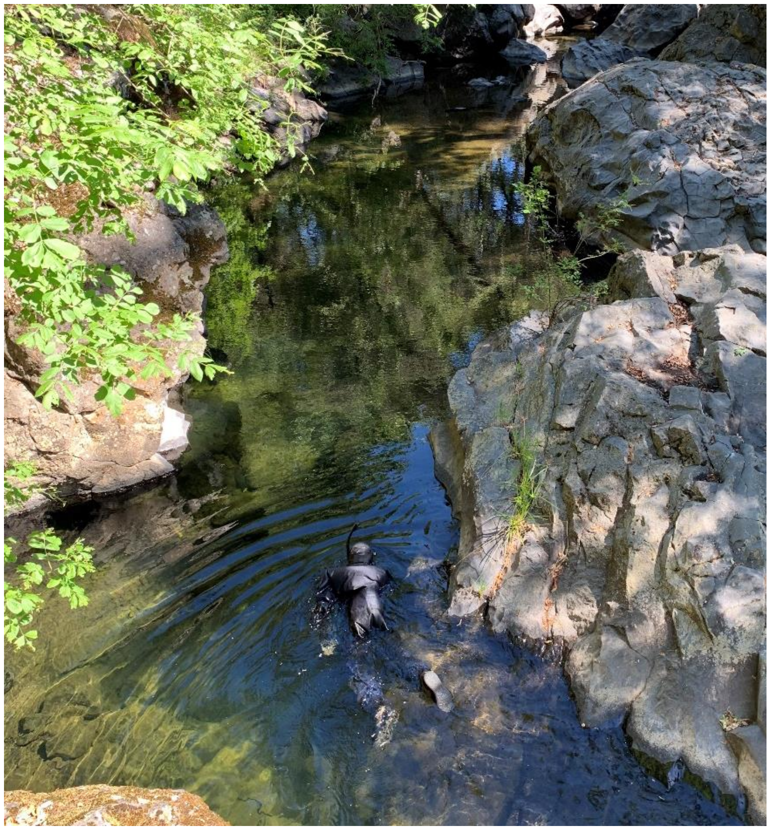
Coho Salmon and Steelhead Monitoring Report

Summer 2023



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Contents

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1. Background

In 2004, the Russian River Coho Salmon Captive Broodstock Program (Broodstock Program) began releasing juvenile coho salmon raised at the US Army Corps of Engineer's (USACE) Don Clausen Fish Hatchery into tributaries of the Russian River with the goal of reestablishing populations that were on the brink of extirpation from the watershed. California Sea Grant at University of California (CSG) worked with local, state, and federal biologists to design and implement a coho salmon monitoring program to track the survival and abundance of hatchery-released fish. Since the first Broodstock Program releases, CSG has been closely monitoring smolt abundance, adult returns, survival, and spatial distribution of coho salmon populations in four life cycle monitoring (LCM) watersheds: Willow, Dutch Bill, Green Valley, and Mill creeks. Data collected from this effort are provided to the Broodstock Program for use in evaluating the success of hatchery releases and adaptively managing future releases.

In 2013, CSG began partnering with Sonoma Water (SW) and California Department of Fish and Wildlife (CDFW) to implement the California Coastal Monitoring Plan (CMP) in the Russian River watershed. The CMP is a statewide effort to document status and trends of anadromous salmonid populations to inform recovery, conservation, and management activities. This work complements the Broodstock Program monitoring by incorporating a basinwide component that includes surveys in over 40 streams and expanding the species monitored to include steelhead and Chinook salmon.

In 2023, CSG began transitioning away from field data collection and subcontracted with SW to conduct field activities associated with Broodstock Program monitoring. During the summer of 2023, all field data was collected by SW.

The intention of our monitoring is to provide science-based information to stakeholders involved in salmon and steelhead recovery. Our work would not be possible without the support of our partners, including public resource agencies and non-profit organizations, along with hundreds of private landowners who have granted us access to the streams that flow through their properties.

In this seasonal monitoring report, we provide results from our summer Broodstock Program and CMP snorkel surveys, including relative abundance and spatial distribution of juvenile salmonids in Russian River tributaries. Additional information and previous reports can be found on our website.

2. Juvenile Presence and Distribution

2.1. Goals and objectives

Summer snorkel surveys were conducted in Russian River tributaries to document the relative abundance and spatial distribution of juvenile coho salmon and steelhead during the summer of 2023. These data were used to determine whether successful spawning occurred the previous winter and to track spatiotemporal trends in relative abundance and occupancy.

2.2. Methods

2.2.1. Sampling reaches

For Broodstock Program monitoring, we surveyed juvenile salmonid reaches of Willow, Dutch Bill, Green Valley, and Mill creeks (Figure 1). For CDFW's Coastal Monitoring Program (CMP), a spatially-balanced random sample of reaches from the Russian River sample frame (a sample frame of stream reaches identified by the Russian River CMP Technical Advisory Committee[1] as having coho salmon, steelhead, and/or Chinook salmon habitat) was selected using a generalized random tessellation stratified (GRTS) approach as outlined in Fish Bulletin 180 (Adams et al. 2011). The reaches selected using the GRTS draw were used to estimate basinwide juvenile coho salmon occupancy.

2.2.2. Field methods

Sampling was based on modifications of protocols described in Garwood and Ricker (2014). On each snorkel survey, salmonids were counted in every other pool within the reach, with the first pool (one or two) determined randomly. Pools were defined as habitat units with a depth of greater than one foot in an area at least as long as the maximum wetted width and a surface area of greater than three square meters. A GPS point was collected at the downstream end of each pool snorkeled. For reaches that were included in the occupancy estimate, a second snorkeling pass was completed the following day. Suring the second pass, every other pool that was snorkeled during the first pass was snorkeled a second time in order to account for snorkel count efficiency in the occupancy model.

During each survey, snorkeler(s) moved from the downstream end of each pool (pool tail crest) to the upstream end, surveying as much of the pool as water depth allowed. Dive lights were used to inspect shaded and covered areas. In larger pools requiring two snorkelers, two lanes were agreed upon and each snorkeler moved upstream through the lane at the same rate. Final counts for the pool were the sum of both lane counts. All observed salmonids were identified to species (coho salmon, Chinook salmon, steelhead, or unknown salmonid) and age class (young-of-year (yoy) or parr (≥ age-1)), based on size and morphological characteristics. Presence of non-salmonid species was documented at the reach scale. Trimble TDC600 tablets were used for data entry and, upon returning from the field, data files were downloaded, error checked, and transferred into a SQL database. Spatial data were downloaded, error checked, and stored in an ArcGIS geodatabase for map production.

[1] A body of fisheries experts, including members of the Statewide CMP Technical Team, tasked with providing guidance and technical advice related to CMP implementation in the Russian River.

2.2.3. Metrics

2.2.3.1. Relative abundance

First-pass counts were used to document the minimum number of coho salmon and steelhead yoy and parr observed in each reach. Because only half of the pools were snorkeled, minimum counts were doubled for an expanded minimum count. Expanded minimum counts did not incorporate variation among pools or detection efficiency; therefore, they should only be considered approximate estimates of abundance for relative comparisons.

