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Northern Subbasin

The Northern Subbasin includes the watershed area immediately north of the SLR River from Rice Canyon, approximately one mile east of Interstate 15 (RM 20), to just upstream of the Escondido Canal Diversion (RM 40) (Figure 2). This subbasin does not include the SLR River, rather all the tributaries north of the river within this geographical area. Differing from the lower elevations and alluvial streams in the Southern Subbasin, most of the Northern Subbasin tributaries flow out of the steeper, higher Agua Tibia Range and Palomar Mountain as a part of the southern Peninsular Ranges of southern California. These mountain ranges, particularly the area around Mount Palomar, typically receive over 30 inches of annual precipitation, considerably more moisture than the rest of the basin. Stream elevations range from 300 feet in the southwestern portion of the subbasin to approximately 5,200 feet in the headwaters of Doane and French creeks, near Palomar Mountain State Park. The Northern Subbasin occupies less than one fifth of the total basin at 92 square miles and is the second smallest assessment subbasin.

This assessment area is predominantly rural, containing only portions of the small communities of Pala and Pauma Valley. Almost a third of the basin is held in Indian tribal lands, primarily between three tribes: Pala Band of Luiseño Indians, La Jolla Band of Luiseño Indians, and the Pauma Band of Mission Indians. A portion of the Rincon Band of Mission Indians Reservation is also located within the Northern Subbasin. The remaining land area is held in larger private parcels managed for agricultural crop production, and there are also large amounts of federal and state lands.

The Northern Subbasin provides suitable habitat for steelhead trout in several tributaries to the SLR River, but most of these streams have fish passage barriers, hindering steelhead's access to potential spawning and rearing habitat. Historical evidence documents steelhead in Gomez Creek, Pala Creek, Agua Tibia Creek, Frey Creek, and Pauma Creek. Pauma Creek and a few of its tributaries currently support a healthy population of native rainbow trout. Genetic sampling performed on these fish concluded that "it seems more than likely that these fish are part of a native coastal *O. mykiss* lineage" (NOAA 1999). This report went on to state, "these populations may be reasonable choices to consider in efforts to re-establish anadromous runs in their respective streams." Pauma Creek's resident trout population is currently blocked from accessing the SLR River due to an impassible culvert that runs below Highway 76. This culvert also prevents passage upstream into the Pauma Creek watershed. Prior to the 2007/2008 CDFG stream surveys, very few surveys have been conducted in any of the tributaries in the Northern Subbasin.

Figure 1. Northern Subbasin. Photo taken just east of the Pauma Creek drainage facing southwest.

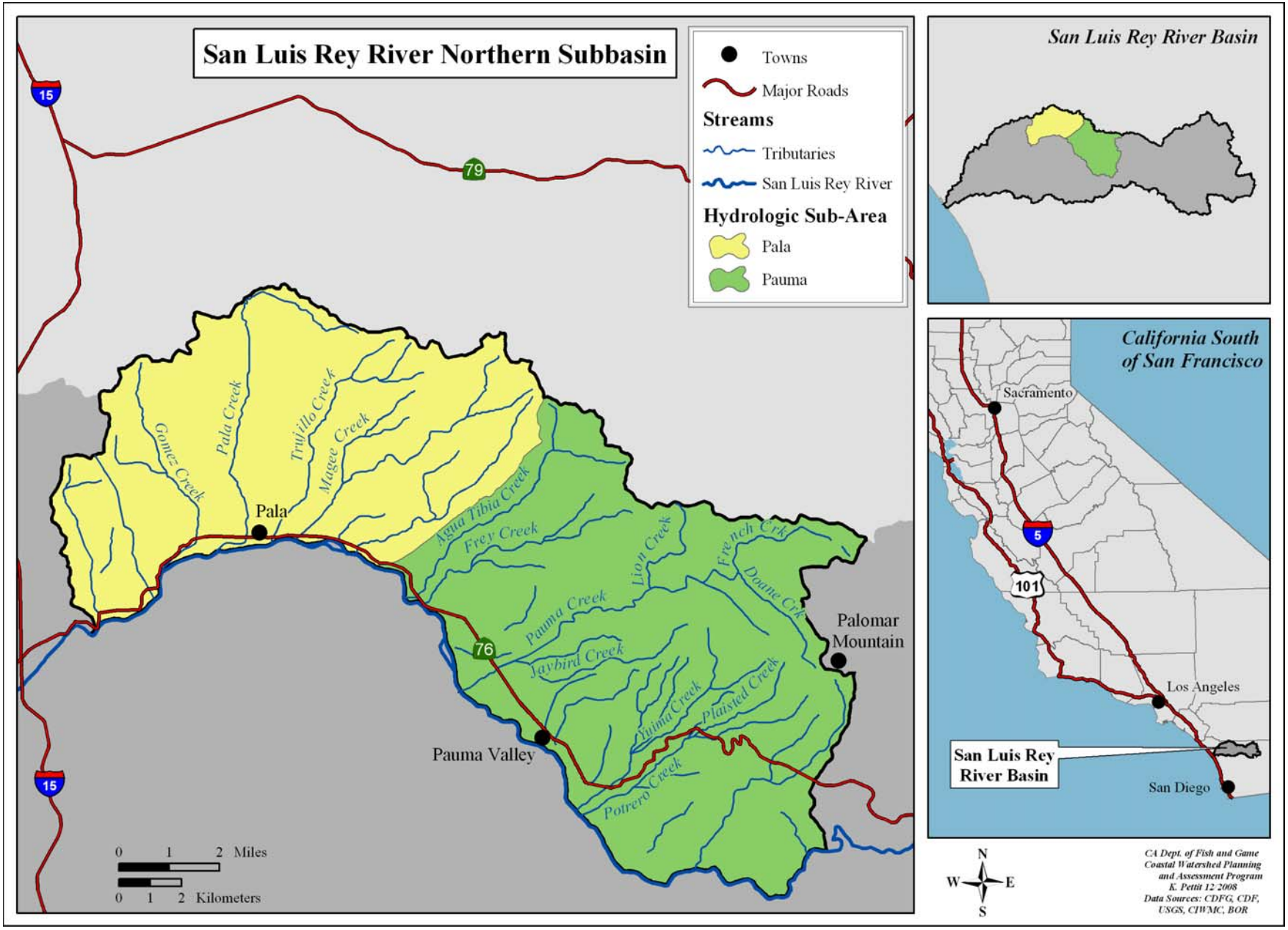

Figure 2. SLR Northern Subbasin and CalWater Units.

Hydrology

The Northern Subbasin is made up of portions of two CalWater Units, the Pala and Pauma CalWater Units (Figure 2). There are twelve named streams (Table 1) and 127.9 permanent and intermittent stream miles in this subbasin. Other than the Pauma Creek watershed, the majority of these stream miles are intermittent. Pauma Creek is easily the largest creek by drainage area and is considered a second order stream, using the Strahler (1964) classification. There are also numerous named and unnamed canyons containing intermittent streams.

