



JUVENILE SALMONID AND SMOLT MONITORING IN THE LAGUNITAS CREEK WATERSHED – 2024-2025

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EXECUTIVE SUMMARY

This report summarizes two salmonid monitoring efforts conducted by Marin Water in 2024 and 2025. Between August 27 and October 11, 2024, Marin Water staff and Watershed Stewards Program members captured and tagged juvenile 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. Downstream-migrating salmonid smolts were monitored between March 26 and June 12, 2025 using a rotary screw trap (RST) in lower Lagunitas Creek, near Point Reyes Station. These two surveys were performed in accordance with Marin Water's Lagunitas Creek Stewardship Plan (MMWD 2011) and the data collected were used to estimate survival rates of these species during critical life stages.

In 2024, survey crews captured 1,647 juvenile Coho Salmon and 478 juvenile steelhead, and implanted Passive Integrated Transponder (PIT) tags into 1,230 coho and 151 steelhead. Juvenile coho abundance at three historic index reaches suggested a study area population of approximately 41,000. During smolt monitoring in the spring of 2025, the RST captured 5,357 Coho Salmon smolts, 1,169 Chinook and 422 steelhead smolts. Emigration estimates were as follows: 13,086 Coho Salmon, 3,300 Chinook and 1,535 steelhead. The coho emigration was larger than average but somewhat smaller than the emigration three years earlier. The steelhead emigration estimate was smaller than average, while the Chinook emigration was above average, following an extraordinarily large run of adult Chinook.

Of the juvenile Coho Salmon tagged in 2024, 22% were detected at the RST or nearby antennas in spring 2025, suggesting an overwinter survival rate of approximately 28%. Using this survival rate to back-calculate from the smolt abundance estimate, juvenile coho abundance in 2024 was 47,000. Coho Salmon tagged in San Geronimo Creek appeared to survive at lower rates than coho tagged in the other streams.

INTRODUCTION

Lagunitas Creek is a regionally important coastal stream for Coho Salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*), with recent Coho Salmon escapement estimates averaging approximately 500 individuals, while steelhead runs are somewhat smaller. Chinook Salmon (*O. tshawytscha*) also spawn in Lagunitas Creek and smolts have been observed in most years.

Salmonid surveys are conducted cooperatively between Marin Water, the California Department of Fish and Wildlife (CDFW), the National Park Service (NPS), the Marin Resource Conservation District, the Watershed Stewards Program (WSP), and the Salmon Protection and Watershed Network (SPAWN). Summer and fall surveys for juvenile Coho Salmon and steelhead were conducted in Lagunitas Creek starting in 1970 and annually since 1993. This represents one of the longest data records for juvenile salmonids in coastal streams of California. Systematic Coho Salmon adult spawner surveys began in 1982 and have been conducted annually since 1995. Marin Water has conducted annual smolt surveys on Lagunitas Creek since 2006, as well as in 1983, 1984 and 1985. Since 2012, juvenile Coho Salmon have been implanted with passive integrated transponder (PIT) tags. Other data collection activities include stream flow monitoring conducted by the United States Geological Survey at gages in Samuel P. Taylor State Park and Point Reyes Station. Another stream gage is maintained by Marin Water on San Geronimo Creek. Marin Water has also monitored water temperature continuously since the early 1990s. Lagunitas Creek streambed conditions are monitored annually and salmonid habitat is quantified approximately every five years.

Marin Water is primarily responsible for salmonid monitoring in Lagunitas Creek (upstream of tidal influence), in the main stem of San Geronimo Creek, and in Devil's Gulch (Figure 1). These streams are collectively referred to as the Lagunitas Creek Study Area. NPS conducts surveys for salmonid adults, juveniles and smolts in Olema Creek, a major tributary to Lagunitas Creek. NPS has monitored salmonid smolt emigration from Olema Creek since 2004, and smolt monitoring was conducted on a tributary to Olema Creek between 1998 and 2004. SPAWN has conducted adult salmonid monitoring in the tributaries to San Geronimo Creek since 1997 and has operated a smolt trap in lower San Geronimo Creek since 2006.

The primary goals of salmonid monitoring in the Lagunitas Creek Study Area include:

- Estimating Coho Salmon survival rates between life stages for multiple streams within the Lagunitas Creek watershed, and identifying the factors that influence those survival rates.
- Estimating Coho Salmon abundance at each life stage.
- Collecting data on steelhead and other salmonid species, including migration timing and distribution.

METHODS

A full description of survey methods is provided in Ettlinger et al. (2025).

Juvenile Salmonid Survey

Between July 1 and July 22, 2024, three surveyors snorkeled Lagunitas Creek from the confluence with Nicasio Creek to Peters Dam. The goal of this survey was to identify areas with high densities of juvenile coho salmon and assess whether the fish could be efficiently captured with electrofishers or seines. Surveyors collected data on water depth, largest observed substrate, and overhanging vegetation for each snorkeled habitat. All juvenile coho habitat that was suitable for either electrofishing or seining was snorkeled.

Between August 27 and October 11, 2024, juvenile salmonids were captured using a combination of electrofishing and seining. The goal of this survey was to implant at least 400 juvenile coho salmon and 50 age 1+ steelhead with PIT tags in each of three study streams (Lagunitas Creek, San Geronimo Creek, and Devil's Gulch).

Smolt Survey

Between March 26 and June 12, 2025, Marin Water operated a rotary screw trap (RST) in lower Lagunitas Creek, to count downstream-migrating salmonid smolts. Catches of salmonids and estimates of trap efficiency were used to estimate the numbers of salmonid smolts migrating each week. Concurrently, Marin Water operated PIT tag antennas in Lagunitas Creek, Olema Creek, San Geronimo Creek, and Devil's Gulch.

