



Lagunitas Creek PIT tag antenna

## Smolt Monitoring in the Lagunitas Creek Watershed - 2020



*Prepared by*  
Eric Ettliger, Aquatic Ecologist  
Jonathan Koehler, Fisheries Program Manager

February, 2021

## **Introduction**

Marin Water has operated a rotary screw trap to capture salmonid smolts (downstream migrants) in lower Lagunitas Creek every spring since 2006. This annual trapping effort is intended to provide two main pieces of information: 1) the estimated number of smolts migrating out of the system (emigration), and 2) an estimate of winter survival for juvenile Coho Salmon and Steelhead from the previous year. Shortly before the start of the season in March of 2020, the Coronavirus Pandemic arrived in California. Marin Water staff determined that we could not install and operate a rotary screw trap and maintain six feet of distance between staff at all times. For the first time since 2005, no smolt trapping was conducted at the lower Lagunitas Creek site.

Two other monitoring efforts continued in spring 2020 that allowed us to produce a relatively coarse estimate of Coho Salmon emigration from the Lagunitas Creek watershed. These included Marin Water's operation of a Passive Integrated Transponder (PIT) antenna in lower Lagunitas Creek, and the Salmon Protection and Watershed Network's (SPAWN) downstream migrant trapping effort in San Geronimo Creek. The National Park Service (NPS) was not able to monitor Olema Creek smolts in 2020.

## **Methods**

### *Available Data*

No smolt data were available for mainstem Lagunitas Creek or Olema Creek in 2020. SPAWN operated a fyke/pipe trap in lower San Geronimo Creek from April 17 to June 4, 2020. The results were analyzed with DARR software to calculate an estimate of Coho smolt emigration. SPAWN provided their catch data and Coho smolt estimate to Marin Water for inclusion in our analysis.

During the previous summer/fall of 2019, a total of 480 Coho Salmon smolts were PIT tagged by Marin Water in Lagunitas Creek, San Geronimo Creek, and Devil's Gulch as part of our annual juvenile abundance surveys. Two types of tags were used, as Marin Water was in the middle of a transition from half duplex (HDX) to full duplex (FDX) tags. Marin Water's PIT antenna was replaced in fall of 2020. The old antenna, which was operational during the 2020 smolt outmigration period, was only capable of detecting HDX tags, so it could not detect any of the 296 Coho Salmon smolts implanted with FDX tags during the summer/fall of 2019. FDX tags are normally detected during smolt trapping by using handheld scanners on captured smolts. Subsequent analysis of winter survival and emigration estimates therefore relied on detections of the relatively small pool of just 185 Coho Salmon implanted with HDX pit tags. A breakdown of where these fish were originally tagged in 2019 is provided in Table 1.

No Steelhead or Chinook Salmon were PIT tagged in 2019, so no estimates of smolt abundance were possible for either of these species in 2020.

*Analysis*

Coho Salmon smolt estimates were generated separately for three streams: San Geronimo Creek, Lagunitas Creek, and Devil’s Gulch. First, we used PIT tag detection data to estimate the percentage of Coho smolts that migrated out of San Geronimo Creek early in the spring, and were therefore missed by SPAWN’s trapping effort beginning on April 17, 2020. This percentage was calculated by dividing the number of smolts detected by the PIT tag antenna prior to April 17 (n=4) by the total number of smolts detected all season (N=44). We then multiplied SPAWN’s smolt estimate by this percentage to get an expanded estimate of the total number of smolts, including early migrants, from San Geronimo Creek.

Next, we compared the expanded 2020 San Geronimo smolt estimate to the juvenile estimate (N=9,812) from our surveys in summer/fall 2019 (Marin Water 2020). The smolt estimate was divided by the juvenile estimate to generate a juvenile-to-smolt survival (i.e. winter survival) rate (Table 2). This estimated winter survival rate, when applied to the 41 juvenile salmon tagged from San Geronimo Creek, provided an expected number of detections at the PIT antenna, and an antenna efficiency rate based on actual detections. This antenna efficiency estimate allowed us to further estimate the total number of tagged fish we think actually passed the antenna in 2020 (i.e. estimated tag passage). Detections of tagged fish from Lagunitas Creek and Devil’s Gulch were expanded using the antenna efficiency estimate as well, which allowed us to estimate survival rates for fish from these streams. The final step was to generate total Coho smolt estimates for each stream by applying these survival rates to juvenile salmon estimates from 2019.

