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Memorandum

DATE: 13 May 2022
TO: Roland Sanford, Chris Lee, and Alex Rabidoux, Solano County Water Agency
FROM: Tim Salamunovich, TRPA Fish Biologists
RE: October 2021 Western Solano County Streams Fish Survey – Final Report

Introduction

Prior to 1999, Solano Irrigation District (SID) conducted annual maintenance for the Putah South Canal (PSC) that included flushing water from the canal into several western Solano County creeks via canal wasteways. In late December 1998 and early January 1999 this practice resulted in the deposition of fine sediment in the Suisun Creek stream channel. Most deposition was in the one-mile reach between the PSC and the Morrison Lane Bridge (Figure 1) and was largely concentrated in the first 600 feet of stream below the canal (Thomas R. Payne & Associates 1999a). Ten days of intensive clean-up effort using a suction dredge followed by five weeks of prolonged high stream flows removed or transported the fine sediment depositions from the area. A resurvey of the affected area of Suisun Creek and additional areas downstream in mid-March 1999 did not find any significant fine sediment deposits remaining (Thomas R. Payne & Associates 1999b). Re-survey of the Suisun Creek below the PSC in late October 2000 found few fine sediment deposits (Thomas R. Payne & Associates 2000). In 1999 SID discontinued flushing sediment from the PSC wasteways as part of their standard maintenance operations.

Fish surveys in Suisun and Green Valley basins were first conducted in the summer and fall of 1999 to augment the sediment survey data collection as assess the potential impacts from the sediment deposition on fish populations. Ledgewood Creek sites were included when the basin surveys were repeated in 2000 and 2001 to provide additional information on the distribution and abundance of fish within these basins that intersect the PSC, two of which (Suisun and Green Valley) had been subjected to annual canal wasteway release prior to 1999 (Thomas R. Payne and Associates 1999c, 2000, and 2001). All three creeks had continuous stream flow at the time of these summer and fall surveys. Fish populations throughout the basins were composed almost entirely of native species and no impacts from the early 1999 sediment deposition were found. One hundred and sixty-nine rainbow trout/steelhead (*Oncorhynchus mykiss*) were captured in the Suisun and Green Valley basins during 1999-2001 surveys. No *O. mykiss* were found in Ledgewood Creek.

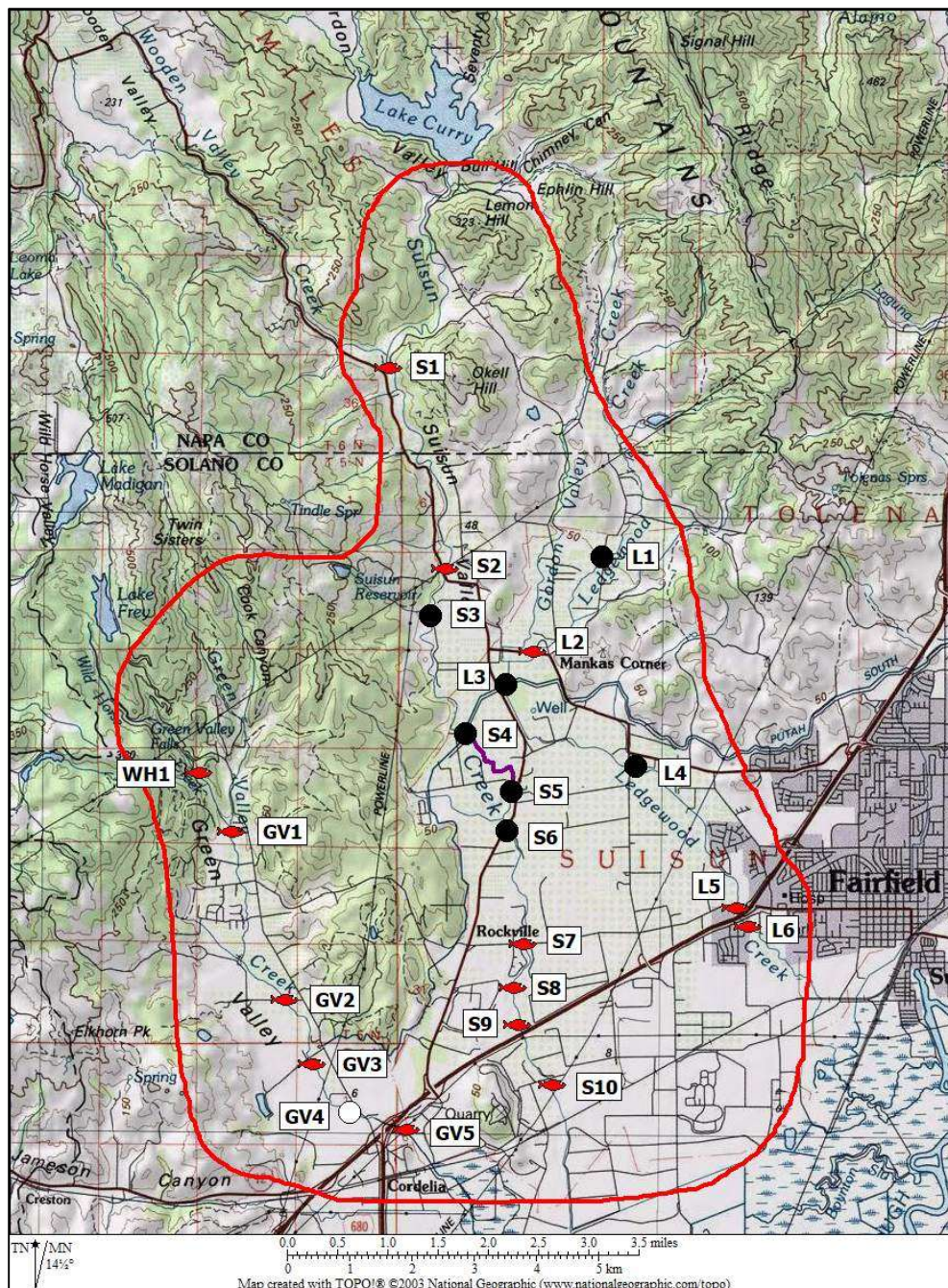


Figure 1. Western Solano County stream sites surveyed 11-14 October 2021: WHC1=Wild Horse at Green Valley Water Treatment Plant; GV1=Green Valley at Country Club; GV2=Green Valley at Mason Rd; GV3=Green Valley at Reservoir Ln; GV4=Green Valley at Turner Ct; GV5=Green Valley at Commerce Ct; S1=Suisun at Wooden Valley X Rd; S2=Suisun at upper Suisun Valley Rd; S3=Suisun at Caymus/Vezer; S4=Suisun at PSC; S5=Suisun at lower Suisun Valley Rd; S6=Suisun at Morrison Ln; S7=Suisun at Rockville Rd; S8=Suisun at Solano College; S9=Suisun at Suisun Pkwy; S10=Suisun at Cordelia Rd; L1=Ledge at Clayton Rd; L2=Ledge at Mankas Corners; L3=Ledge at PSC; L4=Ledge at Abernathy Rd; L5=Ledge at Rockville Rd; L6=Ledge at Auto Mall Pkwy; Sampling conducted at flowing (red fish) sites. No sampling at dry (black dot) or excessively deep (white dot) sites. Purple line shows Suisun Creek reach between the PSC and Morrison Lane.