Back-Calculating Juvenile Abundance

Juvenile Coho Salmon abundance was back-calculated from the smolt estimate by estimating survival rates of PIT-tagged coho between late-summer and smolt outmigration in spring. Tagged coho were determined to have survived if they were detected at either the lowest antenna in Lagunitas Creek (the Gallagher Ranch antenna), the Olema Creek antenna, or at the rotary screw

trap. The detection efficiency of these antennas and the RST was estimated using PIT-tagged coho smolts, which were subsequently detected and/or recaptured. The apparent survival rate of tagged coho was calculated as the detection rate divided by detection efficiency.

RESULTS

Juvenile Salmonid Observations

In 2024, snorkelers observed 11,056 juvenile coho salmon and 8,620 juvenile steelhead in Lagunitas Creek. Of the 139 habitat units surveyed, 18 were identified as suitable for electrofishing or seining. Marin Water crews electrofished eight of these pools, seined one, and captured 412 juvenile coho and 93 juvenile steelhead (Table 1). A total of 386 coho and 51 steelhead were PIT tagged. Coho averaged 76 mm in length and 5.2 g in weight, while steelhead averaged 118 mm in length and 25.1 g in weight.

In San Geronimo Creek, Marin Water crews electrofished eight pools and seined two, capturing 665 juvenile coho and 205 steelhead. A total of 420 coho and 55 steelhead were tagged. Coho averaged 65 mm in length and 3.4 g in weight, while steelhead averaged 89 mm in length and 13.8 g in weight.

In Devil's Gulch, Marin Water crews electrofished 32 pool and glide habitat units, capturing 570 juvenile coho and 180 steelhead. A total of 424 coho and 45 steelhead were tagged. Coho averaged 65 mm in length and 3.5 g in weight, while steelhead averaged 91 mm in length and 12.8 g in weight.

Table 1. Salmonid observations and tagging

Stream	Sample Sites	Coho Captured	Coho Tagged	Steelhead Captured	Steelhead Tagged
Lagunitas Creek	9	412	386	93	51
San Geronimo Creek	10	665	420	205	55
Devil's Gulch	32	570	424	180	45
Study Area Total	51	1,647	1,230	478	151

At the three historic index reaches in Lagunitas Creek, a total of 365 juvenile Coho Salmon were observed during snorkel surveys. Applying a proportion of 0.9% to that observation (the historic ratio of juvenile coho at these index reaches to the study area estimate), the corresponding abundance estimate for the entire Lagunitas Creek Study Area was approximately 41,000 (Table 2).

Table 2. Juvenile Coho Population, Extrapolated from Three Index Reaches

Index Reach Observations				Preliminary Population Estimate
LG-2	LG-5	SG-4	Total	
133	96	136	365	41,000

Incidental mortalities from our juvenile sampling effort consisted of 11 Coho Salmon (0.6% of captured fish) and three steelhead (0.6% of captured fish).

Other Species Encountered During Juvenile Monitoring

In addition to Coho Salmon and steelhead, four other native fish species were observed: Southern Coastal Roach (*Hesperoleucus venustus subditus*), Threespine Stickleback (*Gasterosteus aculeatus*),

Pacific Lamprey (*Lampetra tridentata*), and sculpin (*Cottus* spp). 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). California Freshwater Shrimp (*Syncaris pacifica*) were also observed in Lagunitas Creek.

Lagunitas Creek Rotary Screw Trap

Marin Water's rotary screw trap (RST) was operated for 48 days in 2025, during which flows at the Point Reyes Station stream gage ranged between 15 and 133 cubic feet per second (cfs). The highest daily catch of 363 Coho Salmon smolts occurred on April 30. Peak weekly smolt passage was estimated at 2,819 for the week of May 5. Coho Salmon emigration for the season was estimated at 13,086 (Table 3).

Table 3. Salmonid Smolt Captures, Emigration Estimates, Lengths and Weights

Species	Smolts	Emigration Estimate	Confidence Interval		Mean Length (mm)	Mean Weight (mm)
			Low	High		
Coho Salmon	5,357	13,086	11,663	14,509	109.9	14.0
Chinook Salmon	1,169	3,300	2,585	4,015	85.5	7.0
Steelhead	422	1,535	1,194	1,876	171.1	50.5

The highest daily catch of Chinook Salmon was 125 smolts on May 20. Peak weekly Chinook passage was estimated at 1,049 for the week of May 19. For the season, an estimated 3,300 Chinook Salmon emigrated past the RST. Steelhead emigration peaked during the first week of trap operation, with an estimate of 391 smolts. The peak catch of 39 steelhead smolts occurred on March 28. An estimated 1,535 steelhead emigrated past the RST. During the monitoring period we measured lengths and weights of 1,015 Coho Salmon, 469 steelhead, and 377 Chinook Salmon (Table 4).

Weekly trap efficiency for Coho Salmon smolts varied from 16% to 75% (mean 38%). Trap efficiency for Chinook Salmon ranged from 28% to 60% (mean 47%). Trap efficiency for steelhead ranged from 17% to 38%, with a mean of 35% (Figure 2).

Based on size breaks (Table 4), 94% percent of captured Coho Salmon appeared to be one year old, 6% were young-of-the-year, and two individuals were two years old. During the last two weeks of monitoring, some young-of-the-year coho were similar in size to small age1+ coho smolts. Scale analysis identified an age break between 85 and 90 mm during that period. Steelhead demonstrated clear size breaks between young-of-the-year, age 1+ and age 2+ age classes. The size distinction between age 2+ and older steelhead was indistinct. All Chinook Salmon smolts appeared to be less than one year old.

