2016 and 2017 Fish Assemblage Report For the Guadalupe River Watershed Mercury Total Maximum Daily Load



Santa Clara Valley Water District Santa Clara Valley Water District 5750 Almaden Expressway San Jose, CA 95118 February 7, 2017

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Introduction

The Guadalupe River Watershed covers a 170-square mile area in the cities of San Jose, Los Gatos, Monte Sereno, Campbell, and Santa Clara. The Santa Clara Valley Water District (SCVWD) operates five reservoirs in the Guadalupe Watershed including Lexington, Vasona, Guadalupe, Almaden, and Calero. One additional reservoir in the watershed, Lake Elsman, is not operated by the SCVWD. The watershed holds more than 80 miles of streams, with major tributaries of the Guadalupe River including Los Gatos, Ross, Alamitos, Canoas, and Guadalupe Creeks. The watershed provides many beneficial uses such as drinking water supply, sport fishing, and habitat for wildlife including endangered species. However, it is estimated that from 1850 to 1920 6,500 tons of mercury seeped into local streams as a result of mining work during the California Gold Rush in the 1800s. Mercury concentrations in fish tissue that exceed the U.S. EPA human health mercury fish criterion (0.3 mg/kg) have been measured at numerous creeks and reservoirs in the Guadalupe River Watershed. Mercury may bioaccumulate in the food web. According to the State Water Resources Control Board, elevated mercury concentrations in fish tissue may also pose a threat to wildlife such as birds, amphibians, and mammals.

The Guadalupe River Watershed Mercury Total Maximum Daily Load (TMDL) is a regulatory driver requiring agencies to control the prevalence of mercury in the system. In addition to being the primary regulatory means of achieving water quality goals in the watershed, the Guadalupe River Watershed Mercury TMDL will simultaneously reduce the amount of mercury in the Bay in accordance with the San Francisco Bay Mercury TMDL's proposed requirements.

The Basin Plan Amendment of the Guadalupe River Watershed Mercury TMDL calls for special studies to provide information on and improve understanding of mercury cycling in the watershed. The special studies may answer two questions:

- 1. How do the fish assemblages in reservoirs and lakes in the Guadalupe River Watershed differ from one another?
- 2. Is it possible to increase the assimilative capacity for methylmercury in reservoirs and lakes?

The SCVWD installed oxygenation systems into reservoirs listed as impaired for mercury (Calero, Guadalupe, and Almaden) which may limit anoxic conditions where the methylation of mercury occurs. The SCVWD also installed an oxygenation system in Stevens Creek Reservoir as a reference site to account for regional variation. It is reasonable to assume that limiting the production of the bio-available form of mercury will reduce mercury accumulation in fish tissues. There is further potential to affect fish assemblages by oxygenating additional levels in the water column. Since it would be difficult to predict the effects of these actions on fish populations, in 2012 the SCVWD began sampling fish assemblages in reservoirs impacted by the presence of mercury. The goal was to document fish presence and relative changes in fish populations over time, and the 2017 sampling event represents the sixth year of reservoir fisheries monitoring. Datasets are not continuous for each reservoir over the six-year span as sampling constraints and conditions that did not facilitate sampling were encountered; therefore, data gaps occur for some years at some reservoirs. This sampling duration also occurred during a variety of climatic conditions. At the start of the calendar year in 2012, Santa Clara County was in a moderate drought. At the start of 2013, that designation was reduced to abnormally dry. By the

start of 2014, Santa Clara County was in a severe drought. This escalated to an extreme drought at the start of 2015 through the start of 2016, followed by a slight reprieve at the start of 2017 to severe drought conditions. By the time the sampling commenced in 2017, no drought conditions were present (National Drought Mitigation Center 2018). The warm-water fish species within Santa Clara County Reservoirs are very tolerant to conditions such as increased water temperatures and reduced dissolved oxygen. The water quality impacts associated with drought conditions are not expected to impact the species present in the reservoir as much as it would native cold-water fisheries. Reservoir elevation changes associated with drought could potentially impact fish in the reservoirs. Drawdowns during spawning seasons could result in spawning beds becoming dewatered. This would be reflected in young of the year capture rates during the summer sampling period.

Prior to 2016, sampling timing was variable by season. 2016 and 2017 sampling occurred consistently in the spring and summer. In 2016 Guadalupe, Almaden, Calero, and Stevens Creek Reservoirs were sampled during a spring and summer sampling period. Boat-based electrofishing is the preferred method of sampling, but due to low reservoir levels at Almaden Reservoir during summer months, boat electrofishing is not possible during the summer sampling period. Therefore, hook and line surveys (angling surveys) were conducted in the summer to obtain samples for the body burden analysis, but was not an adequate assessment of assemblage. Body burden analysis measures the levels of environmental toxins, such as mercury, accumulating in fish tissues. Boat electrofishing was conducted at Stevens, Guadalupe, and Calero Reservoirs during both sampling periods. The effort reported herein is a continuation of this sampling effort including fish assemblage and relative occurrence data collected in Guadalupe, Almaden, Calero, and Stevens Creek Reservoir in the summer and spring of 2016 and 2017. Comparisons of prior years' data are included. This report covers all species encountered during the sampling, but focuses on fish (largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus), and black crappie (*Pomoxis nigromaculatus*)) targeted for body burden analysis and provides detailed analysis into those specific species. Data on mercury body burden analyses will be reported in the SCVWD's Guadalupe River Watershed Mercury TMDL: 2016-2017 Progress Report on Methylmercury Production and Control Measures in December 2017.

Methods

Reservoir Fish Sampling

In 2016 and 2017, fish were captured using a Smith-Root Model H electrofishing boat in Calero, Almaden, Guadalupe, and Stevens Creek Reservoirs in spring and in Calero, Guadalupe, and Stevens Creek Reservoir in summer. Settings were 120-340 volts DC, in 60% of selected range. Four fetches (stations) were sampled at each reservoir when electrofishing occurred except in spring 2016 at Stevens Creek Reservoir where 3 fetches were sampled. Sampling was initiated at night, shortly after dusk. Stations were located along the shoreline following the lake margin with sampling occurring in water 2 to 15 feet in depth. Two forward netters and two flank netters were positioned on the boat with a captain driving the boat and controlling shocking duration. Station distances were defined by the amount of shoreline sampled in 15-minute spans with positioning recorded on a GPS. At the end of each sampling station, the boat was stopped and anchored away from the shoreline. Fish were then identified to species, measured, and counted. Fork length was taken for the first 25 individuals of each species measured at a station. Fish selected for the body burden analysis were sacrificed and preserved for shipment to the lab. In summer of 2016 and 2017, samples were collected in Almaden Reservoir using hook and line sampling from a 14-foot aluminum Jon Boat, as reservoir elevations did not allow for launching the electrofishing boat. This sampling does not provide an accurate estimate of assemblage or size distribution within the reservoir. Two methods of fishing were used to catch different species and different size classes, with a primary focus on collecting samples for the body burden analysis. All hook and line sampling was conducted during daylight hours. The first method used was open water trolling along two to three transects by two anglers. Each transect was trolled for 15 minutes. The other method used stationary angling along the shore margins at seven stations. The boat was anchored and two anglers fished from the boat using various techniques for half-hour increments. Lures and hooks were scaled to catch fish of various sizes and each lure size and technique was used for an equal amount of time at each station. If a specific lure was working well to catch desired species for the body burden analysis, no changes were made, and that lure was fished the entire duration. All fish collected using both methods were held in a livewell and fork length was taken for the first 25 individuals of each species measured at a station. If fish showed signs of stress induced from the capture method, they were rehabilitated and released without measurement to reduce mortality. Fish selected for the body burden analysis were sacrificed and preserved for shipment to the lab.

Sampling bias is associated with all sampling methods, especially in an uncontrolled field environment. Boat electrofishing and hook and line survey possess various biases associated with the limitations of the sampling equipment. Boat electrofishing only samples the water column between the surface and approximately 15 feet deep, depending on the conductivity and settings. This limits the area that can be sampled, thus only targeting fish nearshore or within the top of the water column. Electrofishing also has bias in terms of specific species' catchability, fish size, and netting efficiency. Certain species (especially bottom-dwelling fish such as *lctalurus, Cottus*, and *Catostomus* species) are not as easily captured due to morphological and physiological characteristics. Often larger fish are more readily collected with electrofishing since they are more susceptible to electric shock and they are highly visible when stunned (Mantyniemi et al. 2005; Marshal 2009). Netting efficiency also results in bias as human error is a variable that is difficult to control. Hook and line sampling is biased by location of sampling, limitations of the equipment, and ability of the sampler. The sample size of fish measured (25 of each species at each station) is sized to reduce bias in length frequency, but no true randomization of which fish were measured occurred. Length frequency may not be a true representation of fish size within the station and size data could be skewed based on how fish were removed from the livewell.

