ADULT SALMONID MONITORING

IN THE LAGUNITAS CREEK WATERSHED 2020-2021

Eric Ettlinger, Aquatic Ecologist, Marin Municipal Water District
Annabelle Howe, Watershed Stewards Program Member
Jaclyn Sherman, Watershed Stewards Program Member

In collaboration with the National Park Service, Point Reyes National Seashore and the Salmon Protection and Watershed Network (SPAWN)

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MARIN WATER

NATIONAL PARK SERVICE

SPAWN

Contact Information:

Address: Marin Water, 220 Nellen Avenue, Corte Madera, CA 94925
Phone: (415) 945-1193
Email: eettlinger@marinwater.org

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Cover photo: Steelhead Trout in Lagunitas Creek (Sherry Lavars, Marin IJ)

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EXECUTIVE SUMMARY

Adult salmonid surveys were conducted by staff and volunteers of Marin Water, the Watershed Stewards Program (WSP), National Park Service (NPS), Salmon Protection and Watershed Network (SPAWN), and the California Department of Fish and Wildlife (CDFW). Surveys were conducted on the main stem of Lagunitas Creek and four tributaries: San Geronimo Creek, Devil's Gulch, Cheda Creek, and Olema Creek. These annual surveys are intended to document the spawning run of Coho Salmon (*Oncorhynchus kisutch*), while also collecting data on steelhead (*O. mykiss*), Chinook or "king" Salmon (*O. tshawytscha*), Chum Salmon (*O. keta*), and Pink Salmon (*O. gorbuscha*). The first survey of the season was conducted by Marin Water on October 6, 2020 and surveys ended on March 22, 2021.

This year, 173 Coho Salmon redds and 343 live Coho Salmon were observed in the Lagunitas Creek Watershed. The official coho escapement estimate was 346, based on a conservative assumption of two spawners per redd. The run was 73% of the average observed since 1997 and an increase of 57% over the spawning run three years earlier. Coho spawning was distributed as follows: 83% in Lagunitas Creek, 8% in San Geronimo Creek and its tributaries, 7% in Olema Creek, and 2% in Devil's Gulch.

The steelhead run was somewhat below the ten-year average with 145 redds and 49 live fish observed. The steelhead escapement was 290 adults, based on an assumption of two spawners per redd. Marin Water and WSP surveyors in Lagunitas Creek observed 44 live Chinook Salmon and 19 Chinook Salmon redds. This season, no live Pink Salmon or Chum Salmon were sighted, and surveyors saw no evidence of redds for either species.

INTRODUCTION

Salmonids of the Lagunitas Creek Watershed

Two species of salmonids are found in the Lagunitas Creek Watershed year-round: Coho Salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*). Adult Chinook or "king" Salmon (*O. tshawytscha*) are observed spawning in most years, while Chum Salmon (*O. keta*) are observed in a minority of years. In 2017 Pink Salmon (*O. gorbuscha*) became the fifth salmonid species to be documented in Lagunitas Creek.

Coho Salmon and steelhead populations in the watershed have fluctuated widely since 1970 and are significantly reduced from anecdotal reports of large historic populations. Throughout California, populations of native fish species, including coho 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 2012). 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 listed as federally “threatened.” Coho Salmon and steelhead are anadromous fishes, rearing at least partially in freshwater, migrating to the ocean as smolts, spending their adult life in the ocean, and then migrating back into freshwater streams to spawn. Most Coho Salmon from California streams 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, after which they die (Shapalov and Taft 1954, Moyle 2002). They can be grouped into three-year classes, defined as the current generation of spawners, the parent generation that spawned three years earlier, as well as previous generations. Spawning years with relatively poor reproductive success can result in poor spawning runs three years later. While the majority of coho return as three-year-old fish, some males, called jacks, spend less than a year in the ocean before becoming sexually mature and returning to their natal stream to spawn at two years of age (Sandercock 1991). Spawning coho begin to arrive near the mouth of Lagunitas Creek in early fall to begin acclimation to freshwater before migrating upstream (Bratovich and Kelley 1988). The spawning period is generally from mid-November to late-January, but adult coho have been observed from late-October to late-February. The life history of steelhead is more flexible than that of Coho Salmon. Steelhead generally spend one to three years in freshwater and one or two years in the ocean before returning to spawn, although the most common life history pattern is to spend two years in fresh water and one year in the ocean (Shapalov and Taft 1954). Unlike coho, steelhead can return to the ocean after spawning and spawn multiple times. This flexibility means that steelhead do not show strong year class patterns in their spawning runs. Steelhead are generally first observed in Lagunitas Creek in late December or early January and continue spawning through April or even into May. Coho Salmon and steelhead usually spawn at the heads of riffles with gravel substrate (Moyle 2002). Females may excavate small test pits in the gravel substrate before deciding on a site to lay their eggs. Once decided, the female will dig a larger pit (called a “redd”) where she deposits her eggs. Often more than one adult male will fertilize the eggs by releasing milt before the female covers the eggs with additional gravel (Moyle 2002). Following spawning, female coho may guard the redd for up to four weeks before dying, while steelhead attempt to return to the ocean.

Location and Organizations

Lagunitas Creek originates on the north slope of Mount Tamalpais and flows in a northwesterly direction for 40 km to Tomales Bay (Figure 1). The lower 19 km is accessible to anadromous salmonids. San Geronimo Creek, Devil’s Gulch, Nicasio Creek, and Olema Creek are the major tributaries to Lagunitas Creek. Devil’s Gulch, which flows through National Park and State Park land before entering Lagunitas Creek, is the smallest of these tributaries but provides important spawning and rearing habitat for Coho Salmon and steelhead. Other tributaries to Lagunitas

Creek include Cheda Creek, which supports Coho Salmon spawning, and McIsaac Creek, where Coho Salmon have not been seen in many years. The tributaries to San Geronimo Creek that provide spawning habitat include Arroyo, Evans, Larsen, Montezuma and Woodacre Creeks. Fifty-two percent of the land within the Lagunitas Creek watershed is publicly owned by Marin Water, the National Park Service, California Department of Parks and Recreation, and Marin County Parks.

Marin Water is a public agency that withdraws water from the Lagunitas Creek basin in order to provide water to residents of central and southern Marin County. Marin Water operates four reservoirs on the mainstem of Lagunitas Creek and a fifth reservoir on Nicasio Creek. Water is released from Kent Lake to ensure year-round minimum stream flows in Lagunitas Creek (Table 1). In addition, Marin Water releases periodic "upstream migration flows," which are intended to facilitate passage of anadromous fish through shallow areas in the creek, and are required on November 15, December 1, January 1, and February 1 in the absence of a natural storm event preceding those dates.

Table 1. Flow requirements on Lagunitas Creek at S.P. Taylor State Park.