Non-salmonid fish species included the following native and non-native species, in order of abundance: Southern Coastal Roach, sculpin spp., Bluegill (*Lepomis macrochirus*), crappie (*Pomoxis spp.*), Golden Shiner (*Notemigonus crysoleucas*), Threespine Stickleback, catfish (likely *Ameiurus catus*), Pacific Lamprey (*Entosphnus tridentata*), Goldfish (*Carassius auratus*), and yellowfin goby (*Acanthogobius flavimanus*). Non-fish captures included California Freshwater Shrimp, Signal Crayfish (*Pacifastacus leniusculus*), Red Swamp Crayfish (*Procambarus clarkii*), and Northwestern Pond Turtle (*Actinemys marmorata*).

Table 4. Salmonids Captured in the Lagunitas Creek Rotary Screw Trap by Length and Week, 2025.

Coho Salmon												
Week:	1	2	3	4	5	6	7	8	9	10	11	12
Dates	3/25	4/1	4/8	4/15	4/22	4/29	5/6	5/13	5/20	5/27	6/3	6/10
Dates	3/31	4/7	4/14	4/21	4/28	5/5	5/12	5/19	5/26	6/2	6/9	6/16
Length (mm)	Age 0+											
< 40				1								
40-44												
45-49												
50-54												
55-59												
60-64						1	1	2				
65-69						3	2		1		1	
70-74						1	3					2
75-79						1	1					5
80-84	1			1					1	2	9	12
85-89	1							1	1		5	6
90-94		2		2	2	3		1	1	1	3	14
95-99	4	7	3	4	6	5	8	3	8	5	10	10
100-104	9	7	5	11	12	10	13	16	21	5	8	6
105-109	6	9	11	21	41	31	26	25	18	4	3	3
110-114	8	11	17	32	48	29	27	26	17	1	1	2
115-119	3	5	9	30	39	26	20	16	11	4		1
120-124		4	11	15	14	13	8	10	8	2	3	
125-129	4		4	3	4	2	2	2	2	1		
130-134		4	3	1	2	1	1	3	2		2	1
135-139		4	1	1				1		1		1
140-144						1						
145-149				1								
150-154												
155-159												
160-164					1							
165-169												
170-174												
175-179												
180+												
Totals												
Age 0+	0	0	0	1	0	6	7	2	1	2	15	25
Age 1+	36	53	64	121	168	121	105	104	90	24	30	38
Age 2+	0	0	0	1	1	0	0	0	0	0	0	0

Steelhead												
Week:	1	2	3	4	5	6	7	8	9	10	11	12
Dates	3/25	4/1	4/8	4/15	4/22	4/29	5/6	5/13	5/20	5/27	6/3	6/10
Dates	3/31	4/7	4/14	4/21	4/28	5/5	5/12	5/19	5/26	6/2	6/9	6/16
Length (mm)	Age 0+											
< 40												
40-44												
45-49												
50-54												
55-59									1			
60-64												1
65-69									1			2
70-74												
75-79												
80-84												
85-89		1					1					2
90-94							2					1
95-99					1							
100-104	2		1		1	1						
105-109		1		2	2		1					
110-114			1	1	2	1			3			
115-119		1		3	2	1	2					
120-124			1	1	3	3			1			
125-129	1	2			4	2	2		1	2		
130-134								2	1			
135-139	4	1		1		2						
140-144	3	1		3		1	3	2				
145-149	1	4	4	3	4	4	3		2			
150-154	2	3	5	4	9	5	4					
155-159	6	2	3	6	5	5	2					
160-164	5	3	8	12	11	5	3	1	1			1
165-169	2	5	8	11	15	11	4	2	2			
170-174	5	3	5	11	9	5	1	1				
175-179	5	3	6	12	4		1	1	1			
180-184	7	4	9	5	2	2	1	1				
185-189	3	4	6	8	7	4	1		1			
190-194	3	2	5	1	3	2		1				
195-199	1	1	1	1	3			1				
200-204	1	1			2	1						
205-209	2	1		1	1							
210-214	1		1									
215-219	1				1							
220-224			1									
225-229	2											
230-234												
235-239												
240-244												
245-249	1											
250-254												
255-259												
260-264												
265-269												
270-274												
275-279												
280-284	1											
285-289												
290-294												
295-299												
300+	1	1										
Totals												
Age 0+	0	0	0	0	0	0	0	0	2	0	0	6
Age 1+	3	5	3	7	15	11	7	1	5	2	0	0
Age 2+	57	39	62	79	76	47	23	10	8	0	0	1

Note: Age classifications are based on this year's length histograms as well as historical size distributions. Shaded cells indicate scale age analysis.

Juvenile Coho Salmon Abundance and Overwinter Survival

Juvenile coho salmon tagged in 2024 could be detected in the lower watershed at three locations: the Lower Lagunitas Creek antenna, the Olema Creek antenna, and the rotary screw trap (RST). Detections at these locations and the probability of detecting tags (i.e., detection efficiency) are shown in Table 5. Of the 1,230 juvenile coho tagged, 274 were subsequently detected in the lower watershed (Table 6). We estimated that 72 tagged coho were not detected, and 28% of tagged coho survived to emigrate from Lagunitas Creek. Based on this apparent survival rate, approximately 47,000 juvenile coho were present in the study area in the late summer of 2024.

Table 5. Tagged coho salmon detection efficiency

Coho tagged at RST in 2025	710
Coho recaptured at RST	303
Rotary Screw Trap (RST) efficiency	43%
Coho detected at Lower Lagunitas or Olema Creek antennas	403
Antenna efficiency	57%
Coho detected at RST or antennas	562
Combined detection efficiency	79%

Table 6. Back-calculated juvenile abundance

Juvenile coho tagged in 2024	1,230
Coho detected at RST, Lower Lagunitas or Olema Creek antennas	274
Tag detection rate	22%
Detection efficiency (Table 5)	79%
Apparent coho survival rate (Tag detection rate divided by detection efficiency)	28%
Smolt estimate (Table 3)	13,086
2024 Juvenile Population	47,000

Overwinter survival rates for Lagunitas Creek and Devil's Gulch coho were similar, while San Geronimo Creek coho appeared to survive at a somewhat lower rate (Table 7).