2.2.3.2. Spatial distribution

Multiscale occupancy models were used to estimate the probability of juvenile coho salmon occupancy at the sample reach scale (ψ) and conditional occupancy at the sample pool scale (θ), given presence in the reach (Nichols et al. 2008; Garwood and Larson 2014). Detection probability (*p*) at the pool scale was accounted for using the repeated dive pass data in the occupancy models. The proportion of area occupied (PAO) was then estimated by multiplying the reach- and pool-scale occupancy parameters (ψ*θ).

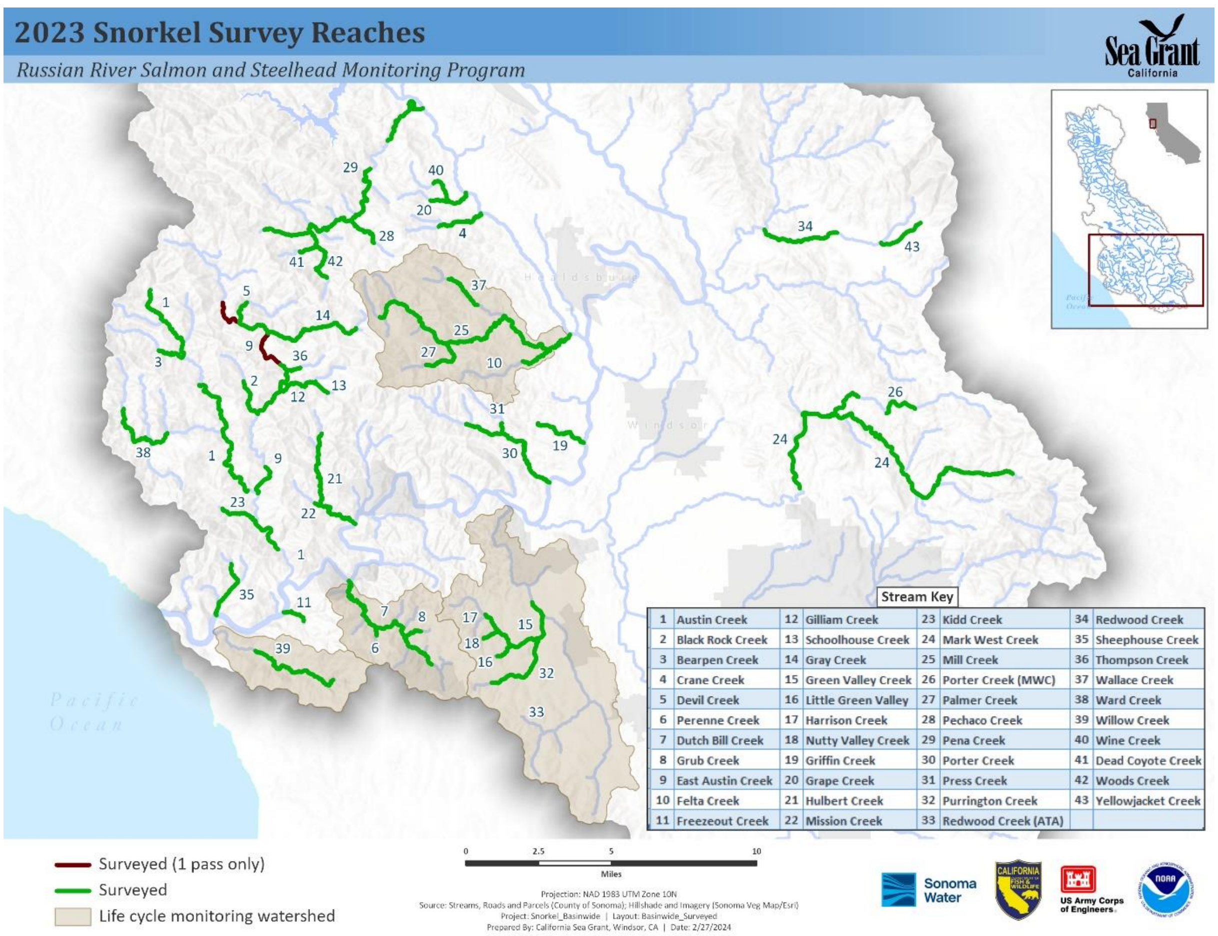

Figure 1. Reaches snorkeled during 2023 summer juvenile snorkel surveys. Note that in two reaches of East Austin only a single pass survey was conducted and Harrison Creek and Redwood Creek (Atascadero) were not surveyed in 2023.

2.3. Results

Between June 5 and September 13, 2023, SW biologists snorkeled 69 reaches representing 200 km of stream length in 41 tributaries. All juvenile coho salmon rearing reaches of Willow, Dutch Bill, Green Valley, and Mill creeks were surveyed for Broodstock Program monitoring, and 67 reaches within the Russian River sample frame that were considered to contain juvenile coho salmon habitat (64% of coho salmon reaches) were included in the basinwide occupancy estimate. Two reaches of East Austin Creek (EAU6 and EAU8) were not included in the occupancy estimate because data from one of the two passes was lost due to technical errors.

During the summer of 2023, we observed a total of 375 coho salmon yoy, with an expanded minimum coho count of 750 (Table 1), and we observed 12,768 steelhead yoy, with an expanded minimum steelhead count of 25,536 (Table 2). Coho salmon yoy were observed in 24 of the 69 juvenile coho salmon *reaches* surveyed and in 19 of the 41 juvenile coho salmon *streams* snorkeled (35% and 46%, respectively) (Figure 2). Steelhead yoy were observed in 62 of the 69 steelhead reaches and 35 of the 41 steelhead streams surveyed (90% and 85%, respectively). In seven of the 19 streams where coho yoy were found, fewer than 10 coho were observed. Coho yoy counts were highest in Green Valley, Grape, and Dutch Bill creeks, though even in those streams numbers were low. Counts of steelhead yoy were highest in Pena, Mill, and Felta creeks, all tributaries within the Dry Creek watershed.

Based on results of the multiscale occupancy model, we estimate that the probability of coho salmon yoy occupying a given reach within the basinwide Russian River coho salmon stratum (ψ) in 2023 was 0.38 (0.27 - 0.52, 95% CI), and the conditional probability of coho salmon yoy occupying a pool within a reach, given that the reach was occupied (θ), was 0.21 (0.16 – 0.27, 95% CI). The proportion of the coho salmon stratum occupied (PAO) was 0.08, lower than any previous years in our survey record and approximately 30% of the 9-year average (Table 3).

Juvenile coho salmon were observed in all four Broodstock Program monitoring watersheds, though in extremely low numbers (Table 1). In all four watershed, concentrations of juvenile coho were limited to one or two locations (Figure 3 - Figure 6). In Willow Creek, coho were found in a small number of pools in the upper half of the surveyed stream length (Figure 3). In Dutch Bill Creek, coho were found concentrated in a short section at the upstream end of the surveyed stream length (Figure 4). In Green Valley Creek watershed, the majority of the coho yoy were found in a single pool near the lower Green Valley Road crossing, with another concentration in the middle reach of Purrington Creek (Figure 5). In the Mill Creek watershed, coho were only observed in lower Felta Creek and in Mill Creek near the confluence with Felta Creek (Figure 6).