After a fifteen-year hiatus, fish surveys restarted in late August 2016 after five consecutive years of below normal to critical water years (Normandeau Associates 2017). Streamflow in both Suisun and Ledge wood creeks was intermittent, and no trout were captured in either basin. No trout were captured in either Suisun or Ledge wood creeks and fewer *O. mykiss* were found in the Green Valley basin in 2016 compared to the prior surveys. The 2016 fish monitoring also showed higher percentages of non-native fish, especially bluegill sunfish, in the intermittent reaches of Suisun Creek. Despite the local changes in fish fauna noted in 2016, native species still dominated the fish fauna in the Suisun, Green Valley, and Ledge wood basins. Sculpin, roach, pikeminnow, and sucker remained abundant and widely distributed in both the Suisun and Green Valley basins.

Surveys were repeated in the summer of 2017 following a wet winter, and the first above average water year in seven years (Normandeau Associates 2018). Continuous streamflow conditions were present in both Suisun and Green Valley creeks, with intermittent flows in Ledge wood Creek. Despite the return of continuous streamflow in August 2017, no rainbow trout were captured at any of the seven Suisun Creek survey sites. The August 2017 surveys found fewer exotic fish in the non-tidal areas of Suisun Creek compared to 2016. The 2017 surveys found healthy trout populations in the upper Green Valley basin, especially in Wild Horse Creek and in Green Valley Creek near the confluence of the two creeks. The 2017 fish monitoring indicated that native California species continue to dominate the aquatic habitat in the Suisun, Green Valley, and Ledge wood basins.

Fish surveys were conducted in the three western Solano County stream basins during the summer of 2018, a below normal water year (Normandeau Associates 2019). Despite continuous streamflow during the August 2018 surveys, no rainbow trout were captured in Suisun Creek survey sites. The 2018 surveys found healthy trout populations in the upper Green Valley basin, especially in Wild Horse Creek and in Green Valley Creek near the confluence of the two creeks. The 2018 fish monitoring indicated that native California species continue to dominate the populations of all three western Solano County basins.

In 2019, a wet water year, the fish surveys were in the three western Solano County stream basins were delayed until early October at the request of CDFW in order to conduct surveys during cooler daytime water temperatures (TRPA Fish Biologists 2020). Despite continuous streamflow during the October 2019 surveys, only one rainbow trout was captured at the nine Suisun Creek sites sampled. The 2019 surveys continued to find healthy trout populations in the upper Green Valley



basin, especially in Wild Horse Creek and in Green Valley Creek near the confluence of the two creeks. The 2019 fish monitoring indicated that native California species continue to dominate the populations of all three western Solano County basins.

Fish surveys were repeated during the fall of 2020, a dry water year, and intermittent streamflow was noted in the Suisun basin, with long stretches of dry stream channel evident throughout the middle portion of the basin (TRPA Fish Biologists 2021). Despite the intermittent flow, native fish dominated the Suisun Creek catches, and one *O. mykiss* was captured, which was only the second documented capture of a trout in the basin in the last five years of recent sampling. Native fish also dominated the fall 2020 fish populations in the Green Valley basin. Two potentially concerning issues suggested from the 2020 survey include the lack of *O. mykiss* captures at the Green Valley Country Club site and the relatively large percentage of trout at the Wild Horse Creek site exhibiting lower condition factors compared to past surveys (TRPA Fish Biologists 2021). Both survey sites represent optimal over-summer rearing habitat required by anadromous steelhead that typically remain and rear in freshwater for at one to two years before migrating to sea, where they mature to adulthood. Both the Green Valley Country Club and Wild Horse Creek sites combine suitable water temperature, instream and overhead cover, stream habitat diversity, gradient, and lack of streamside development and trout populations at both sites represents the most reliable indication on the status of trout in the Green Valley Basin. The 2020 fish monitoring indicated that native California species continue to dominate the populations of all three western Solano County basins.

This report will present the results of the latest surveys conducted in the fall of 2021, following a critical (i.e., critically dry) water year in the Sacramento Valley according to the Sacramento Valley 40-30-30 Hydrologic Classification Index (DWR California Data Exchange Center, Water Supply Index WSIHIST).

Methods

Fish surveys were conducted using a portable backpack electrofisher to stun and capture fish at sites distributed along Suisun, Green Valley, and Ledgebrook creeks where access could be arranged and where suitable habitat conditions existed (i.e., flowing water or isolated pools that could be safely waded). Captured fish were held in a bucket equipped with a small aerator until completion of the survey, at which time they were identified and measured to the nearest millimeter fork length (FL) (or total length [TL] for stickleback and sculpin).



Trout were weighed to the nearest 0.1 gram on an electronic scale. Prior to handling, trout were anesthetized in a weak CO₂ solution using commercially available effervescent pain-relief tablets (two tablets: $\frac{3}{4}$ gallons of clean river water). In addition, $\frac{1}{4}$ teaspoon (1.25 ml) API® Stress Coat+ was added to the anesthetic water bucket. 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.

Fulton's Condition Factor (K) was calculated for trout using the formula of Bagenal and Tesch (1978). 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. A value of 1.0 is generally considered normal for a healthy trout. After processing, all fish were released back to the site of capture. Trout were held for an extended period in a bucket of aerated water and allowed to fully recover prior to release back to the site of capture.

The length of sample reaches at each site varied based upon the length of individual habitat units (i.e., pool, riffle, run). Generally, several hundred feet of stream was sampled at each site with continuous flow and typically this included a minimum of three riffle-pool sequences. In those cases where only intermittent pool habitat was present, one or two intermittent pools were sampled.