Largemouth Bass Age Analysis

Scale analysis on largemouth bass was completed to further understand age distribution and growth rates within the reservoirs. The age of a fish was determined by counting completed annuli, or growth rings, on the scale. Annuli are characterized by wide ridges indicating fast summer growth, and consistent crowding of ridges indicating slow winter growth. Each annulus represents one year (Schneider et al. 2000). Due to the temperate Santa Clara County climate, results are often inconclusive, or confidence is low. The lack of distinct growing seasons limits the development of clearly defined annuli in the scale. The scale analysis provides age estimates that indicate the average size of fish in each age class (Table 1). To estimate length-to-age relationships on a watershed-scale basis, the results were combined and an overall Guadalupe River Watershed largemouth bass age estimate was generated. This information was applied to this analysis by looking at size distributions and assessing size range overlap.

Mean comparisons to investigate differences in length-age relationships were done using the Kruskal Wallis one-way analysis of variance. The results of the test are shown in Table 1. The age category 0+ is used to describe a fish in its first year of life. Age 1+ is a fish greater than one year of age, but less than two, and this pattern continues for all age categories.

Age		Mean	Min	Max	Standard	
Category	egory n		(mm)	(mm)	Error (mm)	
Age 0+	31	89.10	82.37	95.82	6.73	
Age 1+	14	132.21	121.46	142.97	10.76	
Age 2+	33	221.21	208.29	234.13	12.92	
Age 3+	26	305.27	292.93	317.61	12.34	
Age 4+	7	367.00	325.20	408.80	41.80	
Age 5+	5	469.60	444.76	494.44	24.84	

Table 1: Results of the Kruskal Wallis one-way analysis of variance on the length-age relationship for largemouth bass in the Guadalupe Watershed and Stevens Creek Reservoir.

Results

Guadalupe Reservoir

Spring and Summer 2016

Sampling occurred on the Guadalupe Reservoir on March 24, 2016 and August 30, 2016. Reservoir water elevation at the time of spring sampling was 598.8 feet (64% capacity) and summer sampling was 581.5 feet (40% capacity). A total of 4,740 linear feet in spring and 4,885 linear feet in summer of the reservoir margin was sampled through the 4 sampling stations (Figure 1). Three species were collected: largemouth bass, bluegill, and black crappie. Common carp (*Cyprinus carpio*) were observed but not collected to avoid overcrowding the livewell. All four species are non-native. Total capture data for each sampling station and standardized results (catch per unit effort (CPUE) (fish captured per minute of sampling)) are reported in Table 2.

Bluegill was the dominant species encountered during both sampling events, followed by black crappie in the spring and largemouth bass in the summer. The total number of fish captured in summer was higher than in the spring. The higher total number is expected, as the summer sampling occurs after spawning and a higher abundance of young of the year fish are present. Also, during the spring sampling event the reservoir elevation is higher, which can contribute to steeper reservoir margins and deeper water in the areas sampled by electrofishing. This increase in depth limits the efficiency of boat electrofishing.



Figure 1: 2016 Guadalupe Reservoir sampling locations spring and summer.

The size distribution of collected fish can be seen in Figure 2. The size distribution shows different age classes of largemouth bass and bluegill in both sampling events, but limited size distribution was present with black crappie in spring. Just as was observed in fall 2015, almost all black crappie were greater than 150 mm and therefore would not fall into the young of the year designation. In summer (after spawning season), evidence of a new age class of black crappie that fall within the size range of young of the year was captured.

Spring Fish Capture Guadalupe Reservoir (3/24/2016)											
Station	StationDuration (min)Largemouth BassBluegillBlack Crappie										
1	15	11	98	1							
2	15	6	52	15							
3	15	13	15	5							
4	15	4	78	19							
Total		34	243	40							
per min		0.57	4.05	0.67							
	Summer Fish	Capture Guadalupe Res	servoir (8/30/20	016)							
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie							
1	15	16	55	1							
2	15	11	248	4							

Table 2: Electrofishing captures in Guadalupe Reservoir spring and summer 2016.

3	15	33	369	24
4	15	28	171	3
Total		88	843	32
per min		1.47	14.05	0.53



Figure 2: Guadalupe Reservoir fish size distribution in spring and summer 2016.

The size distribution indicates successful spawning of largemouth bass, black crappie, and bluegill occurred in spring 2016, and that the spring sampling event occurred before the fish spawned, or the young of the year fish were too small to capture. The size distribution seen with black crappie in spring indicates that either successful spawning did not occur in 2015, juvenile fish were not using portions of the reservoir sampled, or high level of predation of juvenile black crappie occurred, as young of the year fish were not encountered. However, the data suggests that black crappie did successfully reproduce in the spring of 2016. According to Moyle (2002), black crappie 40 mm to 80 mm are first year, 120 mm to 210 mm are second year and fish 150 mm to 280 mm are at the end of their third year. All black crappie collected in spring were greater than 120 mm, with most exceeding 150 mm. The data collected in summer shows black crappie in the 37 mm to 75 mm range. This size range indicates a cohort of young of the year fish were present.

Bluegill size data displayed limited distribution between size classes, but smaller fish were observed in summer (young of the year). Very limited size distribution is observed between spring and summer. This could indicate slow growth rates, that spawning is occurring late in the season, or that overlap of sizes within age class appears to be common. Moyle (2002) indicates that bluegill at the end of their first year will be between 40 mm and 60 mm and tend to grow 20 mm to 50 mm each additional year.

During the spring event, when young of the year bluegill are expected to be at the largest size, many fish were under 40 mm (the low range of size indicated by Moyle 2002). Moyle (2002) indicates that growth of small bluegill is limited by intraspecific competition. This could be the case within Guadalupe Reservoir as bluegill are the most abundant fish observed. Older bluegill may be smaller than what is anticipated. Based on the literature, bluegill size distribution indicates that fish are present that are over 4 to 5 years of age, but could potentially be older if stunting is occurring in the water body.

The size distribution between summer and spring in largemouth bass indicates successful spawning occurred. Largemouth bass growth rates are highly variable due to temperature, competition, genetic background, forage availability, and limnological conditions (Moyle 2002). As expected, the spring event had larger fish in the first size cohort than the summer event due to the seasonal timing. Sampling occurs at the start of the breeding season, so all fish in the reservoir are expected to be approaching 1 year of age or older. The smallest fish collected during the summer event are expected to be true young of the year age class. Based on Moyle (2002), fish were observed that were young of the year ranging to likely in their fifth or sixth year. A more detailed analysis of largemouth bass age within Guadalupe Reservoir will be discussed later in this section.

Spring and Summer 2017

Sampling occurred on Guadalupe Reservoir on April 25, 2017 and August 28, 2017. Reservoir water elevation at the time of the spring sampling was 590.9 feet (63% capacity) and summer sampling was 582.0 feet (40% capacity). A total of 5,697 linear feet in spring and 5,376 linear feet in summer of reservoir margin was sampled through 4 sampling stations (Figure 3). Three species were collected: largemouth bass, bluegill, and black crappie. Common carp were observed but not collected to avoid overcrowding the livewell. Total capture data for each sampling station and standardized results (CPUE) are reported in Table 3.



Figure 3: 2017 Guadalupe Reservoir sampling locations spring and summer.

Table 3. Electrofishing captures in Guadalupe Reservoir spring and summer 2017.

	Spring Fish Capture Guadalupe Reservoir (4/25/2017)										
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie							
1	15	12	137	3							
2	15	5	172	5							
3	15	10	165	2							
4	15	15	109	0							
Total		42	583	10							
per min		0.7	9.72	0.17							
	Summer Fish Capture Guadalupe Reservoir (8/28/2017)										
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie							
1	15	30	138	0							
2	15	28	165	0							
3	15	57	187	1							
4	15	56	253	3							
Total		171	743	4							
per min		2.85	12.38	0.07							

Bluegill were the dominant species encountered during both sampling events, followed by largemouth bass. The total number of fish captured in summer was higher than spring, with the exception of black crappie. Black crappie capture was low in summer, with two stations resulting in zero captures. This could indicate a population reduction of black crappie in the reservoir, or that black crappie are using different portions of the reservoir not sampled by electrofishing. The higher number of all other species in summer is expected, as the sampling occurs after spawning and a higher abundance of young of the year fish are present. As mentioned in the 2016 Guadalupe Reservoir summary, higher reservoir elevation can impact electrofishing efficiency, which could contribute to lower captures in spring.