The Northern Subbasin receives significantly more moisture than the other subbasins; therefore, many of the streams sustain surface flows for a longer duration throughout the year during typical rainfall years. The larger streams in the Northern Subbasin, such as Pauma Creek, Pala Creek, Agua Tibia Creek, and Frey Creek once played an important role in helping maintain surface flows in the mid to lower SLR River. Many of these tributaries are labeled as perennial streams on USGS 7.5 quadrangles, but have been reduced to intermittent streams whose surface flows seldom reach the SLR River during late spring/summer until the first significant rains of fall because of water diversions. Gomez Creek, Pala Creek, Agua Tibia Creek, Pauma Creek, and other streams within the subbasin are utilized for human consumption via agricultural practices or household uses. Northern Subbasin stream drainage areas range from a 3 square mile watershed (unnamed stream in the western portion of the subbasin) to as large as the 15.2 square mile Pauma Creek watershed.

Table 1. Major streams in the Northern Subbasin.

Stream	Tributary to	River Mile	Drainage Area (square miles)	Stream Order	Permanent (miles) (in Subbasin)	Intermittent (miles)
Gomez Creek	SLR River	22	7.10	1	1.9	3.2
Pala Creek*	SLR River	24	9.48	Intermittent	1.0	7.6
Truijillo Creek	SLR River	24.7	5.68	Intermittent	0.0	5.8
Magee Creek	SLR River	25.7	6.78	Intermittent	0.0	3.4 (0.7)
Agua Tibia Creek	SLR River	28.1	5.62	1	0.8	4.8
Frey Creek	SLR River	28.5	4.01	1	2.0	2.7
Pauma Creek	SLR River	30.8	15.21	2	5.3	1.9
Jaybird Creek	Pauma Creek	1.3	0.83	Intermittent	0.0	2.1
Lion Creek	Pauma Creek	5.3	1.70	1	0.7	1.8
Doane Creek	Pauma Creek	7.8	2.27	1	0.7	2.0
French Creek	Pauma Creek	7.8	2.56	1	1.5	1.3 (0.2)
Yuima Creek	SLR River	34.7	4.78	Intermittent	0.0	5.3
Potrero Creek	SLR River	34.9	5.17	Intermittent	0.0	4.2
Plaisted Creek	Potrero Creek	38.0	3.04	Intermittent	0.0	2.7

*A portion of Pala Creek retains perennial flows.

Geology

The Northern Subbasin is predominately underlain by granitic rock types of the Peninsular Range Batholith that intruded into older (Mesozoic) sedimentary, marine rock types between 90 and 140 million years ago (Figure 3) and has subsequently been exposed by tectonic uplift and erosion. Intrusion of the Peninsular Range Batholith as well as regional tectonics has caused some of the marine, sedimentary rocks to undergo metamorphosis.

Erosion has exposed the batholith leaving behind mountains of granitic rock with remnants of the sedimentary rocks it intruded into. Weathering of the granitic rocks has created younger unconsolidated sediments that are very susceptible to erosion and mass movement such as landslides and debris-flows. These sediments have been deposited in a series of alluvial fans, marine and river terraces, as well as active channel deposits. These sedimentary deposits range from partially consolidated sandstone, siltstone, mudstone, and shale to unconsolidated sand and gravel.

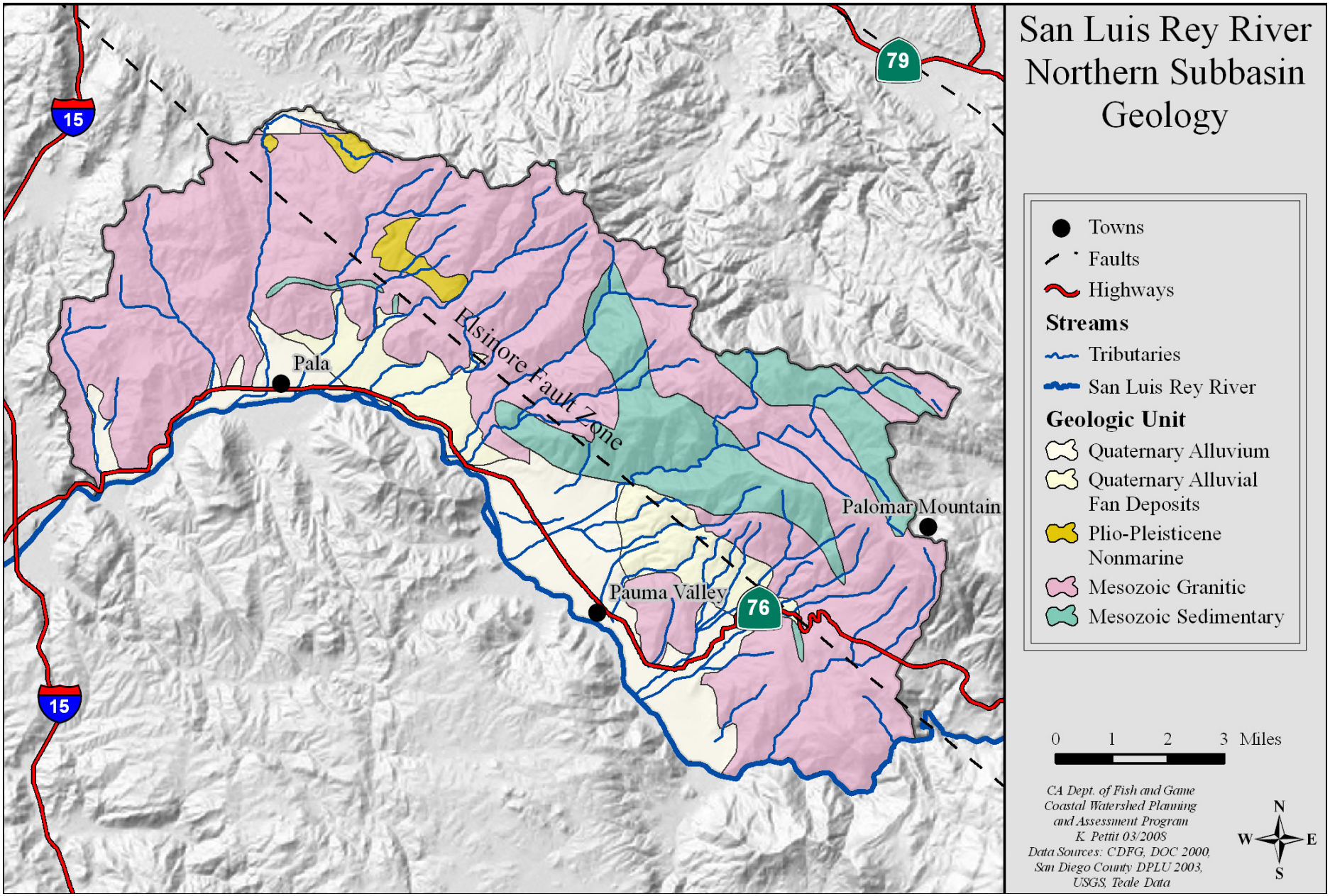

Figure 3. Geology of the Northern Subbasin.