It should be noted that surveys provide data on the relative abundance of fishes at each study site and should not be construed as suitable for determining population estimates. It was not possible to capture every fish within the study reaches, and capture success varied among the various species and life stages at a particular site as well as between sites based largely on water salinity, conductivity, turbidity, and instream cover.

Some water quality parameters were measured at the time of the fish surveys and included water (and air) temperature, conductivity, pH, and salinity. Dissolved oxygen concentrations were not recorded during the surveys due to meter malfunction.



Results

Suisun Creek

Ten sites distributed along a 9.7-mile-long reach of Suisun Creek were visited on 11-14 October 2021 and included sites where access could be obtained from Wooden Valley Cross Road (in Napa County) downstream to Cordelia Road (Figure 1).

The City of Vallejo typically maintains a continuous release of water of two to three cubic feet per second (cfs) from Lake Curry into upper Suisun Creek (BOR 2003). During the October 2021 survey, a release of one cfs was being provided from Lake Curry (John Palesi, City of Vallejo Water Department, personal communication, 18 October 2021 email). Continuous stream flow was noted at six of the ten Suisun Creek sites during the October 2021 surveys (Plate 1) and flow was visually estimated to range from 0.1 to 1.0 cfs at the sites (Table 1). Somewhere downstream of the upper Suisun Valley Road Bridge stream flow appeared to go subsurface and at the four sites in the 3.5 miles of the Suisun Creek channel between the Caymus Vineyards Site and the lower Suisun Valley Road Bridge there was no surface flow, and the channel was completely dry (Plate 2).

Water temperatures at the Suisun Creek sites ranged from 12.5° to 15.4°C to (54.5° to 59.7°F; Table 1). The October 2021 water temperatures were considerably cooler than those noted during the previous October 2020 survey when Suisun Creek water temperatures were about four degrees Centigrade warmer (TRPA Fish Biologists 2021).

The October 2021 dissolved oxygen (DO) concentrations varied by site and ranged from 5.1 to 9.5 milligrams per liter (Table 1) and were at or near levels considered optimal for trout at five of the six sites. Only the Upper Suisun Valley Road Site had lower dissolved oxygen, which measured less than 50 percent saturation. Dissolved oxygen levels of 8 mg/L or higher are typically considered optimal for trout at ambient temperatures (Raleigh et al. 1984; Carter 2005) and concentrations near saturation are required for growth (Moyle 2002). The incipient lethal level of dissolved oxygen for adult and juvenile rainbow trout is about 3 mg/L (Matthews and Berg 1997). Dissolved oxygen levels were above these lethal levels at all six sites.

Water conductivities at the Suisun Creek sites ranged from 280 to 420 microSiemens per centimeter ($\mu\text{S}/\text{cm}$), which are suitable for satisfactory electrofishing, while the pH levels were good and averaged 6.4 for the six Suisun Creek sites (Table 1).



Plate 1. Photographs of full flow conditions in Suisun Creek in mid-October 2021. A: Cordelia Road Site; B: Suisun Parkway Site; C: Solano College Site; D: Rockville Road Site; E: Upper Suisun Valley Road Site; F: Wooden Valley Cross Road Site.



Table 1. Suisun, Green Valley, and Ledge wood creeks survey sites (listed from downstream to upstream), site length, sample date, survey time, stream flow estimate, air temperature, water temperature, dissolved oxygen, conductivity, and salinity at time of survey for the 11-14 October 2021 fish monitoring surveys.

Site	Length (ft)	Date	Time	Flow ^{1/} (cfs)	Temperature (°C)		Dissolved Oxygen		Conductivity (µS/cm)	Salinity (ppt)	pH
<u>Suisun Creek</u>											
Cordelia Road	530	10/11/21	1620	1.0	20.6	15.0	7.85	78.0	340.7	0.2	6.7
Suisun Parkway	630	10/12/21	1531	0.5	21.1	15.4	8.90	89.3	327.0	0.2	6.8
Solano College	370	10/14/21	0905	1.0	13.3	13.5	9.46	91.0	283.1	0.2	6.2
Rockville Road	665	10/13/21	1440	0.5	22.2	15.4	8.26	82.8	298.0	0.2	6.5
Lower Suisun Valley Road		10/13/21	0748	dry							
Morrison Lane		10/13/21	0740	dry							
Putah South Canal		10/13/21	0820	dry							
Caymus Vineyard		10/13/21	0835	dry							
Upper Suisun Valley Road	510	10/13/21	1007	0.1	17.8	13.0	5.05	48.1	422.1	0.2	6.1
Wooden Valley Cross Road	455	10/13/21	1110	0.1	21.1	12.5	8.71	82.8	353.2	0.3	6.3
<u>Green Valley Creek</u>											
Commerce Court	570	10/13/21	1525	1.0	19.4	17.9	8.84	92.8	365.2	0.2	6.6
Turner Court ^{2/}	too deep	10/11/21	1427	1.0							
Reservoir Lane	1,175	10/11/21	1318	1.0	20.0	14.6	9.38	92.2	309.3	0.2	6.6
Mason Road	465	10/11/21	1120	1.0	18.3	14.4	7.62	74.6	298.0	0.2	6.5
GV Country Club	390	10/11/21	0858	0.5	13.3	13.6	8.22	79.5	154.8	0.1	6.7
Wild Horse at GVWTP	835	10/12/21	1007	0.3	16.1	11.7	10.05	92.3	146.4	0.1	6.6
<u>Ledge wood Creek</u>											
Auto Mall Parkway	225	10/12/21	1622	0.1	20.6	16.0	10.85	108.7	670	0.4	6.6
Rockville Road	340	10/12/21	1122	0.5	21.7	13.0	8.42	80.3	670	0.4	6.4
Abernathy Road		10/12/21	1510	dry							
Putah South Canal		10/13/21	0808	dry							
Mankas Corners	525	10/13/21	1707	0.1	21.7	10.7	4.87	43.9	489	0.3	6.4
Clayton Road		10/13/21	1830	dry							

^{1/} visual flow estimate

^{2/} six-foot tall beaver dam created extensive deep pool habitat too deep to electrofish



Plate 2. Photographs of dry channel conditions in middle Suisun Creek basin in mid-October 2021. A: Lower Suisun Valley Road Site; B: Morrison Lane Site; C: Putah South Canal Site; D: Caymus Vineyard Site.

