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Memorandum

DATE: 12 May 2023
TO: Chris Lee, Alex Rabidoux, and Max Stevenson, Solano County Water Agency
FROM: Tim Salamunovich, TRPA Fish Biologists
RE: 2022 Pleasants Creek Fish Monitoring – Final Report

There is little information on aquatic species in the Pleasants Creek basin. While there is some information on fishes that might be present based on their range (UC Davis California Fish website), there is no available information on which species are currently present nor their actual distribution or abundance in the basin. As part of these investigations, TRPA was contracted to conduct preliminary surveys to document information on the existing aquatic resources in the basin. The results of the preliminary fish surveys conducted between November 2019 and November 2021 were presented in prior reports (TRPA Fish Biologists 2020, 2022). A separate report on geothermal habitat in the basin was prepared by SCWA (Pascual 2020).

Background

Pleasants Creek is a small, intermittent, third order tributary to Lake Solano (impoundment on Putah Creek) that enters the lake about 1.0 mile upstream of the Putah Diversion Dam (Figure 1). The Pleasants Creek basin, which includes its major tributary, Miller Canyon, has a drainage area of approximately 17.3 square miles. The headwaters of Pleasants Creek originate at about 2,700 feet elevation along the Pleasants and Blue ridges of the Vaca Mountains in northwest Solano County about seven miles north of the City of Vacaville, California. Much of the basin is composed of grassland/oak habitat. Streamflow in Pleasants Creek is intermittent and significant flows are typically limited to winter and spring following rainfall events. Pleasants Creek typically starts to flow in September prior to significant rain events as shorter days and lower air temperatures reduce evapotranspiration of surrounding vegetation and springs begin to flow again. During most years there is no streamflow during the dry summer

