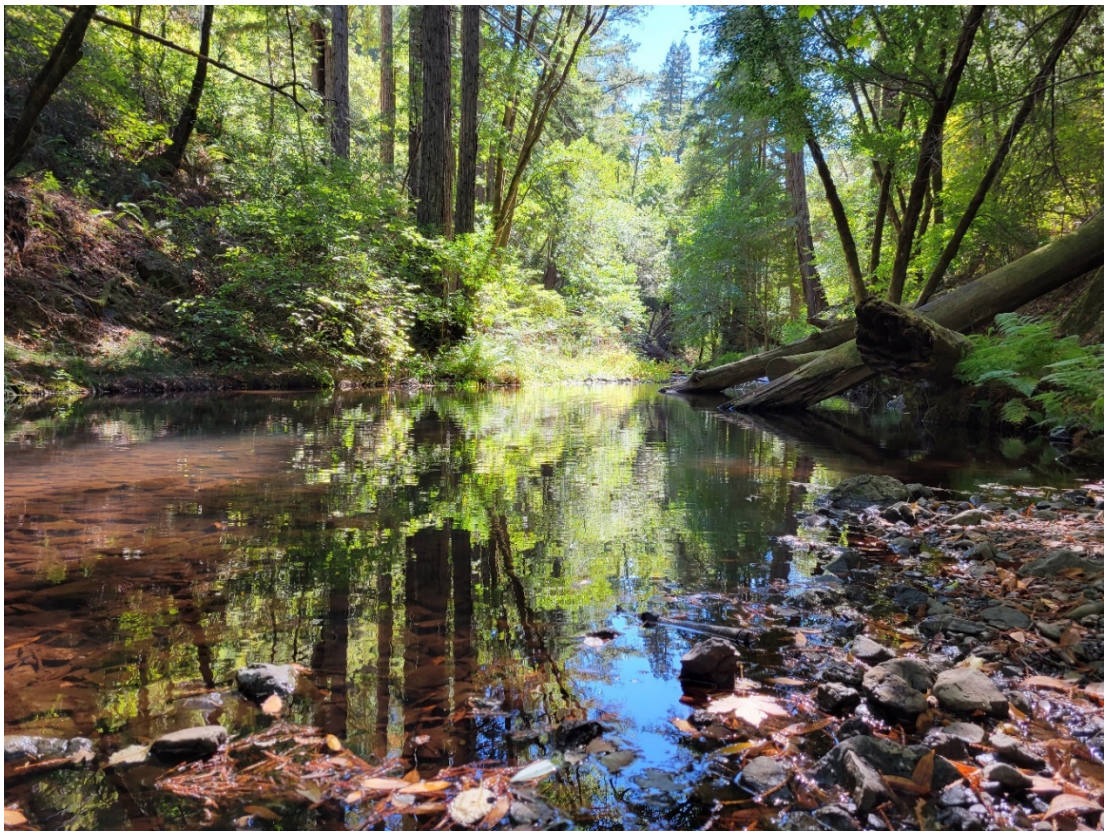
LAGUNITAS CREEK SALMONID HABITAT 2022-2023



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MARIN WATER

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In the summer of 2022, a habitat typing survey was conducted in Lagunitas Creek and two of its tributaries, San Geronimo Creek and Devil's Gulch. This was the ninth survey conducted since 1992. This report assesses current habitat conditions and trends.

Overall changes in habitat quality were mostly positive between 2016 and 2022. There was an observed increase in riffles per mile, large wood, bank vegetation, canopy cover, and gravel in most reaches. However, the number of pools per mile was consistently below what the National Marine Fisheries Service considers to be "properly functioning." Large wood in pools increased in Lagunitas and San Geronimo Creeks, but decreased in Devil's Gulch.

Across the decades of habitat monitoring in the Lagunitas Creek Watershed there has been an overall improvement in habitat, particularly in recent years. Bank vegetation and canopy cover have increased consistently. In 2022 riffle and pool frequencies, wood in pools, and gravel abundance were above the long-term averages in most reaches. Habitat enhancement efforts, particularly the placement of large logs, appear to be working. Ongoing habitat improvements are likely to be observed as enhancement efforts continue.

1.0 INTRODUCTION

Lagunitas Creek flows from the north slope of Mount Tamalpais through a series of four water supply reservoirs, the downstream-most being Kent Lake. From there the creek flows northwestward for 12 miles before discharging into Tomales Bay. The Lagunitas Watershed supports coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), and California freshwater shrimp (*Syncaris pacifica*). The dams on Lagunitas and Nicasio Creeks prevent these species from accessing half of the watershed. Lagunitas Creek has three main tributaries: San Geronimo Creek, Devil's Gulch Creek, and Olema Creek. Although Devil's Gulch is a small tributary, it provides good spawning habitat for salmonids. The San Geronimo Valley is the most developed part of the watershed and continues to provide suitable habitat for different salmonid life stages. Salmonid habitat in Olema Creek is managed and monitored by the National Park Service.

The Marin Municipal Water District (MMWD; Marin Water), the National Park Service (NPS), California Department of Parks and Recreation (DPR), and Marin County Open Space District publically own much of the Lagunitas watershed. These organizations and others work collaboratively to manage and improve habitat for salmonids.

In 1992, MMWD began habitat typing surveys of Lagunitas Creek seeking to identify ways to improve habitat for salmonids. In 1995, the State Water Resources Control Board (SWRCB) mandated MMWD to monitor populations of salmonids and freshwater shrimp in Lagunitas Creek as part of SWRCB Order WR95-17. MMWD developed the *Aquatic Resources Monitoring*

Workplan for the Lagunitas Creek Drainage (Trihey 1996), which was updated as part of the *Lagunitas Creek Stewardship Plan* (MMWD 2011). Both of these plans stipulate that habitat typing is to be conducted at least every five years, or more frequently if unusually high flow events alter the riparian zone and stream channel (Trihey 1996, MMWD 1997). Habitat typing enables MMWD to:

- Assess salmonid habitat composition and quality,
- Extrapolate fish densities at index reaches to similar habitats throughout the watershed, and
- Evaluate the success of habitat enhancement efforts.

Habitat typing was previously conducted in the Lagunitas Creek watershed in 1992, 1995, 1997, 1998 (completed in 1999), 2003, 2006, 2011, and 2016.

2.0 METHODS

2.1 Habitat Typing

The survey was conducted by MMWD fisheries department staff and two members from the Watershed Stewards Program (WSP) serving at MMWD. The survey was conducted from the end of June to the beginning of August, 2022. The Lagunitas Creek survey spanned approximately eight miles from Nicasio Creek to Peters Dam. The Devil's Gulch survey started at its confluence with Lagunitas Creek to a point about two miles upstream. The San Geronimo Creek survey started at the confluence with Lagunitas Creek at Shafter Bridge to the Dickson Weir, approximately five miles upstream (Figure 1). Habitat data were aggregated by reach for analysis. Lagunitas Creek was divided into three reaches: Nicasio Creek to Tocaloma, Tocaloma to Devil's Gulch, and Devil's Gulch to Peters Dam. San Geronimo Creek was split into two reaches: Mouth to Larsen Creek (lower) and Larsen Creek to Dixon Weir (upper). Devil's Gulch data were analyzed as one reach. Large woody debris data for all reaches were collected in 2023 by two members from the Watershed Stewards Program (WSP) serving at MMWD.

The California Salmonid Stream Habitat Restoration Manual (Flossi et al. 2010) methodology was followed for a "Level II" stream. It classifies habitats as either "pool," "riffle," or "flatwater." There were two modifications to this methodology. "Flatwater" habitats were distinguished as "run" or "glide" and "riffle" habitats were identified as either "riffle" or "cascade." Habitats that had no surface water at the time of the survey were classified as "dry." Habitat units were therefore classified as "pool," "riffle," "run," "glide," "cascade," or "dry."

This survey was conducted when flows in the mainstem of Lagunitas Creek are regulated at approximately eight cubic feet per second (cfs). Data collected during summer base flows, which were mandated by the State Water Board Order in 1995, can be compared across years.