Compositional Overview

Rock Types

The rock types depicted in the geologic map (Figure 3) presented in this report have been combined from various other published source maps. Like rock types based on similar age, composition, genesis, orgin, and geologic history have been combined to help simplify the information presented herein. General descriptions of the geolgic units displayed in the map and in Table 2 are as follows.

Mesozoic Granitic

Granitic rocks make up the majority of this subbasin as they occupy approximately 64% of its surface area. The mountains of the subbasin are composed almost entirely of these granitic rocks (Figure 3). They are predominantly Cretaceous (65.5 through 154.5 million years ago) in age. These rocks are very hard and resistant to erosion, however, they do tend to exfoliate to some extent in exposed surfaces and preferentially weather at structural joints. Over long periods of time granitic rocks tend to decompose, become "soft," and much less resistant to erosion producing "decomposed granite." In more advanced forms, the minerals within the granite disaggregate and form "Arkosic Sand" which is highly susceptible to erosion, sliding, and fluvial transport.

Mesozoic Sedimentary

Mesozoic sedimentary rocks make up around 14% of the subbasin and consist mostly of siltstone, sandstone, and conglomerate and were deposited some 65.5 to 225 million years ago. The original deposition of the sediments that make up these rock types occurred in environments ranging from marine to terrestrial. Some of these rock types have subsequently undergone metamorphism especially in areas in contact with granitic rock types. These sedimentary rock types are generally more susceptible to erosion than granitic rock types.

Quaternary Alluvium

Alluvium covers about 13% of the basin. It consists of unconsolidated sediments that range from clay to boulders. Alluvium is transported and deposited by streams and makes up most of the bed and banks of the streams. Units of alluvium delineated by the geology map (Figure 3) include sediment currently being acted upon by the streams and bank and flood-plain deposits occasionally acted upon by the streams. If the alluvium within the stream channel is of sufficient depth it can readily transport water via the subsurface pore-spaces allowing stretches of the stream to "run dry."

Quaternary Alluvial Fan Deposits

Fan deposits make up less than 8% of the subbasin and consist of unconsolidated sediments ranging from clay to boulders. They wash out of canyons on high slopes and are usually deposited where there is a significant change of slope. They are not usually transported far from their source and therefore consist of sediments made from the bedrock of the mountains from which they originate.

Plio-Pleisticene Nonmarine

This unit occupies about 1.5% of the subbasin. It is composed of sedimentary rocks ranging in composition from siltstone through conglomerate and from poorly consolidated to well indurated. The sediments that make up these rock types were deposited on land between 11,000 and 5 million years ago as river flood-plain, colluvium, as well as alluvial fan deposits (Kennedy 2000).

Table 2. Rock types in the Northern Subbasin.

Lithologic Unit	% Basin
Mesozoic Granitic	63.78
Mesozoic Sedimentary	13.58
Quaternary Alluvium	13.10
Quaternary Alluvial Fan Deposits	8.07
Plio-Pleisticene Nonmarine	1.46

% area of basin represents a rough approximation based on GIS mapping.

Soils

The underlying bedrock is generally responsible for a soil's texture and erodability characteristics. The sediment contribution from soils found in the Northern Subbasin is dependent largely on slope, soil sediment size, consolidation, cohesion, compaction, the type and amount of vegetation cover, land use, and amount, intensity, and duration of local rainfall (Table 3).

The majority of bedrock throughout the subbasin is composed of various granitic rock types producing associated soil types that are in general very well drained and is somewhat prone to erosion and transport by fluvial processes as well as wind. Soils with high sand and silt content are typically more susceptible to erosion than soils with high clay content which exhibit a greater degree of cohesion.

Table 3. Soil types in the Northern Subbasin.

Soil Type	Percent of Upper Subbasin	Parent material
Hotaw-Crouch-Boomer (s1015)	22.5	weathered metavolcanic/granite
Sesame-Rock outcrop-Cieneba (s1010)	20.01	weathered granite
Tujunga-Salinas-Elder (s1001)	19.8	Weathered granite, sandstone-shale, alluvium
Rock outcrop-Las Posas (s1012)	18.85	Basic igneous
Sheephead-Rock outcrop-Bancas	9.69	weathered granite/gneiss
Tollhouse-Rock outcrop-La Posta	4.28	weathered granite/igneous
Rock outcrop-Lithic Torriorthents (s1021)	3.63	weathered granite
Ramona-Placentia-Linne-Greenfield (s999)	1.25	shale/sandstone/alluvium

% area of basin represents a rough approximation based on GIS mapping.

Landslides

Like the other SLR River subbasins, the Northern Subbasin is partially mantled with unstable soils. The mainstem and its floodplain in the Northern Subbasin consist predominately of alluvial material, while the hillsides are often composed of granite, weathered granite, and sedimentary rock. Except for fresh granite, these rock types are susceptible to surface erosion, headword erosion, gullying, stream bank raveling, and landsliding. This area has undergone tectonic uplift leaving steep canyon walls above the streams. As tectonic forces push the land up gravity tries to pull it down, typically resulting in landslides and rock falls. Landsliding is further exacerbated by seasonal rain storms. As the hillsides become saturated, pore pressure between grains becomes greater making them unstable and more prone to landsliding.

Earthquakes and Faults

The whole of the San Luis Rey River Basin is tectonically and seismically active, and the possibility of seismic activity occurring in this subbasin is similar to the entire southern California region. Due to active faults within this subbasin, such as the Elsinore Fault, as well as those in close proximity, the subbasin has the potential for strong seismic movement. The Elsinore Fault Zone (currently established Alquist-Priolo Earthquake Fault Zone) runs northwest through the middle of this subbasin. The Elsinore Fault is a right-lateral, strike-slip fault system that is related to translational plate boundary tectonics between the Pacific and North American plates. The Elsinore Fault is capable of producing earthquakes in the range of M 6.5–7.5. It has an average recurrence interval of approximately 250 years (http://www.data.scec.org/faultindex/elsfault.html). The most recent major earthquake was a M 6.0 in 1910. Ground shaking generated by earthquakes can trigger rock falls and landslides that deliver large amounts of sediment to the streams. The 1994 Northridge earthquake (M 6.7) triggered in excess of 11,000 landslides in a 6,200 square mile area (USGS) in similar terrain. Other than being able to trigger landslides strike-slip faults can weaken bedrock, offset streams, truncate and oversteepen certain topographic landforms thus enhancing erosion and transport of sediment to the streams.

Wildfires

Wildfire can and frequently will increase the erodability of a region. As a fire moves through an area it is capable of burning off the duff layer that effectively armors the soil. It can also intensively dry the soil as well as destroying organic matter that helps to bind the soil together, leaving behind a loose, “hydrophobic” soil in its wake (Figure 4). During subsequent rain storms the soil’s capacity to absorb water is greatly reduced and surface flows are proportionally increased. Wildfires can destroy woody debris strewn on hill slopes allowing for less resistance to the erosive power of surface runoff transporting increased amounts of sediment downstream. The propensity for debris flows is also increased following a wildfire on steep slopes which can block drainage ways, destroy structures, strip vegetation, and deliver great amounts of sediment to the streams (Cannon et al. 2004). Relatively hot fires may cause thermal expansion of individual minerals within the rock causing fracturing of its surface layers leading to enhanced erosion.

