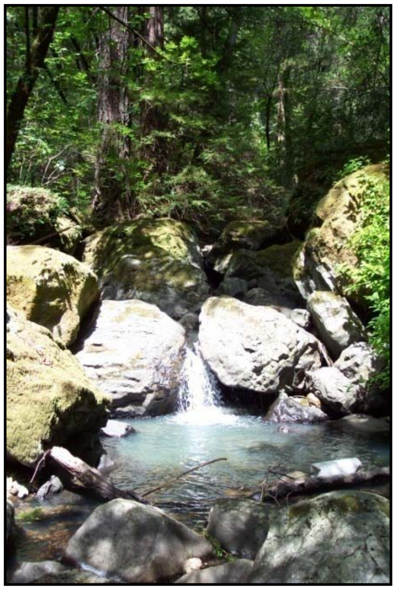
SOUTHERN NAPA RIVER WATERSHED RESTORATION PLAN





FINAL REPORT

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NAPA COUNTY RCD Resource Conservation District

SOUTHERN NAPA RIVER WATERSHED PROJECT

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APPENDICES

1 INTRODUCTION

In 2002, the Napa County Resource Conservation District (RCD) was awarded a grant from the California Department of Fish & Game (DFG) to fund a study of the southern region of the Napa River watershed. This study was the final phase in a three part process of creating a watershed plan encompassing the entire Napa River watershed. The northern and central portions of the watershed were addressed in the *Northern Napa River Watershed Project* and *Central Napa River Watershed Project* respectively.

The goal of this study was to develop a comprehensive anadromous salmonid habitat assessment of the southern portion of the Napa River and its tributaries. The project provides both general and site-specific recommendations for restorative actions benefiting salmonids, with emphasis on steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*). Recommendations are focused on creating or restoring geomorphic and ecological functions and processes that support anadromous salmonids and improve aquatic and adjacent riparian habitat.

1.1 BACKGROUND

The Napa Valley supports a diverse community of plants, fish, and wildlife within a mosaic of landuses comprised largely of agriculture, rural residential development, and urban development (Figure 1.1.1). Over the past century, the Napa River watershed has experienced rapid and widespread change. Foremost of which has been vineyard development with wine grape growing becoming the primary landuse within the valley. The majority of vineyards have been planted along the Napa River and all of its 48 major tributaries, which has had both direct and indirect effects on the aquatic and riparian ecosystems. Additionally, urban and rural residential expansion has brought roads and other changes into previously undisturbed areas of the watershed.

The Napa River watershed covers an area of approximately 426 square miles, and is contained on three sides by mountains to the north, west, and east. The watershed is typical of the California coastal range with northwest-southeast trending topography. The Napa River runs through the center of the watershed on the valley floor. It drains 48 major tributaries and numerous smaller ephemeral streams on its 55 mile path from the headwaters of Mt. St. Helena in the Mayacamas Mountain range to the San Pablo Bay. Along this route the river winds through varied landscapes of forested mountain slopes, vineyards, urban areas, open pasture, industrial zones, grasslands, marshes, and brackish estuary.

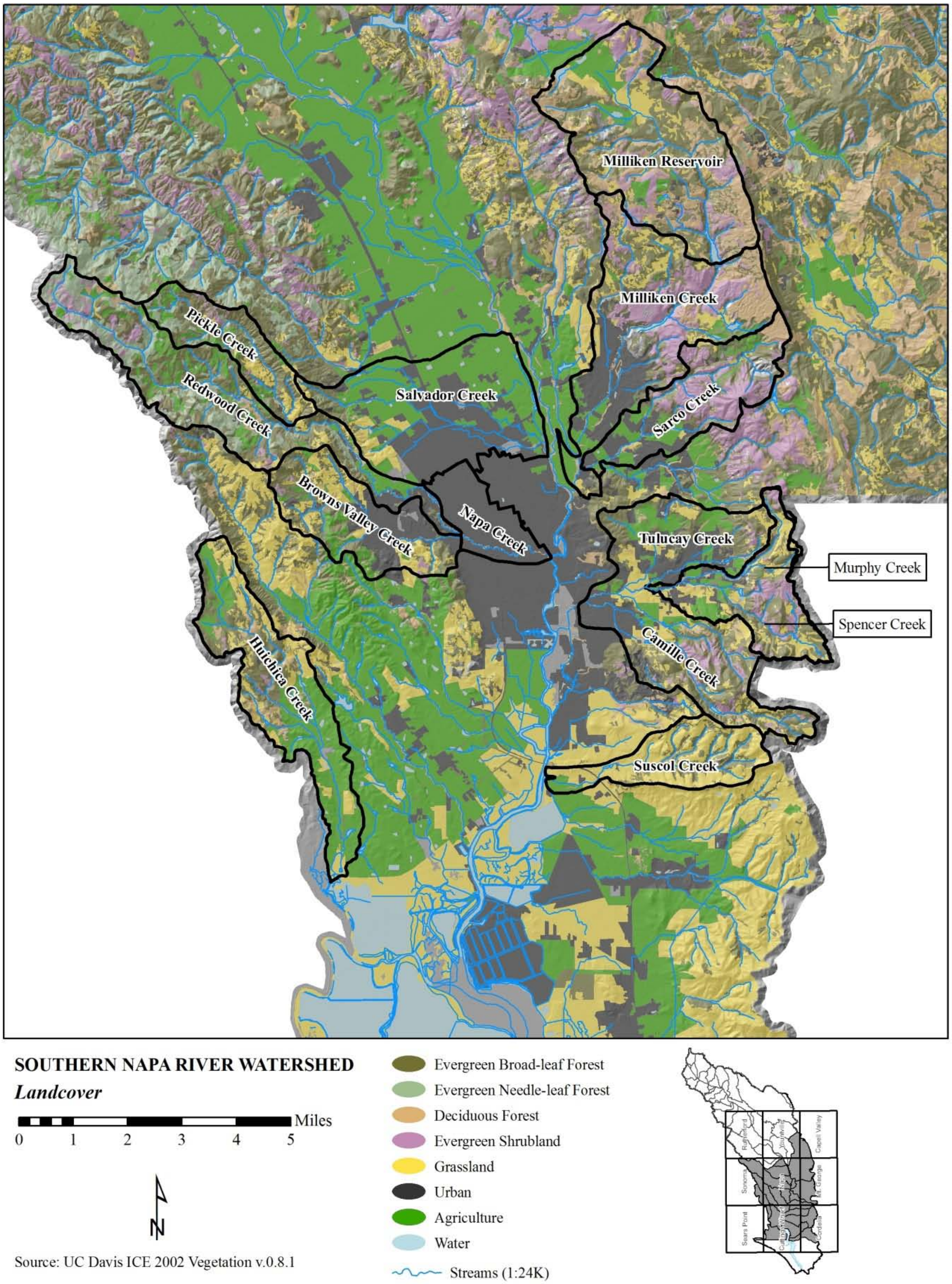


Figure 1.1.1. Landcover classifications within the project study area.

1.2 NAPA RIVER FISH COMMUNITY

There are 29 native and 22 non-native fish species that occur in freshwater and low-salinity (light brackish) habitats of the Napa River basin (Koehler, 2007). Additionally, the Napa River historically supported thicktail chub (*Gila crassicauda* – now extinct), Sacramento perch (*Archoplites interruptus* – extirpated from the watershed), and coho salmon (*Oncorhynchus kisutch* – extirpated from the watershed). Juvenile chum salmon (*Oncorhynchus keta*) have recently been captured in the lower Napa River, although their status is unknown (Stillwater 2005). American shad (*Alosa sapidissima*) have been captured in the estuary occasionally, but they likely do not regularly occur in the river above the estuarine lower reaches. Brown Trout (*Salmo trutta*) were captured in 1997 (Leidy) but have not been documented by any recent efforts and likely no longer occur or are very uncommon within the basin.

A total of 14 native and 14 exotic fish species are known to occur in the freshwater portion of the watershed. Many of the non-native fish species have been documented only a few times in reaches upstream of Oak Knoll Avenue, as the river transitions from estuary to a low-gradient pool/riffle morphology. It is likely that most exotic fishes captured or documented in these upstream reaches are strays from irrigation ponds or have been intentionally released for fishing. Based on observations in the river during the past decade by RCD and others, it appears that no exotic fish species have established large, self-sustaining populations in the non-tidal reaches of the Napa River, and the native fish assemblage is mostly intact.

Steelhead are the most abundant and broadly distributed salmonid species within the Napa River watershed. Napa River steelhead populations have been greatly reduced from historical levels. It is estimated that the watershed historically supported a population of approximately 8,000 adult steelhead; however current population levels are unknown. Recent basin wide surveys estimate the population to be between 200 and 1,000 adult fish (Stillwater Sciences, 2002; EcoTrust, 2001). NOAA Fisheries listed steelhead as a federally threatened species in Napa County in August 1997 as part of the Central California Coast Distinct Population Segment (DPS). Despite reduced populations, the Napa River watershed is considered one of the most important anadromous fish streams within San Francisco Bay (Leidy et al., 2005). Steelhead spawning and rearing occurs primarily in coldwater tributary streams; very few steelhead appear to spawn in the mainstem Napa River in most years.

Beginning around 2001, an estimated run of 400-600 Central Valley fall-run Chinook salmon have spawned annually in the mainstem Napa River (Koehler 2005; 2006; 2007; 2008). Although spawning has been documented in southern watershed tributaries, including Tulucay and Redwood Creek, most spawning has been observed upstream from Yountville to Calistoga. Capture of juvenile Chinook from the Napa River in each of the past six years (2004 - 2009) indicates successful reproduction has occurred in most years.

Very little is known about historical Chinook salmon abundance and distribution in Bay Area streams. In a recent review of existing fisheries information, no conclusive evidence of historical Chinook salmon populations could be found for the Napa River basin (Leidy et al., 2005). However, based on analysis of natural channel form, hydrology, and ecology, the Napa River likely supported a large, sustainable population of Chinook salmon under historical conditions (Stillwater Sciences, 2002). Additionally, the geographic location of the Napa River at the entrance to the Sacramento and San Joaquin River systems makes it likely that wild Chinook salmon would naturally stray into the Napa River during favorable periods.

During the past 150 years, a combination of factors including reduction in spawning habitat, channel and floodplain alterations, and the introduction of exotic predatory fishes have all reduced the river's potential to support a viable population of Chinook salmon. Today, there are approximately 25 miles of suitable Chinook spawning habitat in the mainstem Napa River and an additional 15 miles within low gradient reaches of several large tributaries.

	Common Name	**Scientific Name**	**Origin**	**Family**	**Status**
1	White Sturgeon	*Acipenser transmontanus*	Native	Acipenseridae	present
2	Sacramento Sucker	*Catostomus occidentalis*	Native	Catostomidae	present
3	Sacramento Perch	*Archoplites interruptus*	Native	Centrarchidae	extirpated
4	Pacific Herring	*Clupea pallasii*	Native	Clupeidae	present
5	Northern Anchovy	*Engraulis mordax*	Native	Clupeidae	present
6	Riffle Sculpin	*Cottus gulosus*	Native	Cottidae	present
7	Coastrange Sculpin	*Cottus aleuticus*	Native	Cottidae	present
8	Prickly Sculpin	*Cottus asper*	Native	Cottidae	present
9	Pacific Staghorn Sculpin	*Leptocottus armatus*	Native	Cottidae	present
10	Sacramento Pikeminnow	*Ptychocheilus grandis*	Native	Cyprinidae	present
11	Thicktail Chub	*Gila crassicauda*	Native	Cyprinidae	extinct
12	Hitch	*Lavinia exilicauda*	Native	Cyprinidae	present
13	Sacramento Blackfish	*Orthodon microlepidotus*	Native	Cyprinidae	present
14	California Roach	*Hesperoleucus symmetricus*	Native	Cyprinidae	present
15	Hardhead	*Mylopharodon conocephalus*	Native	Cyprinidae	present
16	Sacramento Splittail	*Pogonichthys macrolepidotus*	Native	Cyprinidae	present
17	Shiner Perch	*Cymatogaster aggregata*	Native	Embiotocidae	present
18	Tule Perch	*Hysterocarpus traski*	Native	Embiotocidae	present
19	Three-spine Stickleback	*Gasterosteus aculeatus*	Native	Gasterosteidae	present
20	Bay Goby	*Lepidogobius lepidus*	Native	Gobiidae	present
21	Longjaw Mudsucker	*Gillichthys mirabili*	Native	Gobiidae	present
22	Tidewater Goby	*Eucyclogobius newberryi*	Native	Gobiidae	likely extirpated
23	Arrow Goby	*Clevelandia ios*	Native	Gobiidae	present
24	Delta Smelt	*Hypomesus transpacificus*	Native	Osmeridae	present
25	Jack Smelt	*Atherinopsis californiensis*	Native	Osmeridae	present
26	Longfin Smelt	*Spirinchus thaleichthys*	Native	Osmeridae	present
27	Pacific Lamprey	*Lampetra tridentata*	Native	Petromyzontidae	present
28	River Lamprey	*Lampetra ayresi*	Native	Petromyzontidae	present
29	Speckled Sanddab	*Citharichthys stigmaeus*	Native	Pleuronectidae	present
30	Starry Flounder	*Platichthys stellatus*	Native	Pleuronectidae	present
31	Steelhead / Rainbow Trout	*Oncorhynchus mykiss*	Native	Salmonidae	present
32	Chinook Salmon	*Oncorhynchus tshawytscha*	Native	Salmonidae	present
33	Coho Salmon	*Oncorhynchus kisutch*	Native	Salmonidae	extirpated
34	Chum Salmon	*Oncorhynchus keta*	Native	Salmonidae	status unknown

Table 1.2.1 Native fish species currently or historically present in the Napa River basi

	Common Name	Scientific Name	Origin	Family	Status
1	Inland Silverside	*Menidia beryllina*	Exotic	Atherinidae	present
2	Smallmouth Bass	*Micropterus dolomieui*	Exotic	Centrarchidae	present
3	Bluegill	*Lepomis macrochirus*	Exotic	Centrarchidae	present
4	Redear Sunfish	*Lepomis microlophus*	Exotic	Centrarchidae	present
5	Green Sunfish	*Lepomis cyanellus*	Exotic	Centrarchidae	present
6	Largemouth Bass	*Micropterus salmoides*	Exotic	Centrarchidae	present
7	Black Crappie	*Pomoxis nigromaculatus*	Exotic	Centrarchidae	present
8	White Crappie	*Pomoxis annularis*	Exotic	Centrarchidae	present
9	Threadfin Shad	*Dorosoma petenense*	Exotic	Clupeidae	present
10	American Shad	*Alosa sapidissima*	Exotic	Clupeidae	present
11	Common Carp	*Cyprinus carpio*	Exotic	Cyprinidae	present
12	Goldfish	*Carassius auratus*	Exotic	Cyprinidae	present
13	Golden Shiner	*Notemigonus crysoleucas*	Exotic	Cyprinidae	present
14	Rainwater Killifish	*Lucania parva*	Exotic	Fundulidae	present
15	Shimofuri Goby	*Tridentiger bifasciatus*	Exotic	Gobiidae	present
16	Yellowfin Goby	*Acanthogobius flavimanus*	Exotic	Gobiidae	present
17	Brown Bullhead	*Ameiurus nebulosus*	Exotic	Ictaluridae	present
18	Black Bullhead	*Ameiurus melas*	Exotic	Ictaluridae	present
19	White Catfish	*Ameiurus catus*	Exotic	Ictaluridae	present
20	Channel Catfish	*Ictalurus punctatus*	Exotic	Ictaluridae	present
21	Wakasagi	*Hypomesus nipponensis*	Exotic	Osmeridae	present
22	Striped Bass	*Morone saxatilis*	Exotic	Percichthyidae	present
23	Western Mosquitofish	*Gambusia affinis*	Exotic	Poeciliidae	present
24	Brown Trout	*Salmo trutta*	Exotic	Salmonidae	status unknown

Table 1.2.2 Exotic fish species currently or historically present in streams of the Napa River basin.

1.3 PROJECT DESCRIPTION

This study was intended to assess the quality and quantity of available aquatic habitat, specifically targeting salmonid life history requirements, and identify key areas for restoration, improvement, or preservation. The geographic scope of this project covered the Napa River basin south of Soda Creek. All study streams are known to either currently support salmonids or have historical accounts of salmonid presence (DFG; Leidy et al., 2005; Napa County RCD).

Field surveys were conducted in the following 13 tributaries:

- Browns Valley Creek
- Camille Creek
- Huichica Creek
- Milliken Creek
- Murphy Creek
- Napa Creek
- Pickle Creek
- Redwood Creek
- Salvador Creek
- Sarco Creek
- Spencer Creek
- Suscol Creek
- Tulucay Creek

Carneros Creek was not included in this project, as it has been assessed by previous studies (NCRCD et al. 2002).

2 METHODS

2.1 HABITAT TYPING

Habitat typing surveys were conducted in accordance with methodology described in the California Salmonid Stream Habitat Restoration Manual (Flosi and Reynolds, 1994). The inventory uses a method that samples approximately 10% of the habitat units within the surveyed length. All habitat units included in the survey are classified according to habitat type and their lengths are measured. Habitat unit types encountered for the first time are further measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement. Since quantity and quality of pool habitat has been identified as a critical factor affecting salmonid populations in California streams, approximately every third pool encountered was fully measured.

Detailed habitat typing methodology is described in Appendix C.

2.2 FIELD INVENTORIES

Field inventories were conducted on a stream-by-stream basis during reconnaissance visits, gravel permeability sampling, and habitat typing surveys. These included:

1) Biological inventories of riparian vegetation species composition as well as aquatic flora and fauna observed in each survey.

2) Steelhead spawning surveys as permitted during gravel permeability sampling in Pickle, Redwood, Milliken, Napa, and Huichica Creeks.

3) Observations of potential sediment sources such as eroding banks, road crossings, and streambank slides.

Results of these inventories are incorporated into individual stream reports in section 3.

2.3 WATER TEMPERATURE MONITORING

Water temperature within a stream has a major effect on the physical condition of salmonids. Salmonids are coldwater species, exhibiting relatively low tolerance for elevated water temperatures. Exposure to elevated water temperatures may lead to reduced health and fitness, reduced growth rates, increased susceptibility to predation and disease, and depending on life-stage and duration of the exposure, may cause direct mortality. Seasonal fluctuations in water temperatures are caused by several factors including ambient air temperature, instream flow, groundwater influence, and riparian shading.

Intermittent streams experience the highest temperatures in summer and early fall, particularly in isolated pools found during periods of low flow. Elevated stream temperatures are a significant limiting factor for steelhead since they spend at least one year rearing in freshwater. Juvenile Chinook salmon on the other hand typically migrate to cool estuary waters during their first year, avoiding high temperature stream conditions in summer. In general, during critical rearing months for steelhead (July-September), stream temperatures are not considered stressful to juvenile fish if average daily temperatures remain below 20° C (68° F), with maximum hourly temperatures of approximately 23° C (73° F) or less. The optimal temperature range for growth of rainbow trout is between 15° and 18° C (Moyle, 2002).

Steelhead are sensitive to elevated water temperature during all life stages. Given adequate time to gradually acclimate, adult steelhead, and even larger parr, are capable of surviving temperatures as high as 26 - 27° C for short periods. It should be noted however, that the increased metabolic demand under such conditions has chronic effects on growth rates and vulnerability to disease. Even when acclimation temperatures are high, temperatures of 24 – 27°C are invariably lethal to trout, except for very short exposures (Moyle,2002).

Steelhead eggs are stenothermal, with highest survival rates between 5 – 10° C, but published data show considerable variation among strains. They can tolerate temperatures as low as 2° C or as high as 15° C, but are subject to increased mortality at the extremes of this range. The time required for hatching is inversely related to temperature, but as the temperature increases past the optimal range, there is reduction in alevin size (Myrick et. al, 2001).

To determine whether water temperatures were suitable for salmonids, continuous temperature monitoring was carried out at eleven sites using digital data loggers (*HOBO Water Temp Pro v2*) manufactured by Onset Computer Corporation. Sites were selected in potential steelhead rearing pools. Each data logger was housed inside a short length of ABS plastic pipe to protect them from damage and direct sunlight. The assembly was anchored to the streambed using a combination of cable and rebar. Each data logger was set to record water temperature at 15-minute intervals. Physical characteristics of each site were documented at the time of installation including water depth, canopy, substrate, estimated flow, and vegetation. If a site was found to be dry during a regular check, the data logger was relocated to nearby reaches with sufficient water. The maximum weekly average temperature (MWAT) was calculated for each site using the running average weekly temperature.

2.4 WATER QUALITY MONITORING

Water quality conditions affect all life stages of salmonids. In streams with limited dry season flow, water quality plays a critical role in the quality of summer rearing habitat for juvenile steelhead and salmon. As stream flows diminish in late spring and early summer, juvenile steelhead can become trapped in isolated pools for the duration of the summer. Under such conditions, water quality can quickly degrade without the flushing effects of continuous surface flow. In stream reaches with sufficient groundwater exchange, freshwater is available in isolated pools throughout the year. However, groundwater provides no agitation from moving surface flow and therefore contributes little or no dissolved oxygen, which can limit rearing success.

A total of thirteen sites were established to monitor water quality for a minimum of one year (Table 2.4.1 and Figure 2.4.1). Parameters included dissolved oxygen (DO), electrical conductivity (EC), pH, water temperature, air temperature, and flow. Additional qualitative information on physical habitat was also collected including water color, odor, weather, streambed appearance, water depth, and habitat change.

All water quality tests were carried out by RCD staff or trained volunteers using the RCD stream monitoring protocols. Site selection was limited by the presence of water. Samples were collected on an approximately monthly basis at all sites. Sampling was done using a handheld YSI-85 field meter and pH strips. Instruments were calibrated prior to each sampling event.

Stream	**Description**	**Code**	**Latitude**	**Longitude**
Browns Valley	Browns Valley Rd	BV4	38.30429	-122.32061
Huichica	DFG Bridge	HCH1	38.22065	-122.35376
Huichica	Vineyard Bridge	HCH4	38.26413	-122.37899
Milliken	Hedgeside Bridge	ML1	38.33837	-122.26936
Murphy	Shady Brook Ln	MUR5	38.29386	-122.22026
Pickle	Mt. Veeder Rd	PCK1	38.33421	-122.37197
Redwood	Redwood Rd	RED5	38.31603	-122.34312
Spencer	Green Valley Rd	SPC1	38.29126	-122.22756
Sarco	Vichy Ave.	SRC1	38.33175	-122.25298
Suscol	Devlin Rd	SUS1	38.23937	-122.26817
Salvador	Big Ranch Rd	SV5	38.32819	-122.28983
Tulucay	South Terrace Rd	TUL1	38.28857	-122.26899

Table 2.4.1. Water quality monitoring locations. Note: Napa Creek is not included in this report, as data are included in an earlier report available from the Napa County RCD.

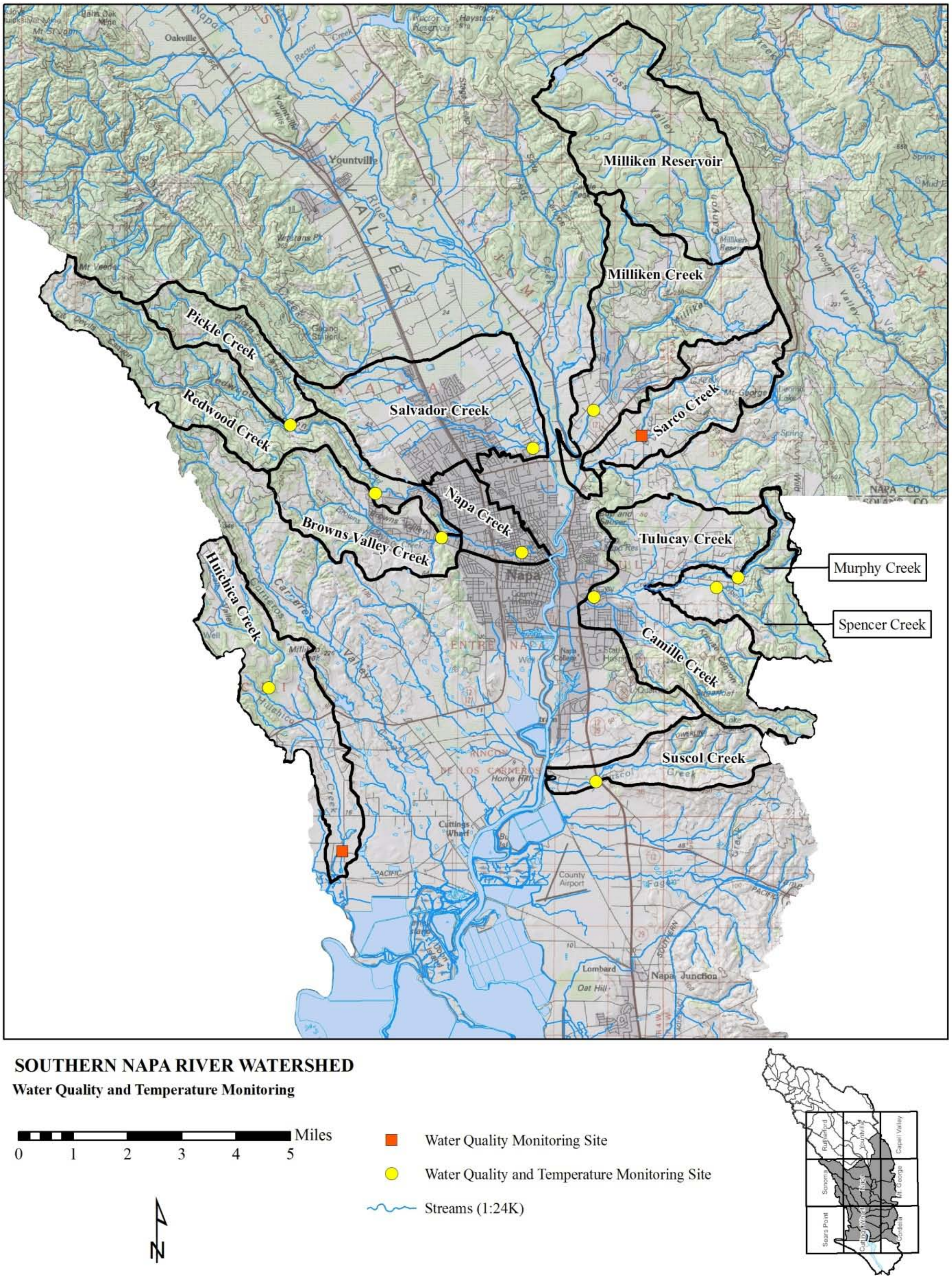


Figure 2.4.1. Stream monitoring sites established for each stream within the study area.

2.5 STREAMFLOW MONITORING

Surface flow was monitored at least monthly at all water quality sites (Table 2.4.1 and Figure 2.4.1) for the duration of the study. Flow was estimated and categorized using the following scale:

Level 3	Briskly flowing
Level 2	Moderately flowing
Level 1	Slowly flowing
Level 0	Stagnant flow with isolated pools present
Level -1	Dry

Streamflow was also assessed during gravel permeability (winter flow) and habitat surveys (summer flow) to document seasonal patterns in each stream. Results are incorporated into individual stream reports in section 3 and discussed in further detail in Section 4.1.

2.6 GRAVEL PERMEABILITY

Gravel permeability was measured at 113 sites in twelve streams (Figure 2.6.1). Potential spawning sites were selected within a randomly chosen reach based on gravel size and other physical characteristics. At each site, the median particle size (D50) of each spawning patch sampled was visually estimated prior to permeability sampling. Water temperature, water depth, and the area of each spawning patch were measured, and the location of each spawning patch was recorded using a handheld GPS receiver. Digital photographs were taken and a sketch of each site was made.

Gravel permeability was measured using a modified Mark IV standpipe (Terhune 1958, Barnard and McBain 1994). The recharge rate (the rate at which water moves through the substrate) derived from these measurements was converted to permeability using a rating table with a temperature and viscosity correction from Barnard and McBain (1994). These methods have been used in previous studies throughout the Napa River watershed (Stillwater Sciences, 2002; NCRCD, 2005). Calculations are based on relationships between survival-to-emergence and permeability from two data sets (McCuddin 1977, Taggart 1976). We used the following simple linear regression on the combined data sets to estimate survival based on our permeability measurements:

$$\text{Survival} = 0.1488 * \ln(\text{Permeability}) - 0.8253$$

where permeability is in units of cm/hr and:

$$\text{Mortality Index} = (1 - \text{Survival})*100$$

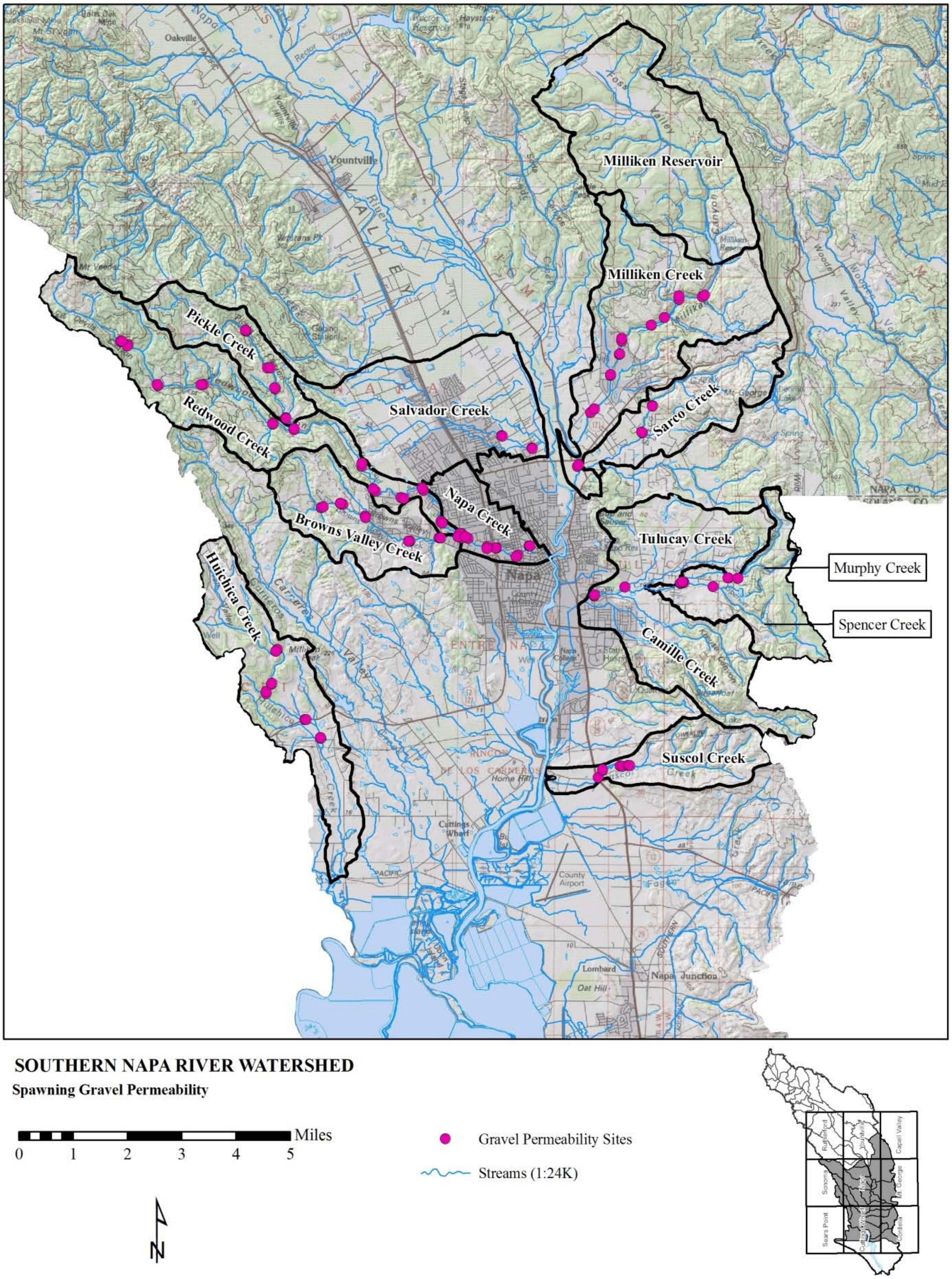


Figure 2.6.1. Gravel permeability was assessed at 113 potential spawning sites in twelve streams.

3 STREAM REPORTS

3.1 BROWNS VALLEY CREEK

Browns Valley Creek is a tributary to Napa Creek, which is a tributary to the Napa River and ultimately the Pacific Ocean via San Pablo Bay (Figure 3.1.1). Browns Valley Creek's location at the confluence with Napa Creek is 38.304674N latitude, 122.313685W longitude with an LLID number of 1223123383048. Browns Valley Creek is a second order stream and has approximately 8.9 miles of blue line stream according to the USGS Napa 7.5 minute quadrangle. Browns Valley Creek drains a watershed of approximately 4.48 square miles. Elevations range from about 50 feet at the mouth of the creek to 1,100 feet in the headwater areas. The watershed is moderately developed with residential and rural residential areas. Mixed hardwood forest and grassland dominate the undeveloped areas of the watershed. The watershed is almost entirely privately owned, and vehicle access exists via Browns Valley and Partrick roads.

HISTORICAL INFORMATION (excerpted from Leidy et al., 2005)

In November 1958, DFG visually surveyed portions of Browns Valley Creek accessible by car. No fish were found. Because Browns Valley Creek typically dried by early spring, DFG considered this creek to have no fishery functions except contributing flows to Napa Creek (Elwell 1958l).

In October 1966, DFG again visually surveyed Browns Valley Creek from the mouth to the headwaters. No *O. mykiss* were observed, and DFG reported that the creek did not support *O. mykiss* (McCurdy 1966).

Ecotrust and FONR carried out surveys in tributaries of the Napa River system in July and August 2001. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. One reach (of four) in Browns Valley Creek was found to have *O. mykiss* at density level “1” (Ecotrust and FONR 2001).

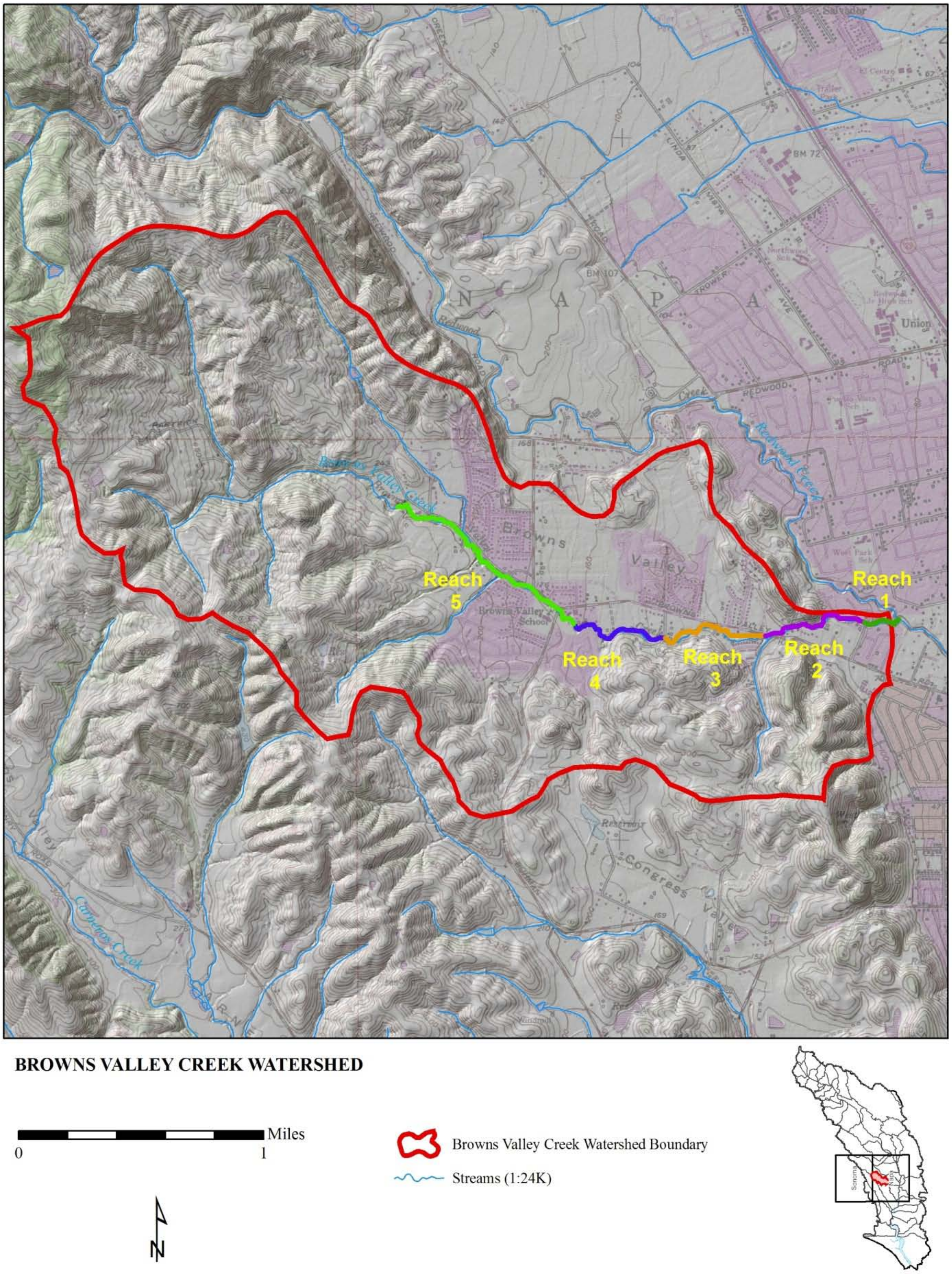


Figure 3.1.1 – Watershed map with habitat survey reaches.

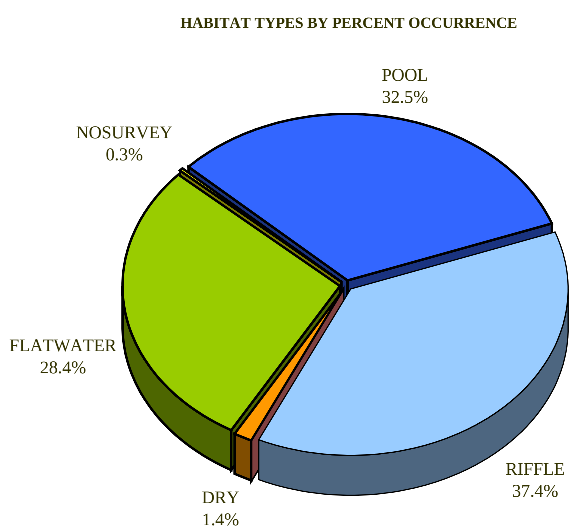
HABITAT

All habitat typing result tables are located in Appendix C.

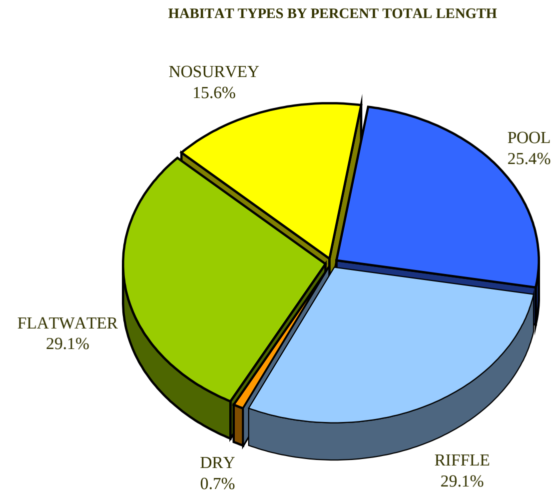
A stream inventory was conducted between 10/10/2006 and 11/27/2006 of Browns Valley Creek by J. Koehler, and C. Edwards of the NCRCD. The survey began at the confluence with Napa Creek and extended upstream approximately 2.9 miles (15,647 feet) and was divided into five reaches (Figure 3.1.1). Reach 4 was not surveyed due to lack of landowner permission. The survey ended when the channel became dry for several thousand feet. The objective of the survey was to document the amount and distribution of habitat available to anadromous salmonids in Browns Valley Creek.

Browns Valley Creek was classified as an F4 channel type for all surveyed reaches. Generally, F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width-to-depth ratios and gravel-dominant substrates.

Based on frequency of occurrence there were 33% pool units, 37% riffle units, and 28% flatwater units (Graph 1). Based on total length of Level II habitat types there were 25% pool units, 29% riffle units, and 29% flatwater units (Graph 2).

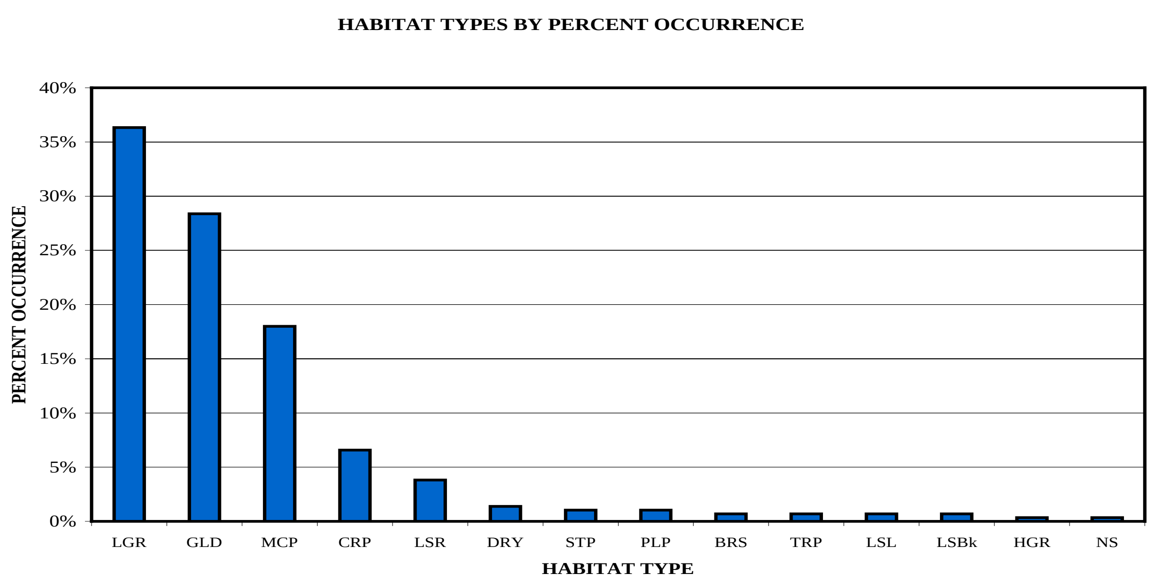


GRAPH 1



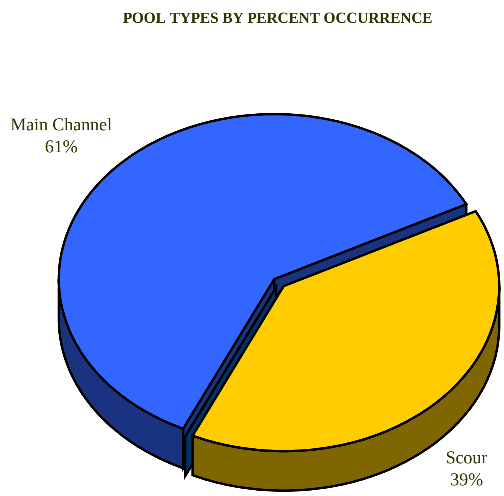
GRAPH 2

In total, 13 Level IV habitat types were identified. The most frequent habitat types by percent occurrence were: low-gradient riffles and glides (Graph 3). Based on percent total length the most frequent habitat types were also low-gradient riffles (28%), and glides (29%).

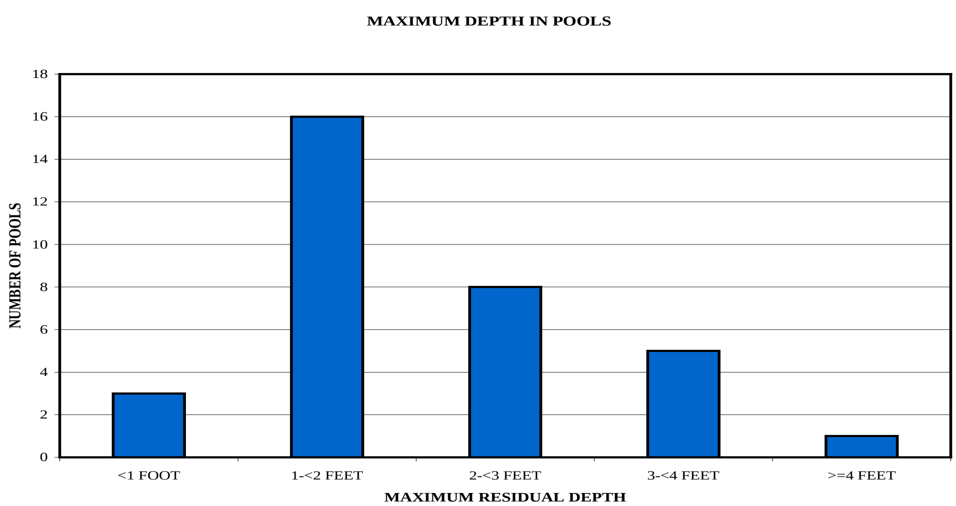


GRAPH 3

A total of 94 pools were counted. Mid-channel pools were the most frequently encountered and comprised 66% of the total length of all pools (Graph 4) Pools throughout the survey were relatively deep, with 14 of the 33 (42%) fully measured having a maximum residual depth greater than 2 feet (Graph 5). In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined as having a maximum residual depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low-flow channel width.

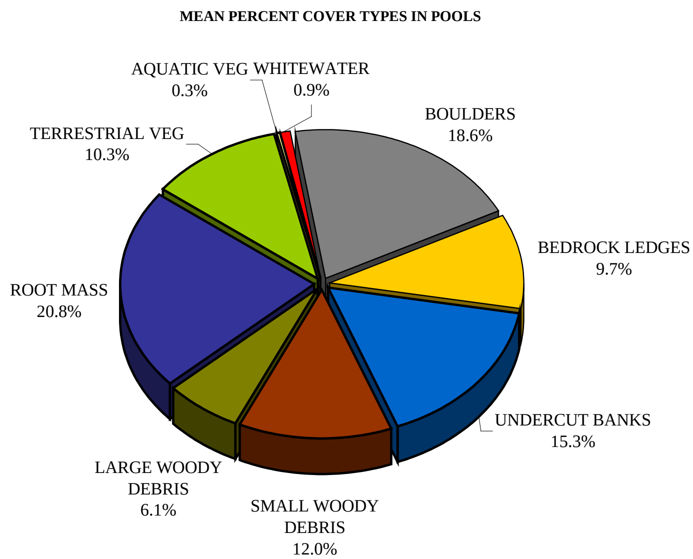


GRAPH 4



GRAPH 5

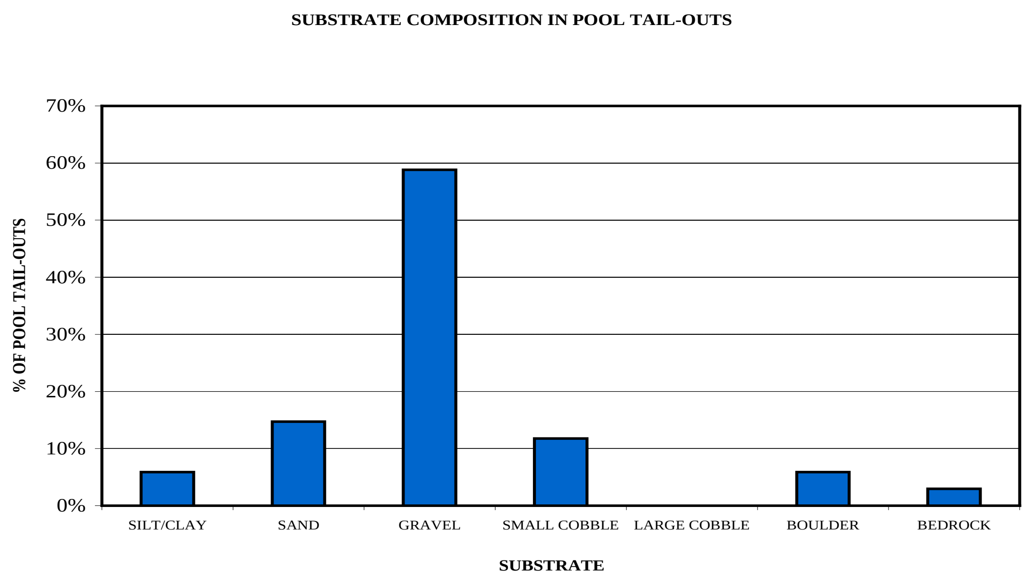
A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffles had a mean shelter rating of 9, flatwater habitat types had a mean shelter rating of 14, and pool habitats had a mean shelter rating of 52. Of all pool types, main channel pools had a mean shelter rating of 46, and scour pools had a mean shelter rating of 68. Root mass was the dominant pool cover type, followed by boulders (Graph 6)



GRAPH 6

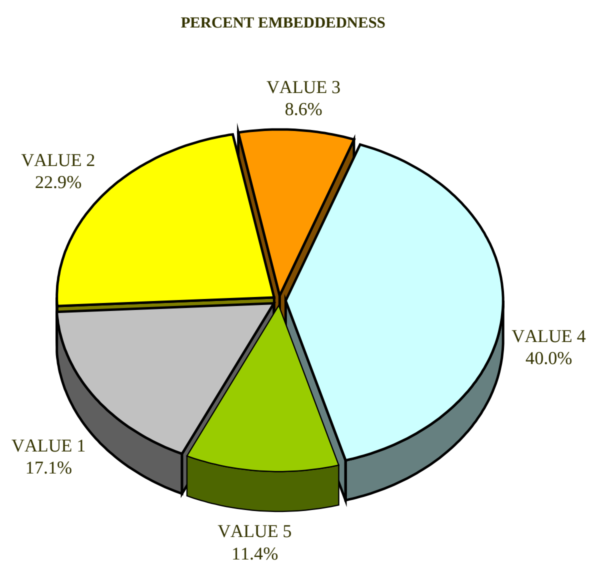
A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders and root masses from riparian vegetation. Increasing the amount of instream cover in Browns Valley Creek may be difficult due to its highly confined channel geometry.

Potential spawning sites were generally fine-bedded with sand and gravel being the most common substrate found in pool tail-outs (Graph 7).



GRAPH 7

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 35 pool tail-outs measured in Browns Valley Creek, 6 had a value of 1 (17%); 8 had a value of 2 (23%); 3 had a value of 3 (9%); 14 had a value of 4 (40%); and 4 had a value of 5 (11%) (Graph 8). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

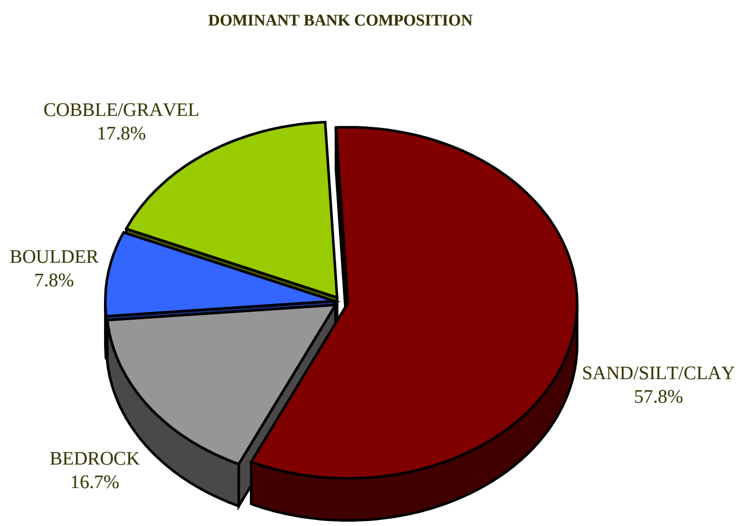


GRAPH 8

In total, 14 of the 35 pool tail-outs measured had embeddedness ratings of 1 or 2, and 17 of the pool tail-outs had embeddedness ratings of 3 or 4. Four of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Twenty-four of the 34 pool tail-outs (70%) measured had gravel or small cobble as the dominant substrate. Additionally, 10 of the 34 (29%) pool tail-outs had silt, sand, large cobble, boulders, and bedrock or concrete as the dominant substrate, which are all generally unsuitable for spawning salmonids.

The stream banks were generally made up of fine material throughout the survey, consisting mostly of sand and clay, with a few short reaches of bedrock (Graph 9).



GRAPH 9

A total of 12 potential spawning sites were measured for gravel permeability (Figure 3.1.2). The predicted egg-to-emergence survival estimates ranged from 22% to 48%.

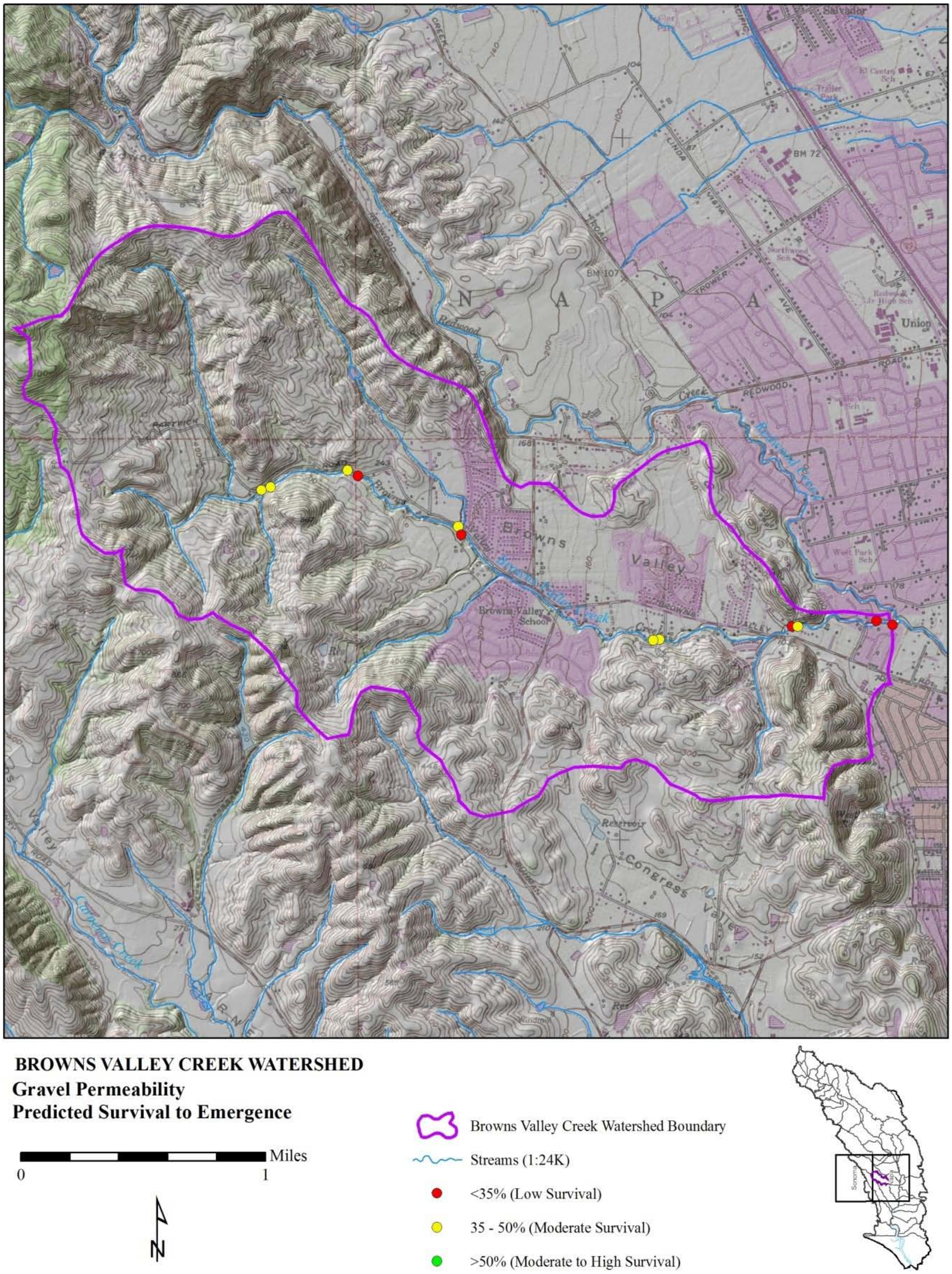
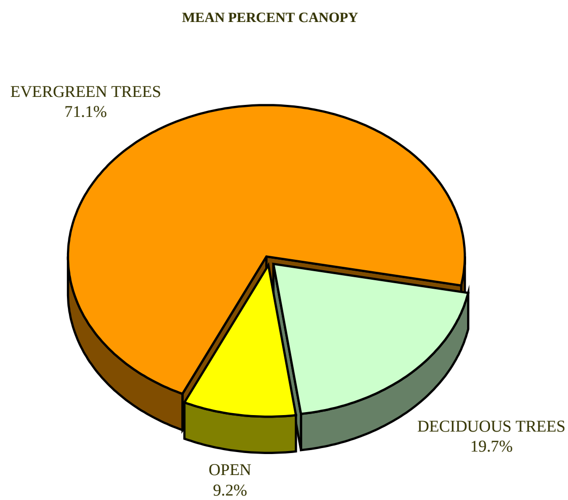


Figure 3.1.2 – Gravel permeability sites on Browns Valley Creek. Estimated survival values ranged from 22 to 48%.