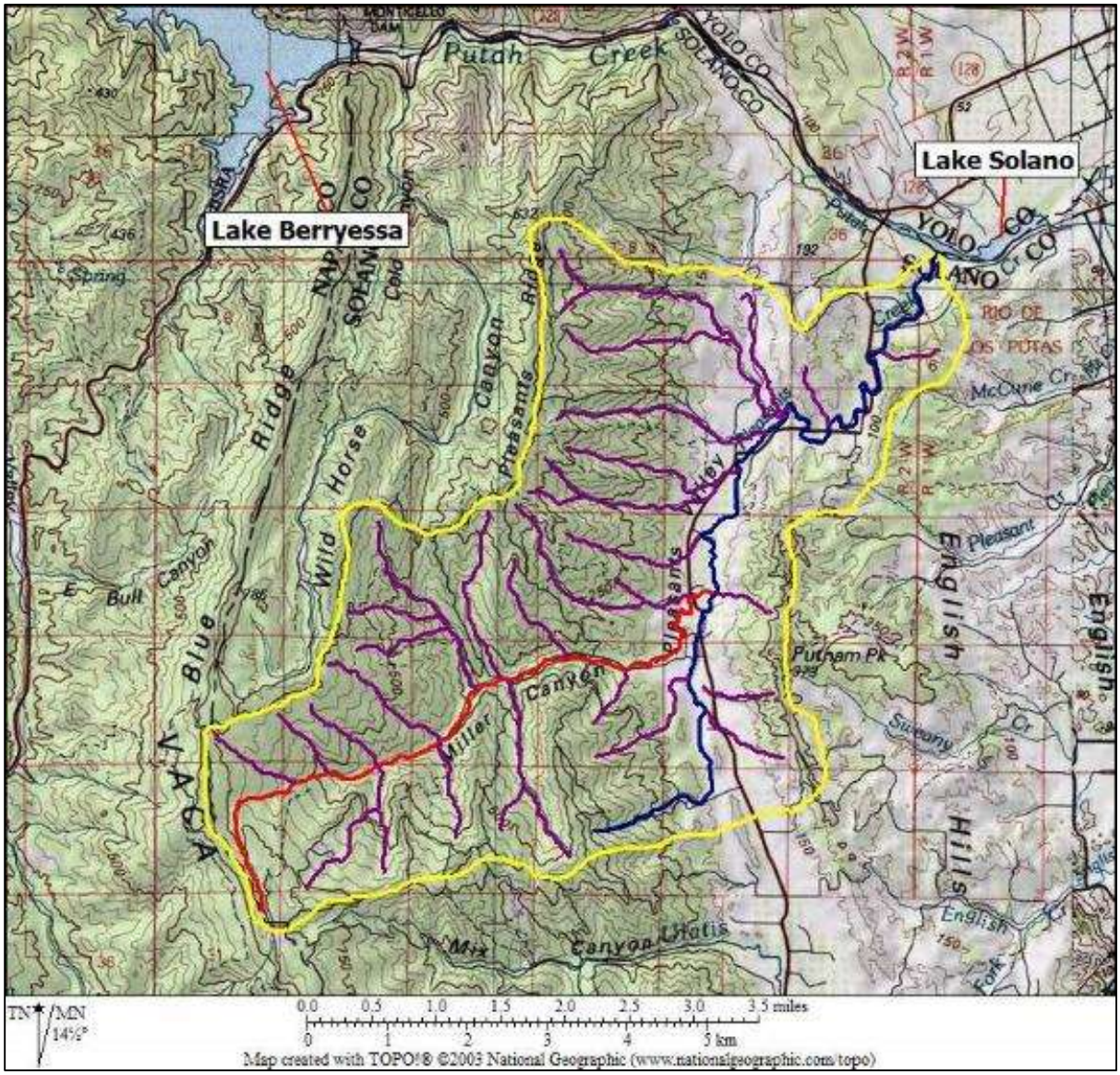

Figure 1. Map showing the Pleasants Creek basin. The blue line is the Pleasants Creek channel; red line shows the Miller Canyon channel; purple lines show unnamed tributaries; and yellow line delimits the watershed.

and fall periods and aquatic habitat is limited to isolated pools fed by subsurface flow and groundwater seepage (Photographs 1 through 4). The lower 2,200 feet of Pleasants Creek is lacustrine backwater habitat from Lake Solano (Photograph 5). Upstream of a small agricultural road ford, that delimits the downstream lake backwater and upstream stream channel, Pleasants Creek channel is narrow and deeply incised and its highly erodible banks serve a sediment source to Lake Solano and Putah Creek (Photograph 6). The average gradient on Pleasants Creek is 20 feet per mile, more than twice as steep as the Interdam Reach, between Monticello Dam and Lake Solano.

Research has suggested that bank failure and erosion has accelerated since the construction of Monticello Dam due to reduced flows on mainstem Putah Creek that have led to steeper water surface gradients on the tributary creeks during high-flow events, therefore resulting in higher velocity flows and more erosion (EDAW 2005). Pleasants Creek has been identified for low quality riverine habitat, which limits its fish and wildlife potential and has been targeted as a candidate basin for habitat restoration (EDAW 2005). Solano County Water Agency, which manages the Solano Project, has studied the erosion problems in Pleasants Creek and is promoting restoration projects to limit bank erosion and sediment transport with the goal of restoring the historical channel configuration.

Wildfires in 2020 burned in the hills and valleys of Pleasants Creek, damaging, and destroying structures, trees, and rangeland along the creek and all its tributaries (TRPA 2022). Following the fires, SCWA embarked on habitat restoration efforts, that included installing rock vane weirs (Photographs 7 and 8) as grade controls to trap sediment pulses that were expected to occur when winter rains occurred on the burnt-over, denuded and unstable hills throughout the watershed. The vanes were designed to provide grade control upstream and convergent flows downstream and were intended to retard channel down cutting and widening by directing flow to thalweg and away from banks. The vanes should promote substrate deposition upstream of the structures and create persistent scour holes downstream of the vanes. Some of these scour holes retain water over the summer and provide refugia for fish and watering holes for wildlife

Photograph 1. Isolated pool in Pleasants Creek, RM 1.0, August 2022.

Photograph 2. Isolated pool in Pleasants Creek, RM 2.5, August 2022.

Photograph 3. Isolated pool in Pleasants Creek, RM 4.4, August 2022.

Photograph 4. Isolated pool in Miller Canyon, RM 0.1, November 2022.

Photograph 5. Lake Solano backwater of lower Pleasants Creek, RM 0.40, August 2022.

Photograph 6. Pleasants Creek dry stream channel immediately upstream of the farm road ford, RM 0.42, August 2019.

Photograph 7. View downstream toward rock vane #2, lower Pleasants, May 2022.

Photograph 8. View upstream toward rock vane #16, lower Pleasants Creek, May 2022.

(Rich Marovich, personal communication). As the channel bed elevation aggrades, it is hoped that water surfaces upstream of the vanes will be raised and provide more substrate to absorb winter flows and release water back into the channel increasing base flows (Rich Marovich, personal communication). Ongoing monitoring at several nearby well sites will be able to help assess the rock vanes' impacts on groundwater levels in the Pleasants Creek Basin.

The original intent was to sample fish populations along Pleasants Creek quarterly, but California Department of Fish and Wildlife biologists expressed concern over any surveys during the winter months (December through April) when rainbow trout from Lake Solano could potentially spawn in Pleasants Creek. To avoid disturbing potential trout spawning no winter surveys were conducted and sampling was limited to three annual surveys: spring, summer, and fall. This report will discuss the results of three surveys conducted during the Spring (4-5 May), Summer (9-10 August), and Fall (6-7 November) of 2022.

Methods

Much of the Pleasants Creek basin is privately owned. TRPA Fish Biologists worked closely with Rich Marovich, the former Putah Creek Streamkeeper, to identify a list of landowners. Contact with landowners was made and while most were willing to allow access along Pleasants Creek, we were unable to get access to Miller Canyon upstream of the Pleasants Valley Road Bridge. Based on our access contacts were able to obtain access to about 5.3 miles of Pleasants Creek and about 0.25 miles of lower Miller Canyon. A reconnaissance site visit in August 2019 identified eight sites that possessed pool habitat where surveys could be conducted.

