



JUVENILE SALMONID MONITORING IN THE LAGUNITAS CREEK WATERSHED - 2019

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Cover photo: MMWD Watershed Aides from left to right: Alex Johanson, Keana Richmond, and Tucker Wasuta.

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EXECUTIVE SUMMARY

Marin Municipal Water District (MMWD) staff conducted a population monitoring survey for Coho Salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*) in the Lagunitas Creek Study Area, which consists of Lagunitas Creek and two of its main tributaries, San Geronimo Creek and Devil's Gulch. Surveys were conducted between July 21 and October 1, 2019 and were performed in accordance with MMWD's Lagunitas Creek Stewardship Plan (MMWD 2011). Fish observations from electrofishing and snorkeling were used to estimate Coho Salmon and steelhead populations in the study area, which were compared to population estimates going back to 1970.

We estimate a population of 22,302 ($\pm 5,918$) juvenile Coho Salmon in the Lagunitas Creek study area, which was above average but a large decline from three years earlier. Coho Salmon abundance was above average in both Lagunitas and San Geronimo Creeks, and average in Devil's Gulch. The Coho Salmon run in 2018-19 was the largest in 12 years, but many redds may have been destroyed during a large February storm. In Olema Creek the National Park Service estimated a population of 8,978 ($\pm 3,607$) juvenile Coho Salmon. Steelhead abundance in the Study Area exceeded 70,000 for the third year in a row, which was well above-average.

INTRODUCTION

Salmonid monitoring in the Lagunitas Creek watershed was initiated by the California Department of Fish and Game in 1970. Nine index reaches were established on Lagunitas Creek and two tributaries, San Geronimo Creek and Devil's Gulch. These index reaches were monitored again in 1980 and 1982, and six reaches were monitored through most of the 1980s. Beginning in 1993, the Marin Municipal Water District (MMWD) began monitoring the original reaches and also established new sites. MMWD has continued monitoring salmonids annually at thirteen index reaches, which comprises one of the longest salmonid datasets on the California coast.

The Point Reyes National Seashore (PRNS) began juvenile salmonid monitoring at index reaches on Olema Creek, a major tributary to Lagunitas, in 1999. Beginning in 2003, PRNS instituted a program of systematic snorkel surveys in addition to their index reach monitoring.

Coho Salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*) populations in the Lagunitas Creek watershed have fluctuated widely since 1970 and have declined in comparison with anecdotal reports of large historic populations. Throughout California, populations of native fish species, including Coho Salmon and steelhead, have been steadily declining. Human-caused factors for this decline include habitat alterations such as water diversions, road building, timber harvest, urbanization, flood control structures and practices, and climate change (NMFS 2010). This decline resulted in the listing of Coho Salmon in the Central California Coast Evolutionarily Significant Unit (ESU) as "endangered" under federal and California Endangered Species Acts. Steelhead are federally listed as "threatened."

METHODS

The goal of this monitoring effort is to produce long-term trends in juvenile salmonid populations for the Lagunitas Creek study area. Population estimates were produced by estimating the numbers of fish, using a combination of electrofishing and snorkeling, at established index reaches (sample sites) in Lagunitas Creek and two of its tributaries, San Geronimo Creek and Devil's Gulch. Index reach fish abundance estimates were then extrapolated to estimate the total populations of fish in the study area.

The Lagunitas Creek study area includes 13.4 km of Lagunitas Creek, 7.2 km of San Geronimo Creek, and 3.3 km of Devil's Gulch. In Lagunitas Creek, the habitats downstream of the confluence with Nicasio Creek (5.9 km) were not included in our analyses because existing juvenile index reaches do not accurately represent this section of creek. For San Geronimo Creek and Devil's Gulch, salmonid populations were estimated for the main stem reaches for which habitat data were available. The most recent habitat typing survey of Lagunitas Creek, San Geronimo Creek, and Devil's Gulch was completed in 2016. The habitat typing survey classified habitats as pool, glide, run, riffle, cascade, and dry. Cascades and dry habitats represented approximately 0.5% of the study area and have been excluded from our population extrapolations because these habitat types were not included within our index reaches and/or do not provide salmonid habitat. Side channel habitats were also excluded because the index reaches did not adequately represent these habitats.

Seven sites in Lagunitas Creek, four in San Geronimo Creek, and two in Devil's Gulch were sampled between July 21 and October 1, 2019 (Figure 1). Each index reach consisted of one or more riffle, run, glide, or pool habitat units. The index reaches in Lagunitas Creek were (in a downstream to upstream listing): LG-2, LG-3u, LG-5, LG-7, LG-9, LG-15.86, and LG-12. The sites in San Geronimo Creek were: SG-1, SG-2, SG-3, and SG-4. Sites in Devil's Gulch were DG-1 and DG-2. These sites have been sampled annually for juvenile salmonids since 1993, with the exception of LG-15.86 (added in 1994), SG-1 (added in 1998), LG-2 (added in 2002), and LG-3u (added in 2004).

Index reaches were electrofished with the exception of LG-2 and LG-15.86, which were too deep to electrofish and were snorkeled. A long glide habitat in Lagunitas Creek was also snorkeled to better assess salmonid abundance in this habitat type. The snorkeled glide was selected because it was bounded by riffles that discouraged fish movement out of the habitat. Glides typically transition gradually into other habitat types, which allows fish to move easily between habitats.

Electrofishing was conducted in compliance with National Marine Fisheries Service guidelines (NMFS 2000). Prior to electrofishing a sample site, block nets were erected at the downstream and upstream end of each habitat unit to prevent fish migration during sampling. ETS Electrofishing Systems ABP-3 backpack electrofishers were used to make a minimum of three passes through each habitat. Electrofishers were set to a pulse rate of 60 Hz and a duty cycle of 25%. Voltages ranged from 130 to 280 volts depending on water conductivity (expressed as microSiemens/cm (mS)), measured prior to electrofishing, and water depth. One or two electrofishers were used at each of the sample habitats (depending on the width of the site) with one or two people using dip-nets to capture immobilized fish. Netted fish were placed into buckets containing fresh stream water, carried by the electrofishing surveyor. Habitat units were sampled from the downstream net to the upstream net and then back downstream again to complete one pass.

After each pass, aerators were placed in catch buckets and sculpin were moved into separate buckets to reduce predation on salmonids. All fish were identified to species, except for sculpin (*Cottus spp.*), which were identified only to genus. Non-salmonids such as California roach (*Lavinia symmetricus symmetricus*), Pacific lamprey (*Entosphenus tridentata*), Sacramento sucker (*Catostomus occidentalis*), sculpin, threespine stickleback (*Gasterosteus aculeatus*), California giant salamander (*Dicamptodon ensatus*) and California freshwater shrimp (*Syncaris pacifica*) were counted but not measured. Juvenile lampreys were classified as "eyed" or macrothalmia (if they had eyes, well-developed sucking mouths and silver coloring) or ammocoetes (if they lacked smolt features).

Coho Salmon and steelhead were anesthetized using tricaine methanesulfonate (MS-222) and measured in millimeters (mm). All Coho Salmon were weighed to the nearest tenth of a gram while a subset of steelhead were weighed. In Lagunitas Creek weights were collected for at least two steelhead within each ten-millimeter length group (e.g. 50-59 mm) for each sample site, except when fewer than two fish in a particular length group were caught. In San Geronimo Creek and Devil's Gulch three and four steelhead, respectively, were weighed for each length group.

In the field, steelhead captured in Lagunitas Creek that were longer than 110-115 mm fork length, depending on site, were considered to be 1+ steelhead (one to three years old) and those smaller

were considered to be 0+ steelhead (young-of-the-year; <1 year old). Steelhead captured in San Geronimo Creek and Devil's Gulch that were 90 mm or larger were considered to be in the 1+ age class. Scale samples were taken from several representative steelhead ranging from 85 to 119 mm in order to estimate a more accurate size break between 0+ and 1+ steelhead. Scales were obtained by scraping the side of the fish above the lateral line and behind the dorsal fin. Subsequently ages were determined for each steelhead by viewing the scales under a microscope and counting their annuli (yearly rings). When annuli were indistinct and age class could not be determined, size breaks (natural gaps in the size range) were used to determine age class. At sites snorkeled but not electrofished, steelhead age classes were determined by visual inspection only.

Coho Salmon at least 60 mm fork length were implanted with passive integrated transponder (PIT) tags to estimate over-winter survival. A PIT tag was inserted into the abdominal cavity of anesthetized Coho Salmon just anterior to the pectoral fins. Fish between 60 and 69 mm fork length received an 8 mm full duplex tag and fish ≥ 70 mm received a 12 mm half-duplex tag.

After handling, all fish were first transferred into a black recovery bucket containing cool, aerated stream water and then transferred to live cars (holding pens consisting of a mesh basket lined with netting), which had been placed in the stream, outside of the block netted habitat unit. Large sculpin were placed into separate live cars to avoid predation of salmonids. Aerators were installed on live cars when fish densities were high. Once sampling was completed, captured fish were released back into the habitat unit from which they were captured.

In addition to fish data, we collected habitat data including length, width, depth, substrate composition, shelter ratings, and bank vegetation. Water temperatures were measured at each sample site using hand held digital thermometers. Water temperatures and stream flow were also being recorded, independently, at the USGS stream gage at Samuel P. Taylor State Park (upstream of the mouth of Devil's Gulch and sample site LG-7).

Snorkel surveys followed procedures outlined in Adams et al. (2011). Depending on creek width and visibility, two or three divers surveyed each sample unit. The divers entered the water at the downstream limit of the sample unit and proceeded together in an upstream direction. Individuals of each fish species were counted in each habitat type (glide, pool, run), and observations were recorded on dive slates. For steelhead, the age of individuals was visually estimated as either young-of-the-year or older, where 110 mm total length was the approximate cutoff between these age classes. One crew member totaled and recorded observation data at the completion of each pass. The highest total count for each salmonid species after two passes was used to estimate salmonid abundance for each habitat unit.

Data Analysis

Coho Salmon and steelhead capture data were tallied by sample site (Appendix A) and entered into MicroFish 3.0 software (Van Deventer and Platts 1989). Output from this program was used to calculate population estimates of Coho Salmon, 0+ steelhead, and 1+ steelhead (Appendix B). Population estimates of Coho Salmon, 0+ steelhead, and 1+ steelhead were made for individual

habitat units and for each sample site. The population estimates for each sample site were then extrapolated for entire stream segments (Appendix C).

Habitat typing completed in 2016 throughout the Lagunitas Creek Study Area allowed for a comparison of the habitat composition of the index reaches to the habitat composition of the streams or stream reaches. Juvenile salmonid population sizes were estimated by extrapolating fish densities in individual habitats (pool, glide, run, riffle) to entire streams based on the proportions of habitat types within those streams (Appendix C). Salmonid densities in each habitat type were multiplied by the linear length of the same habitat type in the applicable stream. The extrapolated population estimates from this year's survey can be compared to the annual juvenile salmonid surveys conducted since 1995, when we began estimating salmonid populations using habitat proportions.

Between 1970 and 1994 salmonid populations were monitored by measuring fish densities within index reaches. Those densities, which were compiled from data presented in Trihey & Associates (1995, 1996) and previous MMWD juvenile salmonid survey reports, were multiplied by stream lengths to produce population estimates for those streams. Set creek lengths were used, based on the 2003 habitat typing data (Garcia and Associates 2004), so that estimates were comparable across all years. This trend analysis was based on reported fish densities and did not take into account habitat changes in the study area, changes in index reaches, or sample site representativeness.

The stream segments used in estimating the juvenile salmonid populations of the Lagunitas Creek study area have changed multiple times over the years. New sample sites have been added, one was abandoned, and the stream reaches represented by these sites have also changed over the years. Finally, the size of the study area has changed multiple times, influencing the estimated populations. These methodological changes are described in detail in Appendix D.

In addition to salmonid abundance, we assessed fish condition using Fulton's Condition K. K was calculated using the formula $K = 10^5 W / L^3$, where W is weight in grams and L is fork length in millimeters.

RESULTS

Salmonid observations

Juvenile Coho Salmon typically spend approximately 18 months in freshwater (including incubation) and 18 months in the ocean, returning to spawn in their natal stream in their third year (Shapovalov and Taft 1954). Therefore, Coho Salmon can be grouped into year classes of three-year increments. In 2019 we observed 968 juvenile Coho Salmon at our index reaches, which was 29% lower than what was observed in 2016 (Table 1).

The total number of steelhead observed at our index reaches in 2019 was 2,480, which was 47% higher than average since 1993. By age class, we observed 2,319 young of the year steelhead and

161 1+ steelhead. For consistency with previous years' reporting, these totals, and those presented in Table 2, do not include our observations from snorkeled glide habitats that were not part of a historic index reach.