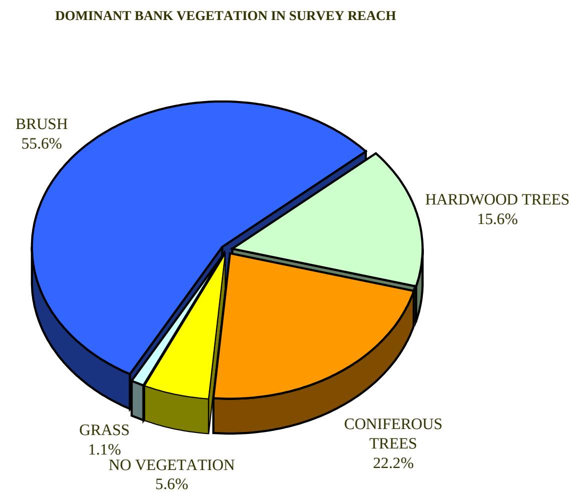
The mean percent canopy density for the surveyed length of Browns Valley Creek was 91%. The mean percentages of deciduous and evergreen trees were 22% and 78%, respectively. Throughout the entire survey, only about nine percent of the canopy was open (Graph 10)



GRAPH 10

Reach 1 had a canopy density of 93%, Reach 2 had a canopy density of 90%, Reach 3 had a canopy density of 91%, and Reach 5 had a canopy density of 91%. Overall, canopy densities were very high throughout the survey. Revegetation projects are generally only considered when canopy density is less than 80%.

For the stream reaches surveyed, the mean percent right bank vegetated was 64%, and the mean percent left bank vegetated was 67%. Brush was the dominant vegetation type observed along with areas of evergreen and deciduous forest higher in the watershed (Graph 11).



GRAPH 11

MIGRATION BARRIERS

Three potential fish migration barriers were documented on Browns Valley Creek. The three sites were culvert road crossings at the following locations: Robinson Lane, Browns Valley Road, and McCormick Lane (3.1.3). All three sites were ranked "Gray" according to the DFG criteria outlined in the California Salmonid Stream Habitat Restoration Manual (*Chapter IX, Figure IX-17*). A ranking of Gray indicates the site is a partial and/or temporal barrier.

Robinson Lane culvert site is being fully assessed by RCD in 2010 as part of a watershed-wide effort to develop treatments for the highest priority barriers in the Napa River watershed. The other two culverts appear to be less severe and should be considered for future improvement.

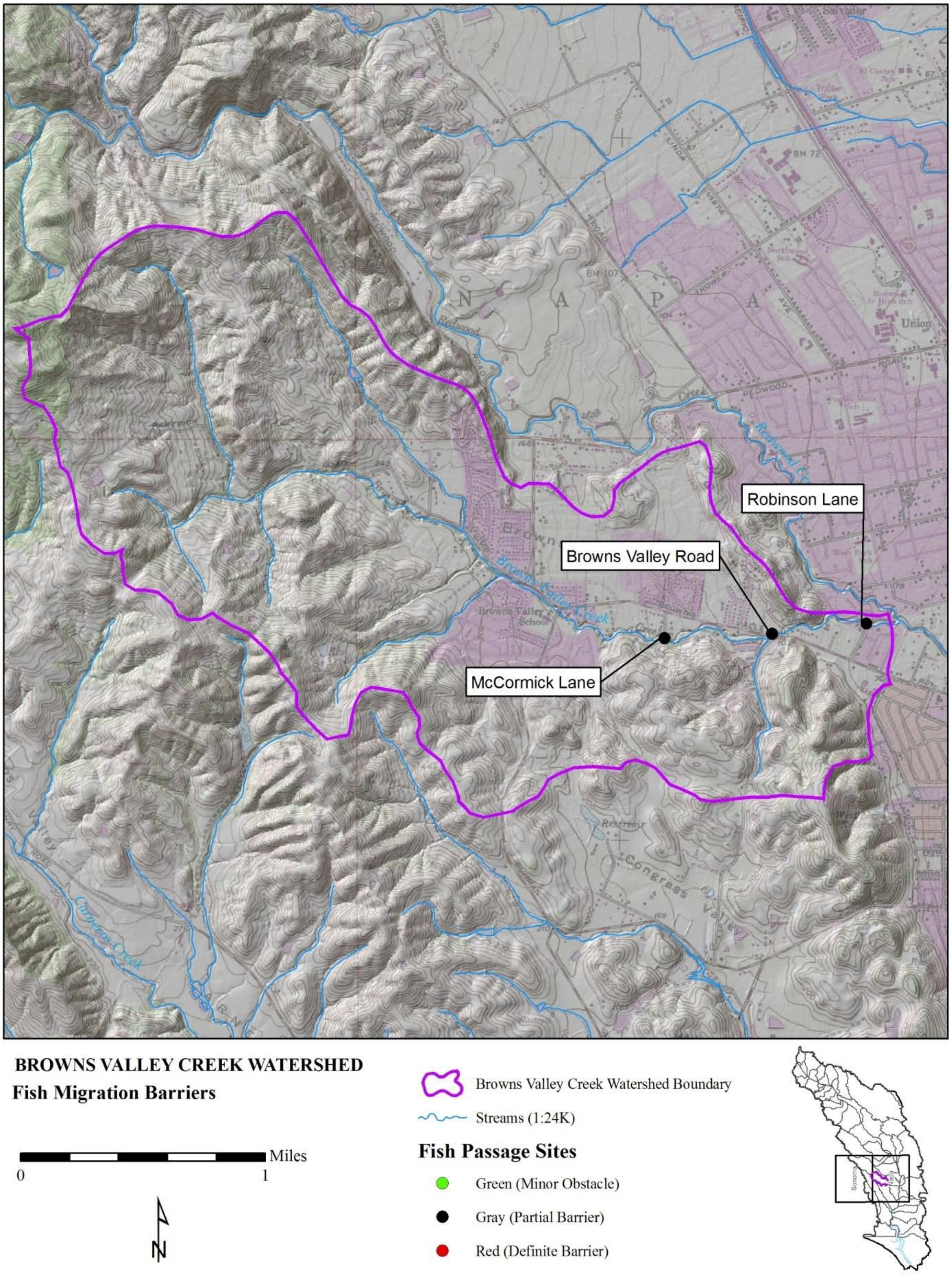


Figure 3.1.3. Browns Valley Creek watershed map.

BIOLOGICAL SURVEYS/ OBSERVATIONS

Juvenile steelhead were observed in Browns Valley Creek in low abundances throughout the habitat survey. No adult or juvenile surveys (e.g. spawner surveys or snorkel counts) were conducted for Browns Valley Creek as part of this study.

WATER QUANTITY

Streamflow was visually estimated to be approximately one cfs in the lower reaches of the creek during the habitat survey period. Stream flow diminished in Reach 5 and eventually, the channel went completely dry. Browns Valley Creek appears to flow year-round in most years, possibly as a result of residential and agricultural runoff during the summer. The channel above Reach 5 appears to go completely dry in most years, and would not therefore be expected to support steelhead rearing habitat.

There are a total of six appropriative water rights on record for the Browns Valley Creek watershed (Figure 4.1.1).

WATER TEMPERATURE

The water temperatures recorded on the survey days between 10/10/2006 and 11/27/2006, ranged from 46 to 53 degrees Fahrenheit. Air temperatures ranged from 48 to 64 degrees Fahrenheit.

Water temperature was measured continuously at one site in Reach 2 from 8/3/2006 to 12/3/2007 (Figure 3.1.4). The MWAT during this period was 19.2° C (Table 3.1.1)

Mean Temperature (°C)	13.82
Median Temperature (°C)	14.07
Maximum Temperature (°C)	22.42
Minimum Temperature (°C)	3.93
Standard Deviation (°C)	3.45
Total Measurements	46,769
Number of records exceeding 20˚C	657
MWAT (°C)	19.2

Table 3.1.1 Water temperature summary statistics for Browns Valley Creek.

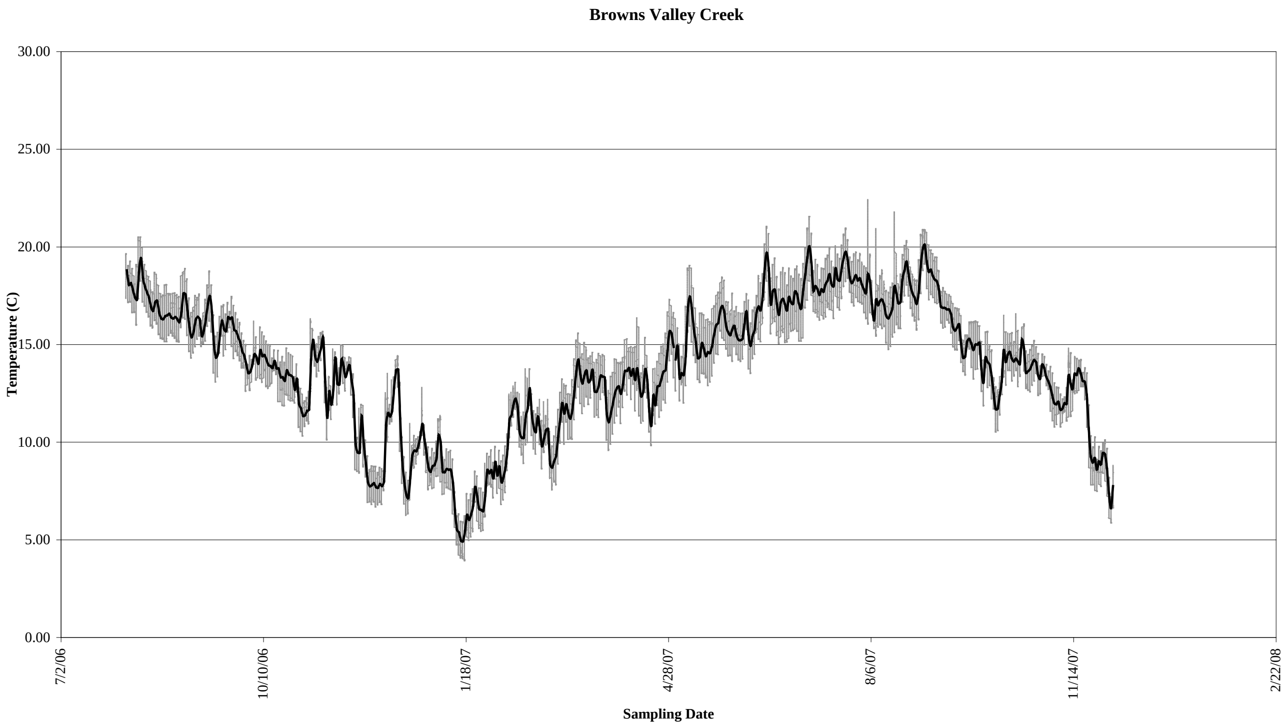


Figure 3.1.4 – Continuous water temperature data from Browns Valley Creek. The dark black line represents the daily average temperature, and the gray line represents daily range.

3.2 HUICHICA CREEK

Huichica Creek is a tributary to Napa Slough, which is in the estuarine portion of the lower Napa River. Huichica Creek's location at the confluence with Napa Slough is 38.213188° north latitude and 122.355744° west longitude, LLID number 1223492381925. Huichica Creek is a third order stream and has approximately 16.5 miles of blue line stream according to the USGS Sonoma and Cutting Wharf 7.5 minute quadrangles. Huichica Creek drains a watershed of approximately 6.33 square miles. Elevations range from sea level at the mouth of the creek to approximately 1,000 feet in the headwater areas. Mixed hardwood forest, grasslands, and vineyards are the primary land cover types in the watershed. Most of the watershed is in private land ownership, and vehicle access is available along Duhig Road and Highway 12/121.

HISTORICAL INFORMATION (excerpted from Leidy et al., 2005)

In March 1966 and in the winters of 1970 and 1971, DFG identified *O. mykiss* in Huichica Creek (Hallett and Lockbaum 1972;Jones 1966, as cited in Hallett, 1972). In December 1976, DFG visually surveyed Huichica Creek from the mouth to Route 121 and concluded that the area surveyed offered little or no value as spawning or nursery grounds for anadromous fish. However, the area was said to provide passage to more suitable areas upstream (Reed 1976).

In January 1980, DFG visually surveyed Huichica Creek from Route 121 upstream to the headwaters. *Oncorhynchus mykiss* ranging from 75–150 mm in length were numerous and were estimated at a density of 10 per 30 meters (Ellison 1980). The survey noted a six-foot falls approximately 1.75 miles upstream of Highway 121 as likely to be a complete barrier to upstream movement of steelhead (Ellison 1980).

A site on Huichica Creek at Highway 121 was sampled as part of a fish distribution study in September 1981. Two *O. mykiss* (79,87 mm FL) were collected by dip net from a ten-meter reach (Leidy 1984).

In April 1983, DFG electrofished three stations on Huichica Creek. A site 1.5 miles upstream of Route 121 and another at Route 121 contained *O. mykiss* (42-252 mm FL) at densities estimated to be 3 per 30 meters. *Oncorhynchus mykiss* also were identified downstream of Route 121 but not collected (Jong 1983).

In September 1985, DFG electrofished the same three stations on Huichica Creek. Two *O. mykiss* (~197 mm FL) were caught about 1.5 miles upstream of Route 121, while three *O. mykiss* (~214 mm) were collected at Route 121. No *O. mykiss* were found downstream of Route 121 (Gray 1985).

In July 1988, DFG electrofished Huichica Creek at Route 121 and caught 19 *O. mykiss* ranging from 60-186 mm FL (Montoya 1988a). In November 1989, DFG electrofished an established site approximately 1.5 miles upstream of Route 121 as well as a new site approximately 0.75 mile upstream of Route 121 at the confluence of an unnamed tributary. The established site yielded three *O. mykiss*, ranging in size from 95–110 mm FL. The new site yielded six *O. mykiss* (90–120 mm FL) (Gray 1989a).

Ecotrust and FONR surveyed Huichica Creek between May and September 2002. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. *Oncorhynchus mykiss* were observed in numerous Huichica Creek reaches, with five reaches having density level “3” (Ecotrust and FONR 2002).

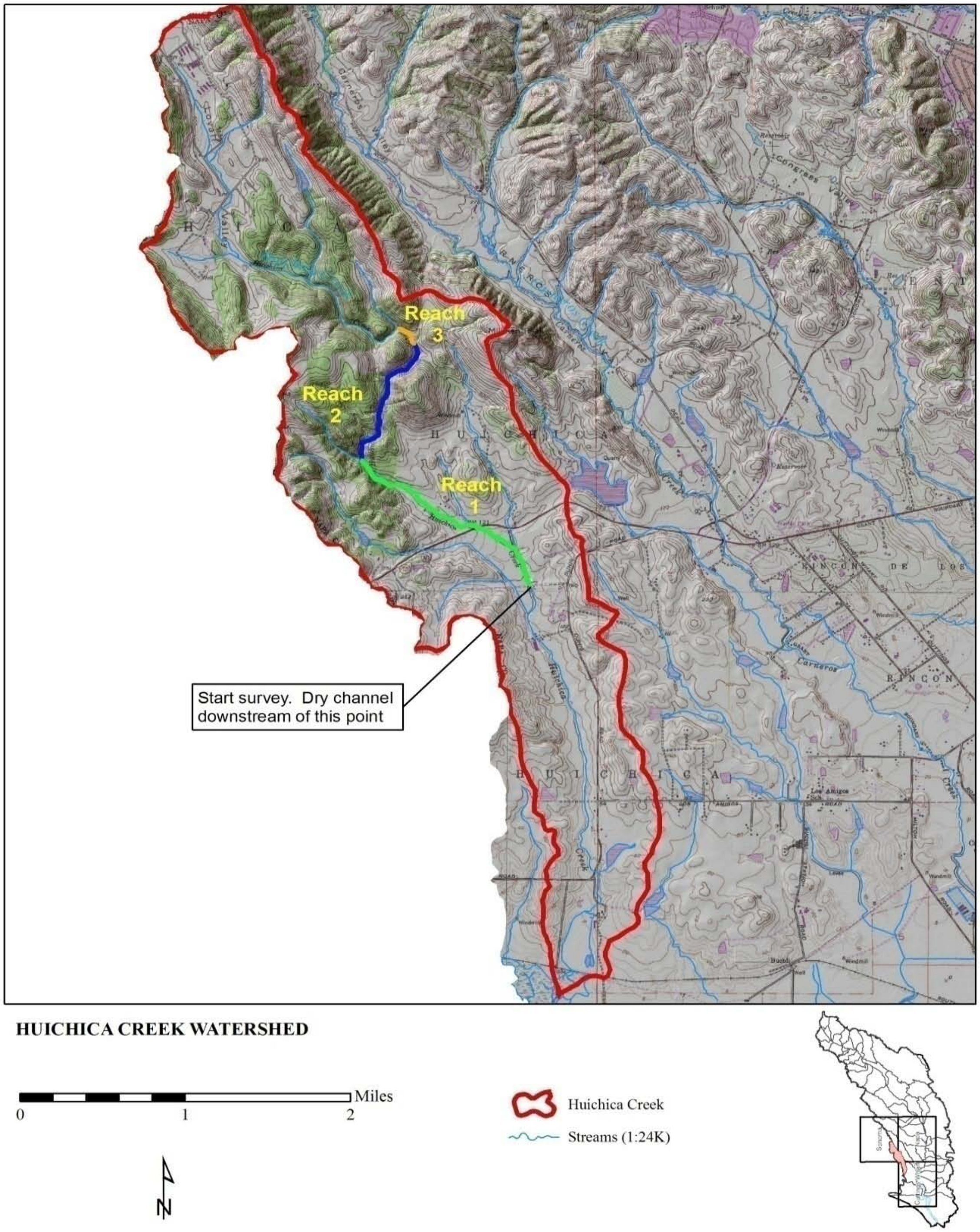


Figure 3.2.1 – Watershed map with habitat survey reaches.

HABITAT

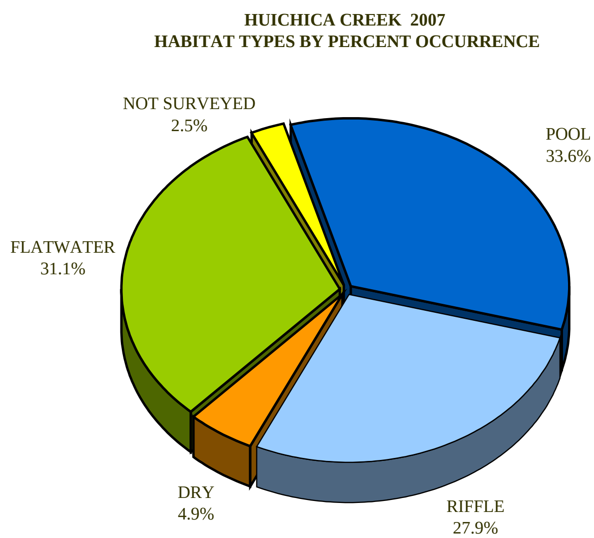
All habitat typing result tables are located in Appendix C.

A stream inventory was conducted during 10/5/2007 to 10/9/2007 on Huichica Creek. The survey began at Nuenschwander Road where surface flow was present for a short length and then went dry before the Highway 12/121 crossing. The entire length downstream of Nuenschwander Road was dry and therefore not surveyed. The habitat survey covered 1.8 miles of potential steelhead rearing habitat. The survey ended when the channel became completely dry for several thousand feet. The objective of the survey was to document the distribution and quality of habitat available to anadromous salmonids in Huichica Creek. Recommendations for habitat restoration are based upon target habitat values suitable for salmonids in California's north coast streams.

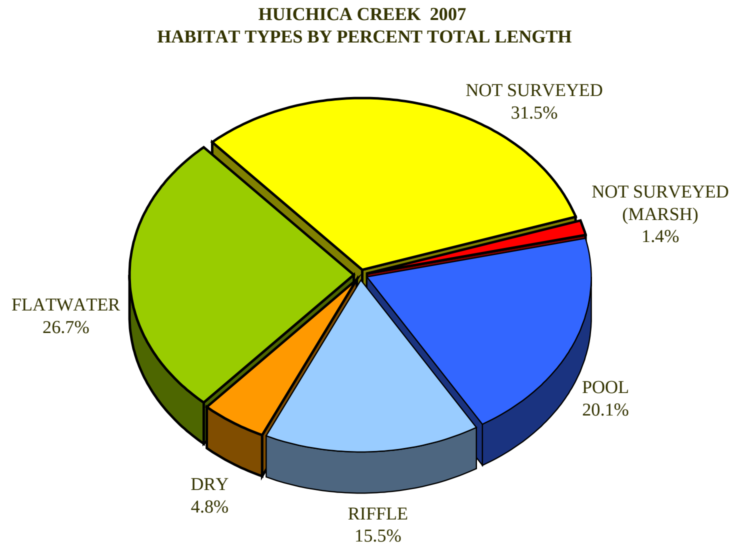
Based on frequency of occurrence there were 31% flatwater units, 28% riffle units, 34% pool units, 2% no-survey units, and 5% dry units (Graph 1). Based on total length of Level II habitat types there were 27% flatwater units, 16% riffle units, 20% pool units, 31% no-survey units, 5% dry units, and 1% no-survey marsh units (Graph 2).

In total, eleven Level IV habitat types were identified. The most frequent habitat types by percent occurrence were; 25% low gradient riffles, and 27% mid-channel pools (Graph 3). Based on percent total length, the most frequent habitat types were mid-channel pools and step runs.

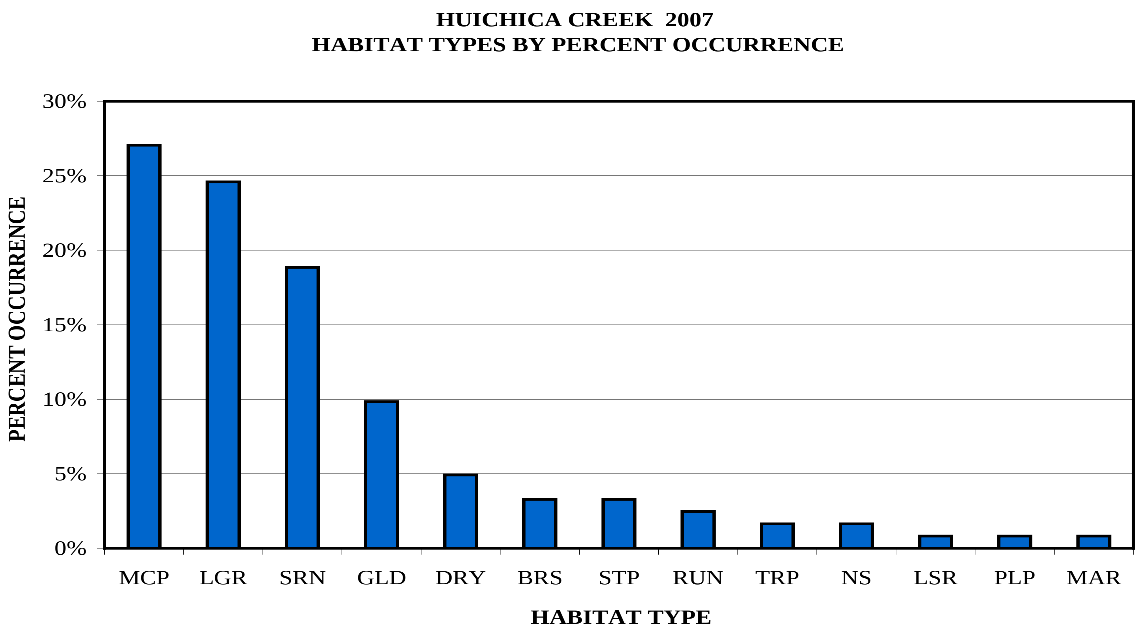
A total of 41 pools were counted. Main channel pools were the most frequently encountered, at 95%, and comprised 98% of the total length of all pools (Graph 4). Pool quality for salmonids generally increases with depth, and 3 of the 17 pools (18%) had a residual depth of two feet or greater (Graph 5).



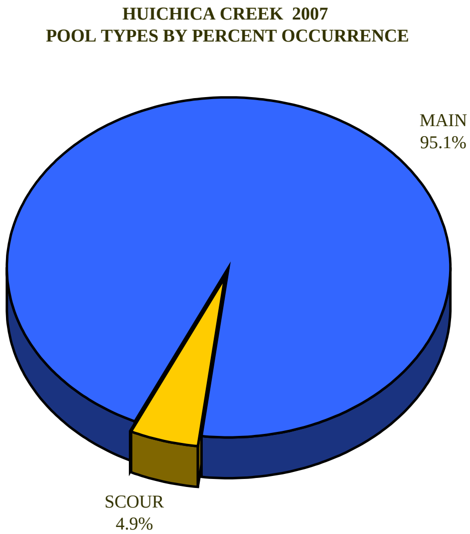
GRAPH 1



GRAPH 2

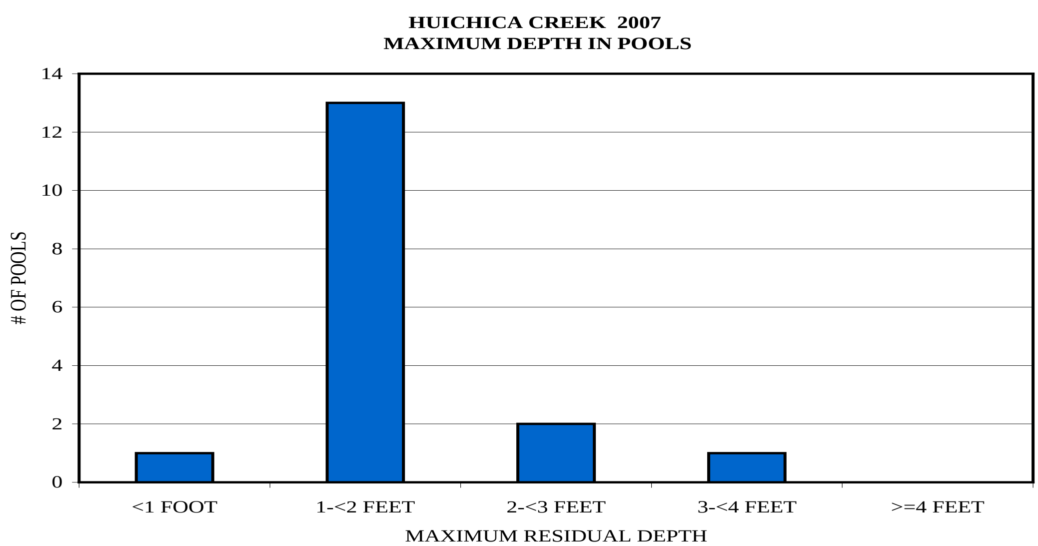


GRAPH 3



GRAPH 4

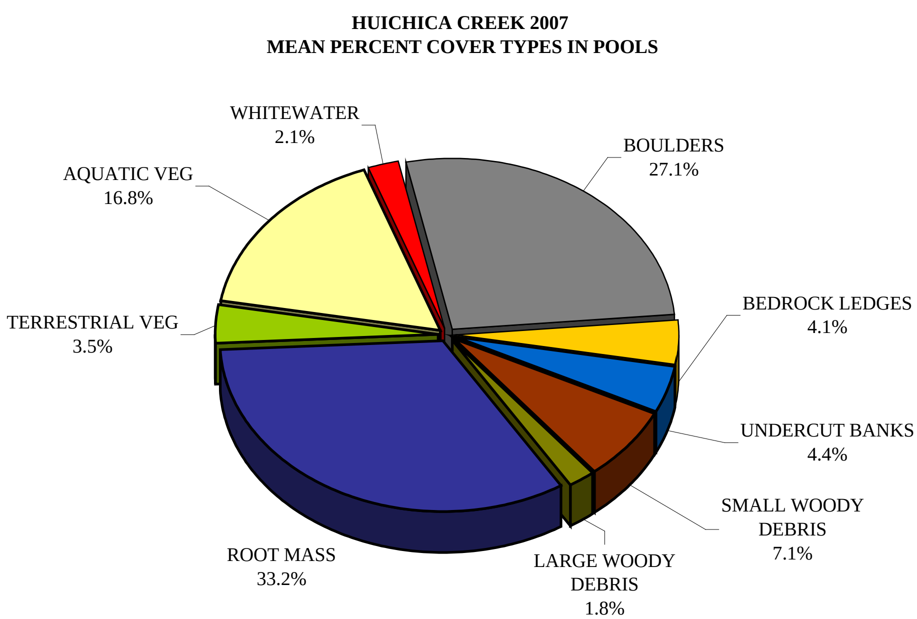
Flatwater habitat types comprised 27% of the total length of this survey, riffles 16%, and pools 20%. The pools were relatively shallow, with only 3 of the 17 (18%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In third order streams, a primary pool is defined to have a maximum residual depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.



GRAPH 5

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of eight, flatwater habitat types had a mean shelter rating of 19, and pool habitats had a mean shelter rating of 78. Of the pool types, main channel pools had a mean shelter rating of 75, and scour pools had a mean shelter rating of 95.

A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by root mass and boulders (Graph 6). Instream cover provides juveniles with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.



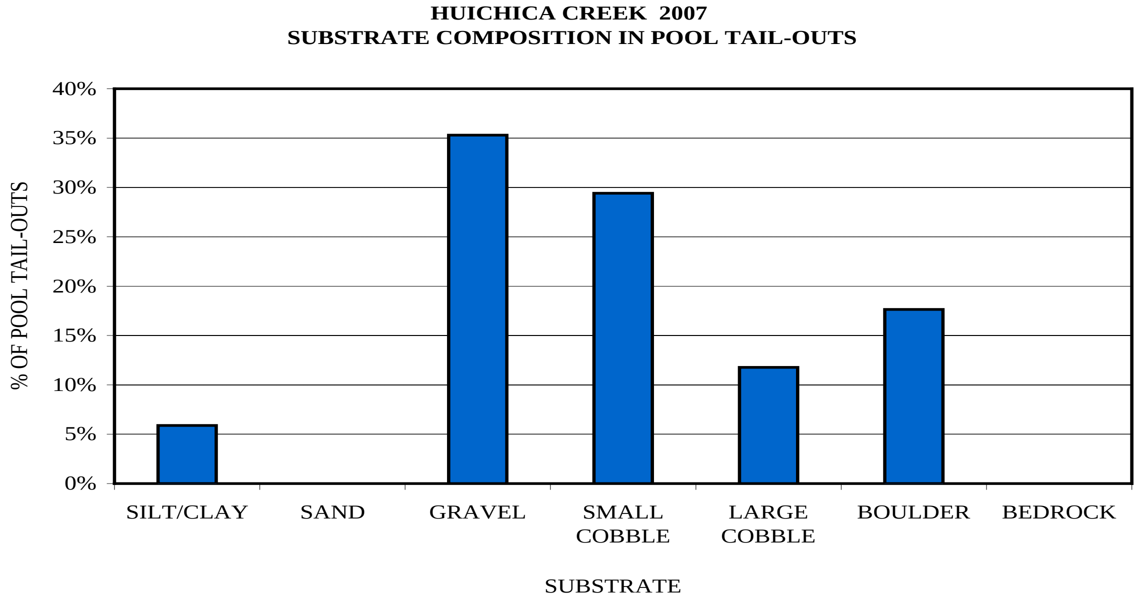
GRAPH 6

Pool tail-outs contained primarily gravel and small cobble, which were observed in 35% and 29% of pool tail-outs, respectively (Graph 7). Suitably sized spawning gravels were generally abundant throughout the survey.

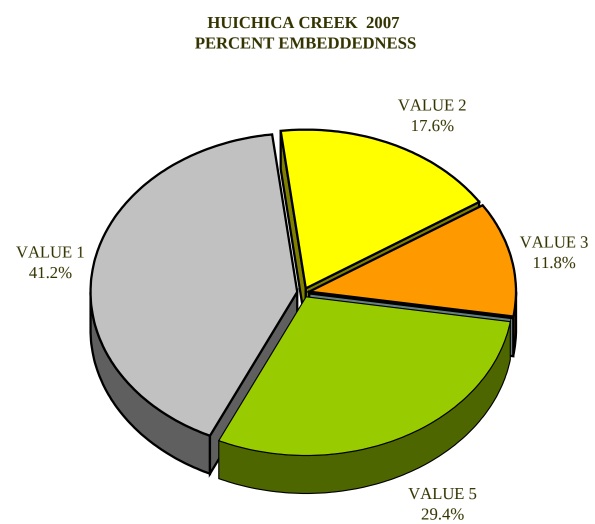
The depth of cobble embeddedness was estimated at pool tail-outs (Graph 8). A value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations. Of the 17 pool tail-outs measured, 7 had a value of 1 (41%); 3 had a value of 2 (18%); 2 had a value of 3 (12%); and 5 had a value of 5 (29%).

In total, 10 of the 17 pool tail-outs measured had embeddedness ratings of 1 or 2, and two of the pool tail-outs had embeddedness ratings of 3 or 4. Five of the pool tail-outs had a rating of 5, mostly due to bedrock. Cobble embeddedness measured to be 25% or less, a rating of 1, indicates good quality spawning substrate for salmon and steelhead.

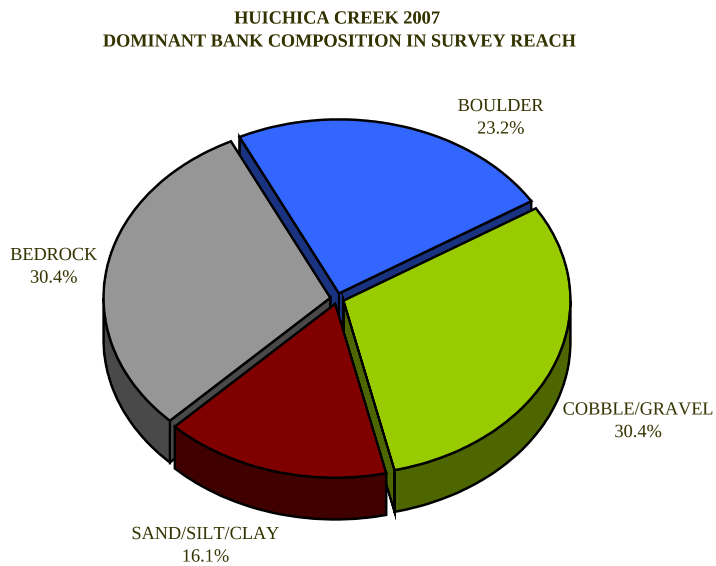
The stream banks were comprised mainly of bedrock (30% of units), cobble/gravel (30% of units), and boulders (23% of units). Sand/silt/clay was a smaller fraction overall and tended to be more common in the lower reaches (Graph 9).



GRAPH 7



GRAPH 8



GRAPH 9

A total of ten potential spawning sites were measured for gravel permeability (Figure 3.2.2). The predicted egg-to-emergence survival estimates ranged from 44% to 72%.

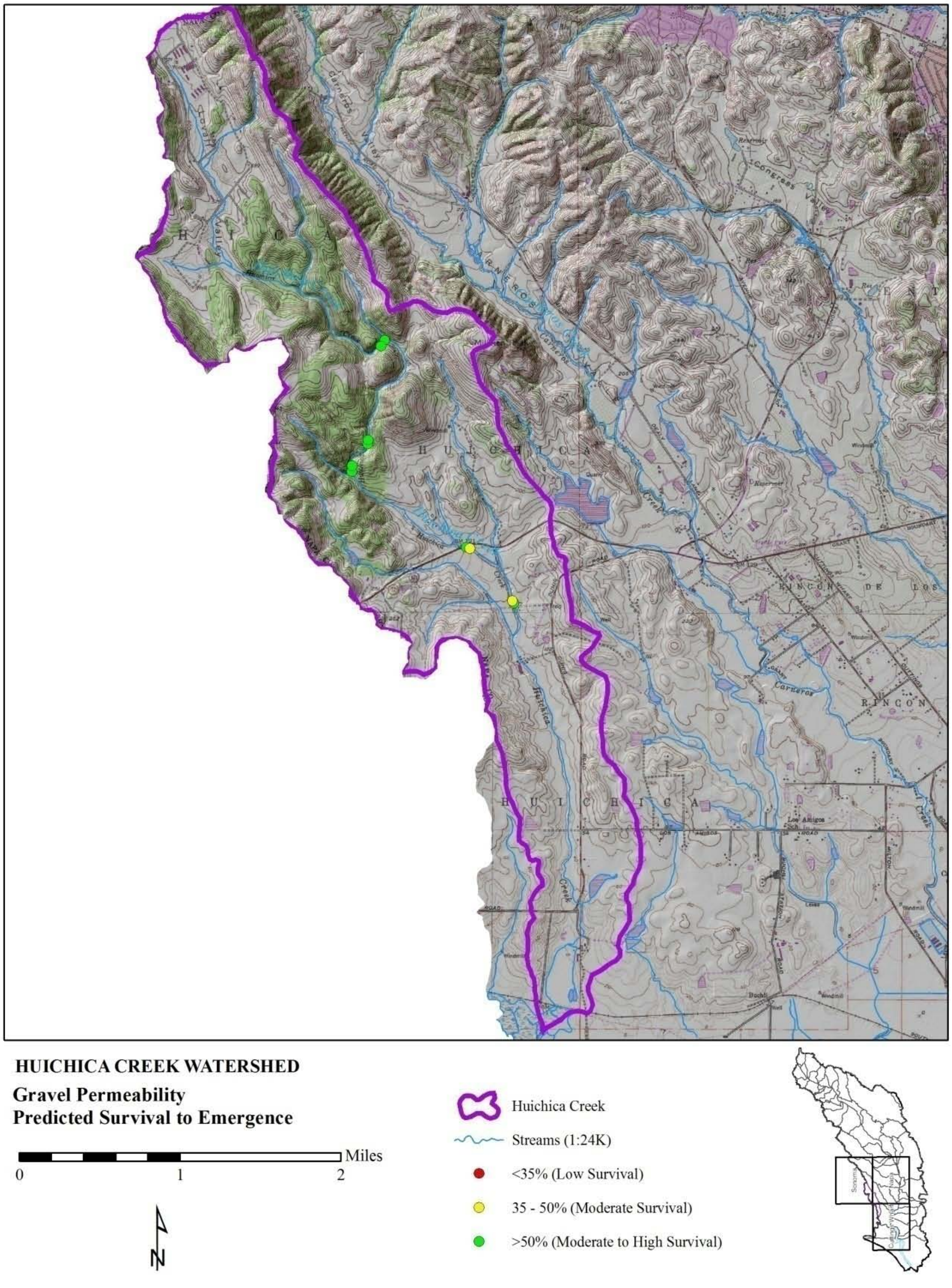
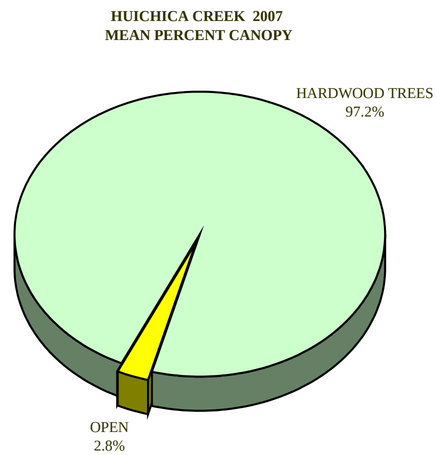


Figure 3.2.2 – Gravel permeability sites on Huichica Creek. Estimated survival values ranged from 44% to 72%.

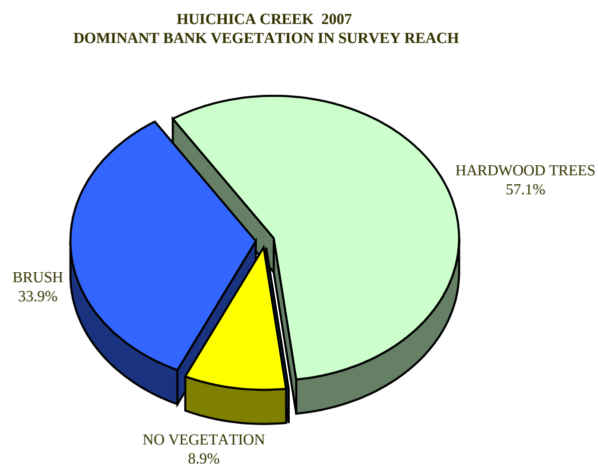
The mean percent canopy density for the surveyed length of Huichica Creek was 97%. Overall, only three percent of the canopy was open (Graph 10). For the stream reach surveyed, the mean percent right bank vegetated was 66%. The mean percent left bank vegetated was 62%.

Hardwood trees were the dominant vegetation type observed in 57% of the units surveyed. Additionally, 34% of the units surveyed had brush as the dominant vegetation type, and 9% had no vegetation on the stream banks (Graph 11).

The mean percent canopy density for the survey was 97%. Reach 1 had a canopy density of 96%, Reach 2 had a canopy density of 97%, and Reach 3 had a canopy density of 96%. The percentage of right and left bank covered with vegetation was moderate at 66% and 62%, respectively.



GRAPH 10



GRAPH 11

MIGRATION BARRIERS

Two potential fish migration barriers were documented on Huichica Creek. The sites consisted of the Highway 12/121 culvert, and an old concrete dam built on a natural bedrock outcrop in Reach 3 (Figure 3.2.3). Both sites were ranked "Red" according to the DFG criteria outlined in the California Salmonid Stream Habitat Restoration Manual (*Chapter IX, Figure IX-17*). A ranking of Red indicates the site is a severe or complete barrier to fish migration.

The highest priority barrier is the Highway 12/121 crossing, which is located low in the watershed and impedes access to high quality habitat in reaches 2 and 3. The concrete dam located in reach 3, although a severe barrier, is located at the upper end of perennial flow and thus would be expected to have a limited impact on the overall steelhead population distribution. Still, allowing fish to pass the structure more easily would provide upstream spawning opportunities in higher flow years and would therefore be beneficial. It would also allow upstream juvenile dispersal, which is currently completely prevented by the structure.

Both sites are planned for full assessment by RCD in 2009 as part of a watershed-wide effort to develop treatments for the highest priority barriers in the Napa River watershed.

Highway 12/121 culvert crossing over Huichica Creek

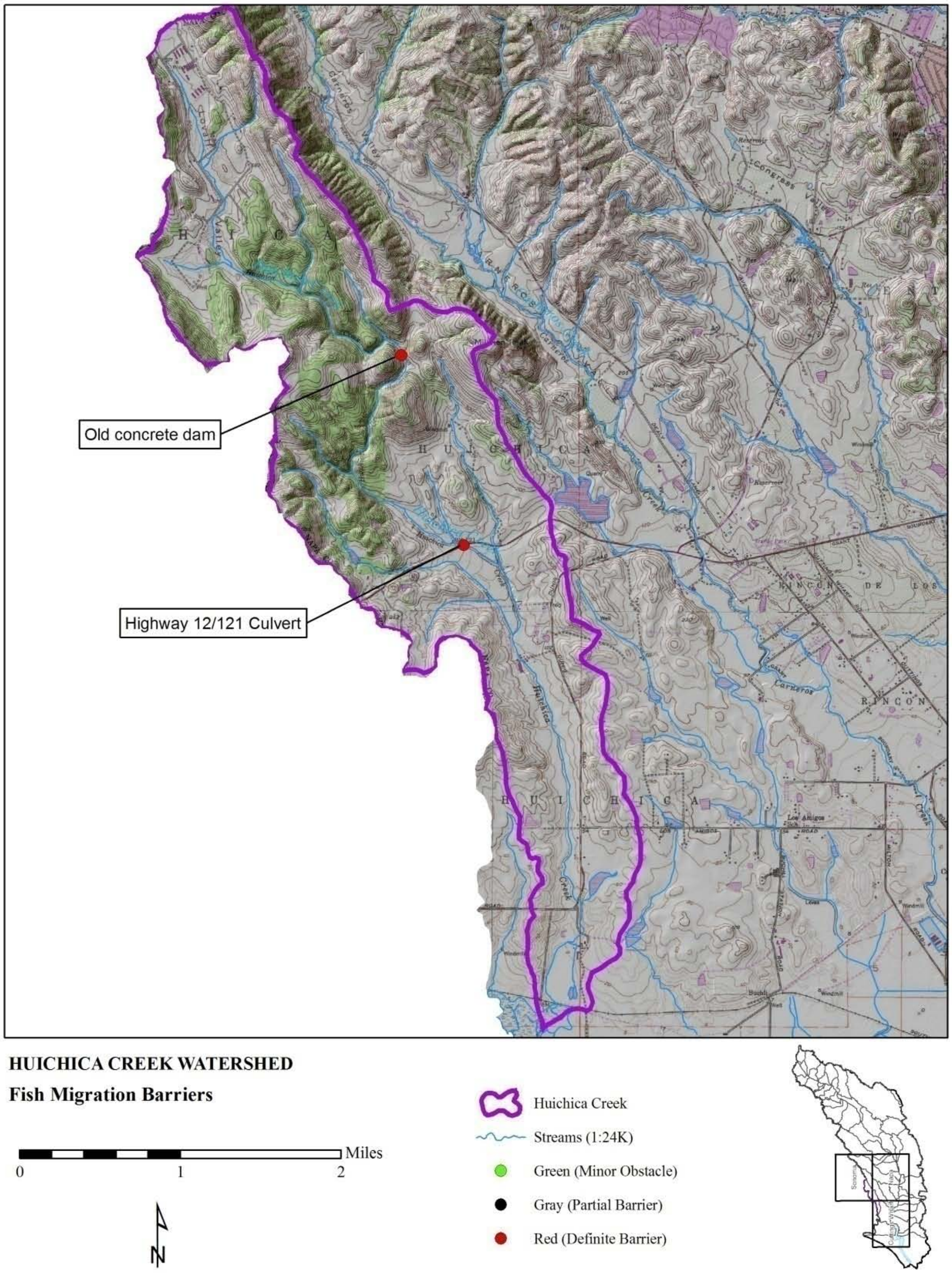


Figure 3.2.3 – Fish migration barrier sites on Huichica Creek

BIOLOGICAL SURVEYS/ OBSERVATIONS

Juvenile steelhead were observed in Huichica Creek in moderate to high abundances in reaches 2 and 3. A few juvenile steelhead were observed sporadically in reach 1, but water quantity and quality were generally lacking to support rearing throughout much of this reach. No adult or juvenile surveys (e.g. spawner surveys or snorkel counts) were conducted for Huichica Creek as part of this study.

WATER QUANTITY

Stream flow was visually estimated at approximately 0.1 to 0.5 cfs in reaches 2 and 3 during the habitat survey period. These reaches are perennial according to the landowner. The channel above Reach 3 appears to go completely dry in most years, and would therefore not be expected to support steelhead rearing. The channel downstream of Highway 12/121 goes completely dry in most years. A very short section of flowing water was observed around the Nuenschwander Road Bridge below reach 1, but the source was not apparent and may have been agricultural return water. Irrigation of an adjacent vineyard and bank restoration project was observed in this area during the survey.

There are a total of 41 appropriative water rights on record for the Huichica Creek watershed (Figure 4.1.1).

WATER TEMPERATURE

Water temperatures taken during the habitat survey ranged from 10° - 15° C. Air temperatures ranged from 15° - 26° C.

Water temperature was measured continuously at one site in Reach 2 from 8/4/06 to 12/3/07 (Figure 3.2.4). The Maximum Weekly Average Temperature (MWAT) during this period was 17.8° C (Table 3.2.1)

Mean Temperature (°C)	12.23
Median Temperature (°C)	12.44
Maximum Temperature (°C)	19.10
Minimum Temperature (°C)	1.51
Standard Deviation (°C)	3.63
Total Measurements	46,719
Number of records exceeding 20˚C	0
MWAT (°C)	17.81

Table 3.2.1 – Summary statistics from continuous temperature monitoring of Huichica Creek.

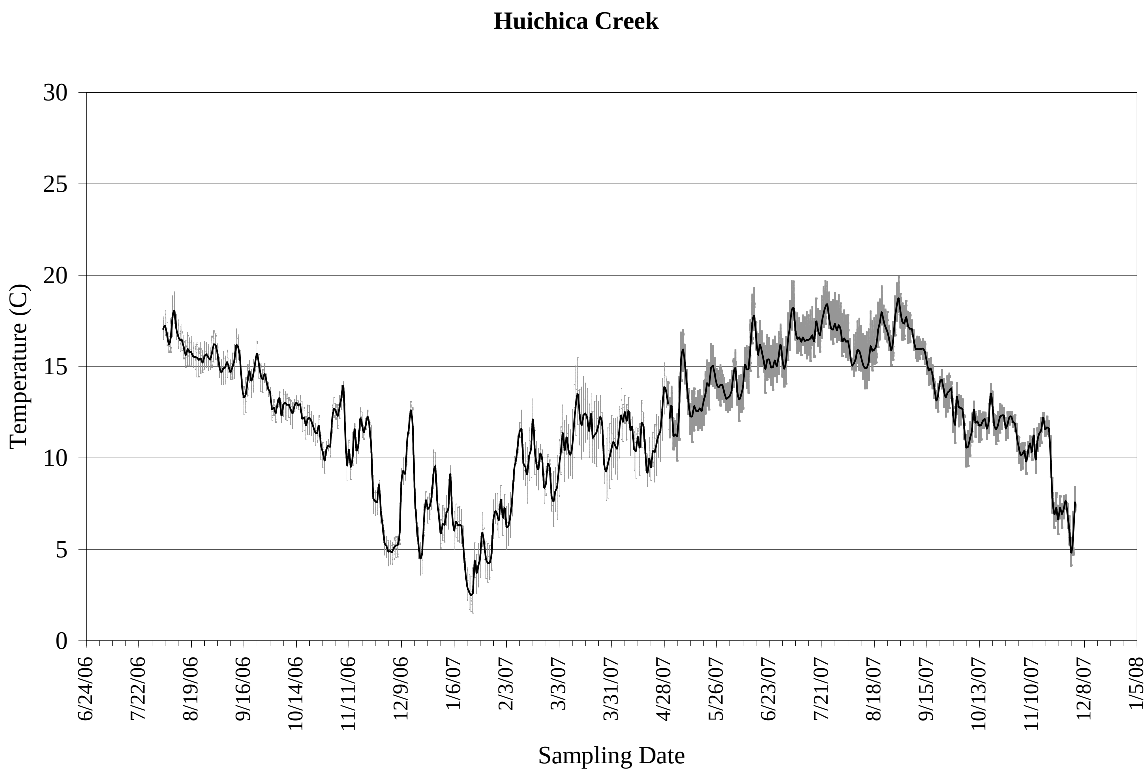


Figure 3.2.4 – Continuous water temperature data from Huichica Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.3 MILLIKEN CREEK

Milliken Creek is a tributary to Napa River, which flows to the Pacific Ocean via San Pablo Bay. Milliken Creek's location at the confluence with Napa River is 38.316743° north latitude and 122.276933° west longitude. Milliken Creek is a fourth order stream and has approximately 20.18 miles of blue line stream below Milliken Reservoir according to the USGS Yountville, Mt. George, Napa, and Capell Valley 7.5 minute quadrangles. Milliken Creek drains a watershed of approximately 18.5 square miles (8.91 square miles below the reservoir). Elevations range from sea level at the mouth of the creek to 2,600 feet in the headwater areas. Mixed hardwood forest and scrub land dominate the watershed with extensive vineyard development in the lower watershed. Much of the upper watershed is owned by the City of Napa for domestic water supply. Vehicle access to Milliken Creek exists via Monticello, Silverado, and Atlas Peak Roads.

HISTORICAL INFORMATION (excerpted from Leidy et al., 2005)

A June 1940 DFG lake survey report noted natural populations of steelhead having moderate success in Milliken Reservoir with YOY (50-65 mm) observed in inlet streams (Shapovalov 1940a). Draining of Milliken Reservoir in 1954 revealed only a few trout (Evans 1954).

In 1958, DFG characterized the six miles of Milliken Creek downstream of the reservoir as useful for spawning by steelhead (Elwell 1958c).

In February 1959, DFG surveyed Milliken Creek upstream of Milliken Reservoir, including a two mile reach downstream of a 40 foot falls that served as a complete barrier to fish migration. Although no fish were observed, the dam's caretaker reported spawning runs of *O. mykiss* from the lake upstream in Milliken Creek in late fall of that year (Fisher 1959b).

In May 1966, DFG visually surveyed Milliken Creek from the mouth upstream to Milliken Reservoir. One 405 mm *O. mykiss* was found at the base of the Silverado Country Club Diversion Dam upstream from Atlas Peak Road. Between the diversion dam and Milliken Reservoir, *O. mykiss* were observed ranging from 50-150 mm and at an estimated density of 40 per 30 meters (Brackett 1966b).

In March 1967, DFG visually surveyed Milliken Creek from the mouth to Milliken Reservoir. A 510 mm steelhead was observed at the base of the Silverado Country Club Diversion Dam (Thompson 1967c).

In July 1975, DFG visually surveyed Milliken Creek from Milliken Reservoir upstream 3.6 miles. Downstream of a natural falls, *O. mykiss* ranging in size from 50-100 mm were observed at an estimated density of 5 per 30 meters. No *O. mykiss* were found upstream of the falls (Henry and Coleman 1975).

In November and December 1975, DFG visually surveyed Milliken Creek from the Silverado Country Club Diversion Dam to Milliken Reservoir. About two miles upstream of the country club, a 20-foot barrier was identified where the city of Napa built a diversion dam at a bedrock outcrop.

No fish were found upstream of this barrier. Steelhead were observed ranging from 50-255 mm downstream of the barrier, at an estimated density of 20 per 30 meters (Tyler and Holstine 1975).

In April and May 1980, DFG visually surveyed Milliken Creek from its mouth to the Napa Diversion Dam. This effort was followed up with an electrofishing survey at four stations. Upstream of the Napa City Diversion Dam, five *O. mykiss* were caught ranging from 115-199 mm FL. At the mouth of Milliken Canyon, 13 *O. mykiss* were caught ranging from 117–187 mm in length. Numerous *O. mykiss* fry were seen but not collected (Ellison et al. 1980).

In June 1981, DFG visually surveyed Milliken Creek from the mouth to the Silverado Country Club Diversion Dam in order to locate steelhead stranded by low flows. No steelhead were found (Ambrosins 1981b).

In July 1987, DFG visually surveyed Milliken Creek from its mouth to Milliken Reservoir, and recorded two *O. mykiss* (50, 380 mm) (Montoya 1987b). In July 1988, DFG electrofished Milliken Creek at the Silverado Country Club and found 11 *O. mykiss* from 61–268 mm (Montoya 1988b).

Leidy found no *O. mykiss* when electrofishing at the Trancas Road Bridge in August 1993 (Leidy 2002). However, in June 1998, he found *O. mykiss* at two other sites electrofished on Milliken Creek. At Atlas Peak Road, Leidy caught one *O. mykiss* (61 mm FL) and at Westgate Drive in the Silverado Country Club he caught two *O. mykiss* (50, 53mm FL) (Leidy 2002).

Ecotrust and FONR carried out surveys in tributaries of the Napa River system in July and August 2001. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. Of seven Milliken Creek reaches, three were found to have *O. mykiss* at density level “1,” while two reaches had density level “3” (Ecotrust and FONR 2001). Follow-up surveys were performed between June and September 2002. *Oncorhynchus mykiss* were found in numerous Milliken Creek and Milliken Creek tributary reaches, including three reaches at density level “3” (Ecotrust and FONR 2002).