The 2007 Poomacha Fire, which began in late October and continued until early November burned a large portion of the Northern Subbasin, including the majority of the middle and upper Pauma Creek watershed (Figure 21, Basin Profile). Due to the underlying geology and steep nature of the surrounding hillsides, most streams east of Agua Tibia Creek within the subbasin were prone to sediment deposition as a result of the fire. Compounding the effects of the fire were several large storm events that hit the region in November and December of 2007 releasing significant amounts of rainfall. For example, during the last

weekend/first weekend in November/December, Palomar Mountain recorded 6.85 inches of rain (Soto 2007). This large amount of precipitation over a relatively short period of time triggered debris flows and a large influx of ash and sediments into the subbasin streams.

CDFG/PSMFC fisheries crews conducted reconnaissance-level surveys in Pauma Creek in December and early January to evaluate the combined effects of the fire and ensuing large rain events on stream habitat conditions and native fish populations within the Pauma Creek watershed. The surveys indicated areas with significant debris and sediment input into Pauma and French Creek, which reduced pool depths, buried potential spawning gravels, and created debris jams. However, considering the high gradient character of Pauma Creek and potential for significant rainfall, which would help to flush out sediments more quickly than in a lower gradient stream the long-term impacts of the increased sediment load may be minimal. Furthermore, the severity of the fire within the watershed appeared to range from low to moderate. Based on CDFG and PSMFC biologists' observations in the upper watershed of Pauma Creek and lower French Creek, the Poomacha Fire appeared to be a low intensity fire, burning mainly the ground cover and understory and leaving mature trees mostly intact. Most conifers and the vast majority of oaks appeared to be in good health. Fire scars on large trees was generally limited to their lower trunks. Only a small percentage of conifers were completely burned. The riparian area remained almost untouched by the fire (Figure 7). Firefighters who were on-site helping to contain the fire in Palomar Mountain State Park, also described the fire as a low intensity ground fire that moved through the area rather quickly without getting into the crown of the trees.

As explained in the Basin Profile (Wildfires section pp. 22-23), post-fire erosion potential has been estimated as moderate to high (Table 5, Basin Profile) for most of this subbasin. This estimate was derived from data prior to 2005; therefore, it does not take into account the results of the more recent fires and other potential land use activities which may or may not have affected the erosion potential. Wildfires, including the 2007 Poomacha Fire are discussed in greater detail in the Fire History and Management section located in the Basin Profile (pp.35-39).

Figure 4. Post-Poomacha Fire (fall of 2007) photo of exposed hydrophobic soil on a steep slope within the Northern Subbasin.

Fluvial Geomorphology

The Northern Subbasin consists of the streams flowing mostly out of the Agua Tibia and Palomar Mountain ranges. These streams contain eroded sediment from the steeper slopes and deliver them to the SLR River which, in turn, redistributes sediments with its floodplain and also transports sediments further downstream. Most of these streams contain extensive areas where the stream gradient is greater than 4%

(Basin Profile, Figure 14).

The most recent full habitat inventory stream surveys in the subbasin were limited to Pauma and French creeks. French Creek is located in the headwaters of the Pauma Creek watershed; the survey provided baseline data for mountainous stream habitat containing native, rainbow trout. Pauma Creek was surveyed in three separate reaches to obtain reach conditions in the: 1) lower canyon, 2) middle canyon, 3) upper canyon (near confluence with French and Doane creeks. The lower and upper reaches were B Rosgen channel types, while the middle reach was an A channel type (Table 4). These reaches and channel types may be representative of other streams in the subbasin. Type A reaches are steep, narrow channels with cascading, step-pool habitat types that contain high energy/debris transport associated with depositional soils. Type B channels are moderately entrenched, moderate gradient, riffle dominated channels with infrequently spaced pools. The banks are usually stable (canyon walls) as well as the plan and profile. They have a moderate relief with moderate sinuosities and stable stream banks (Flosi, et al. 1998).

Table 4. Channel types in surveyed streams of the Northern Subbasin.

Stream	Reach	Length (feet)	Channel Type
Pauma Creek	1	1,373	B2
Pauma Creek	2	1,396	A2
Pauma Creek	3	3,330	B2
French Creek	1	1,374	B2

Vegetation

The predominant vegetation cover type as described by the USFS CALVEG data is mixed sagebrush/chaparral, covering 55.27% of the Northern Subbasin (Figure 5 and Table 5). This cover type is split primarily between lower montane/mixed chaparral and California sagebrush vegetation types. Hardwood forest/woodland was the second most abundant cover type at 15.93%. Canyon live oaks, coast live oaks, black oaks, and Engelmann oaks compose the majority of this cover type. Agriculture, consisting of orchards, pastures, crops, and nurseries is the third most abundant cover type at 11.6 %. Agriculture is the dominant land use in the lower elevations of the subbasin as large areas of native habitat have been converted to agricultural practices. Moreover, similar to the Coastal and Southern subbasins, this figure does not reflect the overall percentage of acres dedicated to the growing of crops or livestock. Within the Northern Subbasin, pastures used for livestock grazing may not be included in this vegetation designation since land use is often difficult to remotely ascertain. For this reason, it can be assumed that areas mapped as annual grasslands may also be agricultural in nature.

The Northern Subbasin contains the greatest percentage of mixed conifer/hardwood woodland (based on each subbasin's acre totals) out of the five subbasins. This cover type is located in the upper elevations of the Peninsular Range. This mountain range also contains the only quantifiable percent of coniferous trees within the basin. As the range extends into the Upper Subbasin, a small percentage of coniferous trees are also present in those localities.

The only significant urban/residential area in the subbasin consists of the communities of Pala and Pauma Valley, which are both located just north of the river, in close proximity to Highway 76. Residential areas continue to expand, but at slower rates than in the Coastal and Southern subbasins. The impact of agriculture and urban/residential areas in the subbasin are described further in the Land Use Section.

Non-Native Plants

Unlike the Coastal and Southern subbasins, non-native, invasive plants are not as problematic in the Northern Subbasin. Invasive plants, aside from non-native grasses which are widespread and common, have generally been found in smaller numbers in a few locations and do not pose the threat of overtaking large areas of habitat as is the case in the Coastal and Southern subbasins. See the Upper Subbasin's Non-Native Plants section for a more detailed discussion of the effects of non-native grasses.