Table 1. Number of coho salmon yoy and parr observed in Russian River tributaries and expanded minimum counts, summer 2023.

Tributary	Pools snorkeled	Stream length snorkeled (km)	Coho yoy	Expanded coho yoy[1]	Coho parr	Expanded coho parr[1]
Austin Creek	140	17.0	4	8	1	2
Bearpen Creek	25	1.9	0	0	0	0
Black Rock Creek	28	2.5	0	0	0	0
Crane Creek (Dry)	38	3.2	0	0	0	0
Dead Coyote Creek	7	1.1	1	2	0	0
Devil Creek	11	1.5	0	0	0	0
Dutch Bill Creek	102	9.7	63	126	2	4
East Austin Creek	117	13.1	0	0	0	0
Felta Creek	31	2.0	14	28	2	4
Freezeout Creek	23	1.5	7	14	0	0
Gilliam Creek	44	2.6	3	6	0	0
Grape Creek	51	2.6	70	140	0	0
Gray Creek	79	6.3	0	0	0	0
Green Valley Creek	85	7.0	75	150	95	190
Griffin Creek	2	3.6	0	0	0	0
Grub Creek	8	1.1	0	0	0	0
Hulbert Creek	112	8.2	0	0	1	2
Kidd Creek	39	2.5	16	32	4	8
Little Green Valley Creek	12	1.2	0	0	0	0
Mark West Creek	206	22.1	10	20	0	0
Mill Creek	155	16.6	18	36	0	0
Mission Creek	3	0.4	0	0	0	0
Nutty Valley Creek	2	1.2	0	0	0	0
Palmer Creek	48	2.9	0	0	0	0
Pechaco Creek	32	2.3	0	0	0	0
Pena Creek	106	15.1	15	30	0	0
Perenne Creek	11	0.5	1	2	0	0
Porter Creek	107	7.4	2	4	0	0
Porter Creek (Mwc)	38	5.1	0	0	0	0
Press Creek	7	0.6	0	0	0	0
Purrington Creek	82	4.8	11	22	0	0
Redwood Creek	42	4.8	0	0	0	0
Schoolhouse Creek	8	1.1	0	0	0	0
Sheephouse Creek	46	3.7	24	48	10	20
Thompson Creek	13	0.9	0	0	0	0
Wallace Creek	27	2.5	0	0	0	0
Ward Creek	72	5.0	0	0	0	0
Willow Creek	92	6.0	11	22	15	30
Wine Creek	36	1.8	3	6	1	2
Woods Creek	55	4.1	27	54	1	2
Yellowjacket Creek	57	2.8	0	0	0	0
Total	**2,199**	**200.3**	**375**	**750**	**132**	**264**

[1] *Expanded count is the observed count multiplied by a factor of 2.*

Table 2. Number of steelhead yoy and parr observed in Russian River tributaries and expanded counts, summer 2023.

Tributary	Pools snorkeled	Stream length snorkeled (km)	Steelhead yoy	Expanded steelhead yoy[1]	Steelhead parr	Expanded steelhead parr[1]
Austin Creek	140	17.0	899	1,798	230	460
Bearpen Creek	25	1.9	38	76	0	0
Black Rock Creek	28	2.5	6	12	1	2
Crane Creek (Dry)	38	3.2	71	142	7	14
Dead Coyote Creek	7	1.1	7	14	0	0
Devil Creek	11	1.5	79	158	5	10
Dutch Bill Creek	102	9.7	2	4	10	20
East Austin Creek	117	13.1	501	1,002	448	896
Felta Creek	31	2.0	1,402	2,804	28	56
Freezeout Creek	23	1.5	1	2	4	8
Gilliam Creek	44	2.6	465	930	36	72
Grape Creek	51	2.6	754	1,508	9	18
Gray Creek	79	6.3	455	910	90	180
Green Valley Creek	85	7.0	710	1,420	106	212
Griffin Creek	2	3.6	0	0	0	0
Grub Creek	8	1.1	0	0	0	0
Hulbert Creek	112	8.2	5	10	5	10
Kidd Creek	39	2.5	55	110	15	30
Little Green Valley Creek	12	1.2	0	0	0	0
Mark West Creek	206	22.1	111	222	98	196
Mill Creek	155	16.6	1,511	3,022	109	218
Mission Creek	3	0.4	0	0	0	0
Nutty Valley Creek	2	1.2	0	0	0	0
Palmer Creek	48	2.9	21	42	33	66
Pechaco Creek	32	2.3	97	194	9	18
Pena Creek	106	15.1	3,923	7,846	99	198
Perenne Creek	11	0.5	4	8	0	0
Porter Creek	107	7.4	72	144	35	92 [2]
Porter Creek (Mwc)	38	5.1	421	842	24	48
Press Creek	7	0.6	0	0	0	0
Purrington Creek	82	4.8	173	346	64	128
Redwood Creek	42	4.8	122	244	60	120
Schoolhouse Creek	8	1.1	6	12	1	2
Sheephouse Creek	46	3.7	1	2	2	4
Thompson Creek	13	0.9	3	6	1	2
Wallace Creek	27	2.5	29	58	11	22
Ward Creek	72	5.0	102	204	35	70
Willow Creek	92	6.0	23	46	13	26
Wine Creek	36	1.8	190	380	1	2
Woods Creek	55	4.1	280	560	31	62
Yellowjacket Creek	57	2.8	229	458	24	48
Total	**2,199**	**200.3**	**12,768**	**25,536**	**1,644**	**3,218**

[1] *Expanded count is the observed count multiplied by a factor of 2.*

[2] *One of the Porter Creek reaches (POR2) was sampled at a frequency of 4 instead of 2 so the expansion was adjusted to account for this. No yoy were observed in POR2.*