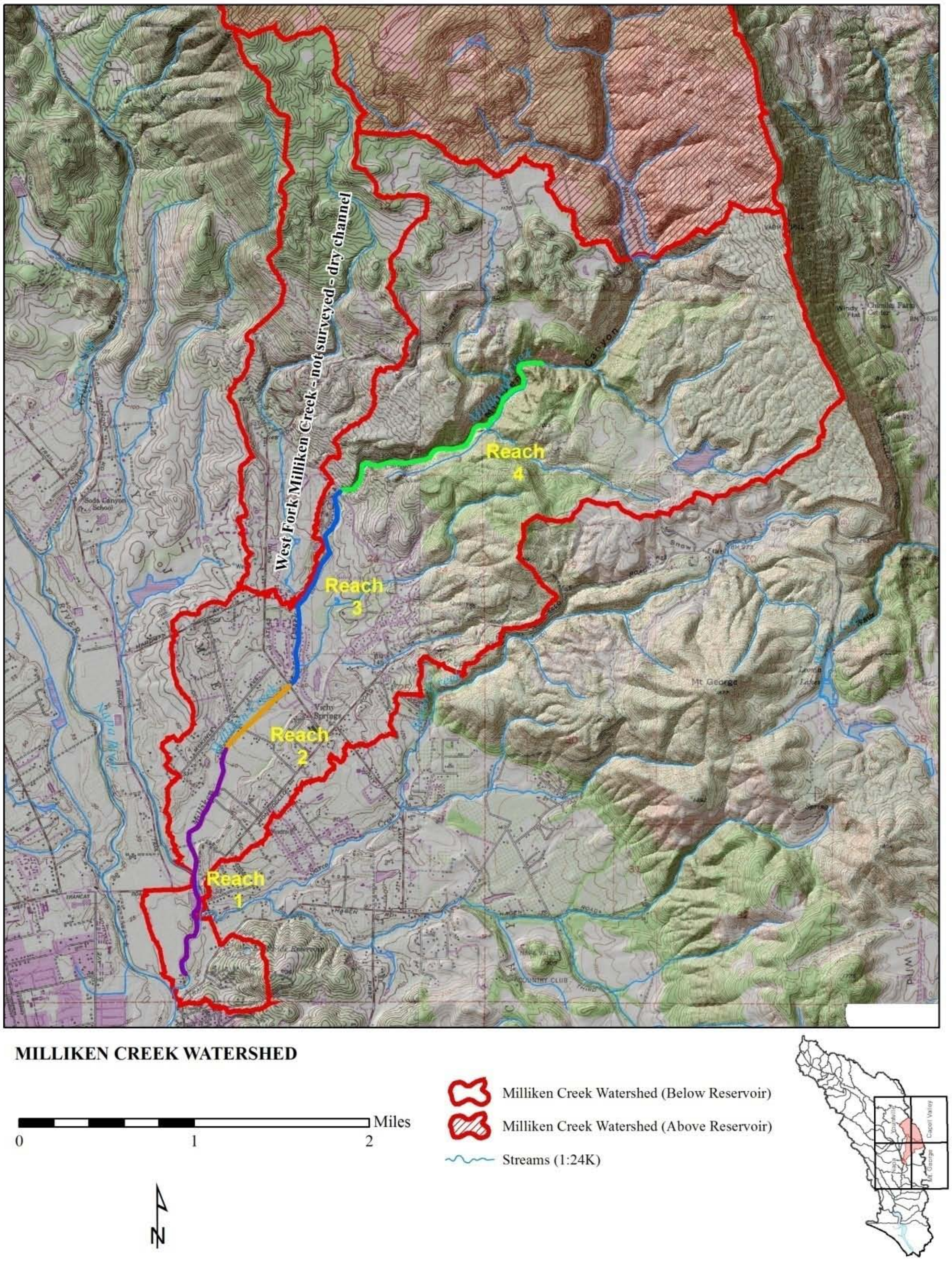


Figure 3.3.1 – Watershed map with habitat survey reaches.

HABITAT

All habitat typing result tables are located in Appendix C.

A stream inventory was conducted during 5/29/2007 to 6/6/2007 on Milliken Creek. The survey began at the confluence with the Napa River and extended upstream approximately five miles to the end of anadromy at a bedrock outcrop with a small diversion dam on top. The total length of the stream surveyed was 26,458 feet with an additional 236 feet of side channel. Stream flow was visually estimated to be <1 cfs during the survey period. The objective of the habitat inventory was to document the distribution and quality of habitat available to anadromous salmonids, specifically steelhead, in Milliken Creek. Recommendations for habitat restoration are based upon target values suitable for salmonids in California's north coast streams.

A total of four channel-typing cross sections were assessed during this survey:

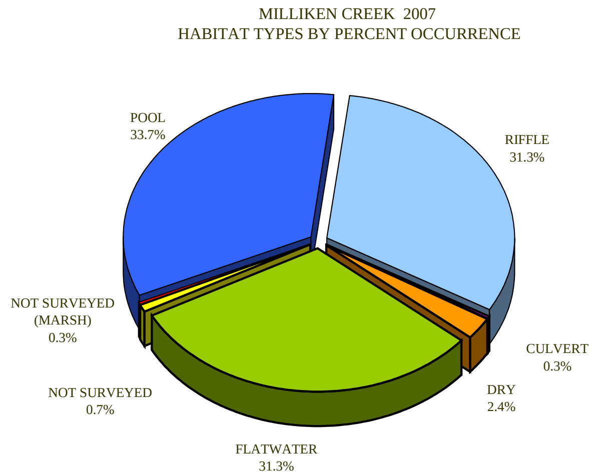
Reach 1	7,597 feet	F4 channel type.
Reach 2	2,883 feet	F1 channel type
Reach 3	6,850 feet	F3 channel type
Reach 4	9,128 feet	B3 channel type

Generally, F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. Type F1 and F3 channels are generally very similar to F4 channel types, with different substrate. In general, F1 channels have a bedrock-dominant substrate, and F3 types are cobble dominated. Type B3 channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, have stable banks on moderate gradients with low width /depth ratios, and cobble dominant substrates.

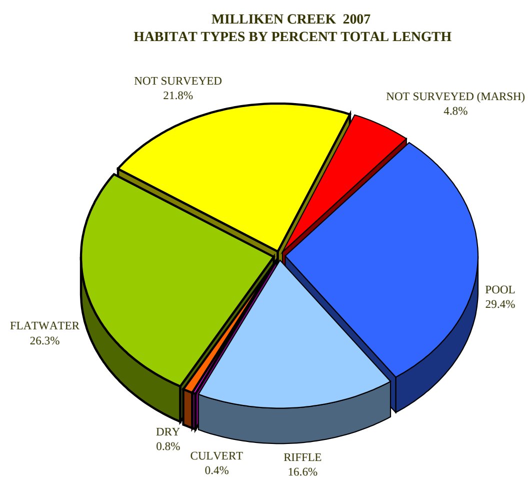
Water temperatures taken during the survey period ranged from 59 to 68 degrees Fahrenheit. Air temperatures ranged from 59 to 79 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 31% riffle units, 34% pool units, and 31% flatwater units (Graph 1). Based on total length, there were 17% riffle units, 29% pool units, and 26% flatwater units (Graph 2).

In total, 16 Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were; 21% Low Gradient Riffle units, 21% Glide units, and 24% Mid-Channel Pool units (Graph 3). Based on percent total length, the most frequent habitat types were as follows: 22% Mid-Channel Pool units, and 17% Glide units.

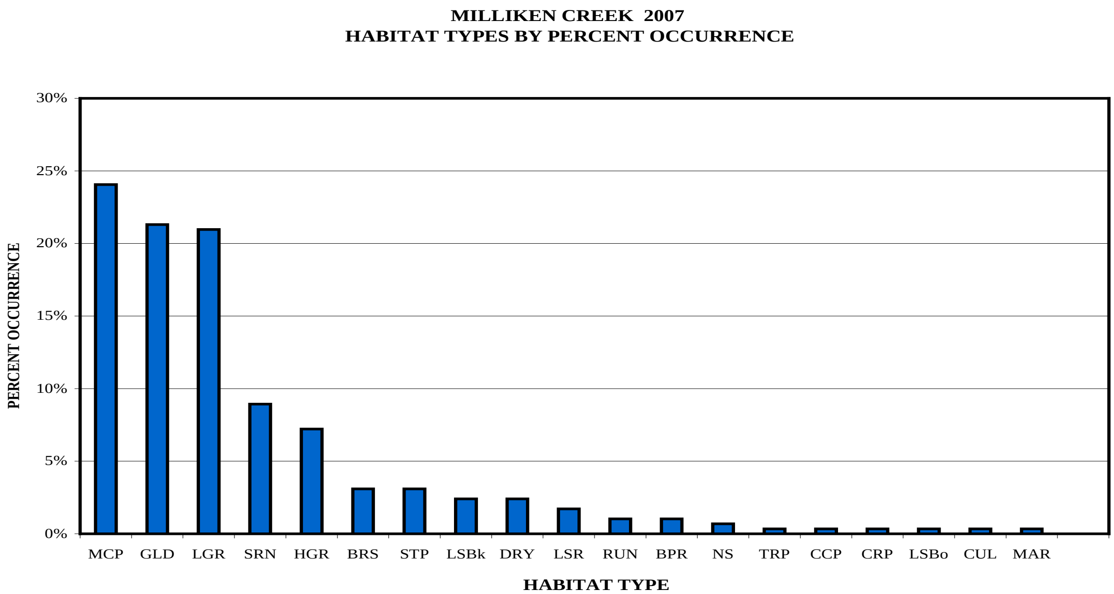


GRAPH 1

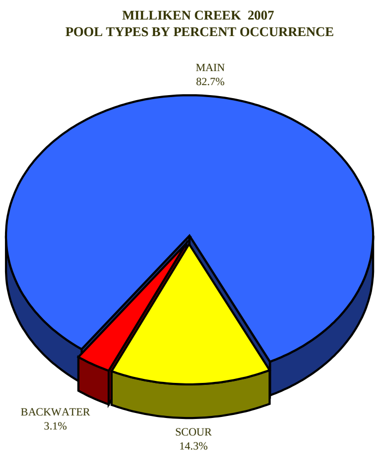


GRAPH 2

A total of 98 pools were measured during the survey (Table 3). Main Channel pools were the most frequently encountered, at 83%, and comprised 87% of the total length of all pools (Graph 4). Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth, and 26 of the 35 pools (74%) had a residual depth of two feet or greater (Graph 5). In addition, 16 of the 35 pools (46%) had a residual depth of three feet or greater (Graph 5).

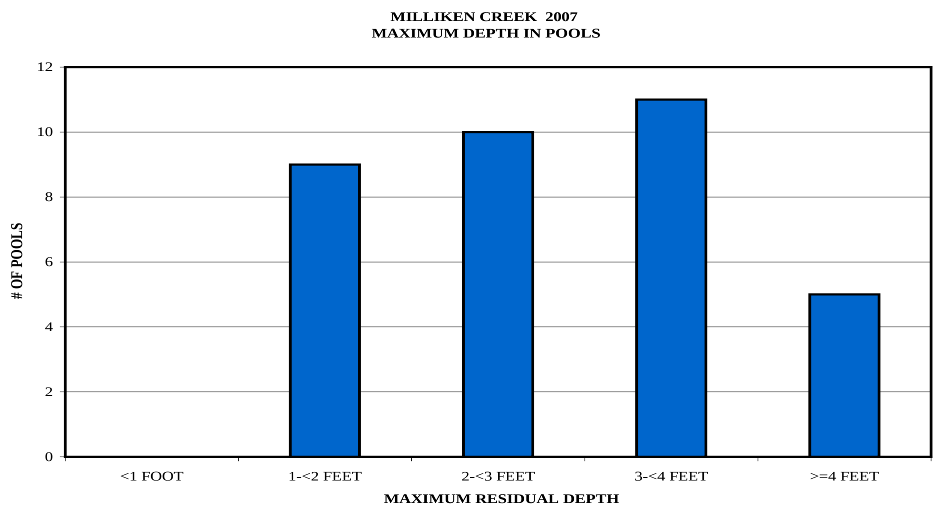


GRAPH 3



GRAPH 4

The pools are relatively deep, with 16 of the 35 (46%) pools having a maximum residual depth greater than 3 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In third and fourth order streams, a primary pool has a maximum residual depth of at least three feet and occupies at least half the width of the low flow channel.



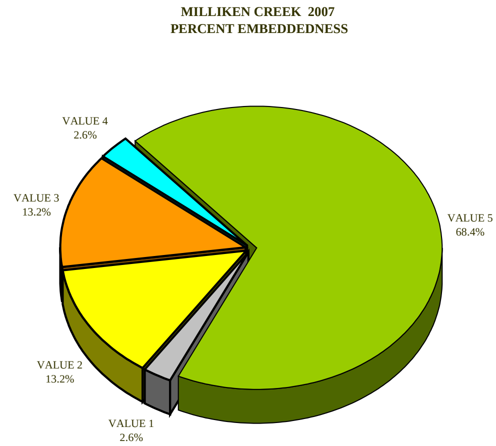
GRAPH 5

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 38 pool tail-outs measured, 1 had a value of 1 (2.6%); 5 had a value of 2 (13.2%); 5 had a value of 3 (13.2%); 1 had a value of 4 (2.6%); and 26 had a value of 5 (68.4%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

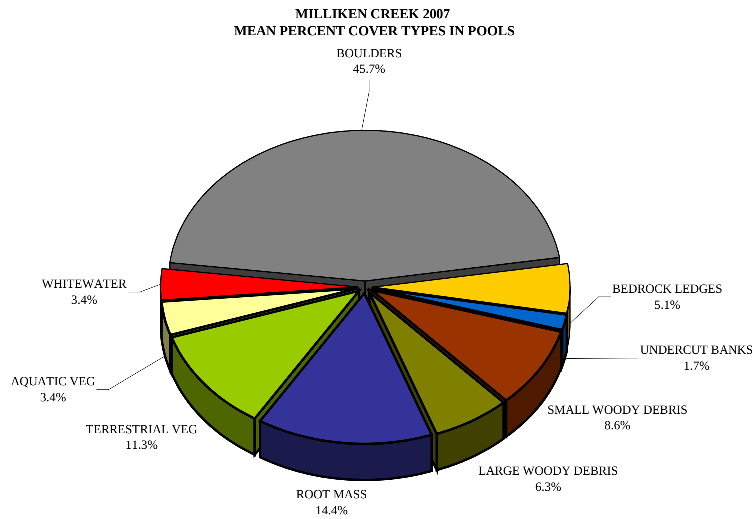
In total, 6 of the 38 pool tail-outs measured had embeddedness ratings of 1 or 2, and 6 of the pool tail-outs had embeddedness ratings of 3 or 4. Overall, 26 of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. This was due largely to the presence of extensive bedrock substrate in reach 4. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

Twelve of the 38 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids. In reach 4, suitable spawning gravels were relatively sparse.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 18, flatwater habitat types had a mean shelter rating of 43, and pool habitats had a mean shelter rating of 74 (Table 1). Of the pool types, the Main Channel pools had a mean shelter rating of 64, Scour pools had a mean shelter rating of 101, and Backwater pools had a mean shelter rating of 105 (Table 3). A pool shelter rating of approximately 100 is desirable.



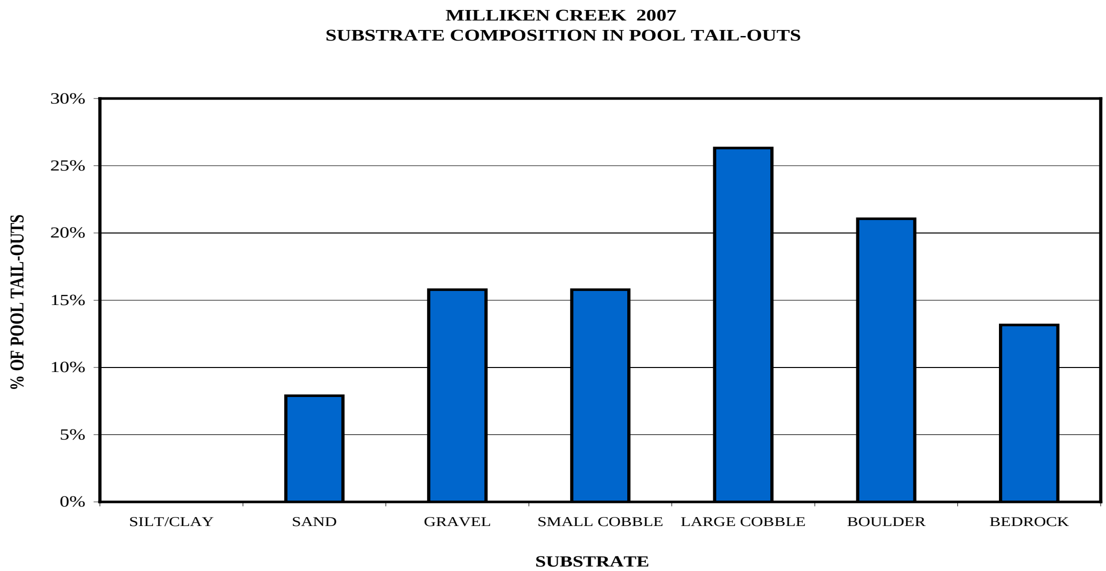
GRAPH 6



GRAPH 7

Boulders and root mass were found to be the dominant cover type in Milliken Creek (Graph 7).

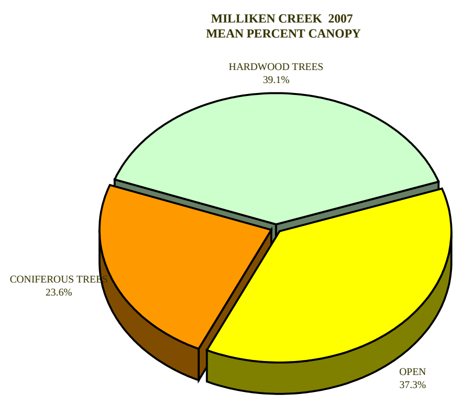
Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. The two dominant types of substrate in the survey were large cobble and boulders.



GRAPH 8

The mean percent canopy density for the surveyed length of Milliken Creek was 63%, and the mean percentages of hardwood and coniferous trees were 62% and 38%, respectively. Overall, 37 percent of the canopy was open (Graph 9).

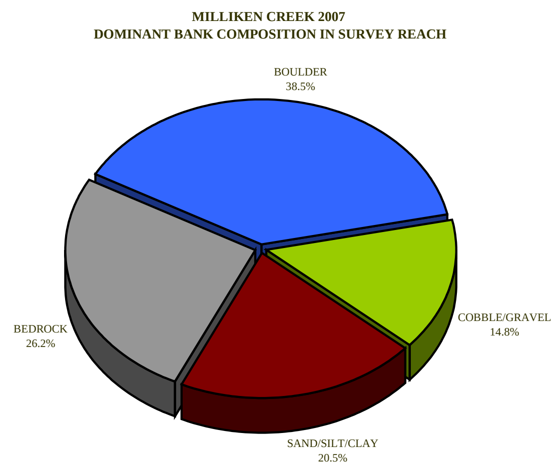
Reach 1 had a canopy density of 87%, Reach 2 had a canopy density of 94%, Reach 3 had a canopy density of 53%, and Reach 4 had a canopy density of 51%. In general, revegetation projects are considered when canopy density is less than 80%.



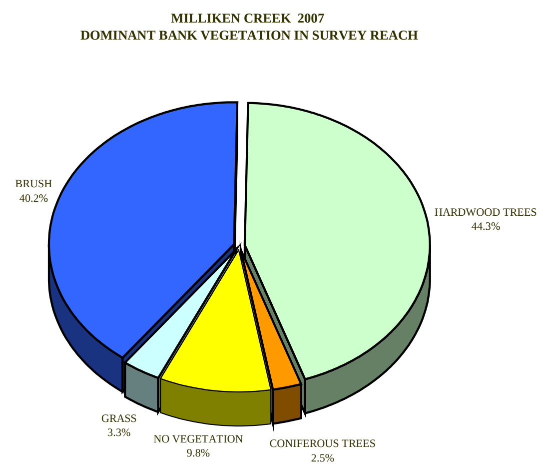
GRAPH 9

For the stream reach surveyed, the mean percent right bank vegetated was 63%, and the mean percent left bank vegetated was 73%. The dominant elements composing the structure of the stream banks consisted of 26% bedrock, 39% boulder, 15% cobble/gravel, and 20% sand/silt/clay (Graph 10).

Deciduous trees were the dominant vegetation type observed in 44% of the units surveyed. Additionally, 40% of the units surveyed had brush as the dominant vegetation type, and 3% had grass as the dominant vegetation (Graph 11).



GRAPH 10



GRAPH 11

<u>SPAWNING GRAVEL PERMEABILITY</u>

A total of 18 potential spawning sites were measured for gravel permeability (Figure 3.3.2). The predicted egg-to-emergence survival estimates ranged from 3% to 71%.

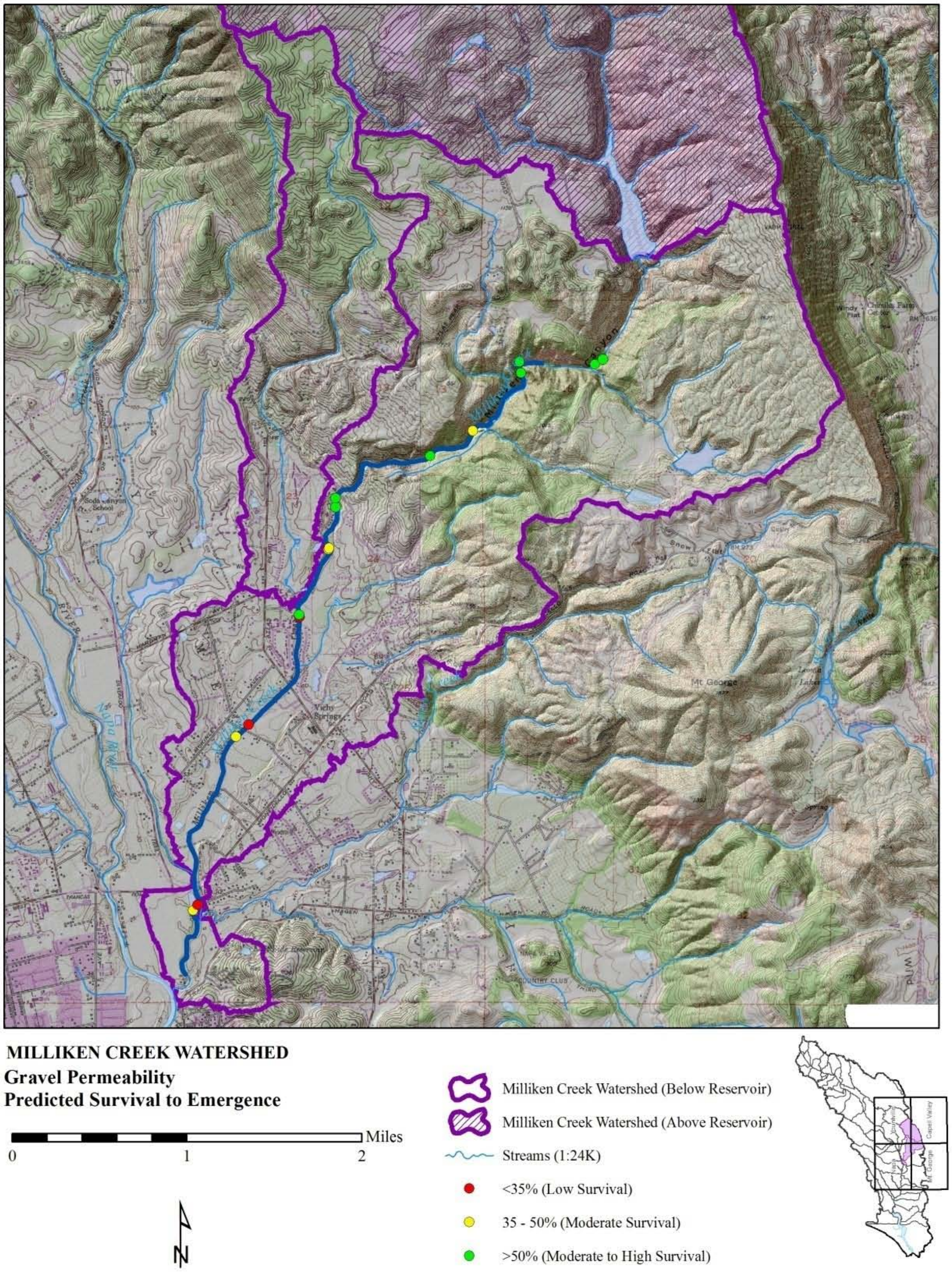


Figure 3.3.2 – Gravel permeability sites on Milliken Creek. Estimated survival values ranged from 3% to 71%.

MIGRATION BARRIERS

A total of four fish migration barriers were identified on Milliken Creek (Figure 3.3.3).

The first site is a small seasonal reservoir located in reach 3, which has the potential to completely block upstream and downstream passage when the outlet gate is closed. The reservoir outlet structure is likely a low-flow barrier for upstream migration, but does not completely block adult passage as indicated by upstream sightings of spawning Chinook salmon in November 2006 and adult steelhead in winter 2007/2008.

The second site is a natural boulder cascade formed by a landslide. Material from the slide, which consists primarily of large boulders, has been deposited in the channel and forms a series of pools and short cascades. This site is likely a complete low flow barrier and may be passable at higher flows.

The third site is a natural bedrock outcrop with a 20+ foot high waterfall. The City of Napa has constructed a small diversion structure on top of this outcrop and diverts some portion of the stream flow into a pipe which flows down the canyon to a treatment facility. This site appears to be the natural end of anadromy for Milliken Creek.

The fourth site is a 30+ foot high natural bedrock waterfall located approximately ¼ mile downstream from the Milliken Reservoir dam.

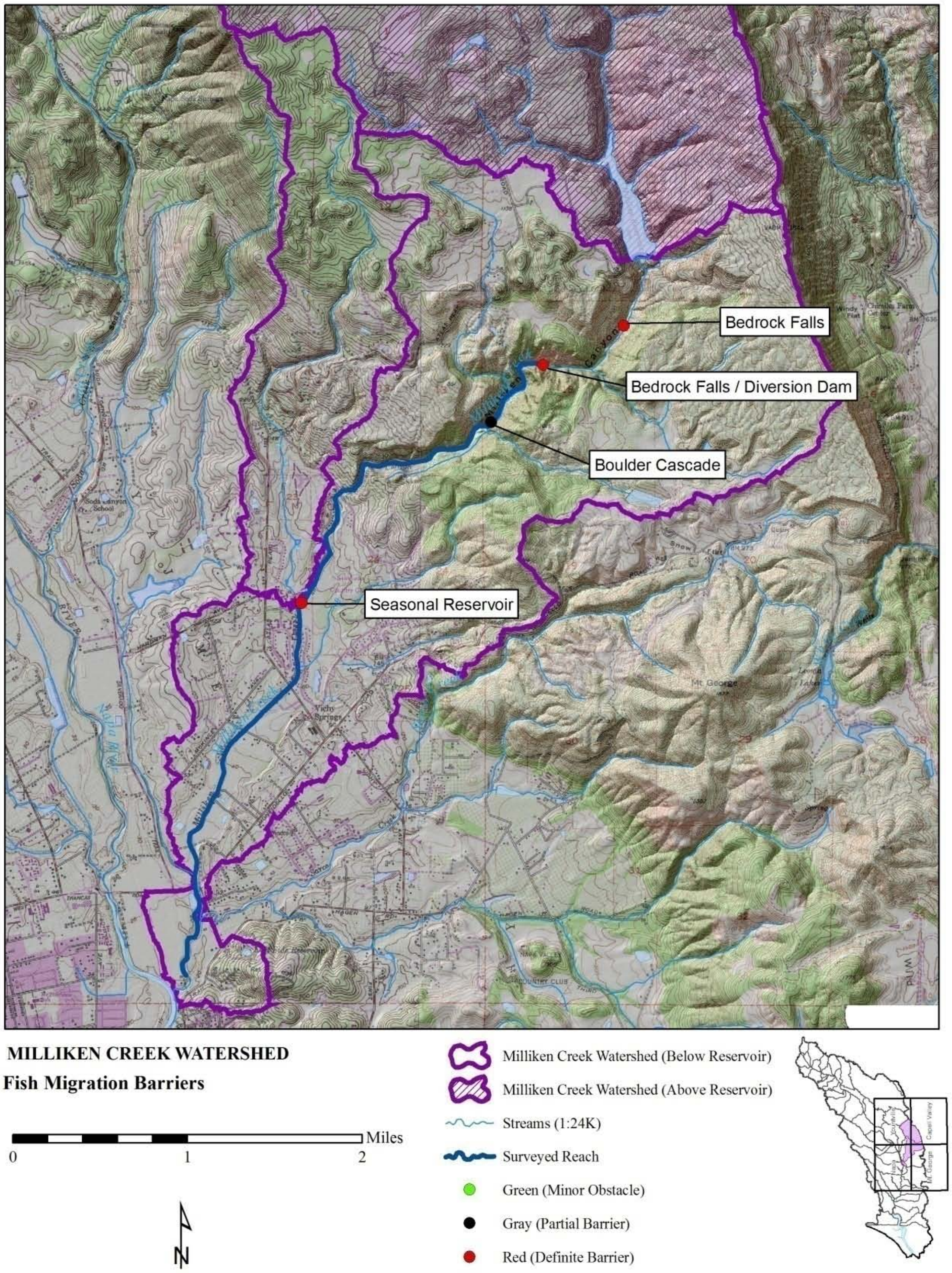


Figure 3.3.3 – Fish migration barrier sites on Milliken Creek.

BIOLOGICAL SURVEYS/ OBSERVATIONS

Juvenile steelhead were observed in Milliken Creek in moderate to high abundances in reaches 2, 3, and 4. A few juvenile steelhead were observed sporadically in reach 1, but water quantity and quality were generally lacking to support rearing throughout much of this reach.

Adult steelhead spawning was observed in reach 4 and recently constructed steelhead redds were observed in reaches 3 and 4 during permeability sampling. RCD staff did not observe Chinook spawning in Milliken Creek directly, but a citizen provided a picture of a Chinook salmon carcass in reach 3 taken in 2006. Chinook spawning appears to be opportunistic and is likely limited to the lower reaches of Milliken Creek.

No adult or juvenile surveys (e.g. spawner surveys or snorkel counts) were conducted for Milliken Creek as part of this study.

WATER QUANTITY

Streamflow was visually estimated at approximately 1 cfs during the habitat survey.

There are a total of 20 appropriative water rights on record for the Milliken Creek watershed below Milliken Reservoir (Figure 4.1.1).

WATER TEMPERATURE

Mean Temperature (°C)	14.53
Median Temperature (°C)	14.98
Maximum Temperature (°C)	23.04
Minimum Temperature (°C)	3.80
Standard Deviation (°C)	4.15
Total Measurements	46,803
Number of records exceeding 20˚C	2456
MWAT (°C)	20.76

Table 3.3.1 – Summary statistics from continuous temperature monitoring of Milliken Creek.

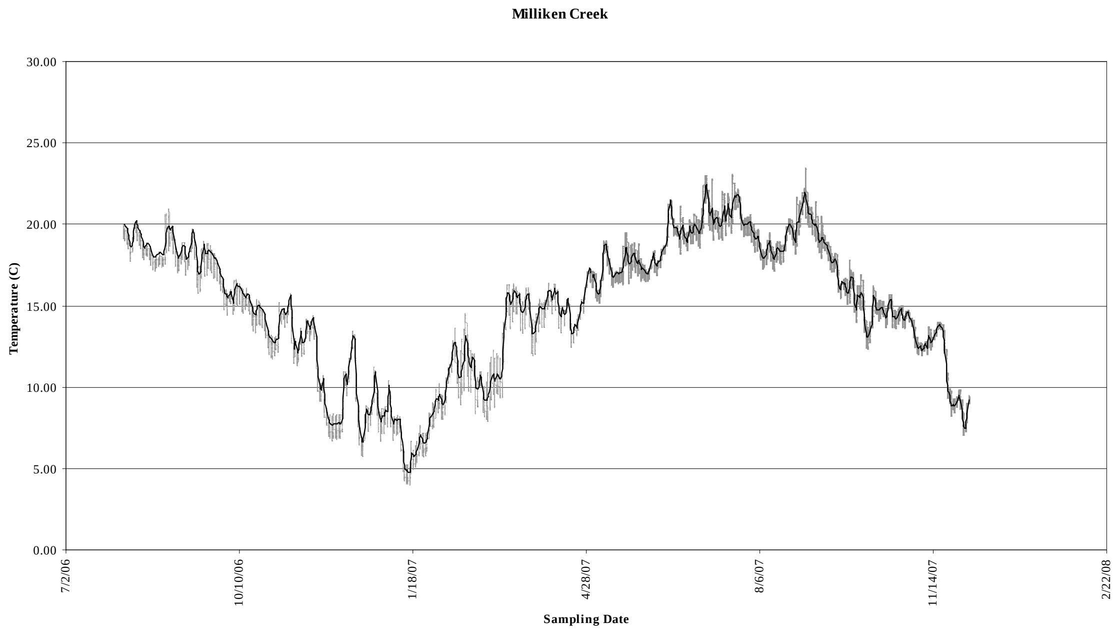


Figure 3.3.4 – Continuous water temperature data from Milliken Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.4 MURPHY CREEK

Murphy Creek is a tributary to Tulucay Creek, which is a tributary of the Napa River, and flows to the Pacific Ocean via the San Pablo Bay. Murphy Creek's location at the confluence with Tulucay Creek is 38.292803° north latitude and 122.238973° west longitude, LLID number 1222378382930. Murphy Creek is a second order stream and has approximately 4.3 miles of blue line stream according to the USGS Mt. George 7.5 minute quadrangle. Murphy Creek drains a watershed of approximately 1.12 square miles. Elevations range from about 100 feet at the mouth of the creek to 1,800 feet in the headwater areas. Mixed hardwood forest dominates this watershed. The watershed is entirely privately owned, and vehicle access exists via Coombsville Road and Shady Brook Lane.

HISTORICAL INFORMATION (Leidy et al., 2005)

In June 1968, DFG investigated reports of a fish kill involving large numbers of Murphy Creek steelhead. During a subsequent survey, juvenile *O. mykiss* were observed between 38-100 mm in length at an estimated density of 20 per 30 meters of stream throughout the surveyed area (Jones 1968).

In August 1990, DFG electrofished pool sites upstream of the crossing at Shady Brook Lane. Five *O. mykiss* were caught ranging in size from 103-210 mm. An additional three to four *O. mykiss* (50-150 mm) were observed but not caught (Gray 1990d). The survey report noted a local resident's statement that, until about 1970, many adult steelhead, typically 610-660 mm long, migrated up Murphy Creek.

In July 1992, DFG electrofished pools at two Murphy Creek sites. *Oncorhynchus mykiss* were found at both sites and ranged from 126-249 mm (Emig 1992a).

Ecotrust and FONR carried out surveys in tributaries of the Napa River system in July and August 2001. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. Two reaches of Murphy Creek were found to have *O. mykiss* at density level "1" and one headwaters reach had level "2" (Ecotrust and FONR 2001).

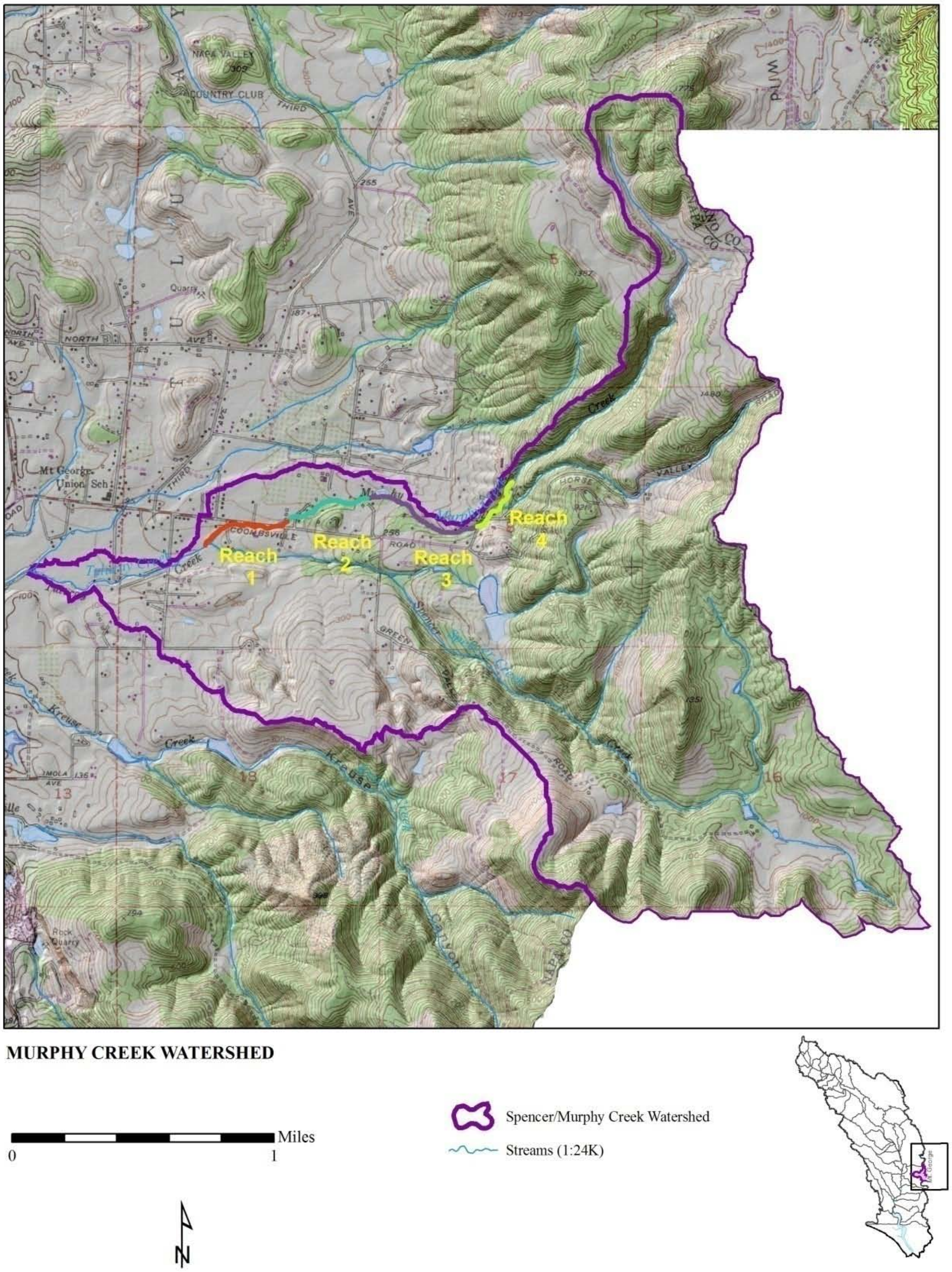


Figure 3.4.1 – Watershed map with habitat survey reaches.

HABITAT

All habitat typing result tables are located in Appendix C.

A stream inventory of Murphy Creek was conducted on 9/17/2007. The survey began at the confluence of Murphy and Spencer Creeks, which converge to form Tulucay Creek, and extended upstream through several small rural neighborhoods. The stream survey continued upstream through several man-made barriers, and ended where property access was not established. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Murphy Creek.

Recommendations for habitat restoration are based upon target values suitable for salmonids in California's north coast streams.

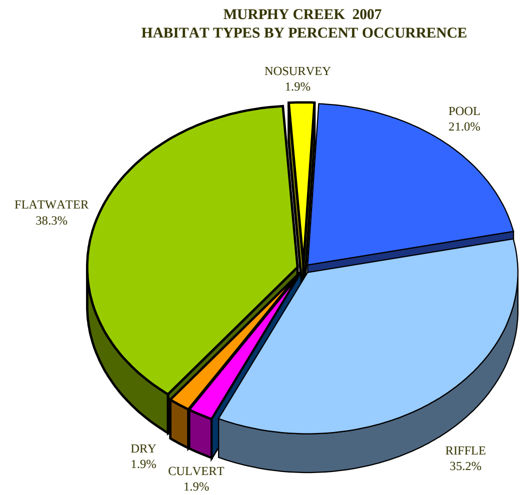
A total of four channel-typing cross sections were assessed during this survey:

Reach 1	1,886 feet	B4 channel type.
Reach 2	1,856 feet	B4 channel type
Reach 3	2,698 feet	F4 channel type
Reach 4	1,363 feet	F4 channel type

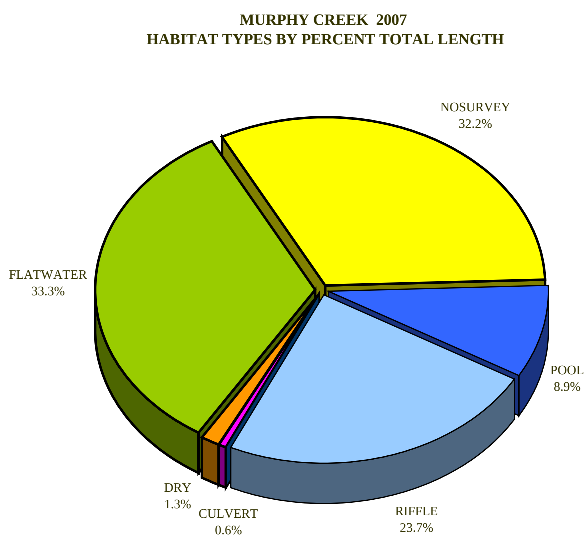
In general, B4 channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios and gravel dominant substrates. F4 channels are generally entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates.

Water temperatures taken during the survey period ranged from 59 to 62 degrees Fahrenheit. Air temperatures ranged from 61 to 77 degrees Fahrenheit. Continuous water temperature monitoring was conducted at one location on Murphy Creek and the results are discussed in the water temperature section of this report.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 38% flatwater units, 21% pool units, and 35% riffle units (Graph 1). Based on total length of Level II habitat types there were 33% flatwater units, 9% pool units, 24% riffle units, and 32% no-survey units (Graph 2).

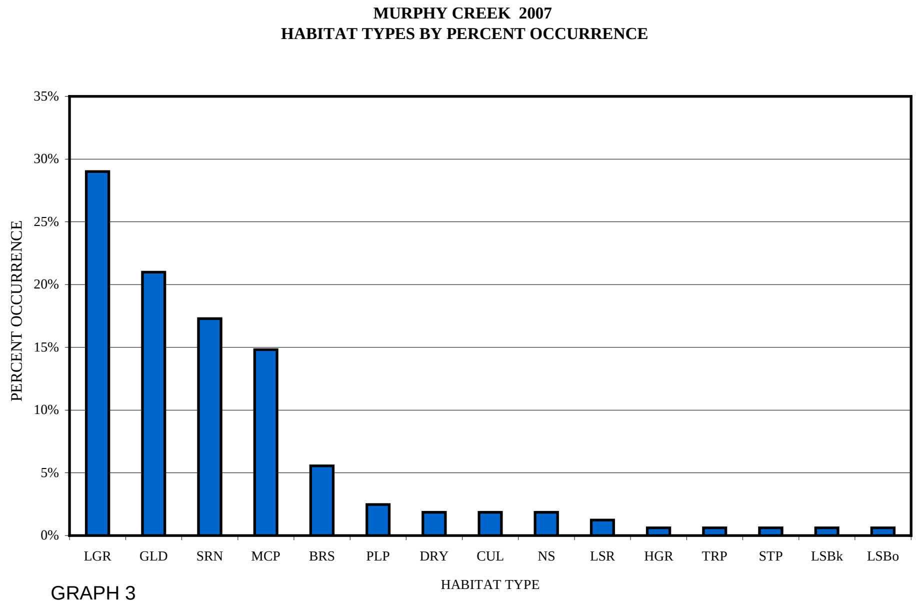


GRAPH 1

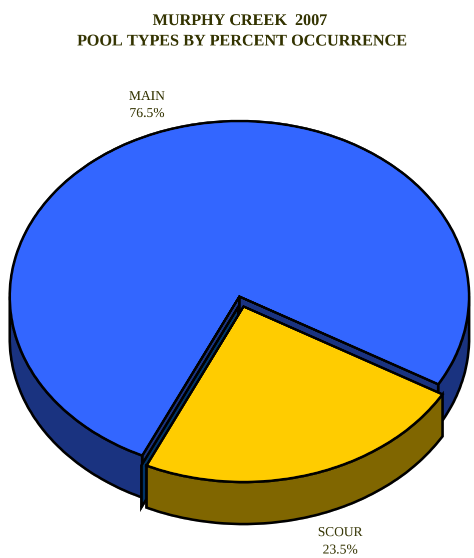


GRAPH 2

A total of 13 Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were: 21% glide units, and 29% low gradient riffle units (Graph 3). Based on percent total length, the most frequent habitat types were: 21% low gradient riffle units, and 22% step run units.

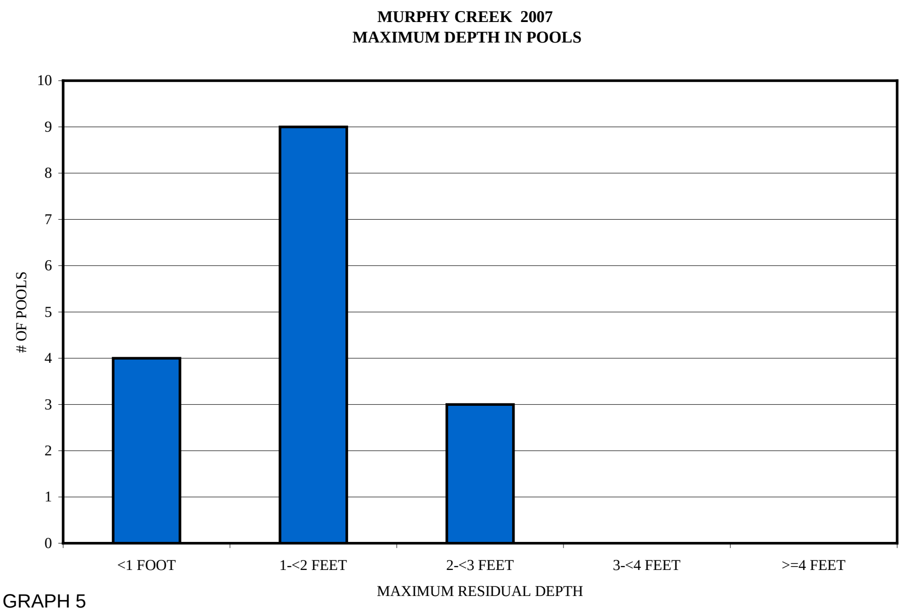


GRAPH 3



GRAPH 4

A total of 34 pools were identified (Table 3). Main channel pools were the most frequently encountered, at 76%, and comprised 81% of the total length of all pools (Graph 4). Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth, and a total of 3 of the 16 pools (19%) had a residual depth of two feet or greater, (Graph 5). None of the 16 pools surveyed had a residual depth of three feet or greater.



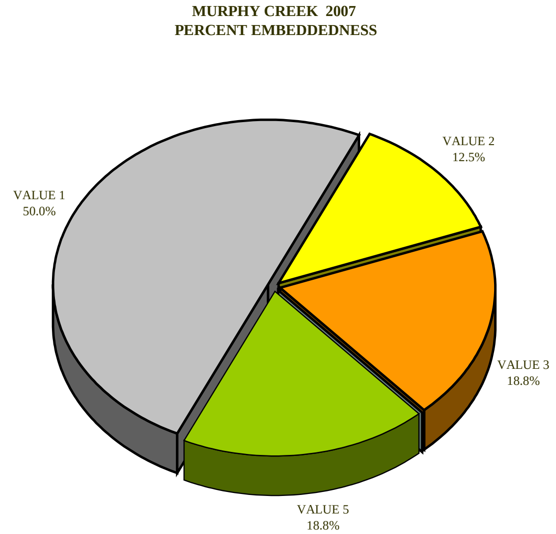
GRAPH 5

Flatwater habitat types comprised 33% of the total length of this survey, riffles 24%, and pools 9%. The pools throughout the survey were relatively shallow, with only 3 of the 16 (19%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool has a maximum residual depth of at least two feet, and occupies at least half the width of the low flow channel.

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 16 pool tail-outs measured, 8 had a value of 1 (50%); 2 had a value of 2 (12.5%); 3 had a value of 3 (18.8%); and 3 had a value of 5 (18.8%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

In total, 10 of the 16 pool tail-outs measured had embeddedness ratings of 1 or 2 and 3 of the pool tail-outs had embeddedness ratings of 3 or 4. Three of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

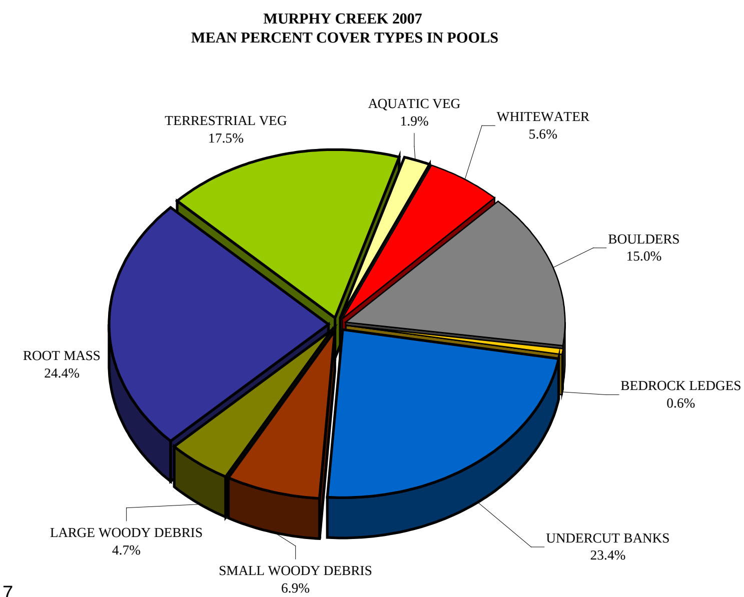
Thirteen of the sixteen (81%) pool tail-outs measured had gravel or small cobble as the dominant substrate, which was generally suitable for spawning salmonids.



GRAPH 6

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 9, flatwater habitat types had a mean shelter rating of 17, and pool habitats had a mean shelter rating of 80 (Table 1). Of the pool types, the Scour pools had a mean shelter rating of 67, and Main Channel pools had a mean shelter rating of 88 (Table 3). A pool shelter rating of approximately 100 is desirable.

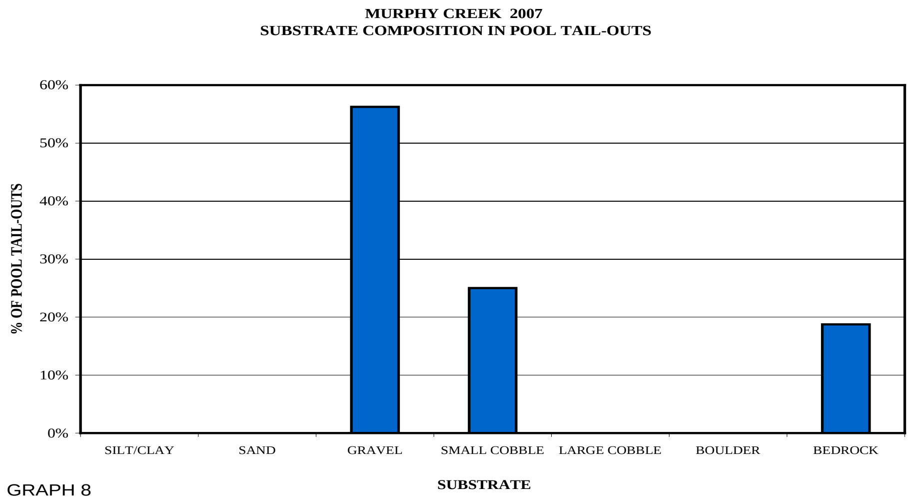
Table 5 summarizes mean percent cover by habitat type. Terrestrial vegetation is the dominant cover type in Murphy Creek (Graph 7). Root mass was found to be the dominant pool cover type followed by undercut banks.



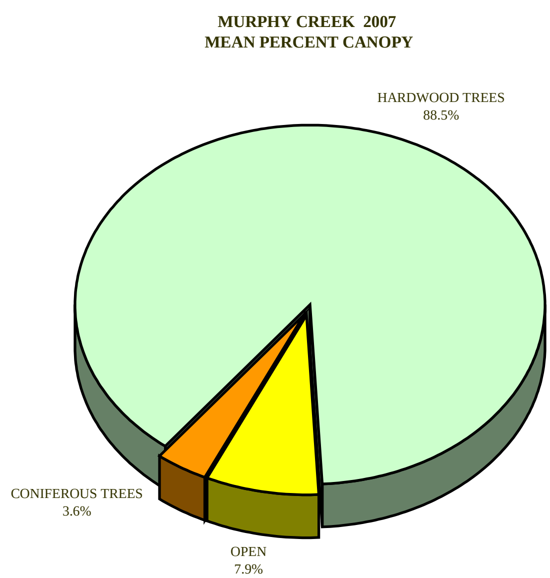
GRAPH 7

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. The two dominant substrate types observed during the survey were gravel and small cobble, which were documented in 56% and 25% of measured pool tail-outs, respectively.

The mean percent canopy density for the surveyed length of Murphy Creek was 92%, and the mean percentages of hardwood and coniferous trees were 96% and 4%, respectively. Overall, only eight percent of the canopy was open (Graph 9). Reach 1 had a canopy density of 92%, Reach 2 had a canopy density of 85%, Reach 3 had a canopy density of 95%, and Reach 4 had a canopy density of 93%. In general, revegetation projects are considered when canopy density is less than 80%.

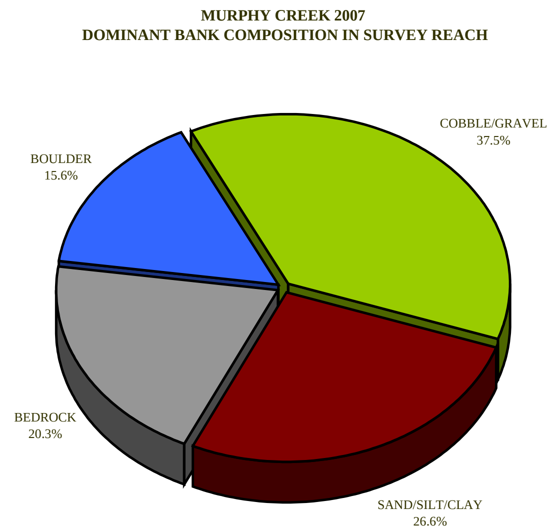


GRAPH 8

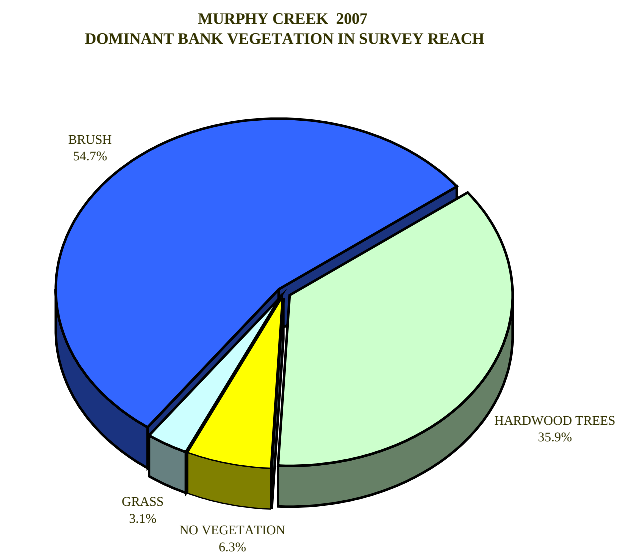


GRAPH 9

For the stream reach surveyed, the mean percent right bank vegetated was 66%, and the mean percent left bank vegetated was 65%. The dominant elements composing the structure of the stream banks consisted of 20% bedrock, 16% boulder, 38% cobble/gravel, 27% sand/silt/clay (Graph 10). Brush was the dominant vegetation type observed in 55% of the units surveyed. Additionally, 36% of the units surveyed had deciduous trees as the dominant vegetation type (Graph 11).



GRAPH 10



GRAPH 11

The percentage of right and left bank covered with vegetation was moderate at 66% and 65%, respectively. However, exotic plant species including Himalayan Blackberry (*Rubus discolor*) were abundant in Reaches 1 and 2.

SPAWNING GRAVEL PERMEABILITY

A total of six potential spawning sites were measured for gravel permeability (Figure 3.4.2). The predicted egg-to-emergence survival estimates ranged from 34% to 71%.

