeks prior to the fish sampling, was classified as a dry water year in the Sacramento basin according to the Sacramento Valley 40-30-30 Hydrologic Classification Index (DWR California Data Exchange Center, Water Supply Index WSIHIST). WY 2020 was the first dry or critical water year in the Sacramento Valley since 2015.

The mean annual flow in the lower basin was 41.4 cubic feet per second (cfs), or about one-twelfth of mean annual flow measured during the previous WY 2019 (which was classified as a wet water year). The maximum flow during WY 2020 was 115 cfs on 29 March 2019 cfs and it occurred as part of the early spring native fish spawning flow release (Figure 2). Typical managed flows in the 43 to 25 cfs range prevailed from early May through the October surveys. An unusual managed elevated flow episode occurred during late spring through early summer in order to provide water to downstream riparian diversions while still maintaining the required



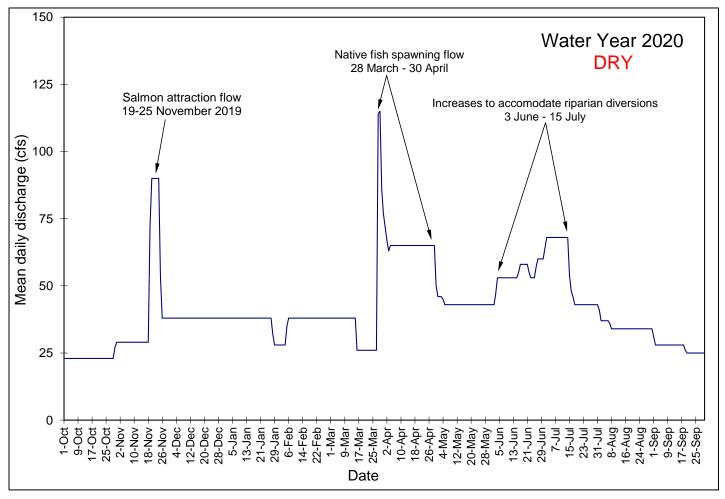


Figure 2. Estimates of the mean daily discharge (in cubic feet per second [cfs]) released into lower Putah Creek at the Putah Diversion Dam during the 2020 Water Year and prior to the October 2020 fish survey. Data from the U.S. Bureau of Reclamation Mid-Pacific Region, Central Valley Office, Reservoir Operations Reports.

Table 2. Number of days that mean daily releases from Putah Diversion Dam exceeded certain values during the 2020 Water Year (1 October 2019–30 September 2020). Data from USBR Mid-Pacific Region, Central Valley Operations Website.

Exceedance (cubic feet per second)	Number of Days
≥ 125 cfs	0
≥ 100 cfs	2
≥ 50 cfs	83
≥ 30 cfs	269



15 cfs minimum flow at the I80 Bridge for those months (Table 1). The exceedance flows for WY 2020 are shown in Table 2. The overall lack of high natural flow events in lower Putah Creek basin were the result of a dry water year conditions when only 12.2 inches of rain were recorded at SCWA's PDO gage between December through March [BOR 2020]). Lake Berryessa did not spill during the 2020 water year.

Stream flows during the late October 2020 TRPA fish monitoring surveys varied and decreased according to distance downstream from the PDD release site, ranging from 30.6 cfs at the Putah Diversion Dam to 9.2 cfs at Mace Boulevard (Table 3).

Table 3. River mile location, sample date, survey time, stream flow, water temperature, dissolved oxygen concentration, conductivity, and salinity at time of survey for the seven lower Putah Creek study sites during the October 2020 fish monitoring surveys. River mile location is the distance upstream of point where creek enters Toe Drain.

Site	River Mile	Date	Time	Flow ^{1/} (cfs)	Temp (°C)	DO (mg/L)	Cond (µS/cm)	Salinity (ppt)
Mace Boulevard Bridge	6.4	10/19/20	1212	9.2	18.7	14.22	361.8	0.2
Old Davis Road Bridge	9.8	10/19/20	1448	9.3	18.9	8.61	371.9	0.2
Pedrick Road Bridge	12.6	10/20/20 2/	0900	13.0	15.5	7.72	283.0	0.2
Pedrick Road Bridge	12.6	10/29/20	0915	12.2	10.3	9.31	246.2	0.2
Stevenson Road Bridge	15.4	10/29/20	1225	12.2	11.2	7.92	252.0	0.2
Interstate 505 Bridge	21.5	10/29/20	1510	17.1	12.4	8.33	253.6	0.2
Winters Putah Creek Park	22.3	10/30/20	0943	17.5	11.2		245.2	0.2
Putah Diversion Dam	25.4	10/30/20	1240	30.6	12.9		254.8	0.2