The size distribution of collected fish in 2017 can be seen in Figure 4. The size distribution shows different age classes of largemouth bass and bluegill in both sampling events, but only black crappie greater than 188 mm were collected in spring and only two size cohorts (and low abundance) were recorded in summer. A similar size distribution was observed in 2016, with higher abundance.



Figure 4: Guadalupe Reservoir fish size distribution in spring and summer 2017.

Two young of the year-sized black crappie (55 mm) were collected in summer, indicating that reproduction occurred in spring 2017, based on the literature (Moyle 2002). The 145 mm black crappies collected in summer were likely in their third year. The spring 2017 sampling event had black crappie sizes that put fish at the end of their third year and potentially their fourth year (Moyle 2002). No young of the year or year 1+ fish were collected in spring 2017. Since young of the year-sized black crappie

were observed in summer 2016, this indicates that either young black crappie had low survival, or fish in this size class are using different portions of the reservoir not sampled by electrofishing. This trend of only larger size black crappie being accounted for in the spring sampling event is most likely due to smaller fish using different portions of the reservoir that are not sampled.

The size distribution in bluegill does not show a clear size variation between young of the year fish between spring and summer sampling. Bluegill at 25 mm were observed in spring when no young of the year fish should be present, and the smallest fish observed in summer was 28 mm. As mentioned above, this limited size distribution could be a result of increased competition due to high population numbers (growth stunting), or it could be associated with the bias in sampling gear (net mesh size too large to capture stunted bluegill) or electrofishing efficiency. The size distribution observed puts bluegill within young of the year size range and could extend into the 6th year. When bluegill sizes are compared to the literature from other California bluegill, it is evident that stunting is occurring in this system. Bluegill may be older than their size is indicating.

The size distribution between summer and spring in largemouth bass indicates successful spawning occurred. Again, as expected, the spring event had larger largemouth bass in the first size cohort than the summer event due to the seasonal timing. A more detailed analysis of largemouth bass age within Guadalupe Reservoir will be discussed later in this section.

Guadalupe Reservoir Summary

An evaluation of overall trends in terms of abundance are difficult to draw from this sampling method, but the results are a good indicator of assemblage and community distribution in portions of the reservoir sampled by electrofishing. During all sampling events in Guadalupe Reservoir (2012-2013, 2015-2017), bluegill made up a majority of the catch followed by largemouth bass and black crappie, except in summer 2013 and spring 2016 when more black crappie were captured than largemouth bass (Table 4). When yearly average CPUE of all species is compared (Figure 5), limited change in capture has been observed during the 5 years of data collection, with exception of a potential decline in black crappie capture. The capture rates associated with black crappie may not be an indicator of less abundance in the system, but a result of behavior. According to Moyle (2002), black crappie are usually found around shoals and submerged structures during the day and move offshore in the evening and early morning. They will move inshore in the evening and morning if prey is abundant. Since pelagic forage fish are not encountered at Guadalupe Reservoir, black crappie may be moving offshore during the evening when sampling occurs. This behavior would limit the detection of the species with boat electrofishing. The higher capture of bluegill could be a result of abundance, but is also a result of life history traits. Bluegill are often associated with rooted aquatic vegetation and are rarely found in water deeper than 16 feet. This makes this species more readily available for collection using boat electrofishing. A trend observed in both largemouth bass and bluegill is a higher capture rate in summer than in spring. This is expected as the summer sampling occurs after the spawn when more of each species is expected to be present. The inverse of this relationship is seen in black crappie with a higher capture in spring versus summer, but the magnitude of the variation is much less. This relationship appears to be based on the species life history and not population abundance. Common carp were observed during each sampling event, but Sacramento sucker (Catostomus occidentalis) have not been

captured since 2012. Bias associated with the sampling method, overall low abundance, or spatial distribution of the sampling could contribute to the lack of detection. The information collected does not provide evidence that the species no longer persists in the reservoir. The cumulative dataset also does not provide any insight to any impacts associated with the climatic conditions during the sampling. The sampling period covered a gamut of drought conditions, but capture rates stayed relatively constant.

Based on the sampling, the trophic distribution within Guadalupe Reservoir is limited. No fish species were observed that predominantly bridge the gap between the phytoplankton and zooplankton and primary predators. The only fish present are assigned as trophic level 3 or higher (Fishbase 2017). This system lacks a "bait fish" species seen in other reservoirs, such as threadfin shad (*Dorosoma petenense*; trophic level 2.8±0.1) or golden shiner (*Notemigonus crysoleucas*; trophic level 2.7±0.1) (Fishbase 2017)), which provide forage for primary predators. It is predicted that cannibalism and predation on higher trophic level species is occurring. This shortens the food chain, which could be influencing mercury accumulation.

Sampling	Largemouth	Bluegill	Black	Common	Sacramento
Date	Bass	Bass Crappie		Carp	Sucker
7/12/2012	5.33	10.55	1.16	0.19	0.05
7/17/2013	0.69	9.19	0.91	0.11	0
10/6/2015	1.93	5.15	0.27	Р	0
3/24/2016	0.57	4.05	0.67	Р	0
8/30/2016	1.47	14.05	0.53	Р	0
4/25/2017	0.7	9.72	0.17	Р	0
8/28/2017	2.85	12.38	0.07	Р	0

Table 4: Guadalupe Reservoir CPUE (catch per minute) 2012-2013, 2015-2017 (P - present but not quantified).



Figure 5: Yearly average CPUE for Guadalupe Reservoir 2012-2013, 2015-2017.

Age analysis based on available literature for bluegill indicates that Guadalupe Reservoir potentially has slower than average growth rates of bluegill. The presence of bluegill under 40 mm in both sampling events indicates that stunting might be occurring, and fish may be older than lengths indicate. This could be influencing the results of the mercury body burden analysis for this species. The low number of individuals makes a growth rate determination difficult for black crappie.

Size data for largemouth bass in Guadalupe Reservoir were compared to the scale analysis information collected by the SCVWD (Figure 6). Figure 6 shows the lengths of largemouth bass from 2016 and 2017 with the age estimates overlaid. The age estimates are based on the average length and standard error of largemouth bass evaluated in the analysis (see Table 1). When the age 0+ category, or fish within their first year, is evaluated (smallest size cohort in the summer sampling event), it shows that most largemouth bass tend to fall below the predicted average size and in spring 2017 they were closer to 0+ age when the seasonal timing puts them closer to 1+. In Guadalupe Reservoir it appears that size overlaps occur between age classes, especially in 0+ and 1+, and often the size clusters (potential age cohorts) fall below the predicted size for the County. This could indicate potential stunting is occurring, but it is not as evident as observed with the bluegill. Based on the age analysis conducted within the Guadalupe Watershed, Guadalupe Reservoir has largemouth bass that are young of the year and that are potentially past their sixth year. Due to the evidence of potential stunting, these large fish could be older than anticipated. A predicted growth spurt is observed between the 1+ and 2+ age category,

which could be a result of a diet change. This growth is observed in the scale analysis data as well, showing Guadalupe Reservoir largemouth bass growth is trending with what is observed in the County, but might be occurring at a slower rate.



Figure 6: Largemouth bass lengths from Guadalupe Reservoir with age class estimates (2016 and 2017).

Calero Reservoir

Spring and Summer 2016

Sampling occurred at Calero Reservoir in spring on April 7, 2016 and summer on September 9, 2016. Reservoir elevation was 461 feet (41% capacity) at the time of the spring survey and 464 feet (45% capacity) for the summer survey. Reservoir fluctuations occurred, with drawdowns in November, February, March, and August. The reservoir was never reduced to below 30% and did not exceed 46% capacity. A total of 7,059 linear feet of reservoir margin was sampled in four survey stations in spring and 5,739 linear feet in four sampling stations in summer (Figure 7). Twelve species were collected in spring and summer: largemouth bass, bluegill, black crappie, threadfin shad (*Dorosoma petenense*), inland silverside (*Menidia beryllina*), bigscale logperch (*Percina macrolepida*), golden shiner (*Notemigonus crysoleucas*), pumpkinseed (*Lepomis gibbosus*), tule perch (*Hysterocarpus traskii*), and Sacramento sucker were collected during both sampling events with brown bullhead (*Ameiurus nebulosus*) collected just in spring, and prickly sculpin (*Cottus asper*) just in summer. Common carp were observed in both spring and summer, but were not collected to avoid crowding in the livewell. All carp observed were estimated at over 300 mm and potentially exceeded 600 mm. Tule perch, Sacramento sucker, and prickly sculpin were the only native species collected. Total capture data is





Figure 7: Calero Reservoir sampling locations spring and summer (2016).