Time Period	Normal Year Flow (cfs)	Dry Year Flow (cfs)
November 1/15* - December 31	20	20
January 1 - March 15	25	20
March 16 - March 31	20	20
April 1 - April 30	16	14
May 1 - June 15	12	10
June 16 - November 1/15*	8	6

* The minimum flow of 20 cubic feet per second (cfs) in November is to begin following the first storm that produces a "trigger" flow of 25 cfs at the USGS gage at S.P. Taylor State Park. In the absence of a storm causing a "trigger" flow, the 20-cfs requirement becomes effective on November 15 of each year.

Marin Water fisheries staff conduct surveys on Lagunitas Creek, San Geronimo Creek, and Devil's Gulch. Surveys on Olema Creek and Cheda Creek are conducted by NPS staff working for Point Reyes National Seashore and the Inventory and Monitoring Program. AmeriCorps members working for The Watershed Stewards Program (WSP) assist NPS and Marin Water staff with their survey work. SPAWN staff and volunteers conduct spawner surveys in five tributaries to San Geronimo Creek, as well as the headwater section of San Geronimo Creek upstream of Woodacre Creek.

METHODS

Marin Water fisheries staff and WSP members walked sections of creek once per week between October 6, 2020 and March 22, 2021. Lagunitas Creek was divided into four sections for weekly surveys (Figure 1): Tocaloma Bridge to Swimming Hole (3.4 km), Swimming Hole to Irving Bridge (3.2 km), Irving Bridge to Shafter Bridge (2.2 km), and Shafter Bridge to Peters Dam (0.8 km). The section of Lagunitas Creek from Tocaloma Bridge downstream to the confluence of Nicasio Creek was surveyed once. In Devil's Gulch, Marin Water biologists surveyed from the mouth to a bedrock cascade approximately three km upstream, which is impassable to coho. We also surveyed a 400 m fork of Devil's Gulch near the upstream end of our survey reach. San Geronimo Creek was walked in two sections: from its confluence with Lagunitas Creek to Meadow Way Bridge (3.8 km) and from Meadow Way Bridge to the confluence of Woodacre Creek (3.4 km). Each stream section was surveyed from the downstream end to the upstream end, apart from the section of Lagunitas Creek downstream of Tocaloma, which was surveyed in a downstream direction using float tubes for the deep sections.

Surveyors recorded observations of redds, live adult salmonids, salmonid carcasses, and test (i.e. incomplete) redds. Live fish were recorded as male, female, jack, or unknown. Their behavior, condition (color, wear marks, pronounced kype, etc.), and their location in relation to landmarks such as tributaries or bridges were noted. All observed spawning activity was also recorded. Marin Water surveyors collected otoliths from carcasses for subsequent life history analyses and tissue samples for genetic analyses by UC Berkeley and the National Marine Fisheries Service (NMFS), respectively. We attempted to determine if female salmonids had spawned by inspecting for retained eggs. Other information recorded during each survey included survey start and stop times, weather conditions, and qualitative observations of stream flow, and water clarity. We intended to collect heads from hatchery origin Chinook salmon, in order to retrieve coded-wire tags, although no carcasses with clipped adipose fins were found.

Redds were classified as having been constructed by one of the salmonid species or recorded as "unknown." Redds were considered to have been conclusively built by one of these species when an identified fish was observed on the redd, or when only one species was present in the creek (e.g., steelhead after January). When fish were not present, redds were classified based on their dimensions, shape, depth, substrate, location, and relative abundance of salmonid species at the time of the survey. When coho were present in the creek, large redds with wide and shallow pits were classified as coho redds. Smaller redds with deep pits and sharp margins were generally classified as steelhead redds after the first live steelhead were observed. Unoccupied redds observed at a time when multiple salmonid species were in the creek and

not displaying clearly diagnostic characteristics were classified as “unknown.” Redd classification was evaluated at the end of the season by reviewing field notes for unoccupied redds and by comparing redd dimensions of occupied and unoccupied redds.

Marin Water surveyors assigned a unique number to each redd and marked its location in the field by hanging colored tape (red this year) on adjacent vegetation. Redds were marked this way so no redd would be double counted during subsequent surveys and so any additional redds near that site could be distinguished. Flagging was labeled with the date, the redd number, redd dimensions, and the position of the redd with respect to the channel (i.e. mid-channel, left- or right-bank, etc.). The flag was hung in line with the upstream end of the redd pit, so further enlargement of the redd would be conspicuous during subsequent surveys. If it was determined that a female made a small “test” pit and not a redd, the site was recorded as a “test redd” and flagged with yellow flagging. We also mapped each redd with a hand-held GPS. We measured the maximum length and width of all redds unless fish were actively constructing the redd or displaying spawning behavior. To avoid disturbing fish we hung yellow flagging, in addition to the colored flagging, next to occupied redds as a reminder to measure the redd later when no fish were present. We attempted to identify when redds appeared to have been built on or overlapping older redds. High levels of such “superimposition” can indicate a shortage of adequate spawning habitat. Superimposition can kill eggs deposited in the first redd through physical shock, exposure, displacement into less favorable incubation conditions, or predation (Burgner 1991).

We had no way of positively determining if we were recounting the same fish during subsequent surveys or missing fish during the intervals between surveys. Most surveys on each section were conducted between five and eight days apart. In addition, an attempt was made to quantify double-counted fish after the survey season had ended. Observations of fish on redds over multiple surveys were subtracted from the total, as were schools of fish observed holding in the same pool over multiple surveys. Even with these efforts, we acknowledge that some fish were almost certainly counted multiple times. For this reason, adult escapement was estimated based on a conservative assumption of two spawners per redd. The marine survival rate for Coho Salmon was calculated as the escapement estimate divided by the previous year’s coho smolt emigration estimate (e.g., 2020-21 escapement / 2019 smolt emigration).

RESULTS

A total of 173 Coho Salmon redds and 343 live Coho Salmon were observed during spawner surveys in the Lagunitas Creek Watershed (Table 2). The redd count was 27% below average, but 57% higher than the count three years ago (Figure 2). The minimum escapement was 346, based on the assumption of two spawners per redd. Approximately 83% of coho spawning this

year occurred in mainstem Lagunitas Creek, 8% occurred in San Geronimo Creek, 7% in Olema Creek, and 2% in Devil's Gulch. No spawning was documented in Cheda Creek.

Steelhead redds were 16% below the ten-year average (Figure 3). A total of 145 steelhead redds were observed, equivalent to an escapement of 290 steelhead, while 49 live steelhead were observed by surveyors. Of the steelhead redds observed, 54% were in Lagunitas Creek, 26% in Olema Creek, 17% in the San Geronimo Creek watershed, and 3% in Devil's Gulch.

Chinook Salmon were also documented in Lagunitas Creek this season. Surveyors documented 44 live Chinook Salmon and 19 Chinook Salmon redds (Table 4). Marin Water surveyors could not determine the origin of 13 redds (5% of Marin Water redds).