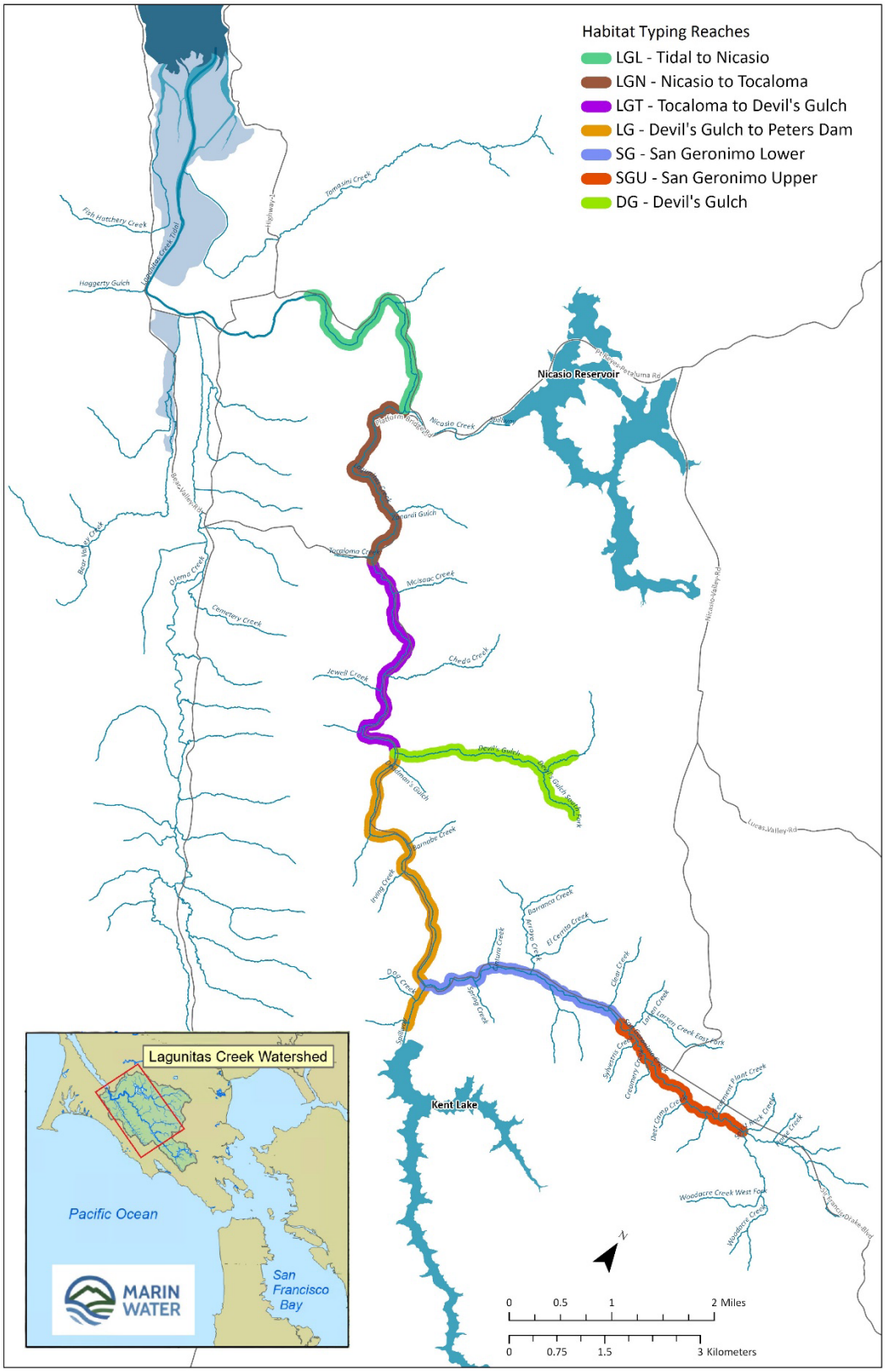

Figure 1. Survey reaches in the Lagunitas Creek Watershed

Surveys were conducted by walking upstream through each reach. Appendix A shows the parameters collected for each habitat since 1992. Measurements were taken using a measuring tape and measuring rod. Data were collected at every third unit of each unit type. Previously, habitat sampling followed guidelines from the California Salmonid Stream Habitat Restoration Manual (Flossi et al. 2010), using the "ten percent methodology." This protocol was changed to collect data for thirty percent of all habitat unit types. At these units, data were collected for width, depth, substrate, bank vegetation, bank composition, and shelter. At all riffle units, riffle crest thalweg depth and substrate data were collected. Bankfull widths were collected every tenth habitat unit, at the next encountered riffle.

Fish shelter quality was assessed by assigning a value to different shelter types: 0 for no shelter, 1 for a single feature, 2 for two features, and 3 for three or more features. These data were collected differently from, and cannot be directly compared to, data collected in previous years. The protocol was changed to collect more useful information going forward about fish shelter.

Large woody debris data were collected by measuring logs at least one foot in diameter and six feet in length or longer. Logs were classified as either being within the wetted stream, or within the bankfull channel. Jams were considered log piles with six or more logs and were measured by volume. Wood volume was compared to loading targets established in the *Lagunitas Creek Watershed Fine Sediment Reduction and Habitat Enhancement Plan* (SFBRWQCB 2014).

Substrate composition was recorded in the field by defining the primary and secondary substrates present. The substrate options were silt/clay/sand, gravel, cobble, boulder, bedrock, and concrete.

Bank vegetation data were collected similarly in all years. Dominant bank vegetation and percent vegetation cover were collected. Since 2003, left and right bank data have been collected separately. "Vegetated" banks included not just ground covered by plants, but areas stabilized by roots, which often required a subjective assessment of root extent.

2.2 Analysis of Parameters

Habitat typing data collected in 2022 were compared to data collected in 2016, 2011, 2006, 2003, 1998 , 1997, 1995, and 1992. For all years, side channel habitats were not analyzed. For each reach, habitat composition was determined by totaling the length of each habitat type and dividing by the total length of that reach. Only length was used in this analysis for comparison to previous years. Most other habitat comparisons were determined using the surface area of the creek.

To compare substrate composition with previous years, only the primary substrate was used in the analysis. Habitats were grouped by their primary substrates and their total area was compared to the total area of the reach. This provided an estimate of the proportion of each dominant substrate type. In 2003, silt and clay were two separate substrate types, which

inadvertently resulted in an underestimation of fine sediments. The 2003 data are not included in this analysis.

To compare bank vegetation data with previous years, data from both banks were combined. The linear extent of each vegetation type was calculated by multiplying the percent cover recorded for each by the length of each habitat unit. These lengths were totaled and divided by the total length of the reach, multiplied by two (for the length of each bank). These percentages were compared to previous years' data.

3.0 RESULTS

3.1 Habitat Composition

The overall habitat composition for Lagunitas Creek in 2022 was 45% pool, 22% run, 12% glide, and 21% riffle. In San Geronimo, the composition was 53% pool, 4% run, 18% glide, and 18% riffle. In Devil's Gulch, the composition was 27% pool, 2% run, 25% glide, and 31% riffle.

There was a significant increase in the proportion of riffles since 2016 (Figure 2a). In Lagunitas Creek riffle habitat increased from 7% in 2016 to 21% in 2022, the highest ever recorded. In Lagunitas and San Geronimo Creeks the average riffle length increased, while in Devil's Gulch there was a decrease in the average riffle length.

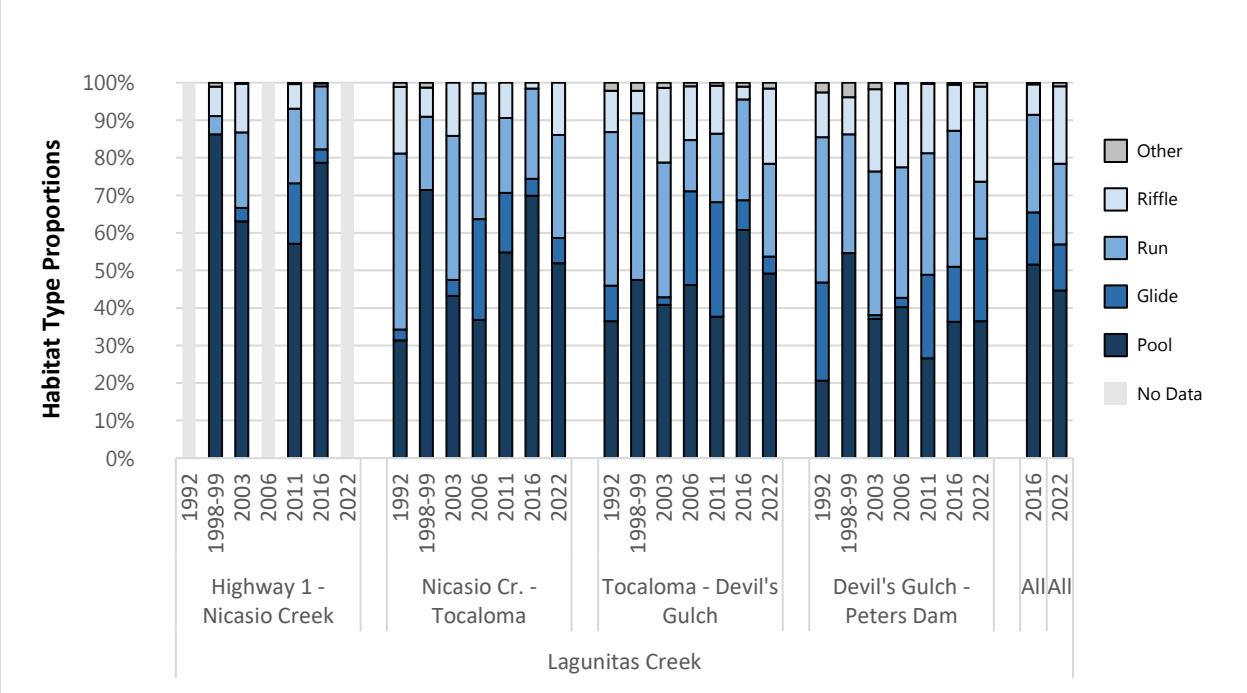

Figure 2a. Habitat composition of Lagunitas Creek

In San Geronimo Creek and Devil's Gulch, glide habitats increased while run habitats shrank significantly (Figure 2b).