The October 2021 surveys at the six Suisun Creek sites captured a total of 585 fish from eight species (Table 2). Native California fish from six species made up 92.3 percent of the total catch in Suisun Creek. Three native fish, California roach (*Hesperoleucus symmetricus*), three spine stickleback (*Gasterosteus aculeatus*), and prickly sculpin (*Cottus asper*), were caught at five of the six Suisun Creek sites surveyed and were among the most abundant fish at each of the five sites where fish were caught, accounting for 39, 32, and 14 percent (respectively) of the total fish captures in October 2021 Suisun Creek survey (Table 2). No trout were captured at any of Suisun Creek sites in 2021.



Table 2. Capture data for the fish monitoring surveys on Suisun, Green Valley, and Ledgewood creeks, 11-14 October 2021.

	Suisun Creek						Green Valley Creek					Ledgewood Creek			Total
	CORD	PRKWY	SCC	RKV	USVR	WVX	COM	RES	MAS	GVCC	WHC	AUTO	RKV	MNKS	
Native Fishes															
Rainbow trout								1 (112 FL)	3 (86-112 FL)	1 (198 FL)	2 (125-130 FL)				7
Sacramento pikeminnow		9 (108-165 FL)						5 (131-197 FL)					2 (129-193 FL)		16
California roach	38 (30-114 FL)	87 (36-107 FL)	41 (31-93 FL)	54 (36-100 FL)		6 (41-72 FL)	1 (97 FL)	151 (25-107 FL)	44 (28-120 FL)	48 (25-122 FL)	57 (28-77 FL)	30 (43-112 FL)	11 (68-97 FL)	63 (48-87 FL)	631
Sacramento sucker		22 (149-302 FL)							2 (182-194 FL)	18 (43-222 FL)		21 (91-236 FL)	3 (156-181 FL)	44 (54-205 FL)	110
Threespine stickleback	42 (27-49 TL)	37 (31-48 TL)	41 (29-45 TL)	61 (26-59 TL)		7 (37-45 TL)	18 (34-50 TL)	15 (39-48 TL)				48 (29-44 TL)	15 (17-52 TL)		284
Prickly sculpin	63 (44-87 TL)	5 (36-73 TL)	8 (59-86 TL)	6 (68-94 TL)		1 (64 TL)	36 (52-87 TL)	6 (45-74 TL)	12 (42-72 TL)	2 (40-45 TL)	22 (27-81 TL)				161
Tule perch	3 (61-71 FL)	7 (64-123 FL)	2 (63-68 FL)				1 (74 FL)	3 (51-70 FL)							16
Exotic Fishes															
Goldfish												1 (164 FL)			1
Common Carp							1 (134 FL)								1
Mississippi silverside							89 (30-73 FL)								89
Western mosquitofish	6 (22-35 TL)		7 (23-47 TL)	27 (17-43 TL)			66 (24-50 TL)	1 (44 TL)	2 (27-44 TL)			26 (18-33 TL)	1 (47 TL)	1 (21 TL)	137
Bluegill sunfish		2 (105-113 FL)	3 (108-146 FL)												5
Green sunfish												1 (121 FL)	1 (57 FL)	1 (39 FL)	3
Total # Individuals	152	169	102	148	0	14	212	182	63	69	81	127	33	109	1,461
# native fish	146	167	92	121	0	14	56	181	61	69	81	99	31	107	1,225
# exotic fish	6	2	10	27	0	0	156	1	2	0	0	28	2	2	236
Total # species	5	7	6	4	0	3	7	7	5	4	3	6	6	4	13
# native species	4	6	4	3	0	3	4	6	4	4	3	3	4	2	7
# exotic species	1	1	2	1	0	0	3	1	1	0	0	3	2	2	6
Shannon's Diversity (ln)	1.272	1.385	1.297	1.174		0.898	1.314	0.697	0.931	0.767	0.693	1.407	1.324	0.769	1.678
Eveness (H'/Hmax)	0.790	0.711	0.724	0.847		0.818	0.675	0.358	0.578	0.553	0.631	0.785	0.739	0.555	0.654

CORD = Cordelia Rd.; PRKWY = Suisun Prkwy; SCC = Solano Community College; RKV = Rockville Rd.; USVR = Upper Suisun Valley Rd.; WVX = Wooden Valley Cross Rd.;
COM = Commerce Ct.; RES = Reservoir Ln.; MAS = Mason Rd.; GVCC = Green Valley Country Club; WHC = Wild Horse Creek at Green Valley Water Treatment Plant;
AUTO = Auto Mall Prkwy; MNKS = Mankas Corners.



The most common and abundant non-native fish captured in the October 2021 Suisun surveys was the western mosquitofish (*Gambusia affinis*) which made up less than seven percent of the total fish captured and were found at three of the six sites surveyed for fish (Table 2).

One notable result was the complete absence of fish at the Upper Suisun Valley Road site in the October 2021 survey. This fishless site appeared to be a recently watered channel. Unlike the other Suisun fish monitoring sites, the Upper Suisun Valley Road Site had bottom substrates were clean and free of fine sediment, there was no distinct algal growth anywhere, there were no aquatic invertebrates evident, and there were no crayfish found anywhere in survey area. All these unusual characteristics suggested that this area of Susin Creek was a newly watered stream channel that fish had yet to repopulate. Emails and phone conversations with the property owner confirm that the channel at this site was indeed dry as recently as the late August 2021, two months prior to our survey. It is not clear exactly what caused this change in hydrology and resulted in surface streamflow at this site during this late summer/early fall period. Perhaps here was reduction of cessation of upstream riparian or groundwater pumping that resulted in streamflow at this site. Whatever the cause, the new streamflow appeared to be localized, since there was no surface flow, and the channel was dry at the Caymus Vineyards Site 0.5 miles downstream (Figure 1; Plate 2D).

The October 2021 survey results were similar to prior surveys in that roach, stickleback, and sculpin dominated the catches and were present throughout the basin. Tule perch (*Hysterocarpus traskii*) were also captured, but only in the lower basin, as was the case in prior surveys.

In the five Suisun Creek surveys conducted in 1999-2001, only two green sunfish (less than 0.1 percent of the captures) and no bluegill were captured. When the surveys resumed in 2016 after multiple consecutive dry and critical water years, non-native bluegill sunfish made up over almost 20% of the fish. While bluegill sunfish (n=5), were found in the October 2020 survey, they were not abundant and made up less than one percent of the total catch in Suisun Creek. These results suggest that non-native fish seem to thrive in when dry condition prevail for extended consecutive years.