Incidental mortalities from our sampling effort (Table 3) consisted of 12 Coho Salmon (1.4% of captured fish) and 38 steelhead (1.6%). Both mortality rates were below average. During the sampling efforts between 1995 and 2018, Coho Salmon mortality rates ranged from 0.0% to 3.6% of captured Coho Salmon and the steelhead mortality rates ranged from 0.8% to 2.8% of captured steelhead (Table 4). This year's salmonid mortalities represent 0.05% of both the Coho Salmon and steelhead populations.

Population estimates and survival

The 2019 juvenile Coho Salmon population estimate, extrapolated from Coho Salmon abundance at the index reaches, was 22,302 ($\pm 5,918$) for the study area. This was an above average juvenile Coho Salmon population but a decline of 47% from three years earlier (Table 5). Coho Salmon abundance in Lagunitas and San Geronimo Creeks was above average, while the Coho Salmon estimate for Devil's Gulch was roughly average. Estimated egg-to-fry survival¹ of this cohort was 3.2%, which is below average. In Olema Creek (surveyed by PRNS), the Coho Salmon population was estimated at 8,978 ($\pm 3,607$). As in the Lagunitas Creek study area, the strongest of the Coho Salmon year classes declined by approximately half from three years earlier (Figure 2).

The 2019 juvenile steelhead population estimate (0+ and 1+) was 71,685 ($\pm 12,614$) for the study area, which was well above average (Figure 3). Steelhead abundance was the highest on record in Devil's Gulch, the second highest on record in San Geronimo Creek, and slightly below average in Lagunitas Creek. The steelhead population of Olema Creek was not estimated.

Another measure of abundance is the density of fish, expressed as either fish per square meter (Appendix E), or fish per linear meter, which has been used to estimate salmonid populations for the entire study area back to 1970 (Figure 4). Over the last decade the Coho Salmon population estimates based only on density have been five times greater than during the 1980s. The steelhead population appears to have increased by 60% during that period.

Coho Salmon and steelhead condition

Coho Salmon tend to be longer in Lagunitas Creek than in San Geronimo Creek or Devil's Gulch and their growth rates in all three creeks appear to be density dependent (Figure 5). In 2019 Coho Salmon lengths were as expected given their abundance in each stream.

Young-of-the-year steelhead growth is weakly associated with steelhead and Coho Salmon densities, spring stream flows, and the average date of steelhead spawning. In 2019 YOY steelhead

¹ Female Coho Salmon in the Lagunitas Creek watershed average 63 cm in length (n = 129, 1997-2008), so can be expected to lay 2,300 eggs (Shapovalov and Taft 1954).

lengths were average in Lagunitas and San Geronimo Creeks and smaller than average in Devil's Gulch.

Scales were collected from 11 steelhead to determine fish ages and derive size breaks between age 0+ and 1+ steelhead for each sample site. For Lagunitas Creek, the largest 0+ steelhead were between 98 and 114 millimeters in fork length, depending on sample site. In San Geronimo Creek and Devil's Gulch, the largest 0+ steelhead were between 76 and 98 mm.

We weighed 668 Coho Salmon and 271 steelhead to assess their condition. Growth curves for both Coho Salmon and steelhead were nearly identical to the length-weight relationships observed in previous years. Condition Factor (K) was found to be a healthy 1.22 for Coho Salmon and 1.18 for steelhead, on average. Average Coho Salmon condition by stream ranged between 1.18 in Lagunitas Creek to 1.26 in Devil's Gulch. Steelhead condition ranged between 1.14 in Lagunitas Creek and 1.25 in Devil's Gulch.

Other species observations

In addition to Coho Salmon and steelhead, five other species of fish were observed: Pacific lamprey, sculpin, California roach, threespine stickleback, and bluegill (*Lepomis macrochirus*) (Table 6). The sculpin were not identified to species but were most likely prickly sculpin (*Cottus asper*). Other, less common sculpin species may include coast range sculpin (*C. aleuticus*) and riffle sculpin (*C. gulosus*) (Page and Burr 1991). Roach numbers have declined by 80% since hitting a peak in 2006 (Figure 6). No Sacramento suckers were observed for the sixth year in a row.

Habitat composition

The overall habitat of Lagunitas Creek upstream of Nicasio Creek was composed of 53% pool, 6% riffle, 30% run, and 10% glide, as measured in 2016. In 2019 the habitat composition of sampled index reaches was 51% pool, 10% riffle, 22% run, and 17% glide (Figure 7).

The overall habitat composition of San Geronimo Creek, in 2016, was 43% pool, 12% riffle, 42% run, and 4% glide. In 2019 the index reaches consisted of 66% pool, 10% riffle, 14% run, and 10% glides (Figure 7).

The overall habitat of Devil's Gulch in 2016 was composed of 34% pool, 30% riffle, 32% run, and 4% glide. In 2019 the index reaches were composed of 61% pool, 13% riffle, 26% run, and no glides (Figure 7).

Stream flows in Lagunitas Creek during the sampling effort, as measured by USGS at the Samuel P. Taylor gage station, remained between 7.7 and 8.3 cubic feet per second (cfs) during the sampling period.

DISCUSSION

The primary factors driving the juvenile Coho Salmon population in Lagunitas and San Geronimo Creeks are adult abundance and winter stream flows that scour redds. In Devil's Gulch the primary factors appear to be adult abundance and spring flows that force/allow Coho Salmon fry to emigrate from that creek. In February of 2019 a strong storm may have scoured redds in Lagunitas and San Geronimo Creeks and an unusual storm in May likely displaced Coho Salmon fry from Devil's Gulch. These factors likely explain why, despite the largest Coho Salmon run in 12 years, the 2019 juvenile population was only the third largest in that period (Figure 2).

The juvenile steelhead population exceeded 70,000 for the third year in a row, following a somewhat larger-than-average spawning run. The distribution of juveniles in the watershed was similar to the distribution of redds, with San Geronimo Creek hosting the most redds and juveniles while Lagunitas Creek saw below-average numbers of both. The record-breaking number of juvenile steelhead in Devil's Gulch was surprising given that only 19 redds were observed. Perhaps additional steelhead spawned in Devil's Gulch after surveys were halted.

Habitat conditions at almost all of the index reaches were very similar to those seen in recent years. A multi-stem redwood fell into Lagunitas Creek at site LG-12, but since it fell during the summer, when movement of juveniles appears to be minimal, it likely had a negligible effect on juvenile salmonid abundance. Changes in habitat conditions at each of the sample sites were unlikely to be significant factors in salmonid abundance.

Annual monitoring continues to refine our understanding of the salmonid populations of the Lagunitas Creek watershed. The unusually large Coho Salmon run and high stream flows in 2018-19 provided additional support for our hypothesis that juvenile Coho Salmon abundance is largely driven by those two factors. This monitoring not only contributes to our overall knowledge, but informs ongoing conservation actions for these imperiled species.

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**Table 1. Juvenile Salmonid Observations in the
Lagunitas Creek Study Area**

Year	Coho	0 + Steelhead	1 + Steelhead	Total Steelhead
1993	216	775	34	809
1994	578	877	110	968
1995	210	1,128	48	1,176
1996	246	798	243	1,041
1997	541	1,226	83	1,309
1998	124	1,977	101	2,078
1999	168	1,626	135	1,761
2000	157	1,695	150	1,845
2001	868	1,348	157	1,505
2002*	1,317	2,353	99	2,452
2003	621	1,561	151	1,712
2004	1,000	1,230	118	1,348
2005	1,010	1,336	113	1,449
2006	126	1,819	123	1,942
2007	1,338	1,488	141	1,629
2008	477	2,214	65	2,279
2009	66	1,375	140	1,515
2010	284	988	148	1,136
2011	330	1,255	137	1,392
2012	862	2,400	208	2,608
2013	1,287	1,572	149	1,721
2014	511	1,491	117	1,608
2015	664	1,618	153	1,837
2016	1,364	1,425	149	1,574
2017	431	1,976	194	2,170
2018	688	1,882	160	2,042
2019	968	2,319	161	2,480
Average	609	1,546	133	1,681

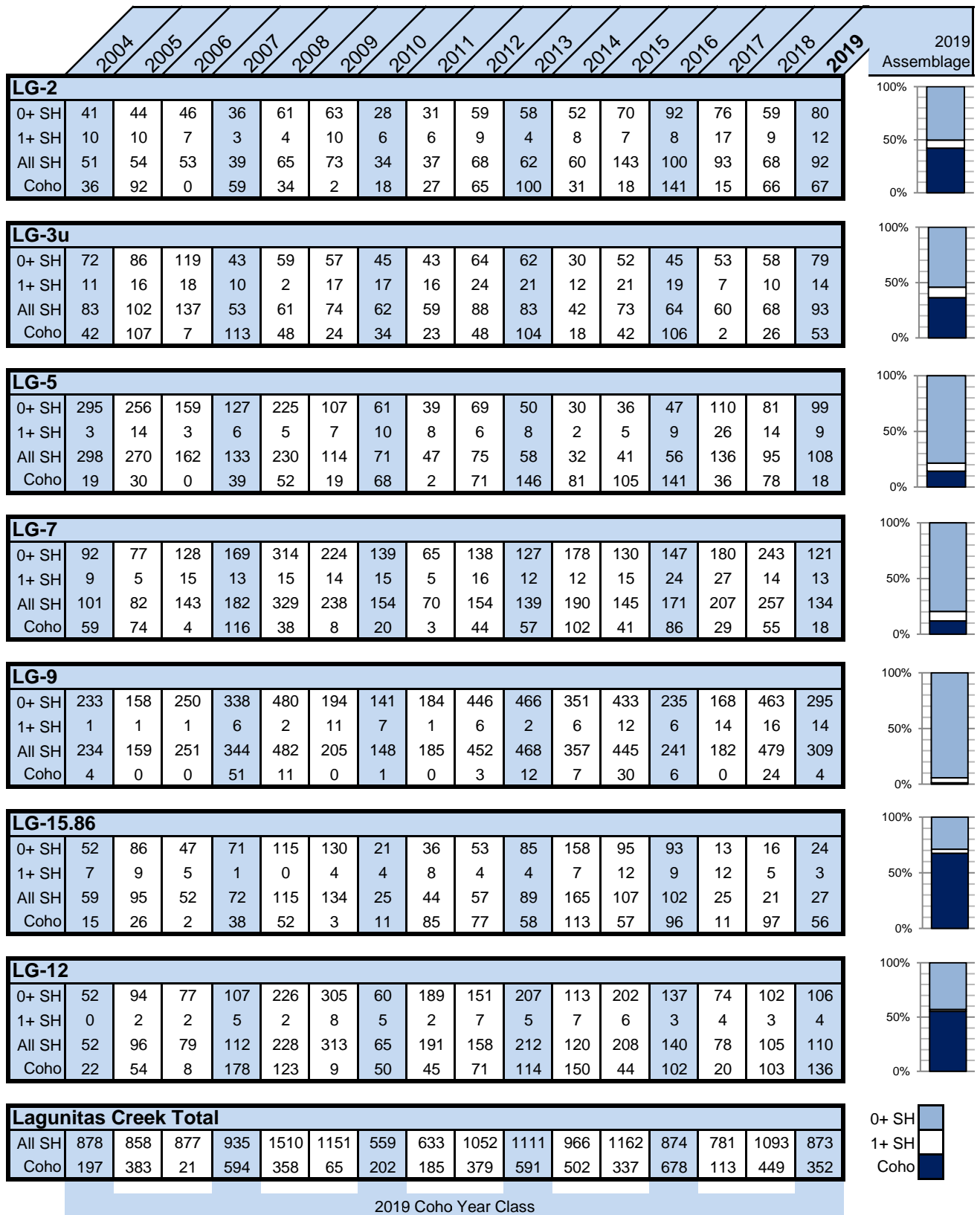
* Starting in 2002 these totals include site LG-2, but do not include site LG-1, which was not sampled after 2001.

Key:

0+ Steelhead (Young-of-the-Year) = <1 year old

1+ Steelhead = 1-3 years old

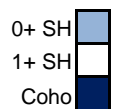
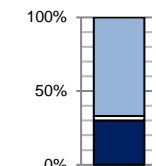
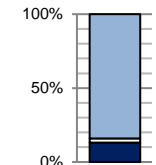
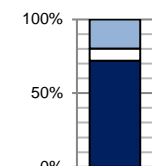
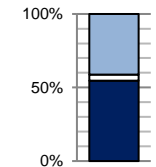
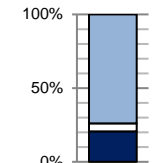
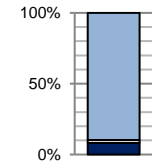
Table 2. Total Observations at Juvenile Salmonid Index Reaches



Note: 0+ SH (young-of-the-year steelhead) = <1 year old; 1+ SH = 1-3 year old steelhead.