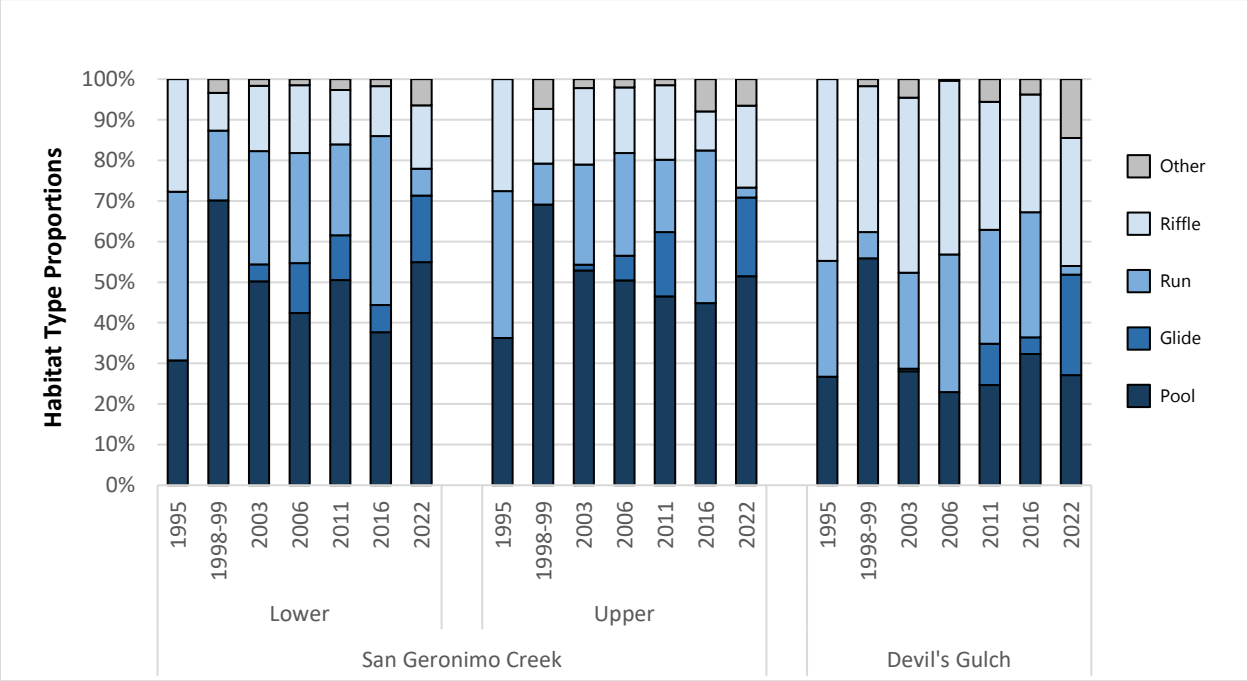

Figure 2b. Habitat composition of tributary streams

An increase in riffle frequency (riffles per mile) was observed in all reaches (Figure 3).

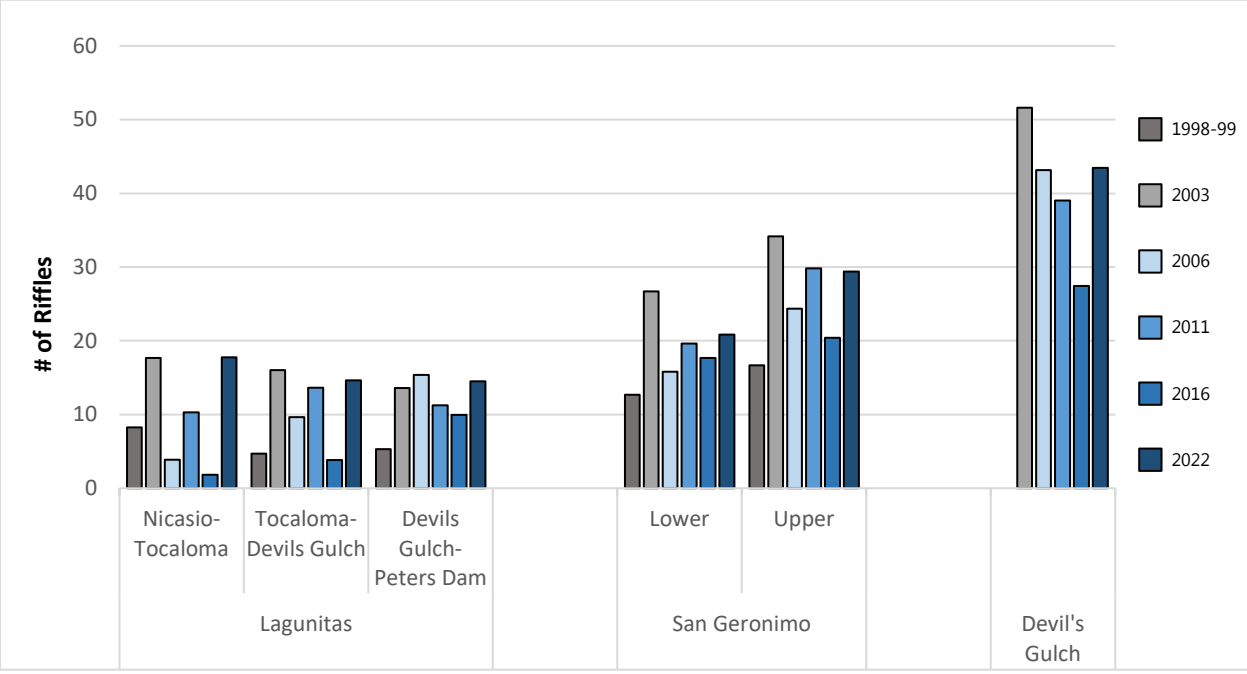

Figure 3. Riffle frequency

Pool habitat in the Lagunitas Watershed is below what is considered “properly functioning” by the National Marine Fisheries Service (NMFS 1996), which is based on stream width and therefore differs between streams and reaches (Figure 4). The number of pools per mile decreased slightly in Lagunitas Creek, remained the same in Devil’s Gulch, and increased in San Geronimo Creek.