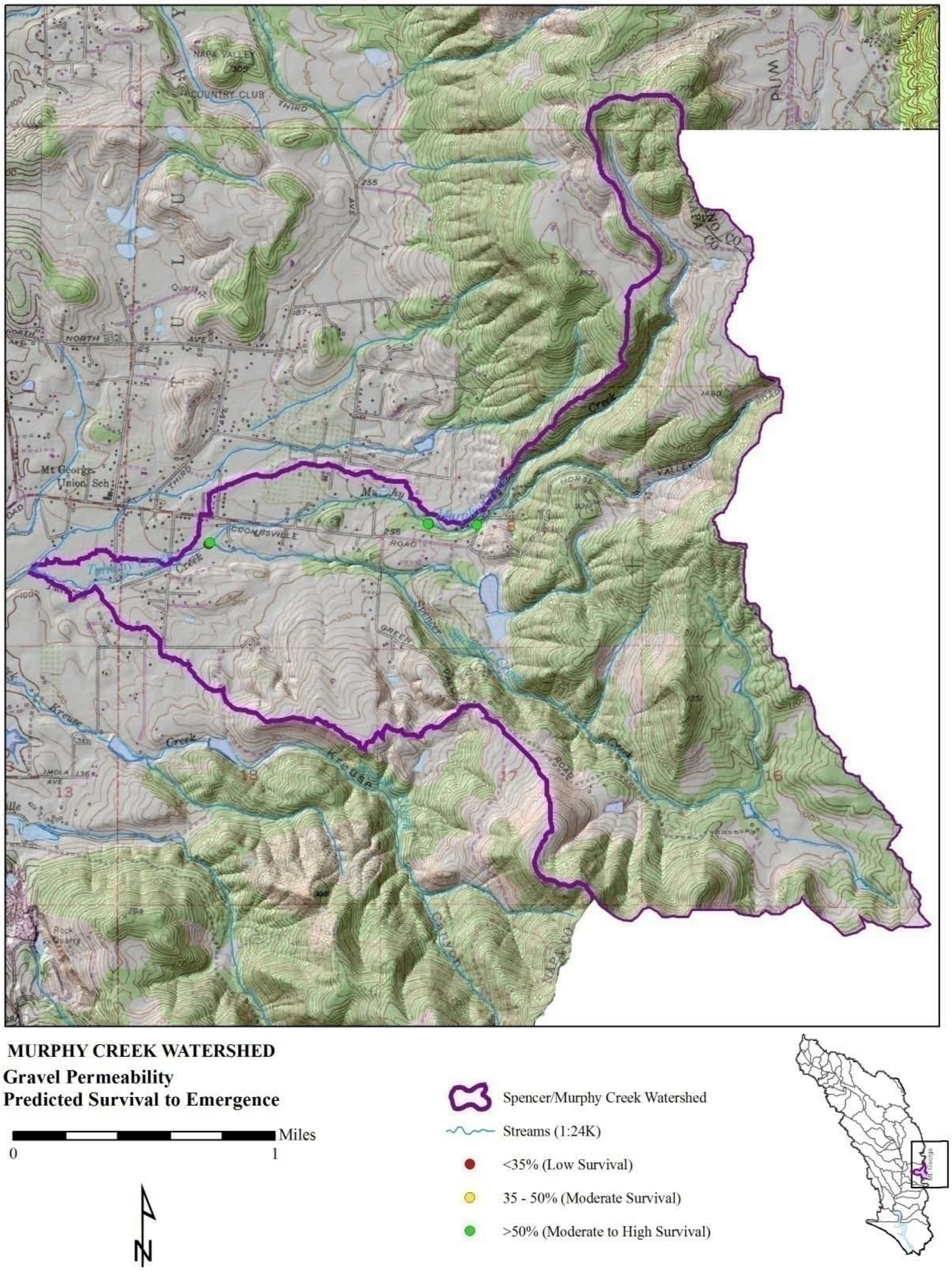


Figure 3.4.2 – Gravel permeability sites on Murphy Creek. Estimated survival values ranged from 34% to 71%.

MIGRATION BARRIERS

A total of ten fish migration barriers were identified on Murphy Creek (Figure 3.4.3). Nine of the sites were artificial and one (MUR-10) was a natural 20+ foot waterfall that represents the end of anadromy for Murphy Creek.

Site	Description
MUR-1	Natural bedrock outcrop with concrete diversion structure at top of bank. Low flow obstacle.
MUR-2	Short sequence of two concrete walls 1.5 ft and 3 ft built on bedrock. Major low flow obstacle.
MUR-3	3 foot concrete wall filled with sediment upstream. Heavily overgrown. Major low flow obstacle.
MUR-4	Series of 2 foot drops in natural boulder cascade. Heavily overgrown. Minor low flow obstacle.
MUR-5	Box culvert no jump at inlet. Sheet flow at lower flows, but very short. Minor low flow obstacle.
MUR-6	Two crossings with culverts. Lower culverts have 2 foot jump to outlet. Low flow obstacle.
MUR-7	Concrete and stone channel with short step pools. Low flow obstacle.
MUR-8	2 foot concrete wall built at top of 10 foot long bedrock chute. Low flow barrier.
MUR-9	Deep pool below concrete/stone/brick wall. Low flow obstacle.
MUR-10	Natural 20+ foot high waterfall. Complete barrier.

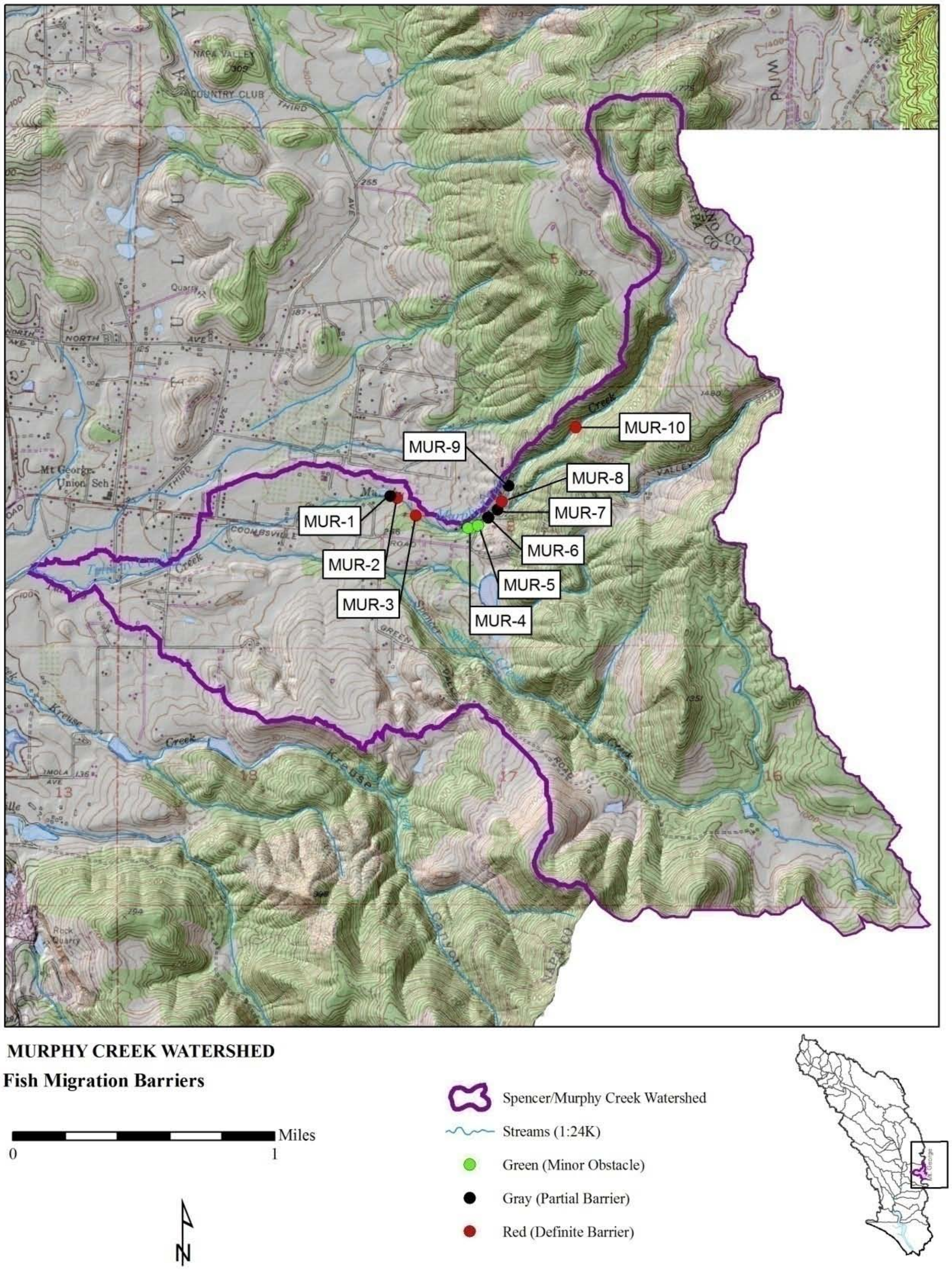


Figure 3.4.3 – Fish migration barrier sites on Murphy Creek

BIOLOGICAL SURVEYS/ OBSERVATIONS

Juvenile steelhead were observed in Murphy Creek in moderate to high abundances in reaches 2, 3 and 4. A few juvenile steelhead were observed sporadically in reach 1, but water quantity and quality were generally lacking to support rearing throughout much of this reach.

No direct evidence of adult steelhead or salmon spawning (e.g. redds, carcasses, etc) was observed during field surveys.

No adult or juvenile surveys (e.g. spawner surveys or snorkel counts) were conducted for Murphy Creek as part of this study.

WATER QUANTITY

Streamflow was visually estimated at approximately 0.5 cfs during the habitat survey. Murphy Creek is a perennial stream, which flows year round in all but the lowest reaches. Landowners near Shady Brook Lane describe the creek as flowing all year – even during periods of prolonged drought.

There are a total of six appropriative water rights on record for the Murphy Creek watershed (Figure 4.1.1).

WATER TEMPERATURE

Mean Temperature (°C)	13.38
Median Temperature (°C)	13.62
Maximum Temperature (°C)	19.39
Minimum Temperature (°C)	5.36
Standard Deviation (°C)	3.06
Total Measurements	46898
Number of records exceeding 20˚C	0
MWAT (°C)	18.28

Table 3.4.1 – Summary statistics from continuous temperature monitoring of Murphy Creek.

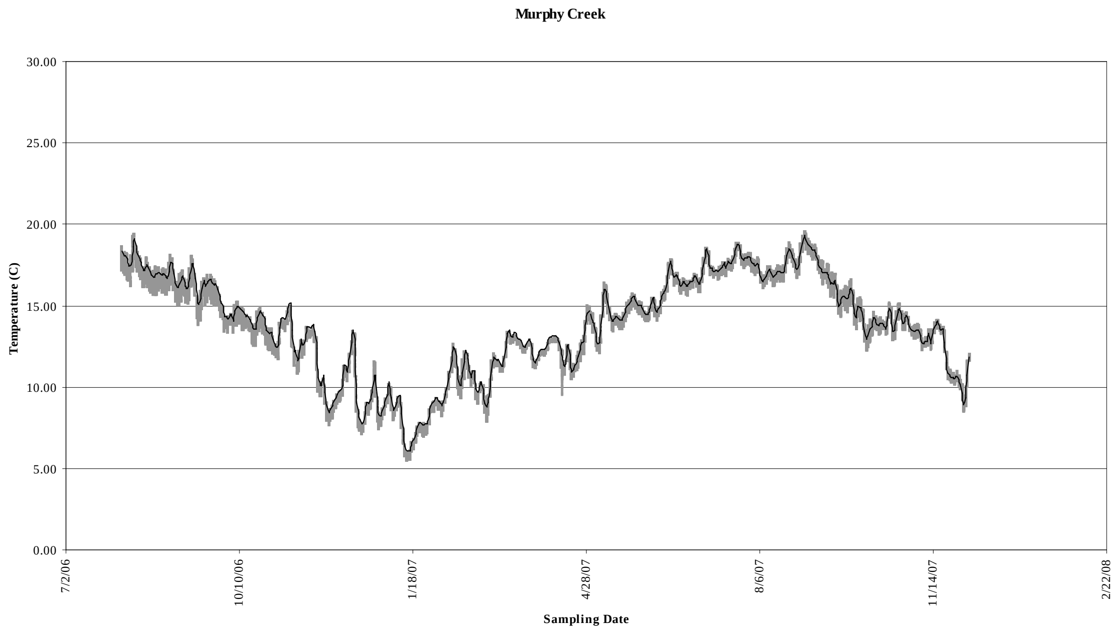


Figure 3.4.4 – Continuous water temperature data from Murphy Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.5 NAPA CREEK

Napa Creek was surveyed as part of a separate three-year project funded by the City of Napa. Please contact the Napa RCD for a copy of the annual reports (2006, 2007, 2008).

3.6 Pickle Creek

Pickle Canyon Creek is a tributary to Redwood Creek, which joins with Browns Valley Creek to form Napa Creek. Napa Creek is a tributary to the Napa River, which flows to the Pacific Ocean via San Pablo Bay. Pickle Canyon's location at the confluence with Redwood Creek is 38.334597° north latitude and 122.371703° west longitude, LLID number 1223704383341. Pickle Canyon is a second order stream and has approximately 7.3 miles of blue line stream according to the USGS Sonoma and Napa 7.5 minute quadrangles. Pickle Canyon drains a watershed of approximately 2.82 square miles. Elevations range from about 350 feet at the mouth of the creek to over 1,900 feet in the headwater areas. Mixed hardwood and conifer forest dominate the watershed, with several stands of redwoods along the creek. The watershed is entirely privately owned. Vehicle access exists along much of Mt. Veeder Road.

Historical Information (Leidy et al., 2005)

In June 1966, DFG visually surveyed Pickle Canyon Creek from the mouth to the headwaters. Numerous juvenile *O. mykiss* (25-75 mm) and a few fish ranging from 150-250 mm in length were observed in the lower two miles of stream. Densities were estimated at 50-70 per 30 meters (Hicks and McCurdy 1966a).

In June 1967, DFG again surveyed the entire creek length. *Oncorhynchus mykiss* densities were estimated at 25-30 per 30 meters in the lower two miles of stream. In the upper survey area, densities dropped to less than one fish per 30 meters (Thompson 1967a). Using population densities from earlier surveys, DFG estimated that 6,200 and 2,900 juvenile steelhead used two miles of Pickle Canyon Creek for rearing in 1966 and 1967, respectively (Jones 1967).

In May 1978, DFG electrofished four stations on Pickle Canyon Creek upstream and downstream of its confluence with an unnamed tributary. A total of 36 *O. mykiss* were caught at the four sites. Fish ranged in length from 61–84 mm FL (Baracco 1978). Population densities were found to range between 6.5 and 11.5 per 30 meters of stream. In June 1981, DFG surveyed the lower 3.2 miles of Pickle Creek to locate stranded steelhead juveniles for rescue. Most of the creek was dry, although a few steelhead juveniles were spotted in isolated pools (Ambrosins 1981c).

Ecotrust and FONR carried out surveys in tributaries of the Napa River system in July and August 2001. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. Of eight Pickle Canyon Creek reaches, two were found to have *O. mykiss* at density level "1," while two reaches had density level "2" and two reaches had level "3" (Ecotrust and FONR 2001). Follow-up surveys were performed between June and September 2002. *Oncorhynchus mykiss* were found in two Pickle Canyon Creek reaches (Ecotrust and FONR 2002).

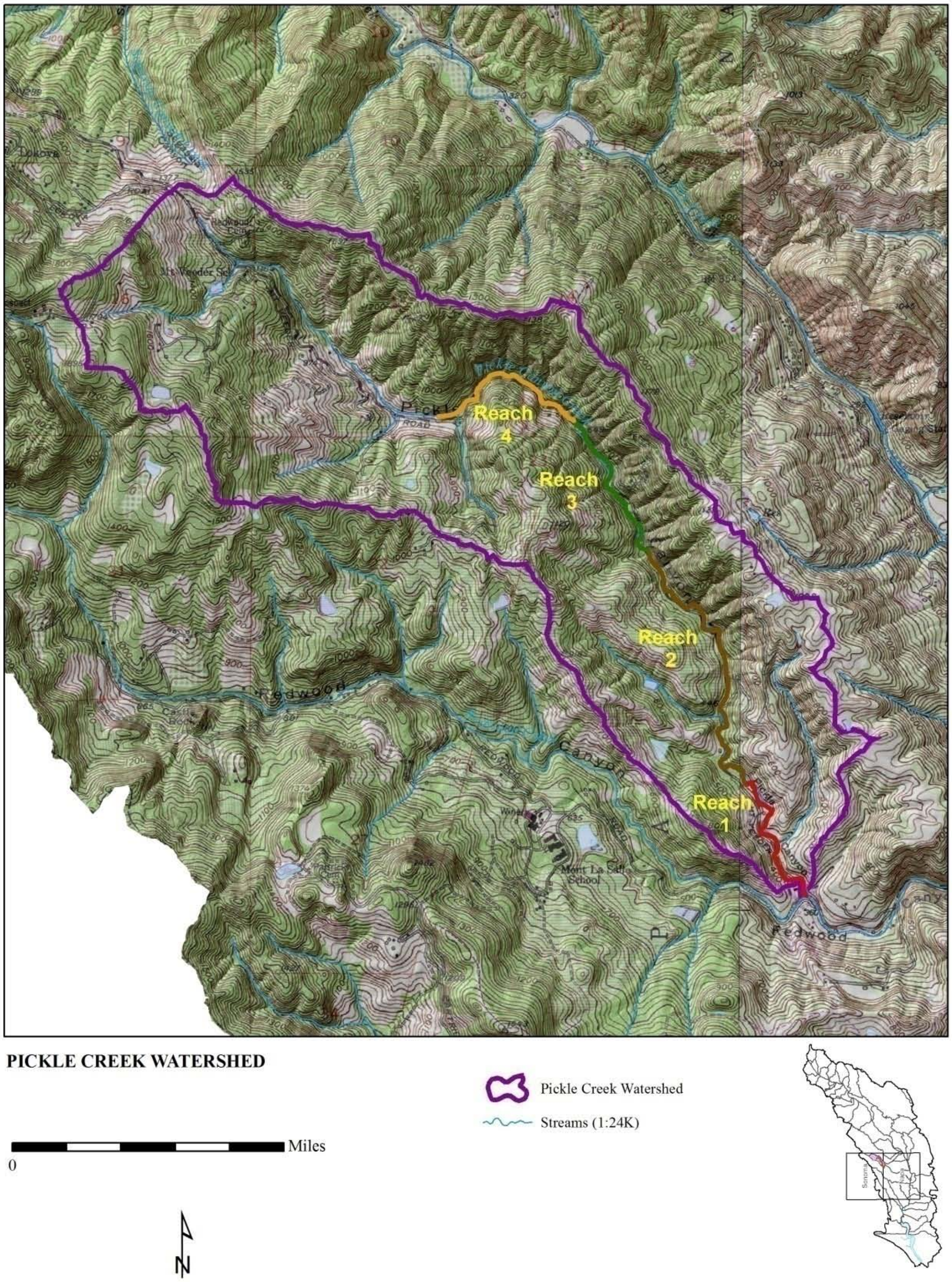


Figure 3.6.1 – Watershed map with habitat survey reaches.

<u>HABITAT</u>

All habitat typing result tables are located in Appendix C.

A stream inventory was conducted during 4/26/2007 to 4/30/2007 on Pickle Canyon. The survey began at the confluence with Redwood Creek and extended upstream 3.2 miles. The total length of the stream surveyed was 16,737 feet.

The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Pickle Canyon. Recommendations for habitat improvement are based upon target habitat values suitable for salmonids in California's north coast streams.

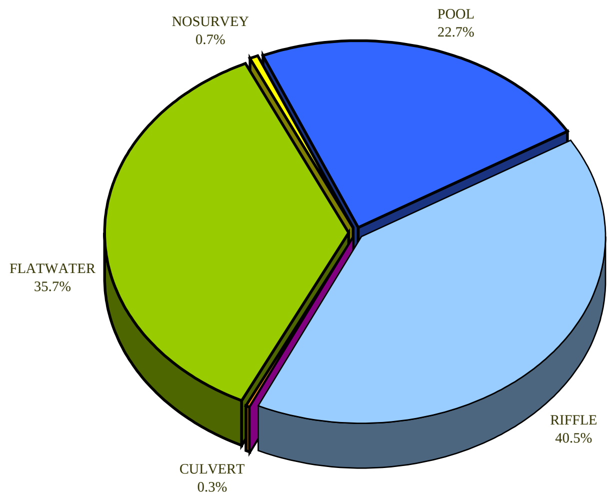
A total of four channel-typing cross sections were assessed during this survey:

Reach 1	3,455 feet	C4 channel type.
Reach 2	6,375 feet	C4 channel type
Reach 3	2,541feet	B4 channel type
Reach 4	4,366 feet	A4 channel type

C4 channels are meandering point-bar riffle/pool alluvial channels with broad well defined floodplain on low gradients and gravel dominant substrates. B4 channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios and gravel dominant substrates. A3 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and have cobble dominated substrates.

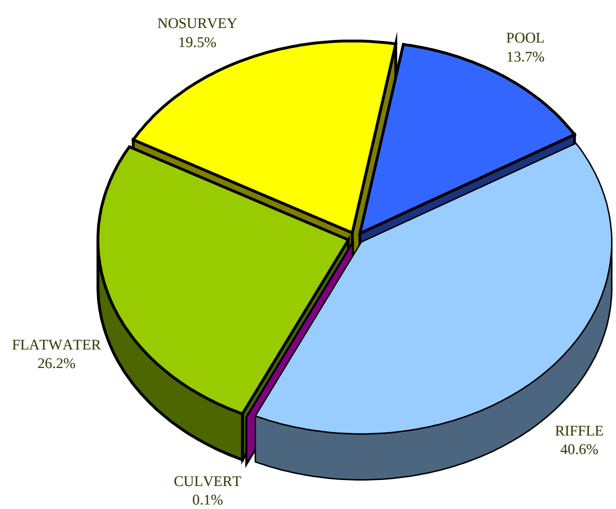
Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 41% riffle units, 36% flatwater units, 23% pool units, 1% no-survey units, and 0% culvert units (Graph 1). Based on total length of Level II habitat types there were 41% riffle units, 26% flatwater units, 14% pool units, 19% no-survey units, (Graph 2).

PICKLE CREEK 2007
HABITAT TYPES BY PERCENT OCCURRENCE



GRAPH 1

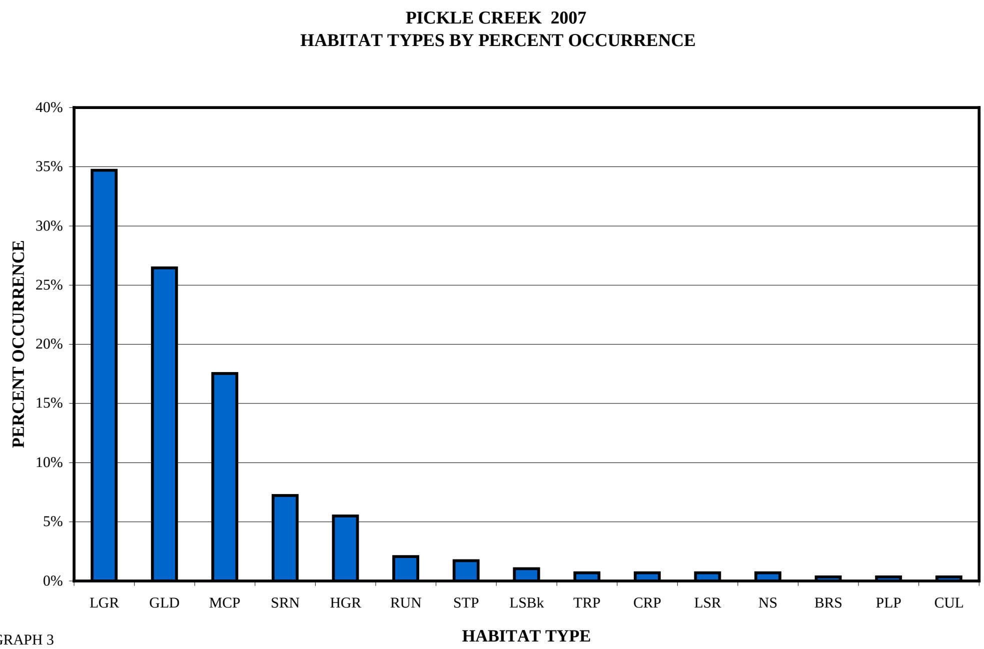
PICKLE CREEK 2007
HABITAT TYPES BY PERCENT TOTAL LENGTH



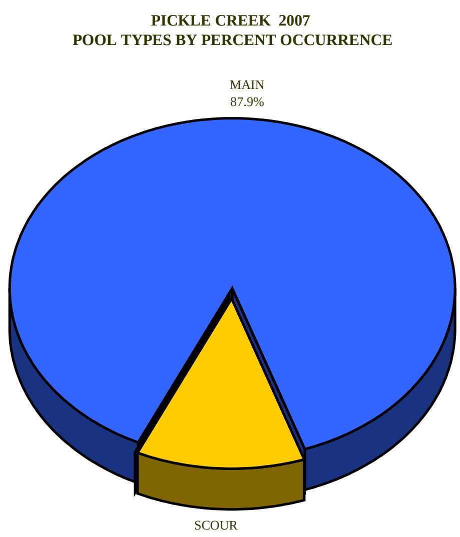
GRAPH 2

In total, 13 Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were; 35% low gradient riffle units, and 26% glide units (Graph 3). Based on percent total length, the most frequent habitat types are as follows; 36% low gradient riffle units, and 18% glide units.

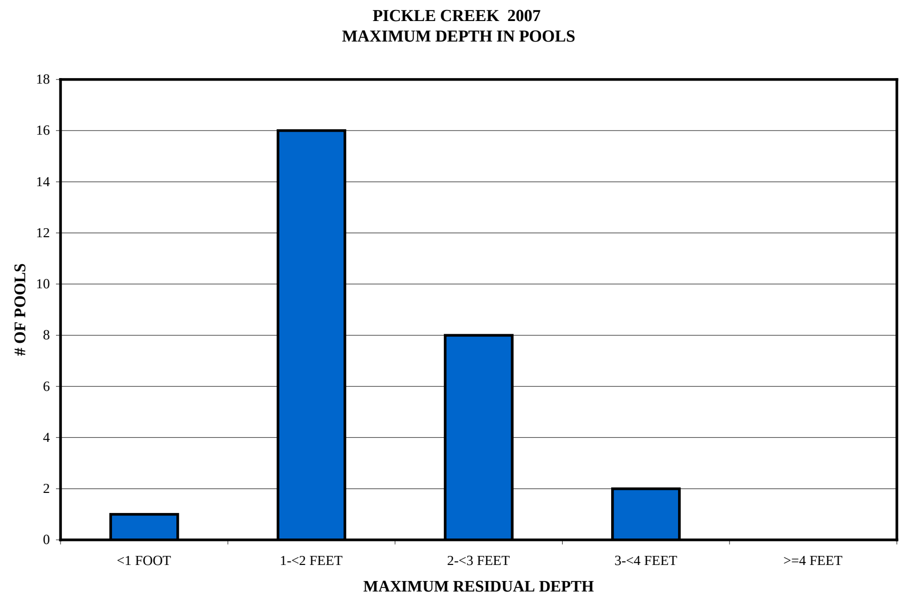
A total of 66 pools were identified (Table 3). Main Channel pools were the most frequently encountered, at 88%, and comprised 87% of the total length of all pools (Graph 4). Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth, and 10 of the 27 pools (37%) had a residual depth of two feet or greater (Graph 5).



GRAPH 3



GRAPH 4



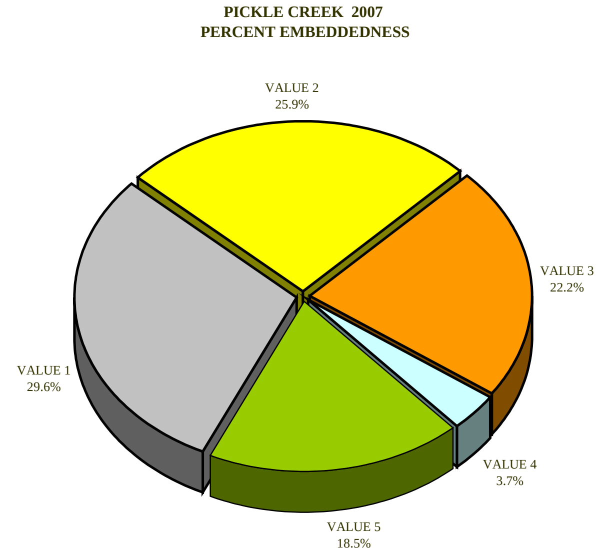
GRAPH 5

The pools are relatively shallow, with only 10 of the 27 (37%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool has a maximum residual depth of at least two feet, occupies at least half the width of the low flow channel, and must be as long as the low-flow channel width.

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 27 pool tail-outs measured, 8 had a value of 1 (29.6%); 7 had a value of 2 (25.9%); 6 had a value of 3 (22.2%); 1 had a value of 4 (3.7%); and 5 had a value of 5 (18.5%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. A value of 5 was assigned to tail-outs deemed unsuitable for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

In total, 15 of the 27 pool tail-outs measured had embeddedness ratings of 1 or 2, and 7 of the pool tail-outs had embeddedness ratings of 3 or 4. Overall, 5 of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

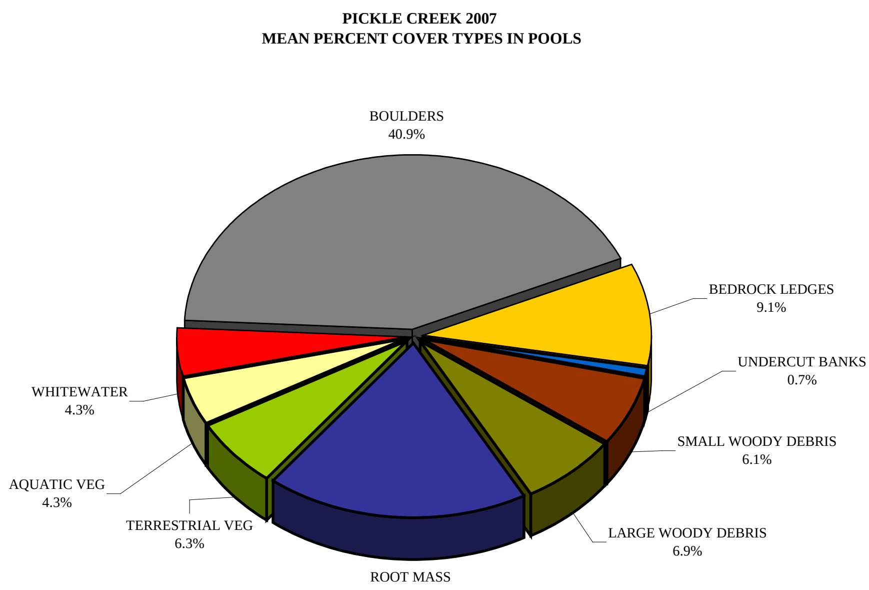
A total of 22 of the 27 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered favorable for spawning salmonids.



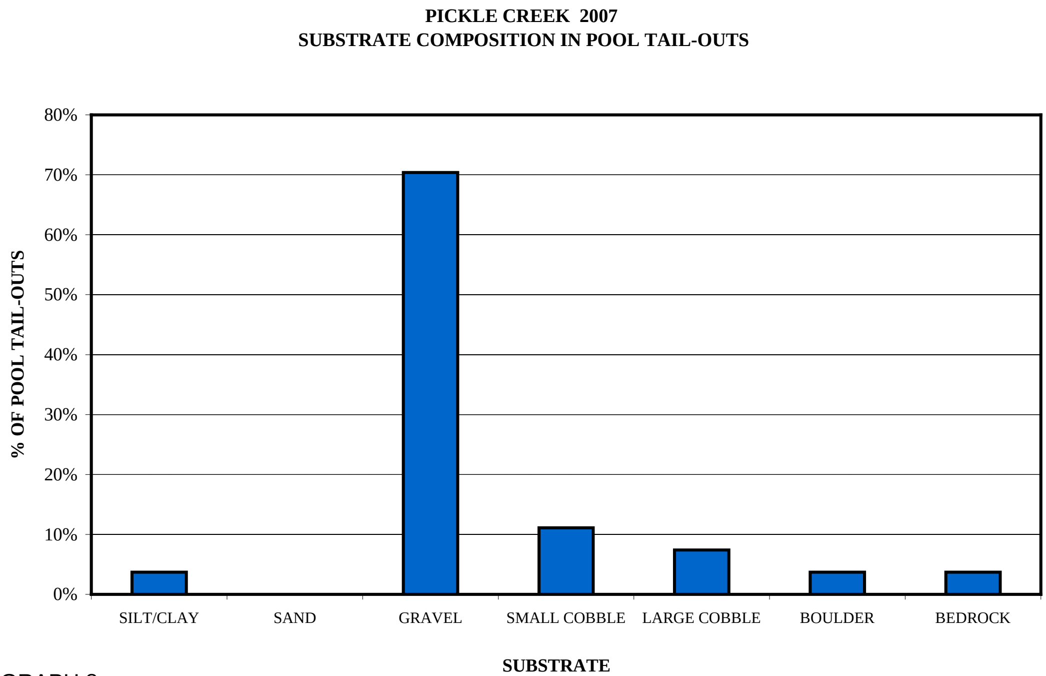
GRAPH 6

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 23, flatwater habitat types had a mean shelter rating of 32, and pool habitats had a mean shelter rating of 72 (Table 1). Of the pool types, main channel pools had a mean shelter rating of 65, and scour pools had a mean shelter rating of 98 (Table 3).

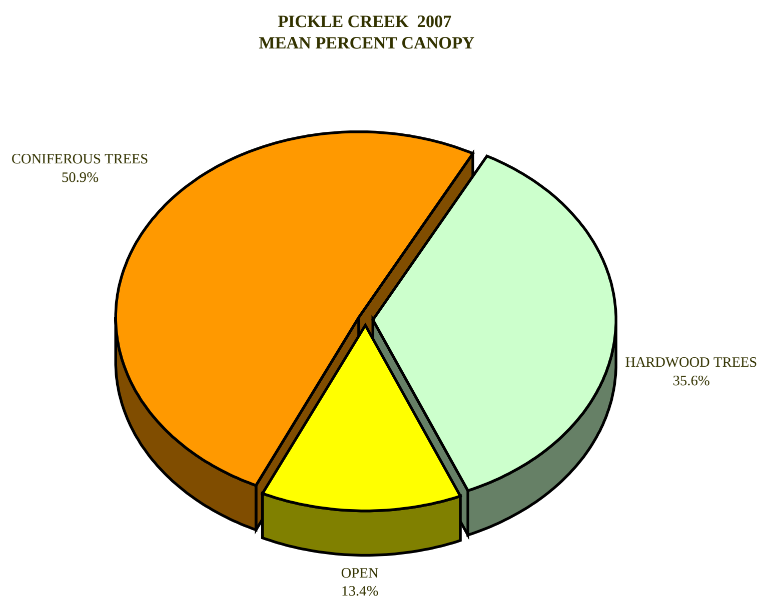
Table 5 summarizes mean percent cover by habitat type. Boulders and root mass are the dominant cover types in Pickle Creek (Graph 7).



GRAPH 7



GRAPH 8

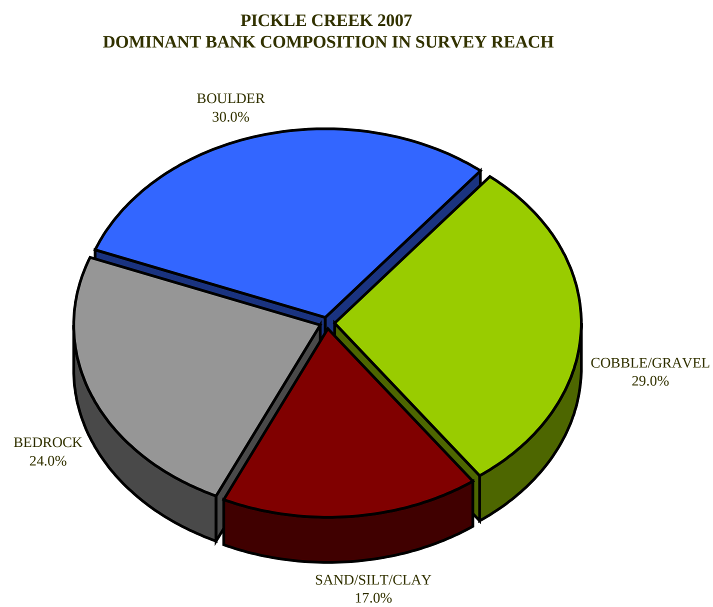


GRAPH 9

The mean percent canopy density for the surveyed length of Pickle Canyon was 87%, and the mean percentages of hardwood and coniferous trees were 41% and 59%, respectively. Overall, 13 percent of the canopy was open (Graph 9).

Reach 1 had a canopy density of 90%, Reach 2 had a canopy density of 85%, Reach 3 had a canopy density of 90%, and Reach 4 had a canopy density of 86%. In general, revegetation projects are considered when canopy density is less than 80%.

For the stream reach surveyed, the mean percent right bank vegetated was 72%. The mean percent left bank vegetated was 80%. The dominant material in the stream banks consisted of 24% bedrock, 30% boulder, 29% cobble/gravel, and 17% sand/silt/clay (Graph 10). Brush was the dominant vegetation type observed in 52% of the units surveyed. Additionally, 24% of the units surveyed had coniferous trees as the dominant vegetation type, and 17% had deciduous trees as the dominant vegetation (Graph 11).

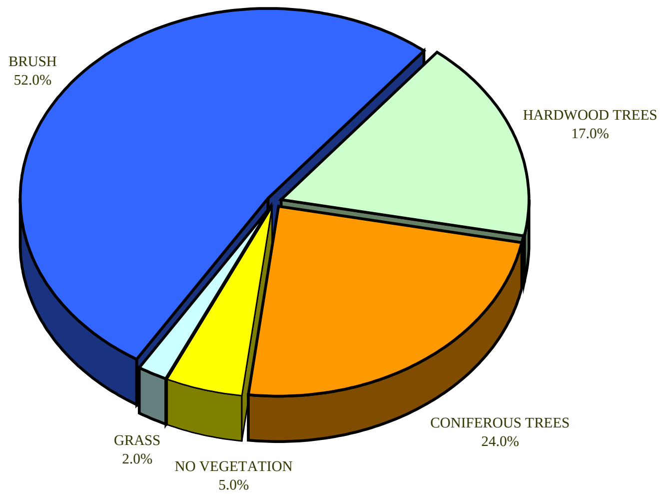


GRAPH 10

The mean shelter rating for pools was 72, and the shelter rating in the flatwater habitats was 32. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in Pickle Canyon. Boulders are the dominant cover type in pools followed by root mass.

The percentage of right and left bank covered with vegetation was high at 72% and 80%, respectively. However, in areas with stream bank erosion or where bank vegetation is sparse, planting native vegetation, in conjunction with bank stabilization, is recommended where feasible.

PICKLE CREEK 2007
DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11

<u>SPAWNING GRAVEL PERMEABILITY</u>

A total of eight potential spawning sites were measured for gravel permeability (Figure 3.6.2).

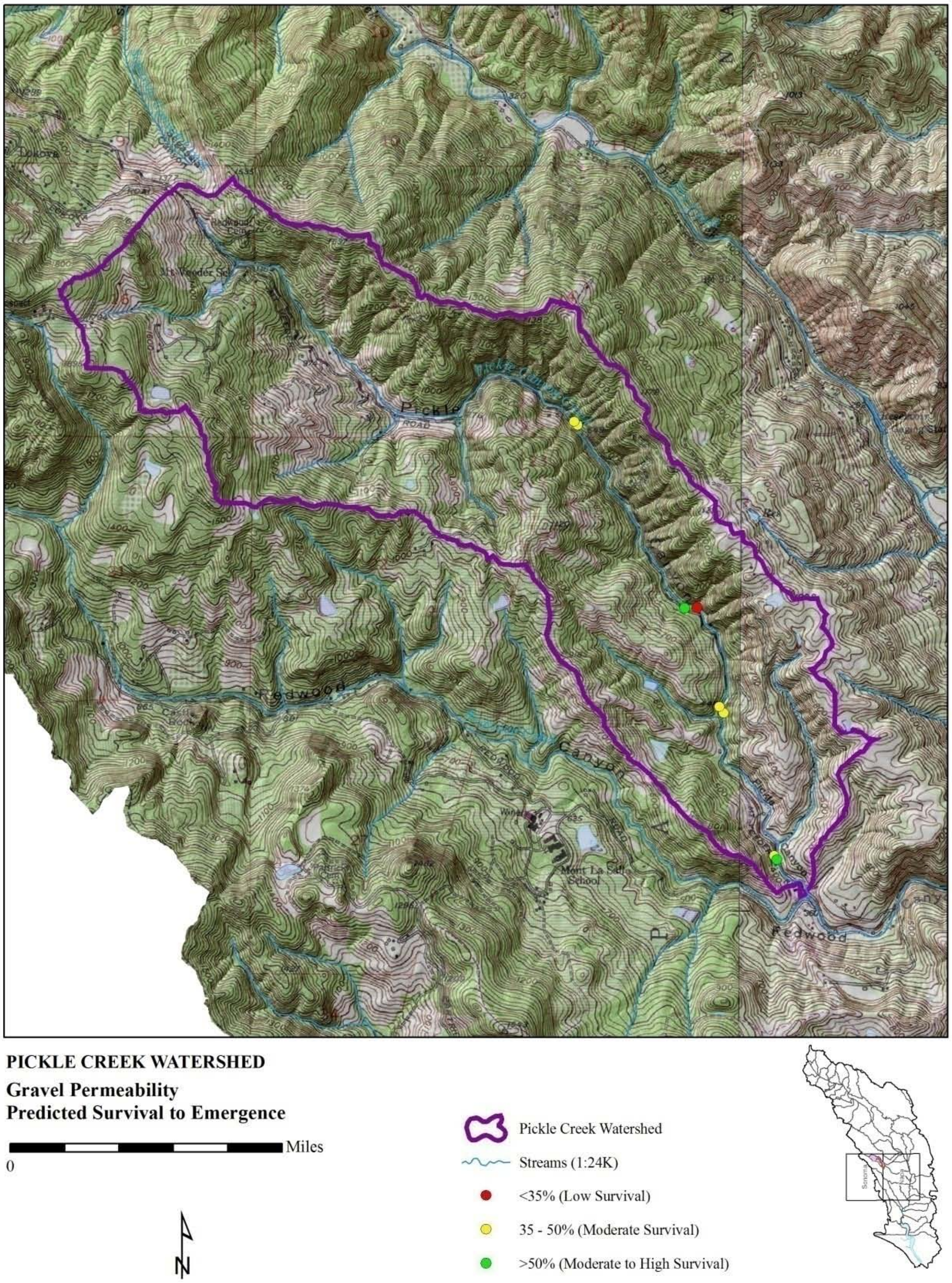


Figure 3.6.2 – Gravel permeability sites on Pickle Creek. Estimated survival values ranged from 18% to 60%.

MIGRATION BARRIERS

One fish migration barrier was identified on Pickle Creek (Figure 3.6.3). The site consists of an old concrete ford crossing on private property, which has scoured out at the downstream side, creating an approximately 4 foot drop to the streambed below. Upstream juvenile migration is likely completely blocked and adult migration is likely limited to higher flows. Since there is high quality steelhead spawning and rearing habitat above this site and it represents the only known barrier, it should be considered high priority for modification or removal.

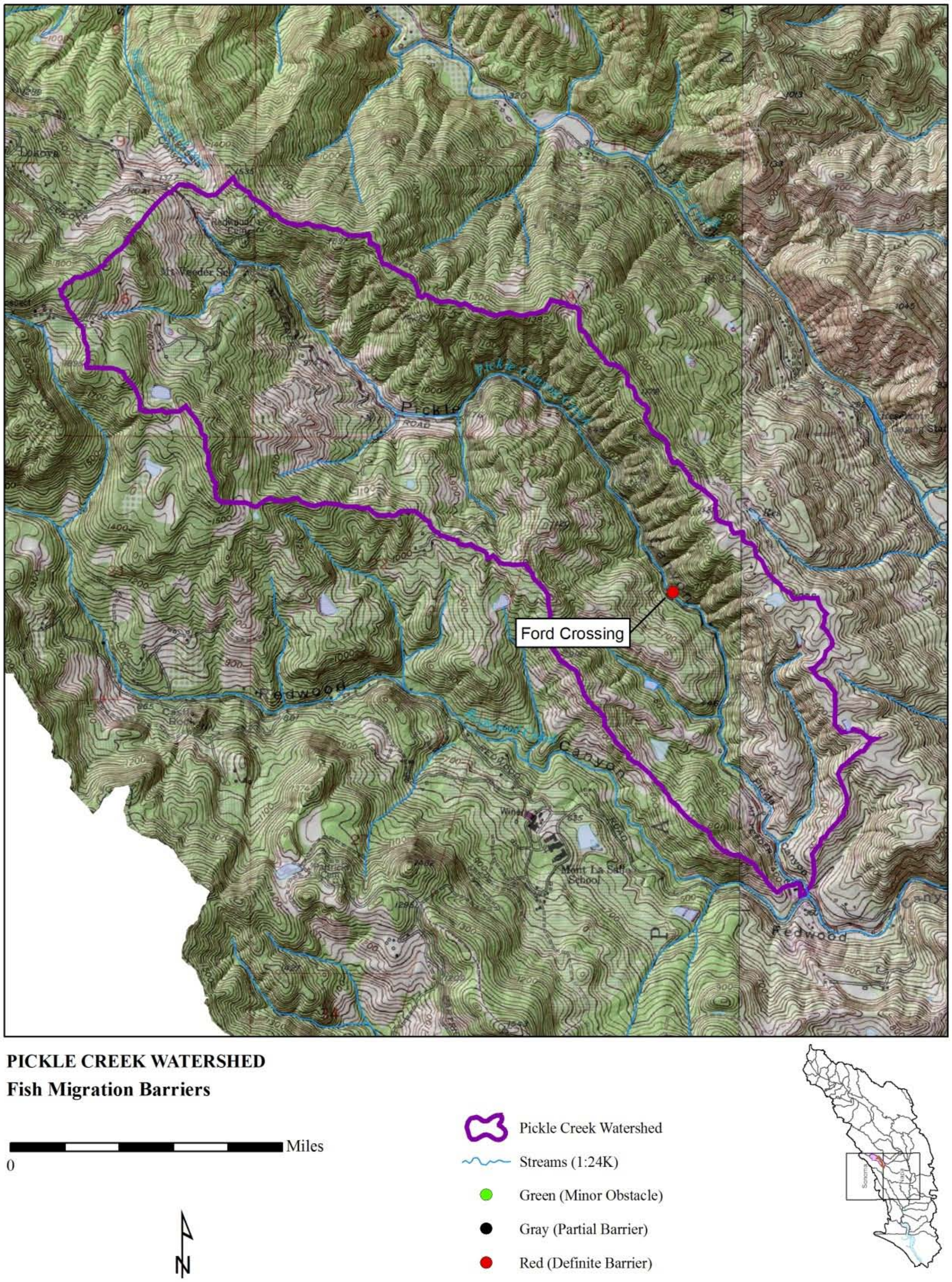


Figure 3.6.3 – Fish migration barrier site on Pickle Creek

BIOLOGICAL SURVEYS/ OBSERVATIONS

Juvenile steelhead were observed in Pickle Creek in moderate to high abundances in reaches 2, 3, and 4. Juvenile steelhead were observed sporadically in reach 1, but water quantity and quality were generally lacking to support rearing throughout much of this reach.

Four adult steelhead were observed in Reaches 1 and 3 on March 7, 2007 while measuring gravel permeability. A newly constructed steelhead redd was observed in Reach 1 on the same date.

No adult or juvenile surveys (e.g. spawner surveys or snorkel counts) were conducted for Pickle Creek as part of this study.

WATER QUANTITY

Streamflow was visually estimated at approximately three cfs during the habitat survey. Extensive sections of Reaches 1 and 2 went dry during the summer of 2007 with a few isolated pools remaining. Reach 3 appears to be perennial in most years. The lower portion of Reach 4 is also perennial, but year round flow diminishes near the top of the reach. Landowner access was insufficient to monitor stream flow above Reach 4.

There are a total of six appropriative water rights on record for the Pickle Creek watershed (Figure 4.1.1).

WATER TEMPERATURE

Water temperatures taken during the survey period ranged from 50 to 58 degrees Fahrenheit. Air temperatures ranged from 61 to 81 degrees Fahrenheit.

Mean Temperature (°C)	12.01
Median Temperature (°C)	11.78
Maximum Temperature (°C)	21.65
Minimum Temperature (°C)	1.82
Standard Deviation (°C)	4.17
Total Measurements	16,059
Number of records exceeding 20˚C	332
MWAT (°C)	21.65

Table 3.6.1 – Summary statistics from continuous temperature monitoring of Pickle Creek.

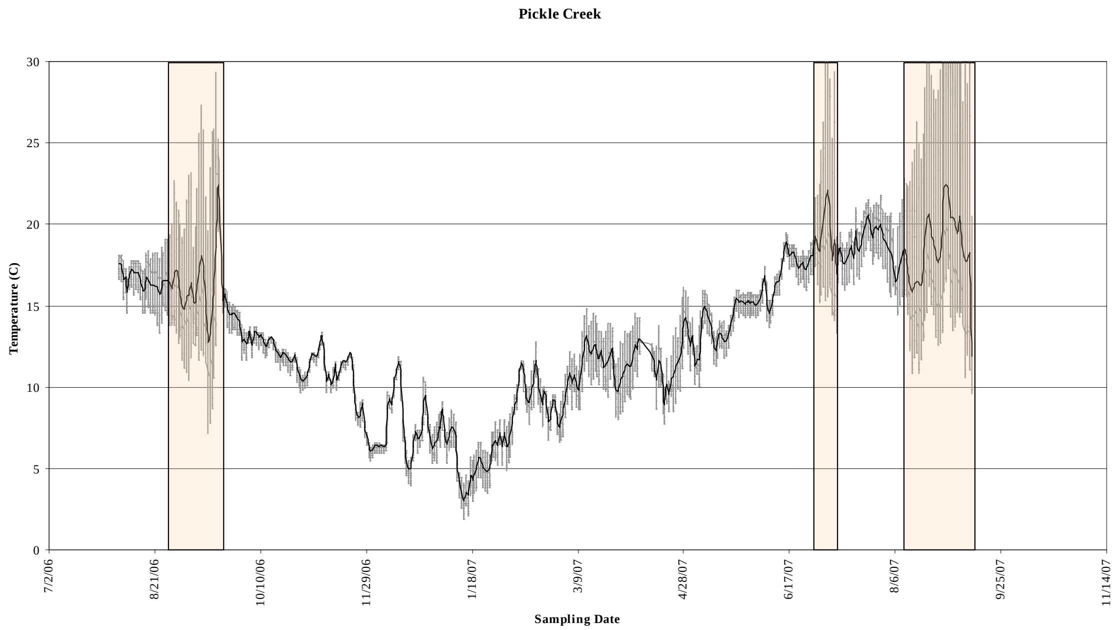


Figure 3.6.4 – Continuous water temperature data from Pickle Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.7 REDWOOD CREEK

Redwood Creek is a tributary to Napa Creek, a tributary to the Napa River that flows to the Pacific Ocean via San Pablo Bay. Redwood Creek's location at the confluence with Napa Creek is 38.304742° north latitude and 122.313676° west longitude, LLID number 1223123383049. Redwood Creek is a third order stream and has approximately 18.8 miles of blue line stream according to the USGS Napa and Sonoma 7.5 minute quadrangles. Redwood Creek drains a watershed of approximately 7.56 square miles. Elevations range from about 50 feet at the mouth of the creek to 2,600 feet in the headwater areas. Mixed hardwood and conifer forest dominate the watershed with extensive redwood groves in the middle and upper watershed. The watershed is entirely privately owned; much of the headwaters are held by the Napa County Land Trust. Vehicle access in the middle and upper watershed exists via Redwood Road.

HISTORICAL INFORMATION (Leidy et al., 2005)

In November 1958, DFG visually surveyed easily accessible reaches of Redwood Creek from the confluence with the Napa River to the headwaters. *Oncorhynchus mykiss* (75-100 mm average length) was found to be fairly common in the reach that sustained perennial flow, beginning just upstream of the junction of Browns Valley and Redwood roads and continuing upstream 3.5 miles to a natural falls. As a result, this reach of Redwood Creek was considered to be an excellent nursery ground for juvenile steelhead (Elwell 1958k).

In April 1965, the Napa Water Department inadvertently discharged chlorine into Redwood Creek, killing more than 10,000 fingerling steelhead in a 1.5 mile reach (Greenwald 1965a). In June 1966, DFG visually surveyed portions of Redwood Creek accessible by automobile. *Oncorhynchus mykiss* were found at a density of 250-330 per 30 meters upstream of the Redwood and Mt. Veeder roads junction. Most of the fish sighted were YOY, with only a very few larger than 75 mm FL. Upstream of the confluence with Pickle Canyon Creek, YOY and other *O. mykiss* up to 230 mm in length were observed at an estimated density of 70-100 per 30 meters. Two five-pound steelhead also were observed in the upper reach (Hicks and McCurdy 1966b). According to DFG, natural propagation appeared to be good throughout the section surveyed (Hicks and McCurdy 1966b).

In June 1967, DFG surveyed Redwood Creek upstream of the confluence of Redwood and Pickle Canyon creeks. *Oncorhynchus mykiss* density in two miles of the creek was estimated on average to be 25 per 30 meters. The greatest densities occurred immediately upstream of the Pickle Canyon Creek confluence, where *O. mykiss* density was estimated at 50 per 30 meters. Fish captured ranged between 25 and 75 mm in length (Thompson 1967b). Using population densities from earlier surveys, DFG estimated that 24,200 and 8,600 juvenile steelhead used 4.25 miles of Redwood Creek for “nursery purposes” in 1966 and 1967, respectively (Jones 1967).

In October 1969, DFG electrofished Redwood Creek one mile northwest of Mont La Salle School, near the end of Redwood Road. Of the 70 *O. mykiss* collected, 68 had fork lengths ranging from 38-76 mm (Anderson 1969c). A 112 mm and a 132 mm steelhead also were noted. Density was estimated at 75 per 30 meters. Based on the survey results, DFG estimated the 1969 standing crop of steelhead juveniles to be between 21,400 and 29,700 fish in Redwood Creek and its tributaries (Anderson 1969c).

In April 1977, DFG visually surveyed Redwood Creek from the mouth to near the headwaters. A small flowing reach near the mouth did not support live *O. mykiss*, although a dead adult steelhead was found at the upstream end of this reach. From five miles upstream of the mouth to the headwaters, *O. mykiss* (100–180 mm) were found at an estimated density of 10 per 30 meters (Gillespie and Rowser 1977).

In October and November 1984, DFG visually surveyed Redwood Creek from the Redwood Road crossing near Dry Creek Road upstream to the end of Redwood Road. *Oncorhynchus mykiss* (50–125 mm) was observed most commonly in the main canyon upstream of the Mt. Veeder Road crossing (Emig 1984c).

In November 1985, DFG electrofished two Redwood Creek sites, one immediately downstream, the other extending 0.25 miles upstream from the intersection of Redwood and Mount Veeder roads. Two juvenile steelhead were caught, one 91 mm in length and the other 92 mm in length (Gray 1986c).

In June and July 1987, DFG visually surveyed Redwood Creek from Castle Rock to the mouth. *Oncorhynchus mykiss* was observed throughout the creek, with various age classes in the upper portion but very few YOY. In the lower part of the creek, most of the trout were YOY (Montoya 1987c). *Oncorhynchus mykiss* was estimated to average 65 mm in length (Montoya 1987c).

Leidy sampled 30-meter reaches at three Napa River locations in January 1994. About 0.3 miles upstream from Castle Rock, he caught 13 *O. mykiss* (50-132 mm FL) and two larger *O. mykiss* (245, 260 mm) (Leidy 2002). The lack of spotting on the sides and the condition of the anal and pectoral fins suggested anadromy in the larger fish. At Castle Rock, Leidy caught five *O. mykiss* (57-93 mm) and observed six others reflecting two size classes (4: 60-100 mm; 2: 125-150 mm). The most downstream station, immediately downstream of the Redwood Road Bridge, produced three *O. mykiss* (104, 119, 122 mm).

Ecotrust and FONR carried out surveys in tributaries of the Napa River system in July and August 2001. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. Of 21 Redwood Creek reaches, eight were found to have *O. mykiss* at density level “1,” while five reaches had density level “2” and three reaches had level “3” (Ecotrust and FONR 2001). Follow-up surveys were performed between June and September 2002. *Oncorhynchus mykiss* were found in numerous Redwood Creek reaches, including two reaches at density level “2” (Ecotrust and FONR 2002).

Figure 3.7.1 – Watershed map with habitat survey reaches.

HABITAT

All habitat typing result tables are located in Appendix C.

A stream inventory was conducted during 4/2/2007 to 4/25/2007 on Redwood Creek. The survey began at the confluence with Napa and Browns Valley Creeks and extended upstream 10.5 miles. A short portion of Reach 2 and much of Reach 3 were not surveyed due to insufficient landowner permission.