Table 2. Total Observations at Juvenile Salmonid Index Reaches

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2019 Assemblage
SG-1																	
0+ SH	203	186	293	262	268	32	36	91	577	240	109	314	240	458	367	372	
1+ SH	14	8	5	9	10	5	13	12	6	11	7	12	11	19	12	8	
All SH	217	194	298	271	278	37	49	103	583	251	116	326	251	477	379	380	
Coho	88	31	0	66	7	0	3	6	1	8	0	3	66	25	14	34	
SG-2																	
0+ SH	81	195	229	168	120	84	257	223	531	178	137	52	178	323	253	437	
1+ SH	24	17	20	38	1	25	22	22	41	30	35	18	30	25	32	33	
All SH	105	212	249	206	121	109	279	245	572	208	172	70	208	348	285	470	
Coho	246	54	14	224	5	1	2	15	6	138	0	81	191	45	30	122	
SG-3																	
0+ SH	22	21	82	50	54	61	51	94	107	28	16	63	28	86	53	104	
1+ SH	4	6	4	20	15	7	15	16	27	12	4	5	12	13	12	11	
All SH	26	27	86	70	69	68	66	110	134	40	20	68	40	99	65	115	
Coho	33	87	25	45	7	0	2	34	74	48	1	55	66	48	1	138	
SG-4																	
0+ SH	14	27	113	69	93	47	81	88	91	38	15	57	38	100	82	45	
1+ SH	16	10	21	22	1	9	11	20	27	12	2	5	12	9	7	19	
All SH	30	37	134	91	94	56	92	108	118	50	17	62	50	109	89	64	
Coho	172	176	43	162	40	0	7	30	139	62	0	65	114	56	2	164	
San Geronimo Creek Total																	
All SH	378	470	767	638	562	270	486	566	1407	549	325	526	549	1035	818	1029	
Coho	539	348	82	497	59	1	14	85	220	256	1	204	437	174	47	458	
DG-1																	
0+ SH	63	57	106	22	103	68	32	76	54	7	151	54	115	254	80	318	
1+ SH	8	9	6	4	6	16	17	14	14	14	11	14	6	14	14	10	
All SH	71	66	112	26	109	84	49	90	68	21	162	68	121	268	94	328	
Coho	131	138	1	125	11	0	32	33	155	246	5	75	135	34	59	50	
DG-2																	
0+ SH	10	49	170	26	96	3	36	96	60	26	151	60	36	81	23	239	
1+ SH	11	6	16	4	2	7	6	7	21	14	4	21	15	7	13	11	
All SH	21	55	186	30	98	10	42	103	81	40	155	81	51	88	36	250	
Coho	133	141	22	122	49	0	36	27	108	194	3	48	114	110	133	108	
Devil's Gulch Total																	
All SH	92	121	298	56	207	94	91	193	149	61	317	149	61	356	130	578	
Coho	264	279	23	247	60	0	68	60	263	440	8	123	440	144	192	158	
Site Totals																	
0+ SH	1230	1336	1819	1488	2214	1375	988	1255	2400	1572	1491	1618	1425	1976	1880	2319	
1+ SH	118	113	123	141	65	140	148	137	208	149	117	153	149	194	161	161	
All SH	1348	1449	1942	1629	2279	1515	1136	1392	2608	1721	1608	1837	1574	2170	2041	2480	
Coho	1000	1010	126	1338	477	66	284	330	862	1287	511	664	1364	431	688	968	
2019 Coho Year Class																	



Note: 0+ SH (young-of-the-year steelhead) = <1 year old; 1+ SH = 1-3 year old steelhead.

Table 3. Juvenile Salmonid Mortalities at Electrofishing Index Reaches in the Lagunitas Creek Study Area, 2019.

Sample Site	Coho Catch	Steelhead Catch	Coho Mortalities	Steelhead Mortalities	Percentage of Coho Mortalities	Percentage of Steelhead Mortalities
LG-3u	53	93	0	3	0.0%	3.2%
LG-5	18	108	0	0	0.0%	0.0%
LG-7	18	134	1	2	5.6%	1.5%
LG-9	4	309	0	2	0.0%	0.6%
LG-12	136	110	4	2	2.9%	1.8%
SG-1	34	380	0	7	0.0%	1.8%
SG-2	122	470	3	3	2.5%	0.6%
SG-3	138	115	2	1	1.4%	0.9%
SG-4	164	64	0	0	0.0%	0.0%
DG-1	50	328	0	12	0.0%	3.7%
DG-2	108	250	2	6	1.9%	2.4%
Total	845	2361	12	38	1.4%	1.6%

Note: Catch totals do not include habitat units surveyed by snorkeling.

Table 4. Juvenile Salmonid Mortalities, 1995-2019

Year	Coho			Steelhead		
	Captured	Mortalities	%	Captured	Mortalities	%
1995	210	1	0.5%	1,176	19	1.6%
1996	246	8	3.3%	1,041	8	0.8%
1997	541	7	1.3%	1,309	36	2.8%
1998	124	1	0.8%	2,078	59	2.8%
1999	168	6	3.6%	1,761	37	2.1%
2000	157	2	1.3%	1,913	26	1.4%
2001	868	20	2.3%	1,588	30	1.9%
2002	1,296	26	2.0%	2,415	56	2.3%
2003	606	14	2.3%	1,677	29	1.7%
2004	965	22	2.3%	1,299	35	2.7%
2005	918	23	2.5%	1,395	30	2.2%
2006	126	1	0.8%	1,889	28	1.5%
2007	1,377	20	1.5%	1,633	37	2.3%
2008	443	8	1.8%	2,212	43	1.9%
2009	45	0	0.0%	1,390	16	1.2%
2010	198	3	1.5%	1,068	19	1.8%
2011	289	4	1.4%	1,354	24	1.8%
2012	797	5	0.6%	2,540	54	2.1%
2013	1,187	29	2.4%	1,659	37	2.2%
2014	480	12	2.5%	1,548	28	1.8%
2015	646	20	3.1%	1,720	46	2.7%
2016	1,223	32	2.6%	1,474	16	1.1%
2017	416	8	1.9%	2077	29	1.4%
2018	525	10	1.9%	1952	42	2.2%
2019	845	12	1.4%	2361	38	1.6%
Mean	588	12	1.8%	1701	33	1.9%

Table 5. Juvenile Salmonid Population Estimates in the Lagunitas Creek Study Area, Based on Index Reaches

Lagunitas Creek

	0+ Steelhead	1+ Steelhead	Total Steelhead	Coho
2001	23,042	1,258	24,300	7,011
2002	41,128	1,072	42,200	7,675
2003	25,705	1,811	27,516	6,198
2004	28,232	931	29,163	4,560
2005	23,517	1,413	24,930	8,597
2006	22,188	1,150	23,338	463
2007	26,961	1,070	28,031	18,745
2008	50,021	661	50,682	7,539
2009	30,020	1,875	31,895	1,777
2010	13,081	1,656	14,737	5,943
2011	15,881	1,116	16,997	4,484
2012	23,330	1,262	24,592	11,228
2013	45,228	1,224	46,452	23,096
2014	27,234	2,175	29,409	18,188
2015	37,337	2,246	39,583	8,607
2016	25,546	2,691	28,237	23,980
2017	30,647	3,224	33,871	2,455
2018	38,249	1,781	40,030	11,217
2019	23,571	2,125	25,696	9,427
Mean	27,740	1,589	29,329	8,023

2019 Coho Year Class

San Geronimo Creek

	0+ Steelhead	1+ Steelhead	Total Steelhead	Coho
2001	12,955	1,778	14,733	10,114
2002	19,878	782	20,660	16,712
2003	19,289	1,388	20,677	5,180
2004	16,363	1,358	17,721	13,076
2005	15,093	1,084	16,177	8,341
2006	21,969	1,166	23,135	1,842
2007	17,041	2,280	19,321	13,098
2008	20,768	1,019	21,787	2,372
2009	5,927	1,023	6,950	20
2010	11,404	1,579	12,983	317
2011	16,255	1,674	17,929	2,499
2012	39,912	2,357	42,269	5,832
2013	16,208	1,233	17,441	6,678
2014	8,251	1,079	9,330	22
2015	19,742	1,052	20,794	6,716
2016	16,498	1,180	17,678	11,959
2017	28,185	1,425	29,610	5,243
2018	28,170	1,163	29,333	1,089
2019	32,119	1,559	33,678	9,812
Mean	19,030	1,356	20,385	5,532

2019 Coho Year Class

Devil's Gulch

	0+ Steelhead	1+ Steelhead	Total Steelhead	Coho
2001	3,095	1,308	4,403	6,456
2002	2,619	583	3,202	9,238
2003	704	363	1,067	3,089
2004	1,821	350	2,171	4,289
2005	2,204	319	2,523	5,724
2006	6,616	380	6,996	397
2007	1,290	148	1,438	5,140
2008	4,137	150	4,287	1,204
2009	1,727	535	2,262	0
2010	1,590	609	2,199	1,728
2011	3,854	410	4,264	1,172
2012	2,721	660	3,381	5,235
2013	731	346	1,077	7,070
2014	8,050	231	8,281	123
2015	2,737	521	3,258	1,841
2016	3,940	362	4,302	5,748
2017	7,072	414	7,486	3,179
2018	2,464	557	3,021	4,262
2019	11,989	322	12,311	3,063
Mean	4,039	446	4,485	3,145

2019 Coho Year Class

Study Area Total

	0+ Steelhead	1+ Steelhead	Total Steelhead	Coho
2001	39,092	4,344	43,436	23,581
2002	63,625	2,437	66,062	33,625
2003	45,698	3,562	49,260	14,467
2004	46,416	2,639	49,055	21,925
2005	40,814	2,816	43,630	22,662
2006	50,773	2,696	53,469	2,702
2007	45,292	3,498	48,790	36,983
2008	74,926	1,830	76,756	11,115
2009	37,674	3,433	41,107	1,797
2010	26,075	3,844	29,919	7,988
2011	35,990	3,200	39,190	8,155
2012	65,963	4,279	70,242	22,295
2013	62,167	2,803	64,970	36,844
2014	43,535	3,485	47,020	18,333
2015	59,816	3,819	63,635	17,164
2016	45,984	4,233	50,217	41,687
2017	65,904	5,063	70,967	10,877
2018	68,883	3,501	72,384	16,568
2019	67,679	4,006	71,685	22,302
Mean	50,808	3,391	54,199	16,699

2019 Coho Year Class

Table 6. Non-salmonid species captured

Year	Native								Non-native			
	Sculpin (all species)	California Roach	Threespine Stickleback	Pacific Lamprey	Sacramento Sucker	CA Giant Salamander	Rough Skinned Newt	CA Freshwater Shrimp	Largemouth Bass	Bluegill	Green Sunfish	Bullfrog
1997	215	396	178	220	1	0	0	2	0	0	0	0
1998	220	285	218	312	2	1	0	3	0	0	0	0
1999	219	278	219	335	2	6	1	24	0	1	1	0
2000	147	118	352	374	0	12	0	51	0	0	0	0
2001	230	364	841	777	4	8	0	32	0	0	0	0
2002	198	30	587	771	1	5	0	7	0	0	0	0
2003	340	86	338	983	63	13	0	0	1	0	0	2
2004	347	101	320	664	6	4	0	3	0	0	0	0
2005	458	166	153	859	12	7	0	6	0	0	0	0
2006	492	523	521	778	56	10	0	3	0	0	0	0
2007	328	277	475	945	16	6	0	5	0	0	0	0
2008	266	406	283	435	3	6	0	9	0	0	0	0
2009	297	241	543	775	6	12	0	8	0	4	4	0
2010	121	190	713	495	2	11	0	2	0	0	0	2
2011	221	283	403	348	0	13	0	4	0	0	0	1
2012	210	292	559	299	1	5	0	9	0	0	0	1
2013	185	108	861	285	1	1	0	3	0	0	0	0
2014	179	69	384	319	0	11	0	11	0	0	0	0
2015	101	201	785	923	0	1	0	11	0	0	0	0
2016	544	157	1,005	794	0	11	1	4	0	15	2	0
2017	1,045	189	1,440	522	0	7	0	4	0	9	0	2
2018	640	79	675	539	0	6	0	10	0	0	0	0
2019	255	102	756	605	0	6	0	13	0	2	0	2