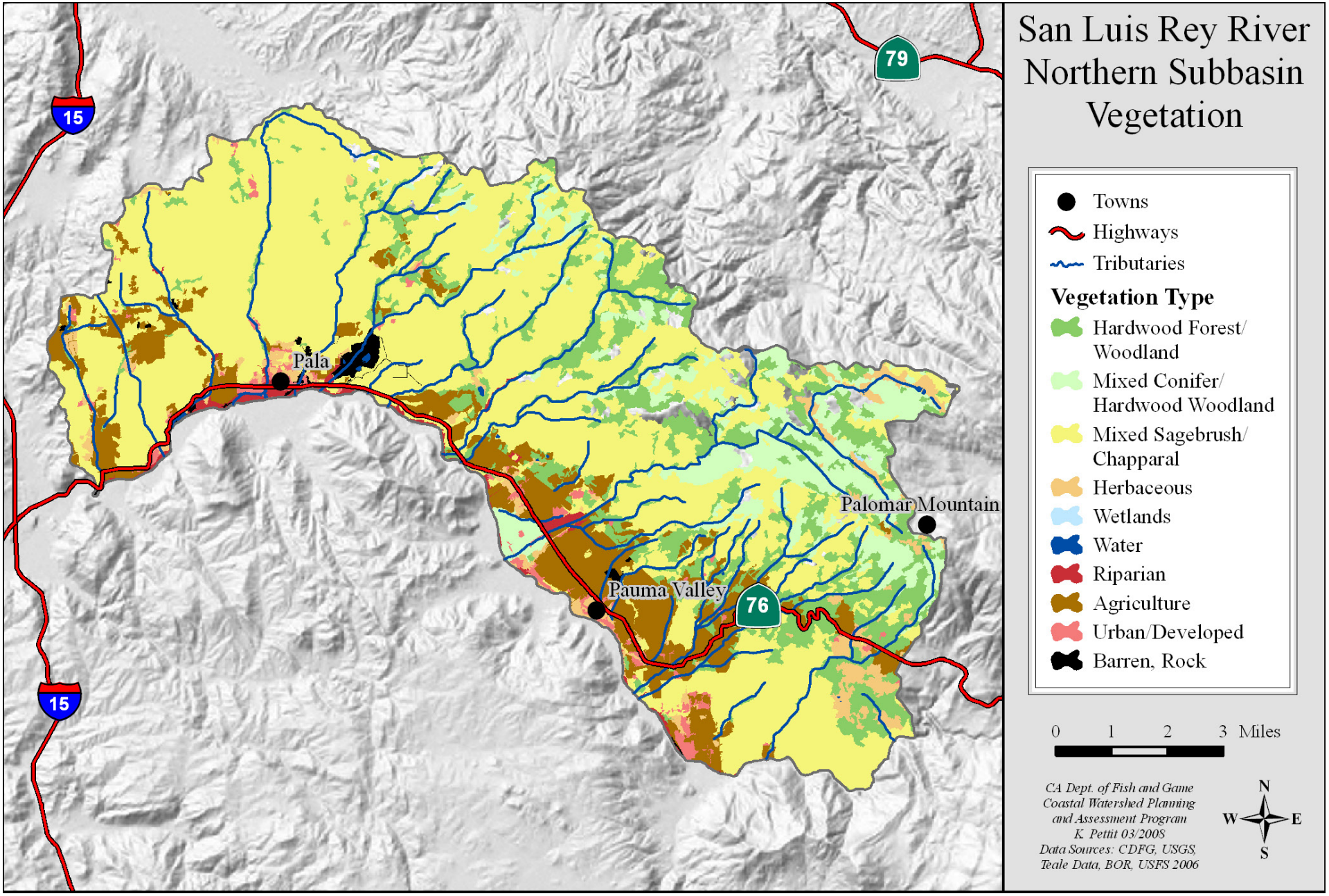

Figure 5. Vegetation of the Northern Subbasin.

Table 5. Vegetation of the Northern Subbasin.

Vegetative Cover Type	Percent of Basin	Primary Vegetation Type	Percent of Cover Type
Mixed Sagebrush/Chaparral	55.27	Basin Sagebrush	0
		Buckwheat	3.2
		California Sagebrush	29.9
		Ceanothus/Mixed Chaparral	0
		Chamise	5.5
		Lower Montane Mixed Chaparral	59.7
		Manzanita Chaparral	0
		Upper Montane Mixed Chaparral	1.3
		Southern Mixed Chaparral	0.28
		Other	0.1
Hardwood Forest/Woodland	15.93	Black Oak	9.3
		California Sycamore	0
		Canyon Live Oak	34.6
		Coast Live Oak	34.2
		Engelmann Oak	8.4
		Eucalyptus	0
		Interior Mixed Hardwood	0
		Non-native/Ornamental Hardwood	13.4
Agriculture	11.62	Agriculture	9.5
		Orchard Agriculture	72.4
		Pastures and Crop Agriculture	19.1
Mixed Conifer/Woodland	9.02	Bigcone Douglas - Fir	54.7
		Coulter Pine	12.7
		Mixed Conifer - Pine	8.8
		White Fir	17.6
		Nurseries	6.2
Herbaceous	3.56	Annual Grasses/Forb Alliance	77.3
		Non-Native/Ornamental Grass	0.10
		Perennial Grasses and Forbs	23.6
Urban/Development	1.64	Urban/Development	100
Scrub Oak	1.32	Scrub Oak	100
Riparian	0.84	Baccharis (Riparian)	55.2
		Fremont Cottonwood	0
		Riparian Mixed Hardwood	33.3
		Riparian Mixed Shrub	9.6
		Willow (Shrub)	1.9
Barren/Rock	0.66	Barren	5.2
		Tilled Earth	15.1
		Urban related bare soil	79.7
Water	0.20	Water	100

These statistics exclude the classification of water. Data from CALVEG, USFS

Land and Resource Use

Historic Land Use

Prior to the settlement of Europeans, the Northern Subbasin was inhabited by the local Indian tribe comprised of the Luiseño people. While acorns from the numerous oaks in the area provided a staple for their diet, there was a variety of other food sources. The SLR River was a prominent natural feature of the Luiseño territory providing the residents with subsistent food sources that included freshwater fish, a wide variety of plants and seeds, birds, and small and large mammals. In the 1760s the Spaniards were the first Europeans to arrive in the basin. They entered in

the Coastal Subbasin and began moving and settling throughout the basin. One of the earliest settlements in the Northern Subbasin coincided with the establishment of the Mission San Antonio De Pala, located in what is now the town of Pala. This mission was founded by Father Antonio Peyri OFM on June 13th, 1816. The location of the mission was based upon the perennial water supplies of Pala Creek and the nearby SLR River. Aside from the mission, prior to California becoming a state, a few early settlers were given grazing rights on large lots of land through enormous land grants, called ranchos, whose property rights were retained by the Mexican government. The ranchos were phased out by the late 1830s.

Similar to the Southern Subbasin, by the 1850s, the Northern Subbasin had slowly become a popular area for a greater number of homesteaders. These homesteaders utilized the area for cattle grazing and growing a variety of crops. Eventually, Mexican and subsequently, American settlers forced Indian tribes off their lands and onto reservations. The Luiseño people were placed on the 10,000-acre reservation (Pala Indian Reservation) in what is now the town of Pala. Shortly afterwards, in the early 1900s, the Cupeños Indian Tribe was removed from their residence in Warner Valley in the Upper Subbasin, and relocated to the Pala Indian Reservation. The Pauma Indian Reservation was created in 1891, at the foothills of the Palomar Mountains, adjacent to Pauma Creek.