Table 7. Coho Salmon overwinter survival by stream

Tagging Location	Coho Tagged in 2024	Coho Detected in 2025	Detection Rate	Detection Efficiency*	Apparent Survival
Lagunitas Creek	386	102	26%	79%	33%
San Geronimo Creek	419	71	17%	79%	21%
Devil's Gulch	424	101	24%	79%	30%
All	1,230	274	22%	79%	28%

* From Table 5

DISCUSSION

Juvenile Coho Salmon Abundance

The juvenile Coho Salmon abundance estimate for 2024 was the second-highest observed in 30 years of annual monitoring. That abundance was likely the result of an above-average and widely distributed spawning run in 2023-2024, and moderate stream flows with limited redd scour or entombment. The egg-to-juvenile survival estimate was above-average for this same year, at 7.9%.

Our abundance estimate of 41,000 juvenile coho, based on juvenile coho observations at three historic index reaches, was similar to the estimate of 47,000 based on overwinter survival rates of PIT tagged fish. The estimate of 47,000 is somewhat more reliable, given the larger sample size and geographic distribution of fish that went into the PIT tag-based estimate.

Smolt Monitoring Conditions and Emigration Timing

High stream flows prevented the installation of the RST until March 25, and continuing high flows resulted in poor trap efficiency into mid-April (Figure 5). As flows dropped, and despite a full moon on April 12, catches of Coho Salmon smolts increased and remained high through the second half of April. The peak catch of 363 coho smolts occurred on April 30, following the new moon. Steelhead numbers were consistently low from late March through April, with a peak daily catch of 39 on March 28. The first Chinook Salmon smolt was not observed until April 22, which was exceptionally late. Catches of Chinook ramped up through May, reaching a near-record catch of 125 on May 20. Chinook catches remained high going into Memorial Day weekend, prompting us to continue operating the RST through June 12, the latest the trap has been in operation.

Age and Salmonid Migration Status

A clear size break was evident between young-of-the-year (YOY) Coho Salmon and smolts through April and early May, but we began to observe large YOY and small age 1+ coho beginning in late-May (Table 4). Some individual coho as small as 69 mm were classified as smolts based on their appearance, while some as large as 87 mm appeared to be parr. Scale age analysis indicated that coho YOY had grown to at least 84 mm long by early June.

Steelhead displayed clear size breaks between YOY and age 1+, and between age 1+ and 2+ age classes. We did not collect scales from large steelhead and could not determine size breaks between older age classes (Table 4). We defined steelhead smolts as being at least 130 mm in length, which was supported for much of the monitoring period by a clear size break between age 1+ and age 2+ steelhead at that length. Of 469 steelhead measured, 15 could not be classified as either parr or smolts and were classified as “transitionals.”

Smolt Abundance Trends and Implications for Winter Survival

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. The 2025 Coho Salmon emigration from Lagunitas Creek was above average and similar in size to the parent generation three years prior (Figure 3). Estimated overwinter survival was surprisingly low, at 28%. The exceptionally low apparent survival of coho tagged in San Geronimo Creek, at only 21%, was also surprising. Long periods of low stream flows and clear water are thought to increase the vulnerability of juvenile coho to predation based on Marin Water’s past analyses (2012-2022) of flows and overwinter survival estimates. During the 2024-25 winter, high stream flows that occurred from late November through the first half of February should have limited predation on coho for much of the late-fall and winter. The influence of the large flood in February, the seventh-largest in over 50 years, is unknown, although a flood of similar magnitude in 2019 was not associated with poor coho survival.

Juvenile coho abundance increased by 47% between 2021 and 2024 (Figure 2). Smolt abundance, however, may have decreased slightly between 2022 and 2025 (Figure 3). The smolt estimate for

Lagunitas Creek declined by 21% during that period, but that decline was somewhat offset by an increase in smolts from Olema Creek (monitored by NPS).

Chinook Salmon emigrated in above-average numbers in 2025, but egg-to-juvenile survival appeared to be poor, considering the record numbers of Chinook that spawned in Lagunitas Creek in 2024. A record run of Coho Salmon resulted in the superimposition of an estimated 19% of all surveyed Chinook redds, and a February 2025 high flow event of over 6,000 cfs at the Samuel P. Taylor gage may have caused mortality among newly-emerged Chinook fry.