Marin Water surveyors found eight Coho Salmon carcasses and two steelhead carcasses. Operculum samples were harvested from six of the Coho Salmon carcasses and otolith samples were harvested from five carcasses.

DISCUSSION

The 2020-21 Coho Salmon spawning run was below average but an improvement in the year class. In 2019, an estimated 11,653 Coho Salmon smolts emigrated from the Lagunitas Creek watershed, which was the third highest estimate on record. Apparent marine survival was below average, with only 3% of smolts returning to spawn.

Redds this year exhibited a high rate of superimposition. Of the 158 Coho Salmon redds observed by Marin Water surveyors, 27 (22%) showed some level of superimposition by later redds. This tends to occur when stream flows remain stable for extended periods and suitable spawning conditions are limited. The 2020-2021 season was the second year in a row when spawning was concentrated in the mainstem of Lagunitas Creek due to significantly lower than average rainfall. There were very few rain events that raised flows enough to allow adults to migrate into tributaries, and redd counts in the smaller tributaries were among the lowest on record (Table 7). On a positive note, this year's unusually dry winter likely resulted in high egg-to-fry survival rates and will hopefully result in a large juvenile coho population.

Counts of steelhead redds and live steelhead were also slightly below average. It is possible that some adult steelhead did not return to spawn this year due to low winter and spring stream flows. Surveys were halted on March 22, 2021 when Marin Water staff began smolt trapping for the 2021 season, and it is possible that significant steelhead spawning occurred after this date.

A moderate number of Chinook Salmon were sighted between the third week of November and the first week of January. No Pink or Chum Salmon were observed in Lagunitas Creek (Figure 5), and none of the 13 unoccupied redds in Lagunitas Creek bore distinctive signs of either species (i.e., size, location, or appearance).

Of the 382 redds observed, 173 were never associated with a live fish. Smaller redds that were observed at the end of the season could be attributed to steelhead. All other unoccupied redds were classified by their measurements, appearance, and time of year. Steelhead redds tend to be narrower than the redds of other species, and 87 redds were classified as being built by steelhead based on being less than two meters wide. Coho Salmon redds tend to have sprawling, shallow pits and are often described as looking “sloppy.” Appearance and relative abundance of spawners were used to classify 64 unoccupied redds as being built by Coho Salmon. Chinook Salmon redds are often wide and deep, although smaller individuals build smaller redds. Nine redds were classified as being built by Chinook Salmon based on width and qualitative observations of depth. Of the remaining unoccupied redds, 13 lacked diagnostic features and were left unclassified.

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Table 2. Observations of Coho Salmon in the Lagunitas Creek Watershed, Spawning Season 2020-21

SURVEY DATE	COHO SALMON IN LAGUNITAS CREEK															TOTAL		
	Nicasio Creek-Tocaloma			Tocaloma-Swimming Hole			Swimming Hole-Irving			Irving-Shafter Bridge			Shafter Bridge-Peters Dam					
	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds
6-Oct-20	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
23-Oct-20	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
6-Nov-20	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
12-Nov-21	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
20-Nov-20	-	-	-	-	-	-	0	0	0	-	-	-	-	-	-	0	0	0
24-Nov-20	-	-	-	-	-	-	-	-	-	1	0	0	0	0	0	1	0	0
1-Dec-20	-	-	-	0	0	2	-	-	-	-	-	-	-	-	-	0	0	2
9-Dec-20	-	-	-	0	0	1	-	-	-	-	-	-	-	-	-	0	0	1
14-Dec-20	-	-	-	17	0	6	-	-	-	-	-	-	-	-	-	17	0	6
15-Dec-20	-	-	-	-	-	-	29	0	8	-	-	-	-	-	-	29	0	8
21-Dec-20	-	-	-	-	-	-	-	-	-	23	2	14	13	0	8	36	2	22
22-Dec-20	-	-	-	14	0	16	-	-	-	-	-	-	-	-	-	14	0	16
23-Dec-20	-	-	-	-	-	-	40	0	15	-	-	-	-	-	-	40	0	15
29-Dec-20	-	-	-	-	-	-	19	0	3	8	1	3	7	0	3	34	1	9
5-Jan-21	-	-	-	31	0	12	24	1	4	-	-	-	-	-	-	55	1	16
7-Jan-21	-	-	-	-	-	-	-	-	-	31	0	11	14	0	6	45	0	17
13-Jan-21	-	-	-	35	1	6	-	-	-	-	-	-	-	-	-	35	1	6
14-Jan-21	-	-	-	-	-	-	24	1	8	-	-	-	-	-	-	24	1	8
15-Jan-21	-	-	-	-	-	-	-	-	-	1	0	5	1	0	0	2	0	5
20-Jan-21	-	-	-	15	1	4	-	-	-	-	-	-	-	-	-	15	1	4
21-Jan-21	-	-	-	-	-	-	-	-	-	3	0	1	0	0	0	3	0	1
22-Jan-21	-	-	-	-	-	-	4	0	1	-	-	-	-	-	-	4	0	1
26-Jan-21	-	-	-	12	0	2	3	0	2	0	0	0	0	0	0	15	0	4
5-Feb-21	-	-	-	-	-	-	-	-	-	1	0	2	0	0	0	1	0	2
10-Feb-21	-	-	-	-	-	-	0	0	1	-	-	-	-	-	-	0	0	1
11-Feb-21	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
17-Feb-21	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
18-Feb-21	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0
24-Feb-21	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
25-Feb-21	-	-	-	-	-	-	0	0	0	-	-	-	-	-	-	0	0	0
26-Feb-21	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
3-Mar-21	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
4-Mar-21	-	-	-	-	-	-	0	0	0	-	-	-	-	-	-	0	0	0
11-Mar-21	-	-	-	0	0	0	0	0	0	-	-	-	-	-	-	0	0	0
12-Mar-21	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
17-Mar-21	-	-	-	0	0	0	0	0	0	-	-	-	-	-	-	0	0	0
22-Mar-21	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
SUBTOTAL	**0**	**0**	**0**	**124**	**2**	**49**	**143**	**2**	**42**	**68**	**3**	**36**	**35**	**0**	**17**	**370**	**7**	**144**
Corrected*	**0**			**109**			**138**			**54**			**33**			**334**		

SURVEY DATE	COHO SALMON IN SAN GERONIMO CREEK									COHO SALMON IN DEVIL'S GULCH			COHO SALMON IN OLEMA CREEK[2]			TOTAL		
	Mouth-Meadow Way			Meadow Way-Woodacre Cr.			Tributaries[1]											
	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds	Live Coho	Carcasses	Redds
5-Jan-21	-	-	-	2	0	7	-	-	-	-	-	-	-	-	-	2	0	7
10-Jan-21	-	-	-	-	-	-	-	-	-	-	-	-	1	2	5	1	2	5
12-Jan-21	0	1	3	-	-	-	-	-	-	-	-	-	-	-	-	0	1	3
24-Jan-21	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	0	0	1
31-Jan-21	-	-	-	-	-	-	-	-	-	-	-	-	6	5	6	6	5	6
3-Feb-21	-	-	-	-	-	-	0	0	1	-	-	-	-	-	-	0	0	1
4-Feb-21	-	-	-	-	-	-	-	-	-	0	0	3	-	-	-	0	0	3
11-Feb-21	0	0	1	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1
13-Feb-21	-	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	1	0
16-Feb-21	-	-	-	-	-	-	0	0	2	-	-	-	-	-	-	0	0	2
SUBTOTAL	**0**	**1**	**4**	**2**	**0**	**7**	**0**	**0**	**3**	**0**	**0**	**3**	**7**	**8**	**12**	**9**	**9**	**29**
Corrected*	**0**			**2**			**0**			**0**			**7**			**9**		

Notes:

(-) Indicates that the spawner survey did not cover the area on that date.