Green Valley Creek Basin

Five sites in the Green Valley Creek basin distributed along 5.2 miles from the City of Vallejo's Green Valley Water Treatment Plant (GVWTP) on Wild Horse Creek downstream to Green Valley Creek at Commerce Court in Cordelia (just upstream of the tidal zone) were sampled on 11-13 October 2021 (Figure 1; Plate 3). The GVWTP Site is located about 0.6 miles upstream of its confluence with Green Valley Creek and 1.7 miles downstream of Lake Frey. One of the usual Green Valley sample sites at the Turner Court footbridge could not be sampled due to a large beaver dam about 350 feet downstream that created a large deep pool habitat that could not be waded (Plate 3B and 3C). The dam looks to be a partial barrier to upstream and downstream salmonid migration except at the highest stream flows, which are limited in most years. This beaver dam is likely an impediment to steelhead migration. A second very large beaver dam, which is also appeared to be a probable fish barrier was also noted in the Reservoir Lane Site.

Most of the streamflow in lower Green Valley Creek appears to derive from a combination of groundwater input and Wild Horse Creek, where two City of Vallejo-owned domestic water supply reservoirs, Lake Frey and Lake Madigan, are located in the upper basin (Figure 1). The City of Vallejo was reportedly releasing 0.10 cfs from Lake Frey Dam during the October 2021 sampling (John Palesi, City of Vallejo Water Department, personal communication, 18 October 2021 email). During our surveys, continuous flow, estimated to be one-third to one cfs, was present at all five sites (Table 1). It is assumed that tributary and groundwater accretion supplemented the Lake Frey releases. During the four 1999-2001 surveys continuous flow was present throughout the basin (Thomas R. Payne and Associates 1999c, 2000, and 2001). Continuous streamflow was also noted throughout Green Valley Creek during the summers of 2016 through 2018 and the fall of 2019 and 2020 (Normandeau Associates 2017, 2018, 2019; TRPA Fish Biologists 2020, 2021).

The early October 2021 water temperatures at the five Green Valley basin sites averaged 14.3°C (57.7°F) and ranged from 11.7° to 17.9°C (53.1° to 64.2° F; Table 1). The early fall water temperatures noted in 2021 were two to three degrees cooler than those noted for the Fall 2020 survey and significantly cooler than those recorded during the previous summer

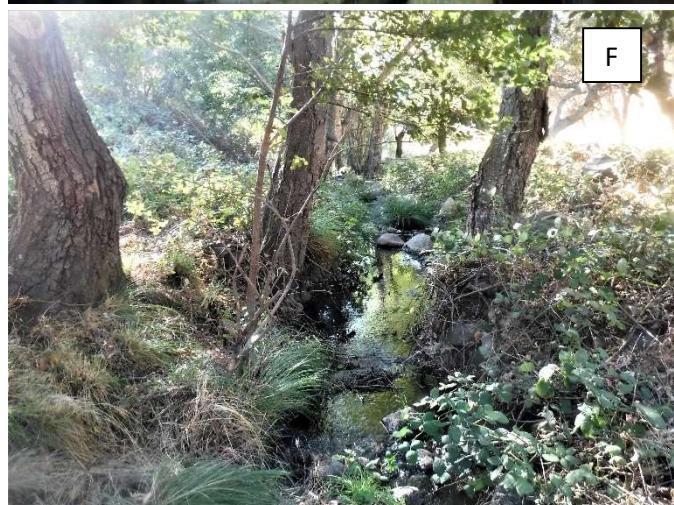


Plate 3. Photographs of the Green Valley Basin sites during the mid-October 2021 fish surveys. A: Commerce Court Site; B: beaver dam at Turner Court Site; C: unsampleable deep pool at Turner Court Site; D: Mason Road Site; E: Green Valley Country Club Site; F: Green Valley Water Treatment Plant Site on Wild Horse Creek.



surveys. Dissolved oxygen levels were near or above optimal for trout at all five Green Valley sites and ranged from 75 to 93 percent saturation (Table 1).

The mid-October fish surveys at the five Green Valley basin sites captured a total of 607 fish from ten species, with native resident fish making up over 73 percent of the total catch (Table 2). Native California roach were caught at all five survey sites and made up over 49 percent of the total Green Valley basin fish captures. Prickly sculpin, another native species caught at all five of the survey sites, made up almost thirteen percent of the captures. Other natives (sucker, pikeminnow, tule perch, and stickleback) were also present, but combined, only made up less than eleven percent of the total catch. Only seven *O. mykiss* were captured (1.2 percent of the total catch), from four sites and most from the GVWTP Site on Wild Horse Creek. Examples of some of the native fish captured during the October 2021 survey are shown in Plate 4.

Most of the non-native fish noted during the October 2021 Green Valley basin fish surveys were captured at the Commerce Court Site, the most downstream Green Valley Creek sample site located just upstream of Cordelia Slough and near tidewater (Table 2). At this site, non-native fish, mostly Mississippi silversides (*Menidia audens*) and mosquitofish, made up over 73 percent of the total catch. Silversides is now one of the most abundant and widespread species in the Sacramento-San Joaquin Delta (Mahardja et al. 2016). Another exotic captured in mid-October 2021 included common carp (*Cyprinus carpio*). At the four upstream sites, exotic fish were much less abundant and composed 3 percent or less of the total catch at any of the four sites.

The *O. mykiss* captured in the Green Valley basin during the October 2021 represented multiple size/age classes, which were visually assigned using length frequency (Figure 2, top). Young-of-the-year trout less than 100 mm in fork length (FL) which had dominated the Green Valley Basin trout populations since 2017, were represented by only two fish. Age 1 (100-159 mm FL), and Age 2 (≥ 160 mm FL) sized trout were also present. If this age assignment is accurate, then there may be some portion of the trout population that is resident or non-migratory, since the migratory form of rainbow trout (i.e., steelhead) in the Central California Coast Distinct Population Segment typically migrate to the ocean as one- or two-year-old fish (Moyle et al. 2008). More precise age discrimination using scale or otolith analysis techniques would be needed to confirm this assessment.



Plate 4. Photographs of native fishes captured in Green Valley Creek in mid-October 2021.