With the completion of the Southern California Railway in the 1880s and the highway connecting Los Angeles with San Diego in the 1920s, the Coastal Subbasin continued to expand its populations, but the Northern Subbasin experienced minimum growth. Over time, more of the Northern Subbasin was converted to small and large-scale farming operations. By the early 2000s the Indian tribes had built casinos and later expanded the size and capacity of these casinos; thus more people were drawn into the area, and Highway 76 now experiences heavy vehicular traffic.

Agriculture

Aside from land that was set aside for Indian reservations, agriculture was the most significant historic land and resource use in the Northern Subbasin. Agriculture grew throughout the basin as settlers utilized the foothills of the Peninsular Range for growing a variety of crops such as wheat, corn, beans and other leguminous plants as well as the area along the SLR River for the grazing of cattle, sheep, and horses. As annual grasses became established, replacing perennial native grasses, livestock numbers declined dramatically. With the drop in livestock production, farming of grain and grain hay expanded on homestead lands in the subbasin. Settlers relied on the water sources of streams flowing out of the Peninsular Range and the SLR River. The first commercial mill in the region was a grist mill located in the area of the Wilderness Gardens County Park. Powered by the SLR River, the mill served farmers throughout the region grinding corn and wheat into flour. As agricultural operations expanded, numerous citrus orchards became established by the 1930s. While citrus is still an important crop, many areas have more recently been planted with avocado groves. Imported water supplies and groundwater sources provided the needed resources for many intensive agricultural enterprises in the Northern Subbasin and throughout the watershed such as truck crops, flowers, and nurseries.

Gravel Mining

Gravel mining operations have been an important industry in the SLR River Basin, which has provided the San Diego region with a major source of sand and gravel aggregate. Sand mining operations have extended from the river into the Northern Subbasin.

The last major mining operation was the Felton Mine site operated by Hansen Aggregates. This was an in-stream mine that encompassed 225 acres and mined an average of 600,000 tons of sand per year during the late 1990s and early 2000s. This sand accounted for about 20% of all the concrete used in San Diego County (Chester 2000). Their Major Use Permit expired in 2005 and the site was dedicated as open space. Reclamation and mitigation occurred on this land, which included several large ponds, located in the southwestern portion of the Northern Subbasin.

The cumulative effects of the mining operations have been discussed extensively in the Basin Profile, Coastal, and Southern subbasin sections, but it is important to note that biologically, the degraded streambeds from previous mining operations causes lowering of groundwater levels and loss of riparian vegetation due to erosion and die-offs from the lack of water. Moreover, degraded streambeds generally create a minimal low flow channel that implicates a decrease of cover, loss of deep holding pools for adult migration and juvenile rearing, and overall reduction in complex, instream habitat needed for the successful completion of the lifecycle stages of steelhead.

Current Land Use

A number of the land use issues impacting the natural resources and riverine habitat in the Southern Subbasin

are also present in the Northern Subbasin. Some of these impacts result from the same types of anthropogenic activities and currently proposed projects that will have a detrimental effect on the natural resources of the subbasin.

Agriculture

Agriculture is the fourth largest industry in San Diego County (SLR Watershed Council 2000), generating approximately five billion dollars a year in economic output. The SLR basin is a major agricultural area in San Diego County. The warm climate of the Northern Subbasin makes it ideal for growing avocados, citrus fruit, nursery stock, and flowers. Cattle and other livestock operations still persist as well. Numerous small and large-scale farms populate the subbasin including land adjacent to the river and its tributaries.

The large agricultural production in the basin contributes to reduced water quantity and most likely quality as well. Although many agricultural producers rely on water from imported sources (the Colorado River and State Water Project) (SLR Watershed Council 2000), water extraction pumps were observed during CDFG 2007 field surveys in or near streams and flood plains within the Northern Subbasin. These pumps may divert surface flows or groundwater, which normally contributes to tributary and SLR River flows, to assist crop production. Pauma Creek, for example, is used primarily as a source of irrigation water for agricultural operations within the subbasin. Although not used as a drinking water source, it is hydraulically linked to the aquifer that supplies drinking water. These ground and surface water diversions on Pauma Creek hinder the movement of trout from just downstream of the canyon's mouth to its confluence with the SLR River.

With uncertainties surrounding the delivery of imported water as well as rising costs, a greater importance will be placed on local sources such as groundwater. Increased groundwater pumping would have numerous detrimental impacts to the river and riverine habitat such as lowering the groundwater table, reducing potential surface flows, and placing additional stress on the water demands of riparian plant species. In Gomez Creek, PSMFC biologists witnessed near streamside groundwater pumping, which resulted in a dry streambed; whereas, areas with little to no groundwater pumping retained surface flow. The drawing down of surface flows within the subbasin would minimize the overall potential habitat available to juvenile trout and degrade conditions in areas maintaining flowing water by reducing surface flows, thus potentially raising water temperatures and lowering dissolved oxygen levels.

Much of the farmland in the Northern Subbasin is located on the hillsides and foothills of the Peninsular ranges; therefore, there is the potential for runoff of groundwater and pesticide water into the local streams impacting water quality. Due to the large-scale farming operations and concerns over water quality, the use of pesticides, sediment control, and runoff water, San Diego County is closely scrutinized by the local Agricultural Commissioner's Office. Growers must be concerned with issues involving use of pesticides. Growers are increasingly required to reduce and capture runoff water, re-use tailwater and utilize other best management practices to minimize the effects of agriculture on water quality and water bodies in the areas where they farm. See Agriculture section in the Basin Profile of the assessment for further detail of the impacts of agriculture (pp.43-45).

The recent impact of rising water prices has caused a number of farmers to remove some crops such as citrus and avocados. Due to competition from Mexico, rising cost of water, fuel and other operational costs, agriculture is becoming increasingly marginal in Southern California. There is a concern that more agricultural lands will be taken out of production because these rising costs, and housing developments will occupy current agriculture lands; agriculture and its benefits to the local and regional economy will be permanently lost.

Tribal Indian Lands

Almost a third of the Northern Subbasin is held in Indian tribal lands, primarily between the Pala and the Pauma Band of Mission Indians and to a lesser extent, the Rincon Band of Mission Indians and La Jolla Bands of Luiseño Indians. A portion of the communities of Pala and Pauma Valley is made up of these respective tribal members. The Pala Band of Mission Indians consists of 918 members, the majority of which live on the 12,273-acre reservation (http://www.palatribe.com/). These reservation lands also extend into the Southern Subbasin. The Pauma Tribe consists of approximately 176 tribal members, many living on the 5,877-acre reservation, entirely within the Northern Subbasin. Overall, most of the tribal lands are sparsely populated with single family dwellings. The tribes' reservations support agricultural that primarily grows citrus and avocados.