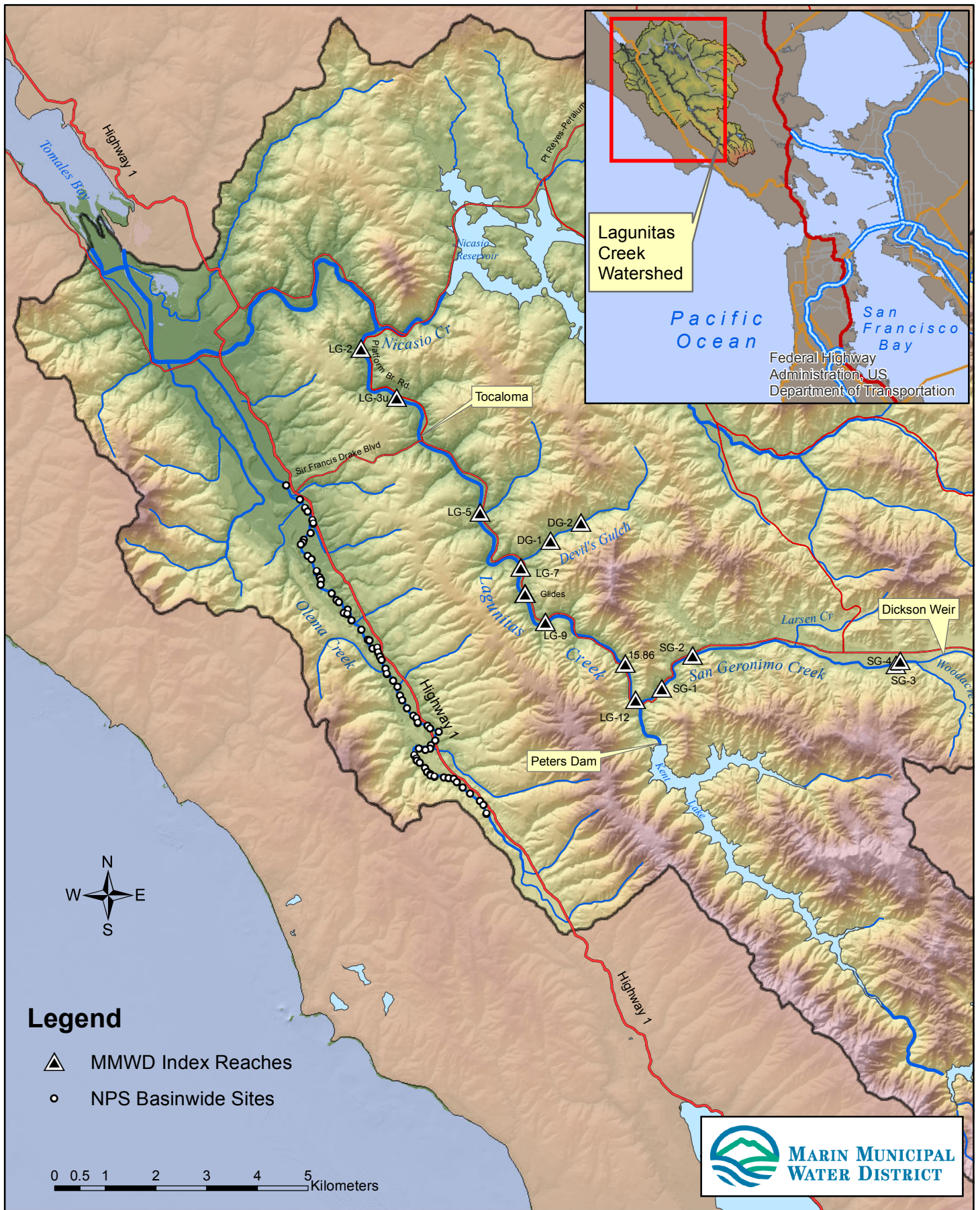


Figure 1. Lagunitas Creek Juvenile Salmonid Monitoring Reaches

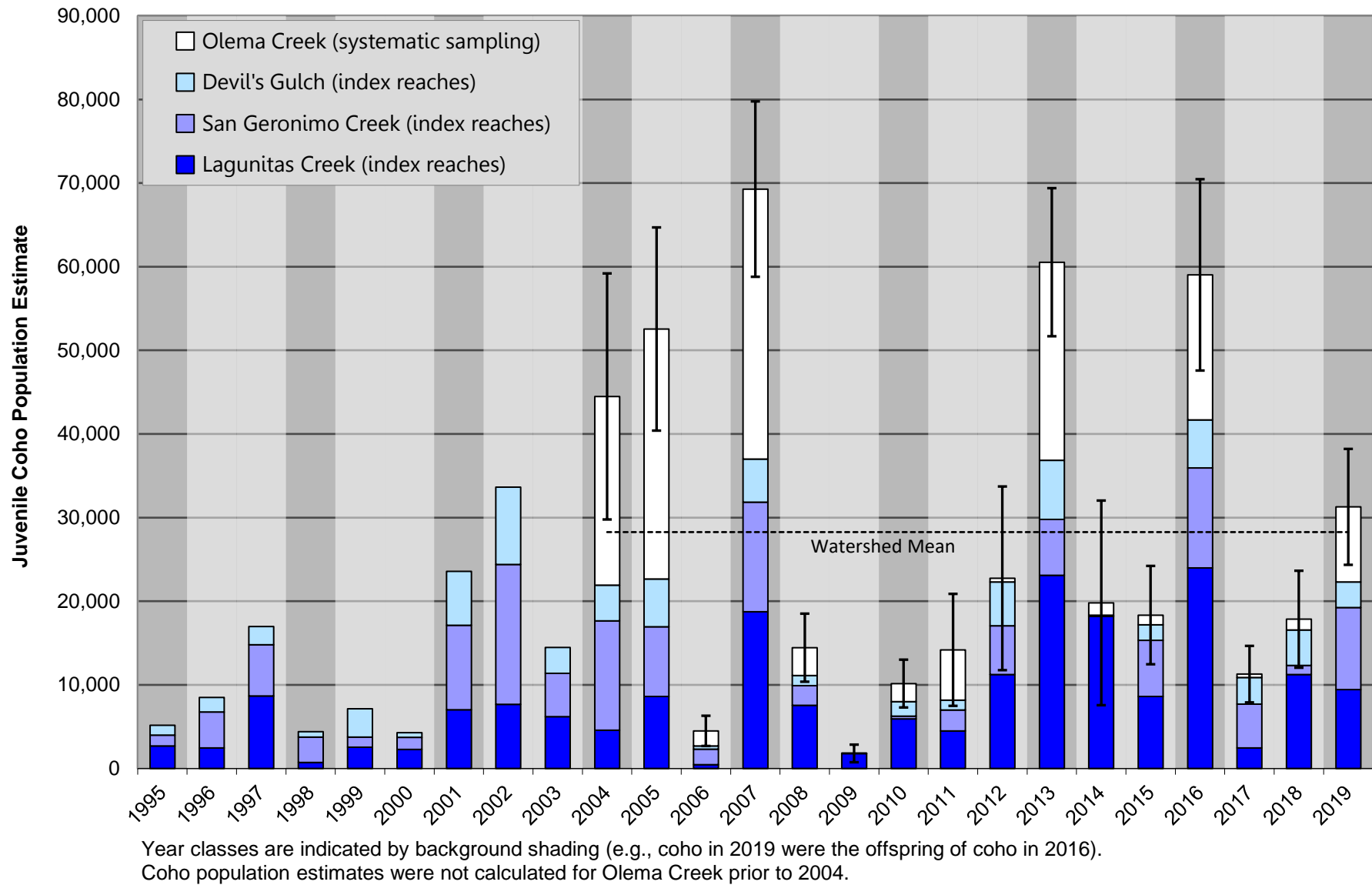


Figure 2. Juvenile Coho Population Estimates.

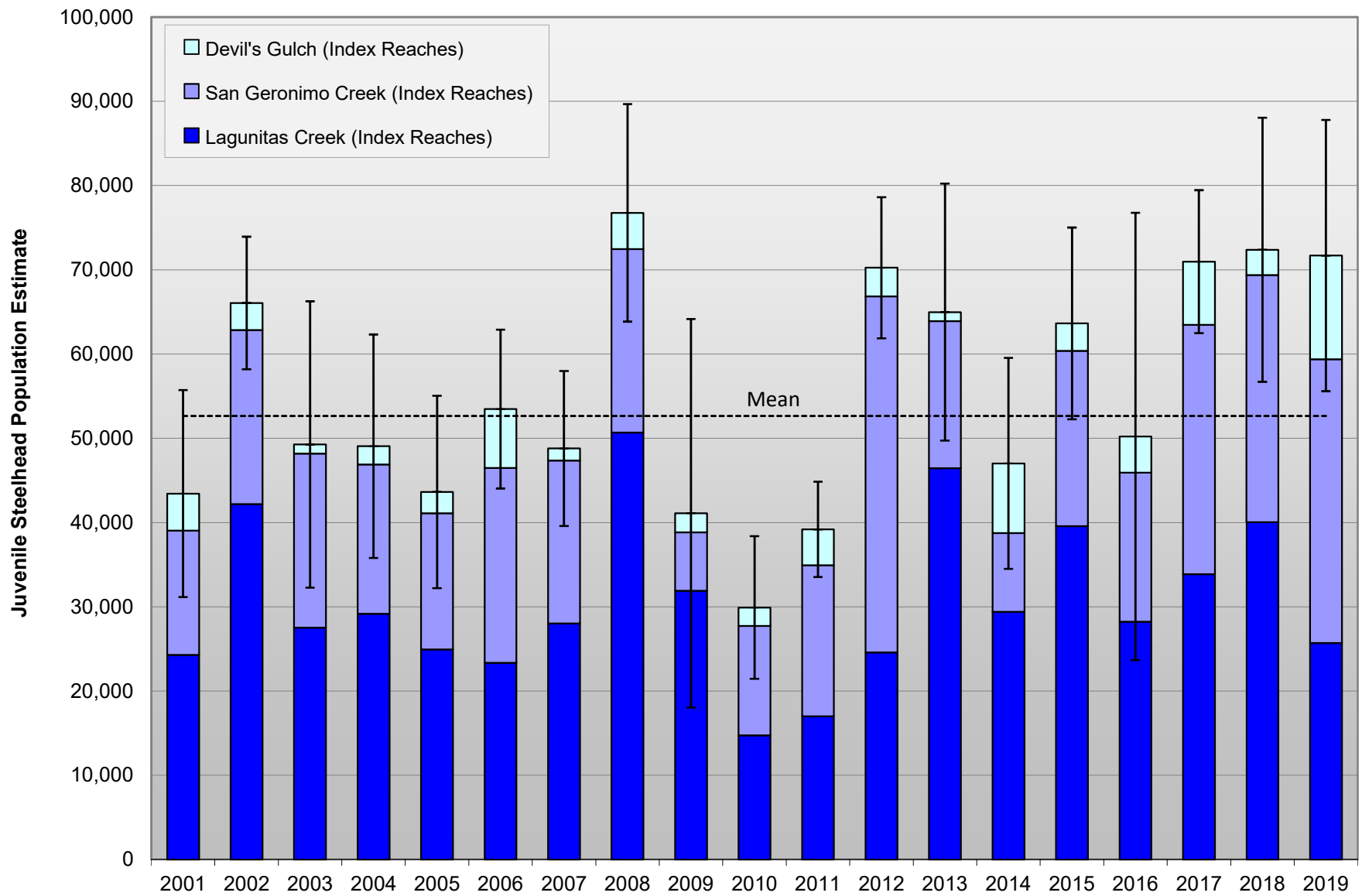


Figure 3. Juvenile Steelhead Population Estimates.