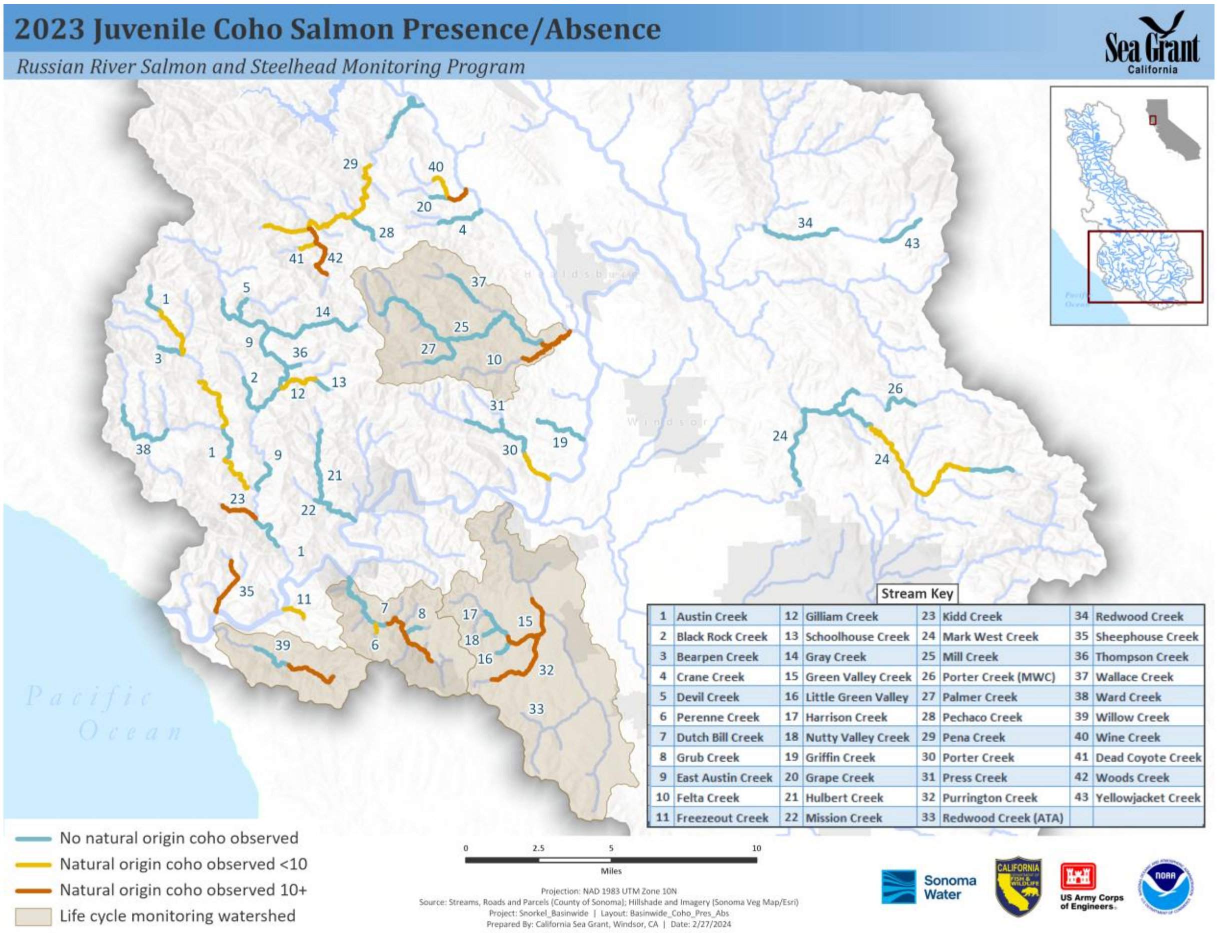

Figure 2. Natural-origin coho salmon presence by reach in surveyed Russian River tributaries, summer 2023. Note that Harrison Creek and Redwood Creek (Atascadero) were not surveyed in 2023.

Table 3. Proportion of area occupied by coho salmon yoy within juvenile coho salmon reaches of the Russian River sample frame, 2015-2023.

Year	Reaches Sampled	Stream length surveyed (km)	PAO
2015	58	167	0.37
2016	72	206	0.33
2017	73	214	0.21
2018	69	205	0.25
2019	70	211	0.15
2020	51	139	0.37
2021	63	178	0.16
2022	69	199	0.45
2023	67	195	0.08

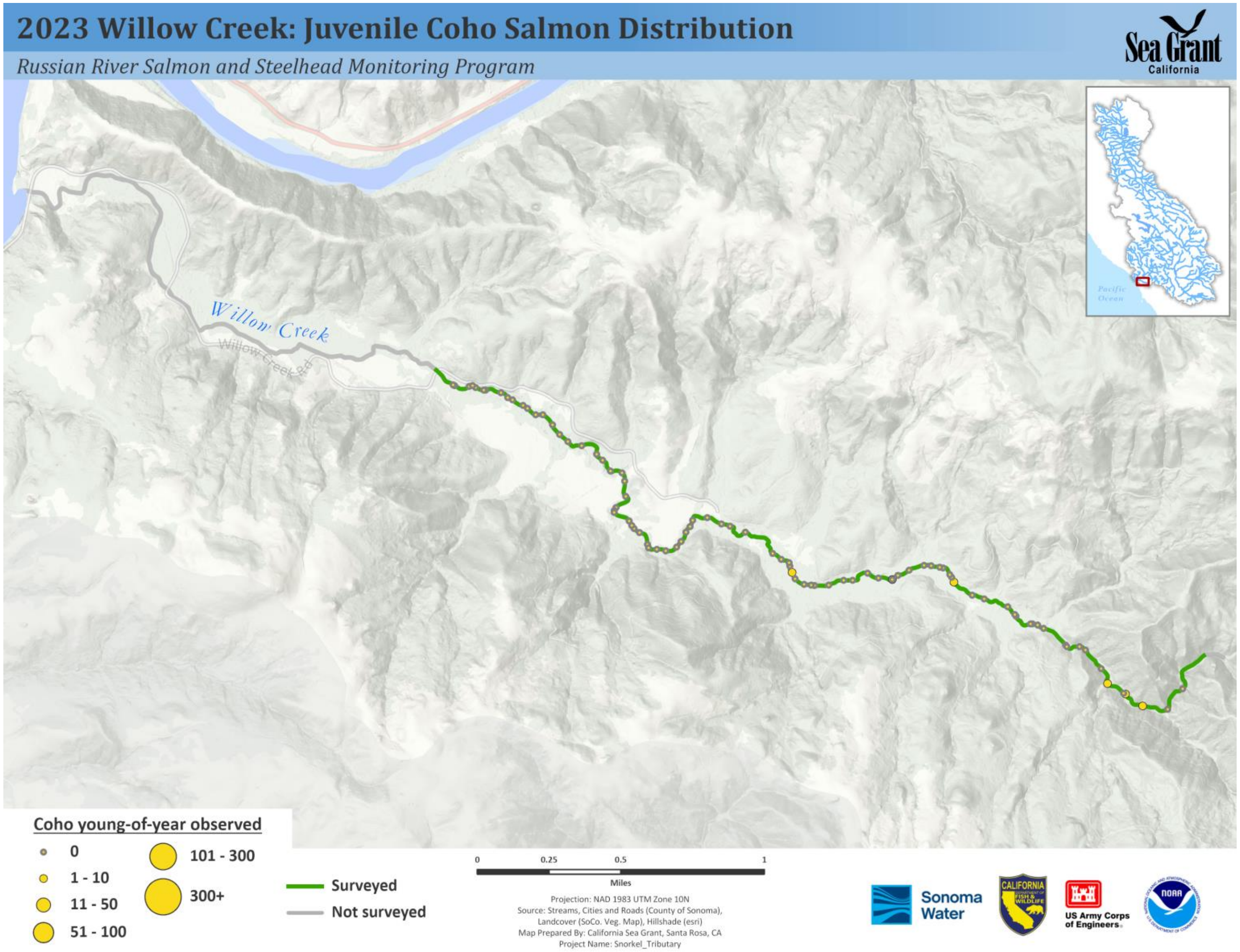

Figure 3. Density and distribution of juvenile coho salmon yoy observed in Willow Creek, 2023. Note that the smallest circle indicates no coho salmon observations in the associated pool.