	Spring Fish Captures Calero Reservoir (April 7, 2016)												
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie	Threadfin Shad	Inland Silverside	Bigscale Logperch	Golden Shiner	Pumpkinseed	Tule Perch	Sacramento Sucker	Brown Bullhead	Prickly Sculpin
1	15	4	15	6	30	16	0	1	1	23	0	0	0
2	15	15	17	1	4	43	0	0	0	21	0	0	0
3	15	11	11	8	1	8	0	1	1	9	9	1	0
4	15	10	6	1	40	19	1	7	12	10	0	0	0
Total		40	49	16	75	86	1	9	14	63	9	1	0
per min		0.67	0.82	0.27	1.25	1.43	0.02	0.15	0.23	1.05	0.15	0.02	0.00
		Summ	er Fish	Captu	res Cale	ero Rese	ervoir (S	Septem	ber 9, 2	2016)			
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie	Threadfin Shad	Inland Silverside	Bigscale Logperch	Golden Shiner	Pumpkinseed	Tule Perch	Sacramento Sucker	Brown Bullhead	Prickly Sculpin
1	15	19	7	2	246	19	9	12	1	43	1	0	1
2	15	39	2	1	97	19	4	8	0	16	0	0	0
3	15	62	8	6	117	14	0	26	2	61	0	0	0
4	15	5	7	4	128	2	0	10	1	1	0	0	0
Total		125	24	13	588	54	13	56	4	121	1	0	1
per min		2.08	0.4	0.22	9.8	0.9	0.22	0.93	0.07	2.02	0.02	0.00	0.02

Table E. Elect	trofiching	conturos in	Caloro	Poconvoir	coring a	nd cummor	2016
Table 5. Elect	u onsning u	aptures in		Reservon	spring a	inu summer	2010.

Threadfin shad and inland silverside were the dominant species encountered during the spring sampling event. Total capture of fish in spring was low (n=363), and slightly turbid conditions limited the sampling efficiency. Summer total capture was 1,008 fish with threadfin shad comprising over half of the fish captured. Low occurrence of Sacramento sucker, prickly sculpin, and brown bullhead can be contributed to sampling method bias (discussed previously), and is likely not an indicator of population level. Native tule perch were encountered at a higher rate than other species in a similar niche, and was the third highest species encountered in both spring and summer.

The size distribution of collected fish with more than one individual can be seen in Figure 8. The size distribution shows different size (presumably age) classes of most fish species. As expected, larger fish were observed in the spring event prior to spawning, except in bluegill where smaller fish were not encountered in summer. The size data suggests that tule perch are successfully reproducing in the system. The growth rate of this species is variable by water body (Moyle 2002), but an estimate of reproductive success occurring for at least three years is plausible, as distinct size classes are present and the fluctuation of larger-sized fish in spring vs. summer (after reproduction) occurred.

The size distribution of largemouth bass indicates that successful spawning has occurred over multiple years. A more detailed analysis of largemouth bass age will occur later in this section.

The size distribution data for bluegill is as excepted in spring, with fish in the size range of one-year old and extending to potentially over 8 years old, although few fish live over 6 years of age (Moyle 2002). Collection of bluegill in summer indicates that limited reproduction occurred, or young of the year bluegill were using different portions of the reservoir than what was sampled. Few bluegill were captured in the young of the year size range, and it also seems that between spring and summer sampling, survival of one-year old fish may have been low. Again, these young of the year fish and fish approaching their second year could have been using a different portion of the reservoir that was not sampled. Similar trends are observed with black crappie. In spring, fish in the upper size range of the one-year old fish were observed, while very few fish in the young of the year size range were captured in summer. It is possible that reproduction of bluegill and black crappie had limited success in 2016. Another potential scenario is that back crappie and bluegill are being outcompeted by the native tule perch, which fills a similar niche and is more abundant. The data also suggests that conditions favor growth in predatory species, adequate forage is available, and longevity within individuals is common. The growth rate and longevity of recreationally caught species can be a concern in terms of mercury contamination.



Figure 8: Calero Reservoir fish size distribution in spring and summer 2016. Abbreviations for fish names are as followed: BLCR-black crappie, BLGI-bluegill, BSLP-big scale logperch, GOSH-golden shiner, INSI-inland silverside, LMBA-largemouth bass, PUMP-pumpkinseed, SASU-Sacramento sucker, THFS-threadfin shad, and TUPE-tule perch.

Spring and Summer 2017

Sampling occurred at Calero Reservoir in spring on April 3, 2017 and summer on September 6, 2017. Reservoir elevation at the time of the spring survey was 462 feet (42% capacity) and 464 feet (46% capacity) during the summer. Reservoir fluctuations occurred, with drawdowns in November, February, March, and August. The reservoir was never reduced to below 30% and did not exceed 46% capacity. A total of 7,059 linear feet of reservoir margin was sampled in four survey stations in spring and 5,739 linear feet in four sampling stations in summer (Figure 9). Eleven species were collected in spring and summer: largemouth bass, bluegill, black crappie, threadfin shad, inland silverside, bigscale logperch, golden shiner, pumpkinseed, tule perch, and brown bullhead were collected during both sampling events with prickly sculpin just in spring. Common carp were observed in both surveys, but were not collected to avoid crowding in the livewell. All carp observed were estimated at over 300 mm and potentially exceeded 600 mm. Tule perch, Sacramento sucker, and prickly sculpin were the only native species collected. Total capture data is reported in Table 6, and to standardize the results, data were converted to a CPUE.



Figure 9: Calero sampling locations spring and summer (2017).

		Spring	; Fish C	apture	s Caler	o Reserv	voir (Ap	ril 3, 20)17)			
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie	Threadfin Shad	Inland Silverside	Bigscale Logperch	Golden Shiner	Pumpkinseed	Tule Perch	Brown Bullhead	Prickly Sculpin
1	15	14	21	10	4	1	3	1	0	33	0	0
2	15	2	1	6	65	0	1	0	0	12	1	0
3	15	9	11	5	81	3	0	1	2	35	0	0
4	15	23	19	42	15	0	3	0	2	21	0	1
Total		48	53	63	165	4	7	2	4	101	1	1
per min		0.8	0.88	1.05	2.75	0.07	0.12	0.03	0.07	1.68	0.02	0.02
	Sur	nmer F	ish Cap	otures (Calero I	Reservo	ir (Sept	ember	6, <mark>20</mark> 17	7)		
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie	Threadfin Shad	Inland Silverside	Bigscale Logperch	Golden Shiner	Pumpkinseed	Tule Perch	Brown Bullhead	Prickly Sculpin
1	15	15	1	1	56	6	0	12	0	11	1	0
2	15	21	12	0	59	69	2	11	0	31	0	0
3	15	33	11	11	63	14	0	14	0	4	1	0
4	15	69	5	8	126	9	4	21	1	1	0	0
Total		138	29	20	304	98	6	58	1	47	2	0
per min		2.3	0.48	0.33	5.07	1.63	0.1	0.97	0.02	0.78	0.03	0.00

Table 6:	Electrofishing	captures in	Calero	Reservoir	spring an	d summer	2017.
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Threadfin shad and tule perch were the dominant species encountered during the spring sampling event. Total capture of fish in spring again was much lower than the summer sampling event. As discussed previously, low occurrence of prickly sculpin and brown bullhead, and the absence of Sacramento sucker, can be contributed to sampling method bias and is likely not an indicator of population level. Native tule perch were encountered at a higher rate than other species in a similar niche in both the spring and summer sampling.

The size distribution of collected fish with more than one individual can be seen in Figure 10. The size distribution shows different size (presumably age) classes of most fish species. As expected, larger fish were observed in the spring event prior to spawning in most species, though this was not the case for bluegill and black crappie. The size data again suggests that tule perch are successfully reproducing in the system. The growth rate of this species is variable by water body (Moyle 2002), but an estimate of reproductive success occurring for at least three years is plausible, as distinct size classes are present. The size distribution of largemouth bass indicates that successful spawning has occurred over multiple years. A more detailed analysis of largemouth bass age will occur later in this section.