A: 178 mm FL Sacramento sucker; B: 122 mm FL California roach; Site; C: 72 mm FL California roach; D: 77 mm TL prickly sculpin; E: 198 mm FL rainbow trout/steelhead captured at the Green Valley Country Club Site; F: 125 mm FL rainbow trout/steelhead captured at the Water Treatment Plant Site on Wild Horse Creek.

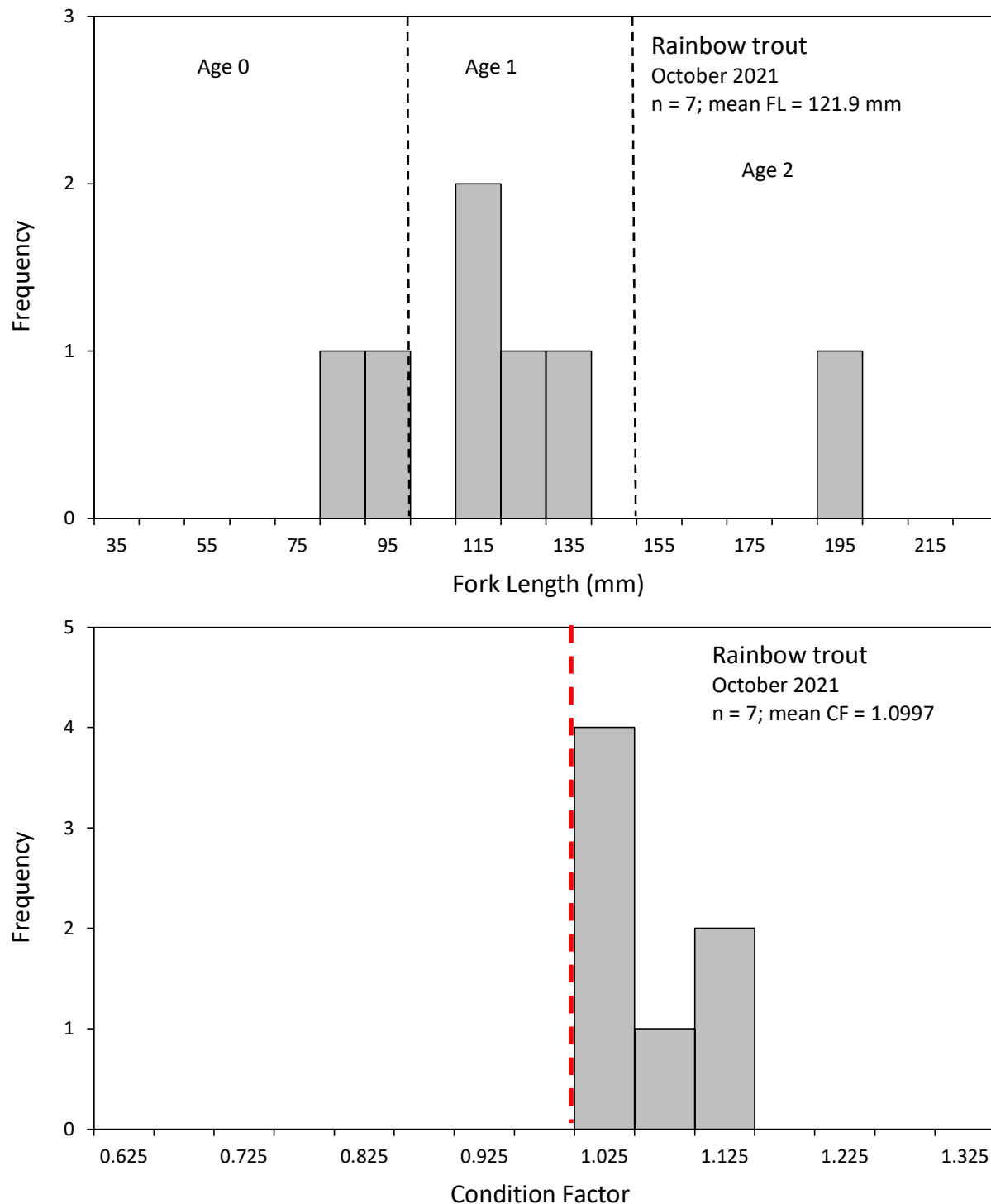


Figure 2. Length frequency (top) and condition factor frequency (bottom) for *O. mykiss* captured in Green Valley Creek Basin, 11-12 October 2021. Dotted red line denotes the 1.0 "good condition" factor threshold for trout.



The mean condition factor for *O. mykiss* captured during the October 2021 surveys was 1.06 and all seven trout had condition factors greater than 1.0, indicative of healthy trout populations (Figure 2, bottom). This was an improvement over the pattern noted in the October 2020 data, when an unusually high numbers of trout with condition factors less than 0.9 (Table 3), indicative of some trout in less than “good condition”, were present compared to previous surveys (TRPA Fish Biologists 2021).

Table 3. Breakdown of number of *O. mykiss* captured in Green Valley Creek basin 2017-2021 and showing numbers with condition factors (CF) less than various values (percentages shown in parentheses).

Year	Total Trout	CF <1.0	CF <0.9	CF <0.8
2017	38	0	0	0
2018	106	5 (4.7%)	0	0
2019	45	14 (31.1%)	2 (4.4%)	0
2020	35	12 (34.3%)	9 (25.7%)	3 (8.6%)
2021	7	0	0	0

One notable trend in the October 2021 survey data is the large decline in *O. mykiss* at the Wild Horse Creek Site compared to the other recent and historic surveys (Table 4). This relatively pristine basin (Plate 3F) some of the most suitable trout spawning and rearing habitat in the Green Valley Basin, with cool water, spawning gravel, and canopy cover. During the October 2021 survey only two *O. mykiss* were captured. Compare this small number to the 1999-2020 surveys when an average of 40 trout were captured at the Wild Horse Sites. This steep decline in *O. mykiss* may be the result of the inability of adult steelhead to access the upstream portions of the basin due to recent low winter flows and presence of large beaver dams that appear to be barriers to upstream migration.



Table 4. Numbers of *O. mykiss* captured in Green Valley Creek Basin by site ^{1/} and river mile (RM) as measured from distance upstream of Cordelia Slough, 1999-2021.