**Results**

San Geronimo Creek Coho smolt estimate from SPAWN: ..... 4,680  
 Tagged smolts detected prior to SPAWN’s trap installation: 4 out of 44 detections..... 9.1%  
 San Geronimo Creek Coho smolt estimate, including early migrants:  $4,680 * 1.091$  ..... 5,106  
 Estimated survival in San Geronimo Creek:  $5,106 \text{ smolts} / 9,812 \text{ juveniles}$ ..... 52%  
 Estimated surviving tagged San Geronimo Creek salmon =  $41 \text{ tagged} * 0.52$  ..... 21  
 Estimated PIT antenna efficiency =  $15 \text{ detections} / 21 \text{ expected}$ ..... 71%

**Table 1.** Coho Salmon smolt estimates, PIT tag detections, and winter survival estimates.

	Lagunitas Creek	San Geronimo Cr.	Devil's Gulch	Total
Juvenile Estimates (2019)	9,427	9,812	3,063	22,302
Coho Salmon Tagged (HDX)	105	41	38	184
Tags Detected	19	15	10	44
Antenna Efficiency	71%	71%	71%	-
Estimated Tag Passage	27	21	14	62
Winter Survival (juv-smolt)	26%	52%	37%	Avg. = 39%
Coho Smolt Estimate	2,424	5,106	1,128	8,658

**Table 2.** Coho Salmon winter survival estimates 2012-2020.

Year	Juvenile Estimates			Smolt Estimate	Total Survival	Survival of Tagged Fish		
	Lagunitas Creek	San Geronimo	Devil's Gulch			Lagunitas Creek	San Geronimo	Devil's Gulch
2012-13	11,228	5,832	5,235	7,479	34%	40%	28%	27%
2013-14	23,096	6,678	7,070	15,418	42%	41%	30%	55%
2014-15	18,188	22	123	10,643	58%	58%	N/A	51%
2015-16	8,607	6,715	1,841	9,719	57%	43%	78%	43%
2016-17	23,980	11,959	5,748	29,306	70%	82%	61%	42%
2017-18	2,455	5,243	3,179	7,812	72%	39%	81%	83%
2018-19	11,217	1,089	4,262	11,246	68%	63%	71%	79%
2019-20	9,427	9,812	3,063	8,658	39%	26%	52%	37%

## Discussion

The 2020 Coho Salmon smolt emigration estimates in this report rely on many assumptions and potentially incorporate multiple sources of error. Some of these could significantly bias the smolt estimate. All estimates included in this report should be interpreted as approximate values, based on limited data. We felt that there was value in calculating and reporting these estimates to maintain continuity in our long-term datasets; however, these estimates do not meet our normal standards for statistical rigor, and their use and citation in future studies should reflect these limitations.

Smolt monitoring is critical for understanding the relationships between habitat conditions, water management, and winter survival of Coho Salmon. As 2020 has shown, multiple monitoring efforts provide important redundancy when efforts are hindered by technology, weather, or a pandemic. Marin Water installed a new PIT antenna in late 2020, which we hope will improve the accuracy of our future Coho Salmon smolt estimates, and ultimately lead to management actions to improve Coho Salmon survival.

### *San Geronimo Creek Coho Smolts*

SPAWN's smolt estimate was based on seven weeks of trapping, with 52-67% of marked smolts being recaptured each week. This resulted in a relatively small standard error of 146 (three percent of the estimate). In addition, daily captures started slowly and peaked after eight days, suggesting that the trapping period successfully captured most of the spring outmigration. It is possible, however, that some Coho Salmon smolts may have migrated earlier in the spring, or perhaps even during the winter.

### *San Geronimo Creek Juvenile Coho Salmon*

Our estimate of juvenile Coho Salmon in San Geronimo Creek was based on electrofishing just over four percent of the stream, including some habitats that were of unusually high quality. An overestimation of

the juvenile estimate could have resulted in underestimating Coho Salmon survival, which may partially explain the unusually low juvenile-to-smolt survival observed.

#### *PIT Antenna Efficiency*

The detection of only 44 PIT tags, out of 184 Coho Salmon tagged, was the result of either poor survival, poor antenna efficiency, or a combination of the two. Our old HDX antenna used in spring 2020 had a long history of technical difficulties and poor detection efficiency. In 2020, wing walls made of hardware cloth were installed to funnel fish into a portion of the antenna that detected nearly all tags passing through it. Consistently low stream flows in spring 2020 likely further improved that efficiency. It is therefore unlikely that the antenna failed to detect enough tags moving past to greatly underestimate Coho Salmon survival rates.

#### *Winter Survival*

Survival of Coho Salmon between the summer of 2019 and smolt emigration in 2020 varied greatly between the three streams where fish were tagged. Survival of Lagunitas Creek Coho Salmon was the lowest on record and much lower than survival of Coho Salmon in San Geronimo Creek (Table 2). However, it is important to remember the assumptions and limited data that went into generating these estimates, so further study would be needed in similar water-year types to corroborate these results.

### **Conclusions**

1. Based on PIT tag detections and SPAWN's monitoring results, we estimate that 8,658 Coho Salmon smolts emigrated from Lagunitas Creek, San Geronimo Creek, and Devil's Gulch in 2020.
2. The average winter survival rate for Coho Salmon in Lagunitas Creek, San Geronimo Creek, and Devil's Gulch was 39%, which was significantly lower than average and the lowest survival since 2013.
3. All calculations and estimates provided in this report were based on limited and indirect data and should be interpreted as approximate values.

### **References**

Marin Water. 2020. Juvenile Salmonid Monitoring in the Lagunitas Creek Watershed – 2019. Prepared by Marin Municipal Water District.