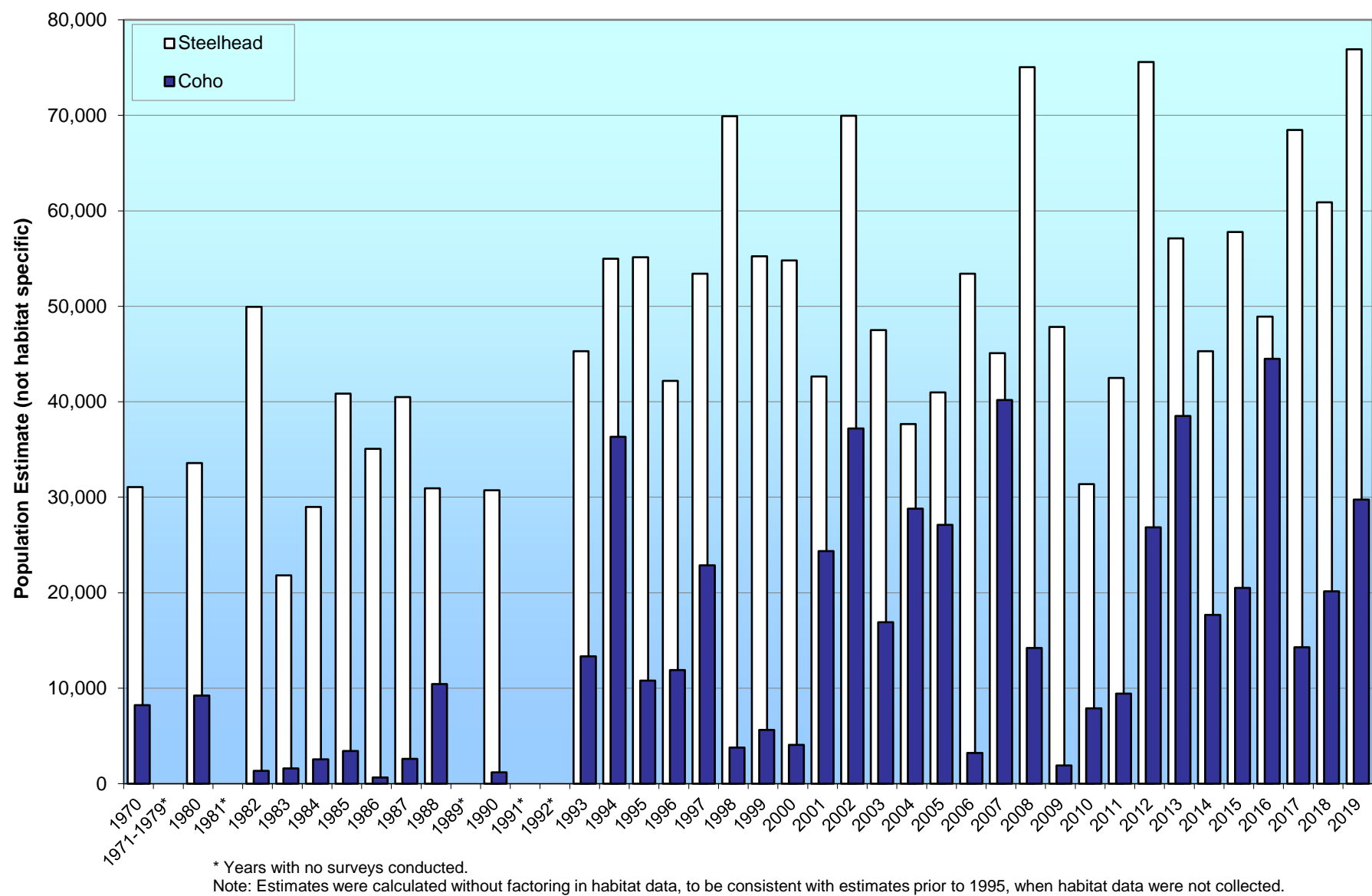


Figure 4. Population Estimates, Based Exclusively on Density Data from Index Reaches.

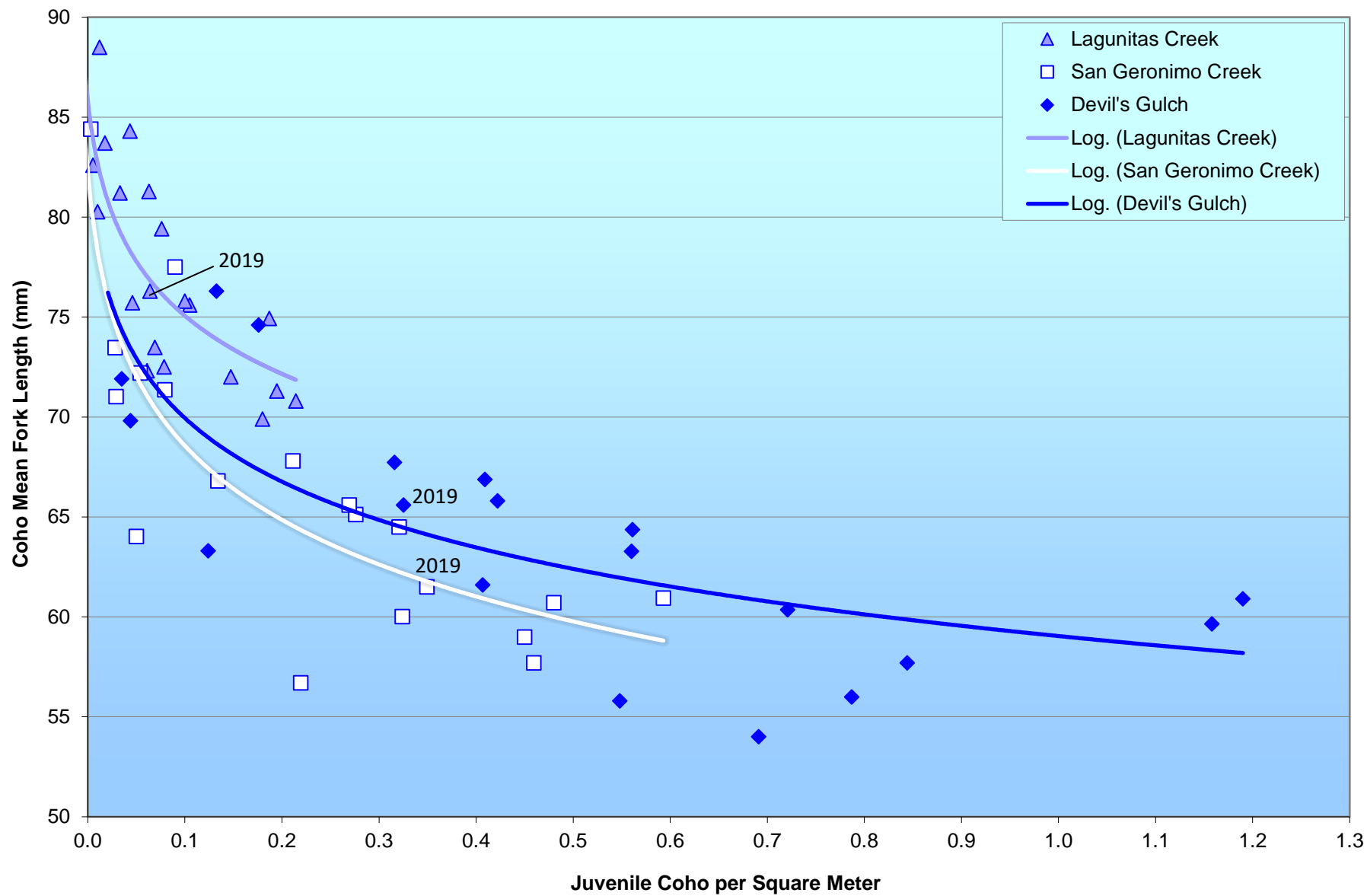


Figure 5. Coho Lengths vs. Coho Densities in Index Reaches, 1999-2019

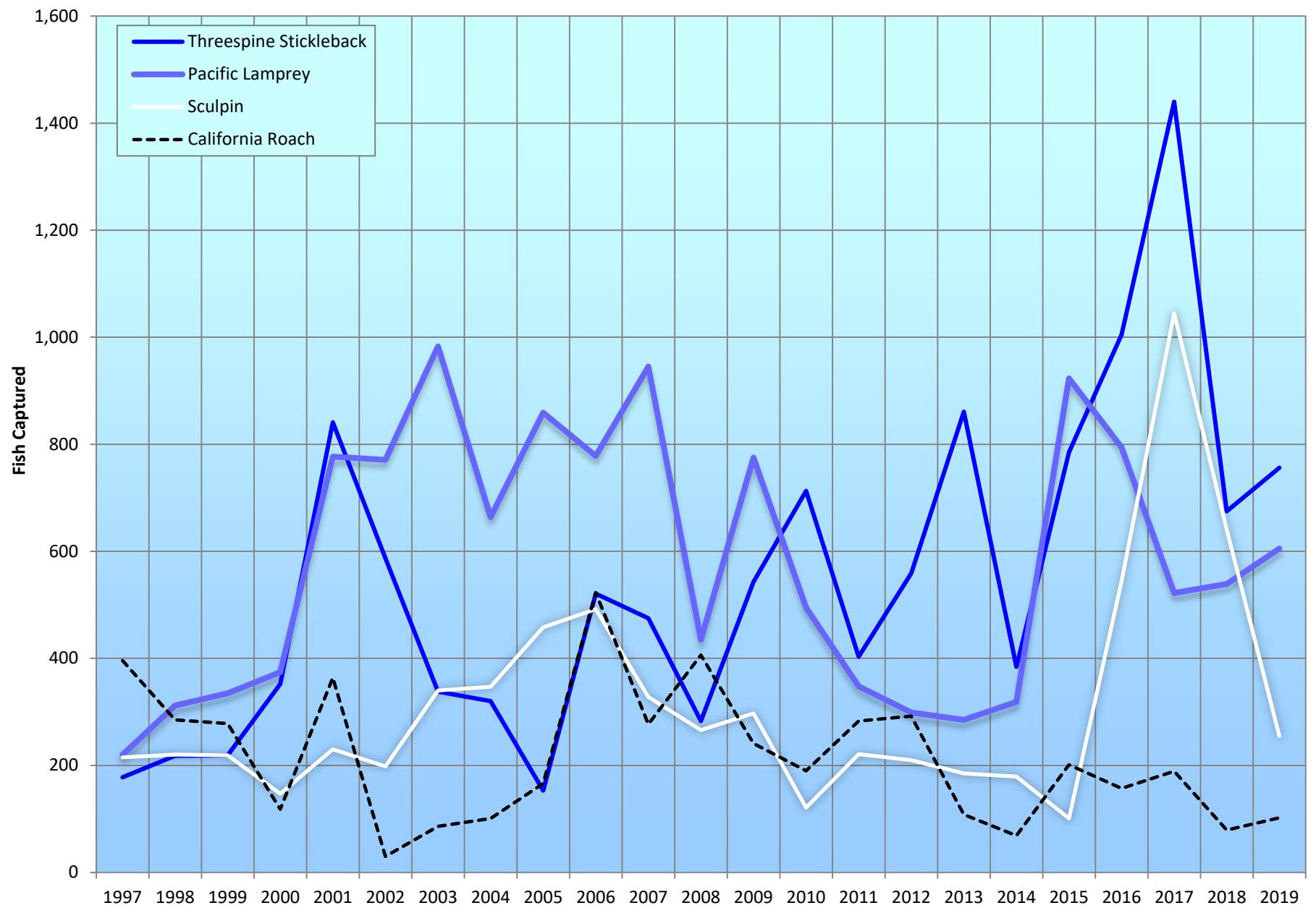
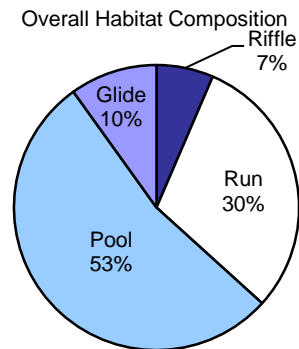
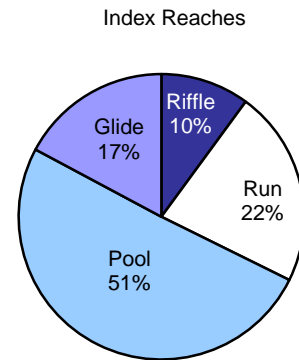
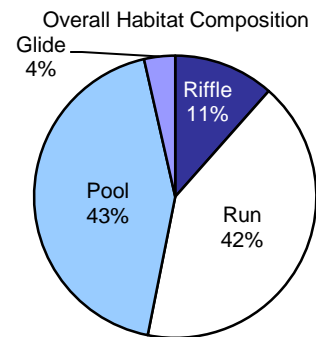
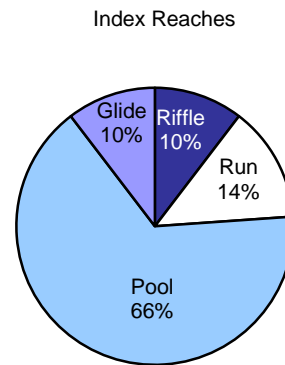


Figure 6. Common non-salmonid fish species incidentally captured during juvenile salmonid surveys.

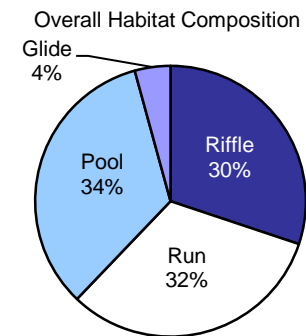
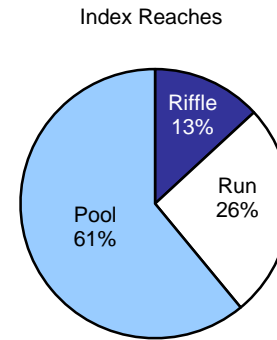
Lagunitas Creek



San Geronimo Creek



Devil's Gulch



Note: Overall habitat compositions were determined during the 2016 habitat typing survey.

Figure 7. Habitat Composition of Surveyed Creeks and Juvenile Salmonid Index Reaches, 2019.