Fish surveys were conducted using a portable backpack electrofisher (Photograph 3) to stun and capture fish. 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 (mm) fork length (FL) (or total length [TL] for mosquitofish, stickleback, and sculpin).

The length of sample reaches at most sites varied by season based on the length of available wetted channel, with more available habitat in the spring and less in the summer and fall. Only the most downstream Pleasants Creek sample site, which is composed of the Lake Solano backwater area, provides the most consistent and stable available aquatic habitat. At the remaining sites typically two or three isolated pools were surveyed at each site consisting of tens of feet to several hundred feet of stream depending on habitat availability. Several water quality parameters including water temperature, dissolved oxygen, conductivity, salinity, and pH were measured with hand-held meters at the time of sampling. A small hand-held global positioning system was used to determine latitude/longitude coordinates at both downstream and upstream ends of each sample site. The waypoints were plotted on Google Earth and were used to estimate the survey reach distances.

It should be noted that surveys provide data on the relative abundance of fish 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 electrofishing effectiveness and capture success among the various species and life stages at each site was determined by conductivity and salinity conditions as well as presence of instream cover such as aquatic vegetation.

Results

During 2022 three separate surveys along Pleasants Creek were conducted: a Spring survey on 4-5 May, a Summer survey on 9-10 August, and a Fall survey on 6-7 November. Typically, sampling was conducted at eight sites during each survey, with seven sites located on Pleasants Creek and one site in lower Miller Canyon just upstream of its confluence with Pleasants Creek (Figure 2). The most downstream site, PC-1, is in the backwater area of Lake Solano. The remaining seven sites are in the intermittent flow area of the basin and usually consisted of isolated pool habitats, with long stretches of dry channel in between survey sites, except after significant rainfall, when dry channel areas were shorter in length.