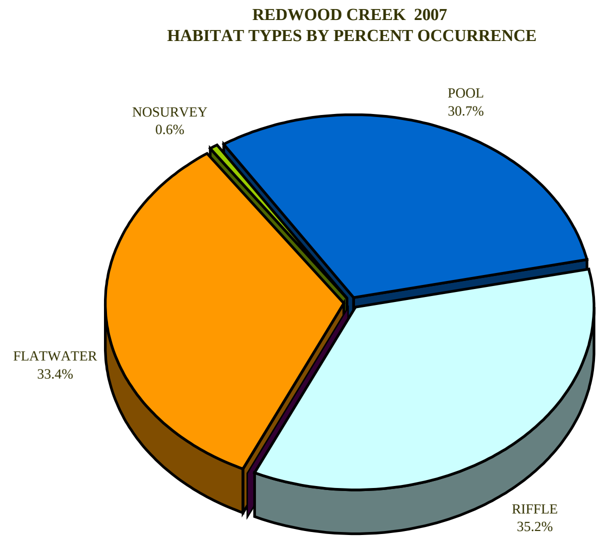
The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Redwood Creek. Recommendations for habitat improvement are based upon target habitat values suitable for salmonids in California's north coast streams.

A total of four channel-typing cross sections were assessed during this survey:

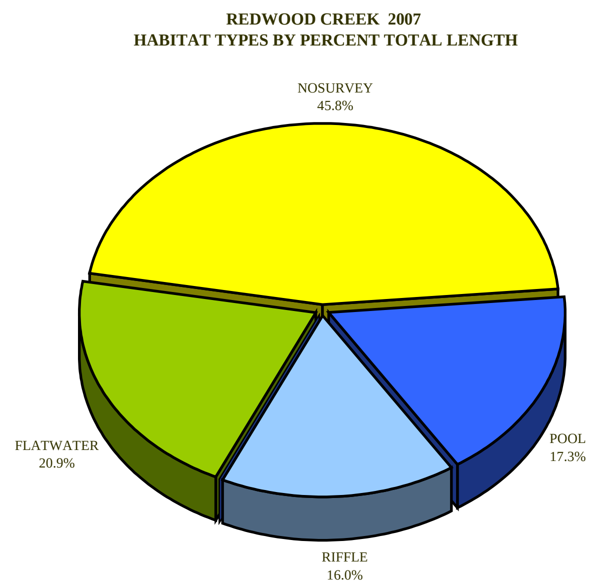
Reach 1	12,454 feet	F4 channel type.
Reach 2	19,789 feet	F4 channel type
Reach 3	18,883 feet	B4 channel type
Reach 4	3,982 feet	A2 channel type

F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. B4 channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios and gravel dominant substrates. A2 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and boulder dominant substrates.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 31% pool units, 35% riffle units, 33% flatwater units, and 1% no-survey units (Graph 1). Based on total length of Level II habitat types there were 17% pool units, 16% riffle units, 21% flatwater units, and 46% no-survey units (Graph 2).



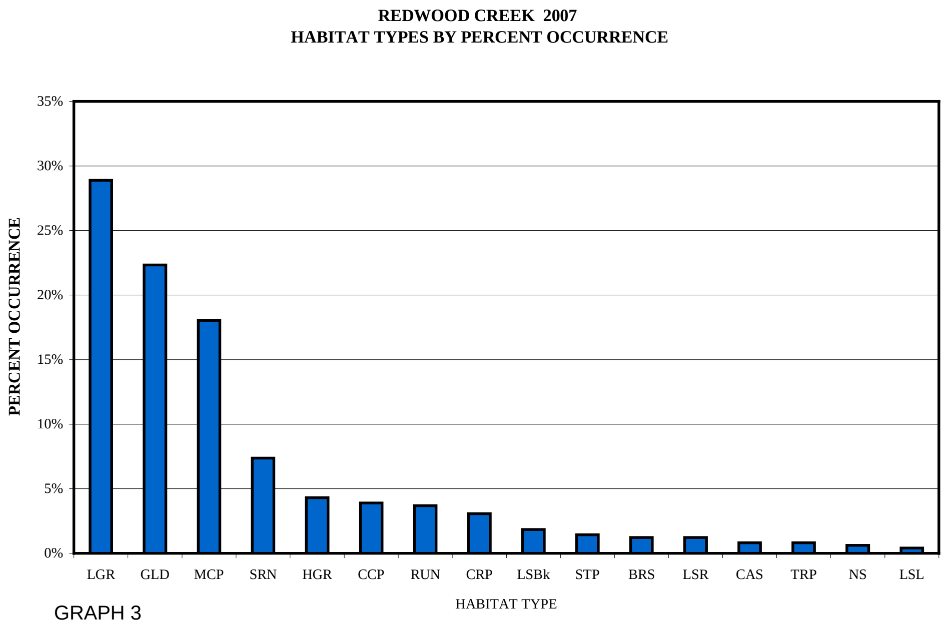
GRAPH 1



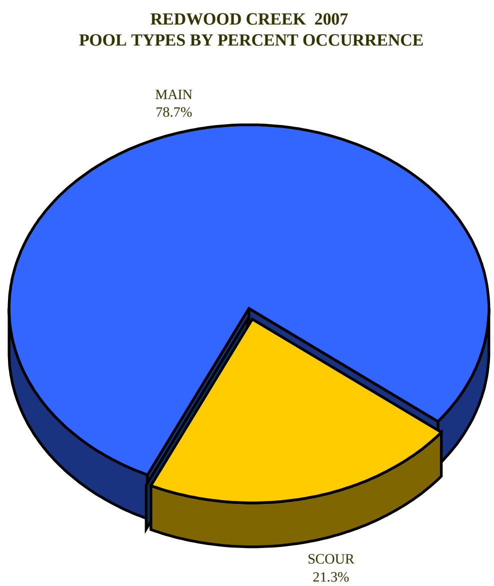
GRAPH 2

In total, 15 Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were; 29% low gradient riffle units, and 22% glide units (Graph 3). Based on percent total length, the most frequent habitat types are as follows; 13% low gradient riffle units, and 14% glide units.

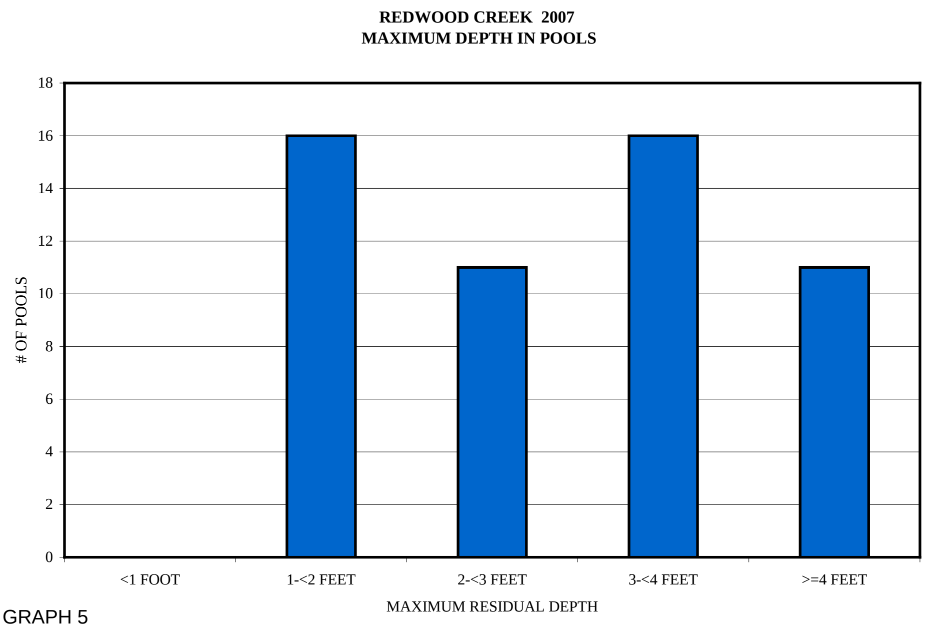
A total of 150 pools were identified (Table 3). Main Channel pools were the most frequently encountered, at 79%, and comprised 76% of the total length of all pools (Graph 4). Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth, and 27 of the 54 pools (50%) had a residual depth of three feet or greater (Graph 5).



GRAPH 3



GRAPH 4



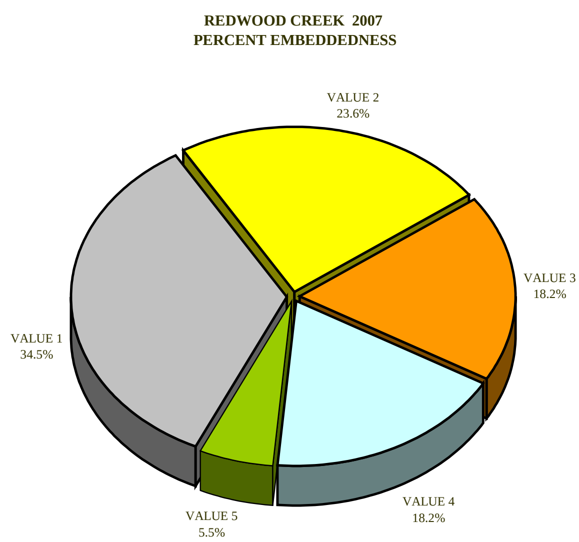
GRAPH 5

The pools were relatively deep, with 27 of the 54 (50%) fully measured pools having a maximum residual depth greater than 3 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In third order streams, a primary pool is defined to have a maximum residual depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 55 pool tail-outs measured, 19 had a value of 1 (35%); 13 had a value of 2 (24%); 10 had a value of 3 (18 %); 10 had a value of 4 (18 %); and 3 had a value of 5 (6%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

In total, 32 of the 55 pool tail-outs measured had embeddedness ratings of 1 or 2, and 20 of the pool tail-outs had embeddedness ratings of 3 or 4. Overall, 3 of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

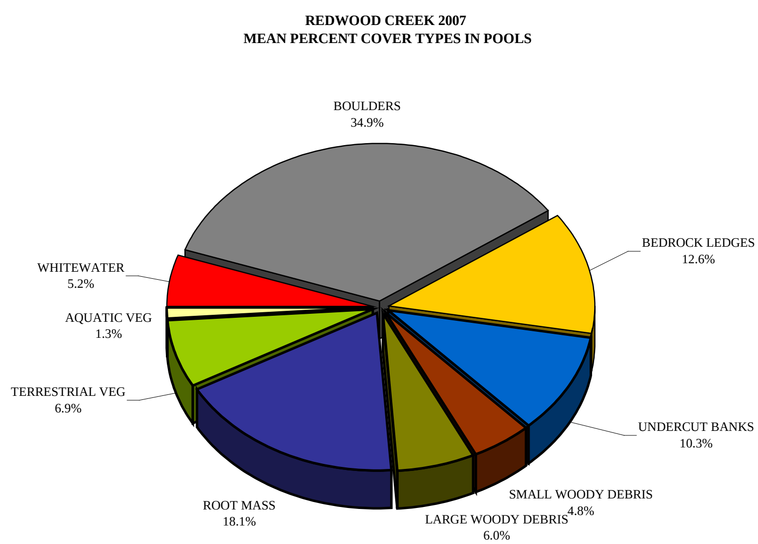
Forty of the 55 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.



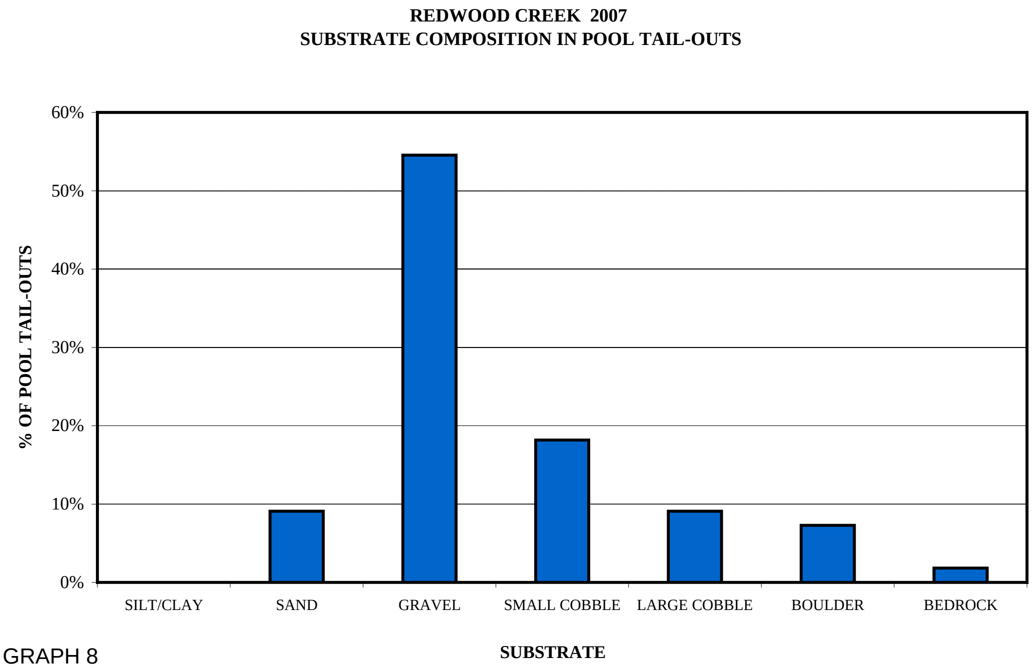
GRAPH 6

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 40, flatwater habitat types had a mean shelter rating of 46, and pool habitats had a mean shelter rating of 72 (Table 1). Of the pool types, the Main Channel pools had a mean shelter rating of 73, Scour pools had a mean shelter rating of 69 (Table 3).

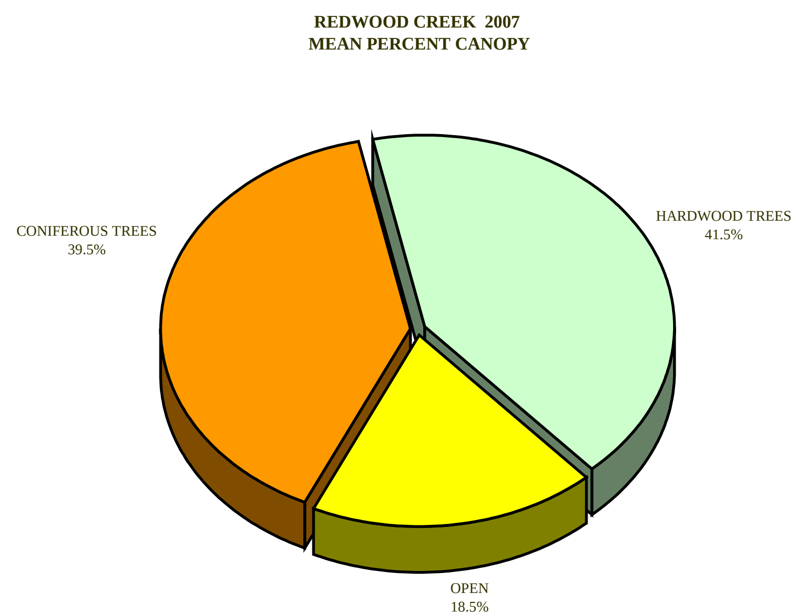
Table 5 summarizes mean percent cover by habitat type. Boulders and root mass are the dominant cover types in Redwood Creek (Graph 7).



GRAPH 7



GRAPH 8

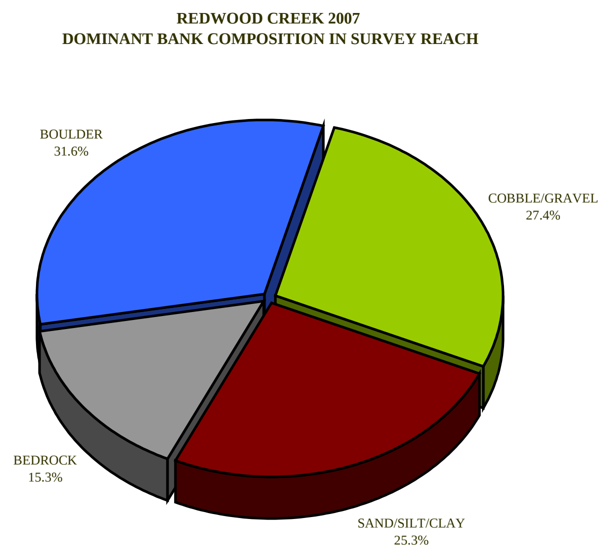


GRAPH 9

The mean percent canopy density for the surveyed length of Redwood Creek was 81%. The mean percentages of hardwood and coniferous trees were 51% and 49%, respectively. Overall, 19 percent of the canopy was open (Graph 9).

Reach 1 had a canopy density of 76%, Reach 2 had a canopy density of 73%, Reach 3 had a canopy density of 92%, and Reach 4 had a canopy density of 96%. In general, revegetation projects are considered when canopy density is less than 80%.

For the stream reach surveyed, the mean percent right bank vegetated was 80%, and the mean percent left bank vegetated was 82%. The dominant stream bank material consisted of 15% bedrock, 32% boulder, 27% cobble/gravel, and 25% sand/silt/clay (Graph 10). Deciduous trees were the dominant vegetation type observed in 44% of the units surveyed. Additionally, 27% of the units surveyed had brush as the dominant vegetation type, and 26% had coniferous trees as the dominant vegetation (Graph 11).



GRAPH 10

The mean shelter rating for pools was 72 and the shelter rating in the flatwater habitats was 46. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in Redwood Creek. Boulders are the dominant cover type in pools followed by root mass.

The percentage of right and left bank covered with vegetation was high at 80% and 82%, respectively. However, in areas with stream bank erosion or where bank vegetation is sparse, planting native vegetation, in conjunction with bank stabilization, is recommended where feasible.

SPAWNING GRAVEL PERMEABILITY

A total of 24 potential spawning sites were measured for gravel permeability (Figure 3.7.2). The predicted egg-to-emergence survival estimates ranged from 13% to 78%.

Figure 3.7.2 – Gravel permeability sites on Redwood Creek. Estimated survival values ranged from 13% to 78%.

MIGRATION BARRIERS

A total of three fish migration barriers were identified on Redwood Creek (Figure 3.7.3). Two of these sites were verified by field observations, and the third was not surveyed due to insufficient landowner access. Additionally, a large portion of reach 3 was unsurveyed due to insufficient landowner access and therefore may contain fish passage barriers that were not documented by this survey.

Juvenile *O. mykiss* were observed above reach 4, indicating that a resident trout population exists in the upstream reaches of Redwood Creek above the limit of anadromy.

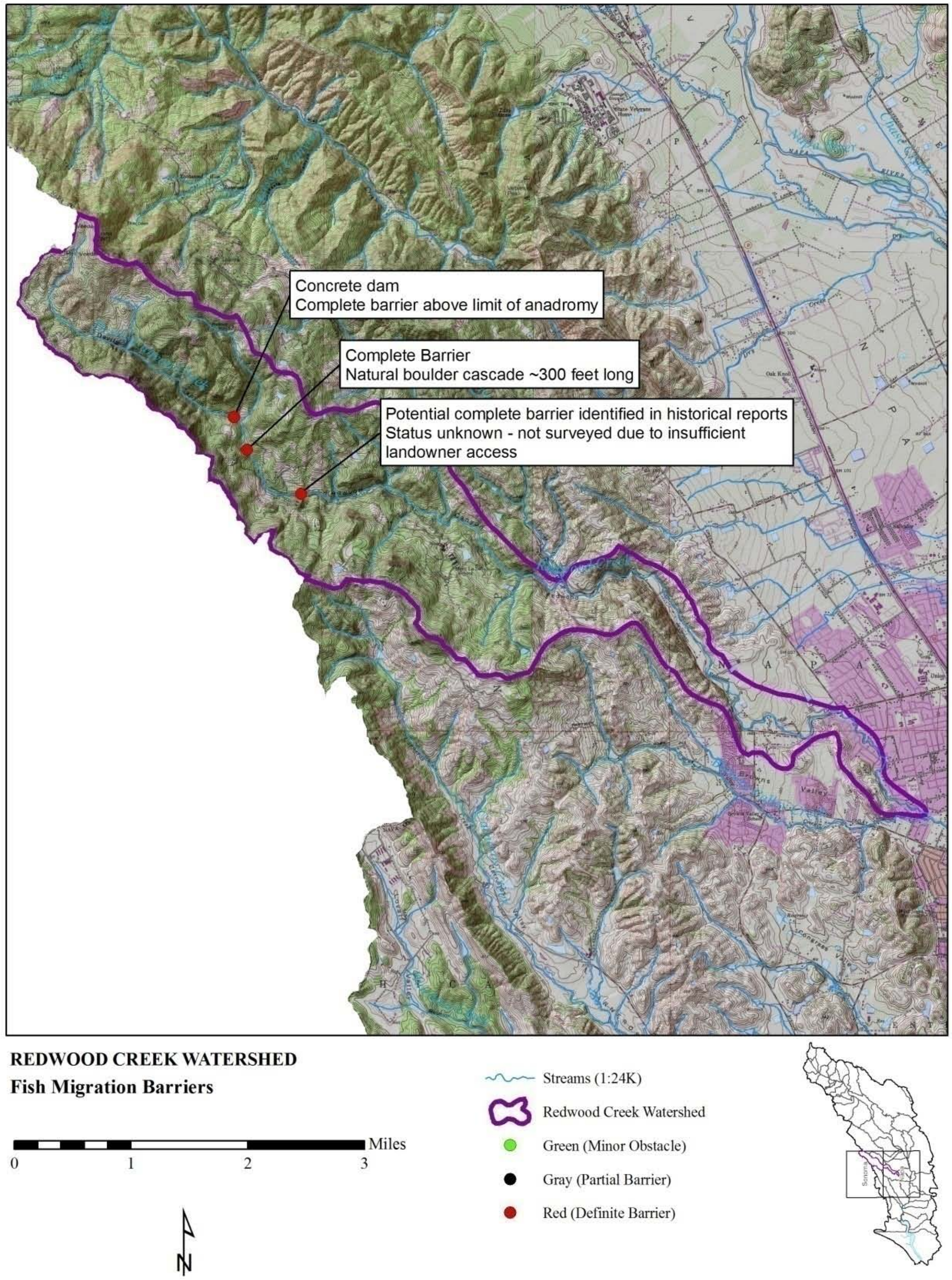


Figure 3.7.3 – Fish migration barrier sites on Redwood Creek. *O. mykiss* were observed above all three barriers, suggesting a resident population exists in the upper reaches of the watershed.

BIOLOGICAL SURVEYS/ OBSERVATIONS

Juvenile steelhead were observed in Redwood Creek in moderate to high abundances in all surveyed reaches. Sections of reaches 1 and 2 went dry in spring and summer 2007, causing fish kills. Juvenile steelhead specimens were recovered from the dry stream by the RCD biologist and retained for genetic analysis.

Adult steelhead were observed spawning in reaches 1, 2, and 3 during permeability and adult spawner surveys in winter 2007. Two tisssue samples were collected from recovered steelhead carcasses for genetic analysis and were sent to NOAA Fisheries Lab in Santa Cruz, California.

Snorkel surveys conducted in reaches 2 and 3 as part of another study showed high densities of juvenile steelhead in spring of 2007. However, low summer survival was documented through follow-up surveys of the same reaches in fall 2007. Lack of streamflow appeared to be the primary factor for this low survival.

WATER QUANTITY

Streamflow was visually estimated at approximately five cfs during the habitat survey in April 2007. As mentioned above, much of reaches 1, 2, and a short section of reach 3 went completely dry in summer. The headwaters and most of reaches 3 and 4 sustained perennial flow during our study period.

There are a total of 24 appropriative water rights on record for the Redwood Creek watershed (Figure 4.1.1).

WATER TEMPERATURE

Water temperatures taken during the survey period ranged from 48 to 55 degrees Fahrenheit. Air temperatures ranged from 54 to 81 degrees Fahrenheit.

Mean Temperature (°C)	13.43
Median Temperature (°C)	13.69
Maximum Temperature (°C)	22.03
Minimum Temperature (°C)	4.30
Standard Deviation (°C)	3.22
Total Measurements	46,718
Number of records exceeding 20˚C	314
MWAT (°C)	19.38

Table 3.7.1 – Summary statistics from continuous temperature monitoring of Redwood Creek.

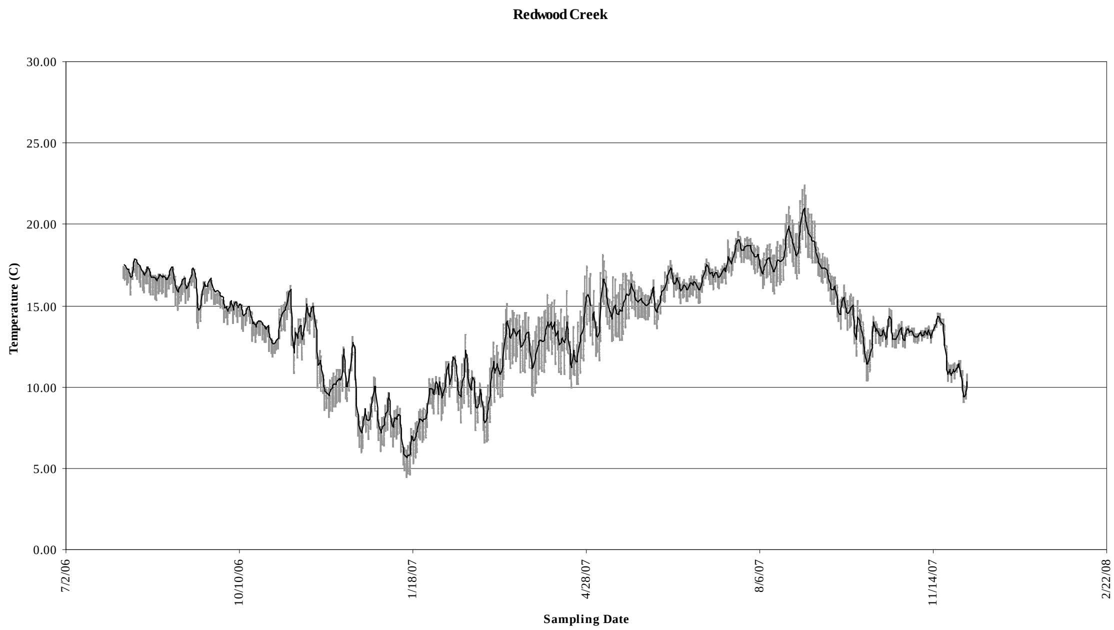


Figure 3.7.4 – Continuous water temperature data from Redwood Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.8 SALVADOR CREEK

Salvador Creek is a tributary to the Napa River, which flows to the Pacific Ocean via San Pablo Bay. Salvador Creek's location at the confluence with the Napa River is 38.326151° north latitude and 122.284412 west longitude, LLID number 1222832383263. Salvador Creek is a third order stream and has approximately 21.2 miles of blue line stream according to the USGS Napa 7.5 minute quadrangle. However, it should be noted that extensive ditching and stream burial has occurred in the Salvador watershed. Many “blueline” channels depicted on the Napa quadrangle no longer exist or have put into culverts. Salvador Creek drains a watershed of approximately 7.71 square miles. Elevations range from sea level at the mouth of the creek to about 900 feet in the headwater areas. Grasslands, and suburban development dominates the watershed. The watershed is primarily privately owned. Vehicle access exists via Big Ranch and Garfield Roads, Villa Lane, and Summer Brook Circle.

HISTORICAL INFORMATION (Leidy et al., 2005)

In March 1977, DFG surveyed approximately one mile of the Salvador Outfall Channel from Vintage High School to the mouth. Six adult steelhead were observed between Big Ranch Road and the mouth. Staff from DFG speculated that adult steelhead used this stream when low flows prevented access to more suitable upstream tributaries of the Napa River, but that flows and water quality were inadequate for juvenile fish (Baracco 1977).

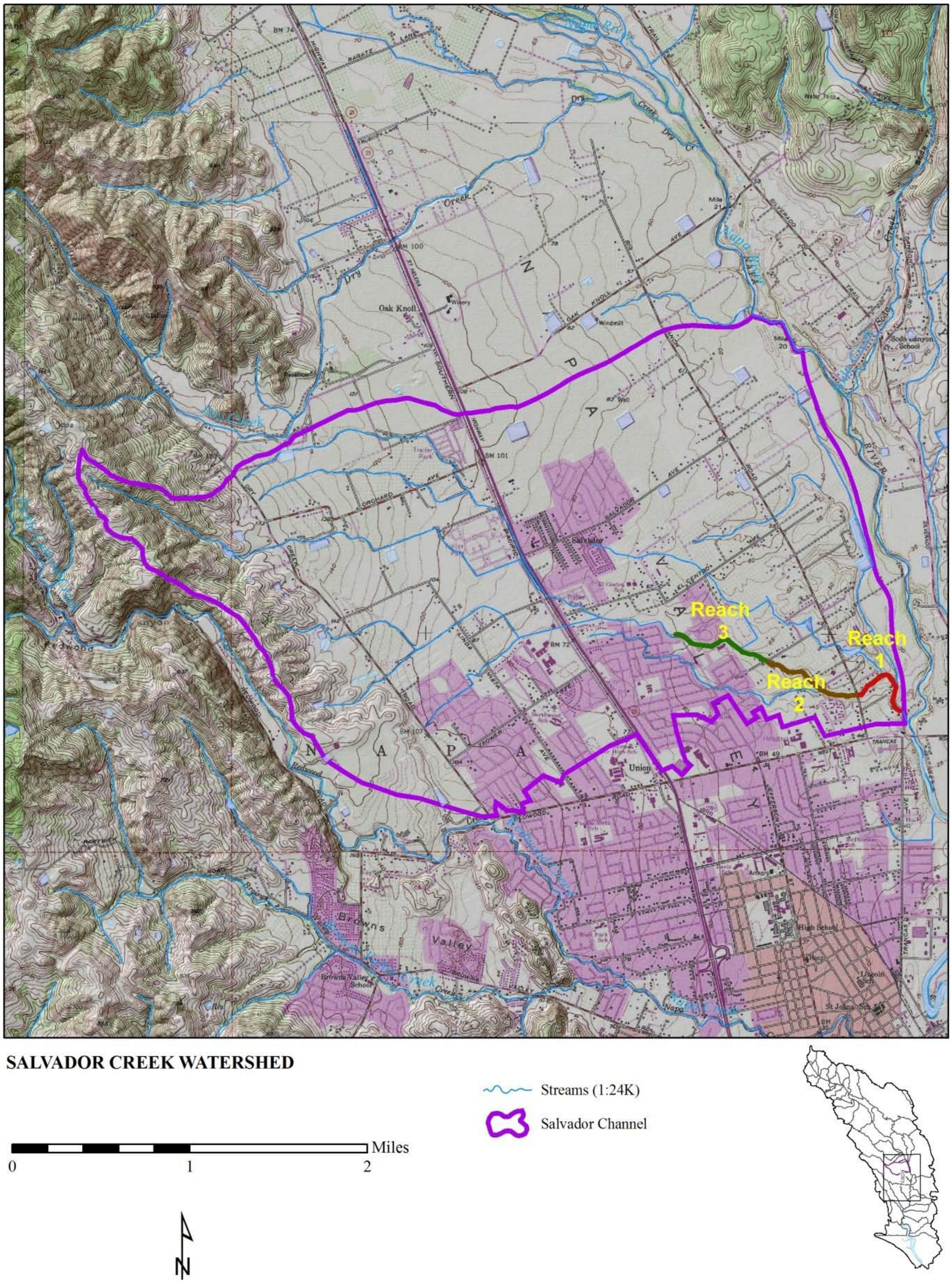


Figure 3.8.1 – Watershed map with habitat survey reaches.

<u>HABITAT</u>

All habitat typing result tables are located in Appendix C.

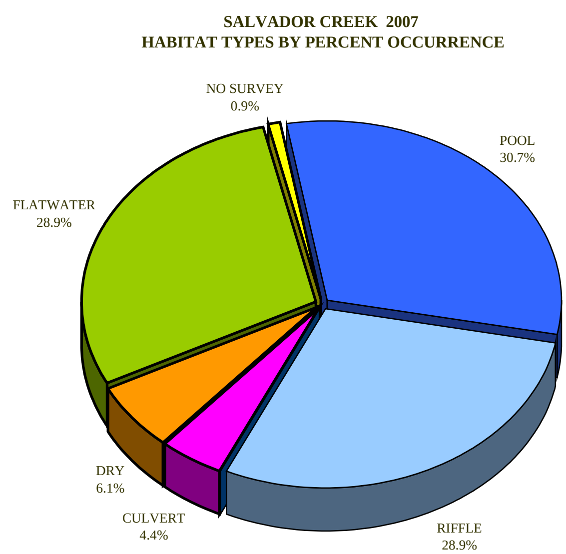
A stream inventory was conducted during 8/30/2007 to 8/31/2007 on Salvador Creek. The survey began approximately 500 feet upstream of the confluence with the Napa River at the first riffle where tidal influence was no longer evident.

The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Salvador Creek. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

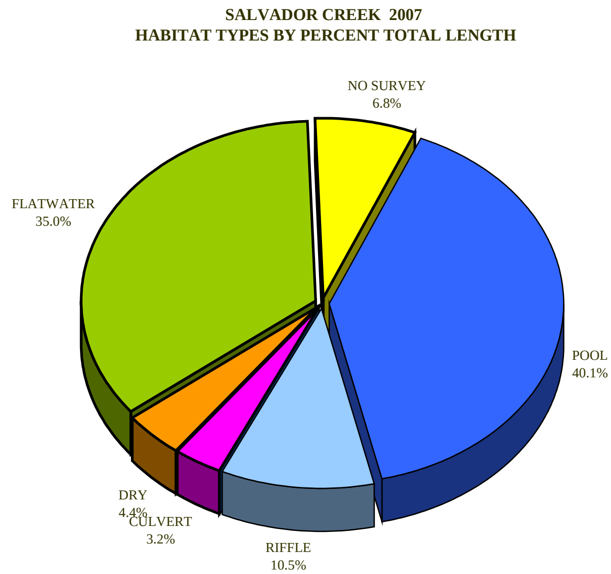
The habitat inventory of 8/30/2007 to 8/31/2007 was conducted by J. Koehler, and C. Edwards (Napa County RCD). The total length of the stream surveyed was 8,864 feet.

During this survey, very little suitable salmonid spawning or rearing habitat was observed. Salvador Creek is channelized beginning just downstream of Vintage High School and is contained in a trapezoidal channel upstream to Hwy 29, where it splits into two ditches running along Solano Avenue. A series of large drainage culverts join the stream at the Highway 29 split and contribute perennial flow via storm drains. There is currently no salmonid habitat value in Salvador Creek above reach 3.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 31% pool units, 29% riffle units, 29% flatwater units, 6% dry units, 1% no-survey units, and 4% culvert units (Graph 1). Based on total length of Level II habitat types there were 40% pool units, 10% riffle units, 35% flatwater units, 4% dry units, and 7% no-survey units, and 3% culvert units (Graph 2).



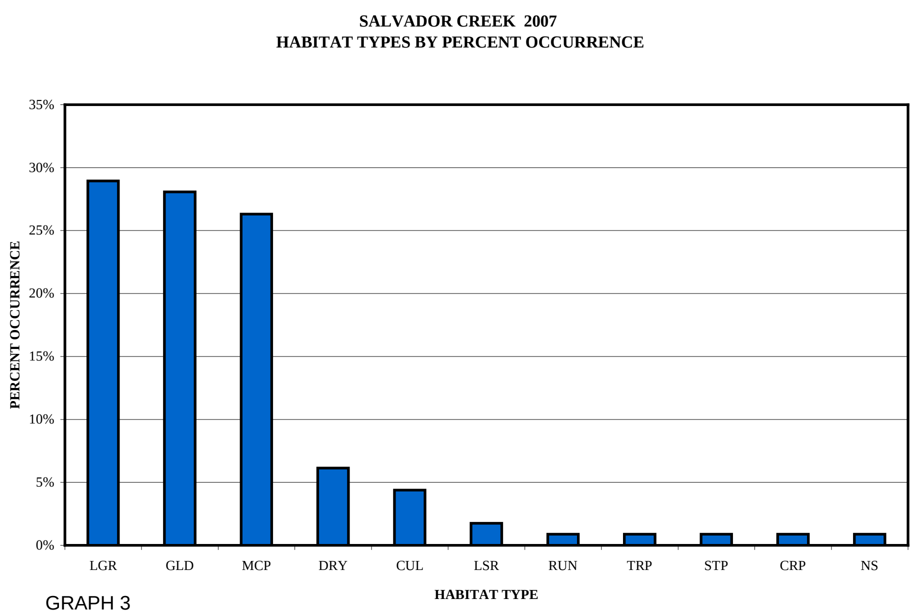
GRAPH 1



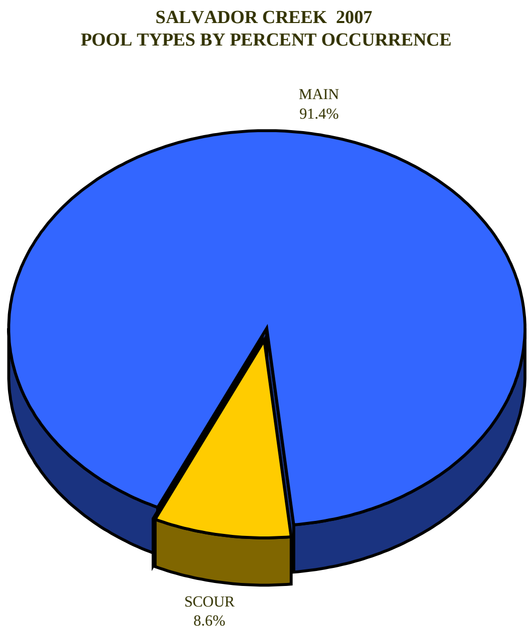
GRAPH 2

In total, 9 Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were; 29% low gradient riffle units, and 28% glide units (Graph 3). Based on percent total length, the most frequent habitat types are as follows; 37% mid-channel pool units, and 34% glide units.

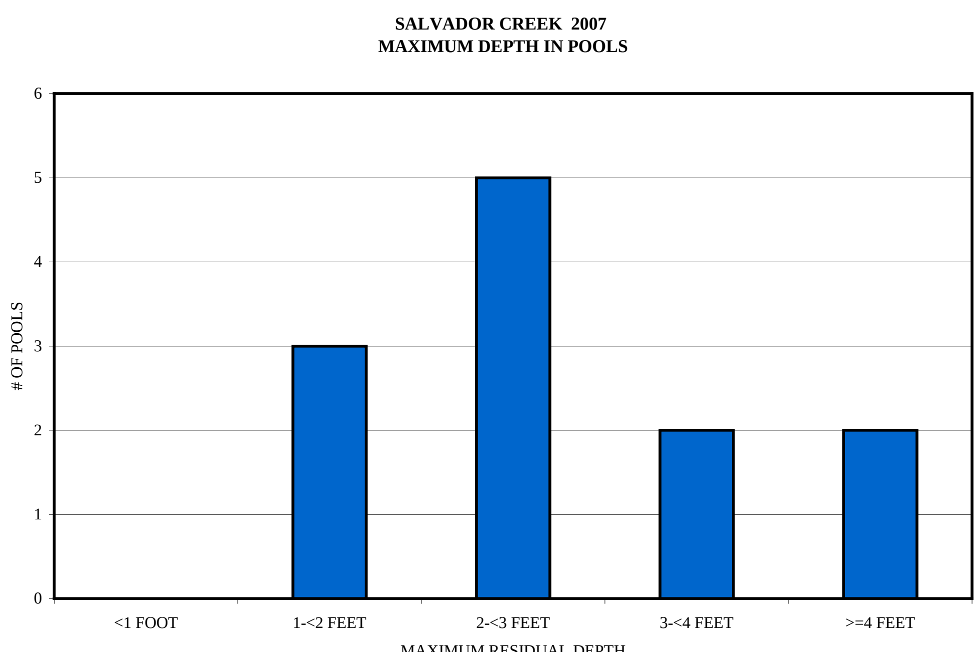
A total of 35 pools were identified (Table 3). Main channel pools were the most frequently encountered, at 91%, and comprised 96% of the total length of all pools (Graph 4). Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth, and 9 of the 12 pools (75%) had a residual depth of two feet or greater (Graph 5).



GRAPH 3



GRAPH 4



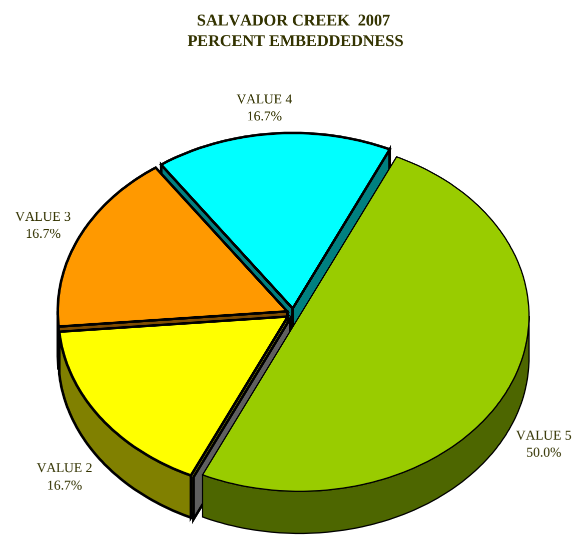
GRAPH 5

The pools are relatively deep, with 9 of the 12 (75%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum residual depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 12 pool tail-outs measured, 2 had a value of 2 (17%); 2 had a value of 3 (17%); 2 had a value of 4 (17%); and 6 had a value of 5 (50%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

In total, 2 of the 12 pool tail-outs measured had embeddedness ratings of 1 or 2, and 4 of the pool tail-outs had embeddedness ratings of 3 or 4. Overall, 6 of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

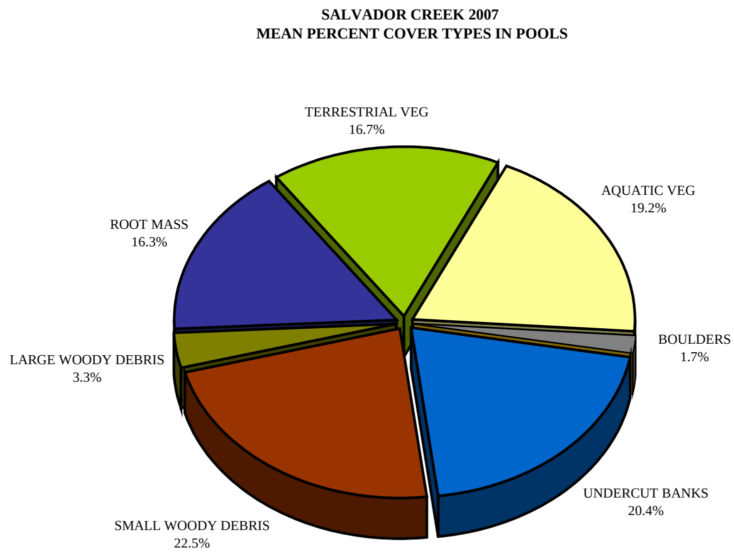
Six of the 12 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.



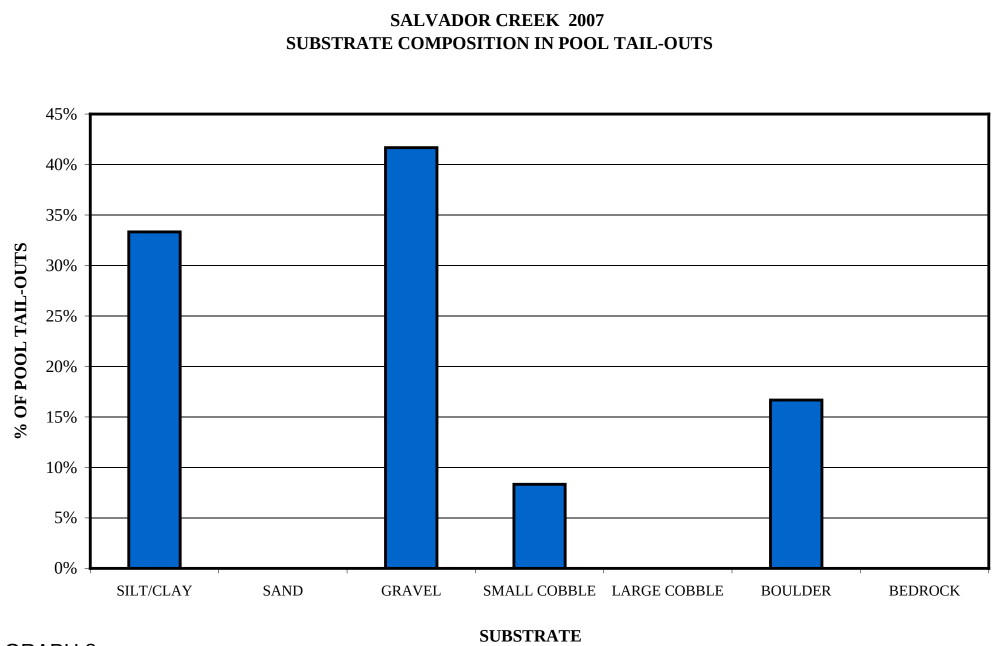
GRAPH 6

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 2, flatwater habitat types had a mean shelter rating of 137, and pool habitats had a mean shelter rating of 76 (Table 1). Of the pool types, the main channel pools had a mean shelter rating of 77, and scour pools had a mean shelter rating of 70 (Table 3).

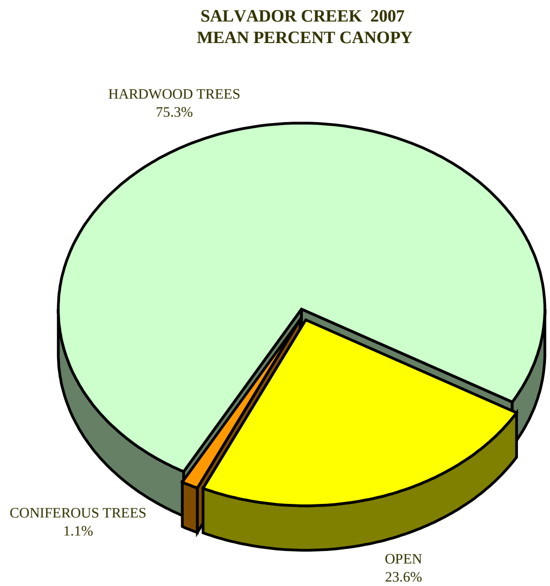
Table 5 summarizes mean percent cover by habitat type. Aquatic vegetation and undercut banks are the dominant cover type in Salvador Creek (Graph 7).



GRAPH 7



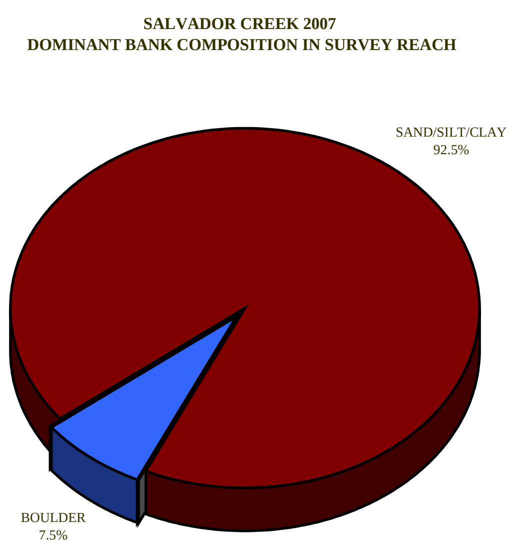
GRAPH 8



GRAPH 9

The mean percent canopy density for the surveyed length of Salvador Creek was 76%. The mean percentages of hardwood and coniferous trees were 99% and 1%, respectively. Overall, 24% of the canopy was open (Graph 9).

For the stream reach surveyed, the mean percent right bank vegetated was 83%. The mean percent left bank vegetated was 84%. The dominant elements composing the structure of the stream banks consisted of 8% boulder, and 92% sand/silt/clay (Graph 10). Brush was the dominant vegetation type observed in 65% of the units surveyed. Additionally, 22% of the units surveyed had deciduous trees as the dominant vegetation type, and 12% had grass as the dominant vegetation (Graph 11).

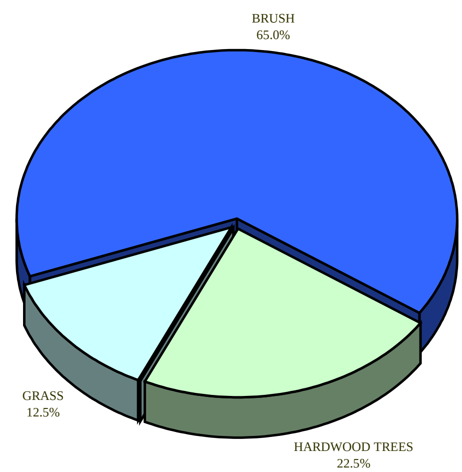


GRAPH 10

The mean shelter rating for pools was 76, and the shelter rating in the flatwater habitats was 137. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by aquatic vegetation in Salvador Creek. Small woody debris is the dominant cover type in pools followed by undercut banks.

The percentage of right and left bank covered with vegetation was high at 83% and 84%, respectively. However, in areas with stream bank erosion or where bank vegetation is sparse, planting native vegetation, in conjunction with bank stabilization, is recommended where feasible.

SALVADOR CREEK 2007
DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11

<u>SPAWNING GRAVEL PERMEABILITY</u>

A total of four potential spawning sites were measured for gravel permeability (Figure 3.8.2). The predicted egg-to-emergence survival estimates ranged from 19% to 35%.

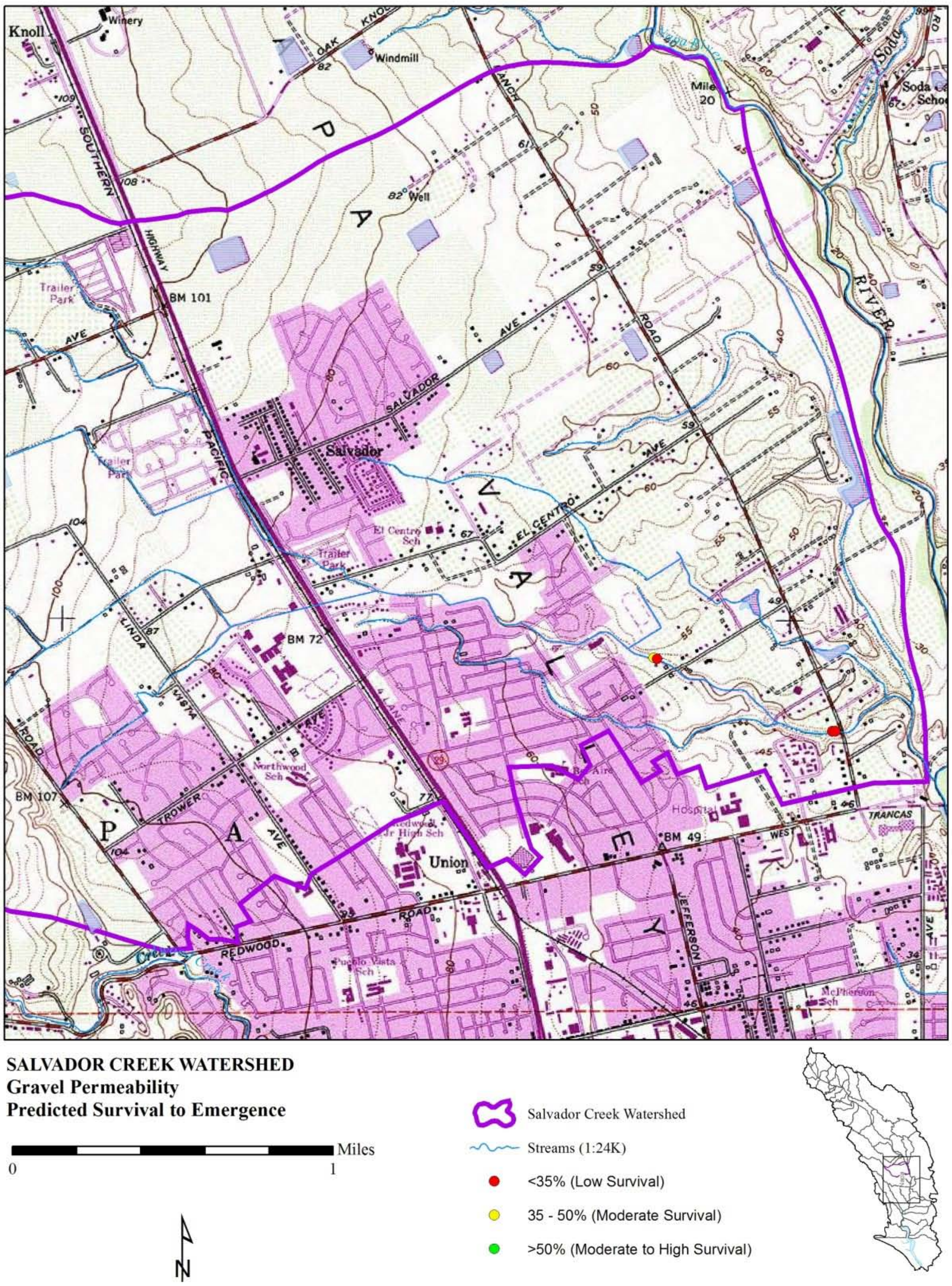


Figure 3.8.2 – Gravel permeability sites on Salvador Creek. Estimated survival values ranged from 19% to 35%.

MIGRATION BARRIERS

No fish migration barriers were identified on Salvador Creek. A few sections of concrete in reach 3 likely hinder low-flow passage by adult salmonids. However, given the poor quality of the habitat in this reach and upstream, these minor obstructions would be a very low priority for modification or removal.

BIOLOGICAL SURVEYS/ OBSERVATIONS

No juvenile steelhead were observed in Salvador Creek during our habitat survey. Juvenile salmon (approximately 60-80 mm) were observed just upstream of Big Ranch Road during permeability measurements. Prior to this observation, it was unknown whether Chinook successful spawned in Salvador Creek.

Adult Chinook salmon have been documented spawning in Salvador Creek for the past several years and we collected tissue samples from four carcasses on 12/28/2007 for genetic analysis. Spawning appears to be concentrated in upper reach 2 and reach 3 near Vintage High School. These fish appear to be attracted to Salvador Creek's early season flows; likely caused by the relatively high fraction of impervious surfaces in the upper watershed. In 2005 and 2006, RCD biologists observed 20-30 carcasses in lower reach three; presumably fish that migrated in to spawn and then became stranded by low flows.

No adult or juvenile surveys (e.g. spawner surveys or snorkel counts) were conducted for Salvador Creek as part of this study.

WATER QUANTITY

Streamflow was visually estimated at approximately 0.5-1 cfs during the habitat survey in August. Salvador Creek is perennial in all reaches, but becomes stagnant in late summer above reach 3. Flow in the summer appears to be primarily urban and suburban irrigation runoff.

There are a total of 8 appropriative water rights on record for the Salvador Creek watershed (Figure 4.1.1).

WATER TEMPERATURE

Water temperatures taken during the survey period ranged from 67 to 75 degrees Fahrenheit. Air temperatures ranged from 77 to 95 degrees Fahrenheit.

Continuous water temperature monitoring was conducted from 8/4/06 through 12/4/2007 in a pool just upstream of Big Ranch Road in reach 2 (Table 3.8.1 and Figure 3.8.3).

Mean Temperature (°C)	15.21
Median Temperature (°C)	15.29
Maximum Temperature (°C)	21.70
Minimum Temperature (°C)	7.07
Standard Deviation (°C)	3.16
Total Measurements	46,801
Number of records exceeding 20˚C	1,406
MWAT (°C)	19.99

Table 3.8.1 – Summary statistics from continuous temperature monitoring of Salvador Creek.