* Corrected coho observations compensate for coho that were presumably double counted.

[1] Data provided by the Salmon Protection and Watershed Network (SPAWN).

[2] Data provided by the National Park Service.

COHO SALMON IN OTHER TRIBUTARIES			
CHEDA CREEK[2]	0	0	0

COHO TOTAL	**343**	**16**	**173**

Table 3. Observations of Steelhead in the Lagunitas Creek Watershed, Spawner Season 2020-21

SURVEY DATE	STEELHEAD IN LAGUNITAS CREEK															TOTAL		
	Nicasio Creek-Tocaloma			Tocaloma-Swimming Hole			Swimming Hole-Irving			Irving-Shafter Bridge			Shafter Bridge-Peters Dam					
	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds
29-Dec-21	-	-	-	-	-	-	-	-	-	0	0	1	0	0	0	0	0	1
5-Jan-21	-	-	-	0	0	3	-	-	-	-	-	-	-	-	-	0	0	3
7-Jan-21	-	-	-	-	-	-	-	-	-	0	0	3	-	-	-	0	0	3
13-Jan-21	-	-	-	0	0	3	-	-	-	-	-	-	-	-	-	0	0	3
14-Jan-21	-	-	-	-	-	-	0	0	2	-	-	-	-	-	-	0	0	2
15-Jan-21	-	-	-	-	-	-	-	-	-	0	0	3	0	0	0	0	0	3
20-Jan-21	-	-	-	0	0	2	-	-	-	-	-	-	-	-	-	0	0	2
21-Jan-21	-	-	-	-	-	-	-	-	-	0	0	1	0	0	0	0	0	1
26-Jan-21	-	-	-	-	-	-	0	0	1	0	0	1	-	-	-	0	0	2
5-Feb-21	-	-	-	-	-	-	-	-	-	5	0	3	0	0	0	5	0	3
10-Feb-21	-	-	-	-	-	-	0	0	2	-	-	-	-	-	-	0	0	2
11-Feb-21	-	-	-	0	0	3	-	-	-	-	-	-	-	-	-	0	0	3
17-Feb-21	-	-	-	5	0	2	-	-	-	-	-	-	-	-	-	5	0	2
18-Feb-21	-	-	-	-	-	-	2	0	6	0	0	0	0	0	0	2	0	6
24-Feb-21	-	-	-	0	0	4	-	-	-	-	-	-	-	-	-	0	0	4
25-Feb-21	-	-	-	-	-	-	2	0	1	-	-	-	-	-	-	2	0	1
26-Feb-21	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
3-Mar-21	-	-	-	-	-	-	-	-	-	2	0	0	4	0	1	6	0	1
4-Mar-21	-	-	-	-	-	-	0	0	3	-	-	-	-	-	-	0	0	3
11-Mar-21	-	-	-	3	0	8	0	0	3	-	-	-	-	-	-	3	0	11
12-Mar-21	-	-	-	-	-	-	-	-	-	1	0	2	0	0	0	1	0	2
17-Mar-21	-	-	-	2	1	10	9	0	6	-	-	-	-	-	-	11	1	16
22-Mar-21	-	-	-	-	-	-	-	-	-	2	0	5	0	0	0	2	0	5
SUBTOTAL	**0**	**0**	**0**	**10**	**1**	**35**	**13**	**0**	**24**	**10**	**0**	**19**	**4**	**0**	**1**	**37**	**1**	**79**
Corrected*	**0**			**10**			**13**			**10**			**4**			**37**		

SURVEY DATE	STEELHEAD IN SAN GERONIMO CREEK									STEELHEAD IN DEVIL'S GULCH			STEELHEAD IN OLEMA CREEK[2]			TOTAL		
	Mouth-Meadow Way			Meadow Way-Woodacre Cr.			Tributaries[1]											
	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds	Steelhead	Carcasses	Redds
5-Jan-21	-	-	-	0	1	6	-	-	-	-	-	-	-	-	-	0	1	6
10-Jan-21	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	0	0	1
31-Jan-21	-	-	-	-	-	-	-	-	-	-	-	-	7	1	14	7	1	14
3-Feb-21	-	-	-	-	-	-	2	0	6	-	-	-	-	-	-	2	0	6
4-Feb-21	-	-	-	-	-	-	-	-	-	0	0	4	-	-	-	0	0	4
11-Feb-21	0	0	7	-	-	-	-	-	-	-	-	-	-	-	-	0	0	7
13-Feb-21	-	-	-	-	-	-	-	-	-	-	-	-	0	3	13	0	3	13
16-Feb-21	-	-	-	-	-	-	0	0	2	-	-	-	-	-	-	0	0	2
17-Feb-21	-	-	-	-	-	-	0	0	3	-	-	-	-	-	-	0	0	3
21-Mar-21	-	-	-	-	-	-	-	-	-	-	-	-	3	3	10	3	3	10
SUBTOTAL	**0**	**0**	**7**	**0**	**1**	**6**	**2**	**0**	**11**	**0**	**0**	**4**	**10**	**7**	**38**	**12**	**8**	**66**
Corrected*	**0**			**0**			**2**			**0**			**10**			**12**		

STEELHEAD IN OTHER TRIBUTARIES			
CHEDA CREEK	0	0	0

STEELHEAD TOTAL	**49**	**9**	**145**

Notes:

(-) Indicates that the spawner survey did not cover the area on that date.

* Corrected coho observations compensate for coho that were presumably double counted.

[1] Data provided by the Salmon Protection and Watershed Network (SPAWN).

[2] Data provided by the National Park Service.

[3] Incidental observation.