Year	RES (RM 1.4)	MAS (RM 2.3)	VPL (RM 3.3)	GVCC (RM 4.2)	WHC-L (RM 4.6)	WHC-GVWTP (RM 5.0)
1999	2	NS ^{2/}	5	NS	13	NS
2000	1	NS	11	NS	45	NS
2000	2	NS	31	NS	30	NS
2016	1	1	NS	5	NS	NS
2017	0	1	NS	4	NS	33
2018	6	2	NS	5	NS	93
2019	0	3	NS	7	NS	35
2020	1	2	NS	0	NS	32
2021	1	3	NS	1	NS	2

1/ Sites: RES = Reservoir Ln.; MAS = Mason Rd.; VPL = Via Palo Linda; GVCC = Green Valley Country Club; WHC-L = Wild Horse Creek at Lowe Property; WHC-GVWTP = Wild Horse Creek at Green Valley Water Treatment Plant

2/ NS = Not Sampled

Ledgewood Creek

Three sites along a 4.7-mile-long reach of Ledgewood Creek from Mankas Corners downstream to Auto Mall Parkway were sampled on 12-13 October 2021 and included Mankas Corners, Rockville Road, and Auto Mall Parkway (Figure 1). Stream flow in this reach was intermittent (Plate 5). Three Ledgewood Creek sites were visited but not sampled (Clayton Road, the Putah South Canal crossing, and Abernathy Road), as they were completely dry stream channels. Streamflow was present at the other three sites, though the Auto Mall Parkway Site appeared to be tidally influenced. During the three Ledgewood Creek surveys conducted during 2000-2001, continuous flow was present in the 2.4-mile-long reach between Mankas Corners and Abernathy Road (Figure 1).

The mid-October 2021 water temperatures at the three flowing Ledgewood Creek sites ranged from 10.7° to 16.0°C (51.3° to 60.8°F; Table 1). These temperatures were several degrees cooler than those noted during the previous fall survey conducted in early October 2020 (TRPA Fish Biologists 2021). Dissolved oxygen levels at the two downstream Ledgewood Creek sites were good, exceeding 80% saturation, while the Mankas Corners site was marginal and was less than 45% saturation (Table 1).



Plate 5. Photographs of flow conditions in Ledge Creek in mid-October 2021. A: full flow at the Auto Mall Parkway Site; B: full flow at the Rockville Road Site; C: dry channel at the Abernathy Road Site; D: dry channel at the Putah South Canal Site; E: full flow at the Mankas Corners Site; F: dry channel at the Clayton Road Site.



The October 2021 fish surveys at the three LedgeWood Creek sites captured a total of 269 fish from seven species, four of which were native fish species (Table 2). Native fish made up over 88 percent of the total fish catch at the LedgeWood sites during the October 2021 survey. California roach dominated the LedgeWood fish populations and made-up almost 39 percent of the total catch. Sucker contributed another 25 percent of the total catch, while stickleback made up 23 percent. Pikeminnow were also captured. No trout were captured during the 2021 survey. Exotic mosquitofish, green sunfish and goldfish (Plate 5) were captured during the October 2021 survey. Most of the exotic species in LedgeWood Creek were captured at the most downstream site near tidewater.



Plate 6. Photograph of non-native 164 mm FL goldfish captured in LedgeWood Creek at the Auto Mall Parkway Site in mid-October 2021.

During the 2000-2001 electrofishing surveys at several LedgeWood Creek sites, the fish populations were dominated by native hitch, sucker and stickleback (Thomas R. Payne and Associates 2000 and 2001). In the 2016 through 2021 surveys California roach, sucker, and stickleback were abundant (Normandeau Associates 2017, 2018, 2019; TRPA Fish Biologists



2020, 2021), and only one hitch has been captured (August 2018). *O. mykiss* have never been captured in Ledgewood Creek during any of these surveys. The most notable differences in both the 2016 through 2020 fish monitoring surveys of Ledgewood Creek compared to prior surveys continue to be the recent absence of hitch, a native minnow, which dominated the earlier surveys, and the new dominance of roach, which were extremely rare in the earlier 2000-2001 surveys.

Conclusion

The October 2021 surveys, which followed a regional critically dry water year, documented extensive areas of intermittent or subsurface streamflow conditions in both Suisun and Ledgewood creeks. The extensive areas of dry channel along the middle Suisun basin noted during the October 2021 were the most noted during recent surveys and were comparable to conditions noted in August 2016 following five consecutive years of critical to below normal water years in the basin.

During the more historic 1999-2001 surveys, native fish dominated all three western Solano stream fish populations and non-native fish were rarely encountered (Table 5). Since the surveys were re-established in 2016, native fish still constitute a large percentage of the fish populations, but exotic fish species have become much more common in all three basins.

Table 5. Numbers of native versus non-native fish (shaded) captured in three western Solano County watersheds during the historic 1999 through 2001 and the more recent 2016 through 2021 stream surveys (percentages shown in parentheses).

Year	Suisun Creek		Green Valley Creek		Ledgewood Creek	
1999 ^{1/}	1,607 (99.9%)	1 (0.1%)	662 (100%)	0 (0%)	NS ^{2/}	
2000 ^{1/}	1,126 (99.9%)	1 (0.1%)	706 (100%)	0 (0%)	199 (99.0%)	2 (1.0%)
2001	949 (100%)	0 (0%)	744 (100%)	0 (0%)	188 (93.1%)	14 (6.9%)
2016	832 (80.1%)	207 (19.9%)	629 (95.2%)	32 (4.8%)	78 (100%)	0 (0%)
2017	913 (96.5%)	33 (3.5%)	934 (89.5%)	110 (10.5%)	270 (100%)	0 (0%)
2018	1,958 (99.5%)	10 (0.5%)	1,138 (97.5%)	29 (2.5%)	431 (97.1%)	13 (2.9%)
2019	1,389 (88.4%)	182 (11.6%)	597 (88.8%)	75 (11.2%)	203 (91.9%)	18 (8.1%)
2020	899 (92.2%)	76 (7.8%)	721 (81.1%)	168 (18.9%)	187 (83.5%)	37 (16.5%)
2021	540 (92.3%)	45 (7.7%)	448 (73.8%)	159 (26.2%)	237 (88.1%)	32 (11.9%)

^{1/} includes both summer and fall surveys

^{2/} Not Sampled



Some of this increase in exotic fish species may be caused by adding downstream sample sites that are in, or near, tidally influenced areas, where non-native fish tend to be more abundant. However, some of the changes in fish populations are no doubt due to changes in basin hydrology. Large areas of both Suisun and Ledge wood basins are under crop and vineyard production that require summer and fall irrigation. Wine grape acreage in Suisun Valley has increased by 375% since 1982 (Suisun Valley Vintners and Growers Association 2017). This increase in local agriculture acreage appears to have altered the hydrology of the stream and contributed to the occasional intermittent streamflow, even following wet winters, through direct instream or groundwater pumping. When periods of persistent below normal rainfall conditions return, intermittent streamflow conditions will likely become more widespread in the Suisun Creek and possibly Green Valley Creek basin, concentrating trout production to upstream areas in the basins. The alarming decline in *O. mykiss* in Wild Horse Creek noted during the October 2021 (Table 4) may be indicative of threats to anadromous salmonid production in the Green Valley Basin. Shorter duration and lower discharge levels of winter flows caused by lower rainfall during dry and critical water years as climate change occurs, and the presence and persistence of large beaver dams that block upstream and downstream migration of anadromous trout, are also impacting the native fishes in both Suisun and Green Valley Creek, which were known to support populations of anadromous fish. Future surveys may help determine if these unusual observations are indicative of long-term problems or are temporary concerns that disappear over time.