The size distribution data for bluegill is as excepted in spring, with fish in the size range of one-year old and extending into their 5th year (Moyle 2002). Collection of bluegill in summer indicates that limited reproduction occurred, or young of the year bluegill were using different portions of the reservoir than what was sampled. No bluegill were captured in the young of the year size range defined by Moyle (2002). The data also potentially suggests that between spring and summer sampling, survival of one-year old fish may have been low. Again, these young of the year fish and fish approaching their second year could have been using a different portion of the reservoir not sampled. Similar trends are observed with black crappie. In the spring event, few individuals within the young of the year size range defined by Moyle (2002) were encountered. During the summer sampling, no fish in the young of the year size range were captured. There is a possibility that reproduction of bluegill and black crappie had limited success in 2017 or they are using different portions of the reservoir. As mentioned in the 2016 analysis, back crappie and bluegill are potentially being outcompeted by tule perch. The data continues to suggest that conditions favor growth in predatory species, adequate forage is available, and longevity within individuals is common.



Figure 10: Calero Reservoir fish size distribution in spring and summer 2017. Abbreviations for fish names are as followed: BLCR-black crappie, BLGI-bluegill, BSLP-big scale logperch, GOSH-golden shiner, INSI-inland silverside, LMBA-largemouth bass, PUMP-pumpkinseed, SASU-Sacramento sucker, THFS-threadfin shad, and TUPE-tule perch.

Calero Reservoir Summary

In 2016 and 2017, spring sampling events had a lower collection rate of many species compared to summer sampling events. This could have been a result of sampling conditions mentioned above

(turbidity, higher water levels, etc.) or fish habitat usage (moving lower in the water column or offshore) in the cooler months. In 2016 and 2017, tule perch showed relatively high CPUE for both the spring and summer sampling event and overall abundance appears to be remaining stable. The catch data and size distribution suggest that the tule perch population is becoming established in the system. When the CPUE data from all sampling events is compared, no clear trends are present (Table 7). Capture rates of individual species fluctuates with the seasons and year to year. Calero Reservoir had the most comprehensive and seasonally diverse data set during the 6-year sampling period. The data presented in Table 7 is standardized in terms of effort but does not represent the same season of sampling in every year, so direct comparisons are difficult. An evaluation of overall trends in terms of population abundance are difficult to draw from these results, but it is a good indicator of assemblage and community distribution. The yearly average CPUE also does not show any clear trends in terms of increases or declines in individual species occurrence (Figure 11). It does indicate that threadfin shad, inland silverside, and largemouth bass are either the most abundant or are the species most easily captured using electrofishing. In 2016 and 2017, data was collected consistently in the same seasons (spring and summer, as opposed to previous years where the sampling season was variable) and it appears the yearly average CPUE is relatively consistent between the two years. With consistent sampling timing, trends will be easier to determine, and seasonal bias will be removed. The cumulative dataset also does not provide any insight to any impacts associated with the climatic conditions during the sampling. The sampling period covered a gamut of drought conditions, but the variation in sampling timing mentioned above prevents any further analysis. Calero Reservoir keeps a consistent elevation throughout the year, so drought might not have influenced conditions in the reservoir.

Sampling Date	Largemouth Bass	Bluegill	Black Crappie	Pumpkinseed	Common Carp	Tule Perch	Inland Silverside	Prickly Sculpin	Bigscale Logperch	Threadfin Shad	Sacramento Sucker	Golden Shiner	Brown Bullhead
6/28/2012	1.70	2.3	0.17	0.08	0.05	0.42	0.53	0.18	0.23	0.42	0.00	0.03	0.00
11/7/2012	5.37	0.25	0.67	0.05	0.03	0.07	5.35	0.05	0.22	0.73	0.05	0.17	0.02
7/31/2013	5.30	0.40	1.33	0.07	0.13	2.98	3.27	0.08	1.08	2.13	0.00	0.08	0.02
12/3/2013	6.67	1.85	3.60	0.02	0.10	0.10	11.45	0.07	0.35	0.45	0.05	0.22	0.02
4/21/2014	1.23	1.33	5.05	0.00	0.02	0.78	2.90	0.18	0.35	1.00	0.03	0.00	0.00
8/7/2014	4.32	1.15	0.78	0.12	0.00	0.85	1.32	0.02	1.00	0.55	0.02	0.00	0.00
11/4/2014	9.67	1.02	1.82	0.10	0.02	0.00	0.47	0.10	0.35	0.15	0.00	0.00	0.00
10/15/2015	4.62	0.56	0.31	0.27	Р	1.38	2.62	0.00	0.20	3.98	0.02	0.27	0.00
4/7/2016	0.67	0.82	0.27	0.23	Р	1.05	1.43	0.00	0.02	1.25	0.15	0.15	0.02
9/13/2016	2.08	0.40	0.22	0.07	Р	2.02	0.90	0.02	0.22	9.80	0.02	0.93	0.00
4/3/2017	0.80	0.88	1.05	0.07	Р	1.68	0.07	0.02	0.12	2.75	0.00	0.03	0.02

Table 7: Calero Reservoir CPUE (catch per minute) 2012-2017 (P- present but not quantified).

9/6/2017	2.30	0.48	0.33	0.02	Р	0.78	1.63	0.00	0.10	5.07	0.00	0.97	0.03



Figure 11: Yearly average CPUE Calero Reservoir 2012-2017.

Size data for largemouth bass in Calero Reservoir in 2016 and 2017 were compared to the scale analysis information collected by the SCVWD (Figure 12). The age estimates are based on the average length and standard error of largemouth bass evaluated in the analysis (see Table 1). When the age 0+ category is evaluated for Calero Reservoir (smallest size cohort in the summer sampling event), it shows that largemouth bass tended to fall within the predicted average size. For the spring events, the smallest cohort of largemouth bass is at the higher end of the 0+ range, when the seasonal timing puts them close to 1 year of age. A predicted growth spurt is observed between the 1+ and 2+ age category, which could be the result of a diet change. This growth is observed in the scale analysis data as well, showing that Calero Reservoir largemouth bass growth is trending with what is observed in the County. The growth spurt seen between 1+ and 2+ aged fish appears to be larger than the County average. Not very many fish fall into the 2+ size category, but they do fall between 2+ and 3+. This could indicate that largemouth bass in Calero Reservoir may have a faster growth rate than those in other reservoirs in the County. Based on the age analysis conducted within the Guadalupe Watershed, Calero Reservoir has largemouth bass that are young of the year and that potentially range to their sixth year.



Figure 12: Largemouth bass lengths from Calero Reservoir with age class estimates (2016 and 2017).

Almaden Reservoir

Spring and Summer 2016

Sampling occurred on Almaden Reservoir in spring on March 22, 2016 using boat-based electrofishing, and in summer on September 2 and 8, 2016 using hook and line sampling. The sensor for the reservoir surface elevation during the spring sampling event was not operable, but based on data from before and after the sensor malfunction, surface elevation was estimated at over 606.0 feet, which is over 90% capacity. The summer sampling event had an average elevation between the two sampling days of 594.15 feet, which is approximately 56% capacity. The 2016 dataset has sampling that occurred at both high and low water conditions, but different sampling methods were used. Spring high water conditions allowed for launching of the electrofishing boat. Four sampling stations totaling 5635 linear feet were sampled along the reservoir margin (Figure 13). The reservoir elevation during the spring event created deeper water conditions along the margin of the reservoir. Depths greater than 10 feet were observed within 2 feet of the wetted edge. This deep water reduces the efficiency of boat-based electrofishing. Five species were collected: largemouth bass, bluegill, black crappie, pumpkinseed, and threadfin shad. None of these species are native. During the summer, low water elevation made it impossible to launch the electrofishing boat. Sampling was conducted using hook and line sampling (angling) methods. A total of seven sampling stations using stationary angling and three trolling transects were sampled (Figure 13). All sampling methods yielded fish. The primary focus of this sampling was to collect fish for the body burden analysis. Angling methods were not designed to capture fish within all feeding guilds in the reservoir; this sampling method targeted predatory fish. Four species were collected: largemouth bass, bluegill, black crappie, and pumpkinseed. Only one species collected during the electrofishing

effort was not encountered (threadfin shad), which is expected, due to the bias associated with the sampling method. CPUE for electrofishing and total catch for hook and line sampling can be seen in Table 8.



Figure 13: Almaden Reservoir sampling locations spring and summer (2016).

	Spring Fish Capture Almaden Reservoir (March 22, 2016)									
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie	Pumpkinseed	Threadfin Shad				
1	15	5	7	2	0	35				
2	15	9	19	0	4	12				
3	15	13	31	2	0	4				
4	15	9	32	1	2	8				
Total		36	89	5	6	59				
per min		0.60	1.48	0.083	0.10	0.98				
	Summer Fi	sh Capture Alm	aden Reser	voir (Septer	nber 2 and 8, 2016)					
	Duration	Largemouth		Black		Threadfin				
Station	(min)	Bass	Bluegill	Crappie	Pumpkinseed	Shad				
1	30	22	15	1	0	0				
2	30	4	0	0	0	0				

Table 8: Captures in Almaden Reservoir for spring and summer 2016.