631 Glide*	Pass		Max.
Species	1	2	
0+ Steelhead	1	5	5
1+ Steelhead	0	0	0
Coho Salmon	3	1	4

* Snorkel survey. 2nd pass coho was on opposite bank from 1st pass coho, so observations added.

LG-2 DS 1st, Pool*	Pass			Max.
Species	1	2	3	
0+ Steelhead	8	24	24	24
1+ Steelhead	0	2	3	3
Coho Salmon	26	21	18	26

* Snorkel survey. Fish moved between units. Counts adjusted.

LG-2 US 2nd, Pool*	Pass			Max.
Species	1	2	3	
0+ Steelhead	35	42	56	56
1+ Steelhead	6	9	7	9
Coho Salmon	25	41	25	41

LG-3u DS 1st, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	14	10	6	30
1+ Steelhead	6	2	0	8
Coho Salmon	17	5	1	23
Stickleback	5	5	3	13
Lamprey (ammo)	18	19	35	72
Lamprey (macro)	23	31	14	68
Freshwater Shrimp	2	3	0	5
Roach	5	8	3	16
Sculpin	7	3	0	10

LG-3u US 2nd, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	29	10	10	49
1+ Steelhead	2	1	3	6
Coho Salmon	15	11	4	30
Lamprey (ammo)	10	15	5	30
Lamprey (macro)	12	8	3	23
Stickleback	11	3	1	15
Roach	1	0	1	2
Sculpin	11	1	1	13

LG-5 1st, Run	Pass			Total
Species	1	2	3	
0+ Steelhead	29	12	9	50
1+ Steelhead	1	0	0	1
Coho Salmon	0	0	0	0
Stickleback	5	10	10	25
Lamprey (ammo)	1	6	2	9
Lamprey (macro)	5	13	6	24
Lamprey (adult)	1	0	0	1
Sculpin	3	0	1	4
Roach	5	9	7	21
Freshwater Shrimp	0	1	2	3

LG-5 2nd, Pool	Pass				Total
Species	1	2	3	4	
0+ Steelhead	25	12	11	1	49
1+ Steelhead	6	1	0	1	8
Coho Salmon	9	1	8	0	18
Stickleback	8	9	7	7	31
Roach	1	6	5	0	12
Freshwater Shrimp	1	2	0	0	3
Sculpin	0	1	1	0	2
Lamprey (ammo)	5	20	26	15	66
Lamprey (macro)	11	15	19	17	62

LG-7 1st, Pool	Pass		Total
Species	1	2	
0+ Steelhead	31	12	43
1+ Steelhead	1	2	3
Coho Salmon	2	2	4
Stickleback	6	7	13
Lamprey (ammo)	12	17	29
Lamprey (macro)	11	20	31
Roach	4	3	7
Sculpin	7	4	11
Freshwater Shrimp	1	1	2

LG-7 2nd, Riffle	Pass		Total
Species	1	2	
0+ Steelhead	9	8	17
1+ Steelhead	1	0	1
Coho Salmon	0	0	0
Sculpin	1	0	1
Stickleback	1	0	1
Lamprey (macro)	0	5	5

LG-7 3rd, Pool	Pass				Total
Species	1	2	3	4	
0+ Steelhead	28	17	13	3	61
1+ Steelhead	8	1	0	0	9
Coho Salmon	10	3	0	1	14
Sculpin	4	0	0	2	6
Lamprey (macro)	11	10	2	3	26
Lamprey (ammo)	1	2	4	3	10
Stickleback	6	1	4	2	13
Roach	0	0	0	3	3

Appendix A. Fish Observations by Index Reach
Lagunitas Creek Juvenile Salmonid Survey 2019

Marin Municipal Water District
10(a)(1)(A) Permit #16110

LG-9 1st, Riffle	Pass			Total
Species	1	2	3	
0+ Steelhead	44	14	6	64
1+ Steelhead	0	0	0	0
Coho Salmon	0	0	0	0
Lamprey (ammo)	1	1	0	2
Lamprey (macro)	3	4	0	7
Sculpin	5	4	1	10
Stickleback	1	1	0	2

LG-9 2nd, Run	Pass			Total
Species	1	2	3	
0+ Steelhead	50	19	2	71
1+ Steelhead	0	0	0	0
Coho Salmon	0	0	0	0
Lamprey (macro)	5	10	5	20
Lamprey (ammo)	0	1	0	1
Sculpin	7	7	0	14
Stickleback	0	0	0	0

LG-9 3rd, Riffle	Pass			Total
Species	1	2	3	
0+ Steelhead	22	7	0	29
1+ Steelhead	2	0	0	2
Coho Salmon	0	0	0	0
Lamprey (macro)	6	3	0	9
Lamprey (ammo)	0	0	0	0
Sculpin	1	0	0	1
Stickleback	0	0	0	0

LG-9 4th, Run	Pass			Total
Species	1	2	3	
0+ Steelhead	69	43	19	131
1+ Steelhead	6	5	1	12
Coho Salmon	3	0	1	4
Lamprey (macro)	21	32	22	75
Lamprey (ammo)	5	7	2	14
Sculpin	18	8	0	26
Stickleback	2	3	0	5

LG-15.86 Pool*	Pass			Max.
Species	1	2	3	
0+ Steelhead	17	23	24	24
1+ Steelhead	0	1	3	3
Coho Salmon	30	45	56	56

* Snorkel survey

LG-12 1st, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	37	20	9	66
1+ Steelhead	2	2	0	4
Coho Salmon	83	38	14	135
Stickleback	4	6	2	12
Lamprey (ammo)	4	3	1	8
Lamprey (macro)	0	1	0	1
Roach	0	1	1	2
Bullfrog	1	0	0	1
Bluegill	0	2	0	2
Spotted Bass	0	1	0	1
Sculpin	39	26	19	84

LG-12 2nd, Run	Pass			Total
Species	1	2	3	
0+ Steelhead	16	10	1	27
1+ Steelhead	0	0	0	0
Coho Salmon	0	0	1	1
Lamprey (ammo)	3	3	1	7
Lamprey (macro)	0	0	2	2
Sculpin	19	14	12	45

LG-12 3rd, Riffle	Pass		Total
Species	1	2	
0+ Steelhead	11	2	13
1+ Steelhead	0	0	0
Coho Salmon	0	0	0
Sculpin	16	3	19

SG-1 1st, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	124	29	12	165
1+ Steelhead	4	2	0	6
Coho Salmon	32	2	0	34
Roach	10	2	2	14
Stickleback	32	81	12	125

SG-1 3rd, Run	Pass		Total
Species	1	2	
0+ Steelhead	57	10	67
1+ Steelhead	2	0	2
Coho Salmon	0	0	0
Stickleback	6	2	8

SG-1 2nd, Glide	Pass			Total
Species	1	2	3	
0+ Steelhead	99	33	8	140
1+ Steelhead	0	0	0	0
Coho Salmon	0	0	0	0
Roach	7	0	0	7
Stickleback	27	4	8	39
CA Giant Salamander	1	0	0	1

SG-2 1st, Pool	Pass				Total
Species	1	2	3	4	
0+ Steelhead	48	27	18	18	111
1+ Steelhead	20	7	2	1	30
Coho Salmon	53	15	15	9	92
Stickleback	5	5	10	9	29
Roach	1	2	0	0	3
Lamprey (macro)	0	1	0	0	1
Lamprey (ammo)	0	0	1	2	3

SG-2 2nd, Riffle	Pass		Total
Species	1	2	
0+ Steelhead	12	6	18
1+ Steelhead	0	0	0
Coho Salmon	0	0	0
CA Giant Salamander	2	1	3
Stickleback	2	0	2

SG-2 3rd, Run	Pass			Total
Species	1	2	3	
0+ Steelhead	54	29	6	89
1+ Steelhead	0	0	0	0
Coho Salmon	0	0	0	0
Stickleback	6	4	7	17

SG-2 4th, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	126	67	26	219
1+ Steelhead	2	1	0	3
Coho Salmon	19	5	6	30
Stickleback	39	35	34	108
Roach	0	0	1	1
Lamprey (ammo)	0	1	0	1

SG-3 1st, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	38	21	14	73
1+ Steelhead	9	1	1	11
Coho Salmon	102	22	14	138
Stickleback	71	52	31	154
Roach	5	5	0	10

SG-3 2nd, Riffle	Pass		Total
Species	1	2	
0+ Steelhead	22	9	31
1+ Steelhead	0	0	0
Coho Salmon	0	0	0

SG-4 DS 1st, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	16	6	3	25
1+ Steelhead	0	0	0	0
Coho Salmon	31	16	7	54
Stickleback	35	27	8	70
Roach	0	0	1	1

SG-4 US 2nd, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	14	4	2	20
1+ Steelhead	17	2	0	19
Coho Salmon	63	28	19	110
Stickleback	40	22	12	74
Roach	0	3	0	3

DG-1 1st, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	73	36	6	115
1+ Steelhead	3	0	0	3
Coho Salmon	17	3	3	23
CA Giant Salamander	0	0	1	1

DG-1 3rd, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	99	31	8	138
1+ Steelhead	5	0	0	5
Coho Salmon	20	4	1	25
Sculpin	0	0	0	0

DG-1 2nd, Riffle	Pass		Total
Species	1	2	
0+ Steelhead	19	6	25
1+ Steelhead	0	0	0
Coho Salmon	0	0	0

DG-1 4th, Run	Pass		Total
Species	1	2	
0+ Steelhead	29	11	40
1+ Steelhead	2	0	2
Coho Salmon	1	1	2
CA Giant Salamander	1	0	1

DG-2 1st, Run	Pass		Total
Species	1	2	
0+ Steelhead	81	17	98
1+ Steelhead	0	0	0
Coho Salmon	17	5	22
Sculpin	0	1	1

DG-2 2nd, Riffle	Pass		Total
Species	1	2	
0+ Steelhead	10	1	11
1+ Steelhead	0	0	0
Coho Salmon	5	0	5

DG-2 3rd, Pool	Pass		Total
Species	1	2	
0+ Steelhead	16	6	22
1+ Steelhead	4	0	4
Coho Salmon	19	4	23
Sculpin	1	0	1

DG-2 4th, Pool	Pass			Total
Species	1	2	3	
0+ Steelhead	81	17	10	108
1+ Steelhead	6	0	1	7
Coho Salmon	34	18	6	58
Sculpin	0	3	4	7

LAGUNITAS CREEKSite: **LG-2**Sequence: **1st**Habitat: **Pool**

	Snorkel Count	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	24	24	NA	NA	NA
1+ Steelhead	3	3	NA	NA	NA
Coho	26	26	NA	NA	NA

Site: **LG-2**Sequence: **2nd**Habitat: **Pool**

	Snorkel Count	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	56	56	NA	NA	NA
1+ Steelhead	9	9	NA	NA	NA
Coho	41	41	NA	NA	NA

LG-2	Snorkel Count	Population Estimate
0+ Steelhead	80	80
1+ Steelhead	12	12
Coho	67	67

Site: **LG-631**Sequence: **1st**Habitat: **Glide**

	Snorkel Count	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	5	5	NA	NA	NA
1+ Steelhead	0	0	NA	NA	NA
Coho	4	4	NA	NA	NA

Glides	Snorkel Count	Population Estimate
0+ Steelhead	5	5
1+ Steelhead	0	0
Coho	4	4

Site: **LG-3u**Sequence: **1st**Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	30	38	21	55	17.3
1+ Steelhead	8	8	7	9	1.0
Coho	23	23	22	24	1.0

Site: **LG-3u**Sequence: **2nd**Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	49	56	44	68	12.2
1+ Steelhead	6	18	104	140	18.4
Coho	30	34	25	43	9.2

LG-3u	Total Catch	Population Estimate
0+ Steelhead	79	94
1+ Steelhead	14	26
Coho	53	57

Appendix B. 2019 Salmonid Population Estimates by Sample Site

Site: **LG-5**

Sequence: **1st**

Habitat: **Run**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	50	57	46	68	11.2
1+ Steelhead	1	1	1	1	0.0
Coho	0	0	0	0	0.0

Site: **LG-5**

Sequence: **2nd**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	49	51	46	56	5.1
1+ Steelhead	8	8	7	9	1.0
Coho	18	19	14	24	5.1

LG-5	Total Catch	Population Estimate
0+ Steelhead	99	108
1+ Steelhead	9	9
Coho	18	19

Site: **LG-7**

Sequence: **1st**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	43	48	38	58	10.2
1+ Steelhead	3	3	5	11	3.1
Coho	4	4	1	9	4.1

Site: **LG-7**

Sequence: **2nd**

Habitat: **Riffle**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	17	33	33	99	33.7
1+ Steelhead	1	1	1	1	0.0
Coho	0	0	0	0	0.0

Site: **LG-7**

Sequence: **3rd**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	61	67	58	76	9.2
1+ Steelhead	9	9	9	9	0.0
Coho	14	14	13	15	1.0