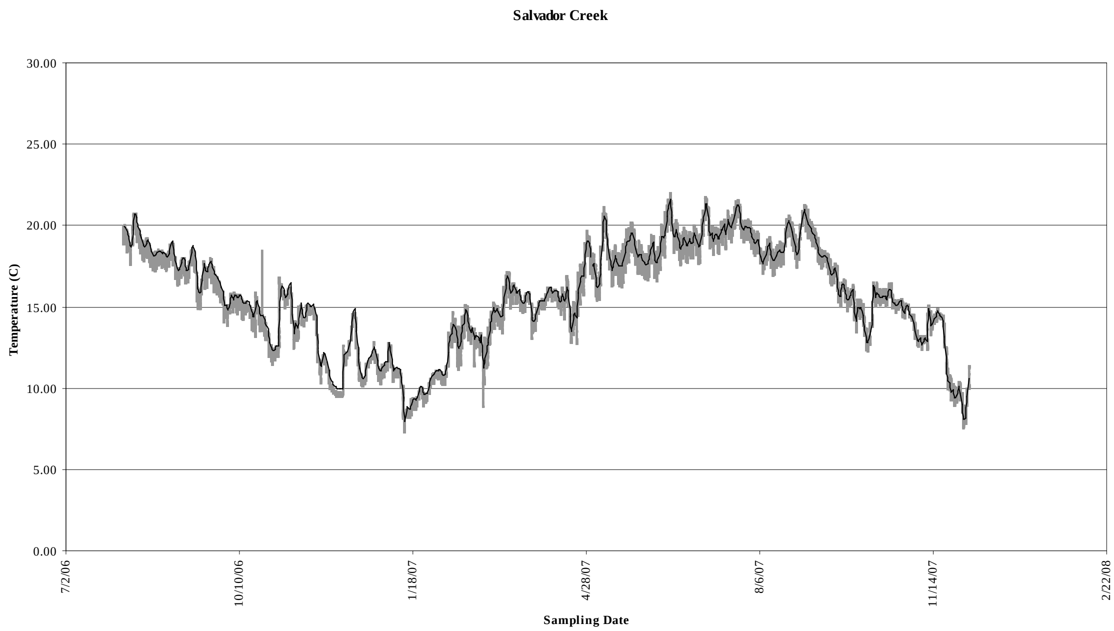


Figure 3.8.3 – Continuous water temperature data from Salvador Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.9 SARCO CREEK

Sarco Creek is a third order tributary to Milliken Creek, which drains a watershed area of approximately 4.5 square miles. Sarco Creek's location at the confluence with Milliken Creek is 38.322899° north latitude and 122.273922° west longitude. There are approximately 9.9 miles of blueline streams in the Sarco Creek watershed according to the Napa and Mt. George 7.5 minute USGS topo quads. Elevations range from about 50 feet near the confluence to over 1800 feet in the headwaters area. The watershed is almost entirely in private ownership and vehicle access exists at two road crossings: Silverado Trail and Vichy Avenue.

HISTORICAL INFORMATION (Leidy et al., 2005)

In August 1987, DFG visually surveyed the lower five miles of Sarco Creek from the mouth to Mount George, and also the lower 3.9 miles of a major unnamed tributary that joins Sarco Creek just upstream of its confluence with Milliken Creek. No *O. mykiss* were observed in either creek (Montoya 1987d, 1987e).

In August 1990, DFG electrofished Sarco Creek at an area off Langley Park Lane. One *O. mykiss* (210 mm FL) was caught. Three *O. mykiss* of comparable size as well as two smaller individuals were observed but not caught (Gray 1990g). The survey report noted that the fish were presumed to be resident forms of an ancestral stock of steelhead.

In August 1993, Leidy electrofished Sarco Creek at the Trancas Road Bridge. No *O. mykiss* were found (Leidy 2002). Ecotrust and FONR carried out surveys in tributaries of the Napa River system in July and August 2001. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. Of two Sarco Creek reaches, one was found to have *O. mykiss* at density level "1" (Ecotrust and FONR 2001). Follow-up surveys were performed between June and September 2002. *Oncorhynchus mykiss* were found in five Sarco Creek reaches, including one reach at density level "2" (Ecotrust and FONR 2002).

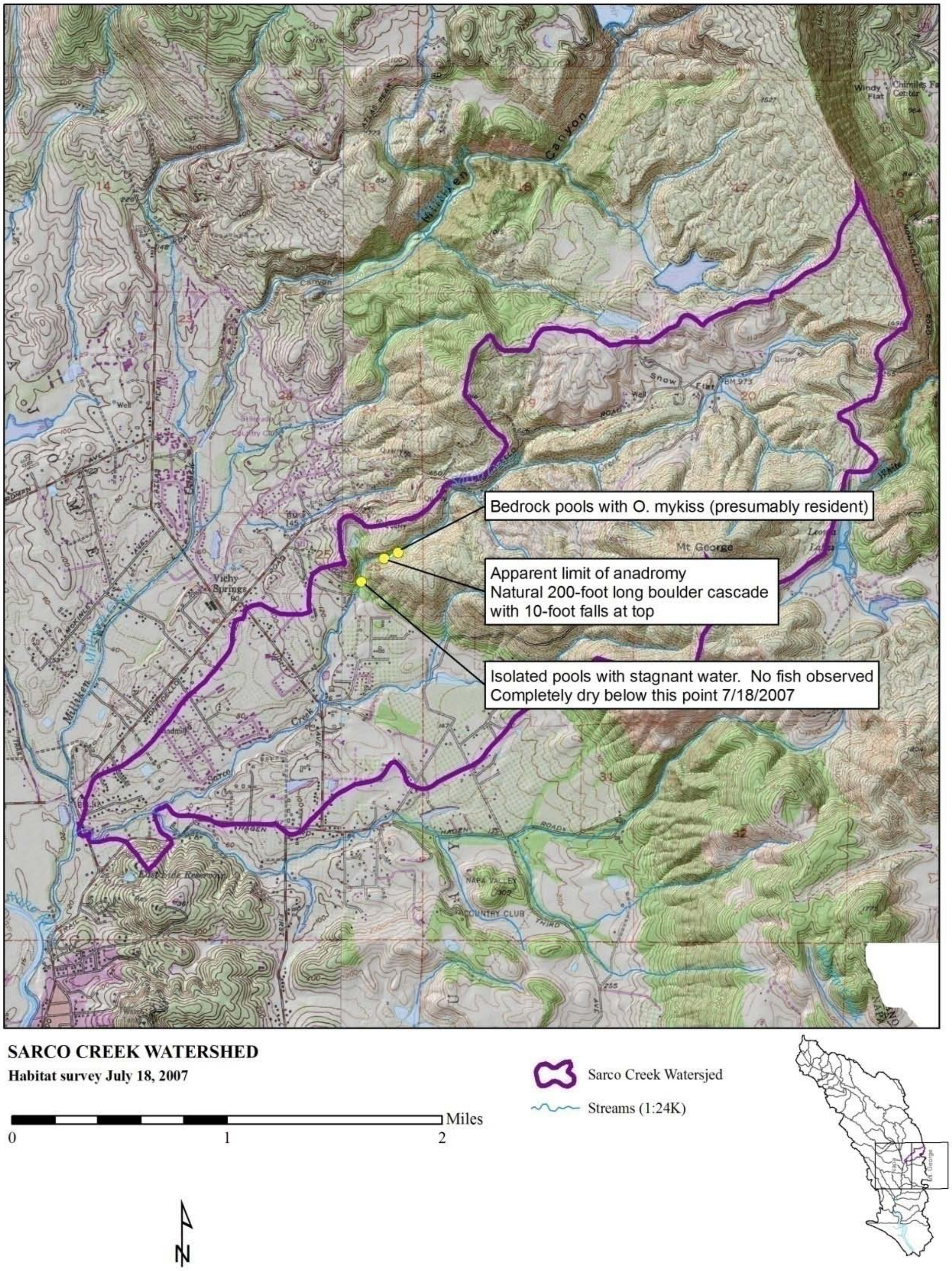


Figure 3.9.1 – Sarco Creek watershed map.

HABITAT

A habitat-typing survey was not performed on Sarco Creek due to lack of water. J. Koehler and C. Edwards of the NCRCD conducted a walking survey of the channel on 7/18/2007. The survey began at the confluence with Milliken Creek and extended upstream approximately 2.4 miles upstream to the natural end of anadromy at a 200-foot long series of boulder cascades with a 10-foot high waterfall at the top. This feature did not appear to be passable by adult steelhead under any flow.

The channel was completely dry for most of the survey and only a few isolated, stagnant pools were observed below the limit of anadromy (Figure 3.9.1). No suitable salmonid rearing habitat was found below this natural blockage. Above this point, we observed a few juvenile O. mykiss (~ 3 inches) in a series of deep bedrock pools. Surface flow was estimated at 0.1 – 0.25 cfs and appeared to be coming from groundwater seeps on both banks. Water temperature was 16.5°C.

SPAWNING GRAVEL PERMEABILITY

A total of four potential spawning sites were measured for gravel permeability (Figure 3.9.2). The predicted egg-to-emergence survival estimates ranged from 38% to 67%.

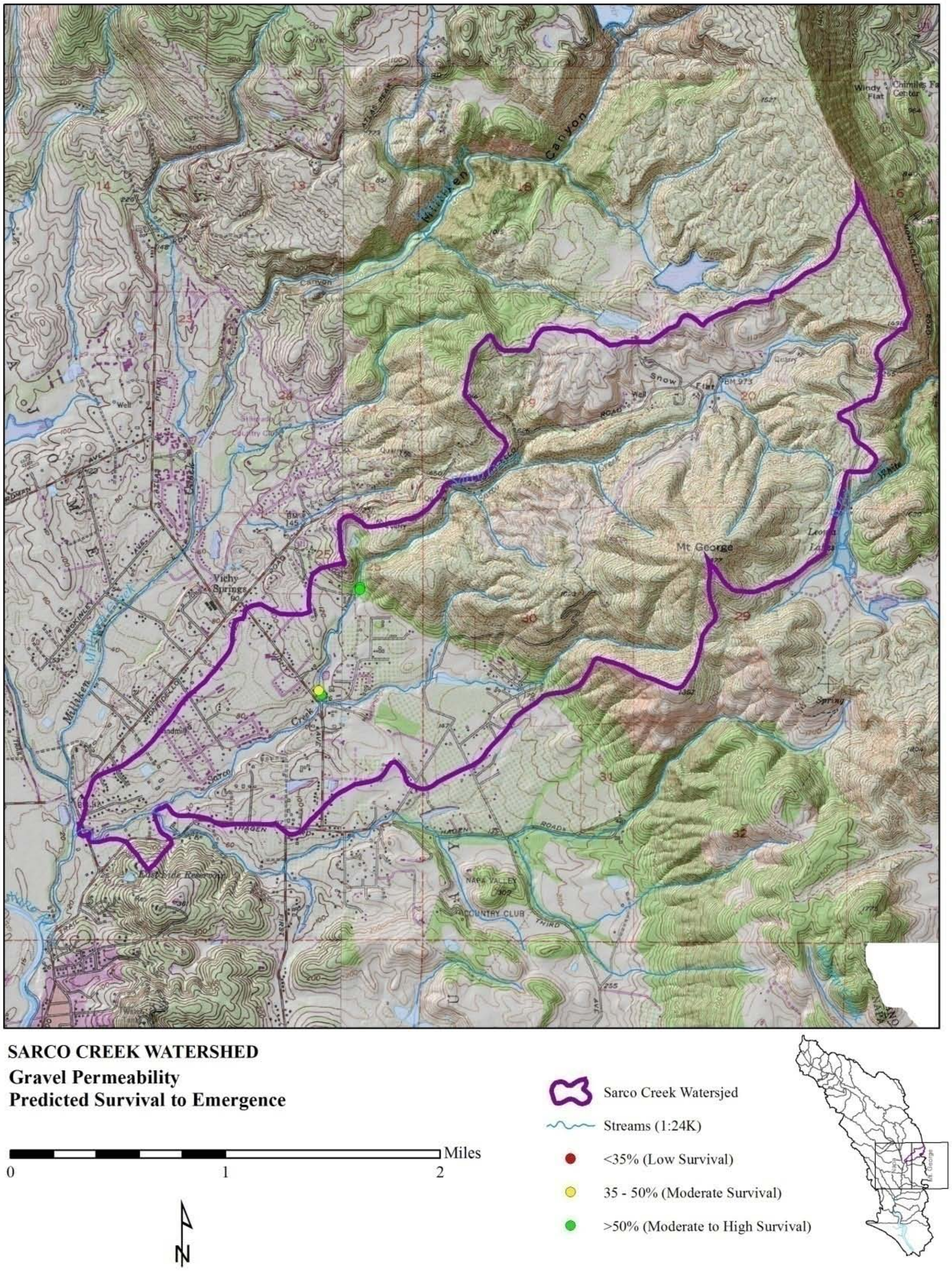


Figure 3.9.2 – Gravel permeability sites on Sarco Creek. Estimated survival values ranged from 38% to 67%.

MIGRATION BARRIERS

A total of two fish migration barriers were identified on Sarco Creek (Figure 3.9.3). Vichy Avenue may be a very minor low-flow obstacle, but it was not fully assessed during winter or spring flows as part of this study.

The first site was a seven-foot high natural bedrock waterfall located approximately 2.27 miles upstream of the confluence. This site was not observed during moderate or high flows, and therefore its severity was not fully assessed. However, based on the relatively shallow residual pool depth below and the height of the jump, this feature is likely a major obstacle for adult steelhead and is a complete barrier at lower flows.

The second site was a 200-foot long series of boulder cascades with a 10-foot waterfall at the top (described above). This appears to be the upper limit of anadromy.

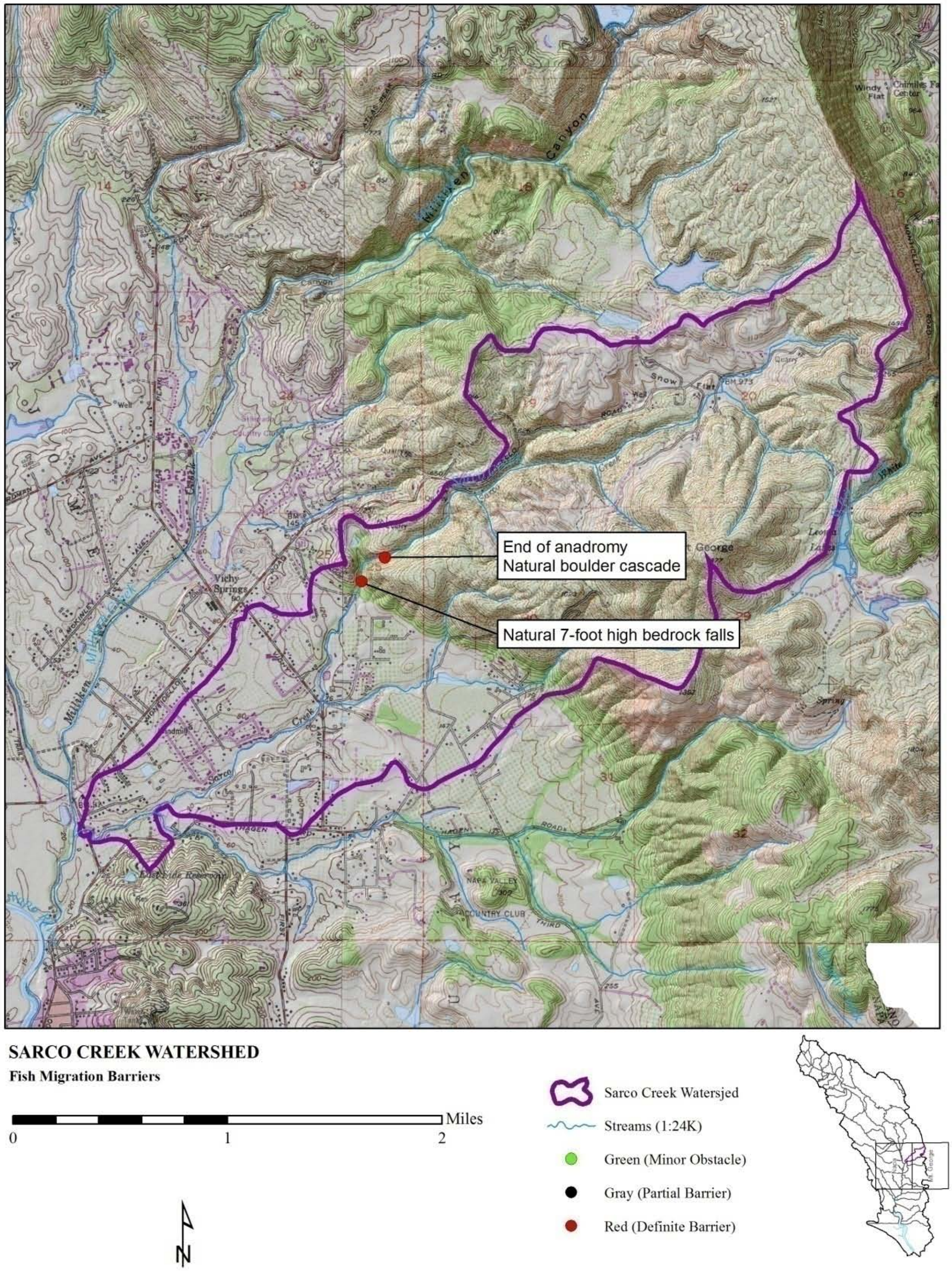


Figure 3.9.3 – Fish migration barrier sites on Sarco Creek

BIOLOGICAL SURVEYS/ OBSERVATIONS

One juvenile O. mykiss was observed in Sarco Creek in a bedrock pool above the upper limit of anadromy. This fish was approximately 3 inches in length and was presumably a resident trout.

No direct evidence of adult steelhead or salmon spawning (e.g. redds, carcasses, etc) was observed during other field surveys including permeability sampling on 3/20/2008. However, there are multiple reports of adult steelhead in Sarco Creek each year by streamside residents. The RCD biologist has observed steelhead smolts and young-of-year stranded at low flow in the pool below Vichy Ave in spring 2005 and 2006. Landowners report that this is a common occurrence as flows recede in spring.

WATER QUANTITY

Streamflow was visually estimated at approximately 0.1 – 0.25 cfs in the uppermost reach of the survey on 7/18/2008. The remainder of the channel was completely dry. It is not known whether this pattern is typical for the stream in a higher rainfall year.

There are a total of seven appropriative water rights on record for the Sarco Creek watershed (Figure 4.1.1).

WATER TEMPERATURE

A continuous temperature logger was placed in Sarco Creek in a pool immediately downstream of Vichy Ave. The logger was located was set to record water temperature every 15 minutes. The logger sampled continuously from 1/17/2007 – 7/17/2009 (although the pool went dry sometime around 6/11/2007). Results are shown in Table 3.9.1 and Figure 3.9.4.

Mean Temperature (°C)	11.88
Median Temperature (°C)	12.00
Maximum Temperature (°C)	32.12
Minimum Temperature (°C)	5.08
Standard Deviation (°C)	3.25
Total Measurements	13977
Number of records exceeding 20˚C	340
MWAT (°C)	25.72

Table 3.9.1 – Summary statistics from continuous temperature monitoring of Sarco Creek.

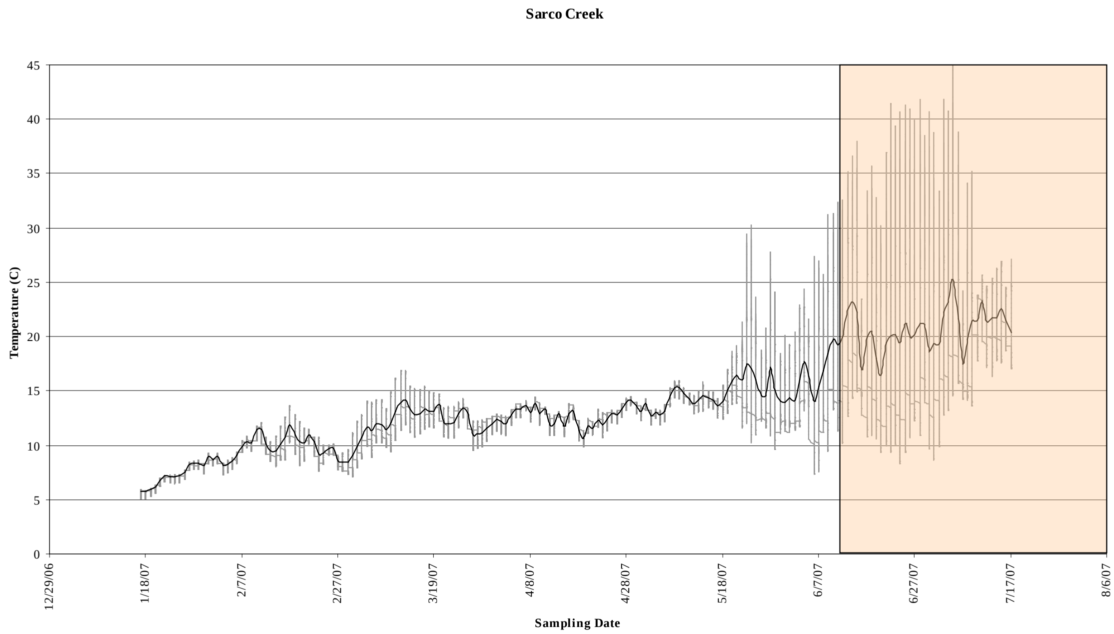


Figure 3.9.4 – Continuous water temperature data from Sarco Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.10 SPENCER CREEK

Spencer Creek joins with Murphy Creek to form Tulucay Creek, which flows to the Napa River. The confluence with Murphy Creek is located at 38.29272° north latitude and 122.239028° west longitude within the Mt. George USGS 7.5-minute quadrangle. Spencer Creek is a second order stream, which drains an area of approximately 2.23 square miles of rural residential land and open space. Elevations range from about 100 feet at the confluence to over 1,300 feet above sea level in the headwaters. Vehicle access is very limited and exists along Green Valley Road.

HISTORICAL INFORMATION (Leidy et al., 2005)

Ecotrust and FONR carried out surveys in tributaries of the Napa River system in July and August 2001. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. One headwater reach of Spencer Creek was found to have *O. mykiss* at density level "2" (Ecotrust and FONR 2001). Follow-up surveys were performed between June and September 2002. *Oncorhynchus mykiss* were found in one Spencer Creek reach (Ecotrust and FONR 2002).

HABITAT

RCD conducted a reconnaissance survey of Spencer Creek on 9/25/2007 and found one short section with water approximately 0.25 miles downstream of Green Valley Road. This section of creek was bedrock-dominated and several *O. mykiss* (approximately 150-200 mm) were seen in one pool. All other pools in this reach were stagnant and did not contain fish.

Perennial flow was observed at the downstream side of the Green Valley Road crossing and suitable rearing habitat was presumed present upstream of this crossing. Continuous water temperature and water quality monitoring were conducted at this site. However, the RCD was unable to acquire landowner permission to assess the reach immediately upstream of Green Valley Road.

A natural 30-foot bedrock waterfall exists approximately 3,200 feet upstream of the Green Valley Road crossing, which is the natural end anadromy for Spencer Creek. In addition, there were several smaller natural falls and cascades upstream of this point and juvenile *O. mykiss* (presumably resident) were observed upstream until the channel became dry. A landowner in the vicinity of the waterfall described the creek as perennial during his 18 year residence on the property and noted there were records of continuous flow for this reach of Spencer Creek for 138 years (D. Smith, pers. comm, 2007).

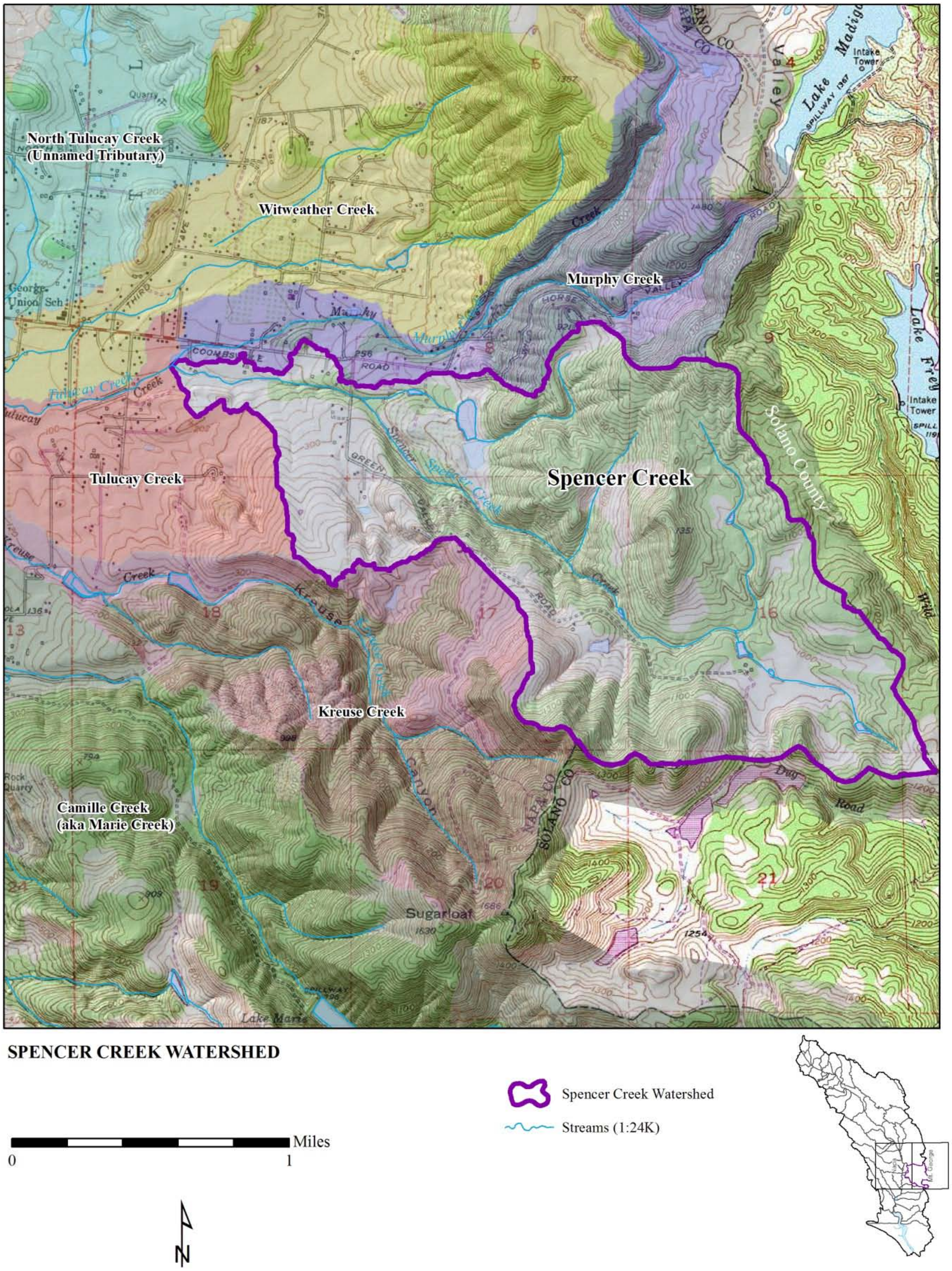


Figure 3.10.1 – Spencer Creek watershed map within the Tulucay sub-watershed.

<u>SPAWNING GRAVEL PERMEABILITY</u>

A total of four potential spawning sites were measured for gravel permeability (Figure 3.10.2). The predicted egg-to-emergence survival estimates ranged from 41% to 68%.

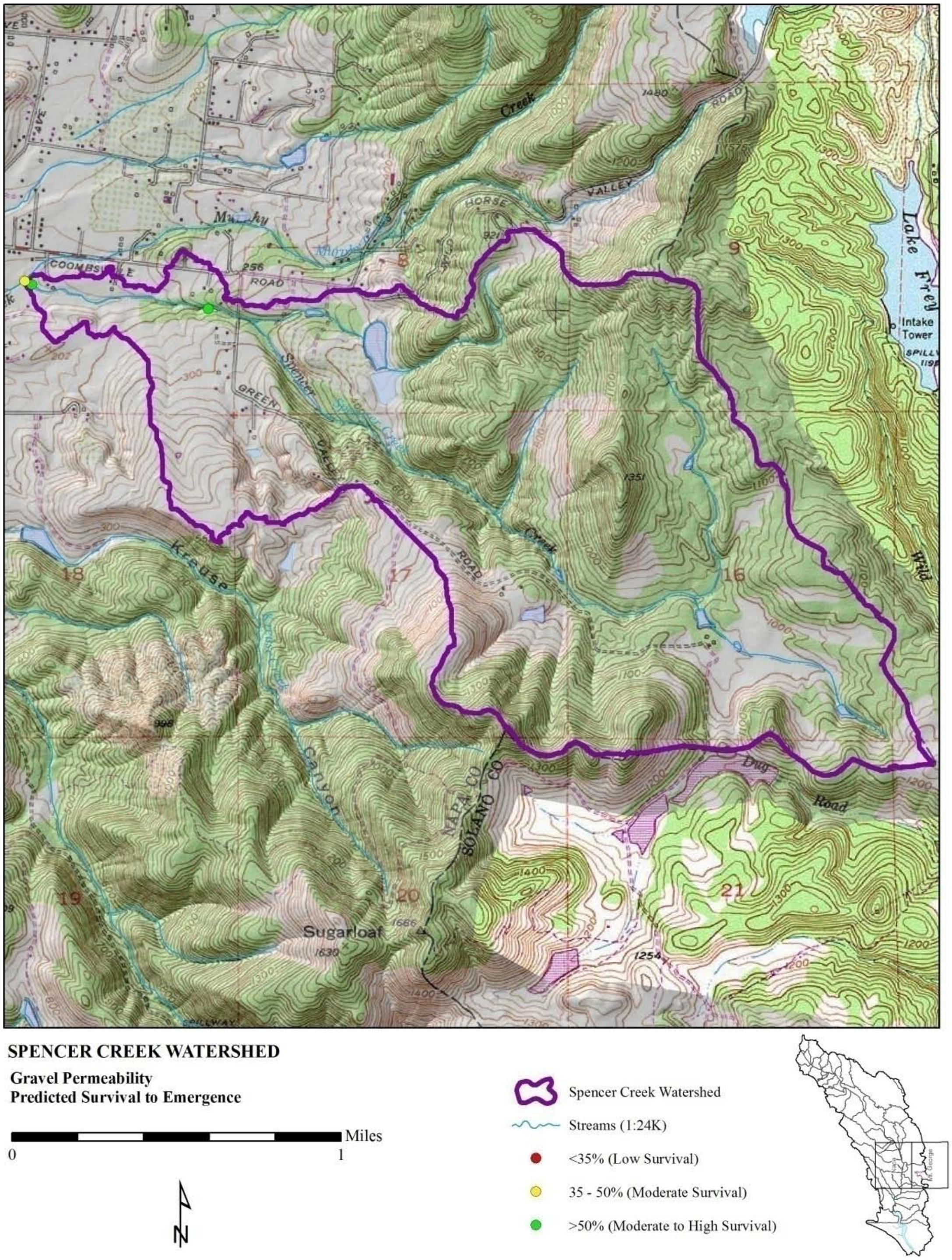


Figure 3.10.2 – Gravel permeability sites on Spencer Creek. Estimated survival values ranged from 41% to 68%.

MIGRATION BARRIERS

A total of three fish migration barriers were identified on Spencer Creek (Figure 3.10.3).

The first site was a 20-foot long bedrock cascade located approximately 0.25 miles downstream of Green Valley Road. This site is likely passable by adult steelhead during typical winter flows, however it appears to be a complete barrier at low to moderate flows.

The Green Valley Road crossing is a significant fish migration barrier. It consists of a long (approximately 80 feet in length), steeply-inclined concrete box culvert with a slightly perched outlet. A full assessment of this site is needed to determine potential impacts to fish migration. Given the lack of landowner access, the quality of the habitat between this crossing and the end of anadromy 3,200 feet upstream is currently unknown.

The third barrier was the natural end of anadromy at a 30-foot waterfall described above.

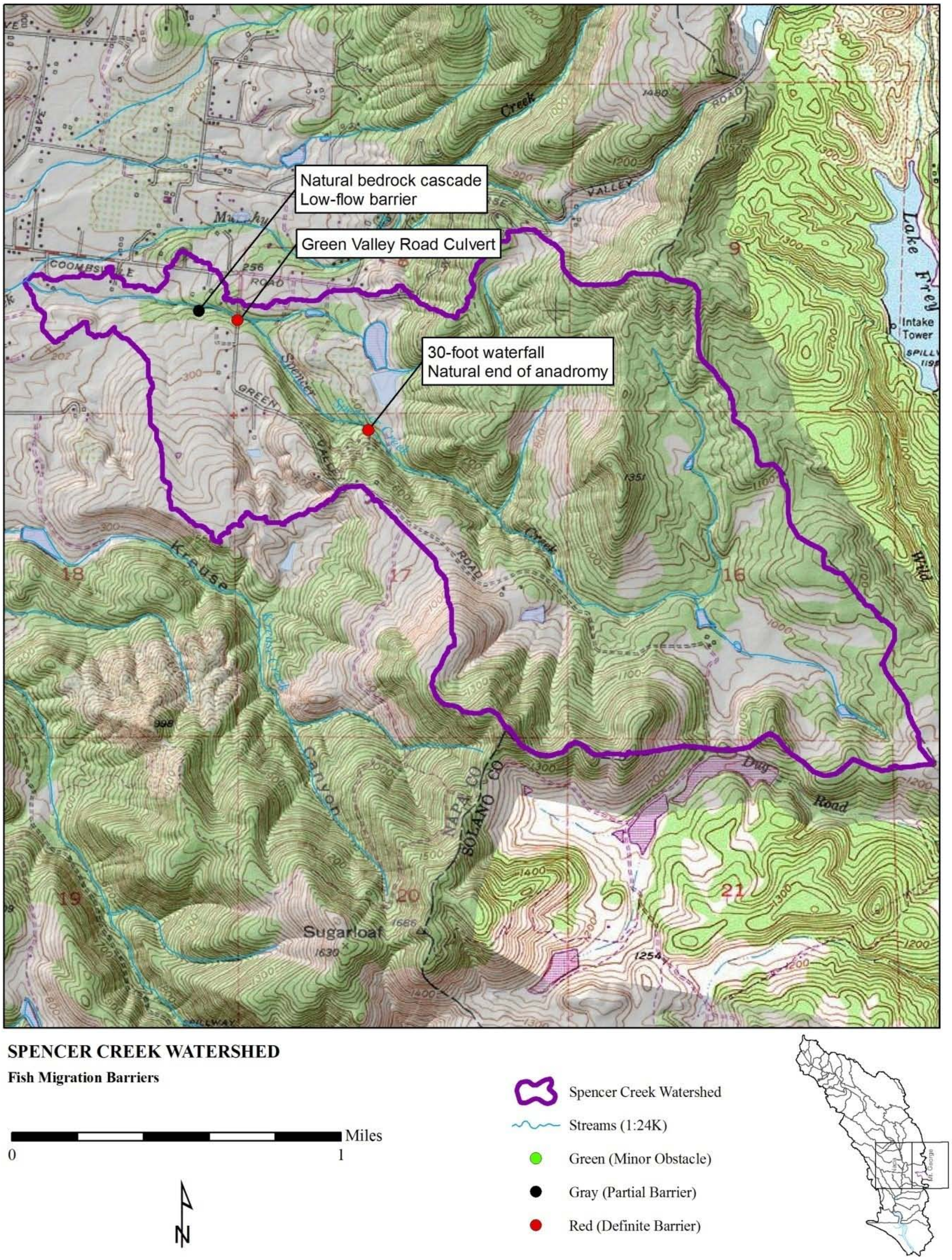


Figure 3.10.3 – Fish migration barrier sites on Spencer Creek

WATER TEMPERATURE

A continuous temperature logger was placed in Sarco Creek immediately downstream of the Green Valley Road culvert. The logger was located in a perennial bedrock pool and was set to record water temperature every 15 minutes. The logger sampled continuously from 8/3/2006 – 12/4/2007. Results are shown in Table 3.10.1 and Figure 3.10.4.

Mean Temperature (°C)	13.23
Median Temperature (°C)	13.55
Maximum Temperature (°C)	24.12
Minimum Temperature (°C)	1.67
Standard Deviation (°C)	3.87
Total Measurements	46,896
Number of records exceeding 20˚C	929
MWAT (°C)	18.93

Table 3.10.1 – Summary statistics from continuous temperature monitoring of Spencer Creek.

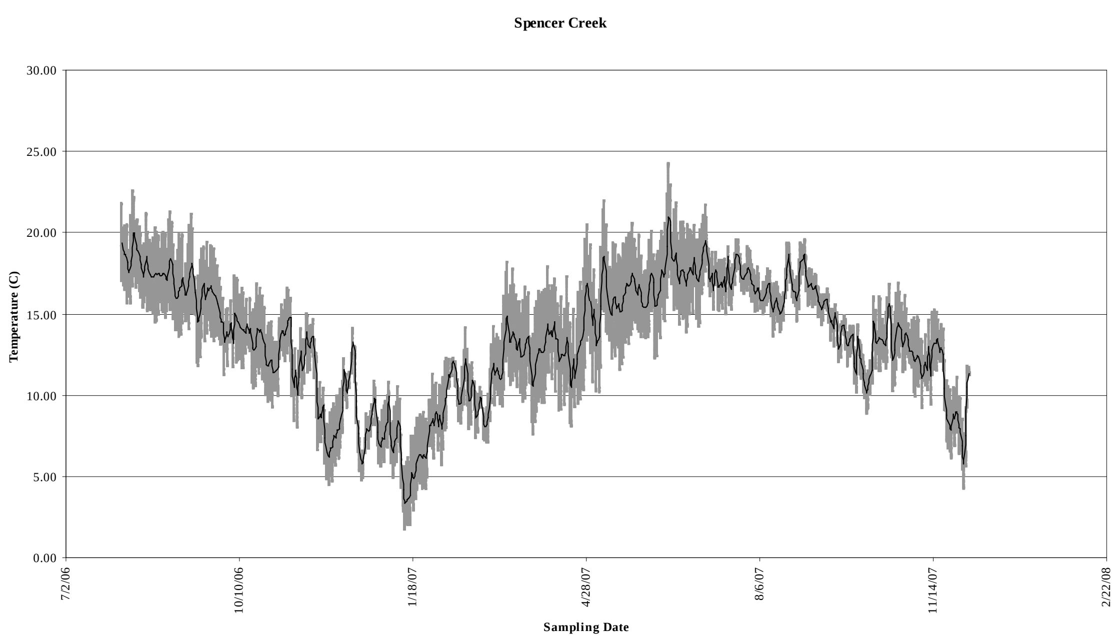


Figure 3.10.4 – Continuous water temperature data from Spencer Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.11 SUSCOL CREEK

Suscol Creek is a tributary to the Napa River, which flows to the Pacific Ocean via San Pablo Bay. Suscol Creek's location at the confluence with the Napa River is 38.239952° north latitude and 122.284806° west longitude, LLID number 1222856382395. Suscol Creek is a third order stream and has approximately 9.35 miles of blue line stream according to the USGS Mt. George, Cordelia, and Cuttings Wharf 7.5 minute quadrangle. Suscol Creek drains a watershed of approximately 3.22 square miles. Elevations range from sea level at the mouth of the creek to about 1,400 feet in the headwater areas. Grassland and vineyards dominate the watershed with areas of oak woodland. The watershed is mostly privately owned. Vehicle access exists via Devlin Rd., Soscol Creek Rd., and Soscol Ferry Rd.

HISTORICAL INFORMATION (Leidy et al., 2005)

In a 1949 letter, a landowner along Suscol Creek reported observing spawning steelhead in the winter and juveniles throughout the year (Berry 1949). The author noted perennial flows in the creek. In January 1955, DFG visually surveyed Suscol Creek in response to a proposed diversion for pasture irrigation. *Oncorhynchus mykiss* were observed and natural propagation was rated as “fair” (CDFG 1955).

In May 1973, DFG visually surveyed Suscol Creek from the mouth to the headwaters. Steelhead were observed throughout the stream, ranging in length from 25-205 mm, at estimated densities of 25-200 per 30 meters of stream (Reynolds 1973).

In January 1997, Leidy electrofished 30 meters of Suscol Creek between Devlin Road and highways 29/37. He caught eight *O. mykiss* ranging from 86–255 mm FL (Leidy 2002). The largest fish (178-255 mm) displayed smolt characteristics.

Ecotrust and FONR surveyed Suscol Creek between May and September 2002. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. *Oncorhynchus mykiss* were observed in six Suscol Creek reaches, with two reaches having density level “2” (Ecotrust and FONR 2002).

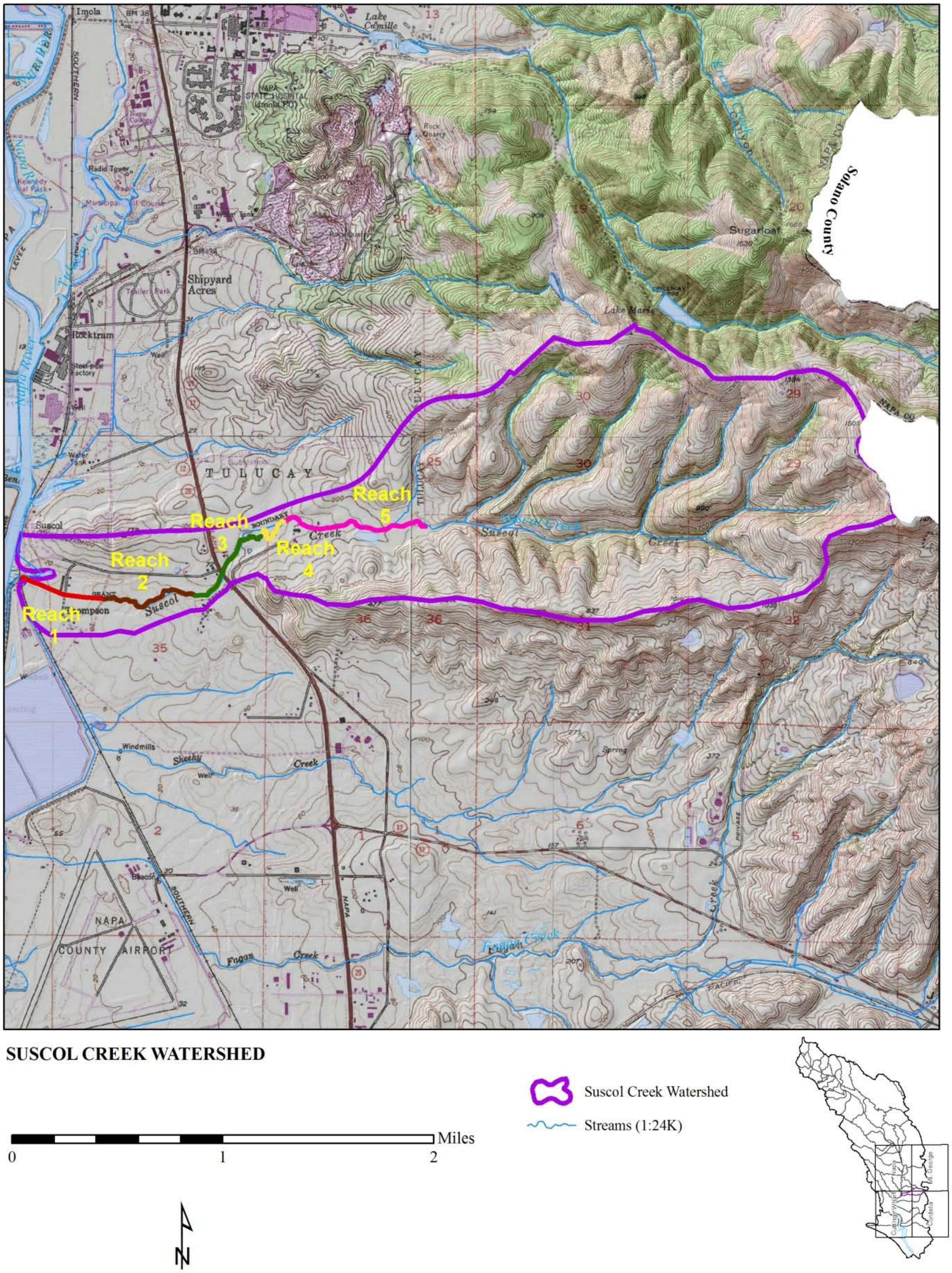


Figure 3.11.1 – Watershed map with habitat survey reaches.

<u>HABITAT</u>

All habitat typing result tables are located in Appendix C.

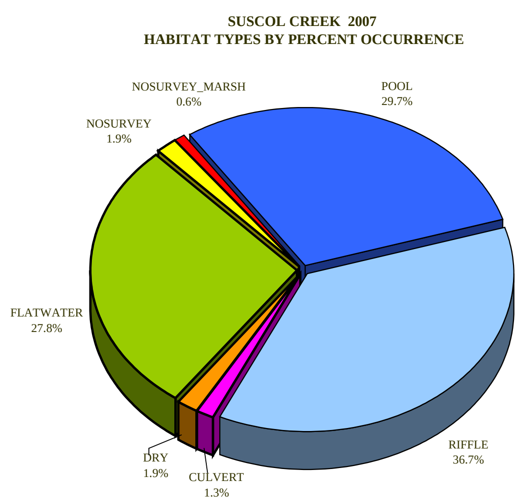
A stream inventory was conducted during 10/15/2007 to 10/22/2007 on Suscol Creek. The survey began just upstream of the confluence with the Napa River at the Napa County Sanitation District wastewater treatment plant and extended upstream 2.7 miles.

A total of reaches were designated during this survey:

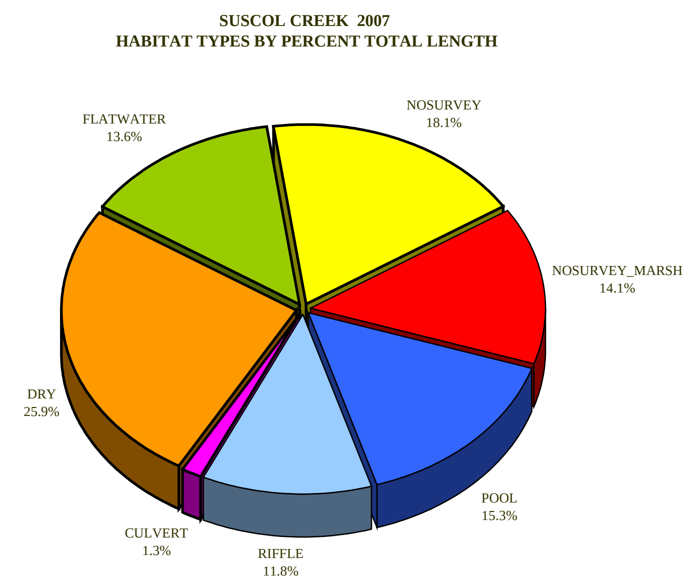
Reach 1	2,040 feet	F4 channel type.
Reach 2	2,848 feet	F4 channel type
Reach 3	4,674 feet	B4 channel type
Reach 4	780 feet	unknown channel type
Reach 5	4,095 feet	C2 channel type

F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. B4 channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios and gravel dominant substrates. C2 channels are meandering point-bar riffle/pool alluvial channels with broad well defined floodplain on low gradients and boulder dominant substrates.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 1% no-survey marsh units, 2% dry units, 28% flatwater units, 37% riffle units, 30% pool units, 1% culvert units, and 2% no-survey units (Graph 1). Based on total length of Level II habitat types there were 14% no-survey marsh units, 26% dry units, 14% flatwater units, 12% riffle units, 15% pool units, 1% culvert units, and 18% no-survey units (Graph 2).



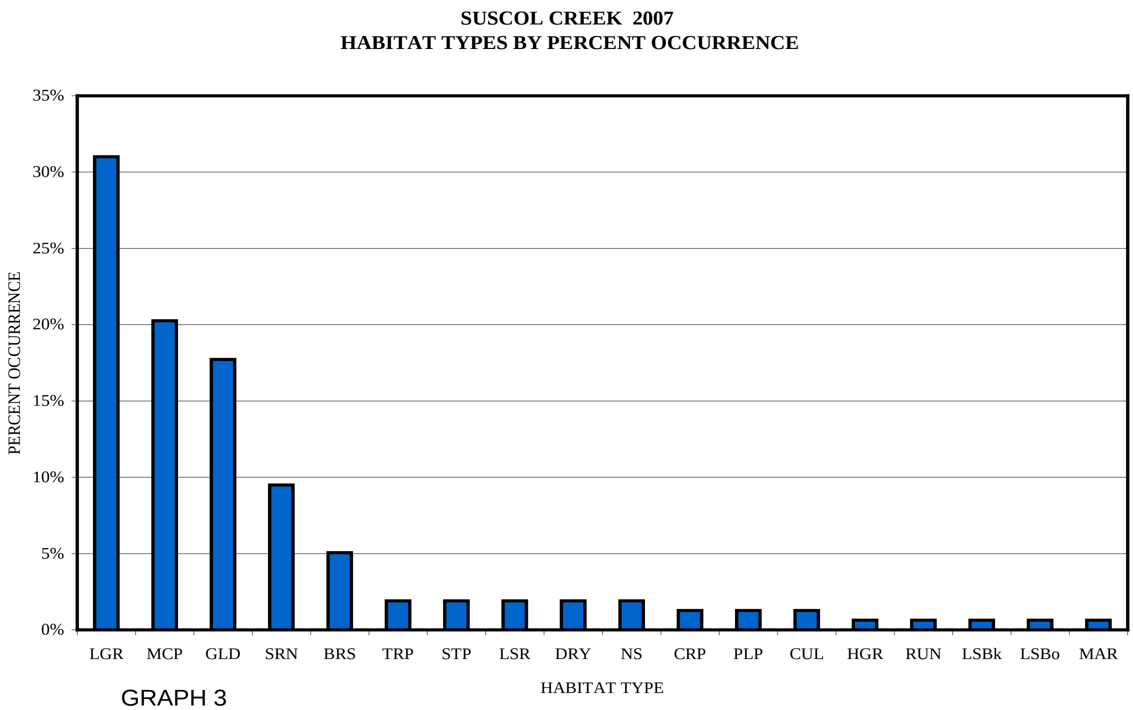
GRAPH 1



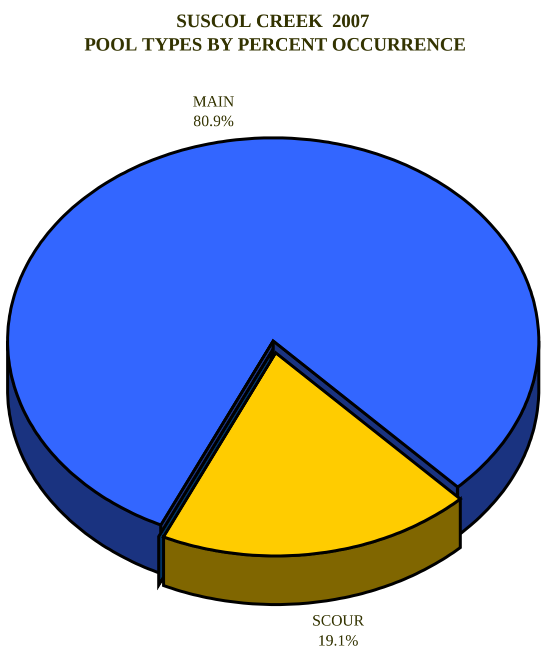
GRAPH 2

In total, 15 Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were; 31% low gradient riffle units, and 20% mid-channel pool units (Graph 3). Based on percent total length, the most frequent habitat types are as follows; 11% low gradient riffle units, and 10% mid-channel pool units.

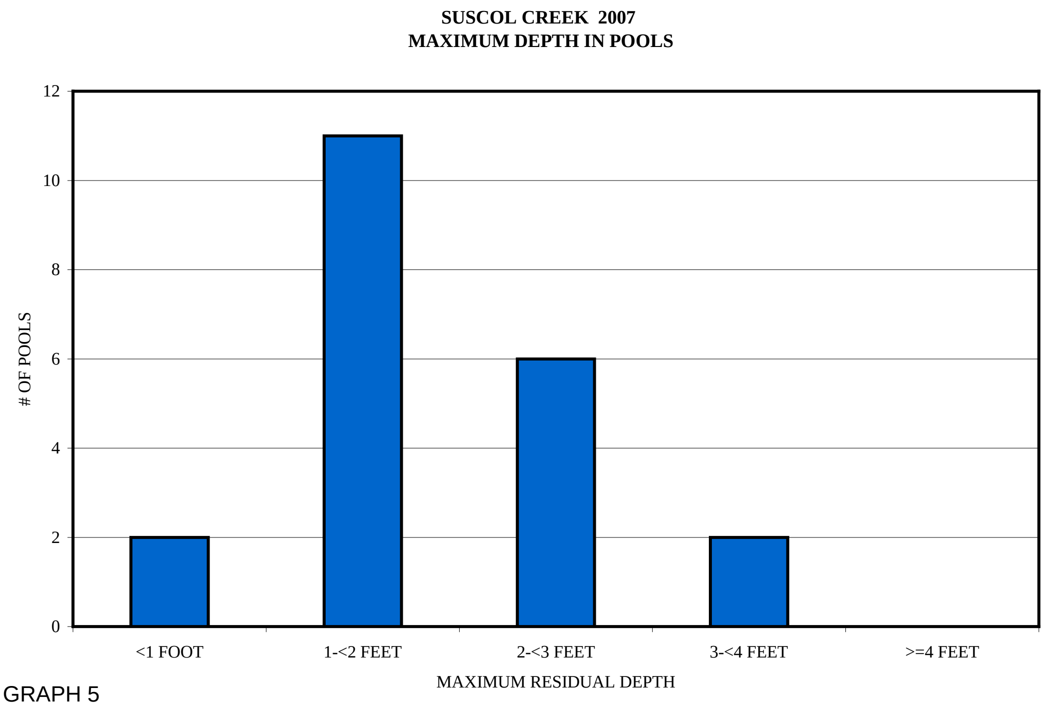
A total of 47 pools were identified (Table 3). Main channel pools were the most frequently encountered, at 81%, and comprised 86% of the total length of all pools (Graph 4). Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth, and 8 of the 21 pools (38%) had a residual depth of two feet or greater (Graph 5).



GRAPH 3



GRAPH 4



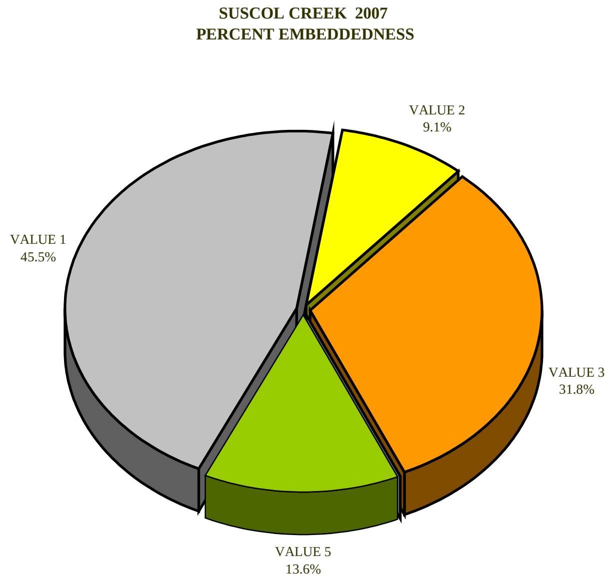
GRAPH 5

The pools are relatively shallow, with only 8 of the 21 (38%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In third order streams, a primary pool is defined to have a maximum residual depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 22 pool tail-outs measured, 10 had a value of 1 (45.5%); 2 had a value of 2 (9.1%); 7 had a value of 3 (31.8%); and 3 had a value of 5 (13.6%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

In total, 12 of the 22 pool tail-outs measured had embeddedness ratings of 1 or 2, and 7 of the pool tail-outs had embeddedness ratings of 3 or 4. Overall, 3 of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead.

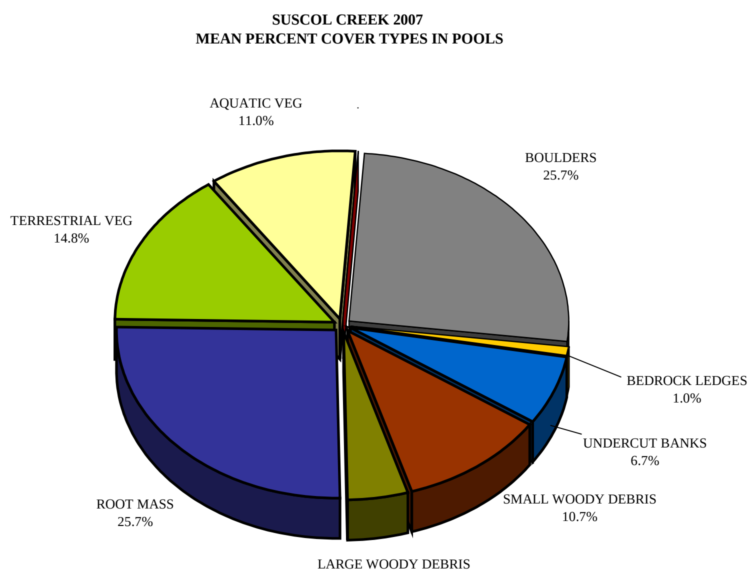
Sixteen of the 22 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.