3	30	9	1	0	0	0	
4	30	1	0	0	0	0	
5	30	9	0	0	0	0	
6	30	23	3	0	1	0	
7	30	11	29	0	1	0	
Troll 1	15	1	0	1	0	0	
Troll 2	15	9	0	0	0	0	
Troll 3	15	7	0	0	0	0	
Total		96	48	2	2	0	
per min		0.38	0.19	0.01	0.01	0.00	

Capture rates during the spring electrofishing were low. The effectiveness of electrofishing was limited due to high reservoir surface elevation, causing deep reservoir margins, and poor water clarity. The low capture rates are not indicative of a population levels. Bluegill were the most abundant species encountered followed by threadfin shad and largemouth bass. The summer hook and line sampling event had a higher capture rate of largemouth bass than any other species. This is as excepted, as this method has certain biases, and as mentioned previously, was specifically designed to capture fish for the body burden analysis. During both the summer and spring events, black crappie and pumpkinseed had the lowest capture rate of the predatory fish. These fish could use different portions of the reservoir not sampled, or potentially make up the smallest proportion of the community.

The size distribution of collected fish can be seen in Figure 14. The size distribution shows different age classes of largemouth bass and bluegill in both spring and summer, but due to bias associated with the hook and line sampling method in summer size distribution is not as expansive. Even with the method shift between spring and summer, the presence of young of the year largemouth bass in summer is shown. This shift of smaller fish in summer after spawning is not seen in bluegill or pumpkinseed due to the switch to hook and line sampling. The gape size of bluegill in the young of the year size range, and potentially 1 year old fish, limits detection by hook and line sampling. The low capture rates of black crappie and pumpkinseed make determining age distribution difficult. Based on the literature (Moyle 2002), no young of the year sized black crappie are present that are at least in their second to fourth year of age. As seen in other reservoirs, it appears black crappie are in lower abundance than other species, or this species is using different portions of the reservoir not sampled.

The presence of bluegill can influence the size and spatial distribution of pumpkinseed, as bluegill competition can influence feeding habits in the reservoir. Due to the high presence of bluegill, small pumpkinseeds may be forced to use more open water habitats. Pumpkinseeds are slower growing than bluegill, and based on the literature it appears fish from 2 years of age and extending past their 4th year are present (Moyle 2002). The size distribution in bluegill in spring shows fish in their first year, and extends potentially into their 5th year. In summer, bluegill again were observed into their 5th year, but as mentioned above, smaller fish were not encountered due to the method of capture. The size distribution of largemouth bass indicates that successful spawning occurred in the reservoir. A more detailed analysis of largemouth bass size will be discussed later in this section.



Figure 14: Almaden Reservoir fish size distribution in spring and summer 2016.

Spring and Summer 2017

Sampling occurred on Almaden Reservoir in spring on April 11, 2017 using boat-based electrofishing, and in summer on September 1, 2017 using hook and line sampling. The spring sampling event had an elevation of 606.8 feet, which is approximately 93% capacity. The summer sampling event had an elevation of 599.4 feet, which is approximately 70% capacity. As in 2016, the 2017 dataset had sampling that occurred at both high and low water conditions, but different sampling methods were used. Spring high water conditions allowed for launching of the electrofishing boat. Four sampling stations totaling 5253 linear feet were sampled along the reservoir margin (Figure 15). The reservoir elevation during the sampling event created deep water conditions along the margin of the reservoir, reducing the efficiency of boat-based electrofishing. Six species were collected: largemouth bass, bluegill, black crappie, pumpkinseed, threadfin shad, and one prickly sculpin. All of these species, except the prickly sculpin, are are nonnative. 2017 was the first documented occurrence of prickly sculpin in Almaden Reservoir. During the summer, low water elevation made it impossible to launch the electrofishing boat. Sampling was conducted using hook and line sampling (angling) methods. A total of seven sampling stations using stationary angling and two trolling transects were sampled (Figure 15). All sampling methods yielded fish. As in 2016, the primary focus of the hook and line sampling was to collect fish for the body burden analysis. Angling methods were not designed to capture fish within all feeding guilds in the reservoir. Four species were collected: largemouth bass, bluegill, black crappie, and pumpkinseed. Two species collected during the electrofishing effort were not encountered (threadfin shad and prickly sculpin), which is expected due to bias associated with the method. CPUE and total catch for both sampling events can be seen in Table 9.



Figure 15: Almaden Reservoir sampling locations spring and summer (2017).

	Spring Fish Capture Almaden Reservoir (April 11, 2017)								
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie	Threadfin Shad	Pumpkinseed	Prickly Sculpin		
1	15	19	52	1	1	3	0		
2	15	2	24	0	0	0	1		
3	15	8	17	1	0	0	0		
4	15	7	22	0	4	0	0		
Total		36	115	2	5	3	1		
per min		0.6	1.92	0.03	0.08	0.05	0.02		
	Summer Fis	sh Capture Alma	aden Reser	voir (Septer	mber 1, 2017)	- Hook and Line			
	Duration	Largemouth		Black	Threadfin		Prickly		
Station	(min)	Bass	Bluegill	Crappie	Shad	Pumpkinseed	Sculpin		
Troll 1	15	2	0	0	0	0	0		
Troll 2	15	2	0	0	0	0	0		
1	30	5	0	0	0	0	0		
2	30	15	0	0	0	0	0		

Table 9: Captures in Almaden Reservoir for spring and summer 2017.

3	30	5	3	0	0	0	0
4	30	6	1	0	0	0	0
5	30	13	6	0	0	15	0
6	30	13	0	0	0	0	0
7	30	4	9	1	0	14	0
Total		65	19	1	0	29	0
per min		0.27	0.08	0.004	0.00	0.12	0.00

In spring, effectiveness of electrofishing was limited due to high reservoir surface elevation, which caused deep reservoir margins, and poor water clarity. This resulted in lower capture rates compared to summer sampling. During the spring event, bluegill were the most common species encountered followed by largemouth bass. Black crappie, threadfin shad, pumpkinseed, and prickly sculpin made up a small percentage of the catch. The summer hook and line sampling event had a higher capture rate of largemouth bass. This is as excepted, as this method has certain biases, and as mentioned previously, was specifically designed to capture fish for the body burden analysis.

The size distribution of collected fish can be seen in Figure 16 (excluding prickly sculpin as only one fish was encountered). The size distribution shows different age classes of largemouth bass, bluegill, pumpkinseed, and threadfin shad in spring, but due to biases associated with the hook and line sampling method implemented in summer, size distribution is not as easily seen. Even with the method shift between spring and summer, the presence of young of the year largemouth bass in summer is shown. As in 2016, the shift of smaller fish in summer after spawning is not shown in bluegill or pumpkinseed, due to the switch to hook and line sampling.



Figure 16: Almaden Reservoir fish size distribution in spring and summer 2017.

The low capture rates of black crappie and pumpkinseed do not show much of an age distribution. Based on the literature (Moyle 2002), young of the year sized black crappie (40-80 mm) were present in spring. This shows that some reproduction did occur in 2016. No fish in a size range that would put them over 2 years of age were collected. As seen in other reservoirs, it appears black crappie are present in lower abundance than other species, or this species is using different portions of the reservoir not sampled by either electrofishing or hook and line sampling. As in 2016, few small pumpkinseeds were collected, and the possibility that bluegill competition could potentially be influencing feeding habits and position in the reservoir is still plausible. Based on the literature, it appears the pumpkinseed collected were likely 3 years of age or greater (Moyle 2002). The size distribution in bluegill in spring shows fish in their first year, that extend potentially into their 6th year. The size distribution of largemouth bass indicates that successful spawning occurred in the reservoir. A more detailed analysis of largemouth bass size will be discussed later in this section.

Almaden Reservoir Summary

The 2016 and 2017 capture results were similar when the same methods are compared. The variation in seasonal timing of the sampling events conducted in 2012 and 2015 make year to year comparison difficult (Table 10). The spring 2017 sampling event had the first documented occurrence of prickly sculpin in the reservoir. This does not necessarily indicate this species is a new arrival in the reservoir, as boat electrofishing may not have sampled this species previously, but heavy rains in the winter of 2017 may have caused downstream movement of the species, making them more abundant.