LG-7	Total Catch	Population Estimate
0+ Steelhead	121	148
1+ Steelhead	13	13
Coho	18	18

Site: **LG-9**

Sequence: **1st**

Habitat: **Riffle**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	64	66	62	70	4.1
1+ Steelhead	0	0	0	0	0.0
Coho	0	0	0	0	0.0

Site: **LG-9**

Sequence: **2nd**

Habitat: **Run**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	71	72	69	70	0.5
1+ Steelhead	0	0	0	0	0.0
Coho	0	0	0	0	0.0

Appendix B. 2019 Salmonid Population Estimates by Sample Site

Site: **LG-9**

Sequence: **3rd**

Habitat: **Riffle**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	29	29	28	30	1.0
1+ Steelhead	2	2	2	2	0.0
Coho	0	0	0	0	0.0

Site: **LG-9**

Sequence: **4th**

Habitat: **Run**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	131	154	132	176	22.4
1+ Steelhead	12	12	9	15	3.1
Coho	4	4	2	6	2.0

LG-9	Total Catch	Population Estimate
0+ Steelhead	295	321
1+ Steelhead	14	14
Coho	4	4

Site: **LG-12**

Sequence: **1st**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	66	74	63	85	11.2
1+ Steelhead	4	4	2	6	2.0
Coho	135	145	134	156	11.2

Site: **LG-12**

Sequence: **2nd**

Habitat: **Run**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	27	28	25	31	3.1
1+ Steelhead	0	0	0	0	0.0
Coho	1	1	1	1	0.0

Site: **LG-12**

Sequence: **3rd**

Habitat: **Riffle**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	13	13	12	14	1.0
1+ Steelhead	0	0	0	0	0.0
Coho	0	0	0	0	0.0

LG-12	Total Catch	Population Estimate
0+ Steelhead	106	115
1+ Steelhead	4	4
Coho	136	146

Site: **LG-15.86**

Sequence: **1st**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	24	24	NA	NA	NA
1+ Steelhead	3	3	NA	NA	NA
Coho	56	56	NA	NA	NA

LG-15.86	Total Catch	Population Estimate
0+ Steelhead	24	24
1+ Steelhead	3	3
Coho	56	56

SAN GERONIMO CREEKSite: **SG-1**Sequence: **1st**Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	165	168	163	173	5.1
1+ Steelhead	6	6	5	7	1.0
Coho	34	34	34	34	0.0

Site: **SG-1**Sequence: **2nd**Habitat: **Glide**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	140	143	138	148	5.1
1+ Steelhead	0	0	0	0	0.0
Coho	0	0	0	0	0.0

Site: **SG-1**Sequence: **3rd**Habitat: **Run**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	67	68	65	71	3.1
1+ Steelhead	2	2	2	2	0.0
Coho	0	0	0	0	0.0

SG-1	Total Catch	Population Estimate
0+ Steelhead	372	379
1+ Steelhead	8	8
Coho	34	34

Site: **SG-2**Sequence: **1st**Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	111	141	111	171	30.6
1+ Steelhead	30	30	29	31	1.0
Coho	92	99	90	108	9.2

Site: **SG-2**Sequence: **2nd**Habitat: **Riffle**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	18	21	11	31	10.2
1+ Steelhead	0	0	0	0	0.0
Coho	0	0	0	0	0.0

Site: **SG-2**Sequence: **3rd**Habitat: **Run**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	89	94	87	101	7.1
1+ Steelhead	0	0	0	0	0.0
Coho	0	0	0	0	0.0

Site: **SG-2**Sequence: **4th**Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	219	243	225	261	18.4
1+ Steelhead	3	3	2	4	1.0
Coho	30	32	26	38	6.1

SG-2	Total Catch	Population Estimate
0+ Steelhead	437	499
1+ Steelhead	33	33
Coho	122	131

Appendix B. 2019 Salmonid Population Estimates by Sample Site

Site: **SG-3**

Sequence: **1st**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	73	90	68	112	22.4
1+ Steelhead	11	11	10	12	1.0
Coho	138	142	136	148	6.1

Site: **SG-3**

Sequence: **2nd**

Habitat: **Riffle**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	31	35	25	45	10.2
1+ Steelhead	0	0	0	0	0.0
Coho	0	0	0	0	0.0

SG-3	Total Catch	Population Estimate
0+ Steelhead	104	125
1+ Steelhead	11	11
Coho	138	142

Site: **SG-4**

Sequence: **1st**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	25	26	22	30	4.1
1+ Steelhead	0	0	0	0	0.0
Coho	54	59	50	68	9.2

Site: **SG-4**

Sequence: **2nd**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	20	20	18	22	2.0
1+ Steelhead	19	19	18	20	1.0
Coho	110	127	109	145	18.4

SG-4	Total Catch	Population Estimate
0+ Steelhead	45	46
1+ Steelhead	19	19
Coho	164	186

DEVIL'S GULCH

Site: **DG-1**

Sequence: **1st**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	115	120	113	127	7.1
1+ Steelhead	3	3	3	3	0.0
Coho	23	23	21	25	2.0

Site: **DG-1**

Sequence: **2nd**

Habitat: **Riffle**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	25	26	22	30	4.1
1+ Steelhead	0	0	0	0	0.0
Coho	0	0	0	0	0.0

Appendix B. 2019 Salmonid Population Estimates by Sample Site

Site: **DG-1**

Sequence: **3rd**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	138	141	136	146	5.1
1+ Steelhead	5	5	5	5	0.0
Coho	25	25	24	26	1.0

Site: **DG-1**

Sequence: **4th**

Habitat: **Run**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	40	44	35	53	9.2
1+ Steelhead	2	2	2	2	0.0
Coho	4	8	34	50	8.2

DG-1	Total Catch	Population Estimate
0+ Steelhead	318	331
1+ Steelhead	10	10
Coho	52	56

Site: **DG-2**

Sequence: **1st**

Habitat: **Run**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	98	101	95	107	6.1
1+ Steelhead	0	0	0	0	0.0
Coho	22	23	19	27	4.1

Site: **DG-2**

Sequence: **2nd**

Habitat: **Riffle**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	11	11	10	12	1.0
1+ Steelhead	0	0	0	0	0.0
Coho	5	5	5	5	0.0

Site: **DG-2**

Sequence: **3rd**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	22	24	18	30	6.1
1+ Steelhead	4	4	4	4	0.0
Coho	23	23	21	25	2.0

Site: **DG-2**

Sequence: **4th**

Habitat: **Pool**

	Total Catch	Population Estimate	Lower Confidence Interval	Upper Confidence Interval	Standard Deviation
0+ Steelhead	108	110	106	114	4.1
1+ Steelhead	7	7	6	8	1.0
Coho	58	62	55	69	7.1

DG-2	Total Catch	Population Estimate
0+ Steelhead	239	246
1+ Steelhead	11	11
Coho	108	113

Lagunitas Creek - Nicasio Creek to Peters Dam**Total Habitat:**

	Length (m)	% of Total
Pool	6,995	53%
Run	3,965	30%
Riffle	847	6%
Glide	1,298	10%
Total	13,105	100%

*Note: Does not include 327 m of cascades, side channels, and dry habitat.

Electrofishing and Snorkel Sites:

	Length (m)	% of Total
Pool	275	51%
Run	121.1	22%
Riffle	54.8	10%
Glide	93.6	17%
Total	544.5	100%

Fish Population Estimates from Sites Sampled: (see Appendix B)

	0+ SH	1+ SH	Coho
Pool	438	65	362
Run	311	13	5
Riffle	141	3	0
Glide	5	0	4
Total	895	81	371

Number of Fish per Habitat Type in the Stream Segment:**0+ SH**

Pool = 438 fish/275 m =>1.593 fish/m x 6995 m of pool =	11,140	+/-	1,634
Run = 311 fish/121.1 m =>2.568 fish/m x 3965 m of run =	10,183	+/-	5,563
Riffle = 141 fish/54.8 m =>2.573 fish/m x 847 m of riffle =	2,179	+/-	2,031
Glide = 5 fish/93.6 m =>0.053 fish/m x 1298 m of glide =	69	+/-	-
	23,571	+/-	2,607

1+ SH

Pool = 65 fish/275 m =>0.236 fish/m x 6995 m of pool =	1,653	+/-	475
Run = 13 fish/121.1 m =>0.107 fish/m x 3965 m of run =	426	+/-	NA
Riffle = 3 fish/54.8 m =>0.055 fish/m x 847 m of riffle =	46	+/-	86
Glide = 0 fish/93.6 m =>0 fish/m x 1298 m of glide =	-	+/-	-
	2,125	+/-	772

Coho

Pool = 362 fish/275 m =>1.316 fish/m x 6995 m of pool =	9,207	+/-	3,980
Run = 5 fish/121.1 m =>0.041 fish/m x 3965 m of run =	164	+/-	NA
Riffle = 0 fish/54.8 m =>0 fish/m x 847 m of riffle =	-	+/-	-
Glide = 4 fish/93.6 m =>0.043 fish/m x 1298 m of glide =	55	+/-	-
	9,427	+/-	3,985

San Geronimo Creek - Mouth to Dickson Weir (Upstream of Woodacre Creek)**Total Habitat:**

	Length (m)	% of Total
Pool	2,936	43%
Run	2,819	42%
Riffle	781	12%
Glide	241	4%
Total	6,776	100%

*Note: Does not include 418 m of cascades, side channels, and dry habitat.

Electrofishing Sites:

	Length (m)	% of Total
Pool	147.5	66%
Run	30.3	14%
Riffle	23.3	10%
Glide	23.3	10%
Total	224.4	100%

Fish Population Estimates from Sites Sampled: (see Appendix B)

	0+ SH	1+ SH	Coho
Pool	688	69	493
Run	162	2	0
Riffle	56	0	0
Glide	143	0	0
Total	1049	71	493

Number of Fish per Habitat Type in the Stream Segment:0+ SH

Pool = 688 fish/147.5 m => 4.664 fish/m x 2936 m of pool =	13693 +/-	10,877
Run = 162 fish/30.3 m => 5.347 fish/m x 2819 m of run =	15071 +/-	1,964
Riffle = 56 fish/23.3 m => 2.403 fish/m x 781 m of riffle =	1878 +/-	2,289
Glide = 143 fish/23.3 m => 6.137 fish/m x 241 m of glide =	1478 +/-	-
	32119 +/-	11,288

1+ SH

Pool = 69 fish/147.5 m => 0.468 fish/m x 2936 m of pool =	1373 +/-	1,414
Run = 2 fish/30.3 m => 0 fish/m x 2819 m of run =	186 +/-	151
Riffle = 0 fish/23.3 m => 0 fish/m x 781 m of riffle =	0 +/-	-
Glide = 0 fish/23.3 m => 0 fish/m x 241 m of glide =	0 +/-	-
	1559 +/-	1,422

Coho

Pool = 493 fish/147.5 m => 3.342 fish/m x 2936 m of pool =	9812 +/-	4,064
Run = 0 fish/30.3 m => 0 fish/m x 2819 m of run =	0 +/-	-
Riffle = 0 fish/23.3 m => 0 fish/m x 781 m of riffle =	0 +/-	-
Glide = 0 fish/23.3 m => 0 fish/m x 241 m of glide =	0 +/-	-
	9812 +/-	4,064

Devils Gulch - Mouth to 3,287 meters upstream.**Total Habitat:**

	Length (m)	% of Total
Pool	1,063	34%
Run	1,013	32%
Riffle	953	30%
Glide	135	4%
Total	3,163	100%

*Note: Does not include 124 m of cascade and dry habitats.

Electrofishing Sites:

	Length (m)	% of Total
Pool	77.5	61%
Run	32.9	26%
Riffle	16.7	13%
Glide	-	0%
Total	127.1	100%

Fish Population Estimates from Sites Sampled: (see Appendix B)

	0+ SH	1+ SH	Coho
Pool	395	19	133
Run	145	2	31
Riffle	37	0	5
Total	577	21	169

Number of Fish per Habitat Type in the Stream Segment:0+ SH

Pool = 395 fish/77.5 m => 5.097 fish/m x 1063 m of pool =	5,415	+/-	3,279
Run = 145 fish/32.9 m => 4.407 fish/m x 1013 m of run =	4,463	+/-	3,577
Riffle = 37 fish/16.7 m => 2.216 fish/m x 953 m of riffle =	2,111	+/-	1,177
	11,989	+/-	4,993

1+ SH

Pool = 19 fish/77.5 m => 0.245 fish/m x 1063 m of pool =	260	+/-	109
Run = 2 fish/32.9 m => 0.061 fish/m x 1013 m of run =	62	+/-	125
Riffle = 0 fish/16.7 m => 0 fish/m x 953 m of riffle =	0	+/-	-
	322	+/-	166

Coho

Pool = 133 fish/77.5 m => 1.716 fish/m x 1063 m of pool =	1,823	+/-	1,430
Run = 31 fish/32.9 m => 0.942 fish/m x 1013 m of run =	954	+/-	711
Riffle = 5 fish/16.7 m => 0.299 fish/m x 953 m of riffle =	285	+/-	269
	3,063	+/-	1,620

APPENDIX D - JUVENILE SALMONID STUDY AREAS, 1993 – 2019

Juvenile salmonid populations for the Lagunitas Creek study area have been estimated since 1993. These estimates have applied to different lengths of streams sampled, ranging from 19.7 to 43.8 total stream kilometers (Table D-1). The streams were also divided into reaches in previous years, with populations being estimated for separate reaches. This section will detail what constituted the study area over the years and how populations were estimated.