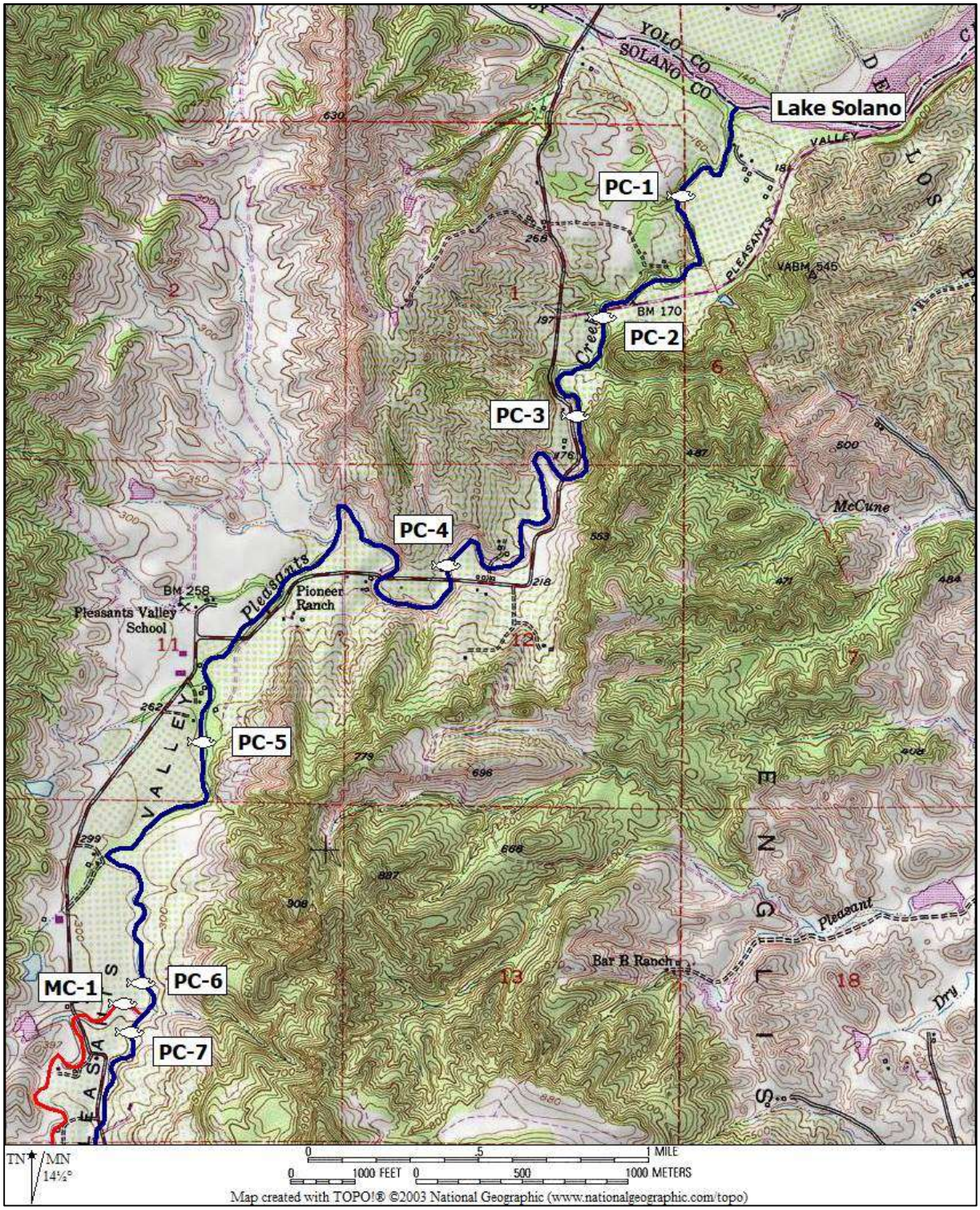

Figure 2. Map of Pleasants Creek (blue line) and lower Miller Canyon (red line) showing the location of the eight fish sampling sites surveyed during 2022.

The survey areas varied in length across sites and across seasons and ranged from twelve feet to 1,050 feet (Table 1). Most sites consisted of one to three isolated pools, which varied in length seasonally as pools became smaller in size during the summer and fall surveys. The PC-1 Site was not surveyed in the November 2022 fish monitoring. The property to access the site was recently sold and access could not be arranged prior to the November survey.

The 2022 surveys occurred during the second consecutive critical water year in the Sacramento Valley according to the Sacramento Valley 40-30-30 Hydrologic Classification Index (Department of Water Resources, California Data Exchange Center, Water Supply Index WSIHIST). During the four months prior to the May 2022 survey, 1.89 inches of rain was recorded at the nearby Solano Irrigation District Putah Diversion Dam Operations (PDO) gage in Winters, CA (Figure 3). The twenty-five-year average for this four-month period is 14.2 inches. Between the May and November surveys only an additional 1.12 inches of rain was recorded at the PDO. The long-term average for this same period is 2.4 inches. These low rainfalls impacted streamflow and groundwater conditions for subsequent surveys and led to the gradual drying of much of Pleasants Creek and Miller Canyon by the summer and early fall and limiting the quality and quantity of the aquatic habitat for fish in the basin.

Water Quality

As might be expected, water temperatures measured at the time of the fish surveys varied between seasons and time of day (Table 1). Warmer average water temperatures were measured during the spring (19.7°C/67.5°F) and summer (21.8°C/71.3°F) surveys compared to the fall (13.2°C/55.8°F). Warmer water temperatures were also measured in the afternoon compared to the morning times. The average water temperature difference between the afternoon and mornings was 2.9°C/5.2°F during the Spring 2022 survey and 4.8°C/8.7°F during the Summer 2022 survey (Table 1). All the Fall 2022 surveys were conducted during afternoon periods so no diurnal comparisons could be made.

Table 1. Survey site identification, river mile location, sample date and time of day, habitat type, site length, water temperature, conductivity, salinity, dissolved oxygen, and pH levels and at time of day for the 2022 Pleasants Creek and Miller Canyon fish surveys.

May 2022	**River mile**	**Date**	**Time**	**Habitat**	**Length (ft)**	**Water Temp**		**Conductivity**	**Specific Conductivity**	**Salinity**	**Dissolved Oxygen**		**pH**
						*C	*F	µS/cm	µS/cm	ppt	mg/L	% saturation	
Pleasants Creek													
PC-1	0.35	5-May-22	8:30	lake BW	555	18.5	65.3	539	---	0.3	6.83	73.5	8.4
PC-2	1.00	4-May-22	10:22	pools	430	17.6	63.7	857	---	0.5	6.97	73.6	7.9
PC-3	1.50	4-May-22	11:40	pools	330	18.9	66.0	870	---	0.5	9.86	111.1	8.0
PC-4	2.50	4-May-22	12:55	pools	570	19.7	67.5	859	---	0.5	8.18	91.5	8.2
PC-5	4.25	5-May-22	10:48	5 pools	1050	18.2	64.8	739	---	0.4	6.94	74.5	7.6
PC-6	5.10	4-May-22	14:30	pools	425	23.0	73.4	801	---	0.4	7.56	89.2	7.7
PC-7	5.30	4-May-22	15:15	pools	350	20.1	68.2	647	---	0.4	7.99	88.9	8.0
Miller Canyon													
MC-1	0.05	4-May-22	16:05	pools	370	21.9	71.4	743	---	0.4	7.44	85.8	7.9