When the CPUE data from all sampling events is compared (2012, 2015-2017), no clear trends are observed. Capture rates of individual species fluctuates with the seasons and year to year. The yearly average CPUE also does not show any clear trends in terms of increases or declines in individual species occurrence or impacts associated with drought conditions, but it does show consistencies from 2016 to 2017 (Figure 17). Sampling in years prior to 2016 did not occur consistently in the spring and summer. With continual consistent sampling timing, trends will be easier to determine, and seasonal bias will be removed.

Sampling Date	Largemouth Bass	Bluegill	Black Crappie	Threadfin Shad	Pumpkinseed	Prickly Sculpin	
7/19/2012	1.95	0.2	1.17	0.02	0	0	
10/15/2015*	0.63	0.02	0	0	0	0	
3/22/2016	0.6	1.48	0.08	0.98	0.1	0	
9/2/2016 and 9/8/2016*	0.38	0.19	0.01	0	0.01	0	
4/11/2017	0.6	1.92	0.03	0.08	0.05	0.02	
9/1/2017*	0.27	0.08	0.004	0	0.12	0	
*Hook and line sampling methods used.							

Table 10: Almaden Reservoir total catch data 2012-2015 (no sampling occurred in 2013 or 2014).



Figure 17: Yearly average CPUE Almaden Reservoir 2012-2017 (no sampling occurred 2013-2014).

Size data for largemouth bass in Almaden Reservoir in 2016 and 2017 were compared to the scale analysis information collected by the SCVWD (Figure 18). The age estimates are based on the average length and standard error of largemouth bass evaluated in the analysis (see Table 1). This dataset is more difficult to interpret than sampling efforts at other reservoirs, due to biases associated with the hook and line sampling method. When the age 0+ category is evaluated (smallest size cohort in the summer sampling event), it shows that largemouth bass tended to fall within the predicted average size, but there is limited size distribution between fish that would be considered young of the year (0+) and fish in their first year. Also, the predicted growth spurt observed between 1+ and 2+ age category is not seen in summer 2016 or spring 2017. Few fish fall into the 2+ size category, but they do fall between 2+ and 3+. This could indicate that largemouth bass in Almaden Reservoir may have a faster growth rate than those in other reservoirs in the County. Based on the age analysis conducted within the Guadalupe Watershed, Almaden Reservoir has largemouth bass that are young of the year and potentially ranging to their 6th year. To better understand size distribution within the reservoir, a more comprehensive sampling method (boat electrofishing) needs to be conducted during the summer months.



Figure 18: Largemouth bass lengths from Almaden Reservoir with age class estimates (2016 and 2017).

Stevens Creek Reservoir

Spring and Summer 2016

Sampling occurred on Stevens Creek Reservoir on April 12, 2016 and September 6, 2016. Reservoir water elevation at the time of the spring sampling was 533.24 feet (95% capacity) and summer sampling was 513.75 feet (48% capacity). Due to technical difficulties with the boat, only three stations were sampled in spring 2016; however, the standard four stations were sampled summer. A total of 3,325 linear feet in spring and 4,729 linear feet in summer of reservoir margin was sampled (Figure 19). Three species were collected in spring: largemouth bass, bluegill, and black crappie. Common carp were observed but not collected to avoid overcrowding the livewell. Five species were collected in summer: largemouth bass, bluegill, black crappie, Sacramento sucker, and one white catfish. Again, common carp were observed, but not collected. Sacramento sucker was the only native species encountered during the sampling effort. Total capture data for each sampling station and CPUE are reported in Table 11.



Figure 19: Stevens Creek Reservoir sampling locations spring and simmer (2016).

Spring Fish Capture Stevens Creek Reservoir (April 12, 2016)										
Duration Largemouth Black Sacramento White Station (min) Bass Bluegill Crappie Sucker Catfish										
1	15	5	22	4	0	0				
2	15	11	94	6	0	0				
3	15	10	66	5	0	0				

Table 11: 2016 Stevens Creek Reservoir Capture table for spring and summer sampling events.

Total		26	182	15	0	0			
per min		0.57	4.04	0.33	0.00	0.00			
Summer Fish Capture Stevens Creek Reservoir (September 6, 2016)									
	Duration	Largemouth		Black	Sacramento	White			
Station	(min)	Bass	Bluegill	Crappie	Sucker	Catfish			
1	15	5	47	0	0	0			
2	15	41	247	6	1	1			
3	15	7	273	6	0	0			
4	15	4	113	33	1	0			
Total		57	680	45	2	1			
per min		0.95	11.33	0.75	0.03	0.02			

Bluegill were the dominant species encountered during both sampling events, followed by largemouth bass, then black crappie. Sacramento sucker and white catfish made up a small percentage of the fish captured. The total number of fish captured in summer was more than double what was encountered in spring. The higher total number is expected as the summer sampling occurs after the spawn and a higher abundance of young of the year fish are present, but environmental conditions (high surface elevation) impacting electrofishing efficiencies are the likely cause of the lower abundance.

The size distribution of collected fish can be seen in Figure 20. The size distribution shows different age classes of largemouth bass and bluegill in both sampling events, but limited size distribution was present with black crappie in spring. All black crappie were greater than 140 mm in spring, and therefore would not fall into the young of the year or year 1 designation. In summer, a size distribution that indicates multiple age classes was present. This suggests that black crappie were using different portions of the reservoir in spring that were not sampled by boat electrofishing. Black crappie size ranges in spring show fish that are potentially in their second or third year. In summer, the size distribution indicates that black crappie are present from young of the year to potentially their 4th year. The size distribution of bluegill and largemouth bass in summer indicate that successful spawning occurred in 2016, but the size distribution of largemouth bass is limited. A more detailed analysis of largemouth bass age will occur later in this section. The size distribution data for bluegill indicates that fish in the size range of young of the year to 5th year are present (Moyle 2002).



Figure 20: Stevens Creek Reservoir fish size distribution in spring and summer 2016.

Spring and Summer 2017

Sampling occurred on Stevens Creek Reservoir in spring on April 19 and 24, 2017 (due to technical difficulties with the boat, the spring sampling event was split into two sampling days) and September 12, 2017. Reservoir water elevation at the time of the spring sampling averaged 534.6 feet (99% capacity) and summer sampling was 519.24 feet (59% capacity). A total of 4,718 linear feet in spring and 4,983 linear feet in summer of reservoir margin was sampled at four sampling stations (Figure 21). Five species were collected in spring: largemouth bass, bluegill, black crappie, Sacramento sucker, and one rainbow trout (*Oncorhynchus mykiss*). Common carp were observed but not collected to avoid overcrowding the livewell. Five species were also collected in summer: largemouth bass, bluegill, black crappie, Sacramento sucker, and one white catfish. Again, common carp were observed, but not collected. Sacramento sucker and rainbow trout were the only native species encountered during the sampling effort. This was the first documented occurrence of rainbow trout during the sampling efforts. It is suspected that the winter storms in 2017 may have pushed this fish into the reservoir from upstream tributaries. Total capture data for each sampling station and CPUE are reported in Table 12.



Figure 21: Stevens Creek Reservoir sampling locations spring and summer (2017).

Table 12: 2017 Stevens	Creek Reservoir o	apture table for s	pring and summe	er sampling events.
				1 0

Spring Fish Captures Stevens Creek Reservoir (April 19 and 24, 2017)								
Station	Duration (min)	Largemouth Bass	Bluegill	Black Crappie	Sacramento Sucker	Rainbow Trout		
1	15	12	104	37	1	0		
2	15	2	132	14	1	1		
3	15	4	118	2	0	0		
4	15	6	53	5	0	0		
Total		24	407	58	2	1		
per min		0.4	6.78	0.97	0.03	0.02		
Summer Fish Captures Stevens Creek Reservoir (September 12, 2017)								
	Duration	Largemouth		Black	Sacramento	White		
Station	(min)	Bass	Bluegill	Crappie	Sucker	Catfish		
1	15	13	251	2	1	0		
2	15	20	231	7	1	0		
3	15	18	249	0	0	1		
4	15	16	129	0	0	0		
Total		67	860	9	2	1		
per min		1.12	14.33	0.15	0.03	0.02		

Bluegill were the dominant species encountered during both sampling events, followed by black crappie in the spring and largemouth bass in the summer. Sacramento sucker, white catfish, and rainbow trout made up a small percentage of the fish captured. As in 2016, the total number of fish captured in summer was more than double what was encountered in spring. While higher numbers of fish are expected in the summer, the high surface elevation of the reservoir in spring was likely a contributing factor, limiting electrofishing efficiency.