Table D-1. Lengths of streams included in the study area, by year

Years	Lengths of Stream in Study Area (km)			
	Lagunitas	San Geronimo	Devil's Gulch	Total
1993-1994	17.3	5.5	2.1	24.9
1995-1996	12.1	5.5	2.1	19.7
1997	13.3	6.7	2.1	22.1
1998-2002	12.6	7.2	3.3	23.1
2003-2005	12.7	7.2	3.1	23.0
2006-2010	13.3	7.7	3.4	24.4
2011-2015	13.3	7.6	3.3	24.2
2013-2014 (GRTS)	19.4	7.6	3.3	43.8*
2016-2019	13.4	7.2	3.3	23.9

* Stream length includes Olema Creek

For the 1993 and 1994 juvenile surveys, Trihey & Associates (1995b) estimated salmonid abundance in three segments of Lagunitas Creek between Highway 1 and Shafter Bridge, and did not differentiate habitat types. All future population estimates were based on fish densities in pools, runs and riffles, and extrapolated based on the proportion of those habitats in the sample reaches. For the 1995 and 1996 surveys, Trihey & Associates (1995c, 1996) excluded the section of creek below Nicasio Creek because they determined that sample site LG-1 did not accurately reflect the habitat composition of that section of creek. For the 1997 and 1998 surveys, the creek upstream of Nicasio Creek was divided into two new sections and sample site LG-1 was included. Starting in 1999 and continuing through 2016, Lagunitas Creek was treated as a single segment, extending from Nicasio Creek to Peters Dam. In 2013 and 2014 Generalized Random Tesselation Stratified (GRTS) sampling was conducted in the reach of Lagunitas Creek between Highway 1 and Nicasio Creek. Salmonid population estimates were generated for the entire watershed, including this lower reach of Lagunitas Creek and Olema Creek.

San Geronimo Creek surveys prior to 1997 eliminated the lower 1.2 km of San Geronimo Creek (from its mouth to the Lagunitas Street Bridge) and divided the remainder of the creek into two segments (Trihey & Associates 1995b, 1995c, and 1996). Since 1997 salmonid populations have been estimated for the creek from its mouth to the confluence with Woodacre Creek.

Prior to 1998, the salmonid populations of Devil's Gulch were estimated for the lower 2.2 km of stream, based on habitat typing data collected in 1995. Since 1998, we have estimated salmonid populations for the lower 3.4 km of Devil's Gulch. Estimating pre-1998 populations for all of Devil's Gulch is difficult due to the lack of habitat data for the upper section for those years.

Appendix E. Juvenile Salmonids per Square Meter

Coho

	Lagunitas Creek						San Geronimo Creek						Devil's Gulch					Watershed Average				
Year	Riffle	Run	Pool	Glide	Mean		Riffle	Run	Pool	Glide	Mean		Riffle	Run	Pool	Mean		Riffle	Run	Pool	Glide	Mean
1998	0.00	0.00	0.01	N/A	0.01		0.00	0.00	0.10	N/A	0.07		0.00	0.00	0.12	0.09		0.00	0.00	0.03	N/A	0.02
1999	0.00	0.00	0.04	N/A	0.02		0.00	0.00	0.05	N/A	0.04		0.01	NA	0.48	0.33		0.00	0.00	0.07	N/A	0.04
2000	0.00	0.01	0.03	N/A	0.02		0.00	0.00	0.05	N/A	0.04		0.00	0.02	0.10	0.05		0.00	0.01	0.04	N/A	0.03
2001	0.00	0.03	0.09	N/A	0.07		0.01	0.01	0.43	N/A	0.33		0.11	0.45	0.72	0.56		0.01	0.05	0.19	N/A	0.15
2002	0.00	0.07	0.11	N/A	0.09		0.00	NA	0.70	N/A	0.60		0.00	0.49	1.51	1.17		0.00	0.08	0.30	N/A	0.25
2003	0.00	0.02	0.14	N/A	0.07		0.00	0.14	0.19	N/A	0.14		0.00	0.35	0.66	0.42		0.00	0.06	0.18	N/A	0.11
2004	0.00	0.07	0.06	N/A	0.06		0.02	0.01	0.57	N/A	0.46		0.00	0.66	0.88	0.73		0.00	0.09	0.21	N/A	0.17
2005	0.00	0.04	0.19	N/A	0.12		0.00	0.00	0.37	N/A	0.29		0.04	0.57	1.15	0.57		0.00	0.06	0.28	N/A	0.17
2006	0.00	0.00	0.01	N/A	0.01		0.00	0.00	0.09	N/A	0.06		0.00	0.00	0.12	0.05		0.00	0.00	0.03	N/A	0.02
2007	0.00	0.12	0.22	0.27	0.20		0.00	0.37	0.57	N/A	0.49		0.14	0.55	1.18	0.80		0.01	0.20	0.34	0.27	0.29
2008	0.00	0.03	0.14	0.03	0.08		0.00	0.03	0.15	N/A	0.09		0.00	0.12	0.23	0.13		0.00	0.03	0.15	0.03	0.08
2009	0.00	0.00	0.04	0.01	0.02		0.00	0.00	0.00	N/A	0.00		0.00	0.00	0.00	0.00		0.00	0.00	0.03	0.01	0.01
2010	0.00	0.01	0.11	0.05	0.05		0.00	0.00	0.02	N/A	0.01		0.03	0.13	0.40	0.19		0.00	0.01	0.10	0.05	0.05
2011	0.00	0.01	0.06	0.06	0.04		0.00	0.00	0.13	0.32	0.10		0.00	0.05	0.31	0.14		0.00	0.01	0.09	0.20	0.06
2012	0.00	0.03	0.23	N/A	0.16		0.00	N/A	0.37	0.00	0.23		0.07	0.62	1.04	0.70		0.00	0.07	0.30	0.00	0.20
2013	0.02	0.11	0.26	0.39	0.20		0.00	0.02	0.74	0.00	0.22		0.04	0.99	1.65	1.20		0.02	0.14	0.48	0.29	0.28
2014	0.01	0.55	0.17	0.31	0.19		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.03	0.03		0.01	0.41	0.13	0.23	0.14
2015	0.00	0.07	0.12	0.08	0.09		0.00	0.10	0.44	0.00	0.33		0.00	0.25	0.57	0.42		0.00	0.08	0.21	0.09	0.13
2016	0.00	0.17	0.29	0.25	0.22		0.02	0.43	0.54	N/A	0.47		0.03	1.25	0.88	0.85		0.01	0.28	0.37	0.25	0.26
2017	0.00	0.00	0.04	0.00	0.03		0.00	0.07	0.38	0.00	0.28		0.00	0.14	0.65	0.43		0.00	0.05	0.13	0.00	0.09
2018	0.01	0.02	0.18	0.04	0.11		0.00	0.00	0.08	N/A	0.06		0.03	0.60	0.64	0.57		0.01	0.05	0.19	0.04	0.09
2019	0.00	0.01	0.14	0.00	0.07		0.00	0.00	0.47	N/A	0.36		0.06	0.17	0.56	0.34		0.00	0.01	0.23	0.00	0.13
Mean	0.00	0.03	0.11	0.13	0.08		0.00	0.04	0.28	0.11	0.20		0.03	0.33	0.71	0.46		0.00	0.08	0.19	0.11	0.12

Steelhead

	Lagunitas Creek						San Geronimo Creek						Devil's Gulch					Watershed Average				
Year	Riffle	Run	Pool	Glide	Mean		Riffle	Run	Pool	Glide	Mean		Riffle	Run	Pool	Mean		Riffle	Run	Pool	Glide	Mean
1998	0.20	0.37	0.21	N/A	0.27		0.13	1.00	0.92	N/A	0.82		1.25	1.03	1.35	1.30		0.25	0.53	0.42	N/A	0.43
1999	0.33	0.24	0.28	N/A	0.27		0.30	1.52	0.65	N/A	0.66		0.35	NA	0.65	0.55		0.33	0.48	0.37	N/A	0.36
2000	0.39	0.35	0.11	N/A	0.20		0.21	1.12	0.64	N/A	0.64		0.34	0.43	0.99	0.70		0.35	0.50	0.26	N/A	0.32
2001	0.37	0.46	0.15	N/A	0.23		0.13	1.32	0.39	N/A	0.45		0.34	0.25	0.38	0.36		0.32	0.62	0.21	N/A	0.28
2002	0.59	0.54	0.40	N/A	0.46		0.35	NA	0.81	N/A	0.75		0.12	0.59	0.43	0.41		0.52	0.44	0.49	N/A	0.52
2003	0.32	0.33	0.25	N/A	0.29		0.24	1.33	0.47	N/A	0.54		0.01	0.11	0.22	0.14		0.29	0.51	0.29	N/A	0.33
2004	0.48	0.37	0.15	N/A	0.26		0.34	0.64	0.35	N/A	0.38		0.22	0.50	0.14	0.25		0.44	0.43	0.19	N/A	0.28
2005	0.27	0.32	0.22	N/A	0.26		0.25	0.59	0.38	N/A	0.39		0.17	0.27	0.33	0.25		0.26	0.37	0.26	N/A	0.28
2006	0.39	0.30	0.18	N/A	0.24		0.32	1.18	0.51	N/A	0.63		0.53	0.53	0.70	0.59		0.38	0.49	0.27	N/A	0.34
2007	0.39	0.38	0.16	0.17	0.24		0.34	1.34	0.46	N/A	0.63		0.11	0.33	0.15	0.18		0.36	0.57	0.22	0.17	0.31
2008	0.62	0.65	0.38	0.18	0.39		0.23	1.36	0.77	N/A	0.91		0.00	0.56	0.63	0.46		0.51	0.79	0.47	0.18	0.50
2009	0.40	0.39	0.33	0.05	0.29		0.08	0.06	0.28	N/A	0.22		0.03	0.13	0.60	0.25		0.32	0.31	0.34	0.05	0.27
2010	0.15	0.15	0.17	0.04	0.13		0.13	0.10	0.50	N/A	0.47		0.07	0.31	0.35	0.25		0.14	0.15	0.24	0.04	0.20
2011	0.34	0.22	0.15	0.03	0.14		0.12	0.71	0.68	0.36	0.69		0.41	0.42	0.58	0.48		0.30	0.33	0.28	0.07	0.27
2012	0.49	0.27	0.14	N/A	0.22		0.91	N/A	1.48	1.41	1.41		0.38	0.37	0.45	0.41		0.57	0.28	0.42	1.41	0.47
2013	0.52	0.72	0.23	0.42	0.37		0.12	0.11	0.59	1.36	0.47		0.00	0.21	0.20	0.16		0.41	0.57	0.31	0.58	0.38
2014	0.42	1.43	0.17	0.17	0.29		0.00	0.32	0.37	0.14	0.29		0.34	1.18	1.22	1.09		0.33	1.19	0.29	0.16	0.35
2015	0.60	0.48	0.19	0.48	0.32		0.23	1.19	0.90	0.65	0.82		0.34	0.43	0.69	0.59		0.52	0.62	0.36	0.49	0.44
2016	0.36	0.40	0.22	0.13	0.26		0.08	1.11	0.46	N/A	0.57		0.54	0.93	0.48	0.57		0.31	0.57	0.28	0.13	0.34
2017	0.47	0.45	0.20	0.20	0.23		0.41	2.79	1.31	1.02	1.36		0.34	1.23	0.89	0.98		0.45	1.05	0.41	0.25	0.44
2018	0.28	0.46	0.23	0.65	0.35		0.45	1.11	1.01	N/A	0.98		0.23	0.19	0.55	0.36		0.31	0.57	0.40	0.65	0.47
2019	0.28	0.35	0.20	0.00	0.19		0.76	1.35	0.72	N/A	0.82		0.44	0.80	1.75	1.19		0.38	0.57	0.39	0.00	0.37
Mean	0.39	0.38	0.22	0.15	0.26		0.26	0.88	0.62	1.04	0.63		0.27	0.40	0.51	0.42		0.37	0.54	0.33	0.32	0.36