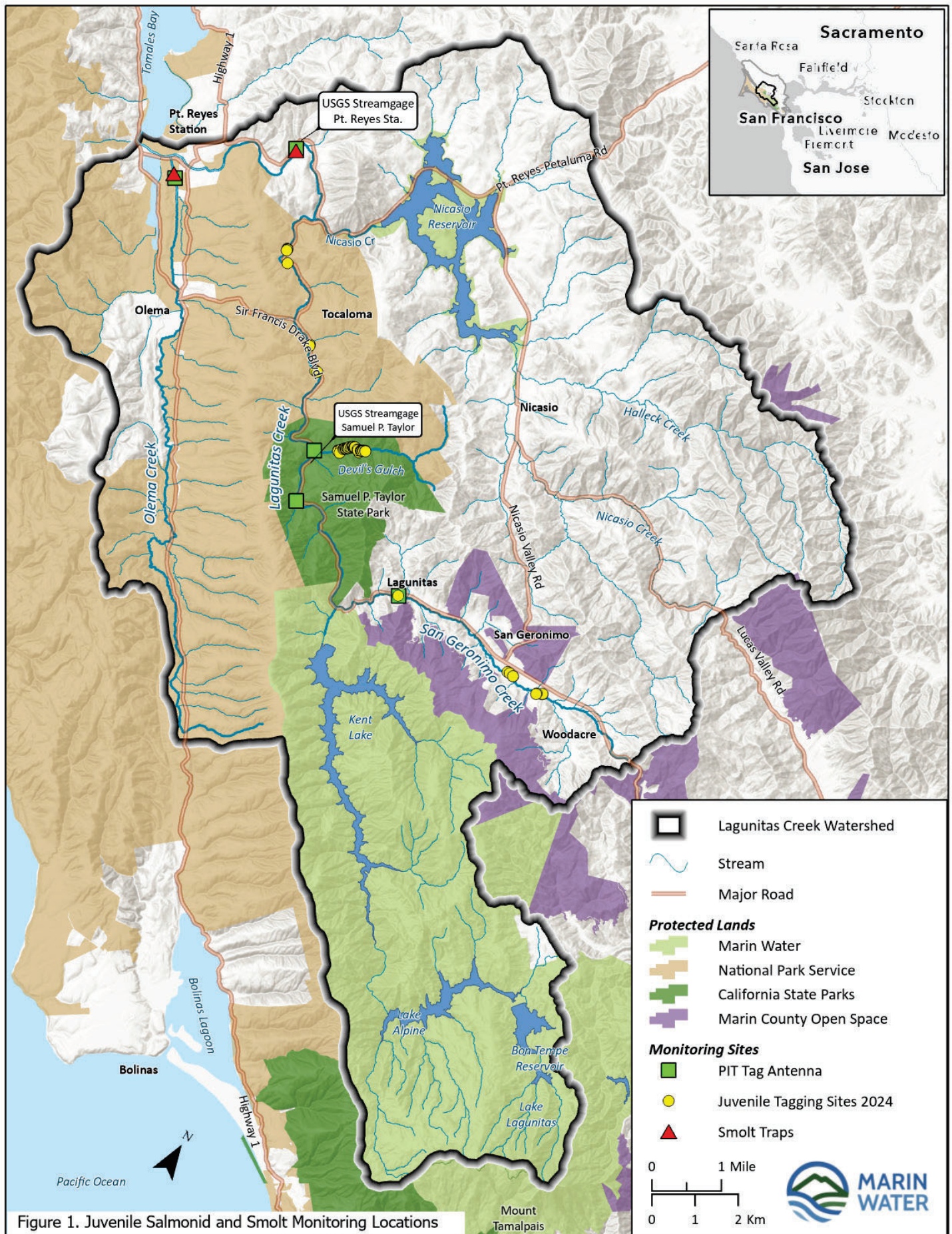
Trends in steelhead are difficult to interpret given their flexible life history strategies and our monitoring methodology. The below-average steelhead outmigration estimate in 2025 excludes fish that migrated prior to trap installation. Of the steelhead tagged in 2024 and subsequently detected in the lower watershed, nearly half were detected prior to trap installation, suggesting that the steelhead emigration was underestimated in 2025. Continued tagging of juvenile steelhead should increase our understanding of their survival and behavior in years to come.

CONCLUSIONS

In 2024 we successfully achieved our tagging target of 1,200 juvenile Coho Salmon and 150 juvenile steelhead. Our preliminary estimate of juvenile coho abundance was consistent with our final estimate, which was back-calculated from estimates of smolt abundance and overwinter survival rates. Marin Water will continue to employ these methods to investigate the factors influencing coho salmon and steelhead populations in the Lagunitas Creek watershed.

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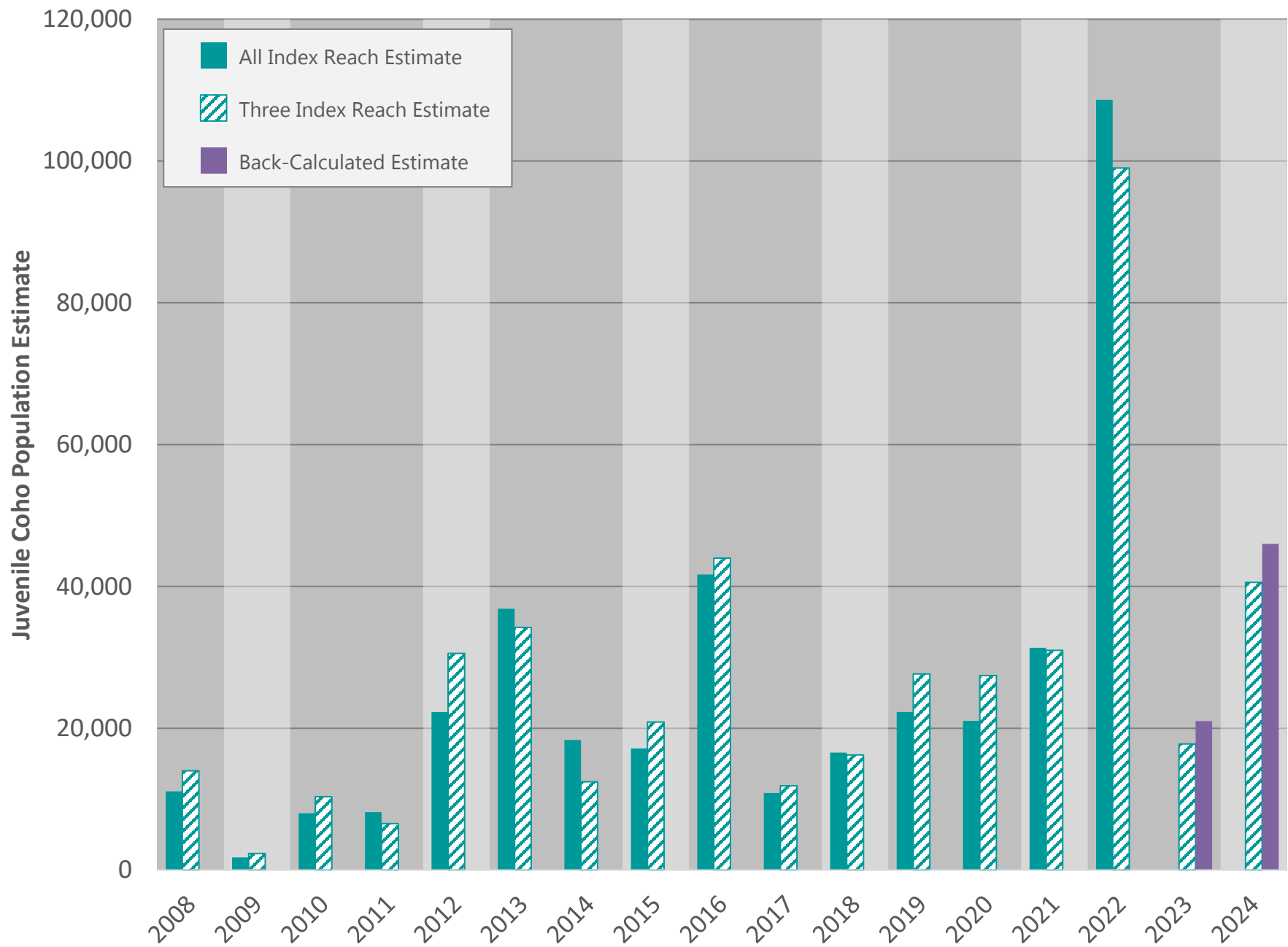