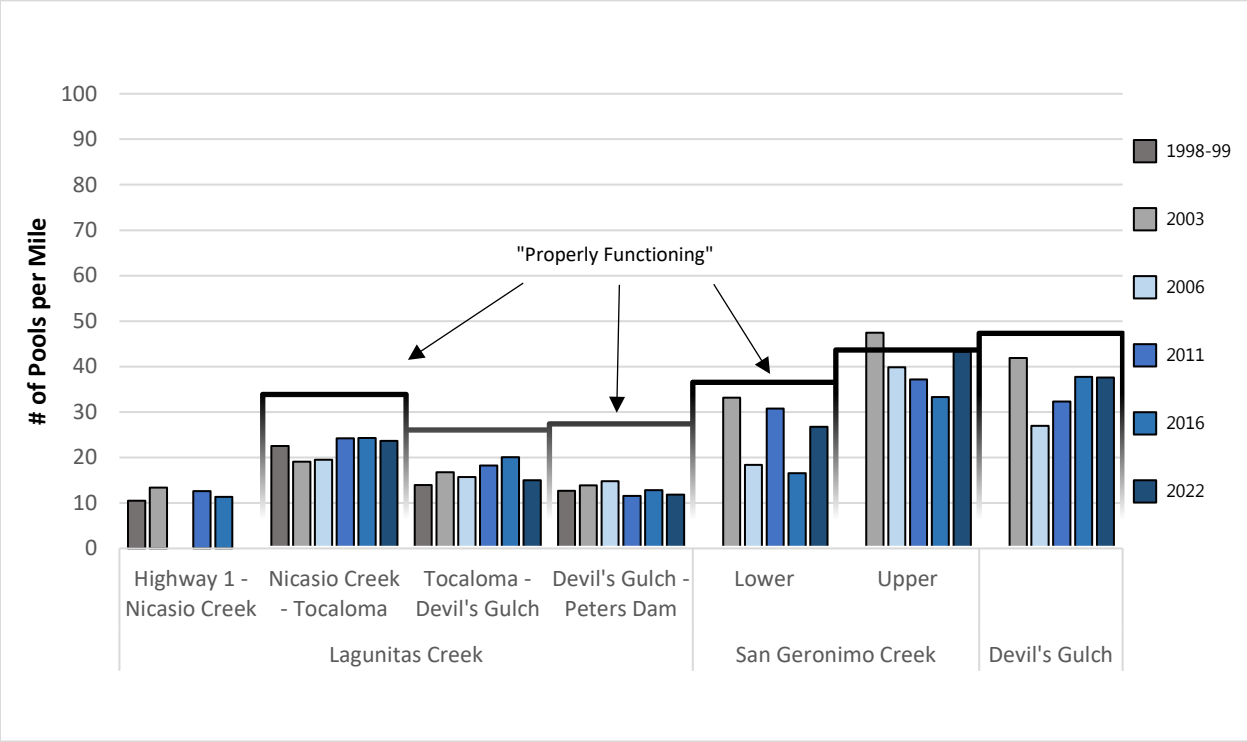

Figure 4. Pool frequencies

3.2 Shelter

Shelter ratings were collected for all reaches (Figure 5). The most salmonid shelter was found in Lagunitas Creek, while Devil’s Gulch had the least shelter available. Due to methodological changes, shelter data collected in 2022 is not directly comparable to previous years.

The number of pools with large woody debris increased in Lagunitas and San Geronimo Creeks since 2016 (Figure 6). Lagunitas Creek had the highest proportion of pools with large woody debris among the surveyed streams.

Large woody debris (LWD) volume increased in all reaches, largely driven by increases in jam volume (Figure 7). The three largest log jams contained nearly a quarter of all the wood in Lagunitas Creek. Changes in log volume were relatively small, except in Devil’s Gulch, where log volume nearly doubled. Very little wood was identified in much of lower San Geronimo Creek (Figure 8).