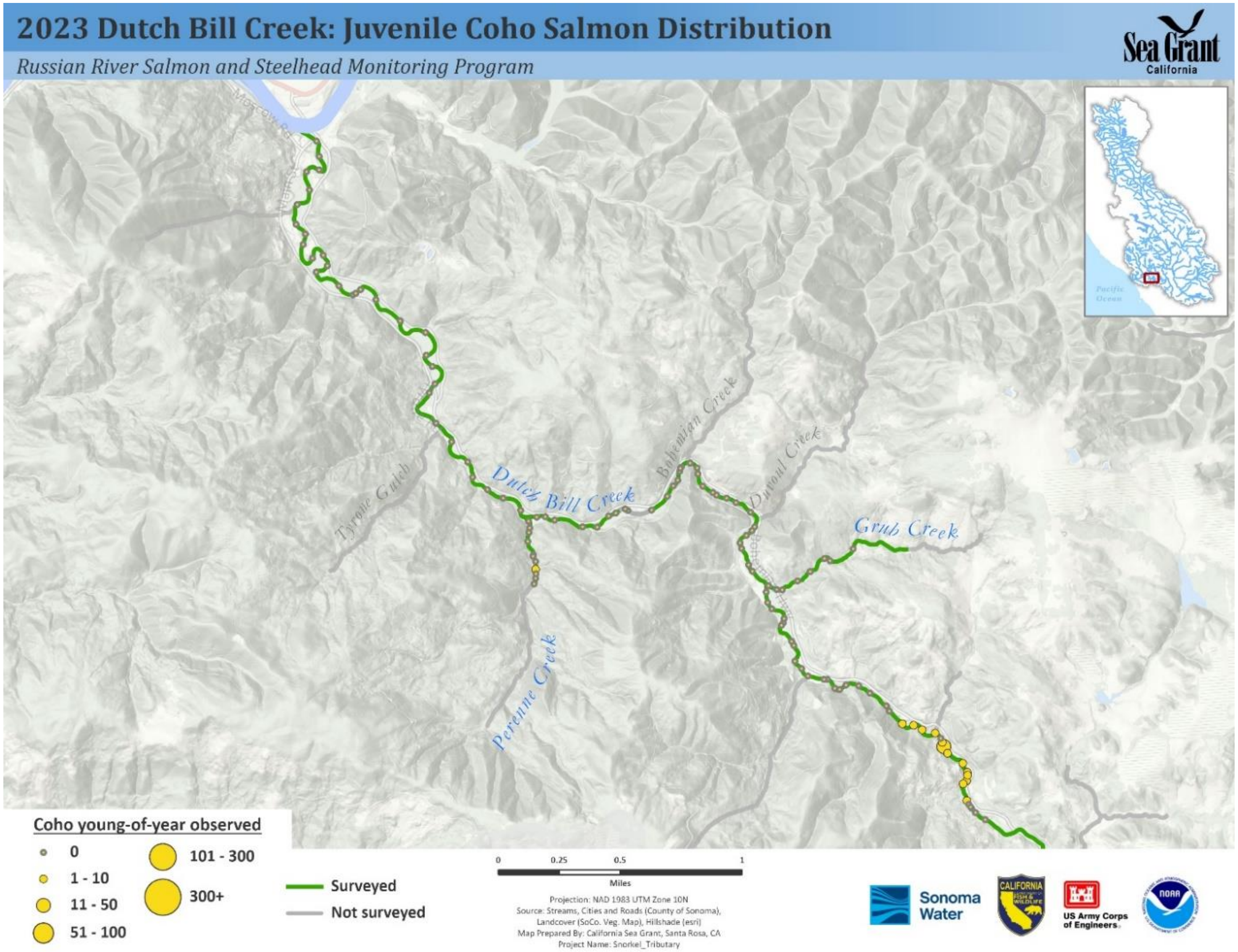

Figure 4. Density and distribution of juvenile coho salmon yoy observed in Dutch Bill Creek, 2023. Note that the smallest circle indicates no coho salmon observations in the associated pool.

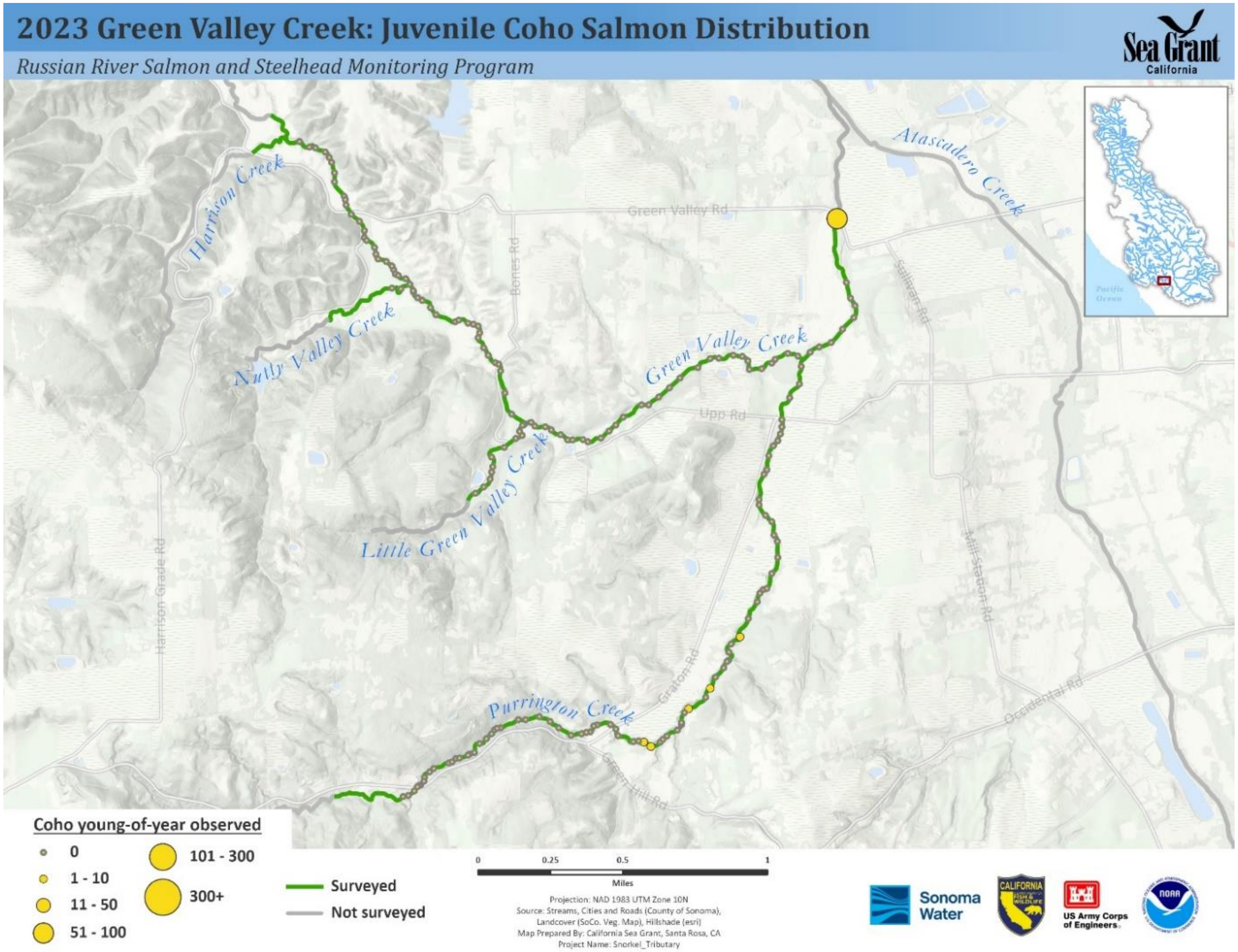

Figure 5. Density and distribution of juvenile coho salmon yoy observed in Green Valley Creek, 2023. Note that the smallest circle indicates no coho salmon observations in the associated pool.