^{1/} Flow data provided by Solano County Water Agency

2/ aborted effort due to equipment malfunction

Water temperatures measured during the October 2020 surveys varied by site as a function of both the time of day and the distance downstream of the Putah Diversion Dam release point (Table 3). The temperatures ranged from 10.3° to 18.9°C (50.5° to 66.0°F). Water conductivity (a measure of total dissolved solids) was higher at the downstream survey sites and conductivity did not vary in the survey area. Dissolved oxygen levels were relatively high and exceeded 7.7 mg/L at all the sites.

The Fall 2020 fish surveys of seven sites along lower Putah Creek captured a total of 1,411 fish representing 19 species (Table 4). Two California native fish species: Sacramento pikeminnow (*Ptychocheilus grandis*) and prickly sculpin (*Cottus asper*) made up over thirty-two percent of



Table 4. Capture data for the October 2020 TRPA fish monitoring surveys on lower Putah Creek.

Fish	PDD	WPK	1505	STEVE	PED	OLD	MACE	Total
Native Fishes								
Sacramento pikeminnow (PKM)		1	8	61	105			175
,		(89 FL)	(80-118 FL)	(45-162 FL)	(63-291 FL)			
Hitch (HTC)		, ,	,	,	15			15
					(68-120 FL)			
Sacramento sucker (SKR)	6	8	15	1	13			43
	(56-168 FL)	(49-99 FL)	(48-161 FL)	(188 FL)	(130-278 FL)			
Rainbow trout (RBT)	61	10	12	2				85
	(118-434 FL)	(99-158 FL)	(103-152 FL)	(131-156 FL)				
Threespine stickleback (SBK)	14							14
. , ,	(43-58 TL)							
Prickly sculpin (PKS)	70	59	137	1	8	6	1	282
	(38-140 TL)	(40-92 TL)	(36-97 TL)	(85 TL)	(71-97 TL)	(65-102 TL)	(55 TL)	
Riffle sculpin (RFS)	1	3	3					7
/	(76 TL)	(66-73 TL)	(74-95 TL)					
Tule perch (TP)	, ,	4	9	37	11			61
		(63-121 FL)	(53-92 FL)	(81-128 FL)	(96-119 FL)			01
Exotic Fishes		·	(/	(- /	(/			
Black bullhead (BLBH)							1	1
(====,							(137 TL)	•
White catfish (WCF)						1	` '	1
						(178 FL)		•
Golden shiner (GSH)						· -· -/	1	1
Column (COII)							(141 FL)	ı
Mississippi silverside (MSS)						1	122	123
viississippi siiveiside (IVISS)						(54 FL)	(25-86 FL)	123
Mostorn magazitafi-b (MACO)					4	(J+1 L)		0
Western mosquitofish (MSQ)					4 (25-66 TL)		4 (18-38 TL)	8
Olive will (DCC)	0					400		250
Bluegill (BGS)	2 (71 77 EL)				4 (107 146 EL)	109	244 (92.169.EL)	359
, , , (DEO)	(71-77 FL)				(107-146 FL)	(43-136 FL)	(82-168 FL)	
Redear sunfish (RES)						1 (405 51)	32	33
						(125 FL)	(105-179 FL)	
Green sunfish (GSF)						13	10	23
						(53-115 FL)	(41-147 FL)	
Smallmouth bass (SMB)					2			2
					(90-94 FL)			
Largemouth bass (LMB)				2	30	54	89	175
				(61-205 FL)	(85-182 FL)	(65-193 FL)	(68-280 FL)	
Bigscale logperch (BLP)						1	2	3
						(122 TL)	(109-110 TL)	
Total # Individuals	154	85	184	104	192	186	506	1,411
# native fish	152	85	184	102	152	6	1	682
# exotic fish	2	0	0	2	40	180	505	729
Total # species	6	6	6	6	9	8	10	19
# native species	5	6	6	5	5	1 7	1	8
# exotic species	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0	0	1	4	7	9	11
Shannon's Diversity (In)	1.159	1.042	0.953	0.922	1.507	1.081	1.350	2.798
Eveness (H'/Hmax)	0.647	0.581	0.532	0.515	0.462	0.520	0.586	0.859



the total catch in the lower basin (Figure 3) and had the widest distribution of any of the native species (Table 4). The most abundant non-native species included bluegill sunfish (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and Mississippi silverside (*Menidia audens*) which contributed over forty-six percent of the total catch and were limited to the downstream study sites.