Gaming casinos are a primary source of income for the Pala, Pauma, and Rincon Indians. The Pala and Pauma Band of Mission Indians currently operate casinos located in the subbasin. The Pala Casino Resort Spa is a multi-functional, Vegas-style casino occupying

approximately 650,000-square feet with a 507-room hotel; whereas, the Casino Pauma is considerably smaller with approximately 35,000 square feet of gaming, dining, and entertainment activities. The Pauma tribe is looking to expand their current casino operations in the near future (Tierra Environmental Services 2008). Pauma has proposed to build a large, 19-story, 400-room hotel in addition to expanding the casino to 102,372 square feet. This development is estimated to add approximately 4,000 vehicles per day on Highway 76 (Soto 2008). While the proposed Pauma casino expansion is projected to use less water through conservation methods than the current casino and adjacent fruit orchards, it will nonetheless place demands on limited local water resources.

Urbanization

Most of the Northern Subbasin remains rural in nature with low-density housing and numerous small and large-scale agricultural operations. The only major population center in the Northern Subbasin is located in the small communities of Pala and Pauma Valley. The 2000 population census indicated that 6,156 people lived within the Community Planning Areas (CPAs) of Pala–Pauma. This figure is expected to only slightly increase to 6,908 by the year 2020. This is a small, sustainable increase compared to many other areas located in the basin. This insignificant amount of growth should only have a slight impact to the natural resources including water quality and quantity of the area. However, there are projects, described in more detail below, which are currently in the planning stages that will have considerable impacts on the subbasin's natural resources and native habitats.

Gregory Canyon Landfill—The proposed Gregory Canyon Landfill, which is discussed more extensively in the Coastal and Southern subbasin Current Land Use sections, is located in the Southern and Northern subbasins, a couple of miles east of Interstate 5 and primarily just south of California Highway 76 (partially extending north of Highway 76 into the Rice Canyon watershed). This 1,770 acre landfill, which is currently in the permitting stages, is a response to the increased need for waste storage as a result of the growth that has and will continue to occur in Northern San Diego County. This proposed landfill has caused a broad and considerable amount of community concern, from a diverse base of interest groups. Organizations that have opposed the landfill include but are not limited to: The Pala Band of Mission Indians, the Federal Bureau of Indian Affairs, the City of Carlsbad, The City of Oceanside, the Natural Resources Defense Council, and the SLR Watershed Council. The SLR Watershed Council has voiced its concerns on the landfill's impacts to air quality, water quality, transportation, wildlife, cultural and historical resources, and general water quality. The Council was particularly concerned with the location of the landfill with respect to the aquifer of the San Luis Rey River (SLR Water Council 2000). The potential exists for the landfill to leak, causing contamination of the groundwater below.

Warner Ranch housing development—As planned, this would be an approximate 900-home development on the 500-acre Warner Ranch located on the north side of Highway 76 just west of the Pala Casino. Considering the average four-person household in San Diego County uses ½ an acre foot of water each year (http://www.sdcwa.org/ about/), a development of this size would require vast amounts of water in an area that is already struggling to maintain its water resources. Currently, this proposed housing development is considered somewhat speculative.

Resort Casinos—The proposed expansion of the Indian gaming casino was discussed in the Indian Tribal Lands section above.

Recreational

Although the majority of land in the Northern Subbasin is held in private or Indian Reservation lands, there are recreational opportunities on state and federal lands. Palomar State Park, located in the northeast corner of the subbasin, is a 1,882 acre park that provides camping, hiking, picnicking, and trout/catfish fishing in Doane Pond and trout fishing in Pauma Creek, Doane Creek, and French Valley Creek. The 2007 Poomacha Fire burned through portions of the park, but the fire appeared to be a low intensity fire. While most of the ground cover and areas of forest understory were burned, larger trees displayed only lower fire scars. Firefighters on scene described the fire as a low intensity ground fire that moved through the area rather quickly without getting into the crown of the trees.

Recreational opportunities also exist in the Cleveland National Forest, which occupies portions of the mountain ranges in the Northern Subbasin. Due to the steep nature of this range, there is relatively little access to these areas of the forest. Mount Olympus Regional Park lies between the Gomez Creek and Pala Creek. This park, consisting of 661 acres, provides protection for native chaparral communities and has limited hiking opportunities.

Mining

Currently there are no mining operations in the Northern Subbasin. The nearest proposed mine is the

Rosemary's Mountain Quarry site, located 1.5 miles east of Interstate 15 and Highway 76. This mine is set to begin operations in 2009/2010 (Jones 2008) and has been discussed in further detail in the Basin Profile and Coastal Subbasin Current Land Use sections.

Fish Habitat Relationship

Fishery Resources

Steelhead trout were historically found in the SLR River and in some of the tributaries of the Northern Subbasin. The steelhead were found in sufficient numbers to provide the Indian tribes with a subsistence food source and, subsequently, the local region with recreational fishing opportunities. Anecdotal accounts from Pauma Indian Tribal elders spoke of annual runs and ceremonies associated with large fish, presumably steelhead, on the SLR River (USFWS 1998). As steelhead migrated through the SLR River, some of them most likely utilized extensive habitat located in Northern Subbasin tributaries for spawning and rearing before returning to the SLR River and eventually the ocean as adults or out-migrants (juvenile fish). One of the Pauma Indian Tribal member elders described catching trout by hand in pools in Pauma Creek (USFWS 1998). See Basin Profile, Fishing and Historical Accounts of Steelhead Runs for additional information.

Currently, resident populations of native rainbow trout exist within the Pauma Creek watershed (Lion Creek, Doane Creek, and French Creek). Although Pauma Creek and Lion Creek were originally stocked by a local landowner with rainbow trout from the state hatchery at Sisson, CA in the late 1800s (Greenwood 1995), recent genetic sampling performed on these fish (NOAA 1999) concluded that "it seems more than likely that these fish are part of a native coastal *O. mykiss* lineage." Furthermore, the report stated, "these populations may be reasonable choices to consider in efforts to re-establish anadromous runs in their respective streams." The NMFS Southern California Steelhead Recovery Plan (2009 *Draft*) recognizes the importance of these resident trout populations above barriers because they may produce progeny, with smolt-like characteristics, that emigrate downstream to the ocean. The potential for the resident trout in Pauma Creek to emigrate successfully downstream of the Highway 76 bridge to the SLR River is extremely unlikely if not impossible. Rescue operations have occurred in recent years to capture and relocate trout that have been washed down from the stream habitat in the canyon to unsuitable habitat upstream of Highway 76. This section of creek tends to go dry in the summer and contains little to no cover from possible bird or mammal predation on the trout.

Recent sightings of steelhead in the subbasin have been limited. However, no annual, or even periodic, systematic surveys have been conducted within the Northern Subbasin tributaries. Consultant biologists observed two large rainbow trout (15-16 inches in length) in lower Gomez Creek during a September 2005 survey (Dudek 2007). However, these were most likely hatchery, resident rainbow trout, as an upstream landowner previously stocked rainbow trout in Gomez Creek for recreational fishing. See Current Conditions for further details.

Access into and out of streams in the Northern Subbasin is severely limited due to insufficient stream flows and fish passage barriers as a result of anthropogenic activities. Steelhead and resident trout would have a difficult time entering and exiting most of the critically important streams. Pauma Creek, Pala Creek, Frey Creek, and Gomez Creek all have man-made barriers in their lower watersheds that would prevent steelhead from accessing potentially suitable spawning and rearing habitat. It is unknown if Agua Tibia Creek contains any fish passage barriers.