The two big beaver dams observed on lower Green Valley Creek are both located in the lower 1.5 miles of the basin (Figure 3) and are downstream of most *O. mykiss* observations and appear to block upstream migration of anadromous steelhead to suitable spawning areas and prevent or limit juvenile production and use of the optimal rearing habitat in upper Green Valley and Wild Horse Creek. Upstream passage by adult steelhead is likely limited to those periods when high flows create opportunities to negotiate over or through the dams. Passage opportunities have been largely absent during the past three water years which have been classified as dry or critically dry. One notable upstream passage opportunity occurred shortly following our October 2021 surveys when a “bomb cyclone” event resulted in record regional rainfall and local flooding. The mean five-day rainfall total for the period of October 21-25,

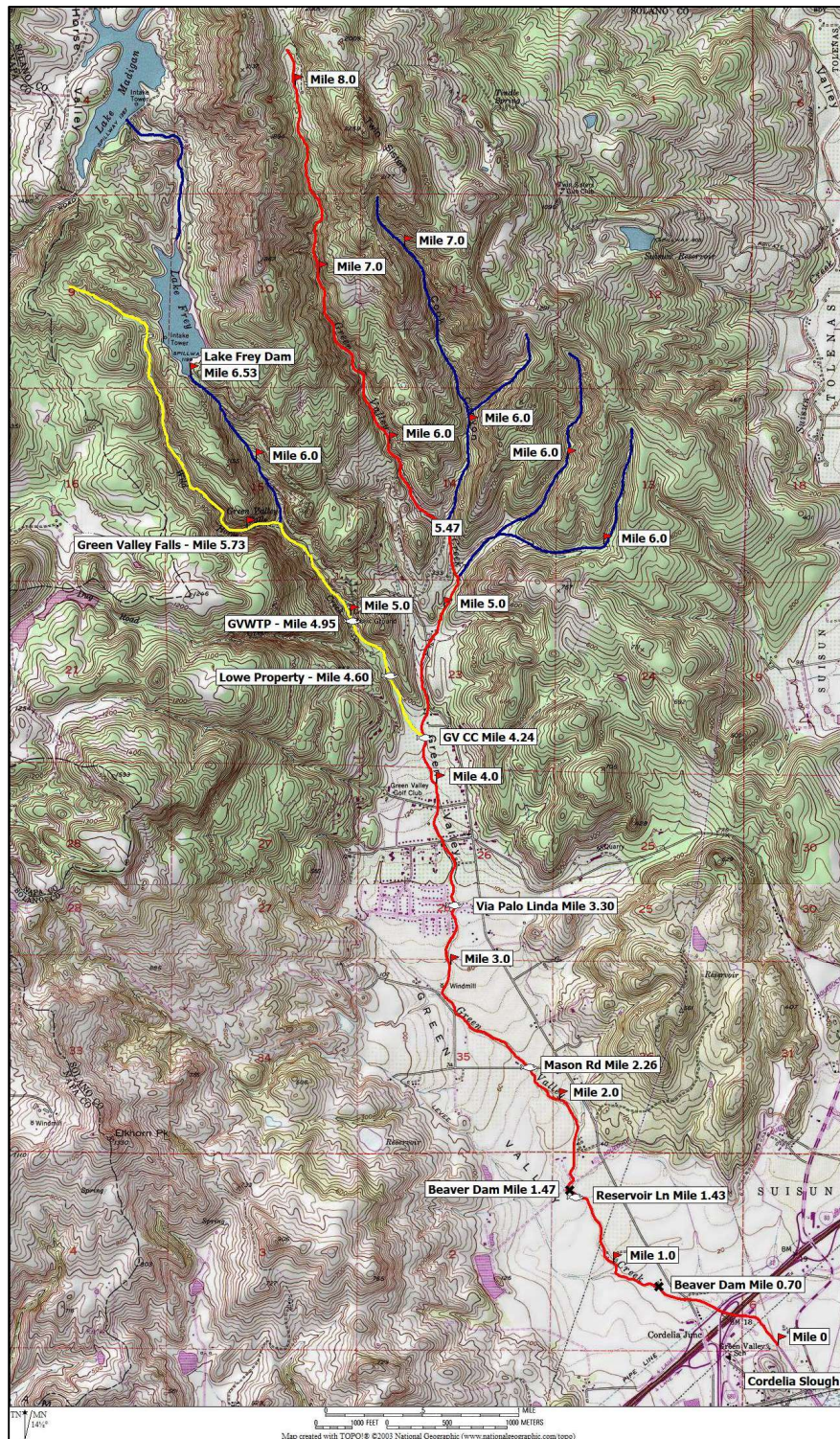


Figure 3. Green Valley Basin showing mileages upstream of Cordelia Slough (red pennants), the locations of sample sites that *O. mykiss* have been captured during the 1999-2021 surveys (white fish), and the locations of the two known large beaver dams (black X symbols). Green Valley Creek is shown in red; Wild Horse Creek is shown in yellow; other unnamed channels are shown in blue.



2021, recorded at the three closest Department of Water Resources California Irrigation Management Information System (CIMIS) gages that surround the Green Valley-Fairfield area (Carneros/Winters/Hastings Tract East) was over 5.8 inches. If adult steelhead were in or near the Green Valley Basin access to the upstream could possibly occurred.

Early estimates for designating WY 2022 as a critical water year may modify fish species distribution and abundance in western Solano County streams later this fall. Repetition of surveys in 2022 and beyond may provide additional information on the resilience of native fish species and their ability to respond to temporal changes in basin hydrology.

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