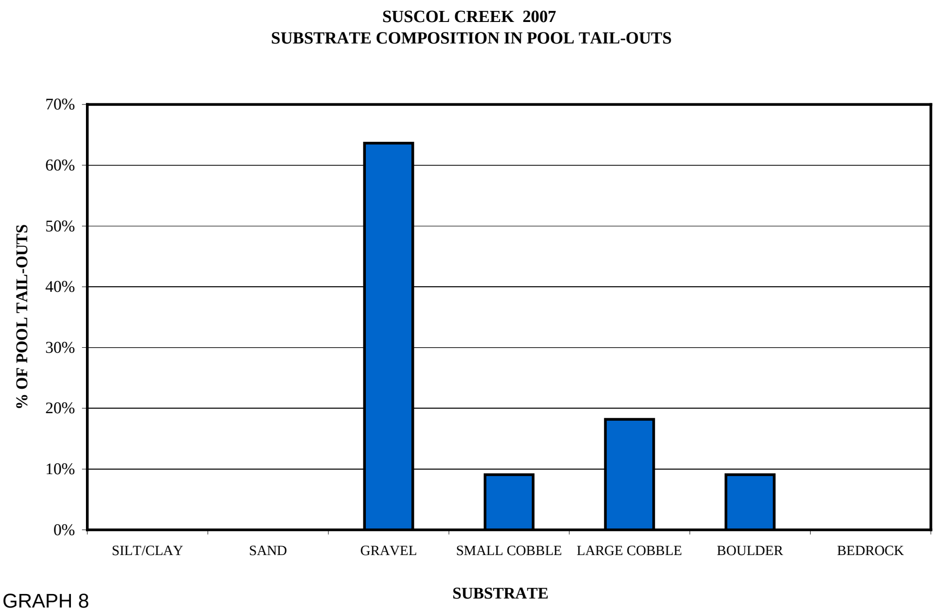
GRAPH 6

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 16, flatwater habitat types had a mean shelter rating of 27, and pool habitats had a mean shelter rating of 85 (Table 1). Of the pool types, the main channel pools had a mean shelter rating of 80, and scour pools had a mean shelter rating of 91 (Table 3).

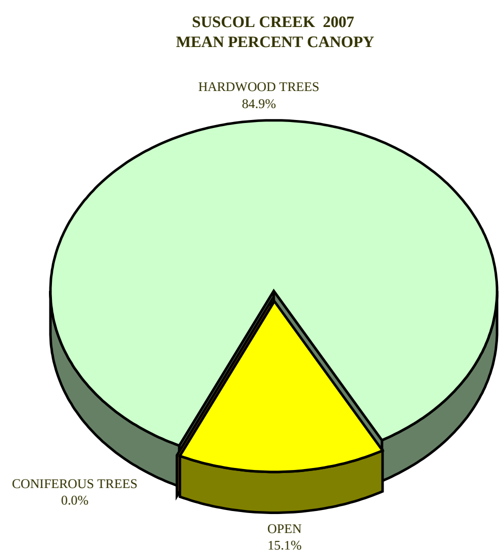
Table 5 summarizes mean percent cover by habitat type. Boulders and root mass were the dominant cover types in Suscol Creek (Graph 7).



GRAPH 7



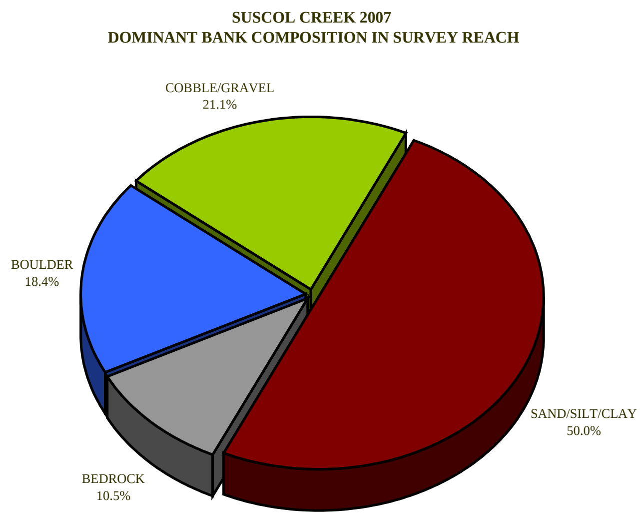
GRAPH 8



GRAPH 9

The mean percent canopy density for the surveyed length of Suscol Creek was 85%, and 15% of the canopy was open (Graph 9). Canopy density was not measured in Reaches 1, 2, or four because no suitable salmonid rearing habitat was documented in these reaches. Reach 3 had a canopy density of 85%, and Reach 5 had a canopy density of 85%. In general, revegetation projects are considered when canopy density is less than 80%.

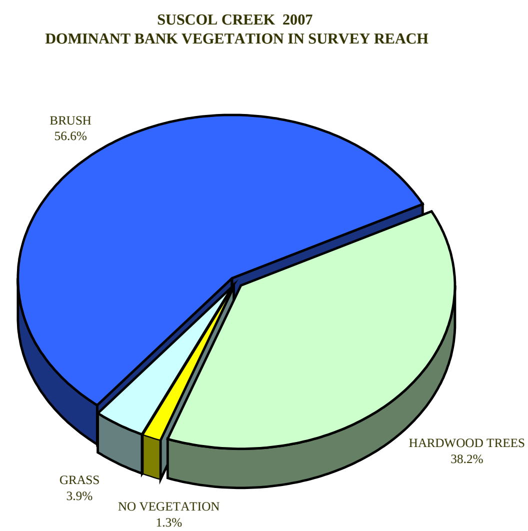
For the stream reach surveyed, the mean percent right bank vegetated was 76%, and the mean percent left bank vegetated was 74%. The dominant elements composing the structure of the stream banks consisted of 11% bedrock, 18% boulder, 21% cobble/gravel, and 50% sand/silt/clay (Graph 10). Brush was the dominant vegetation type observed in 57% of the units surveyed. Additionally, 38% of the units surveyed had deciduous trees as the dominant vegetation type, and 4% had grass as the dominant vegetation (Graph 11).



GRAPH 10

The mean shelter rating for pools was 85, and the shelter rating in the flatwater habitats was 27. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by Boulders in Suscol Creek. Boulders are the dominant cover type in pools followed by root mass.

The percentage of right and left bank covered with vegetation was high at 76% and 74%, respectively. However, in areas with stream bank erosion or where bank vegetation is sparse, planting native vegetation, in conjunction with bank stabilization, is recommended.



GRAPH 11

<u>SPAWNING GRAVEL PERMEABILITY</u>

A total of seven potential spawning sites were measured for gravel permeability (Figure 3.11.2). The predicted egg-to-emergence survival estimates ranged from 38% to 83%.

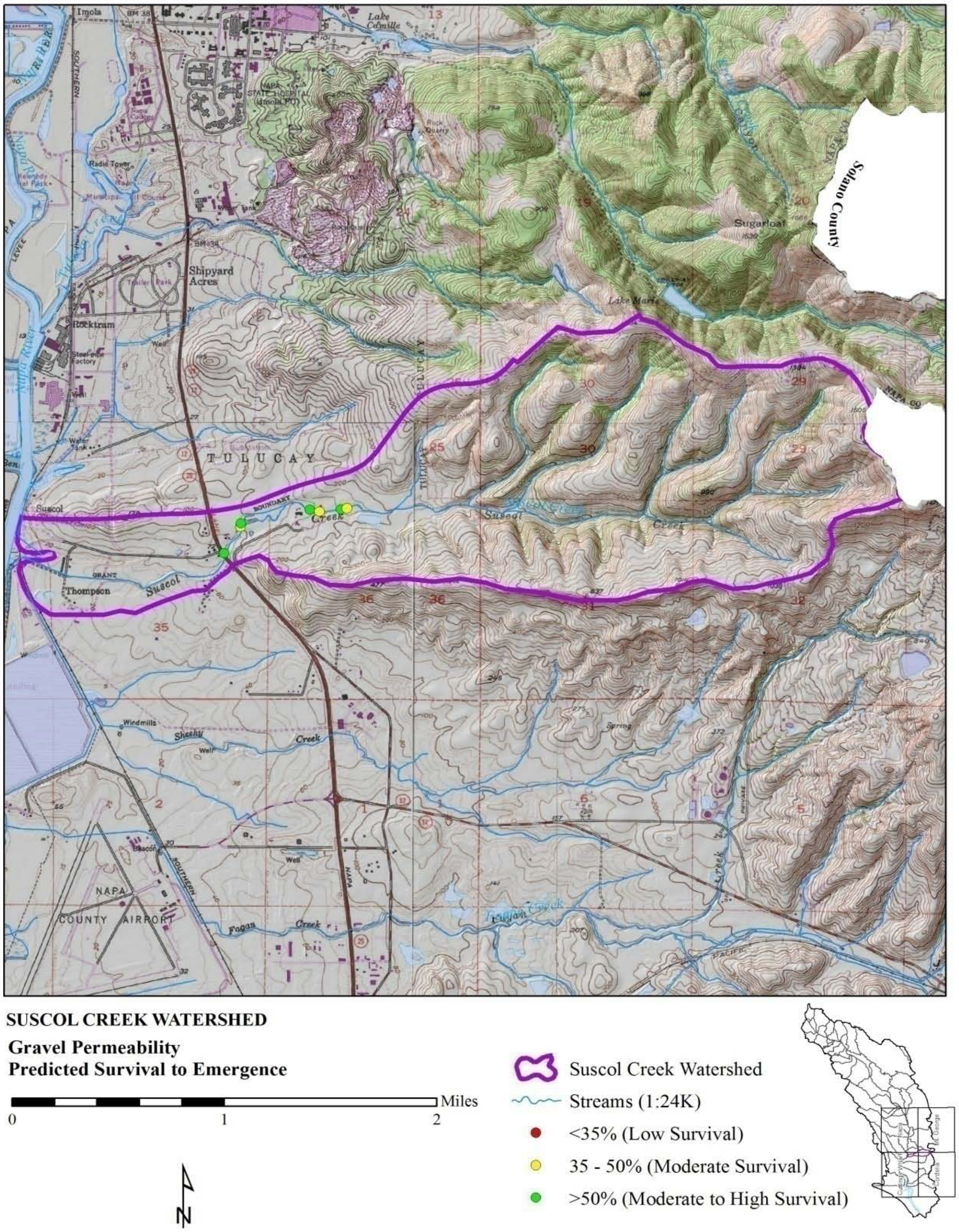


Figure 3.11.2 – Gravel permeability sites on Suscol Creek. Estimated survival values ranged from 38% to 83%.

MIGRATION BARRIERS

A total of five fish migration barriers were identified on Suscol Creek (Figure 3.11.3). All five were qualitatively ranked as "gray" according to DFG screening criteria, which means they are considered partial or low-flow barriers. The upper extent of anadromy could not be determined by our survey due to lack of landowner access in the uppermost reaches of Suscol Creek.

The first obstacle in Suscol Creek was the Highway 12/29 crossing. The site consists of a 181 foot long concrete box culvert. The site is expected to be a barrier to low flow passage due to excessive length and shallow sheet flow.

The second obstacle consists of an old dilapidated concrete dam structure built on a natural bedrock outcrop in the channel. The dam has a 3.2 foot square opening located approximately in the center of the dam face. Passage at low and moderate flows are likely difficult due to excessive water velocity through the outlet and the shallow cascade over bedrock leading up to the structure.

The third obstacle is a five foot high natural bedrock waterfall. The jump pool below this feature was very deep when surveyed and therefore likely allows passage at moderate to high flows. However, at low flows this site is a complete barrier to upstream migration.

The fourth obstacle is natural bedrock cascade. This feature is likely passable for adult steelhead at moderate and high flows, but at low flows it is too shallow and steep to pass. The feature is approximately 20 feet long and has a slope of over 10%.

The fifth obstacle is a small two-foot high bedrock cascade waterfall into a narrow trench pool. The site is a minor obstacle and is likely completely passable for adult steelhead at moderate flows. However, at low flows this site appears to completely prevent upstream juvenile passage and may prevent adult passage during extended dry periods during their migration window.

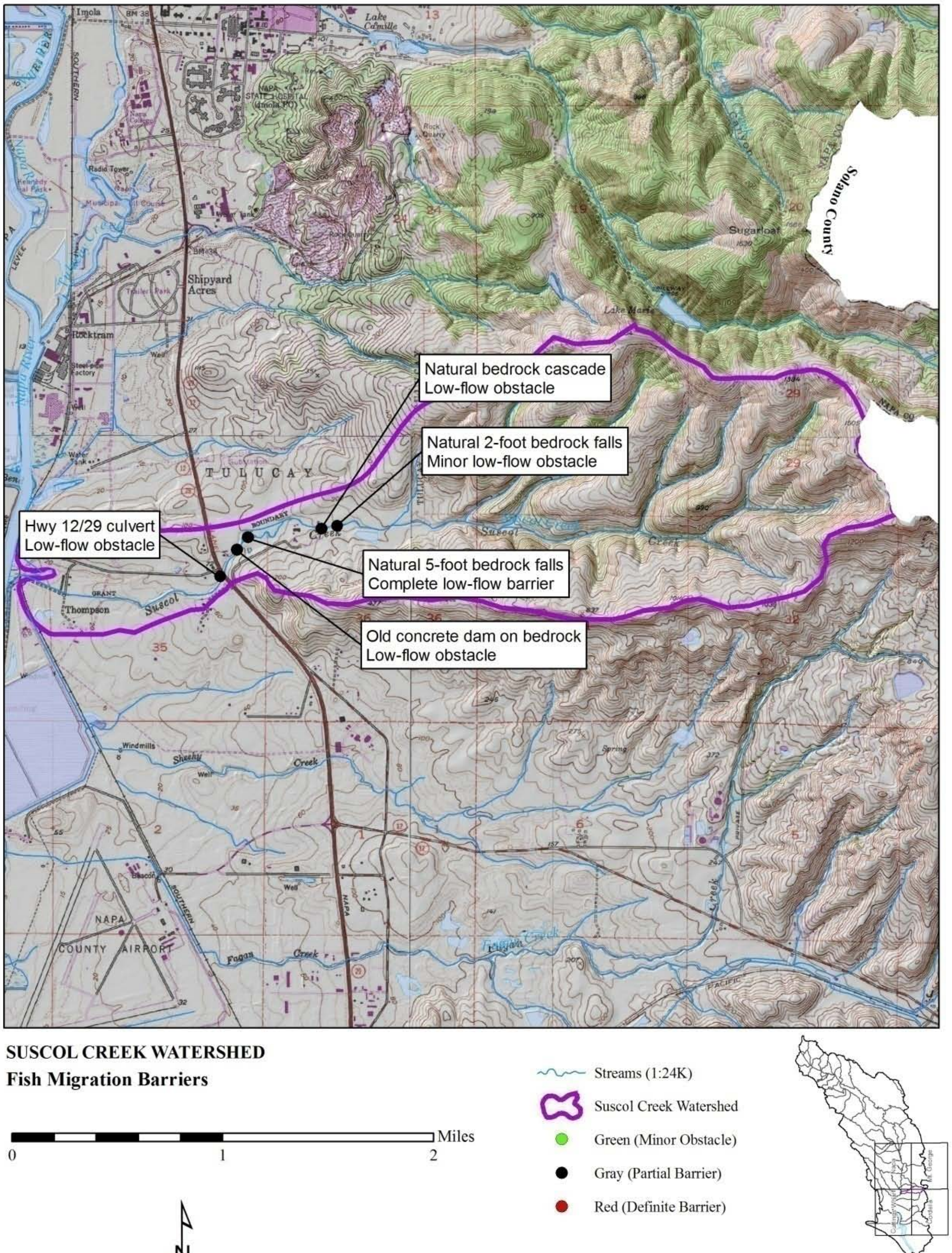


Figure 3.11.3 – Fish migration barrier sites on Suscol Creek

BIOLOGICAL SURVEYS/ OBSERVATIONS

Juvenile steelhead were observed in Suscol Creek in moderate to high abundances in reaches 3 and 5. A few juvenile steelhead were observed in upper reach 2, but water quantity and quality were generally lacking to support rearing throughout much of this reach.

No direct evidence of adult steelhead or salmon spawning (e.g. redds, carcasses, etc) was observed during field surveys. However, no adult or juvenile surveys (e.g. spawner surveys or snorkel counts) were conducted for Suscol Creek as part of this study.

WATER QUANTITY

Streamflow was visually estimated at approximately 0.5 cfs during the habitat survey upstream of reach 2. Reach begins as a tidally influenced slough which appears to remain inundated during all tides. Above the zone of tidal influence, there was no surface flow or standing water in reach 1 during our survey. The upper section of reach 2 had a few isolated, stagnant pools. Low summer baseflow (approximately 0.1 - 0.3 cfs) was present beginning near Soscol Ferry Road and throughout reach 3. Reach 4 was completely dry. Reach 5 had a flow of approximately 0.5 cfs.

There are a total of three appropriative water rights on record for the Suscol Creek watershed (Figure 4.1.1).

WATER TEMPERATURE

A continuous temperature logger was placed in Suscol Creek in at the top of reach 2 just downstream of Highway 29. The logger was located in a perennial bedrock pool and was set to record water temperature every 15 minutes. The logger sampled continuously from 8/4/2006 – 12/3/2007. Results are shown in Table 3.11.1 and Figure 3.11.4.

Mean Temperature (°C)	13.28
Median Temperature (°C)	13.43
Maximum Temperature (°C)	19.06
Minimum Temperature (°C)	5.15
Standard Deviation (°C)	2.83
Total Measurements	46,713
Number of records exceeding 20˚C	0
MWAT (°C)	18.11

Table 3.11.1 – Summary statistics from continuous temperature monitoring of Suscol Creek.

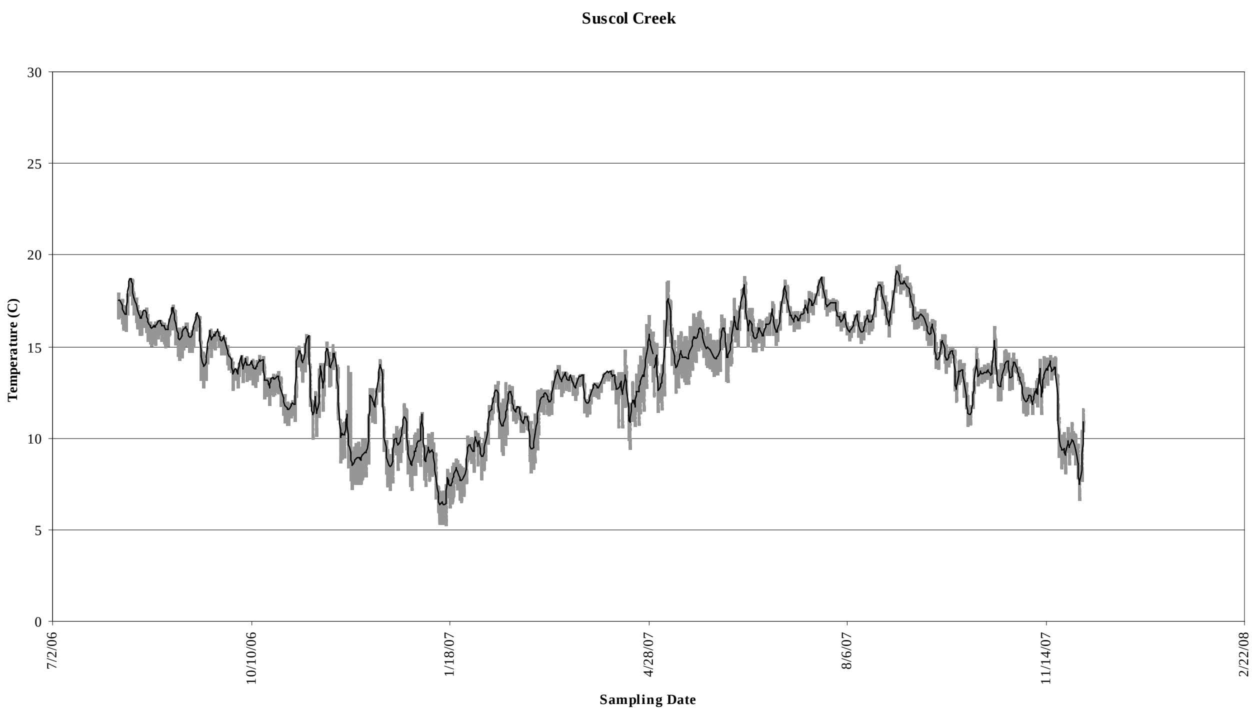


Figure 3.11.4 – Continuous water temperature data from Suscol Creek. The black line represents the daily average temperature, and the gray line represents daily range.

3.12 TULUCAY CREEK

Tulucay Creek is a tributary to the Napa River, which flows to the Pacific Ocean via San Pablo Bay. The creek joins the Napa River approximately 0.5 miles north of Imola Avenue in a constructed flood channel located at 38.286323° north latitude and 122.282413 west longitude. The extreme lower reaches of Tulucay Creek, downstream of Imola Avenue, receive tidal influence.

The Tulucay watershed covers an area of approximately 12.77 square miles and is comprised of seven major sub-basins, including five named tributary streams and the two branches of Tulucay Creek (Figure 3.12.1). The five tributaries are Camille Creek (also called Marie Creek), Kreuse Creek, Spencer Creek, Murphy Creek, and Witweather Creek. Following is a summary of habitat conditions in each stream.

Camille Creek- RCD conducted a reconnaissance survey of the channel on 9/12/2008 beginning at the confluence with Tulucay Creek and extending upstream to the end of anadromy at a natural 15-foot high bedrock waterfall. The channel was completely dry for most of its length. One short section of perennial rearing habitat was found with juvenile *O. mykiss* (approximately 70-100 mm long) present in several pools. This perennial reach is located immediately above Lake Camille near Skyline Park and is approximately 2,000 feet in length. Both Lake Camille and the adjacent Lake Louise are situated off-channel and therefore do not hinder fish passage.

The entire length of Camille Creek downstream of Lake Camille was highly degraded during our survey and was characterized by heavy overgrowth of exotic vegetation (primarily Himalayan blackberry) as well as visible dumping and bank modifications. The lower reaches below Lake Camille provide no rearing or spawning value for salmonids, but may function as a migration corridor if anadromous *O. mykiss* use this stream for spawning. The Terrace Avenue concrete box culvert is a complete low flow fish barrier. The structure is likely passable at higher winter flows, but a more complete assessment is needed.

Witweather Creek- The entire channel goes completely dry by late spring and does not appear to support salmonids.

Kreuse Creek – Lower channel goes completely dry by late spring. No water was found by RCD during reconnaissance surveys in June 2007 or May 2008. The RCD was unable to acquire landowner permission to assess the headwaters area of this stream, so the quality or quantity of habitat above Fourth Avenue is unknown. An instream reservoir is visible in aerial photos just upstream of the Fourth Ave road crossing, which appears to be a complete impediment to fish passage.

Murphy Creek – This perennial stream supports steelhead and is covered separately in section 3.4 of this report.

Spencer Creek – Spencer Creek contains a very short length of steelhead rearing habitat and is covered separately in section 3.10 of this report.

<u>HISTORICAL INFORMATION</u> (Leidy et al., 2005)

In November 1958, DFG surveyed points accessible by car on Tulucay Creek from the mouth to its headwaters. *Oncorhynchus mykiss* averaging 75-100 mm in length were noted but generally were scarce (Elwell 1958o). The report noted that Tulucay Creek supported nursery areas in the mid-section of the drainage adequate to sustain a population of trout (Elwell 1958f).

In June 1981, DFG visually surveyed Tulucay Creek from the mouth to the Green Valley Road crossing for the purpose of rescuing fish stranded by low flows. Several *O. mykiss* 75-200 mm were observed in perennial pools of the upper reach (Harris and Ambrosins 1981f). The Green Valley Road crossing was identified as a passage barrier.

In July 1992, DFG electrofished four Tulucay Creek sites downstream of the confluence with Murphy Creek. A pool at the Fourth Avenue Bridge contained one *O. mykiss* (240 mm FL) (Emig 1992a). The survey report noted that the population probably had been reduced because of low flows resulting from the lack of bypass requirements for upstream diversions (Emig 1992a).

Ecotrust and FONR carried out surveys in tributaries of the Napa River system in July and August 2001. Relative density of steelhead was noted between 1 and 3, with 3 indicating greater than one individual per square meter. One reach of Tulucay Creek was found to have *O. mykiss* at density level “1” (Ecotrust and FONR 2001).

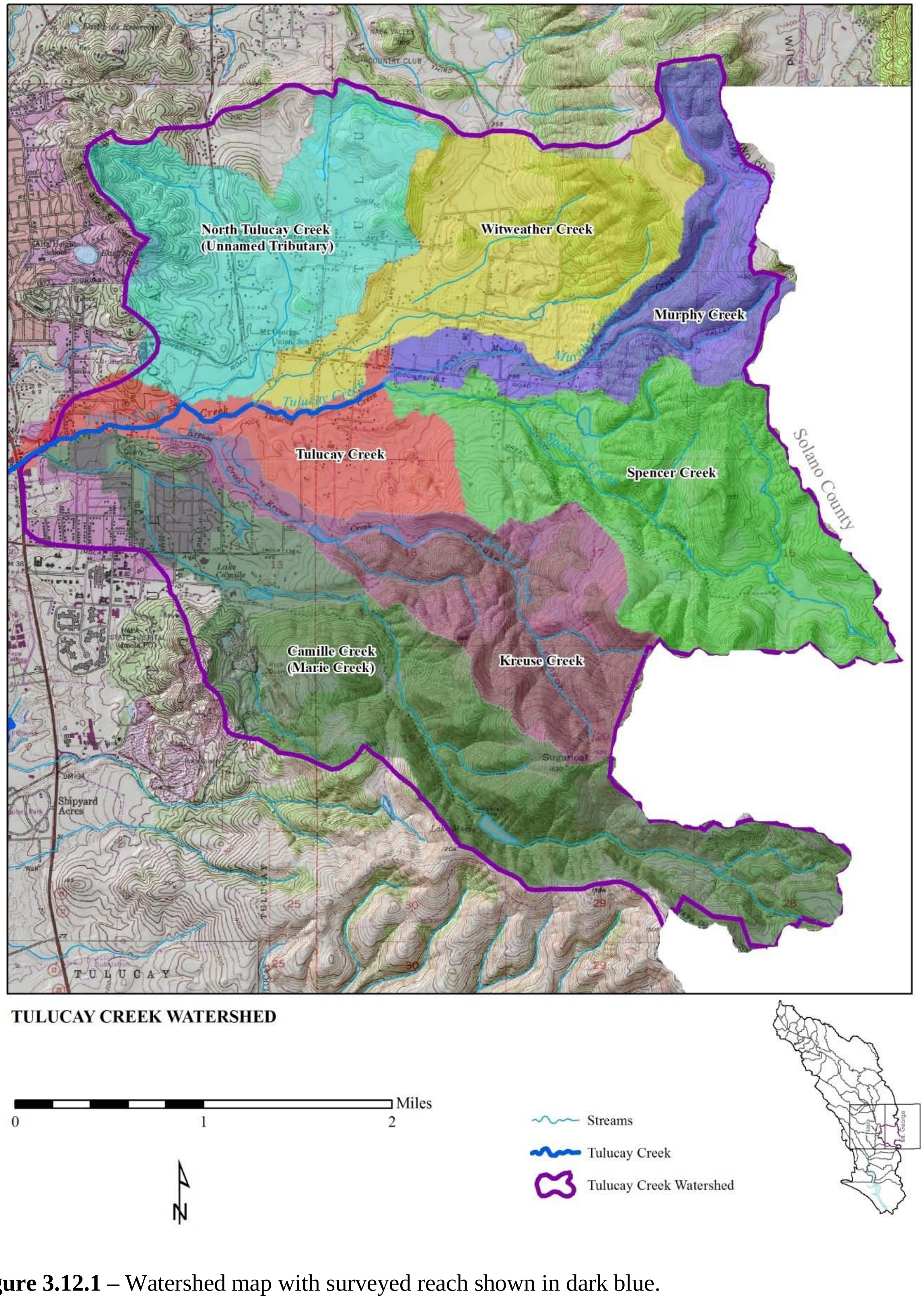


Figure 3.12.1 – Watershed map with surveyed reach shown in dark blue.

HABITAT

RCD staff walked Tulucay Creek on 9/11/2007 and 9/12/2007 beginning at the confluence with the Napa River and extending upstream to the junction of Spencer and Murphy Creeks. No suitable salmonid rearing habitat was found during this survey of approximately 11,500 feet (2.18 miles) of channel. The lower reaches contained a few isolated stagnant ponds with stained water and heavy aquatic plant growth. Tulucay Creek was completely dry upstream of Shurtleff Avenue with the exception of a few small puddles in the stream bed.

SPAWNING GRAVEL PERMEABILITY

A total of 6 potential spawning sites were measured for gravel permeability (Figure 3.12.2). The predicted egg-to-emergence survival estimates ranged from 26% to 66%.

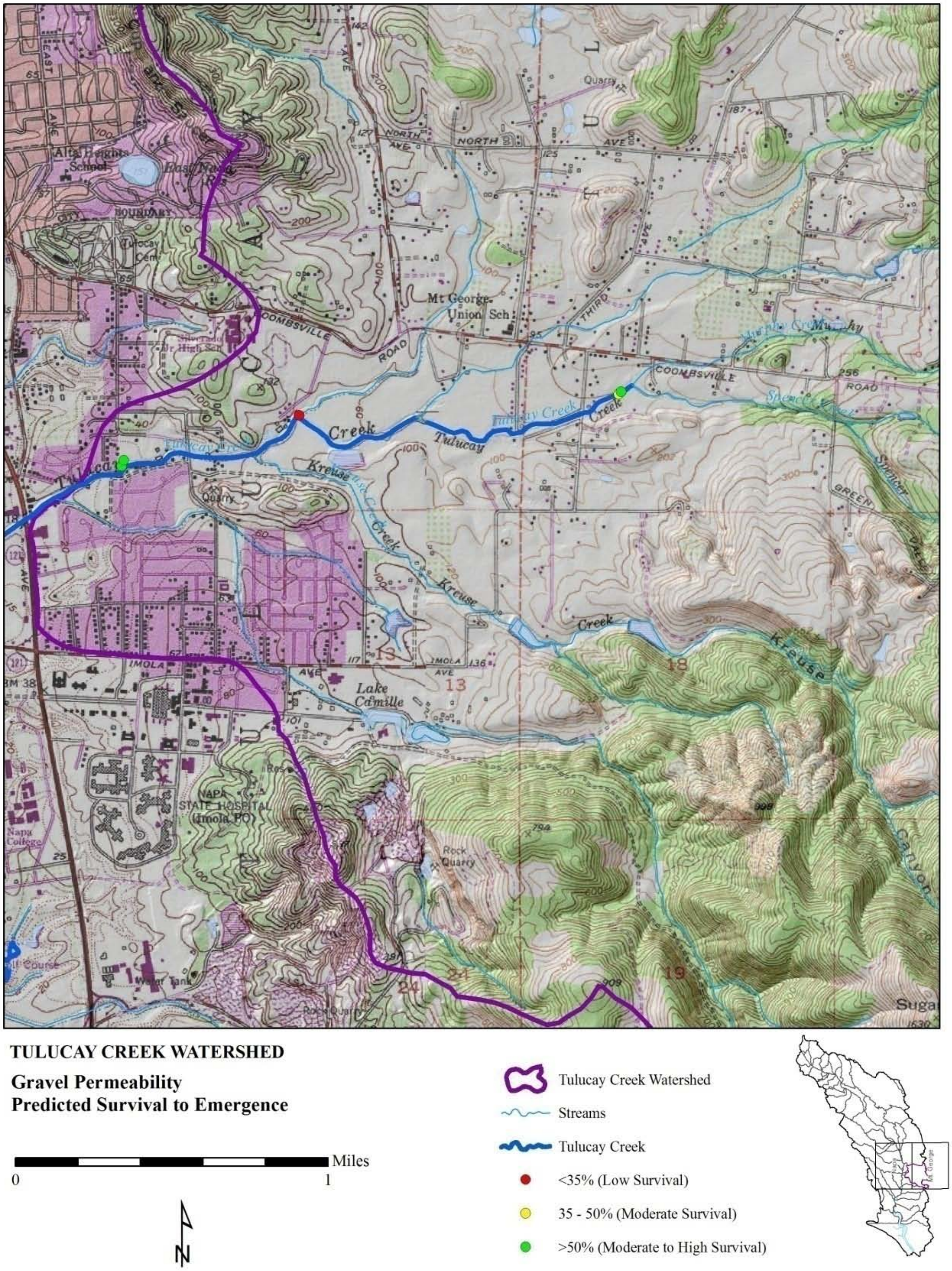


Figure 3.12.2 – Gravel permeability sites on Tulucay Creek. Estimated survival values ranged from 26% to 66%.

MIGRATION BARRIERS

No fish migration barriers were found on Tulucay Creek.

BIOLOGICAL SURVEYS/ OBSERVATIONS

No salmonids were observed in Tulucay Creek during our surveys.

In spring 2007 and 2008, the RCD biologist observed spawning congregations of Sacramento splittail in lower Tulucay Creek near Terrace Avenue. During both site visits, approximately twenty adult splittails were seen spawning and holding in deep pools. Lower Tulucay Creek contains favorable habitat for splittail spawning with a low gradient channel morphology, abundant streamside and aquatic vegetation, and generally fine substrate (Moyle 2002).

WATER QUANTITY

Streamflow was limited in all streams of the Tulucay watershed with the exception of Murphy Creek and a short section of Spencer Creek, which both contained perennial flow. Tulucay, Kreuse, Witweather, Camille, and most of Spencer Creek all go dry early in the year and do not appear to have a significant source of groundwater to maintain suitably cold isolated pools for salmonid rearing.

WATER TEMPERATURE

Continuous temperature monitoring was conducted for Tulucay Creek near Terrace Ave. The original pool went nearly dry and the logger was moved downstream approximately 200 feet to another pool on 6/17/2007. Although both pools remained favorably cool during the monitoring period, water quality was generally poor through the summer months once flow stopped in spring. Therefore, these pools were not considered suitable for summer rearing. The logger was in place from 8/4/2006 through 12/4/2007 and recorded temperature every 15 minutes.

Mean Temperature (°C)	14.34
Median Temperature (°C)	14.82
Maximum Temperature (°C)	18.87
Minimum Temperature (°C)	7.22
Standard Deviation (°C)	2.45
Total Measurements	46,760
Number of records exceeding 20˚C	0
MWAT (°C)	17.64

Table 3.12.1 – Summary statistics from continuous temperature monitoring of Tulucay Creek. Note: statistics exclude data from 6/17/2007 when the logger was moved downstream.

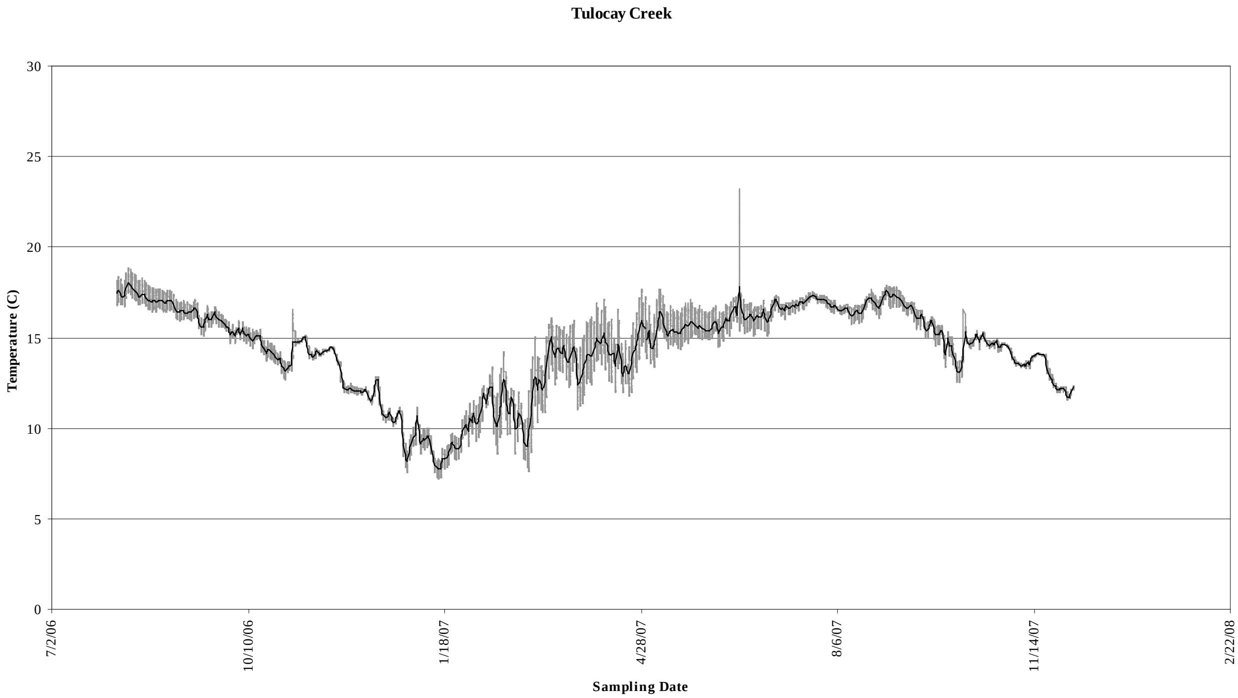


Figure 3.12.4 – Continuous water temperature data from Tulucay Creek. The black line represents the daily average temperature, and the gray line represents daily range. Note- the data logger was moved on 6/17/2007.

4 MONITORING RESULTS

This section summarizes results from ongoing water quality and streamflow monitoring in the study area as a whole. Stream reports in section 3.0 contain specific information for each surveyed reach.

4.1 STREAMFLOW

A total of 251 streamflow observations were made at 12 stations within the study area (Table 4.1.1).

Stream	Description	Code	Latitude	Longitude	Start Date	End Date	# Samples Collected
Browns Valley	Browns Valley Rd	BV4	38.30429	-122.32061	6/14/2006	1/16/2008	17
Huichica	DFG Bridge	HCH1	38.22065	-122.35376	1/8/2006	1/16/2008	10
Huichica	Vineyard Bridge	HCH4	38.26413	-122.37899	7/26/2006	1/16/2008	13
Milliken	Hedgeside Bridge	ML1	38.33837	-122.26936	6/14/2006	2/28/2008	39
Murphy	Shady Brook Ln	MUR5	38.29386	-122.22026	5/17/2006	1/16/2008	24
Pickle	Mt. Veeder Rd	PCK1	38.33421	-122.37197	7/26/2006	1/16/2008	15
Redwood	Redwood Rd	RED5	38.31603	-122.34312	7/25/2006	1/16/2008	21
Spencer	Green Valley Rd	SPC1	38.29126	-122.22756	7/20/2006	1/16/2008	15
Sarco	Vichy Ave.	SRC1	38.33175	-122.25298	1/8/2007	1/16/2008	7
Suscol	Devlin Rd	SUS1	38.23937	-122.26817	7/26/2006	2/25/2008	35
Salvador	Big Ranch Rd	SV5	38.32819	-122.28983	7/25/2006	2/28/2008	29
Tulucay	South Terrace Rd	TUL1	38.28857	-122.26899	3/1/2006	2/10/2008	26

Table 4.1.1. Streamflow sampling locations and duration.

Results of ongoing streamflow monitoring are shown in Figures 4.1.2 through 4.1.12. Specific flow conditions are discussed for individual streams in section 3 of this report.

Appropriative water rights data were obtained from the eWRIMS Database System through the State Water Resources Control Board (Figure 4.1.1). A total of 121 active and pending sites were documented within the study watersheds. In addition, all streamside residents maintain riparian water rights, which allow them to withdraw water for immediate use (no storage). The Huichica Creek watershed had the highest number of appropriative rights on record with 41; however, Figure 4.1.1 shows very dense water use throughout the Carneros watershed as well.

Carneros Creek and Redwood Creek were targeted by the RCD during a study of streamflow, water use, and fish habitat known as *Water for Fish and Farms*. Using our extensive habitat data and baseline information, this project aimed to model various water use scenarios and explore alternative withdrawal practices that would benefit steelhead. Funding for this project was halted in late 2008, which limited outreach efforts to educate water users about timing and quantity of withdrawals. As a result of this project, four new telemetric streamgage were installed in the study area and real-time flow data are accessible online or by phone.

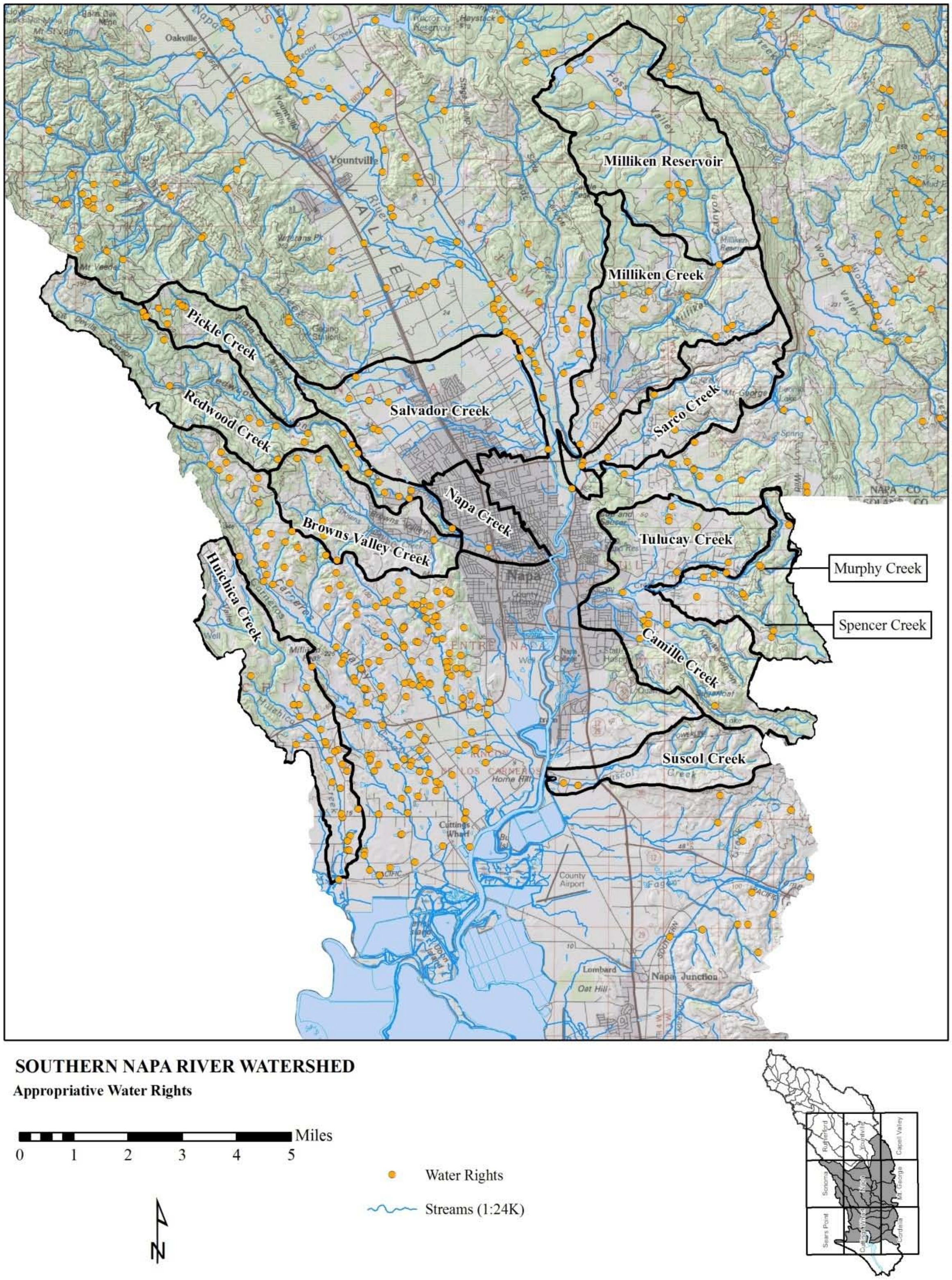


Figure 4.1.1. Current water rights within the project study area. (Source: State Water Resources Control Board, Division of Water Rights 2008)

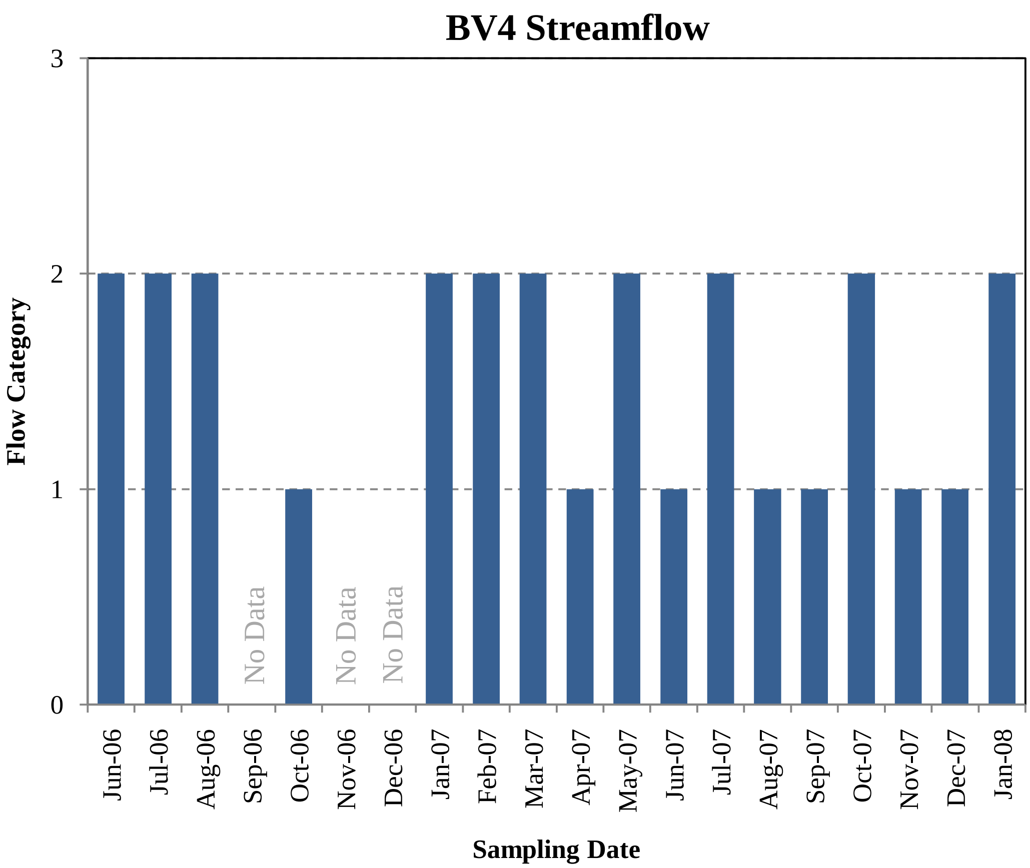


Figure 4.1.2. Streamflow record for station BV4 on Browns Valley Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of BV4.

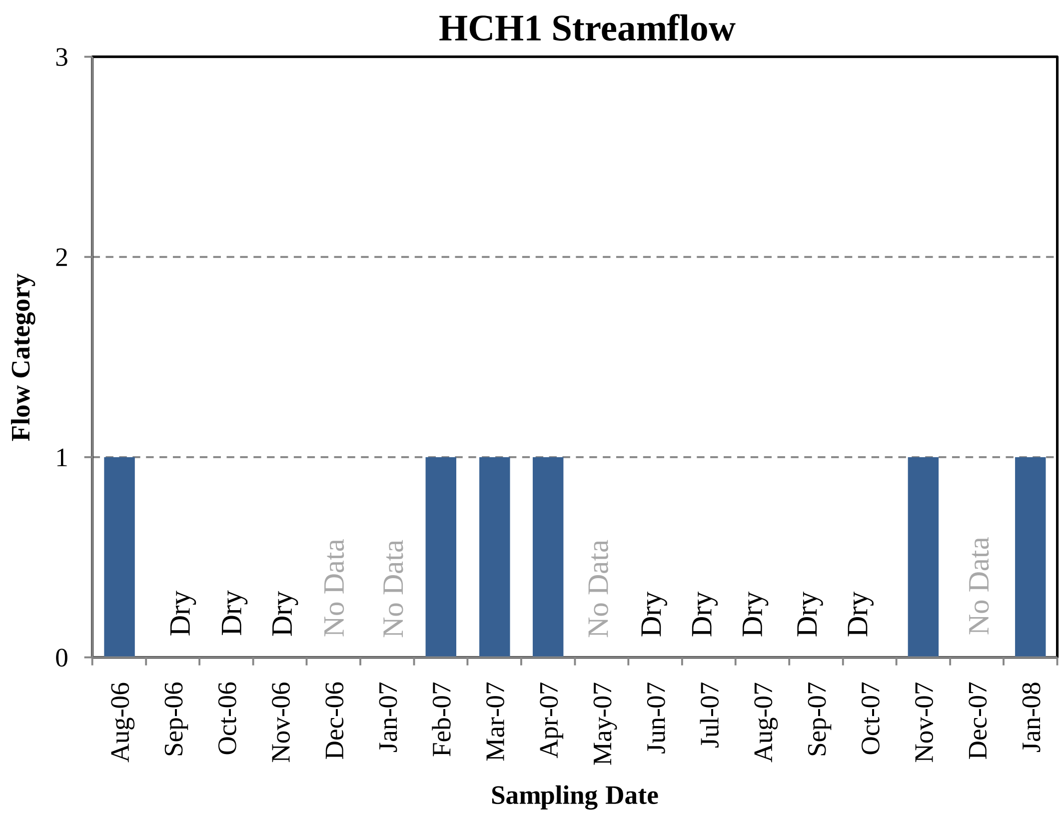


Figure 4.1.3. Streamflow record for station HCH1 on lower Huichica Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

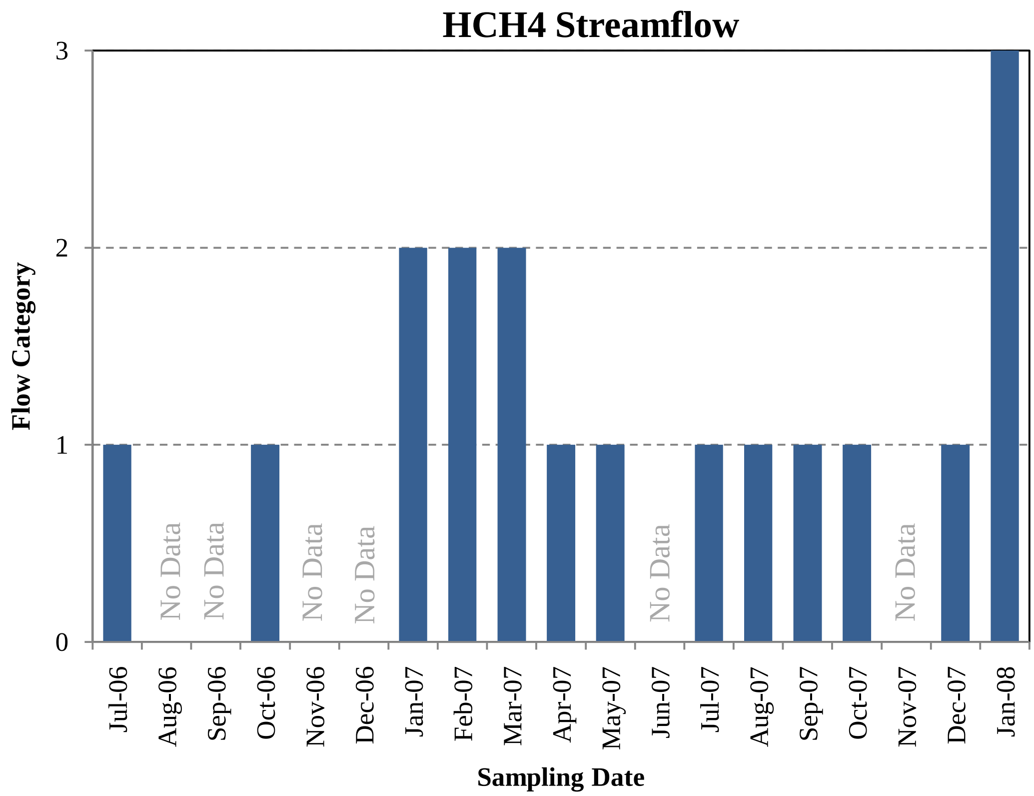


Figure 4.1.4. Streamflow record for station HCH4 on upper Huichica Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of HCH4.

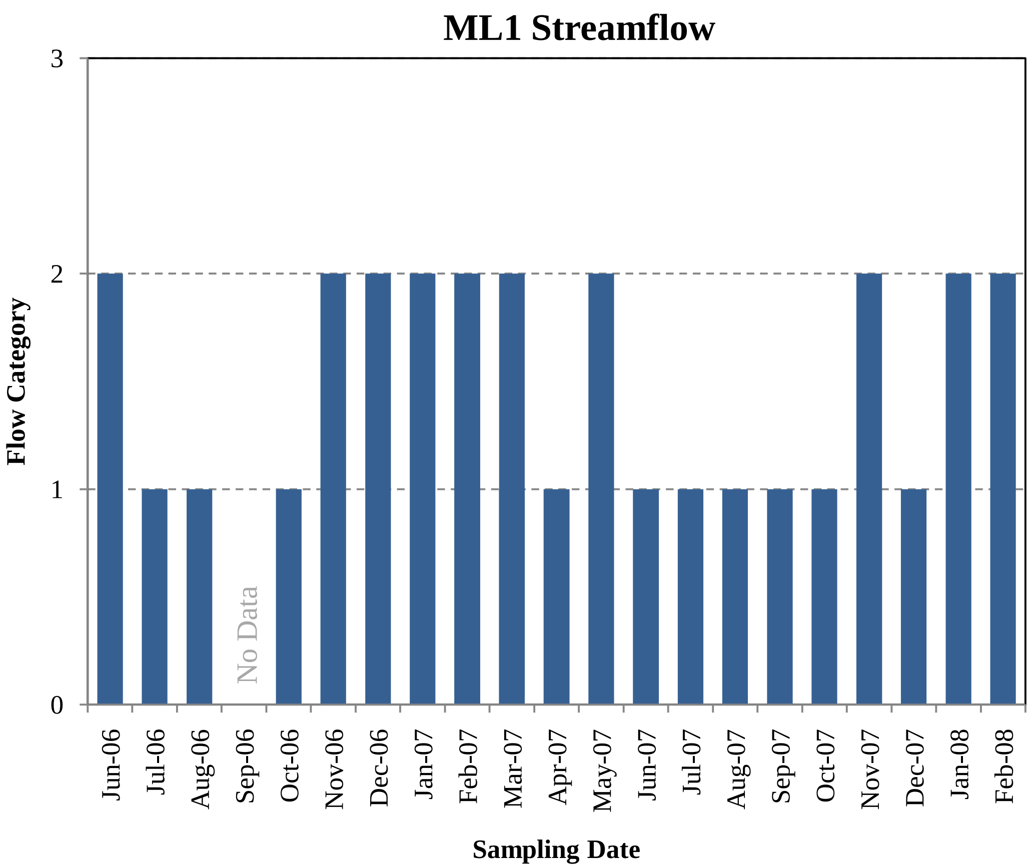


Figure 4.1.5. Streamflow record for station ML1 on Milliken Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of ML1.

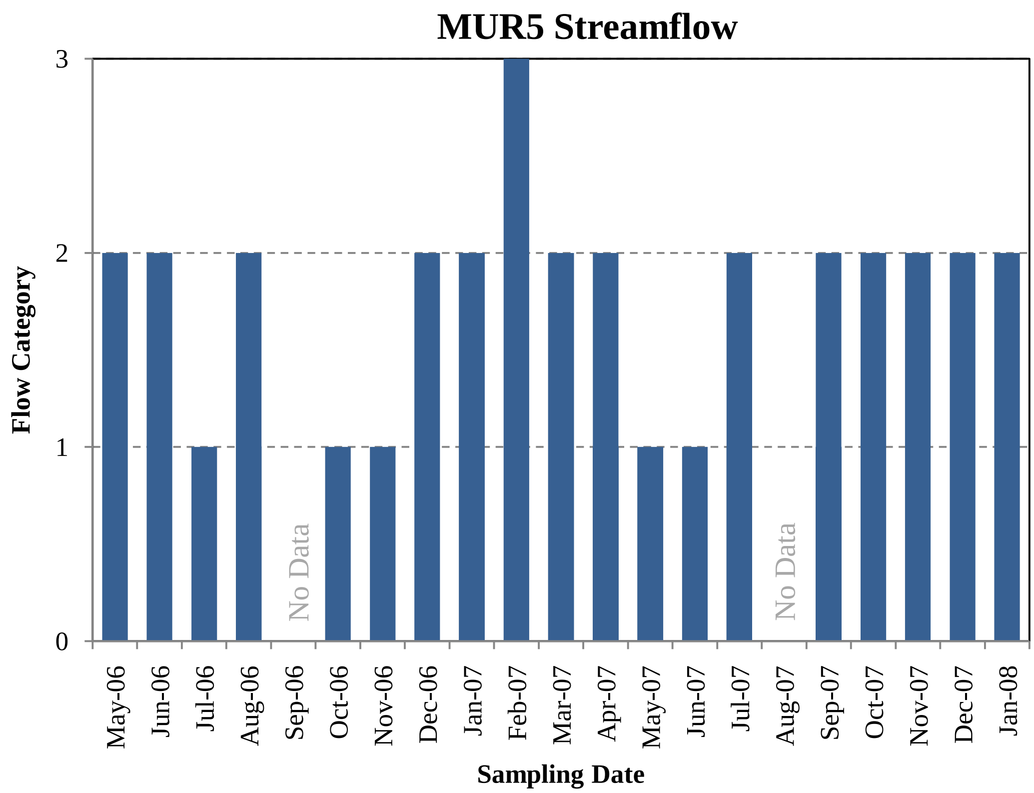


Figure 4.1.6. Streamflow record for station MUR5 on Murphy Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of MUR5.