Table 4. Observations of Chinook Salmon in the Lagunitas Creek Watershed, Spawner Season 2020-21

SURVEY DATE	CHINOOK IN LAGUNITAS CREEK															TOTAL		
	Nicasio Creek-Tocaloma			Tocaloma-Swimming Hole			Swimming Hole-Irving			Irving-Shafter Bridge			Shafter Bridge-Peters Dam					
	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds	Chinook	Carcasses	Redds
20-Nov-20	-	-	-	-	-	-	5	0	1	-	-	-	-	-	-	5	0	1
23-Nov-20	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	0	0	0
24-Nov-20	-	-	-	-	-	-	-	-	-	8	0	4	0	0	2	8	0	6
1-Dec-20	-	-	-	0	0	1	-	-	-	-	-	-	-	-	-	0	0	1
4-Dec-20	-	-	-	-	-	-	8	0	4	-	-	-	-	-	-	8	0	4
9-Dec-20	-	-	-	5	0	2	-	-	-	-	-	-	-	-	-	5	0	2
10-Dec-20	-	-	-	-	-	-	8	0	1	-	-	-	-	-	-	8	0	1
14-Dec-20	-	-	-	0	0	1	-	-	-	-	-	-	-	-	-	0	0	1
15-Dec-20	-	-	-	-	-	-	1	0	0	-	-	-	-	-	-	1	0	0
21-Dec-20	-	-	-	-	-	-	-	-	-	2	0	2	1	0	0	3	0	2
29-Dec-20	-	-	-	-	-	-	4	0	0	1	0	0	0	0	0	5	0	0
5-Jan-21	-	-	-	0	0	0	1	0	1	-	-	-	-	-	-	1	0	1
7-Jan-21	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
SUBTOTAL	**0**	**0**	**0**	**5**	**0**	**4**	**27**	**0**	**7**	**11**	**0**	**6**	**1**	**0**	**2**	**44**	**0**	**19**
Corrected*	**0**			**5**			**27**			**11**			**1**			**44**		

CHINOOK TOTAL	**44**	**0**	**19**

Table 5. Coho Salmon Redds in the Lagunitas Creek Watershed

Year	Lagunitas Creek	San Geronimo Creek	San Geronimo Tributaries	Devil's Gulch	Cheda and Nicasio Creeks	Olema Creek	Total
1982-83	65	47	No Data	27	No Data	No Data	139
1995-96	70	6	No Data	10	No Data	No Data	86
1996-97	98	115	No Data	41	No Data	No Data	254
1997-98	80	107	14	52	No Data	134	387
1998-99	92	46	14	32	0	23	207
1999-00	139	58	3	3	0	10	213
2000-01	119	56	18	11	0	80	284
2001-02	79	102	43	59	3	59	345
2002-03	71	39	22	24	2	20	178
2003-04	124	139	66	48	6	109	492
2004-05	120	140	118	112	6	138	634
2005-06	53	48	54	33	2	9	199
2006-07	128	117	26	55	12	95	433
2007-08	87	46	9	6	1	33	182
2008-09	25	1	0	0	0	0	26
2009-10	42	7	0	2	0	14	65
2010-11	32	40	2	6	0	21	101
2011-12	94	19	3	10	4	7	137
2012-13	108	59	4	44	2	29	246
2013-14	172	7	3	5	1	32	220
2014-15	79	30	7	20	4	6	146
2015-16	91	68	28	31	8	66	292
2016-17	49	49	29	31	0	12	170
2017-18	72	13	6	11	1	7	110
2018-19	118	80	39	60	9	63	369
2019-20	33	22	3	3	0	2	63
2020-21	144	11	3	3	0	12	173
Mean	**90**	**54**	**21**	**28**	**3**	**41**	**236**

Coho year class

Notes: Olema Creek & Cheda Creek data are provided by the National Park Service.
San Geronimo tributaries: Arroyo Creek, Larsen Creek, Evans Canyon, Woodacre Creek, and San Geronimo Creek above Woodacre Creek; data provided by SPAWN.