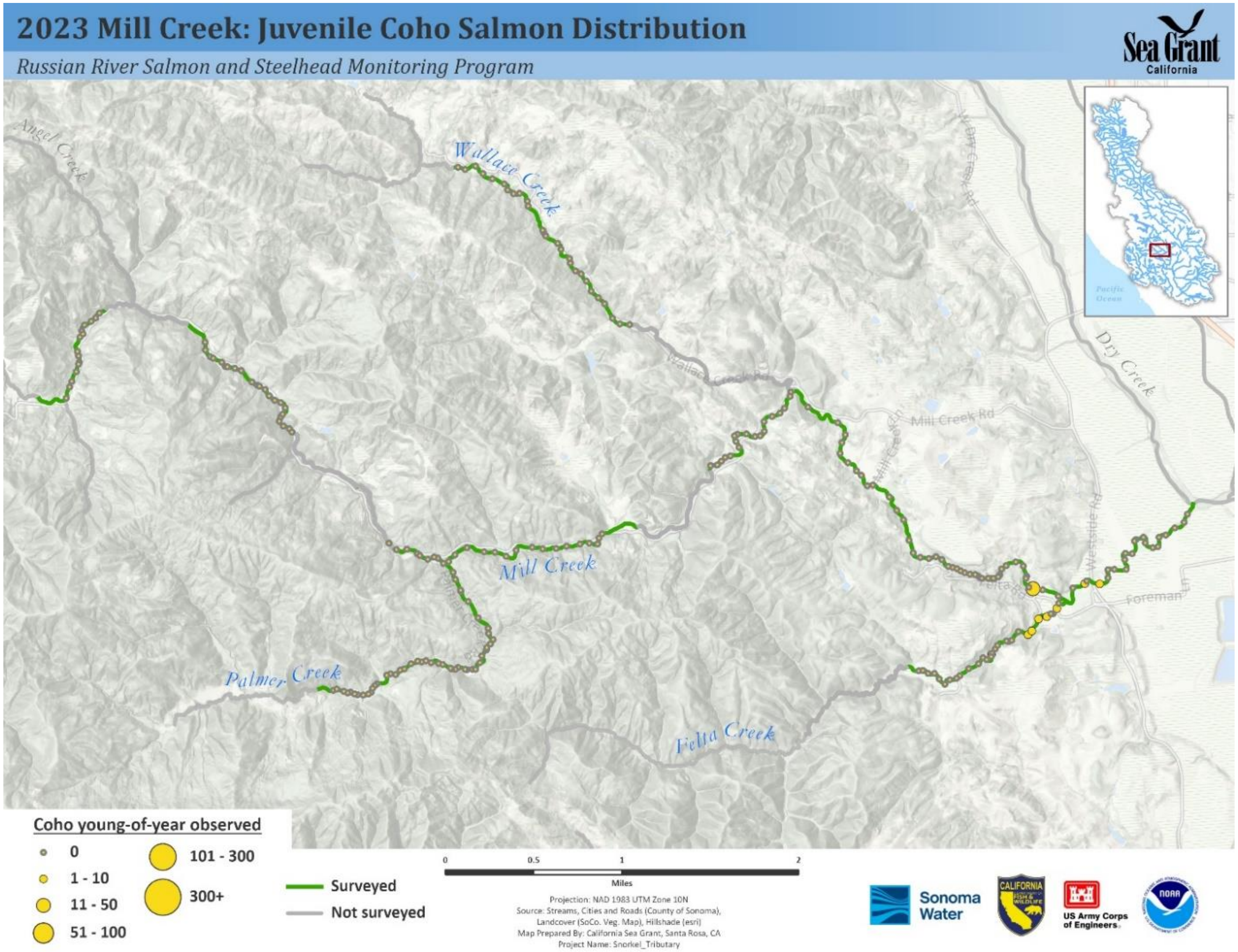

Figure 6. Density and distribution of juvenile coho salmon yoy observed in Mill Creek, 2023. Note that the smallest circle indicates no coho salmon observations in the associated pool.

3. Discussion and recommendations

With an expanded count of only 750 coho salmon yoy (Table 1), relative abundance of coho salmon was lower during the summer of 2023 than in any of the previous nine years of basinwide snorkel surveys. Similarly, spatial occupancy of juvenile coho salmon was lower than in all previous years of sampling (Table 3). In contrast to coho salmon, the relative abundance of steelhead yoy during the summer of 2023 was higher than the previous two years of basinwide surveys, breaking a trend of progressively lower counts.

The low abundance and spatial distribution of coho yoy in summer 2023 was not unexpected and is likely the result of a previous generation that experienced extreme drought conditions during the spring in which they emigrated as smolts. The 2020 cohort (BY2019) experienced extremely low survival to the smolt stage (0.05 mean survival of fall-release fish from release to the smolt stage), resulting in low smolt abundance (California Sea Grant 2021). Extreme low flow conditions during the spring of 2021 prevented smolts from emigrating and is thought to be a primary cause of low survival and low smolt abundance. Sonoma Water also documented low coho smolt survival through the Russian River mainstem during the spring of 2021 (Horton et al. 2021). Low smolt abundance in 2021 carried through to the adult stage with estimated redd abundance in 2022/23 the lowest on record over the last nine years (California Sea Grant and Sonoma Water 2023). We think that the low numbers of redds, in turn, was the primary cause for so few coho yoy observations during summer 2023. It appears that density dependent processes were not able to compensate for the low smolt abundance observed for the 2020 cohort, resulting in almost no natural-production in 2023.

To explore relationships between redd abundance and natural production, we compared basinwide redd abundance estimates with subsequent basinwide expanded coho yoy counts standardized by stream length and proportion area occupied (Figure 7). Over the nine years of data collection, coho yoy density was positively correlated with PAO ($R^2 = 0.63$) but relationships between redd abundance and juvenile metrics were less clear. The lowest coho yoy density and PAO (2023) corresponded with the lowest redd abundance, and the highest coho yoy density and PAO (2022) corresponded to a somewhat high redd abundance. However, aside from these relationships in extreme years, no clear correlations were apparent.