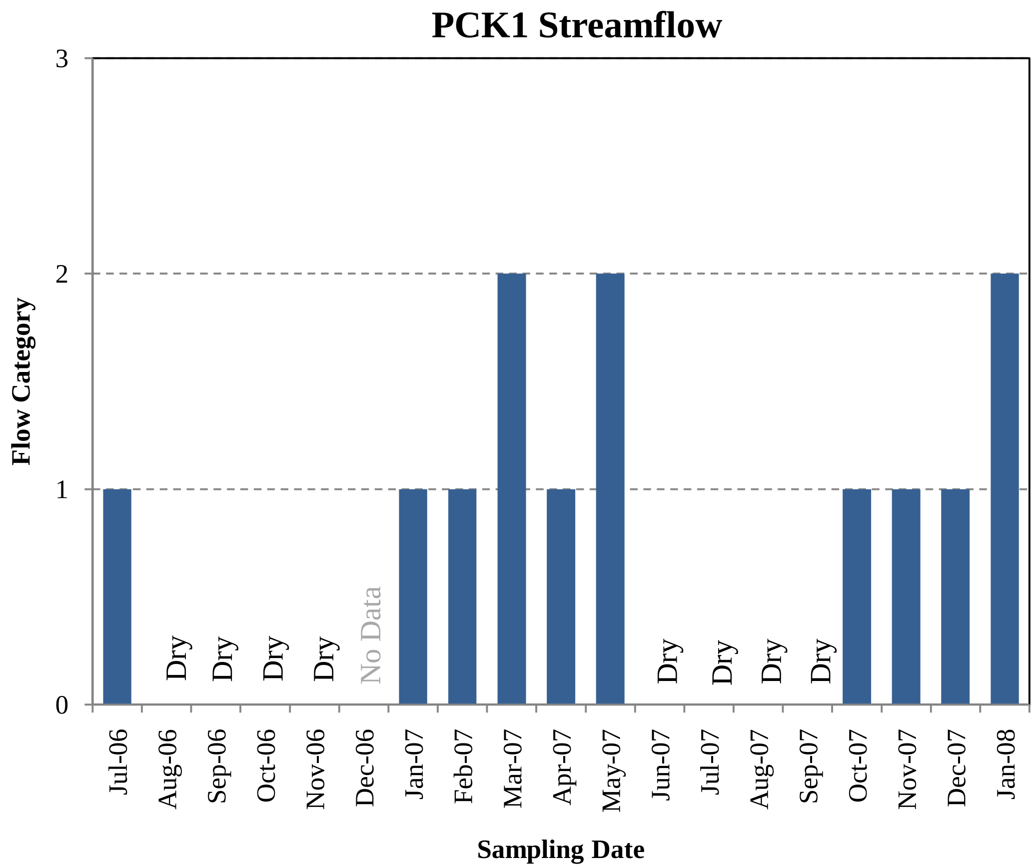


Figure 4.1.7. Streamflow record for station PCK1 on Pickle Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of PCK1

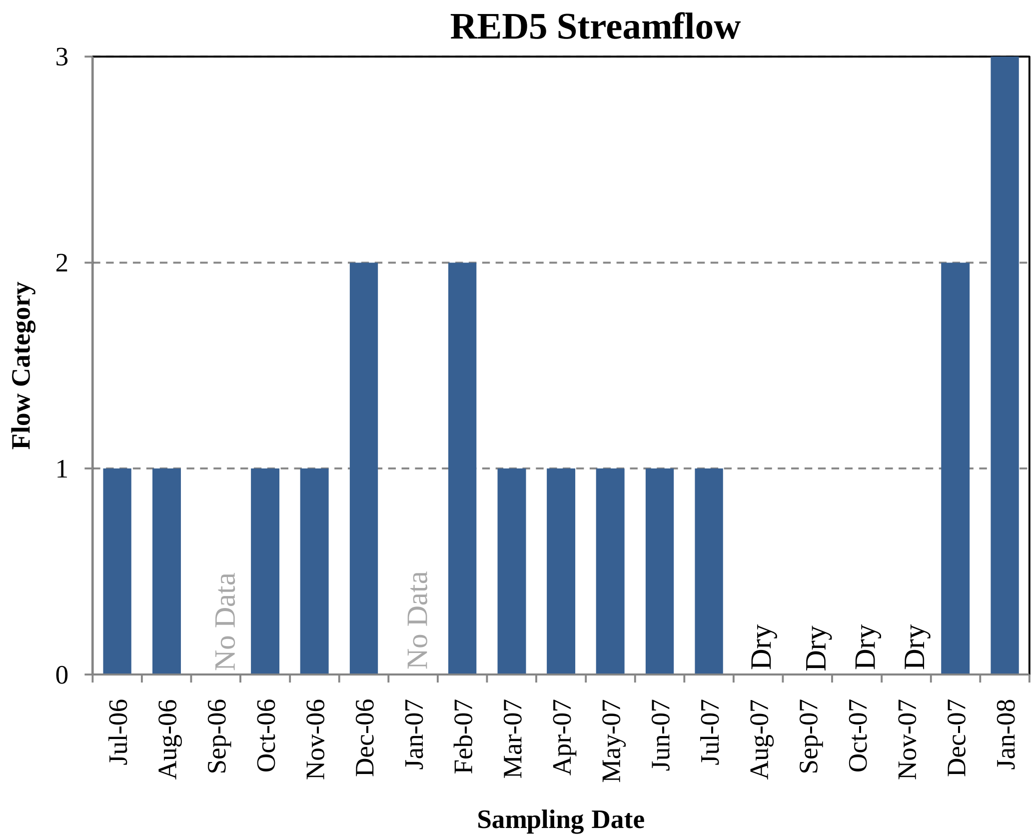


Figure 4.1.8. Streamflow record for station RED5 on Redwood Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of RED5

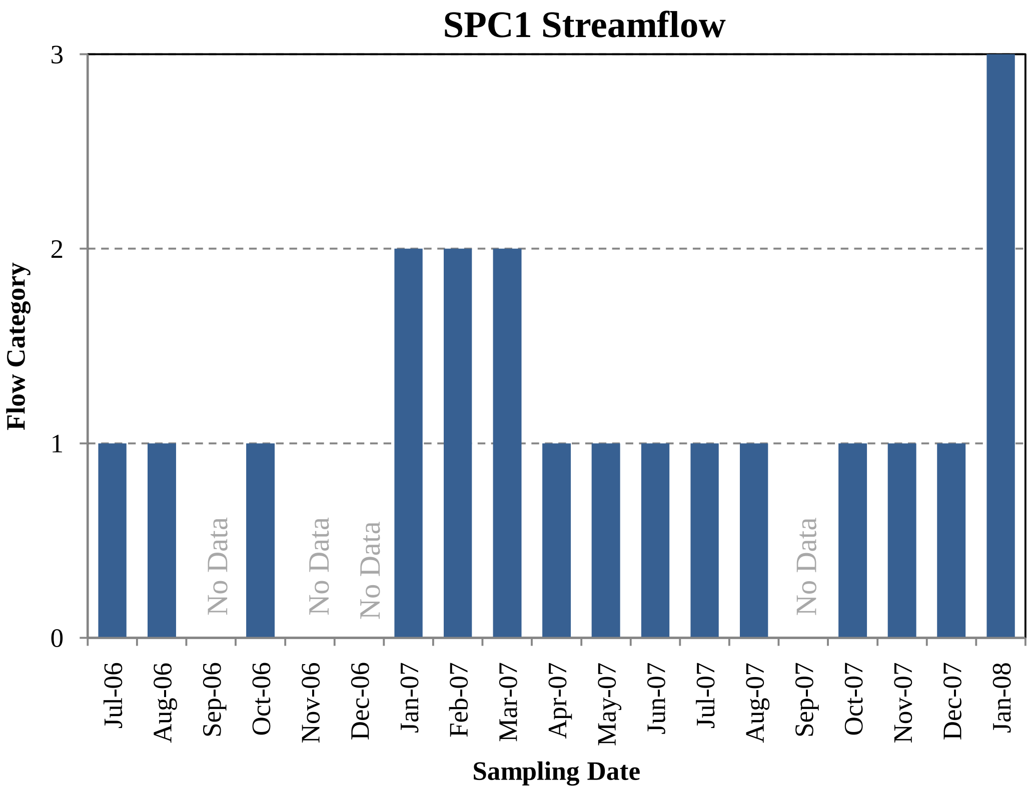


Figure 4.1.9. Streamflow record for station SPC1 on Spencer Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of SPC1

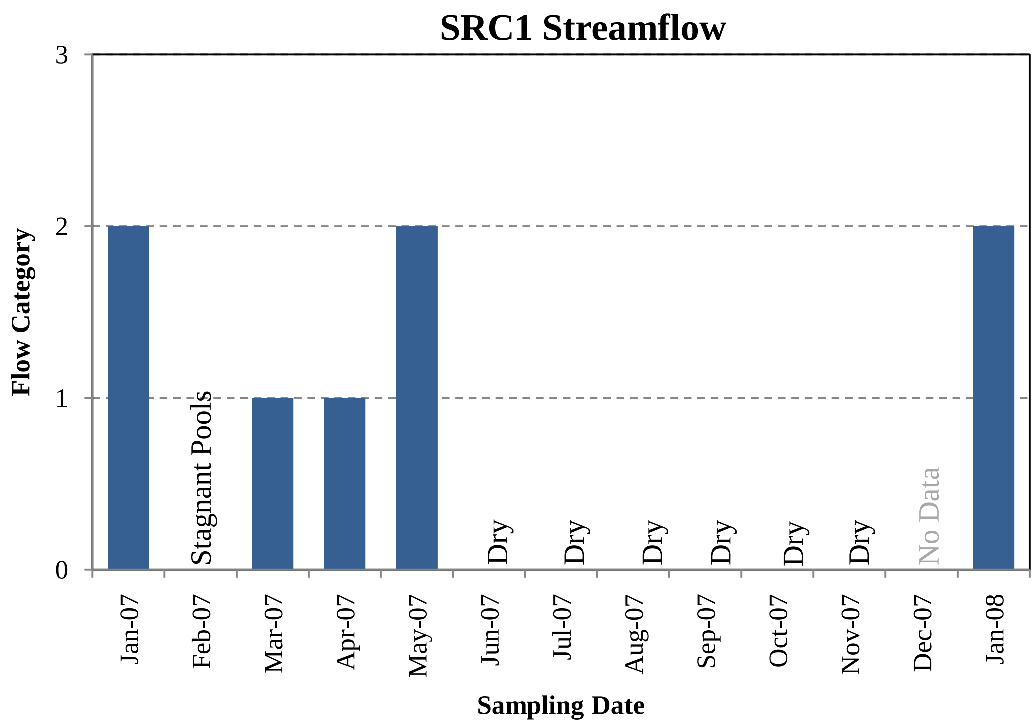


Figure 4.1.10. Streamflow record for station SRC1 on Sarco Creek.

Site photo of SRC1

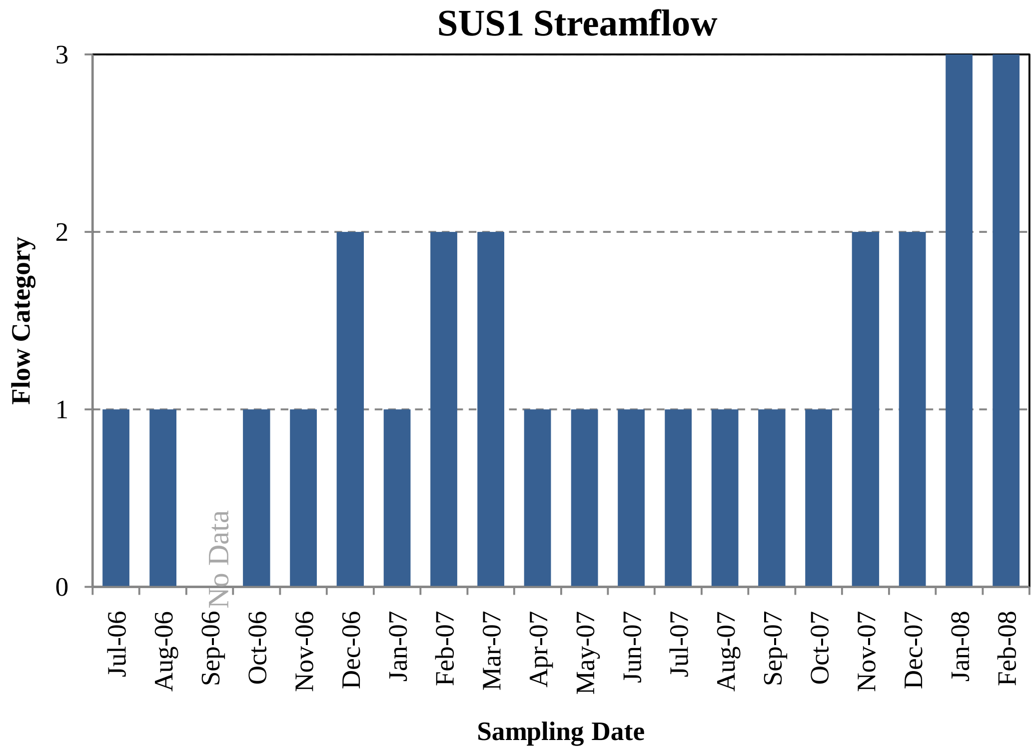


Figure 4.1.11. Streamflow record for station SUS1 on Suscol Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of SUS1

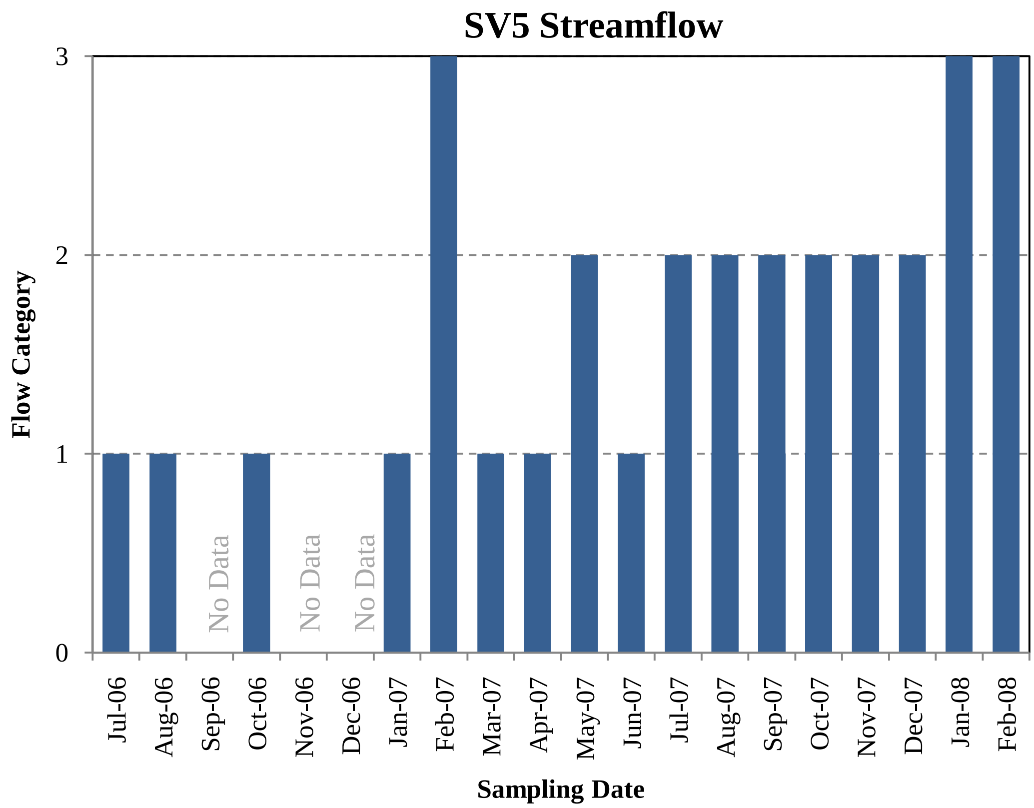


Figure 4.1.12. Streamflow record for station SV5 on Salvador Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of SV5

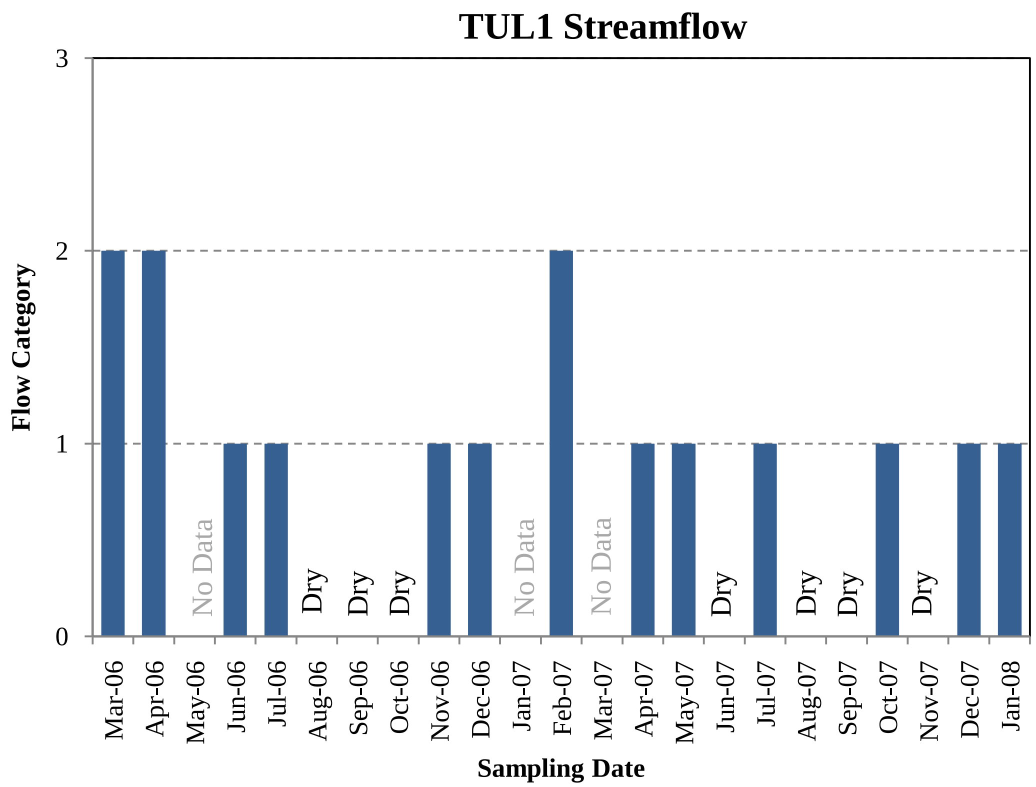


Figure 4.1.13. Streamflow record for station TUL1 on Tulucay Creek (3 = brisk flow, 2 = moderate flow, 1 = low flow, 0 = stagnant or dry).

Site photo of TUL1

4.2 WATER QUALITY

Water quality is directly linked to streamflow; as flow diminishes, water quality can become unsuitable for salmonid rearing. Results from the twelve study sites suggest that basic water quality parameters (DO, pH, Conductivity) are generally suitable as long as flow persists. Streams that experienced severe seasonal reduction in flows (e.g. lower Huichica, Pickle, Tulucay) had relatively poor water quality by the end of summer. During low or no-flow conditions, these sites were characterized by low DO levels, elevated temperature, and increased conductivity.

Electrical conductivity was measured as specific conductance to compensate for temperature variations throughout the sampling period (Figure 4.2.1). Results showed lower Huichica Creek (HCH1) had the highest values of all streams, with a notable spike in late summer. However, the lower-most reach of Huichica Creek is unsuitable for rearing due to lack of flow, and therefore elevated specific conductance levels are a secondary limiting factor. Despite maintaining year round flow, Browns Valley Creek had relatively high specific conductance levels throughout the study period. Potential sources for these elevated levels include geology, urban runoff, pet and livestock waste, or leaking septic systems.

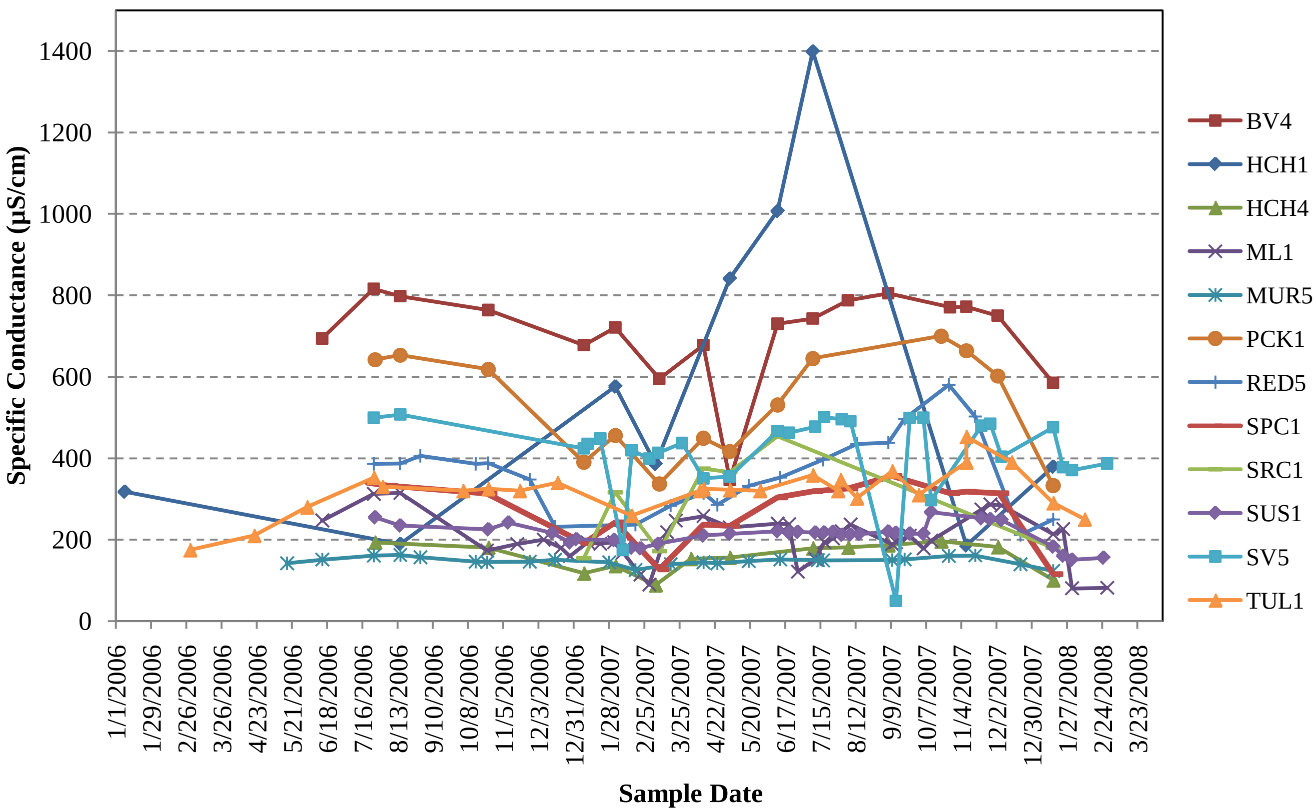


Figure 4.2.1. Specific conductance results for 12 sites.

Dissolved oxygen (DO) results from BV4, HCH4, MUR5, and SPC1 showed relatively high levels of DO were maintained throughout the year. (Figure 4.2.2). All other streams showed a typical seasonal pattern of high saturation (90-100%) during winter and spring months and reduced saturation levels as flows diminish in summer. DO values of approximately zero mg/L were recorded at HCH1, TUL1, and RED5 during summer 2007. The highest DO value measured was 13.14 mg/L on Milliken Creek at ML1 on 1/21/2007 (Figure 4.2.3).

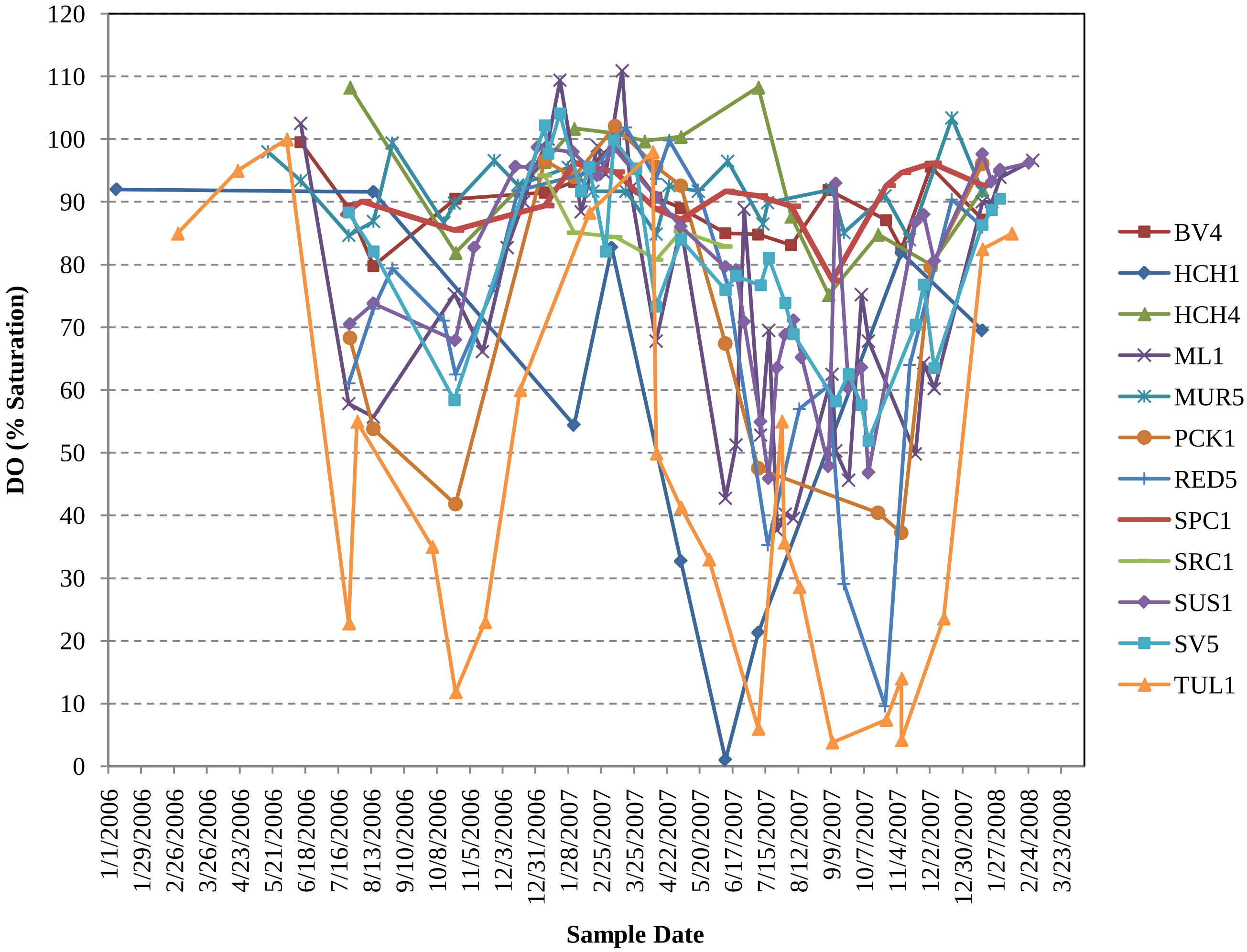


Figure 4.2.2. Dissolved oxygen (DO % Saturation) results for 12 sites.

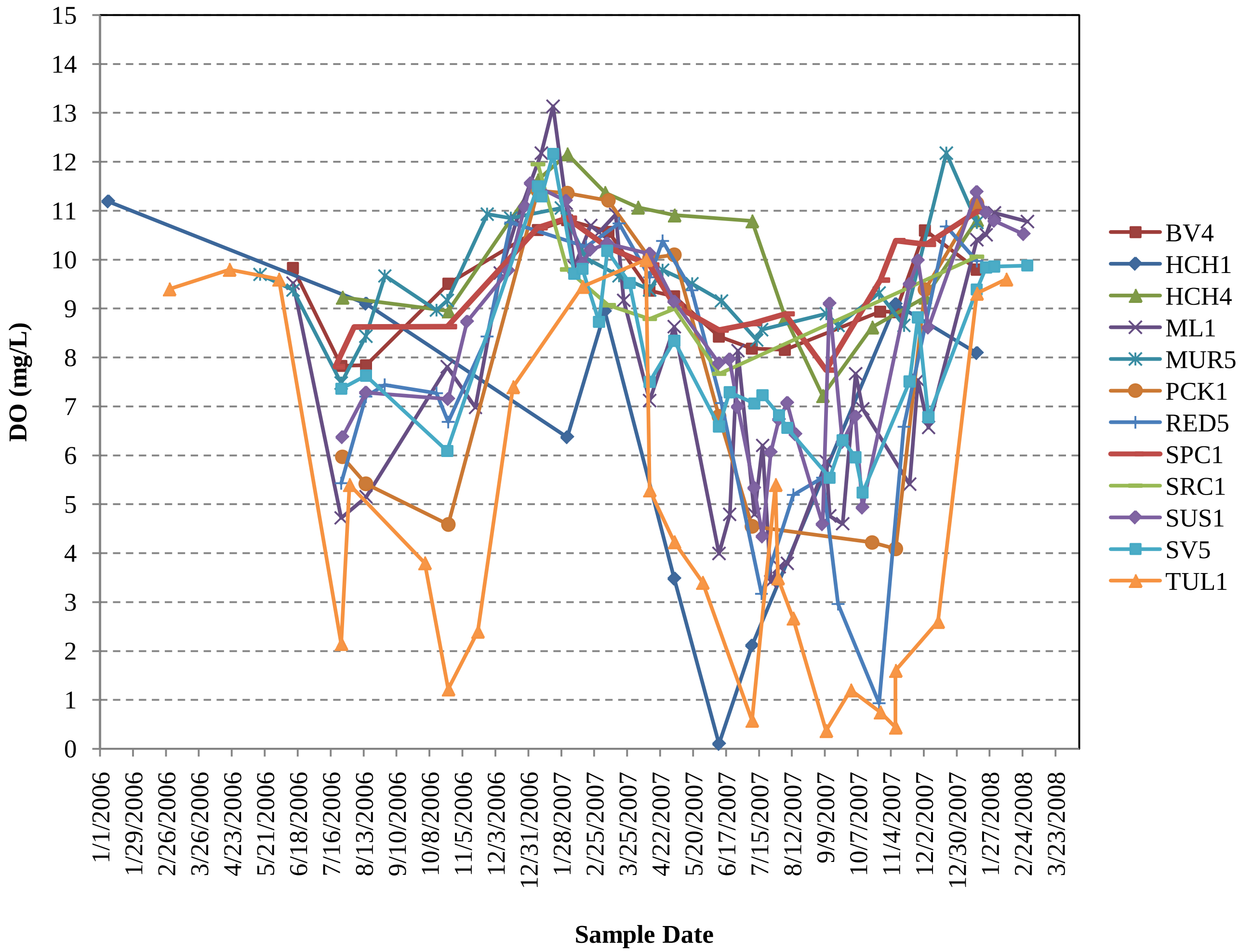


Figure 4.2.3. Dissolved oxygen (DO mg/L) results for 12 sites.

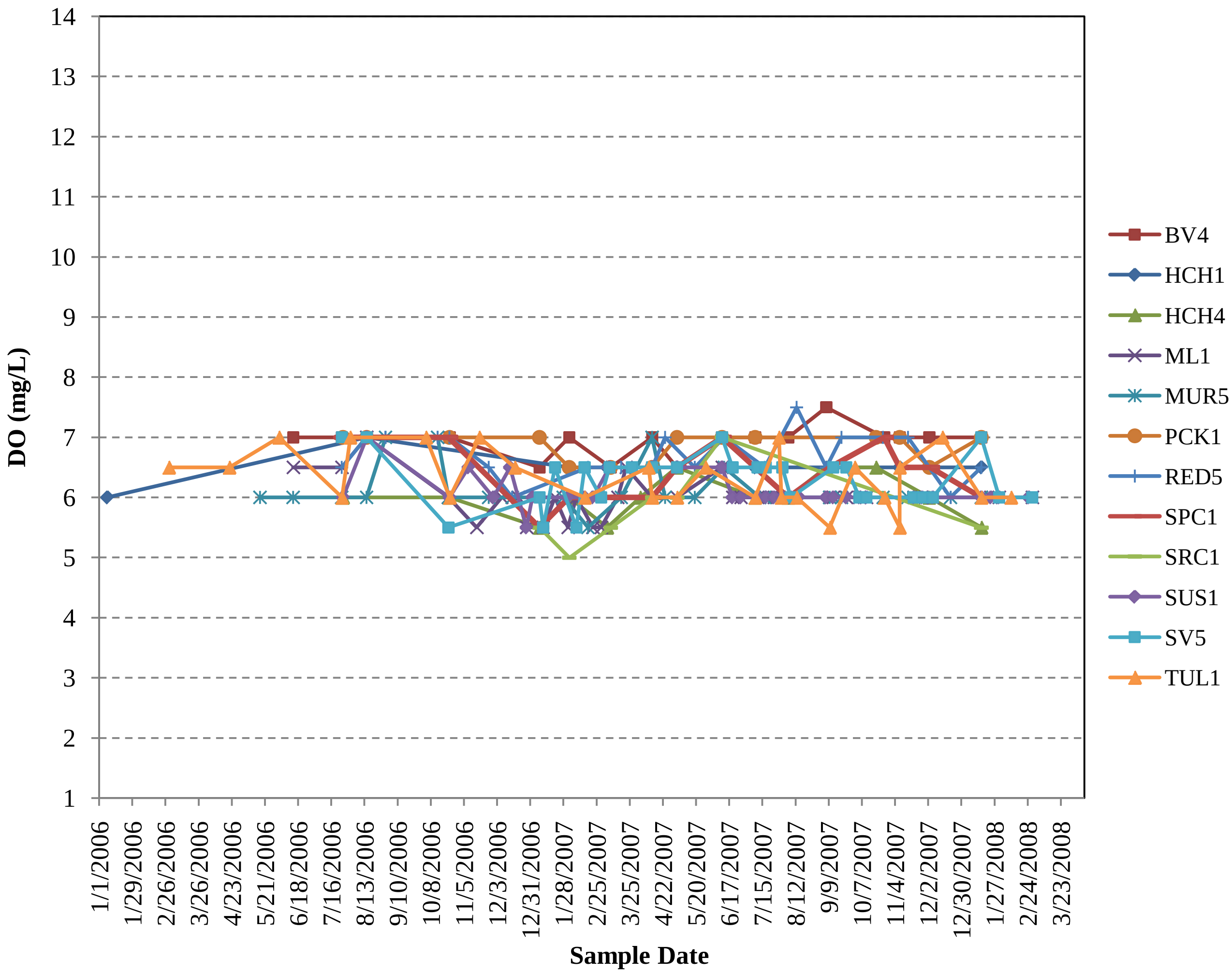


Figure 4.2.4. pH results for 12 sites.

Results for pH showed a relatively narrow range of values (5 - 7.5 pH units) throughout the study period (Figure 4.2.4). All streams tended to have pH values slightly below neutral with most between pH 6 and 7. Only two measurements were taken with a pH of 7.5.

5 CONCLUSIONS AND RECOMMENDATIONS

The southern portion of the Napa River watershed contains several important streams for steelhead and salmon. In general, this area has been modified to a greater extent than any other part of the Napa River watershed as the City of Napa and the land in the surrounding area have been developed. Several of the streams in this study flow through urban areas that no longer function as salmonid spawning and rearing habitat, but now serve primarily as migration corridors between the estuary and suitable habitat in the headwaters. The productivity lost by the loss of such alluvial valley floor habitat is not known, but likely significant.

Recreating the former habitat value of these streams poses a considerable and likely impossible challenge. Therefore, an effort to maximize the amount of currently available habitat while focusing on protecting and expanding all critical remaining habitats is the most practical strategy for increasing salmonid populations. In order to this, fish migration barriers should be given the highest priority for removal or modification to allow free movement of adult and juvenile salmonids to all suitable habitats within the basin. Removal or mitigation of migration barriers is a prudent first priority because it has immediate benefits and will enable anadromous species to fully utilize the available habitat. A total of 31 barriers and obstacles were identified and ranked in the surveyed streams, 19 of which are artificial structures that should be considered for modification or removal.

The effects of fine sediment on spawning success for steelhead appear to be less significant than other factors including flow persistence, juvenile growth, and habitat availability. This study, as well as others (Stillwater Sciences, 2002; Ecotrust & FONR, 2001) found that most tributaries with suitable rearing habitat were well-seeded with juveniles and therefore spawning success does not appear to be a primary limiting factor. However, fine sediment appears to play a more significant role in chinook salmon spawning success in the mainstem Napa River. Reducing fine sediment inputs from chronic sources like roads and bank erosion should focus primarily on the relative contribution to the mainstem Napa River where chinook salmon are expected to spawn. From our limited surveys, we suggest that most salmon spawning occurs upstream of the Yountville Crossroad, and therefore sediment reduction efforts should focus on reaches of the Napa River and tributaries upstream of this area.

Of the surveyed streams, Browns Valley Creek, Salvador Creek, and Tulucay Creek had very little suitable rearing habitat, and therefore likely contribute minimally to the basin-wide salmonid population. These streams appear to support steelhead spawning in some years, as documented by historical records and recent surveys. Due to lack of summer flows in Sarco Creek, Spencer Creek, and Tulucay Creek, juvenile steelhead would need to emigrate downstream to the Napa River or other perennial water to survive the summer. It is not clear to what extent juvenile steelhead are able to carry out this survival strategy.

We have ranked streams on current habitat quality and steelhead densities (Table 5.1) to better assess the relative contribution each stream makes to the overall salmonid population in the basin. Redwood Creek, Milliken Creek, Suscol Creek, and Pickle Creek had the greatest amount of high quality spawning and rearing habitat and relatively high steelhead densities. These four streams maintain areas with perennial flow, making them especially valuable rearing habitat for juvenile steelhead. Redwood Creek appears to be one of the best steelhead spawning and rearing streams within the Napa River basin, and it is likely very important for the overall Napa River steelhead population.

Stream	Overall Habitat Quality	Overall Habitat Quantity	Steelhead Density	Priority
Browns Valley Cr.	Moderate	Low	Low	**Low**
Huichica Cr.	High	Moderate	High	**High**
Milliken Cr.	High	High	High	**High**
Murphy Cr.	High	Moderate	Moderate	**Moderate**
Napa Cr.	Moderate	Moderate	Low	**Moderate**
Pickle Cr.	High	High	High	**High**
Redwood Cr.	High	High	High	**High**
Salvador Cr.	Low	Low	Low	**Low**
Sarco Cr.	High	Low	Low	**Moderate**
Spencer Cr.	Moderate	Low	Low	**Moderate**
Suscol Cr.	High	High	High	**High**
Tulucay Cr.	Low	Low	Low	**Low**

Table 5.1. Qualitative ranking of study streams based on current habitat quality, habitat quantity, and steelhead densities. Priority values of high, moderate, or low were assigned to estimate the relative importance of each stream to the overall steelhead population of the Napa River basin.

5.1 RESTORATION OPPORTUNITIES

During the course of our stream surveys, we documented 224 sites that may be considered for future restoration or habitat improvement efforts (Table 5.1.1). Potential project types were grouped into five broad categories:

Bank Erosion	(ERO)
Riparian Dysfunction	(RIP)
Exotic or Invasive Vegetation	(EXO)
Lack of Cover	(LWD)
Migration Barriers or Obstacles	(BAR)

Stream	**ERO**	**RIP**	**EXO**	**LWD**	**BAR**	**TOTAL**
Browns Valley	22	4	15	0	6	**47**
Huichica	1	0	1	0	2	**4**
Milliken	12	0	13	2	5	**32**
Murphy	0	1	16	0	9	**26**
Pickle	10	0	7	1	2	**20**
Redwood	24	2	16	1	4	**47**
Salvador	4	1	8	0	4	**17**
Suscol	0	4	25	0	2	**31**
TOTAL	**73**	**12**	**101**	**4**	**34**	**224**

Table 5.1.1. Potential restoration sites by type. Note: Barriers include debris jams and other minor or temporary obstructions. Significant fish passage barriers are described in detail for each individual stream in Section 3.

Potential restoration sites are shown in Figure 5.1.1. The landowner agreements used by the NCRCD allowed individual property owners to retain confidentiality with respect to any information gathered on their parcel. Consequently, releasing parcel-specific information may be done only with the landowner's consent. A list of potential sites for each surveyed stream is available from the NCRCD, subject to limitations of these landowner confidentiality agreements.

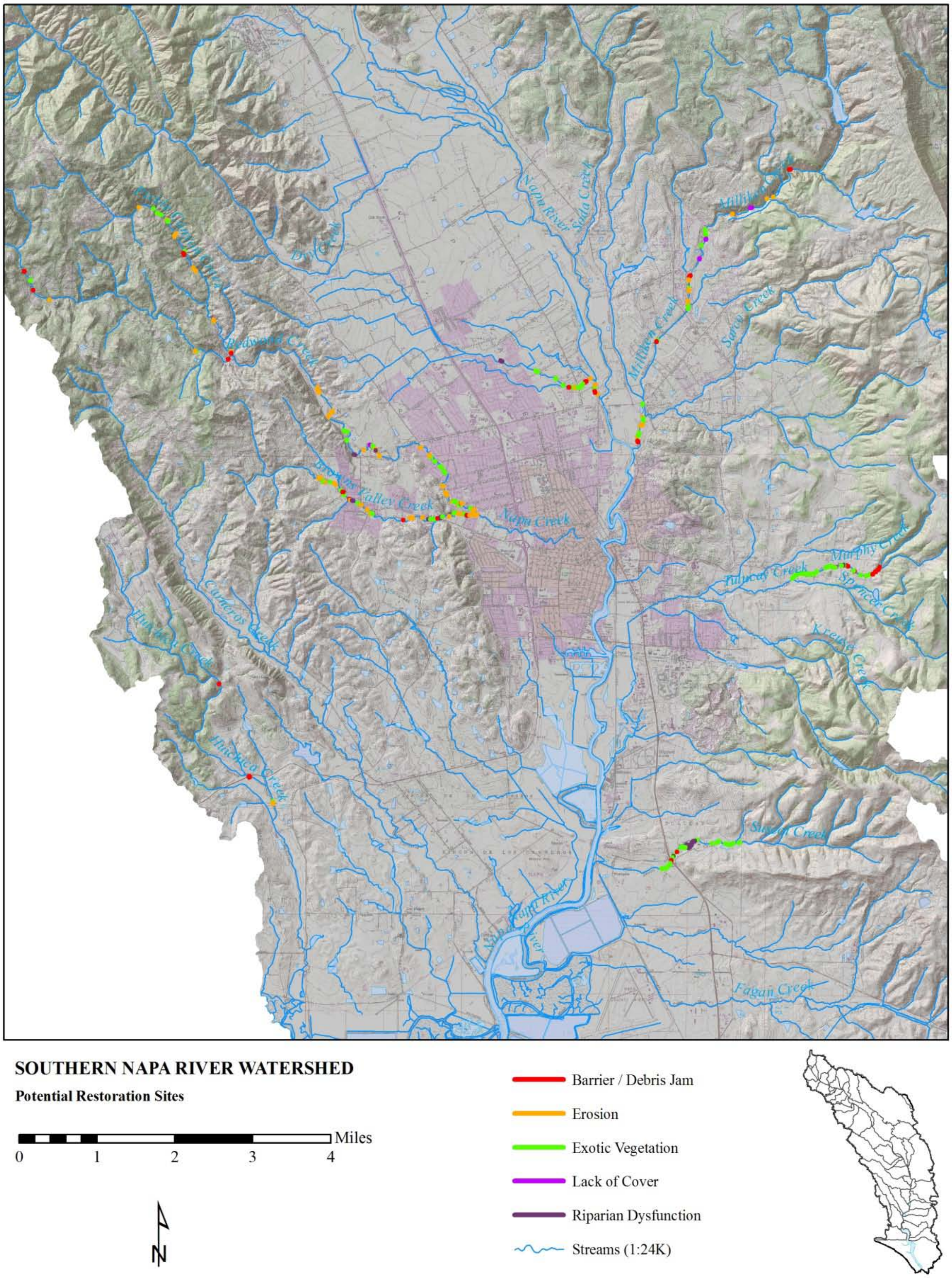


Figure 5.1.1. Potential restoration sites by general type. A total of 224 sites were identified in eight study streams.

5.2 RESTORATION PRIORITIZATION

Potential restoration sites identified during field surveys have been summarized by stream and ranked based on the following criteria:

Landowner cooperation *(5 pts. = High, 3 pts. = Moderate, 1 pt. = Low)*

Species benefited *(3 pts. = both Chinook and steelhead, 2 pts. = 1 salmonid species, 1 pt = no salmonids*

Life stages benefited *(5 pts. = 3 or more lifestages, 3 pts. = 2 lifestages, 1 pt. = 1 lifestage)*

Amount of habitat improved *(5 pts. = watershed level, 3 pts. = stream level, 1 pt. = local level)*

Limiting factors addressed *(9 possible - 1 pt. for each factor: water quantity, water quality, riparian dysfunction, excessive sediment, spawning, overwintering, summer rearing, escape cover, passage, bank erosion)*

Effort and complexity required *(3 pts. = low effort, 2 pts. = moderate effort, 1 pt. = high effort)*

The composite score for each site was prioritized according to the following scale:

Very High Priority **20 or greater**
High Priority **16-20**
Medium Priority **11-15**
Low Priority **10 or less**

Results of this ranking are shown in Table 5.2.1 and Figure 5.2.1. A total of three "Very High" priority sites were identified, which consisted of migration barriers on Pickle Creek, Suscol Creek, and Huichica Creek. In addition, 66 sites were ranked as "High Priority", most of which were in Browns Valley Creek (24), Milliken Creek (14), and Redwood Creek (10).

Stream	Very High	High	Medium	Low
Browns Valley	0	24	23	0
Huichica	1	1	2	0
Milliken	0	14	18	0
Murphy	0	3	22	1
Pickle	1	9	9	1
Redwood	0	10	34	3
Salvador	0	0	16	1
Suscol	1	5	25	0
TOTAL	**3**	**66**	**149**	**6**

Table 5.2.1. Potential restoration sites by priority.

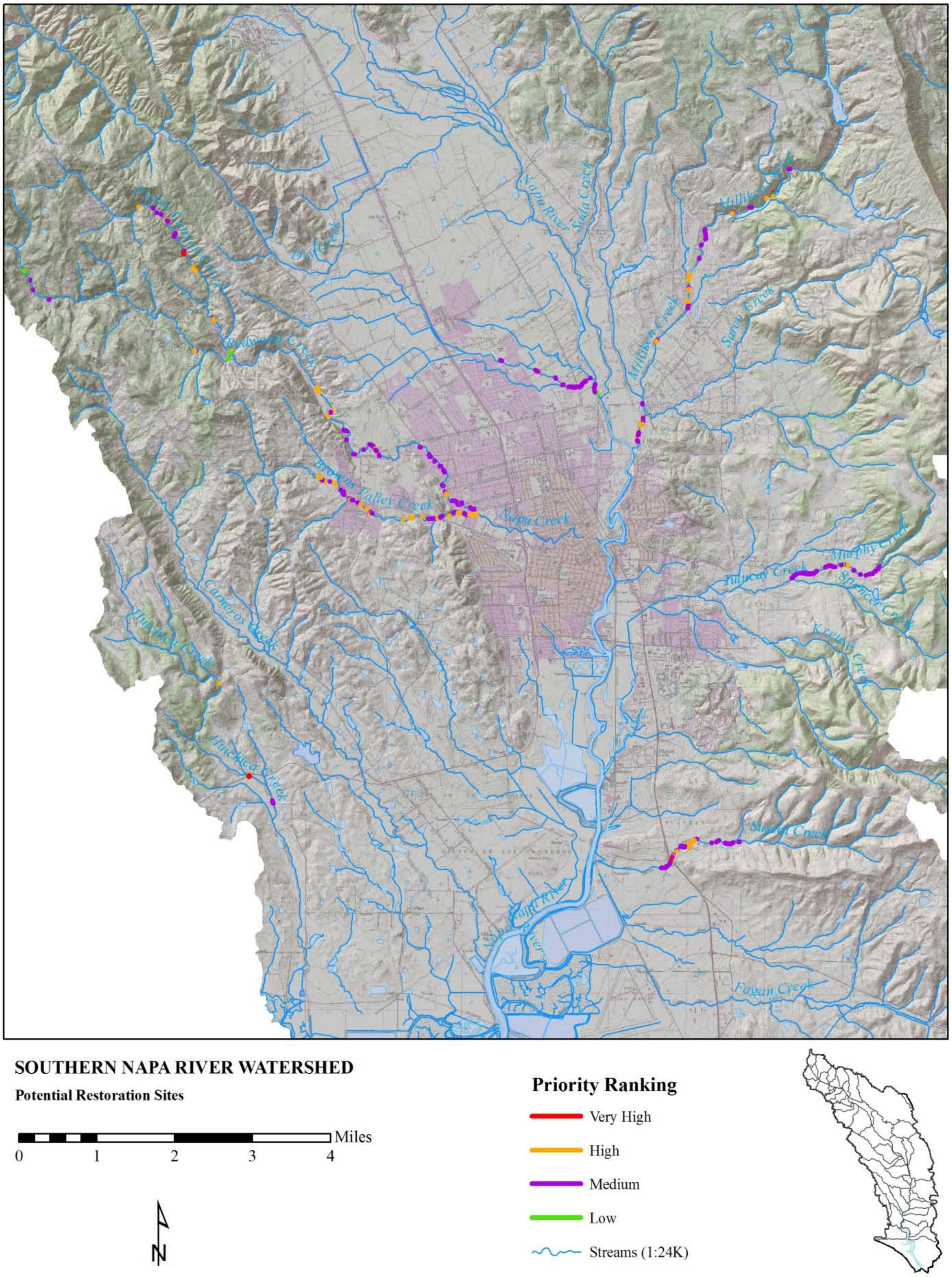


Figure 5.2.1. Potential restoration sites by priority ranking.

5.3 POTENTIAL FUNDING SOURCES

Potential funding for restoration comes from a broad spectrum of sources including federal, state, and local government agencies, private foundations, and local interest groups. There are often grant funds available to offset the cost of restoration planning and implementation available from the following sources:

US Department of Agriculture Natural Resources Conservation Service (USDA NRCS)
The NRCS maintains a local office in Napa and can provide general conservation assistance to agricultural landowners in Napa County. They also operate several grant programs that can provide cost sharing for implementation of conservation practices on agricultural land. Conservation practices may include but are not limited to: cover crops, streamside buffer vegetation, bio-engineered streambank stabilization, livestock troughs and water development, erosion control practices, management of noxious weeds, and Pierce's disease management. Additional information is available at www.ca.nrcs.usda.gov or inquiries can be made to Phillip.Blake@ca.usda.gov.

Environmental Protection Agency (EPA)
The EPA has a regional office in San Francisco. Grant programs administered by the EPA generally involve pollution prevention; terrestrial aquatic, and coastal ecosystem research and monitoring; wetland protection; and ecosystem restoration projects. Additional information about specific grants offered through EPA can be found through a federal grant site at http://fedgrants.gov/Applicants/index.html.

US Fish and Wildlife Service (FWS)
The Mission of the U.S. Fish & Wildlife Service is to work with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. They generally fund projects that involve habitat protection and restoration, species status surveys, public education and outreach, and restoration of species at risk. Additional information about grant programs administered by FWS can be found at: http://grants.fws.gov. Alternatively, FWS grant programs can also be searched on a federal grant website through the Department of Interior: http://fedgrants.gov/Applicants/index.html.

National Oceanic and Atmospheric Administration – Fisheries Division (NOAA Fisheries)
NOAA Fisheries (previously National Marine Fisheries Service) is dedicated to the stewardship of living marine resources through science-based conservation and management, and the promotion of healthy ecosystems. They have a local office in Santa Rosa. They generally fund projects that involve habitat protection and restoration (particularly habitat for threatened and endangered species), public education and outreach, and restoration of species at risk. Additional information about current grants offered through NOAA Fisheries can be found at http://www.nmfs.noaa.gov/mb/grants/. Alternatively, NOAA Fisheries grant programs can be searched on a federal grant website through the Department of Commerce at http://fedgrants.gov/Applicants/index.html.

California Bay-Delta Authority & CALFED Bay-Delta Program
The California Bay-Delta Authority oversees 23 state and federal agencies working cooperatively through the CALFED Bay-Delta Program to improve the quality and reliability of California's water

supplies while restoring the Bay-Delta ecosystem. The mission of the CALFED Bay-Delta Program is to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System. The program supports 11 different elements to support its 4 objectives: Water Supply Reliability, Levee System Integrity, Water Quality, and Ecosystem Restoration. Grant opportunities available can generally be found at the Bay-Delta homepage: http://calwater.ca.gov/.

California State Water Resources Control Board (SWRCB)
The SWRCB's mission is to preserve, enhance and restore the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations. The SWRCB and their Regional Offices administer a variety of water quality and habitat restoration funds. Available grants are posted on the following website: http://www.swrcb.ca.gov/funding/index.html.

California State Coastal Conservancy – SF Bay Area Conservancy Program
The San Francisco Bay Area Conservancy Program, administered by the Coastal Conservancy, was established to address the natural resource and recreational goals of the nine-county Bay Area in a coordinated and comprehensive way. The Conservancy may award grants to help achieve the following Bay Program goals: (1) protect, restore, and enhance natural habitats and other open-space resources of regional significance throughout the nine-county area; (2) improve public access and related facilities to and around the Bay, its surrounding hills, and the coast, through completion of bay, coast, and ridge trails that are part of a regional trail system; and (3) promote projects that provide open space that is accessible to urban populations for recreational and educational purposes. Applications for funding are accepted on a continual basis. Additional information about the Program and the application package are available on line at: http://www.coastalconservancy.ca.gov/Programs/BACP.htm.

California Department of Conservation
The Department of Conservation provides services and information that promote environmental health, economic vitality, informed land-use decisions and sound management of our state's natural resources. Most of the applicable assistance provided is offered through the Division of Land Resource Protection and includes voluntary programs that help to meet individual needs, including property tax incentives, grants for the purchase of agricultural conservation easements, and funding for conservation projects conducted by Resource Conservation Districts. Additional information is available at: http://www.consrv.ca.gov/DLRP/index.htm.

California Department of Fish and Game (DFG)
The mission of the Department of Fish and Game is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. They administer a number of grant programs that make funds available for several types of projects including: restoration implementation, education, assessment, and monitoring. Additional information about DFG can be found at: http://www.dfg.ca.gov.

Wildlife Conservation Commission of Napa County
The Wildlife Conservation Commission awards grant funds to local projects that support the preservation, propagation, and protection of birds, mammals, fish and amphibians. Funds are

generated through local fines levied by the California Department of Fish & Game and may be used for a variety of projects including, but not limited to: education, monitoring, land acquisition, or restoration work. Contact Patrick Lowe at the Napa County Conservation, Development and Planning Department for additional information: 707.253.4188.

Napa County Public Works Program
Napa County has funds available to help with watershed restoration work related to creeks for properties that are not eligible for alternative funds, such as NRCS Environmental Quality Incentive Program (EQIP). Mike Forte, with Napa County Public Works Department, can be contacted regarding these funds.

Napa County Resource Conservation District (Napa RCD)
The Napa RCD is a local non-regulatory agency whose mission is to promote responsible watershed management through voluntary community stewardship and technical assistance. The RCD is available to assist with grant writing for projects and is available on a limited basis to provide advice and assistance to landowners and managers.

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