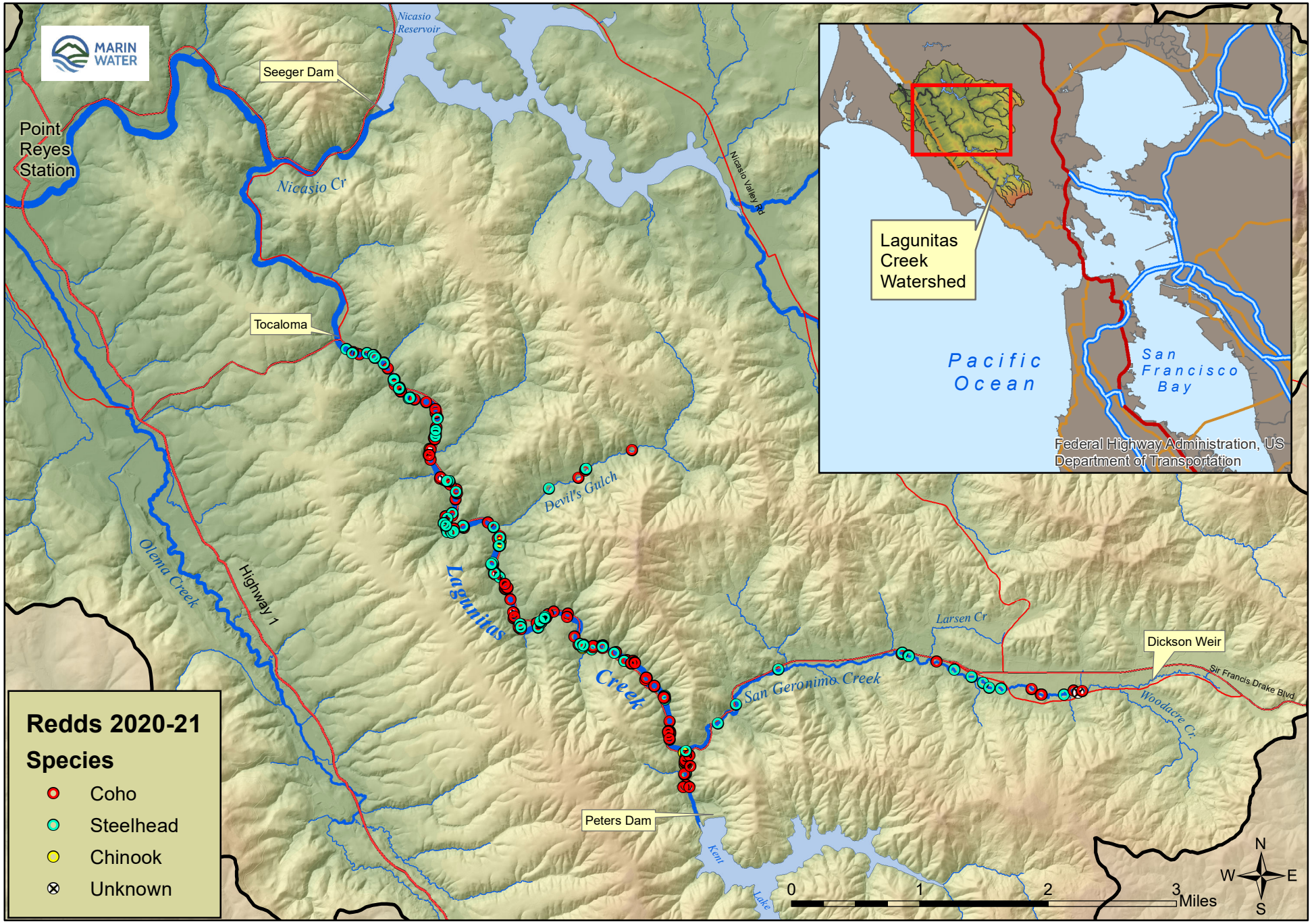

Figure 1. Salmonid Redds in the Lagunitas Creek Watershed, 2020-21

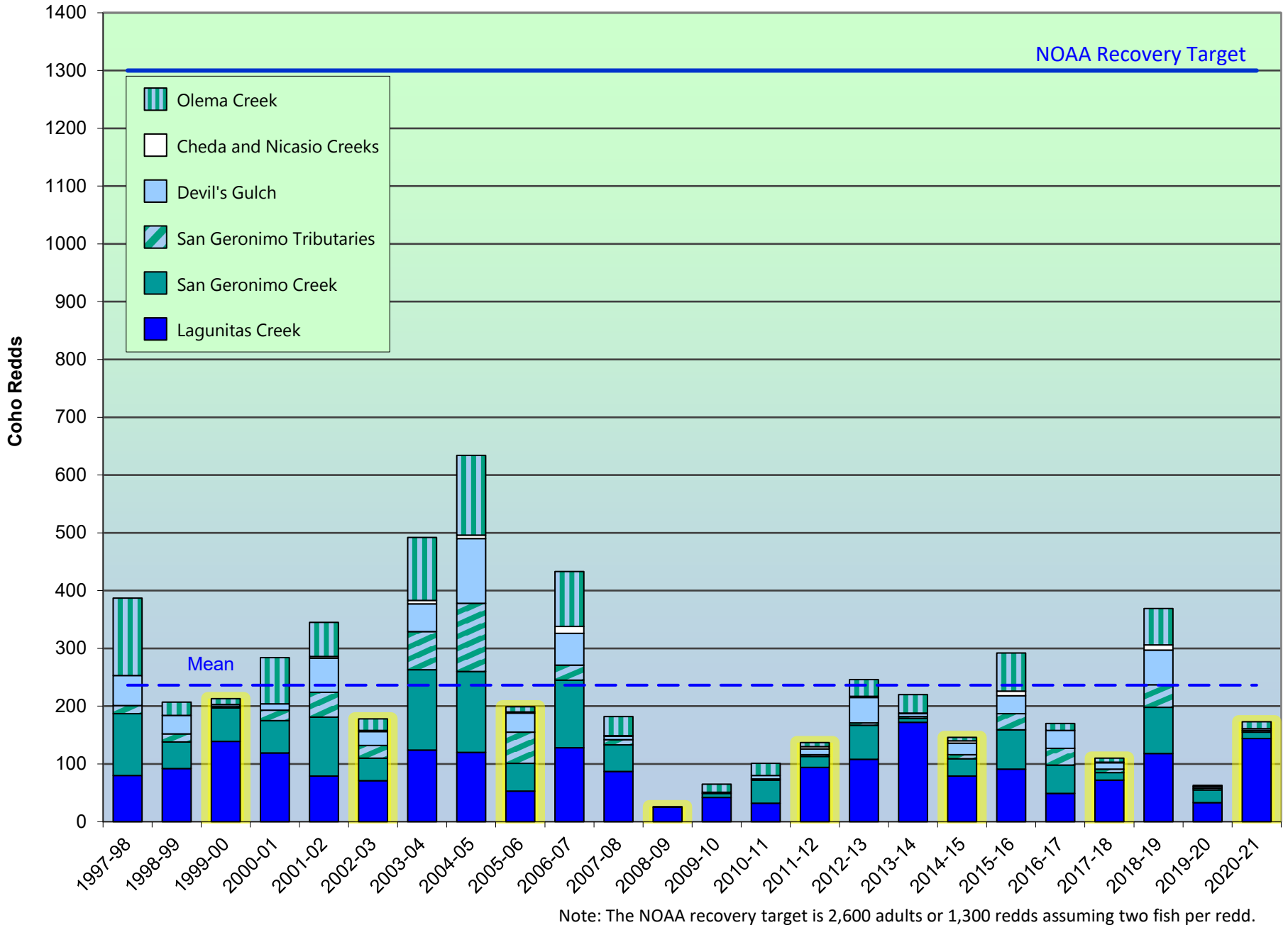

Figure 2. Coho Salmon Redds in the Lagunitas Creek Watershed (the current year class is highlighted).