Figure 2. Juvenile coho population estimates

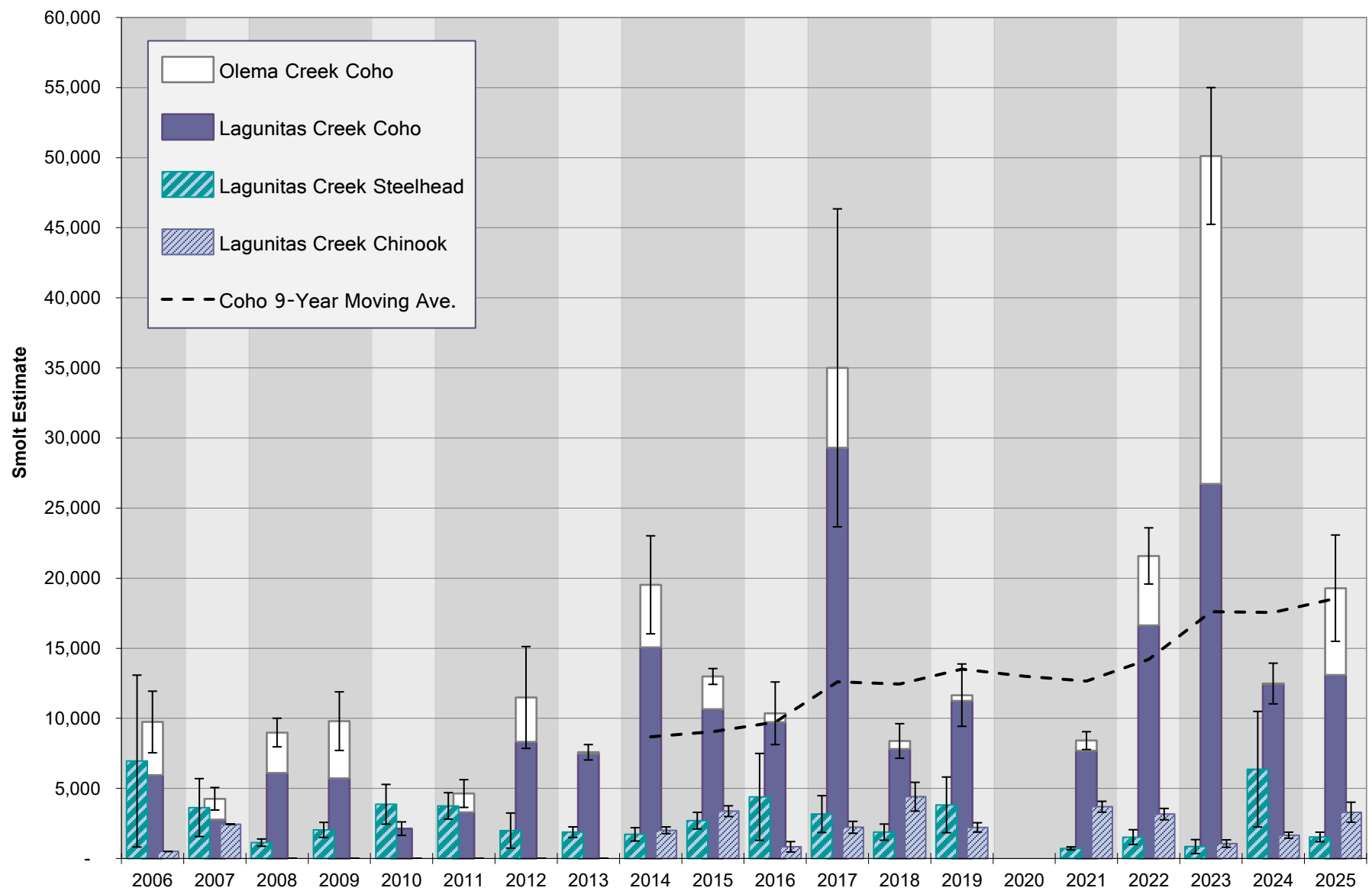


Figure 3. Lagunitas Creek smolt emigration estimates.

Coho year classes are represented by background shading.
(e.g., 2025 smolts are offspring of the 2022 cohort.)