The size distribution of collected fish can be seen in Figure 22. The size distribution shows different age classes of largemouth bass and bluegill in both sampling events, but limited size distribution was present with black crappie in both sampling events. The same trend of black crappie greater than 140 mm, seen in spring 2016, was again observed in spring 2017. This size range in spring show fish that are potentially in their 4th year. In summer, the size distribution indicates that black crappie are present from young of the year to again potentially their 4th year. This again shows that smaller-sized black crappie are likely using different portions of the reservoir not sampled during the spring events. The size distribution of bluegill and largemouth bass in summer indicates that successful spawning occurred in 2017. A more detailed analysis of largemouth bass age will occur later in the document. The size distribution data for bluegill is as excepted in spring, with fish in the size range of one year old and extending potentially into their 6th year. Summer had fish that were young of the year and potentially in their 5th or 6th year (Moyle 2002). The single rainbow trout captured measured 165 mm. This fish was larger than the young of the year size range, and would be considered smolt-sized in an anadromous population.



Figure 22: Stevens Creek Reservoir fish size distribution in spring and summer 2017.

Stevens Creek Reservoir Summary

An evaluation of overall trends in terms of abundance are difficult to draw from this sampling method, but the results are a good indicator of assemblage and community distribution in portions of the reservoir sampled by electrofishing. In Stevens Creek Reservoir, during all sampling events, bluegill made up a majority of the catch followed by largemouth bass and black crappie, except in fall 2015 and spring 2017, when more black crappie were captured than largemouth bass (Table 13). In every sampling event Sacramento sucker and white catfish were either a very small percentage of the species encountered or not present. This is expected due to bias associated with electrofishing for those specific species. The occurrence of rainbow trout, for the first time in five years of sampling efforts on the reservoir, provides potential insight into life history of the landlocked *O. mykiss* population above Stevens Creek Reservoir. There is a potential of potamodromy occurring within the system. In years of increased rainfall, the fish might be using the reservoir in much the same capacity as a steelhead uses the ocean.

The variation in seasonal timing of sampling events over the years makes a direct comparison of each sampling event difficult and impacts associated with drought conditions would be difficult to discern. When yearly average CPUE of primary species encountered is compared, limited change in capture has been observed during the five years of data collection, with the exception of a potential minor decline in largemouth bass capture (Figure 23). The observed minor decline could be a result of seasonal timing impacting the averages or climatic conditions. Capture data between 2016 and 2017 shows very similar trends in CPUE (Figure 23). The higher capture of bluegill compared to other species in each sampling event could be a result of abundance but is also a result of life history traits indicated earlier in the document. The consistent sampling timing each year will provide for more comparable data and allow for better conclusions to be drawn.

Based on data collected during the sampling events, the trophic distribution within Stevens Creek Reservoir is limited. No fish species were observed that predominantly bridge the gap between the phytoplankton and zooplankton and primary predators. The only fish present are assigned as trophic level 3 or higher (Fishbase 2017). This system lacks a "bait fish" species seen in other reservoirs, such as threadfin shad (*Dorosoma petenense*; trophic level 2.8±0.1) or golden shiner (*Notemigonus crysoleucas*; trophic level 2.7±0.1) (Fishbase 2017)), which provide forage for primary predators. It is predicted that cannibalism and predation on higher trophic level species is occurring. This shortens the food chain, which could be influencing mercury accumulation.

Table 13: Stevens Creek Reservoir CPUE (catch per minute) 2012-2013, 2015-2017 (P - present but not quantified).

Sampling Dates	Largemouth Bass	Bluegill	Black Crappie	Common Carp	Sacramento Sucker	White Catfish	Rainbow Trout
5/24/2012	0.13	0.38	0.02	0	0	0	0
6/21/2012	5.2	9.62	0.53	0.2	0.1	0	0

8/9/2012	3.25	0.28	0.12	0	0.12	0.02	0
6/26/2013	1.3	7.53	0.45	0.2	0.03	0.02	0
10/7/2015	1.87	3.89	1.93	0.13	0.02	0	0
4/12/2016	0.43	3.03	0.25	Р	0	0	0
9/6/2016	0.95	11.33	0.75	Р	0.03	0.02	0
4/19/2017 and 4/24/2017	0.4	6.78	0.97	Р	0.03	0	0.02
9/12/2017	1.12	14.33	0.15	Р	0.03	0.02	0



Figure 23: Yearly average CPUE Stevens Creek Reservoir 2012-2017 (no sampling occurred 2014).

Size data for largemouth bass in Stevens Creek Reservoir were compared to the scale analysis information collected by the SCVWD (Figure 24). Figure 24 shows the lengths of largemouth bass from 2016 and 2017 with the age estimates overlaid. The age estimates are based on the average length and standard error of largemouth bass evaluated in the analysis (see Table 1). A lack of size distribution limits the ability of the analysis in 2016. When the age 0+ category or fish within their first year is evaluated (smallest size cohort in the summer sampling event) it shows that a majority of largemouth bass tend to fall below the predicted average size. The size cohort that would be estimated at age 1+ due to seasonal timing (smallest fish in spring sampling event) tend to fall below the predicted size range. In 2017, we also see a size cluster that falls between the 3+ and 4+ age category. This could indicate potential stunting is occurring in this system. Based on the age analysis conducted within the

Guadalupe Watershed, Stevens Creek Reservoir has largemouth bass that are young of the year and that are potentially past their 5th year. Due to the evidence of potential stunting, these large fish could be older than anticipated.



Figure 24: Largemouth bass lengths from Stevens Creek Reservoir with age class estimates (2016 and 2017).

2016 and 2017 Monitoring Year Discussion

It was not anticipated that the addition of oxygen to the reservoirs would significantly change the nearshore fish assemblages that are sampled by the boat electrofishing technique. Changes to the species that occur in the deeper water levels may result from additional oxygenated habitat, but that would require a change in the sample collection methodology to detect. The oxygenation is more likely to change the amount of biologically available mercury to the food web than to significantly alter the food web itself. Changes in methyl mercury in fish tissue over time are monitored and reported in a related effort.

The 2016 and 2017 sampling results indicate that species assemblage has stayed largely consistent over the course of the 6-year sampling period, with a few new species encountered. In most cases the same species are reoccurring at each reservoir, but the abundance is fluctuating. These fluctuations can be contributed to normal population dynamics as well as bias associated with the sampling method. Two new species, a rainbow trout at Stevens Creek Reservoir and prickly sculpin at Almaden Reservoir, were encountered, but only one individual of each species was seen during a single sampling event. It is not likely that these species will ever comprise a significant portion of the capture. In Calero Reservoir, the presence of tule perch in various size classes indicates a potential stronghold of a native fish species

within a system that is normally dominated by non-native species. Based on observations in 2016 and 2017, there is potential that this native species is outcompeting nonnative species in the same niche.

Trends were observed in black crappie occurrence at all reservoirs. It appears they are potentially using different portions of the reservoir not sampled during the spring months, contributing to low capture rates during the spring events. Black crappie may not be the ideal species to target for the body burden analysis as they are not consistently present during the assigned sampling period.

There is also potential that largemouth bass in Guadalupe and Stevens Creek Reservoirs are stunted or experiencing slower growth rates. This could be resulting from the lack of forage fish observed. Stunting of bluegill in Guadalupe Reservoir is also apparent. This stunting could result in older fish being analyzed for mercury concentrations that are thought to be younger. Currently, all bluegill analysis for mercury concentration are greater than 50 mm. These fish could be older than anticipated, resulting in a higher than expected mercury concentration based on length.

Trends and comparisons between sampling years have been difficult to discern as sampling has occurred during different times of the year over time or sampling events did not occur due to reservoir conditions (ex., boat launch accessibility). In 2016 and 2017 a more standardized approach was taken to the monitoring effort and multiple methods were deployed to ensure limited gaps in the dataset occurred. As consistent sampling progresses, more trends will be able to be discerned and a better understanding of the fish trends will develop. The data collected through this monitoring will provide insight on population dynamics of nearshore fish within the sampled reservoirs, and can contribute to a better understanding of the relic mercury contamination and how the remediation efforts can be altered to gain the greatest benefit. As the dataset becomes more standardized and expands, further insight will develop and educated management decisions can be made.

It is recommended that future sampling efforts continue to occur consistently each year and by season to provide a comparable dataset over time. The continual implementation of multiple fishing methods going forward will provide a means to sample in a variety of conditions and help to avoid data gaps. This will provide greater insight into fish assemblages in the reservoirs and help to see trends over time.

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