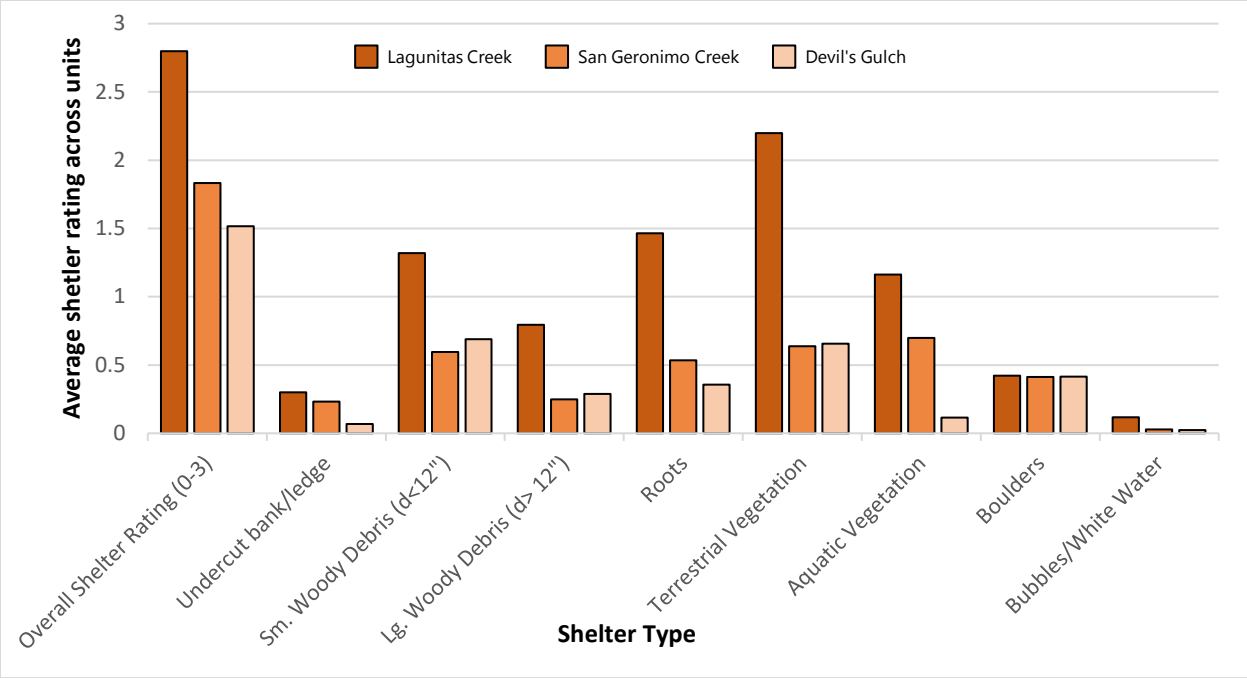

Figure 5. Shelter ratings

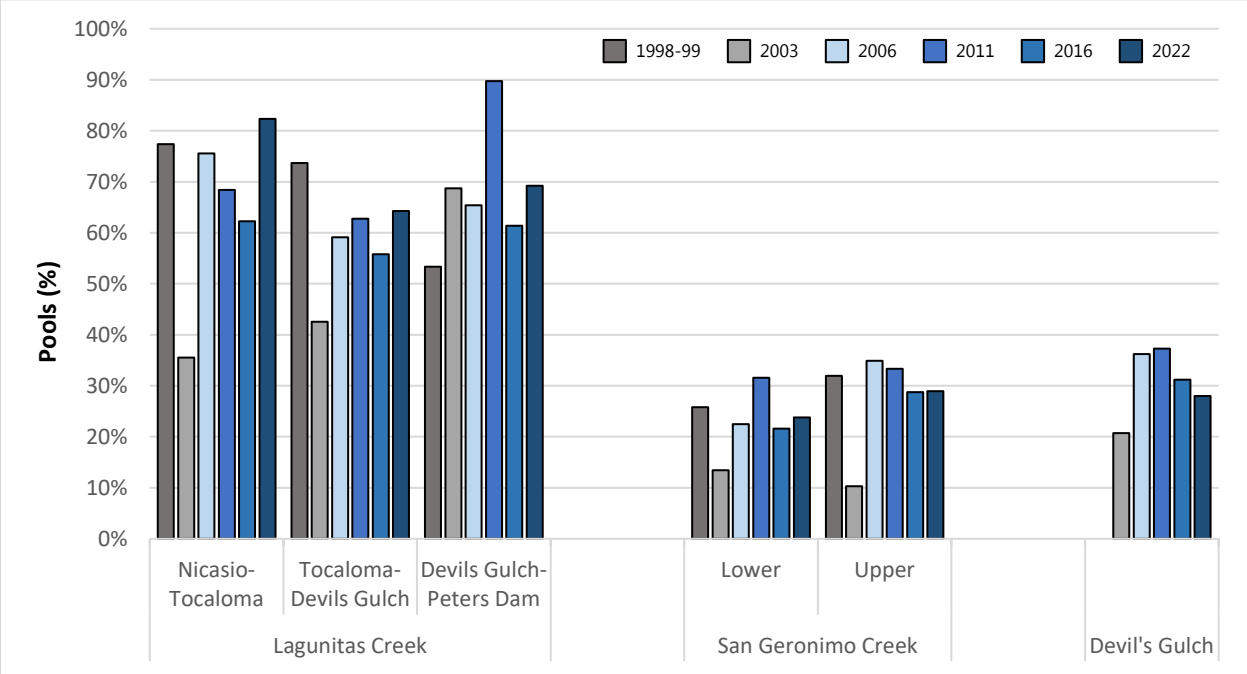

Figure 6. Pools containing large wood

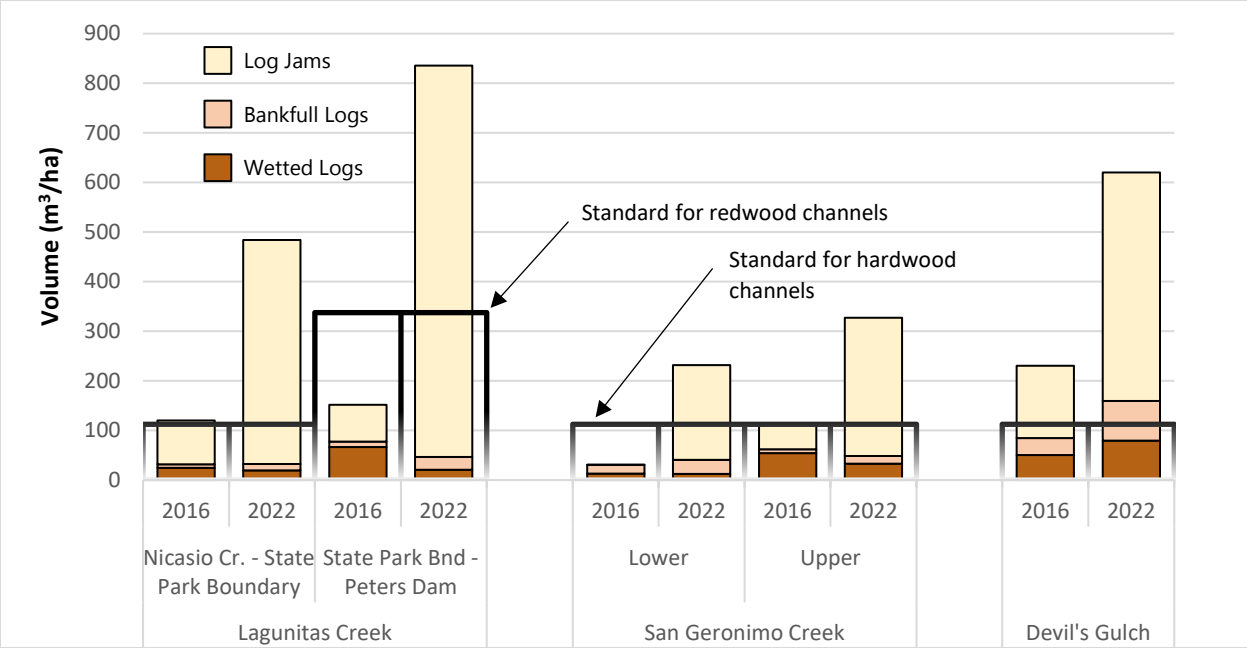

Figure 7. Wood volume (standard defined in SFBRWQCB 2014)

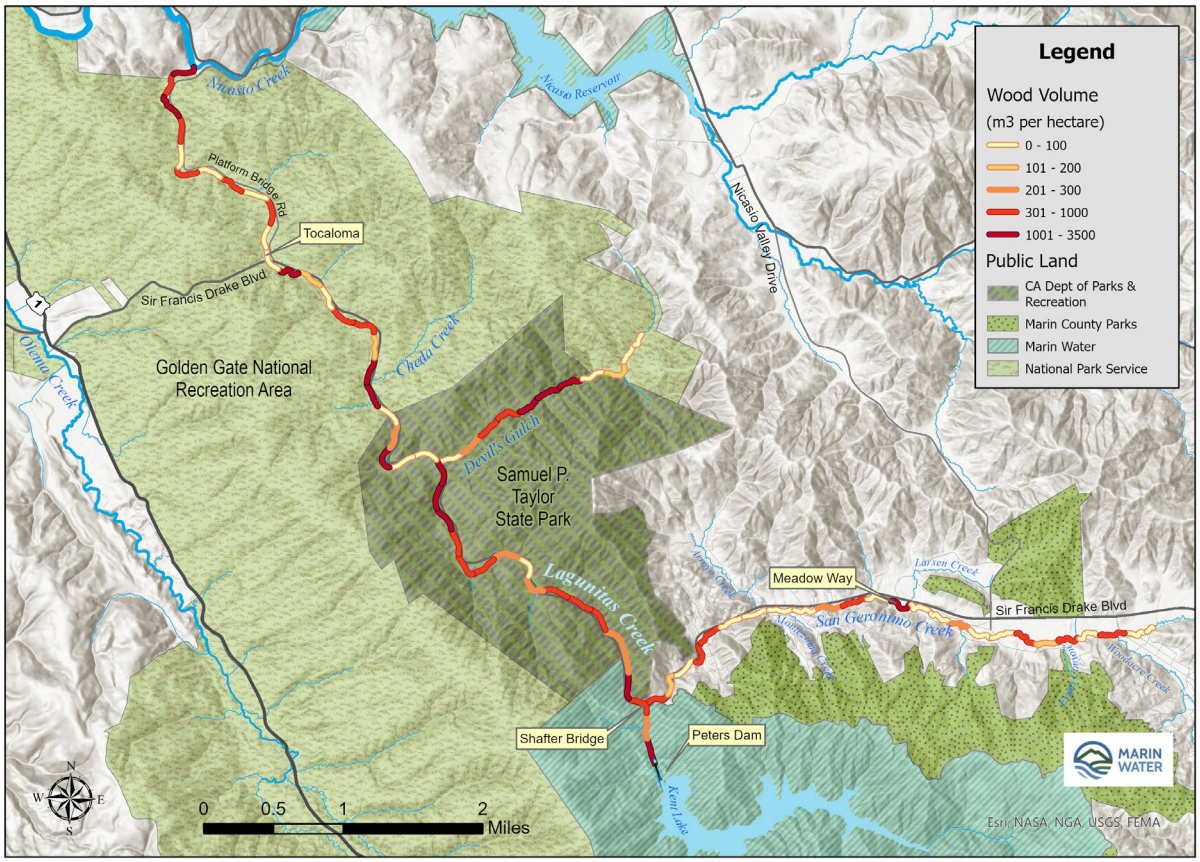

Figure 8. Wood distribution

3.3 Bank Vegetation

Bank vegetation increased in all of the reaches (Figures 9a and 9b). The proportion of deciduous trees (e.g. willow, alder, ash) increased in comparison to evergreen trees (e.g. redwood and Douglas fir). An increase in shrubs and herbaceous plants was recorded in most reaches.