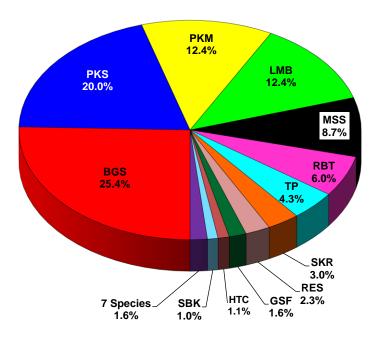


Figure 3. Percentage of total catch by fish species for the October 2020 lower Putah Creek fish surveys.

Especially noteworthy was the low abundance of native Sacramento sucker (*Catostomus occidentalis*), which made up only 3 percent of the total catch. Over the previous eight surveys (2012-2019) suckers averaged 19.4 percent of the total catch (range 12.9% to 35.8%) from the TRPA survey sites, with most of the abundance dominated by young-of-the-year and one year old fish. It is not clear what caused the low abundance of suckers, but lack of large adult spawners the previous spring may have contributed to the poor recruitment noted in the October 2020 surveys. Continued monitoring may help document the status of this important native fish in lower Putah Creek.



Eight-five rainbow trout were captured in the fall surveys, or six percent of the total catch (Table 4; Figure 3). While rainbow trout were most abundant at the most upstream PDD site, they were present at all four sample sites surveyed in the upper ten miles of the study area.

The rainbow trout that were captured had a robust body form and appeared to be healthy and in good condition (Plates 1 and 2).





Plate 1. Rainbow trout captured during the October 2020 surveys at Stevenson Road Site.
A: Fork Length (FL) = 5.2 inches/ Condition Factor (CF)= 1.28; B: FL= 6.1 inches / CF= 1.22





Plate 2. Examples of rainbow trout captured during the October 2020 surveys at Putah Diversion Dam Site. A: Fork Length (FL) = 6.4 inches/ Condition Factor (CF)= 1.26; B: FL= 6.9 inches / CF= 1.40; C: FL= 11.7 inches / CF= 1.27; D: FL= 17.1 inches / CF= 1.41.



The average condition factor for the rainbow trout was 1.22, and individual values ranged from 1.07 to 1.44. These values are considered high compared to other streams and indicate a healthy and robust trout population. The rainbow trout captured at the Stevenson Site were the first *O. mykiss* documented this far downstream in Putah Creek since the June 2000 TRPA surveys.

Of the total fish captured in the October 2020 survey, 48 percent (682 fish from eight species) were native fish endemic to the Sacramento River basin, while 52 percent (729 fish from eleven species were non-native, or exotic fishes (Table 4; Figure 4).

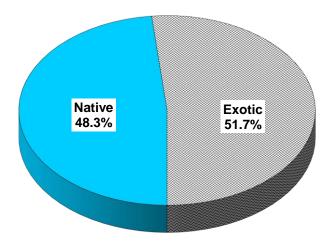
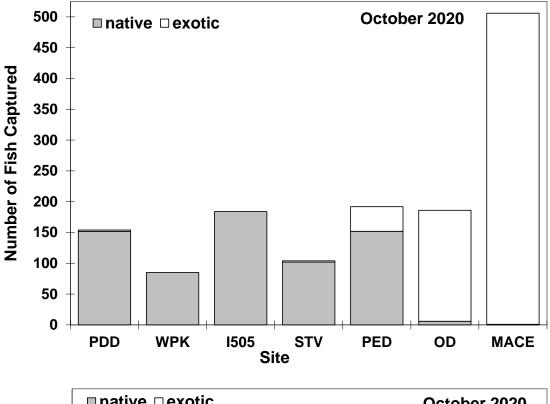


Figure 5. Percentage of total catch by native versus non-native (or exotic) species for the October 2020 lower Putah Creek fish survey.