The lack of correlation between redd abundance and subsequent juvenile abundance and spatial distribution could be caused by variability in survival from the egg to summer yoy stage. For example, in years with high flow storm events following spawning, redds may be scoured, resulting in low early-life stage survival and low juvenile abundance even when redd abundance is high. As another example, low flow conditions following spawning can lead to redd desiccation, another source of early life-stage mortality that could impact expected correlations between parent and juvenile abundance. Alternatively, in years where high early-life stage survival is high, redd abundance might be a strong predictor of juvenile abundance.

Another potential cause for a lack of correlation between redd abundance and juvenile metrics is the high level of uncertainty surrounding the redd abundance estimates, as evidenced by the overlapping confidence intervals across nearly all of the estimates. Winter storm events pose an impediment to acquiring precise redd abundance estimates. While we attempt to survey each stream reach within a 14-day window of time, storm events resulting in high turbidity and unsafe wading conditions frequently preclude this from occurring. Furthermore, we are unable to calculate uncertainty surrounding juvenile abundance and PAO. The high uncertainty surrounding the estimates could be masking patterns that are actually present. We suggest analysis of this developing time series of redd and juvenile data in relation to environmental data, including high and low flow metrics to help disentangle these relationships and further understand why high redd abundance is not always followed by high juvenile abundance.

To compare the spatial distribution of coho yoy in summer of 2023 with redd locations observed during the previous winter, we overlaid the two datasets (Figure 8). To contrast this with a highly productive cohort, we completed a similar overlay for snorkel survey data collected during the summer of 2022 and winter 2021/22 (Figure 9). In the example with lower redd and juvenile abundance (winter 2022/23 and summer 2023), juvenile spatial distribution did not track redd distribution as well as in the year with higher abundance (winter 2021/22 and summer 2022). For the lower abundance cohort, redd and juvenile distribution tracked well in some streams (e.g., lower Mill and Felta), while in other streams, it did not (e.g., lower Pena). As discussed previously, lack of correspondence could be due to poor early life-stage survival (e.g., lower Pena is prone to drying out early, likely leading to poor early-life stage survival). Lack of correspondence may also be related to high uncertainty surrounding estimates, which can be greater when counts are low.

All coho salmon yoy observed during 2023 snorkel surveys were presumed to be of natural-origin since no fished were stocked during the spring of 2023. However, it is possible that some fish documented as yoy were small-sized age-1 fish that did not emigrate from the streams during the spring of 2023. Such “holdovers” have been documented previously in Russian River tributaries using PIT tag data (CSG unpublished data). There is no visual mark we can use to distinguish age classes or hatchery- v. natural-origin juveniles; therefore, estimated length is used to estimate age classes during snorkel surveys. This has the unintended consequence that if age-1 fish are small, they can be incorrectly classified as yoy. This is a likely possibility in streams where fewer than 10 coho yoy were observed and in Green Valley Creek where all 75 of the coho yoy observed were found in a single, 240m-long pool. If this is the case, natural production from the 2022/23 spawning season may be even lower.

Although low juvenile abundance in 2023 was not surprising because of the relatively low redd abundance estimates during the winter of 2023/24, we expected to observe more than 375 coho yoy when surveying half of the pools in 200 km of stream length in the Russian River watershed. To generate a ball-park projection of the expected number of coho yoy produced from an estimated 74 redds in 2022/23 (California Sea Grant and Sonoma Water 2023), we multiplied 74 by an estimated mean number of eggs/female of 2,360 (Broodstock Program unpublished data) and a nine-year mean egg to juvenile survival rate estimated in nearby Olema Creek of 0.10 (Woodward et al. 2010). Using these values, the predicted number of juveniles in Russian River tributaries during the summer of 2023 is 17,464. While this method of prediction is very coarse, the fact that that is orders of magnitude higher than the numbers observed suggests a high level of early-life stage mortality and we recommend analysis and research that focuses on identifying bottlenecks occurring during this portion of the life cycle, as well as restoration actions that improve early life stage survival.

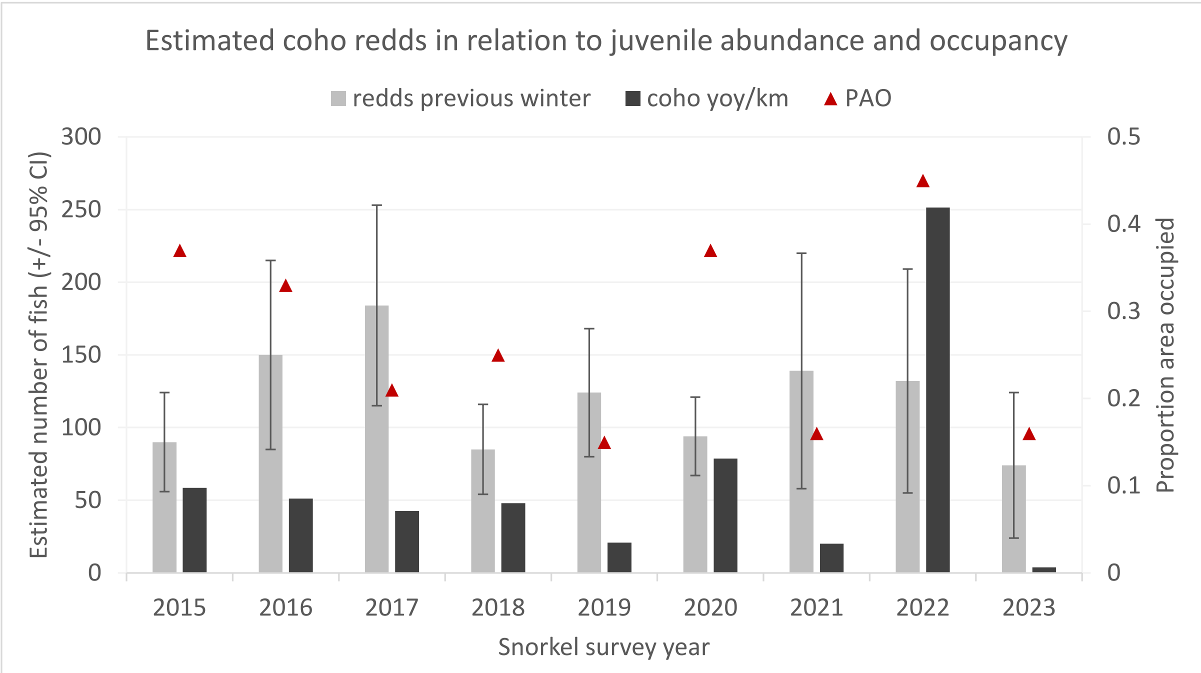

Figure 7. Estimated coho salmon redd abundance in relation to natural production (coho salmon yoy density and percent area occupied (PAO) the following summer) in the Russian River watershed.