August 2022	**River mile**	**Date**	**Time**	**Habitat**	**Length (ft)**	**Water Temp**		**Conductivity**	**Specific Conductivity**	**Salinity**	**Dissolved Oxygen**		**pH**
						*C	*F	µS/cm	µS/cm	ppt	mg/L	% saturation	
Pleasants Creek													
PC-1	0.35	9-Aug-22	9:35	lake BW	555	23.8	74.8	353.9	362.0	0.2	7.81	92.6	9.6
PC-2	1.00	9-Aug-22	11:07	2 isolated pools	90	21.6	70.9	1,213	1,292	0.6	10.40	118.3	7.7
PC-3	1.50	9-Aug-22	12:26	2 isolated pools	120	20.8	69.4	1,015	1,096	0.5	6.82	76.2	7.7
PC-4	2.50	9-Aug-22	13:53	4 isolated pools	155	25.4	77.7	1,897	1,885	1.0	7.84	102.1	8.3
PC-5	4.25	9-Aug-22	15:43	7 isolated pools	780	28.4	83.1	1,484	1,394	0.7	9.40	123.0	7.3
PC-6	5.10	10-Aug-22	7:43	4 isolated pools	375	17.9	64.2	857	990	0.5	1.74	18.6	6.8
PC-7	5.30	10-Aug-22	8:57	6 isolated pools	345	18.3	64.9	693	797	0.4	4.19	45.4	7.5
Miller Canyon													
MC-1	0.05	10-Aug-22	9:33	3 isolated pools	130	18.5	65.3	774	886	0.4	2.54	27.3	7.3

Lake BW refers to backwater from Lake Solano

Table 1. Survey site identification, river mile location, sample date and time of day, habitat type, site length, water temperature, conductivity, salinity, dissolved oxygen, and pH levels and at time of day for the 2022 Pleasants Creek and Miller Canyon fish surveys. (continued)

November 2022	**River mile**	**Date**	**Time**	**Habitat**	**Length (ft)**	**Water Temp**		**Conductivity**	**Specific Conductivity**	**Salinity**	**Dissolved Oxygen**		**pH**
						*C	*F	µS/cm	µS/cm	ppt	mg/L	% saturation	
Pleasants Creek													
PC-1	0.35	**NOT SAMPLED**						**NO ACCESS**					
PC-2	1.00	6-Nov-22	14:25	2 isolated pools	93	16.0	60.8	1,016	1,226	0.6	4.03	40.8	8.9
PC-3	1.50	6-Nov-22	13:27	1 isolated pool	12	13.0	55.4	936	1,222	0.6	8.27	78.9	8.7
PC-4	2.50	6-Nov-22	15:20	3 isolated pools	225	12.9	55.2	1,447	1,885	1.0	0.87	8.2	8.2
PC-5	4.25	6-Nov-22	16:18	1 isolated pool	25	13.7	56.7	794	1,011	0.5	1.56	15.3	7.7
PC-5	4.25	7-Nov-22	12:56	4 isolated pools	480	10.9	51.6	841	1,151	0.6	6.10	55.4	8.0
PC-6	5.10	7-Nov-22	14:30	3 isolated pools	240	13.8	56.8	861	1,095	0.5	4.46	43.1	7.8
PC-7	5.30	7-Nov-22	15:14	1 isolated pool	15	12.1	53.8	633	839	0.4	8.50	83.0	8.5
Miller Canyon													
MC-1	0.05	7-Nov-22	15:40	2 isolated pools	65	13.3	55.9	677	872	0.4	5.85	56.2	7.7