The overall spatial distribution of fishes from the October 2020 survey remains similar that noted in recent prior surveys and continues to demonstrate that lower Putah Creek supports a highly diverse fish fauna. Native fish continue to dominate the 12.7 miles of the lower basin between the PDD at Winters and the Pedrick Road Bridge Site near Davis (Table 4; Figure 6). About 2.8 miles downstream from Pedrick, at the Old Davis Site, exotic species are more abundant and in the twelve miles of creek downstream of the Pedrick site, non-native fish dominate Putah Creek (Figure 6).





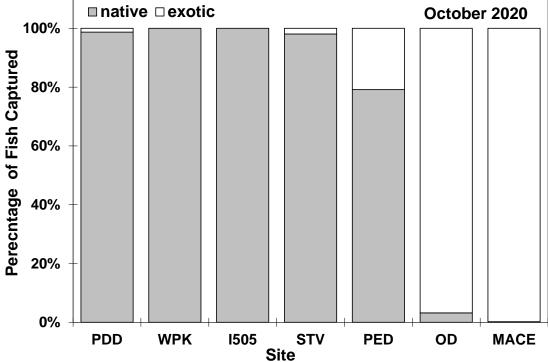


Figure 6. Number (top) and percentage (bottom) of native and exotic fish captured at the seven lower Putah Creek study sites sampled during the October 2020 fish surveys.



Despite the lack of high flows in the Putah Creek basin during 2020, exotic fish did not appear to have been able to expand their distribution in lower Putah creek. Native fish continue to dominate the fish populations at the Pedrick Road Site and they show the same overall abundance noted in October 2019 following a wet year with extended periods of high flow in the Putah Creek basin (Salamunovich 2020a; Figure 7). Non-native fish continue to dominate the fish populations downstream of Pedrick Road.

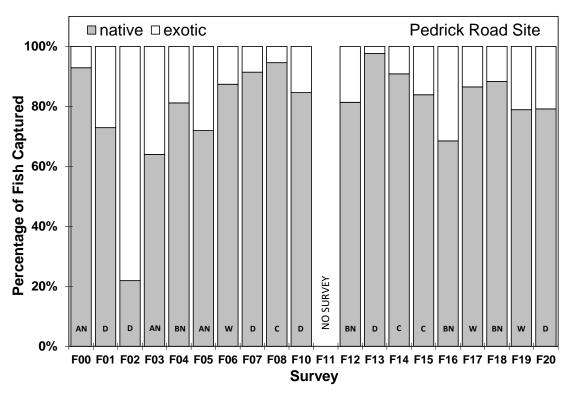


Figure 7. Percentage native and exotic fish captured at the Pedrick Road Site during the Fall fish surveys since 2000. Sacramento Valley Water Year Types: W = wet; AN = above normal; BN = below normal; D = dry; C = critical.

This consistent pattern for native fish dominance at Pedrick Road and sites upstream, and nonnative fish dominance downstream is likely a result of some environmental factor such as summer water temperatures that appear to limit the downstream extent of the native fish fauna, which tend to prefer and thrive in cooler water temperatures compared to the non-native fishes, which tend to consist of slow-water pond species that are more tolerant of higher



summer water temperatures. The Pedrick Site is likely near the interface where the native/exotic species meet and interact. The 2019 catch data show that native fish continue to dominate the catch in the upper 12.7 miles of the study area between the PDD and Pedrick Bridge (Table 4). In fact, only two non-native fish (both bluegill sunfish) were captured in the upper 4.0 miles of the study area, and native fish made up over 99 percent of the total catch at the four study sites located in the upper ten miles of the study area from PDD to Stevenson Bridge Road (Table 4).

The spatial distribution of exotic fishes in the lower basin also varied by species (Table 4). Black bullhead (*Ameiurus melas*), white catfish (*A. catus*), golden shiner (*Notemigonus crysoleucas*), and smallmouth bass (*Micropterus dolomieu*) were limited to single locations in the lower basin, while Mississippi silverside, redear sunfish (*Lepomis microlophus*), green sunfish (*Lepomis cyanellus*), and bigscale logperch (*Percina macrolepida*) were documented at only two sites (Table 4). Largemouth bass and bluegill sunfish, on the other hand, were widely distributed in the 2020 surveys and were captured at four of the seven survey sites. While these two exotic sunfish had a relatively wide distribution, their highest densities occurred along the lower 6.0 miles of the survey area, downstream of Pedrick Road (Table 4).