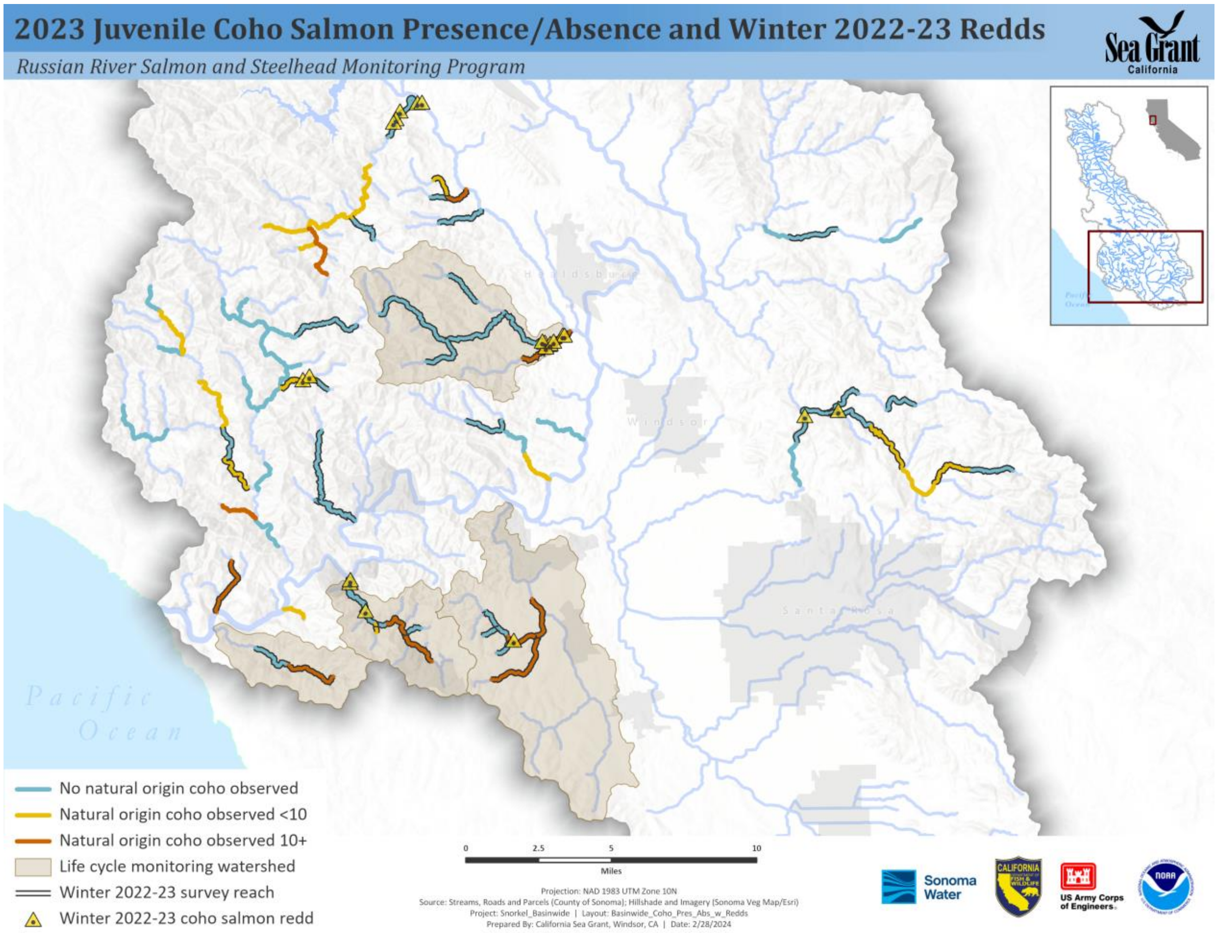

Figure 8. Russian River coho salmon redd locations observed during winter 2022/23 in relation to coho yoy presence/absence in 2023.

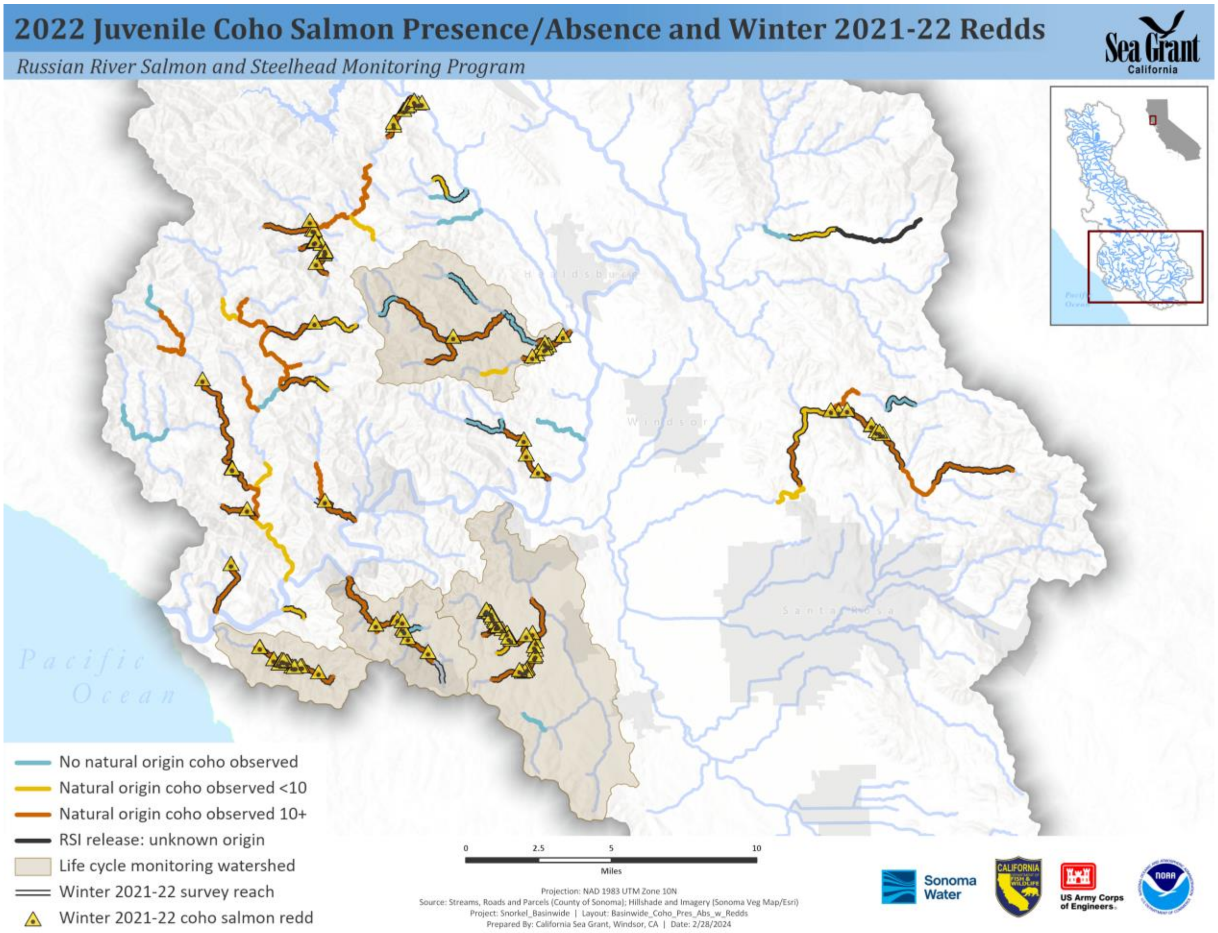

Figure 9. Russian River coho salmon redd locations observed during winter 2021/22 in relation to coho yoy presence/absence in 2022.

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