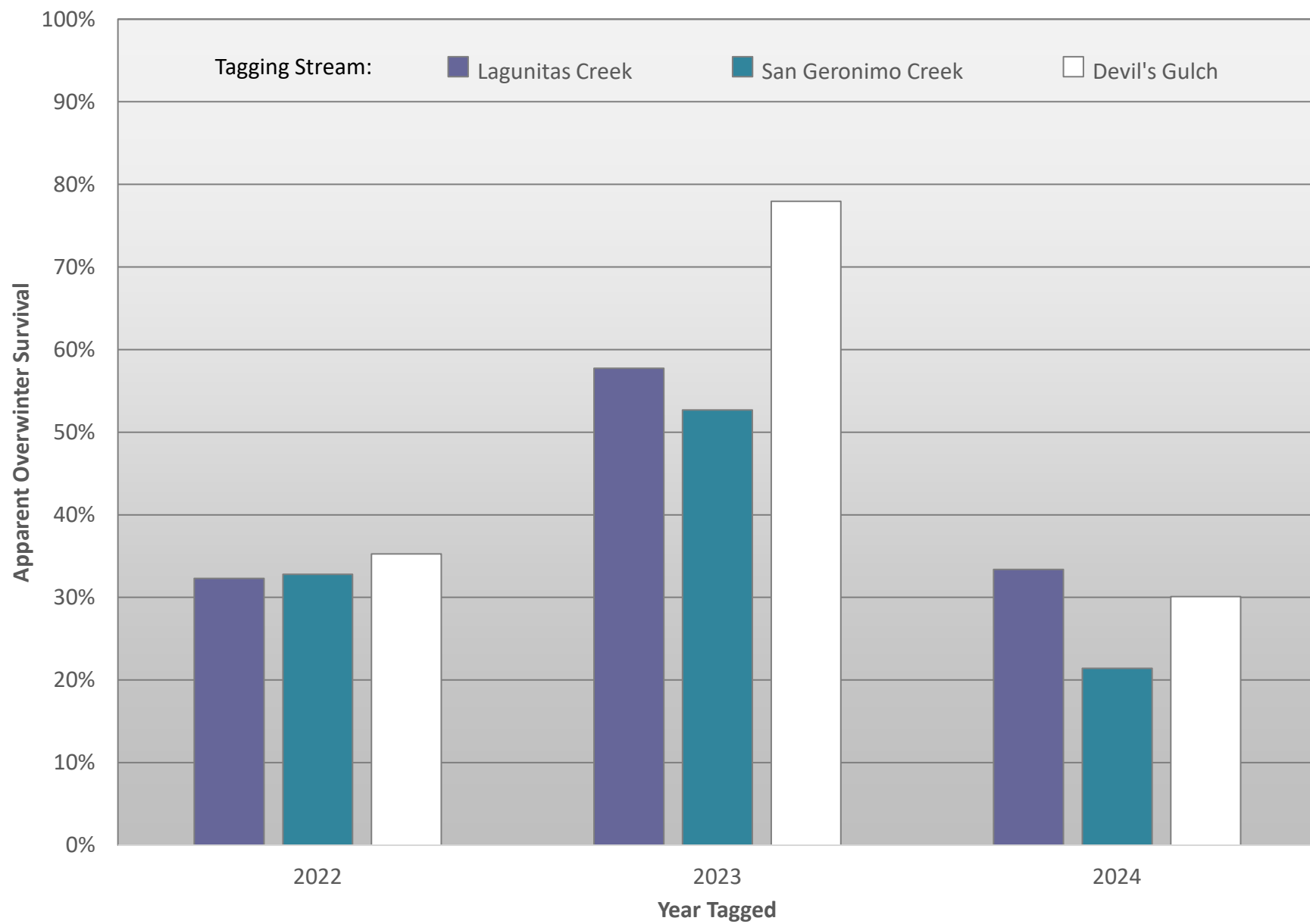


Figure 4. Juvenile Coho Salmon overwinter survival, by stream origin

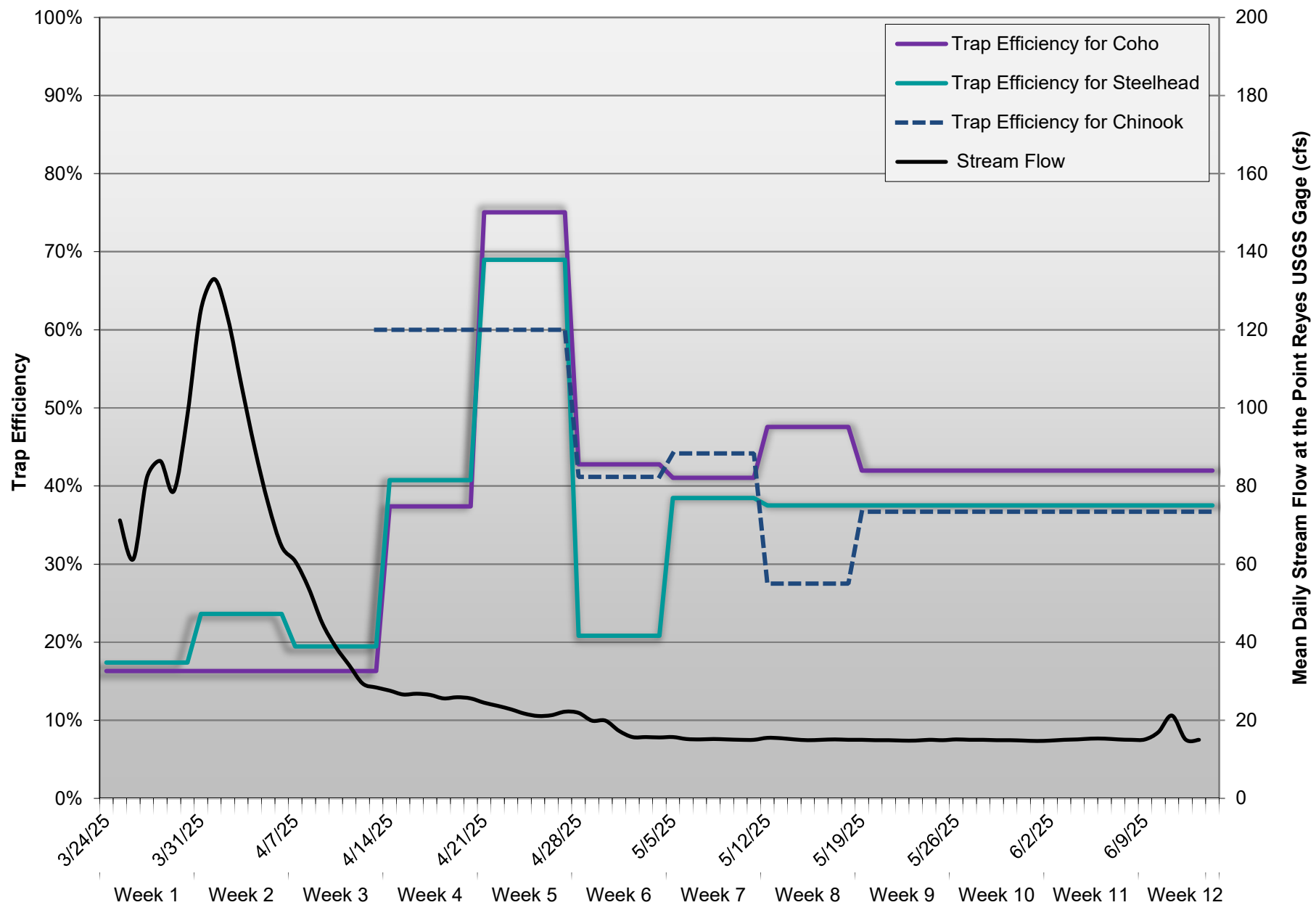