The increasing abundance of non-native "panfish" to the total catch of fish in lower Putah Creek noted during the past several years continued in 2019. This "panfish" group is comprised of the smaller sunfish of the genus *Lepomis* and includes bluegill, green sunfish, redear sunfish, warmouth (*L. gulosus*), and various hybrids forms (referred to here as "lepomids"). Prior to 2010, green sunfish and bluegills were among the most common species of fish found in lower Putah Creek. In the six fall surveys conducted between 2003 and 2008, lepomids made up 28.1 percent of the total captured fish and averaged 1,462 lepomids per survey. In the six complete, basin-wide surveys between 2010 and 2016, lepomids had declined to only 4.4 percent of the total captures and averaged only 199 lepomids per survey. During the 2020 survey, a total of 415 lepomids were captured, or over 29 percent of the total catch (Table 4).

The scarcity of lepomids in 2012 through 2016 is especially surprising since these five water years were all classified as below normal (or drier) in the Sacramento Valley, with few periods of natural high flows that are considered to interfere with sunfish spawning. Non-native sunfish



species usually thrive during these low flow and warm water conditions. The increase of sunfish since 2017 was surprising given the greater than normal winter and spring flows in 2017 and 2019, which would have been expected to disrupt their spawning. It appears that these sunfish populations are in a natural cycle of increasing abundance among the Putah Creek fish populations.

The 2020 electrofishing survey included the Winters Putah Creek Nature Park site, which represents a relatively new sample site along lower Putah Creek that has been surveyed only since 2012. In November 2011, a channel realignment and floodplain restoration project (Winters Park Project) was completed along a 3,700-foot-long section of Putah Creek. This project was designed to restore natural channel form and function, enhance habitat of native species and improve public access in a reach that had been mined extensively for gravel and otherwise enlarged, straightened and dammed for flood conveyance and seasonal water storage. This project included removing an historic concrete low flow barrier (Winters Percolation Dam built in 1938 [Sears 2010]), reconfiguring the creek channel to a narrower and shallower meandering form, lowering elevation of the inset floodplain, and replanting native plants along the riparian corridor. Three existing riffles were augmented with additional gravel substrates and 14 new riffles were created at 200-foot intervals by importing 2,000 tons of salmon spawning gravel mix (Rich Marovich, personal communication). It was anticipated that this channel realignment project would eliminate the extensive areas of large deep pool habitat that acted as a heat sink and harbored large predatory non-native basses, and instead create hydraulically diverse and cooler water habitat that would benefit native fish, including salmonids. Fish salvage and relocation efforts conducted in the project area in September 2011 (prior to construction) found only one rainbow trout in this section of Putah Creek (Peter Moyle, personal communication). Since the November 2011 channel restoration, rainbow trout have regularly been captured in this area. However, the high flows associated with Lake Berryessa spills during the late winter and early spring of 2019 resulted in sand deposition throughout the Winters Park channel restoration area that filled in many of the pools and covered many of the gravel riffles and the upper weir site (Salamunovich 2020a). Despite these recent habitat changes, the 2020 survey of about 400 feet of shallow water habitat in the Winter Park area still captured ten juvenile rainbow trout (Table 4).



The spawning escapement of Chinook salmon (*Oncorhynchus tshawytscha*) into lower Putah Creek for the late-fall of 2019 was less than 50 adult fish (Salamunovich 2020b). Despite the low abundance of adult spawners in the fall of 2019, successful juvenile Chinook production was documented during snorkel surveys conducted in the late winter of 2020, following fry emergence. Over-summer rearing juvenile Chinook have been noted during past fall fish surveys (Salamunovich 2017 and 2019). While most juvenile Chinook salmon smolt and migrate during the first three months after hatching, some juveniles can remain in cold water areas through their first summer and then migrate to the Delta and ocean during first rains of the fall and early winter as yearlings (Moyle 2002). Late summer 2020 snorkel survey counts suggested that few juvenile salmon remained in the lower Putah Creek basin. Not surprisingly, no juvenile salmon were captured during the October 2020 electrofishing surveys.

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