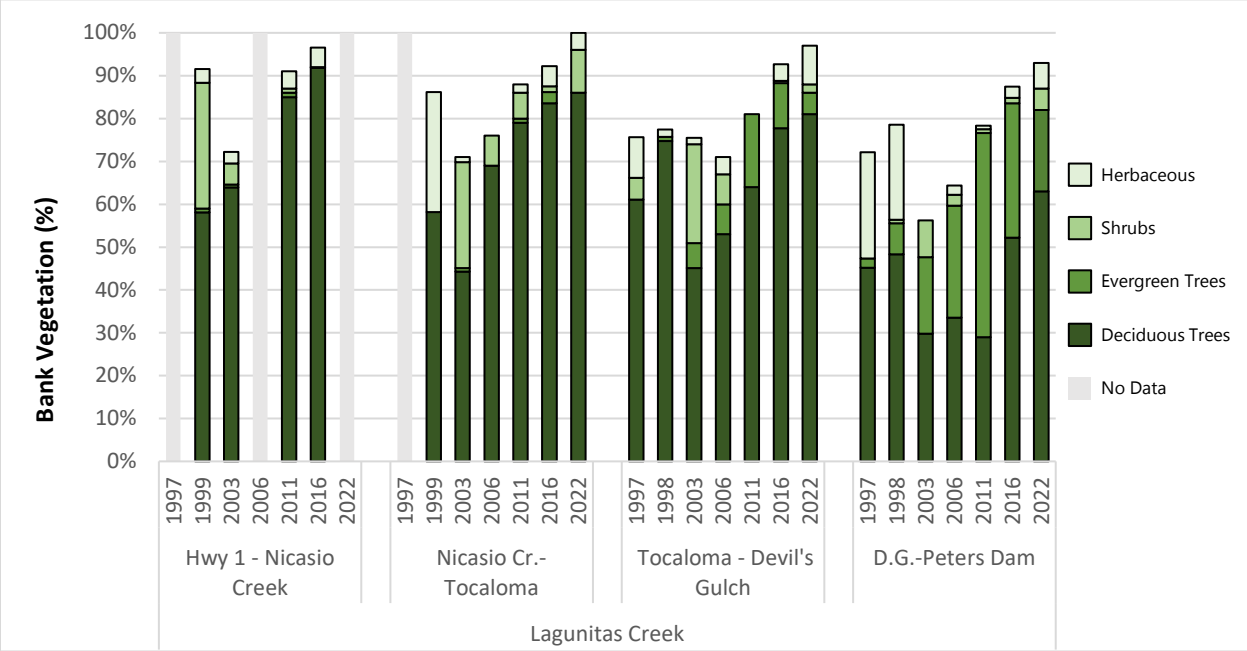

Figure 9a. Dominant bank vegetation in Lagunitas Creek

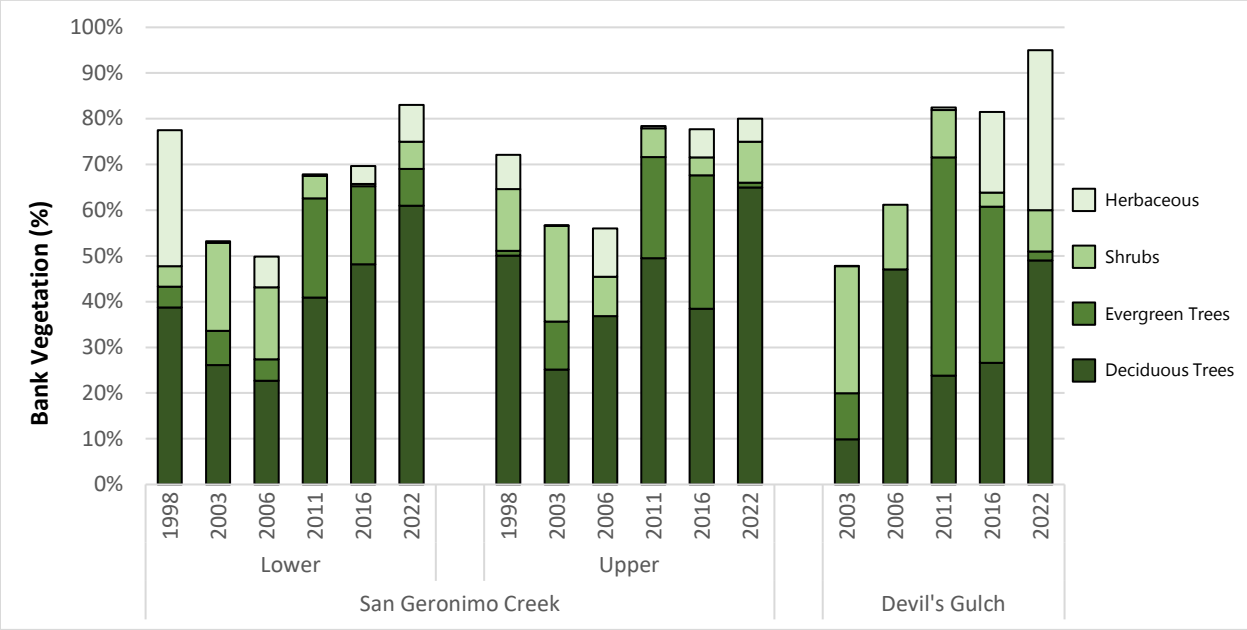

Figure 9b. Dominant bank vegetation in tributaries

Canopy cover increased in all reaches of Lagunitas and Devil's Gulch, reaching the highest percent cover ever recorded (Figure 10). Canopy cover decreased in San Geronimo Creek.

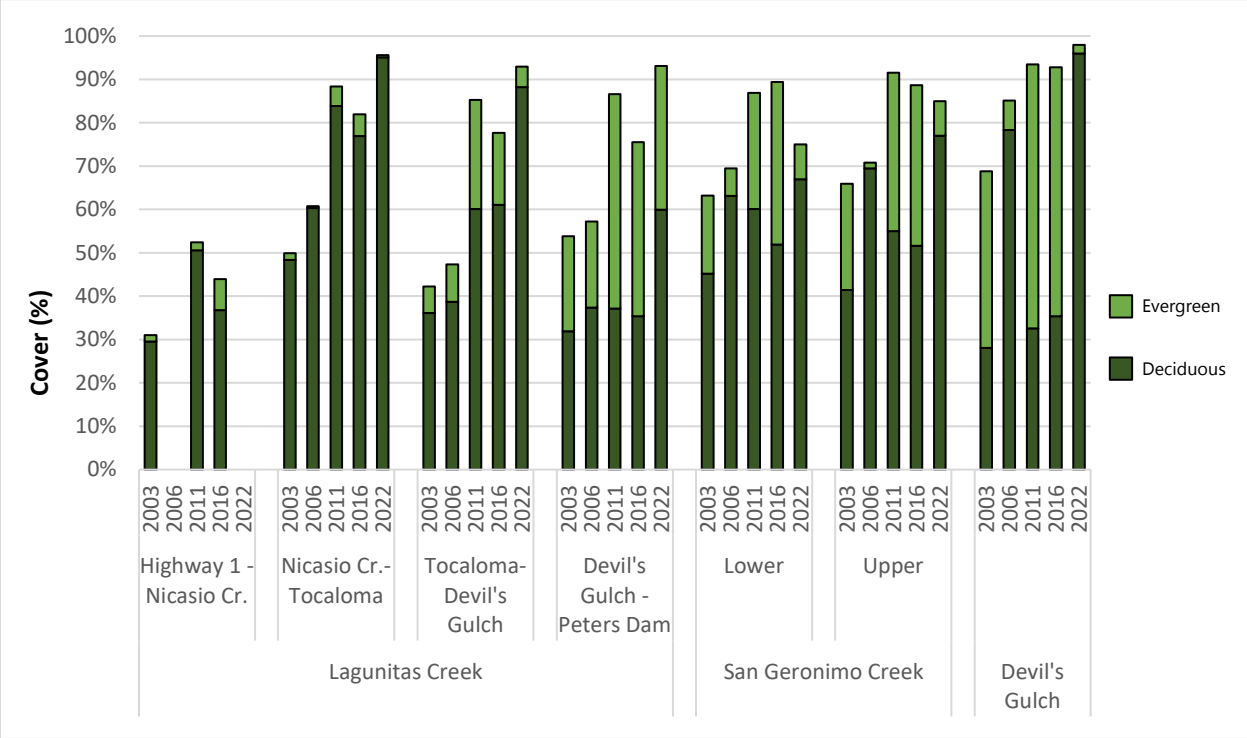

Figure 10. Canopy cover

3.4 Substrates

The largest change in substrate from 2016 to 2022 was the decrease in silt/clay/sand and increase in gravel, to the highest proportion of gravel observed since 2006 (Figures 11a and 11b). This change was seen in all reaches except for lower San Geronimo Creek (mouth to Larsen Creek).