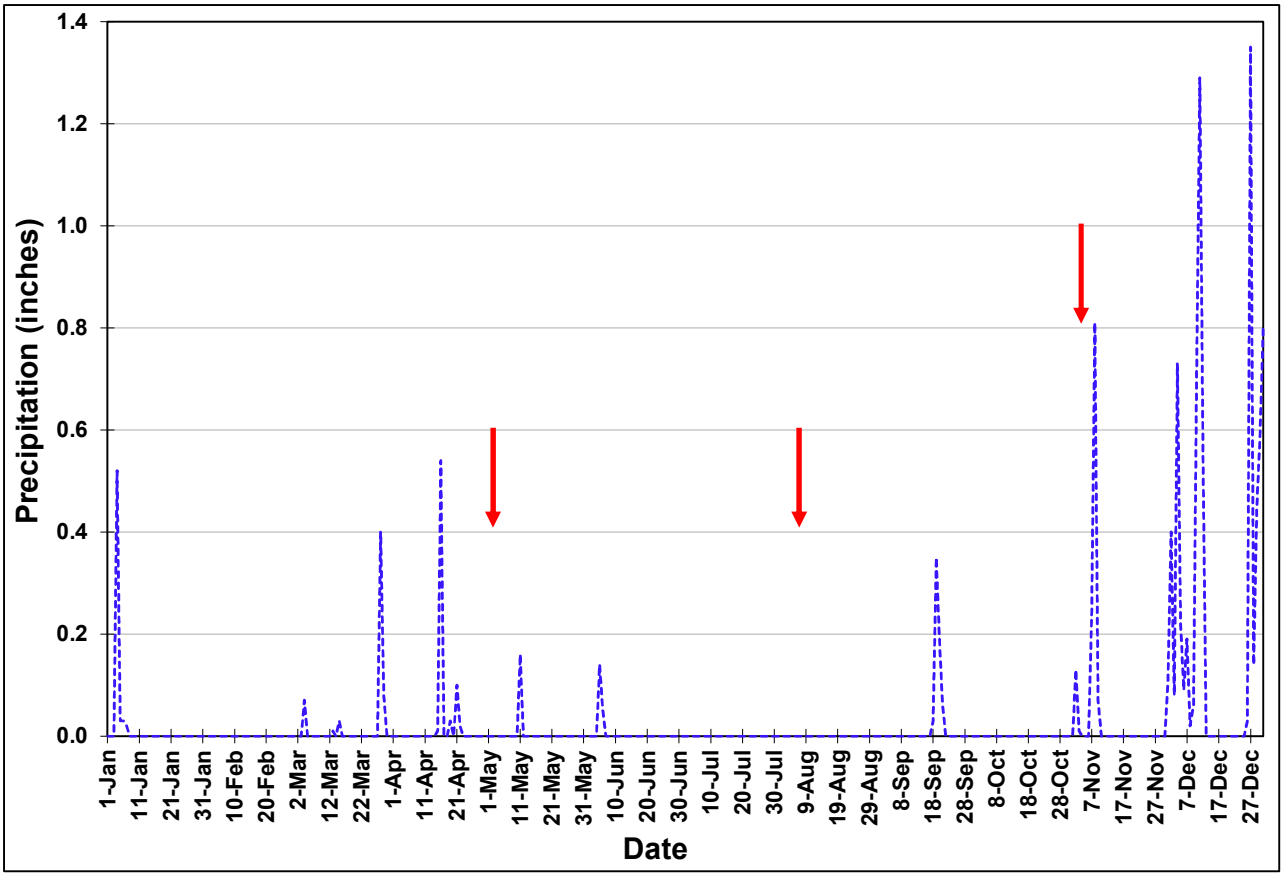

Figure 3. Daily precipitation for the nearby Putah Diversion Office Station for 2022. Red arrows indicate fish monitoring dates.

Conductivity, salinity, and pH varied by site over time and were likely impacted by the residual pool habitat conditions at each site at the time of sampling (Table 1). Dissolved oxygen levels varied by site and season (Table 1). Aquatic vegetation and algae, which was present at most of the isolated pools, may have impacted these readings, especially those collected in the afternoons during peak of photosynthetic oxygen production versus in the morning immediately following the overnight oxygen depletion lag. During 2022 dissolved oxygen levels tended to be highest in the May surveys and lower in the November surveys, with intermediate levels during the summer (Table 1).

Evidence of geothermal seeps along the creek that were noted and confirmed in previous surveys (Pascual 2020; TRPA Fish Biologists 2020) were still detected along several of the survey sites by sulfurous odors and areas of gray water. While evidence of the geothermal seeps was detected during all three 2022 surveys, the seeps did not appear to be as intense as those noted during the June 2020 fish survey or the July 2020 geothermal mapping surveys (TRPA Fish Biologists 2020). The geothermal activity may be tied to local groundwater levels, which appeared to vary across seasons as noted by the presence/absence of water at various sites.

Fish Monitoring

For context, the number and percentage of California native fish versus "exotic" non-native fish has fluctuated since fish monitoring began in November 2019 (TRPA 2020, 2022). During both the Fall 2019 and the Summer 2020 Pleasants Creek fish surveys, California native fish dominated the populations at all sites and made up over 90 percent of the total fish captures in both surveys (TRPA 2020). By the time of the November 2020 survey, native fish made up less than 35 percent of the fish captured across all sites (TRPA 2022). The native fish populations appeared to recover during the Spring 2022 survey, contributing over 62 percent of the total captures. However, by the time of the August and November 2022 surveys, non-native fish dominated the populations in both seasons, making up 97 percent and 60 percent of the total captures, respectively (TRPA 2022).

After a six-month hiatus (i.e., no sampling during the December-April trout spawning period discussed above), a Spring survey was conducted on 4-5 May 2022. Despite the relatively low local precipitation during the winter of 2022 (Figure 3), there was available pool habitat at all the sample sites by the time of the early May 2022 fish sampling and obvious surface flow was observed at the upper four sampling sites. During the May 2022 survey a total of 92 fish from eight different species were captured across all eight sample sites, with 55 percent of the total captures being non-native fish (Table 2). Again, most of the fish were small, with over 84 percent of the captured fish measuring less than 100 mm (3.9 inches) in length. Most of the larger fish were sub-adult and

Table 2. Capture data for the fish monitoring surveys on Pleasants Creek and Miller Canyon, 4-5 May 2022.

	Pleasants Creek							Miller Canyon	
Site	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	MC-1	
RM	0.35	1.00	1.50	2.50	4.25	5.10	5.30	0.05	Total
Native Fishes									
Rainbow trout					1 (182 FL)				1
California roach		6 (18-85 FL)	10 (18-88 FL)	10 (18-102 FL)		3 (22-98 FL)	1 (69 FL)		30
Sacramento sucker	4 (58-76 FL)								4
Threespine stickleback	4 (22-49 TL)								4
Prickly sculpin	2 (22-49 TL)								2
Exotic Fishes									
Western mosquitofish	5 (25-42 TL)								5
Green sunfish	14 (61-100 FL)				9 (57-85 FL)	5 (53-99 FL)	5 (50-88 FL)	6 (62-99 FL)	39
Largemouth bass	7 (207-355 FL)								7
Total # Individuals	36	6	10	10	10	8	6	6	92
# native fish	10	6	10	10	1	3	1	0	41
# exotic fish	21	0	0	0	9	5	5	6	51
Total # species	6	1	1	1	2	2	2	1	8
# native species	3	1	1	1	1	1	1	0	5
# exotic species	3	0	0	0	1	1	1	1	3
Shannon's Diversity (ln)	1.609	0.000	0.000	0.000	0.325	0.662	0.451	0.000	1.489
Eveness (H'/Hmax)	0.898				0.469	0.954	0.650		0.716