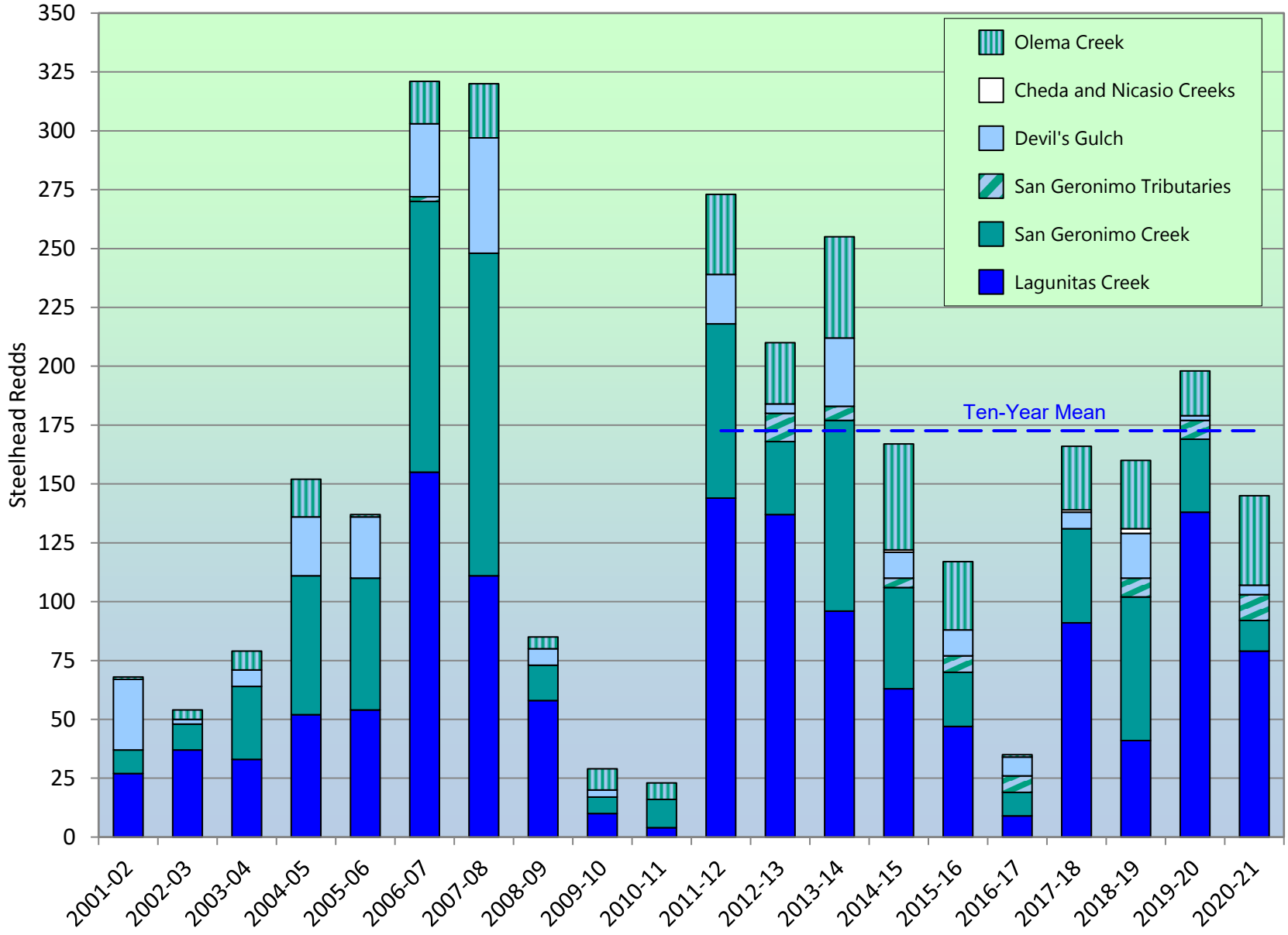

Figure 3. Steelhead Redds in the Lagunitas Creek Watershed.