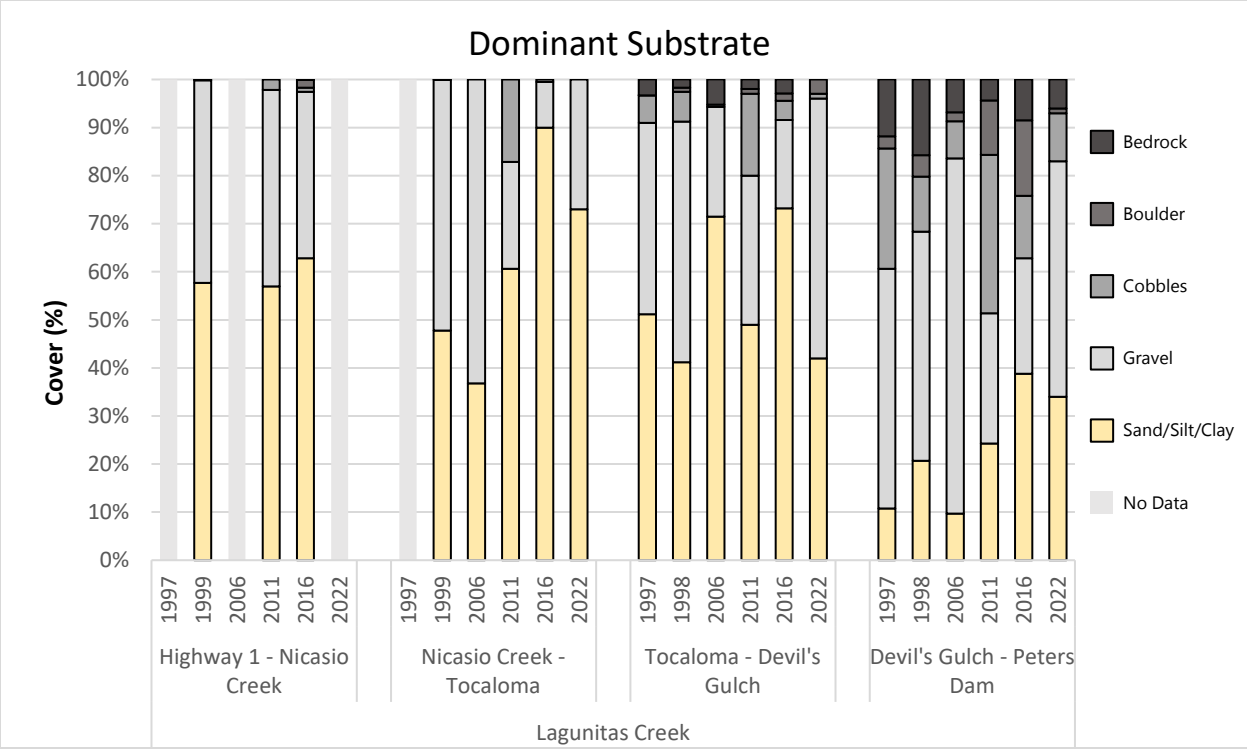

Figure 11a. Lagunitas Creek substrates

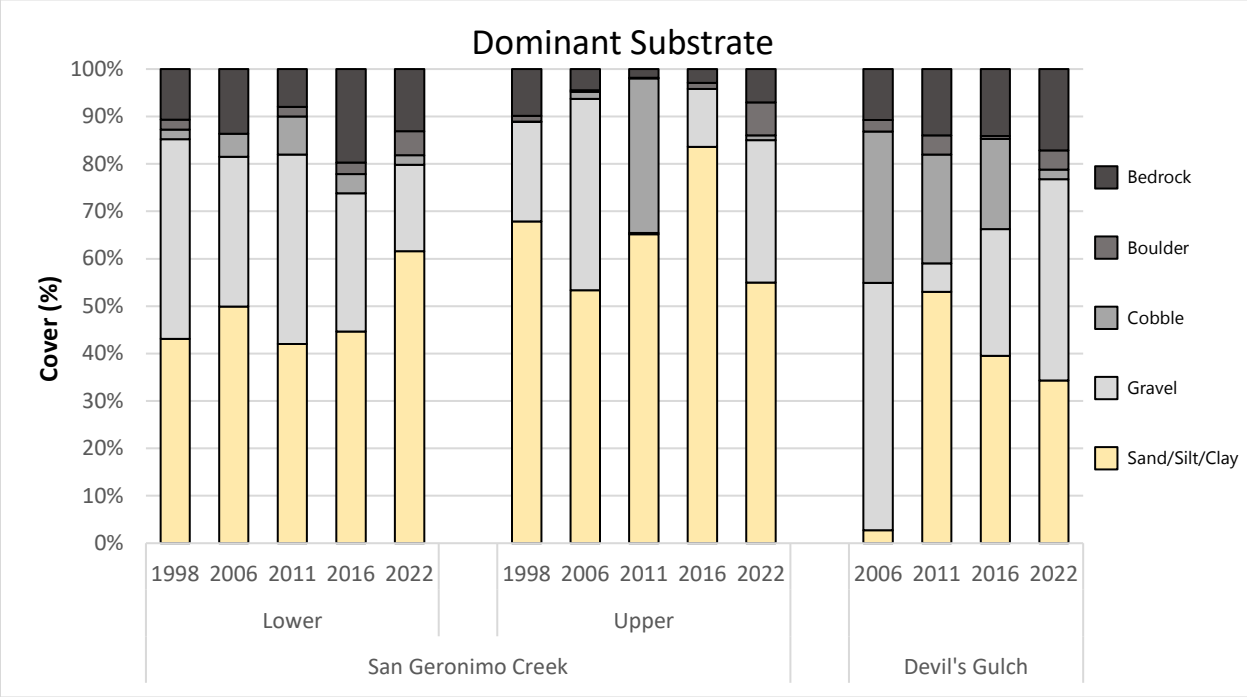

Figure 11b. Tributary substrates

4.0 DISCUSSION

Overall, salmonid habitat in Lagunitas Creek, San Geronimo, and Devil's Gulch showed improvement between 2016 and 2022. One clear improvement in all reaches was the increase in riffles. This coupled with the increase in gravel and decrease in fine sediment points to an overall improvement in salmonid spawning habitat. Only one reach, Lower San Geronimo, did not see this improvement in substrate conditions.

While more riffles were seen in all reaches, along with a decrease in run and glide habitat types, pool habitat results differed between reaches. For the most part, pool frequencies were similar to previous years and remained below what is considered healthy for a "properly functioning" stream.

The number of pools with large woody debris increased in Lagunitas and San Geronimo Creeks, and decreased in Devil's Gulch. The volume of large woody debris increased in all reaches, helping to develop riffles, scouring the streambed to create pools, and providing shelter for juvenile salmonids.

In 2022, canopy cover was greater than ever recorded in Lagunitas and Devil's Gulch, but declined in San Geronimo. The overall increase in canopy cover benefits salmonids by helping to keep streams cool.

Habitat typing data can vary significantly based on the team conducting the survey. Over the years, each survey has been conducted by different people, and combined with the subjective nature of habitat typing can lead to a great deal of "surveyor bias." To investigate this bias, we looked for depth outliers among each habitat type and checked that individual habitat units were at least as long as they were wide. Pools are typically the deepest habitat types, runs and glides are moderately deep, and riffles are the shallowest (Figures 12a, 12b and 12c). We were able to use these depth criteria to confirm habitat classifications in the vast majority of cases. However, runs and glides could not be differentiated by their maximum depths alone, and were thus classified based on additional characteristics, including substrate and water velocity. Habitats dominated by silt/clay/sand were consistently classified as glides, while boulder- and cobble-dominated habitats were consistently classified as runs. However, shallow, gravel-dominated habitats were variably classified as either runs or glides (Figure 13). To reduce such subjectivity in future habitat typing surveys, runs and glides may be lumped as "flatwater" habitats, as suggested for CDFW's "Level II" classification scheme.