adult largemouth bass that were captured in the Lake Solano backwater pool area at Site PC-1 (Table 2; Photograph 9). The dominance of non-native green sunfish (*Lepomis cyanellus*; Photograph 10), a species known to be tolerant of disturbed or unhospitable aquatic habitats (Moyle 2002) may be indicative of the fluctuating habitat conditions that prevent establishment of healthy native fish populations in the basin.

The estimated fish density for the May 2022 survey was a meager 2.3 fish per 100 feet of channel surveyed (Table 1 and Table 3). Despite the availability of aquatic habitat throughout the study area during the May 2022 surveys relatively few fish were captured at any of sample sites. This continues the pattern of low habitat occupancy that was noted during the prior survey in November 2021, when 3.1 fish per 100 feet was documented (TRPA 2022). The low fish densities suggest that recruitment and re-colonization by fish of newly available habitats is limited in Pleasants Creek at least over winter when fish reproduction is not occurring. Fish populations in the basin do not appear to be able to quickly respond to and utilize newly available aquatic habitats.

A small adult rainbow trout was captured during the May 2022 survey at the PC-5 Site (Table 2; Photograph 11). The trout appeared to be in good condition but was not weighed. This was our first trout capture in Pleasants Creek since surveys began in 2019. A healthy resident rainbow trout population has been reported to exist in the upper Miller Canyon portion of the Pleasants Creek basin where permanent year-round cool water habitat reportedly exists (Rich Marovich, personal communication). We have been unable to get access to this area as the landowner has expressed a hesitancy about sampling along the property.

Other non-fish species observed throughout the project area during the early May 2022 surveys included non-native red swamp crayfish (*Procambarus clarkii*), non-native American bullfrog (*Lithobates catesbeianus*) tadpoles, and native Pacific chorus frog (*Pseudacris regilla*) tadpoles. Species that were only encountered as a single individual at a single site included a native Coast Range newt (*Taricha torosa*) tadpole captured at Site PC-5 (Photograph 12) and a non-native red-eared slider turtle (*Trachemys scripta elegans*) noted at Site PC-2.

Photograph 9. 355 mm FL largemouth bass (non-native fish) captured at Site PC-1, 5 May 2022.

Photograph 10. 118 mm FL green sunfish (non-native fish) captured at Site PC-3, 9 November 2020. Note that this photo is from a previous year's survey.

Photograph 11. 182 mm FL rainbow trout (native fish) captured at Site PC-5, 5 May 2022.

Photograph 12. Coast range newt larvae (native amphibian) captured at Site PC-5, 5 May 2022.

By the time of the Summer survey conducted on 9-10 August 2022, much of the Pleasants Creek stream channel was completely dry. Except for the Lake Solano backwater (Site PC-1), the summer aquatic habitat remaining in most of the basin was composed of remnant residual pools.

During the August 2022 survey a total of 370 fish from six species were captured across all eight sample sites (Table 3), with 79 percent of the total captures being native fish, of which all but two were California roach (*Hesperoleucus symmetricus*; Photograph 13). Most of the non-native fish captured in the summer survey were green sunfish. Roach dominated the fish populations at five of the eight sample sites, while green sunfish dominated the populations at two sites. As was the case with previous surveys, most of the fish were small, with over 96 percent of the measured fish being less than 100 mm (3.9 inches) in length. The estimated fish density for the August 2022 survey was 26.9 fish per 100 feet of channel surveyed (Table 1 and Table 3).

Other non-fish species observed throughout the project area during the August 2022 surveys included non-native red swamp crayfish and bullfrog tadpoles. Species that appeared to be more limited in distribution were California toads (*Anaxyrus boreas halophilus*) that were quite abundant along the banks of the creek at the upstream study sites PC-7 and MC-1.

The Fall 2022 Pleasants Creek fish survey occurred on 6-7 November 2022. Overland access could not be arranged for survey Site PC-1 and a large debris jam downstream of the site prevented access by canoe, so this site was not included in the Fall 2022 survey. During the November 2022 survey a total of 934 fish were captured across the seven sample sites (Table 4). What is especially noteworthy was that only two fish species were captured during the November surveys, native California roach and non-native green sunfish. The native roach made up about 74 percent of the Fall survey captures, while non-native green sunfish made up 26 percent of the November 2022 captures. The roach dominated the catch at four of the seven sites sampled, while green sunfish were dominant at two of the sites. At the most upstream sample site, PC-7, only one

Table 3. Capture data for the fish monitoring surveys on Pleasants Creek and Miller Canyon, 9-10 August 2022.