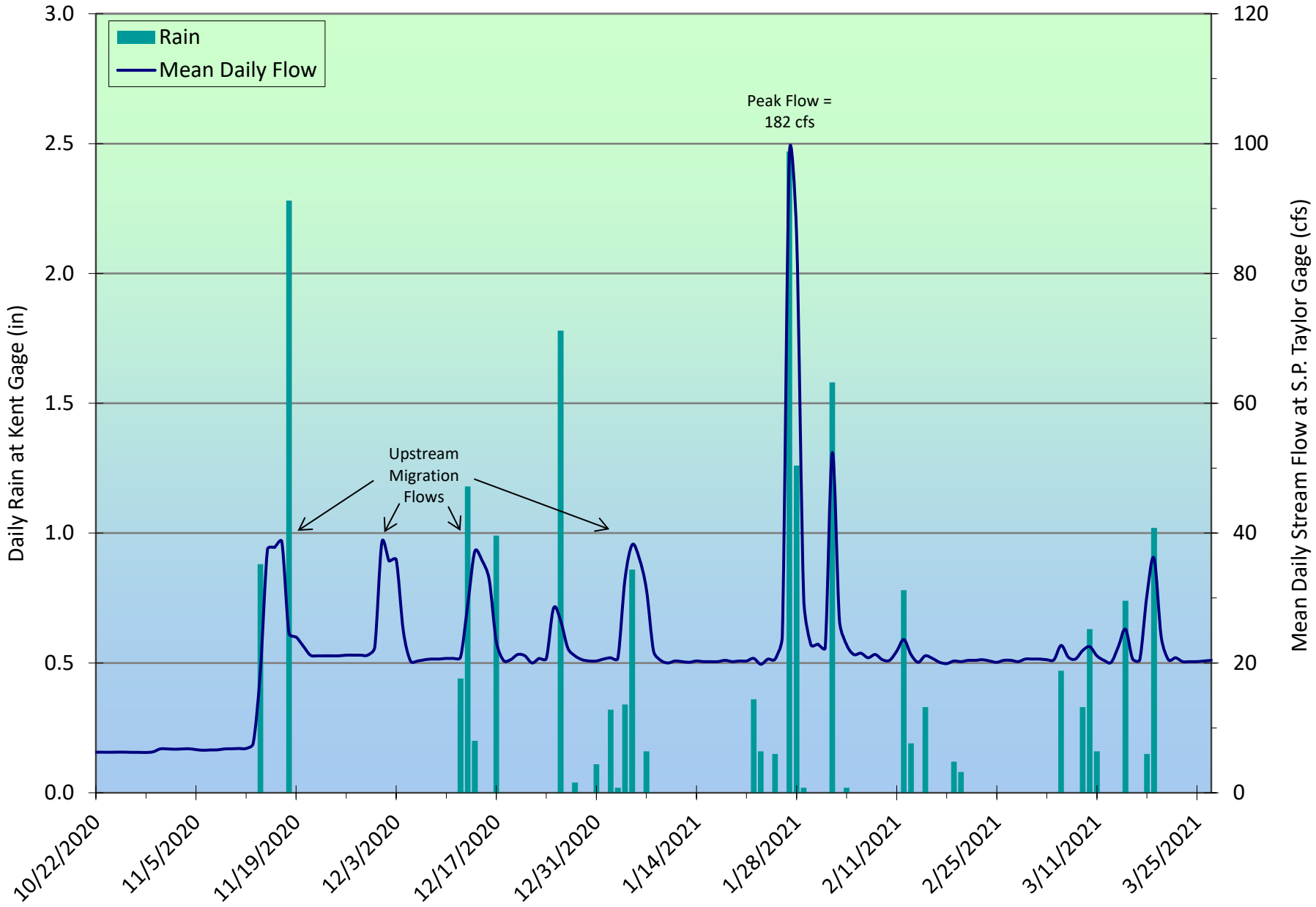

Figure 4. Rain and Lagunitas Creek Stream Flow

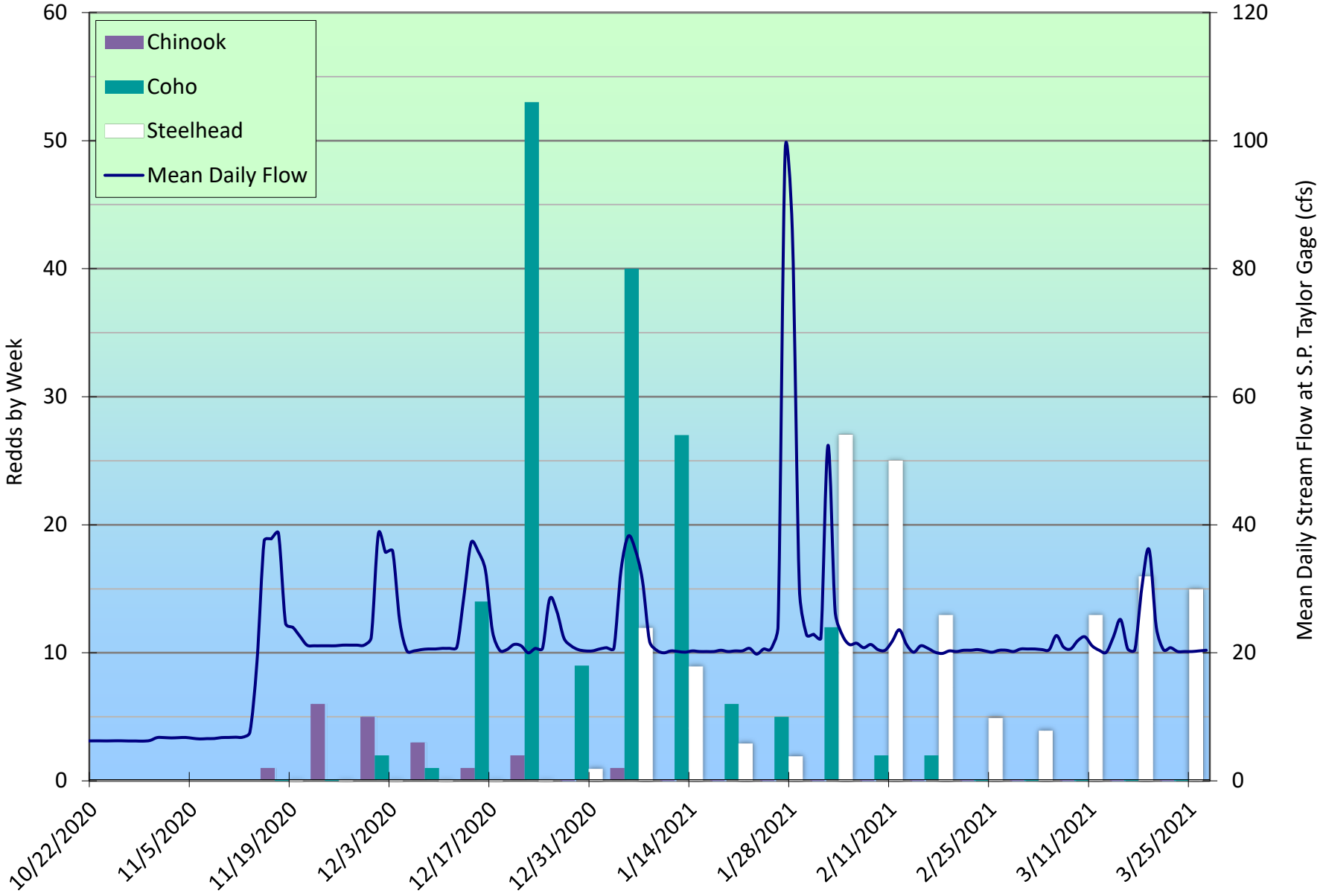

Figure 5. Salmonid Redds and Lagunitas Creek Stream Flows

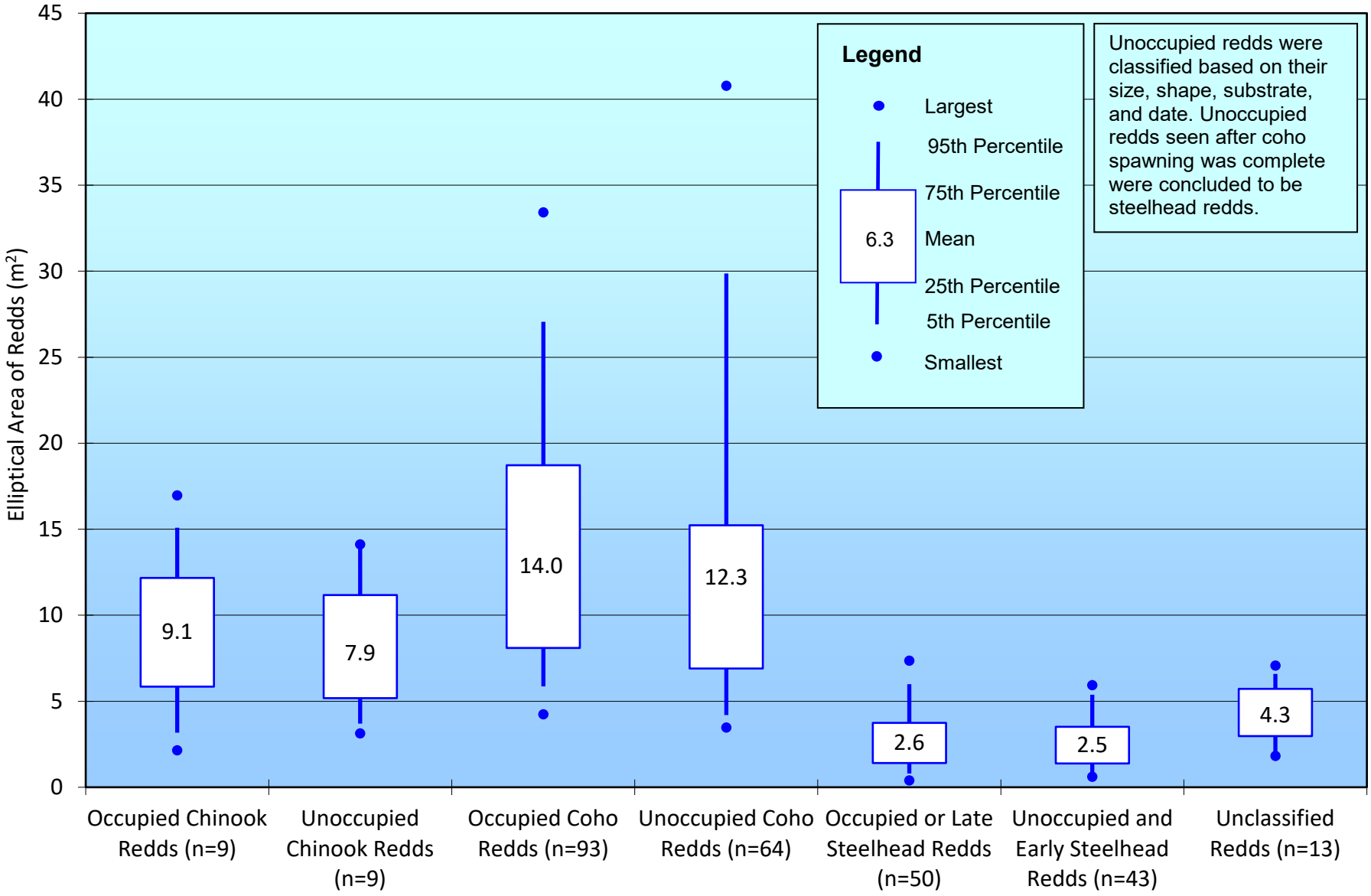

Figure 6. Redd Areas by Species in Lagunitas and San Geronimo Creeks, Spawning Season 2020-2021.