Figure 5. Weekly trap efficiency and Lagunitas Creek stream flow.

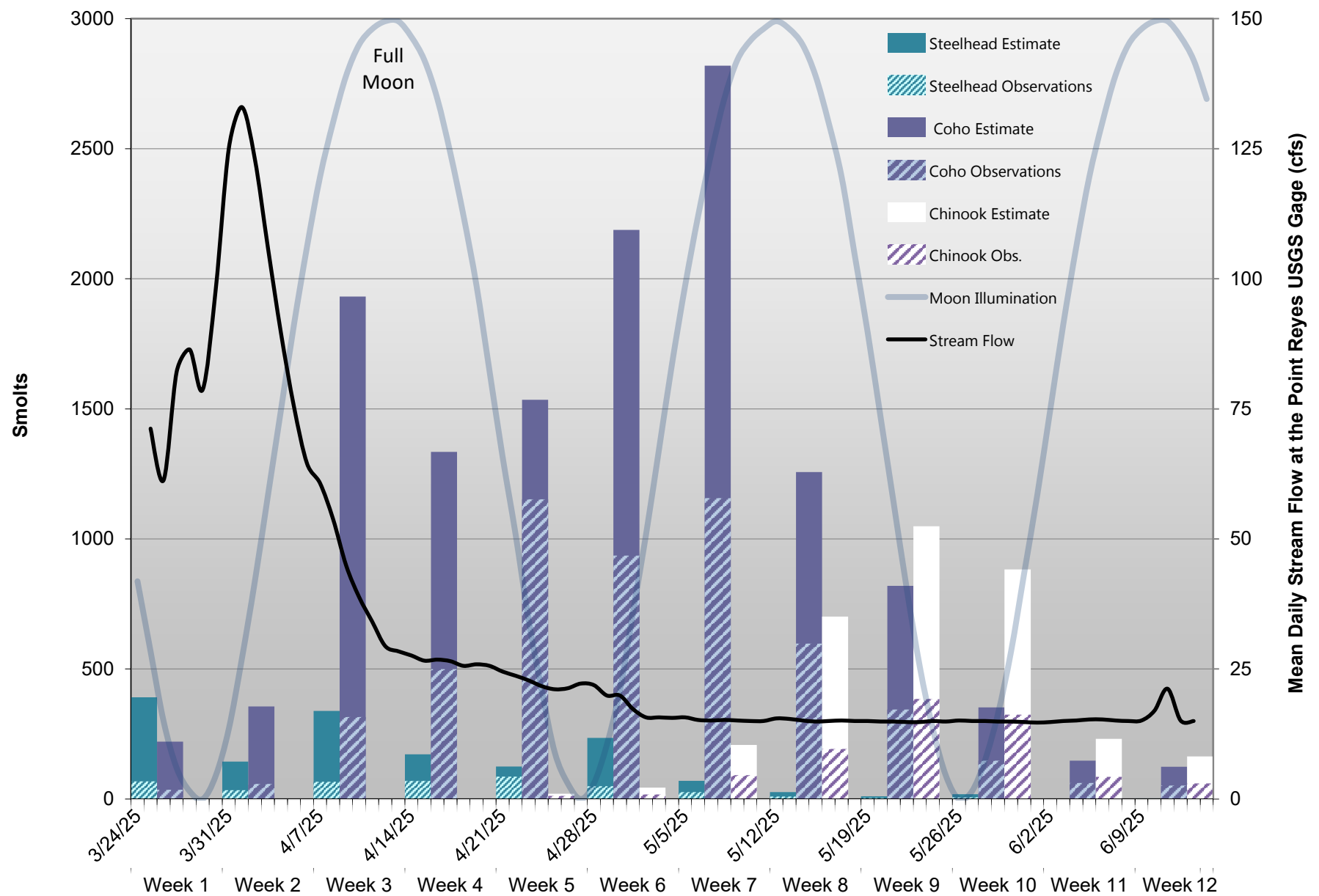


Figure 6. Lagunitas Creek smolt emigration, lunar cycle, and stream flow.