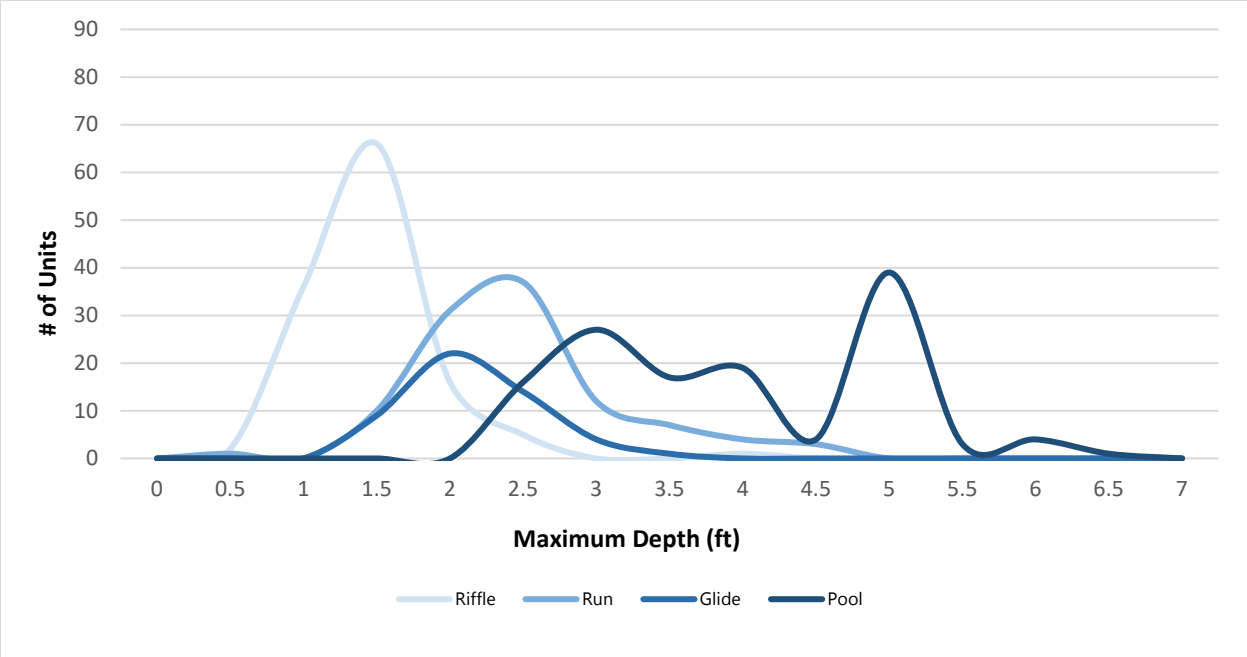

Figure 12a. Habitat depths in Lagunitas Creek

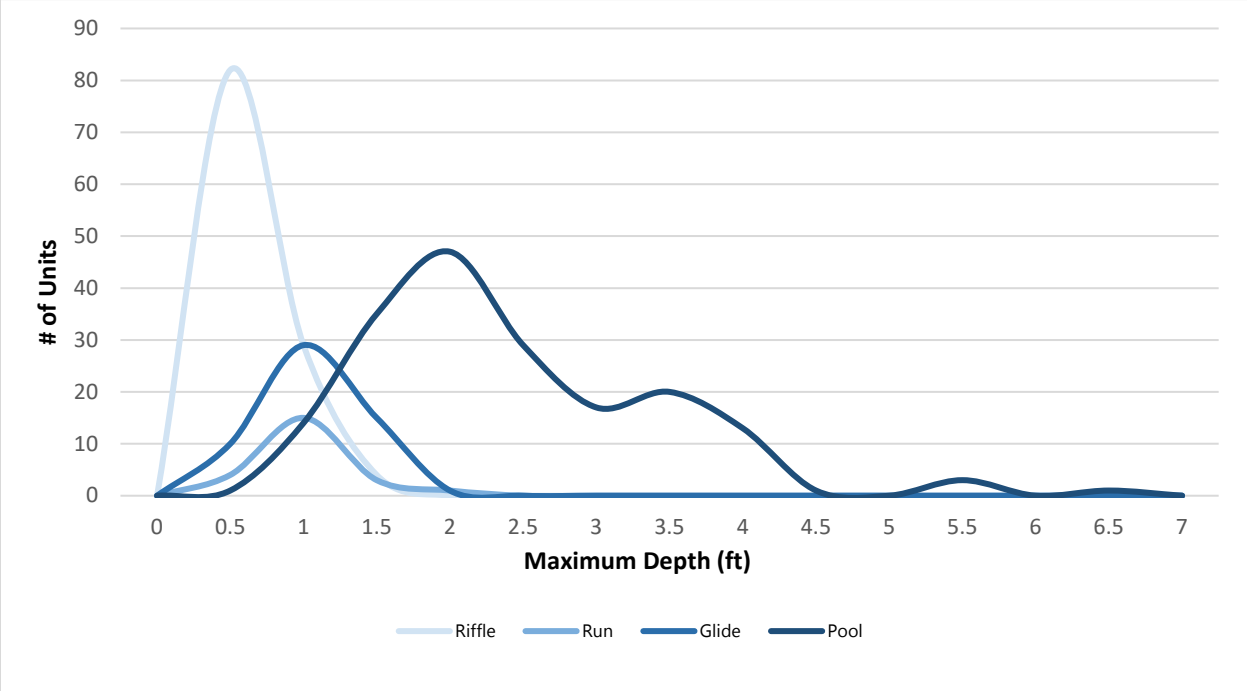

Figure 12b. Habitat depths in San Geronimo Creek

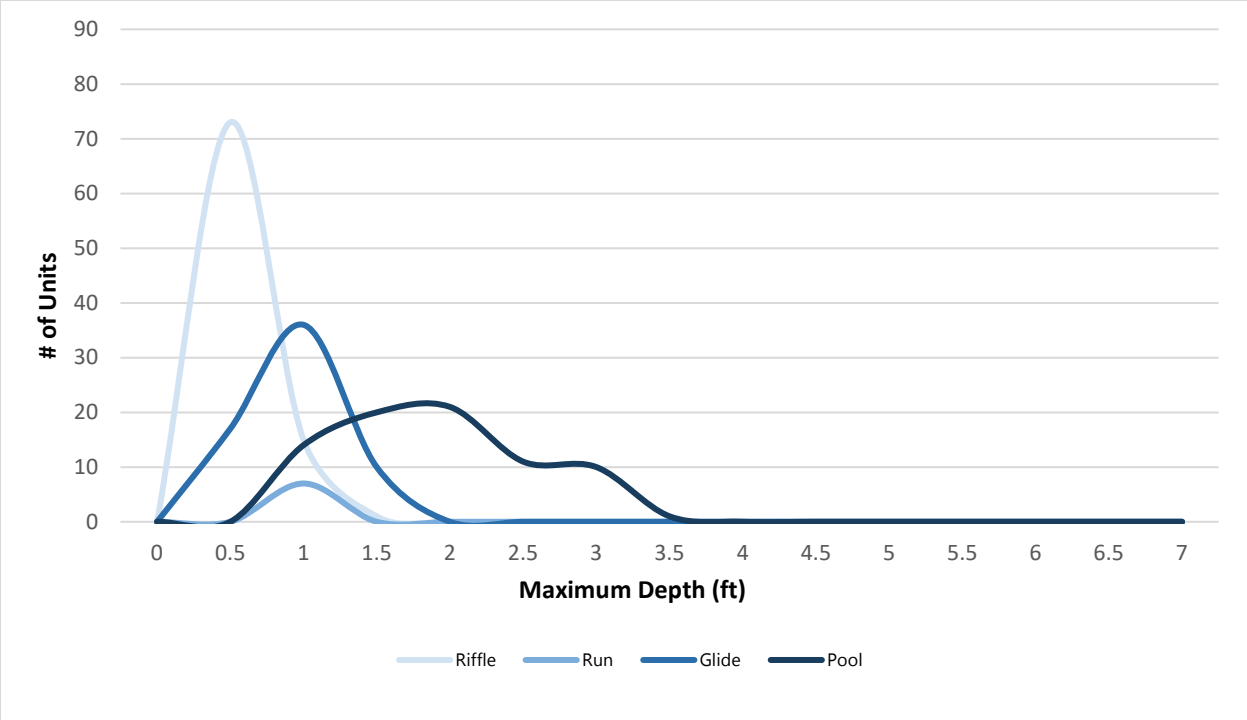

Figure 12c. Habitat depths in Devil's Gulch

5.0 CONCLUSIONS

Marin Water's long-term analysis of salmonid habitat quality over the past 20 years has documented areas of improvements, no discernable change, and declines in various parameters. Describing salmonid habitat as simply improving or declining throughout the entire Lagunitas Creek watershed would be a gross oversimplification. Summarizing broad trends in salmonid habitat quality over decades is similarly difficult. However, some clear trends were found that suggest that habitat enhancement efforts have been effective.

One of Marin Water's goals for placing large wood into streams is to convert long, homogenous habitats (typically glides) into heterogeneous pool-riffle sequences. The long-term increases in riffle frequency and pools containing large wood suggest these efforts are having the desired effect. Additionally, fine sediment contributions to the stream network have been reduced by the many erosion control projects implemented during the past two decades. The shift from sand/silt substrate to gravel in the surveyed reaches may be at least partially attributable to these upland improvements.

While some riparian planting has been undertaken in the watershed, the long-term increases in bank vegetation and canopy cover likely reflect an ongoing recovery from logging and a more hands-off management approach by State Parks. It is notable that the only stream where canopy cover declined between 2016 and 2022 was San Geronimo Creek, where habitat disturbance is most acute. For streams experiencing less disturbance and/or active restoration,

we are likely to see a continuation of trends toward denser canopy cover, improved spawning conditions, and more in-stream shelter for juvenile salmonids.

6.0 REFERENCES

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Appendix A. Habitat typing survey parameters

	1992	1995	1997	1998	1998	1999	2003	2006	2011	2016	2022
	Lag	SG, DG	Lag	Lag, SG	DG	Lag	Lag, SG, DG	Lag, SG, DG	Lag, SG, DG	Lag, SG, DG	Lag, SG, DG
Habitat Unit Number	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Habitat Unit Type	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Side Channel Type	☐	☐	☑	☐	☐	☐	☑	☑	☑	☑	☑
GPS Coordinates	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑
Mean Length	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Mean Width	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Bankfull Width	☐	☐	☐	☐	☐	☐	☑	☐	☐	☑	☑
Mean Depth	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑
Max Depth	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Riffle Crest Thalweg Depth	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Pool Tail Embeddedness	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☐
Riffle Crest Substrate	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Shelter Ratings											
Lg Wood in Stream (6-20' long)	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐
Lg Wood in Stream (>20' long)	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐
Lg Wood in Bankfull (6-20' long)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☐
Lg Wood in Bankfull (>20' long)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☐
Log Dimensions	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑
Log Jam Dimensions	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑
Shelter Value/Rating	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑
% Unit Cover	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑
Undercut Bank	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑
Small Woody Debris (d<12")	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑
Large Woody Debris (d>12")	☐	☑	☑	☑	☐	☑	☑	☑	☑	☑	☑
Root Mass	☐	☑	☑	☑	☐	☑	☑	☑	☑	☑	☑
Terrestrial Vegetation	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑
Aquatic Vegetation	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☑
Bubble Curtain	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Boulders (d>10")	☐	☑	☑	☑	☐	☑	☑	☑	☑	☑	☑
Bedrock Ledges	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☐

	1992	1995	1997	1998	1998	1999	2003	2006	2011	2016	2022
	Lag	SG, DG	Lag	Lag, SG	DG	Lag	Lag, SG, DG	Lag, SG, DG	Lag, SG, DG	Lag, SG, DG	Lag, SG, DG
Substrate											
Primary Substrate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
Secondary Substrate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
Silt/Clay/Sand	☐	☐	☑	☑	☐	☑	☐	☑	☑	☑	☐
Silt/Clay	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐
Sand	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐
Gravel	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☐
Small Cobble	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☐
Large Cobble	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☐
Boulder	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☐
Bedrock	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☐
% Exposed Substrate	☐	☐	☑	☑	☐	☑	☑	☑	☑	☑	☐
Banks											
Bank Composition	☐	☐	☑	☑	☐	☑	☐	☐	☐	☐	☐
Dominant Bank Vegetation	☐	☐	☑	☑	☐	☑	☐	☐	☐	☐	☐
Bank % Vegetated	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐	☐
% Total Canopy	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
% Deciduous Trees	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
% Evergreen Trees	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Rt Bank Composition	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Rt Bank Dominant Veg	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
% Rt Bank Vegetated	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Lf Bank Composition	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
Lf Bank Dominant Veg.	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑
% Left Bank Vegetated	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