	Pleasants Creek							Miller Canyon	
Site	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	MC-1	
RM	0.35	1.00	1.50	2.50	4.25	5.10	5.30	0.05	Total
Native Fishes									
California roach		273 (19-112 FL)	118 (25-98 FL)	52 (26-51 FL)		72 (18-64 FL)	17 (43-70 FL)	7 (38-53 FL)	539
Sacramento sucker	1 (106 FL)								1
Prickly sculpin	1 (40 TL)								1
Exotic Fishes									
Western mosquitofish	17 (18-50 TL)								17
Bluegill sunfish	1 (39 FL)								1
Green sunfish	25 (26-98 FL)	1 (169 FL)			12 (23-51 FL)	28 (24-119 FL)	11 (29-135 FL)	36 (23-136 FL)	113
Largemouth bass	14 (44-57 FL)								14
Spotted bass	1 (90 FL)								1
Total # Individuals	60	274	118	52	12	100	28	43	687
# native fish	2	273	118	52	0	72	17	7	541
# exotic fish	58	1	0	0	12	28	11	36	146
Total # species	7	2	1	1	1	2	2	2	8
# native species	2	1	1	1	0	1	1	1	3
# exotic species	5	1	0	0	1	1	1	1	5
Shannon's Diversity (ln)	1.335	0.024	0.000	0.000	0.000	0.593	0.670	0.444	0.696
Eveness (H'/Hmax)	0.686	0.035				0.855	0.967	0.641	0.335

Table 4. Capture data for the fish monitoring surveys on Pleasants Creek and Miller Canyon, 6-7 November 2022.

	Pleasants Creek							Miller Canyon	
Site	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	MC-1	
RM	0.35	1.00	1.50	2.50	4.25	5.10	5.30	0.05	Total
Native Fishes									
California roach	Not Surveyed No Access	71 (23-55 FL)	316 (28-100 FL)	187 (27-108 FL)	13 (51-78 FL)	93 (31-98 FL)	1 (42 FL)	8 (41-105 FL)	689
Exotic Fishes									
Green sunfish				5 (88-147 FL)	161 (18-130 FL)	27 (25-133 FL)		52 (25-135 FL)	245
Total # Individuals		71	316	192	174	120	1	60	934
# native fish		71	316	187	13	93	1	8	689
# exotic fish		0	0	5	161	27	0	52	245
Total # species		1	1	1	1	1	1	1	1
# native species		1	1	1	1	1	1	1	1
# exotic species		0	0	1	1	1	0	1	1
Shannon's Diversity (ln)		0.000	0.000	0.121	0.266	0.533	0.000	0.393	0.575
Eveness (H'/Hmax)				0.174	0.383	0.769		0.567	0.830

Photograph 13. 72 mm FL California roach (native fish) captured at Site PC-3, 9 November 2020. Note that this photo is from a previous year's survey.

juvenile roach was captured in the one small remaining residual pool (Table 1 and Table 4).

As was the case with all the previous surveys, all fish captured in the November survey were small, with over 96 percent of the measured fish being less than 100 mm (3.9 inches) in length and none over 150 mm (5.9 inches) in length. The estimated fish density for the November 2022 survey was 80.9 fish per 100 feet of channel surveyed (Table 1 and Table 3).

Other non-fish species observed throughout the project area during the November 2022 surveys included non-native red swamp crayfish and non-native bullfrog, both tadpoles and juveniles.

Discussion

The three 2022 Pleasants Creek fish surveys were all conducted during periods of intermittent flow, though the early May survey appeared to have occurred not long after periods of active streamflow. Future sampling in the early spring of wet or above normal water years may coincide with periods of actual streamflow and may provide additional information about habitat use by resident fish species during those periods.

While non-native fish dominated the fish captures in the early spring 2022 survey, very few fish were captured, despite the presence of ample aquatic habitats throughout the basin. The low fish densities noted throughout the basin-wide spring survey are likely due to the timing, with any recently spawned fish likely too small to be captured using electrofishing and so not showing up in the capture data.

By the time of the August survey, native roach and non-native green sunfish were predominant in the limited residual pools available at that time. Then by the time of the November 2022 survey only roach and green sunfish were captured. Both roach and green sunfish are known to be tolerant of disturbed or unhospitable aquatic habitats and can maintain populations in intermittent flow/high water temperature/high conductivity habitats (Moyle 2002; May and Brown 2002). Experiments have shown roach to be tolerant of low dissolved oxygen levels (Cech et al. 1990).

The results from both the 2022 surveys showed low fish densities through the basin's newly restored aquatic habitat that seems to indicate that recruitment and re-colonization by fish into newly available habitats is very limited in Pleasants Creek. Fish populations in the basin do not appear to be able to quickly respond to and utilize newly available aquatic habitats. Future surveys conducted following a wet winter and spring, with more prolonged periods of streamflow, may provide additional insight on how local fish populations respond to changed hydrologic and habitat conditions.

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