Habitat Overview

Historic Conditions

Similar to the other subbasins, there has been a limited amount of coordinated stream surveys performed in the Northern Subbasin. Prior studies pertaining to streams in the Northern Subbasin focused on the genetic makeup of the native trout found in Pauma Creek and its tributaries. While a few infrequent surveys were performed on the SLR River and a couple of its tributaries in the Upper Subbasin, CDFG surveys of the Northern Subbasin streams were not detected during a literature review; therefore, historic stream habitat conditions in this subbasin are relatively unknown.

Adjacent to the Northern Subbasin, the SLR River was once a perennially flowing river with a robust, functioning riparian habitat. According to the Pauma Band's website, "Pauma" describes the area's principal feature, the San Luis Rey River, and the name "Pauma" translates as "place where there is water" (http://www.pauma-nsn.gov/index.php). These year-round flows allowed adult steelhead to migrate up the SLR River and enter the subbasin's tributaries where potential spawning and rearing habitat was located. Deriving water supplies from higher elevations and supplemented by natural springs, some of these tributaries also maintained perennial flows, providing year-round habitat for trout. Historically, several

creeks were noted as steelhead/rainbow trout breeding streams. Allen Greenwood and Mike Pottorff of San Diego Trout, who have compiled anecdotal information from local Indian tribe members and longtime residents of the area, surmised that Pala Creek, Agua Tibia Creek, Frey Creek, and Pauma Creek all contained steelhead/trout at one time. It is unknown whether steelhead used other tributaries within the subbasin.

Table 6. Habitat observations made in the Northern Subbasin.

Stream	Date Surveyed	Source	Habitat Comments	Barrier Comments
Pauma Creek	01/18/2008	CDFG 2008	Reconnaissance level survey to: 1) document the post-burn impacts to the stream from the October 2007 fire, 2) identify and map the barriers to fish migration. Evidence of high flow events from recent storms was apparent in many areas. The storms have washed down a large amount of sediment into the stream from the steep, and now mostly denuded, hillsides that comprise the Pauma Creek Watershed. However, most of the sediment is moving through this area, which is not surprising given the high gradient nature of the stream. The accumulation of sediment in the survey area was relatively minor and most of the gravels should provide high quality spawning habitat. In addition, although there is a layer of fine sediment in many pools, it has not reduced pool volume appreciably, and good rearing/feeding/holding habitat exists throughout the survey area. Very little riparian vegetation was burned and area supports a good canopy.	Seventeen natural barriers (7 partial/10 total) and one-man-made barrier located between RM 3.4 and 4.2

Current Conditions

Stream habitat inventories in the Northern Subbasin conducted by CDFG were limited to Pauma and French creeks. Pauma Creek was surveyed in three separate sections from the Cleveland National Forest property boundary upstream to near its origination at the confluence of Doane and French creeks in Mount Palomar State Park. All of the surveys began above the current accessible habitat for steelhead, but provide a snapshot of the habitat conditions, particularly in the lower two reaches in Pauma Creek, that could be available for steelhead if the Highway 76 Bridge (RM 0.8) over Pauma Creek was modified to allow for fish passage (Figure 8). Upper Pauma and French Creek were surveyed, in part, to acquire baseline data of habitat conditions in stream reaches that supported known populations of rainbow trout. It is important to note that the lowest reach, which began at the Forest Service property boundary, was conducted in January, 2008, a couple of months after the Poomacha Fire. This fire contributed a large amount of debris and sediment to the creek (see Wildfire pp. 8-9). Flows were also substantially higher in the winter as surveyors estimated surface flows at 4.5 cfs compared to summer flows of 1cfs.

A general, reconnaissance level habitat survey was performed on approximately 400 feet of Gomez Creek, about 2.8 miles upstream of its confluence with the SLR River. This survey in June, 2008, was performed by a PSMFC fisheries biologist; at the time of the survey the biologist also deployed a stream temperature data logger. Stream habitat conditions were described as: low flow conditions (<1cfs); cool water temperatures; canopy density was estimated between 85 and 95%, composed primarily of large oaks; spawning gravels were present but not in great numbers; streambed substrate varied, ranging from sand to large boulders; sand/gravel/small cobble were the dominant substrate types; pools were relatively shallow (the deepest pool was 18 inches) and few in number; and pool shelter appeared relatively poor with little cover besides boulders and some undercut banks. A greater amount of Gomez Creek needs to be surveyed to determine overall habitat suitability, but it appears that it could support a small trout population. While this stretch of Gomez Creek retained perennial flows, the landowner noted that upstream sections of the creek were dry due to water extraction for crop production and overall drought-like spring conditions.

In September of 2005, during a follow up survey in Gomez Creek, consulting biologists observed two trout (one was caught via rod and reel, (Figure 6). No scale samples were taken at the time of observation; therefore, it is impossible to determine their origin. However, based on conversations with other landowners and physical appearance of the fish, it is believed that these trout were hatchery derived rainbow trout, planted by a landowner upstream of where they were observed/caught for recreational fishing purposes. They were most likely washed downstream during the significant rain events in the 2004/2005 winter/spring. It is important to note that these trout were able to survive in the creek throughout the spring and summer months, which may indicate that conditions are suitable for trout rearing in Gomez Creek.

Figure 6. Photo of trout caught in Gomez Creek in September 2005 (Dudek 2007).

Figure 7. Mid to upper Pauma Creek after the 2007 Poomacha Fire. Note riparian area remained intact.

Figure 8. Steelhead/trout barriers on lower Pauma Creek.

Top photo: Pauma Creek below Highway 76 (RM 0.8);
Bottom Photo: Pauma Creek, concrete wall barrier located approximately 2.4 miles upstream of Highway 76.

Currently, the CDFG and Trout Unlimited are monitoring stream water temperatures and conducting monthly water quality sampling in Gomez Creek. The 2008-2009 sampling will provide valuable information on the range of water temperatures experienced during the hot summer and early fall months and water chemistry data throughout the year. Considering juvenile steelhead trout spend at least one year rearing in freshwater before migrating to the ocean, these data will help determine habitat suitability, identify potential limiting factors, and if necessary, make habitat improvement recommendations.

Stream habitat inventory methods were conducted on Pauma and French Creek according to methods outlined in the *California Salmonid Stream Habitat Restoration Manual* (Flosi, et al. 1998). Appendix II consists of the full Pauma Creek Stream Inventory Report.

Analysis of Pauma Creek includes the following:

- Canopy Density;
- Habitat Type Categories;
- Pool Characteristics:
- Pools by maximum depth;
- Pool shelter;
- Cobble Embeddedness.

Table 7. Northern Subbasin streams surveyed by CDFG.

Stream	Year of Survey	Survey Length (miles)	Percent of Permanent Stream Surveyed	Number of Reaches
Pauma Creek	2007 & 2008	1.17	19	3
French Creek	2007	0.26	15	1
Doane Creek*	2008	0.7	35	1
Gomez Creek*	2008	0.1	5	1

* Full habitat inventories were not performed on these tributaries

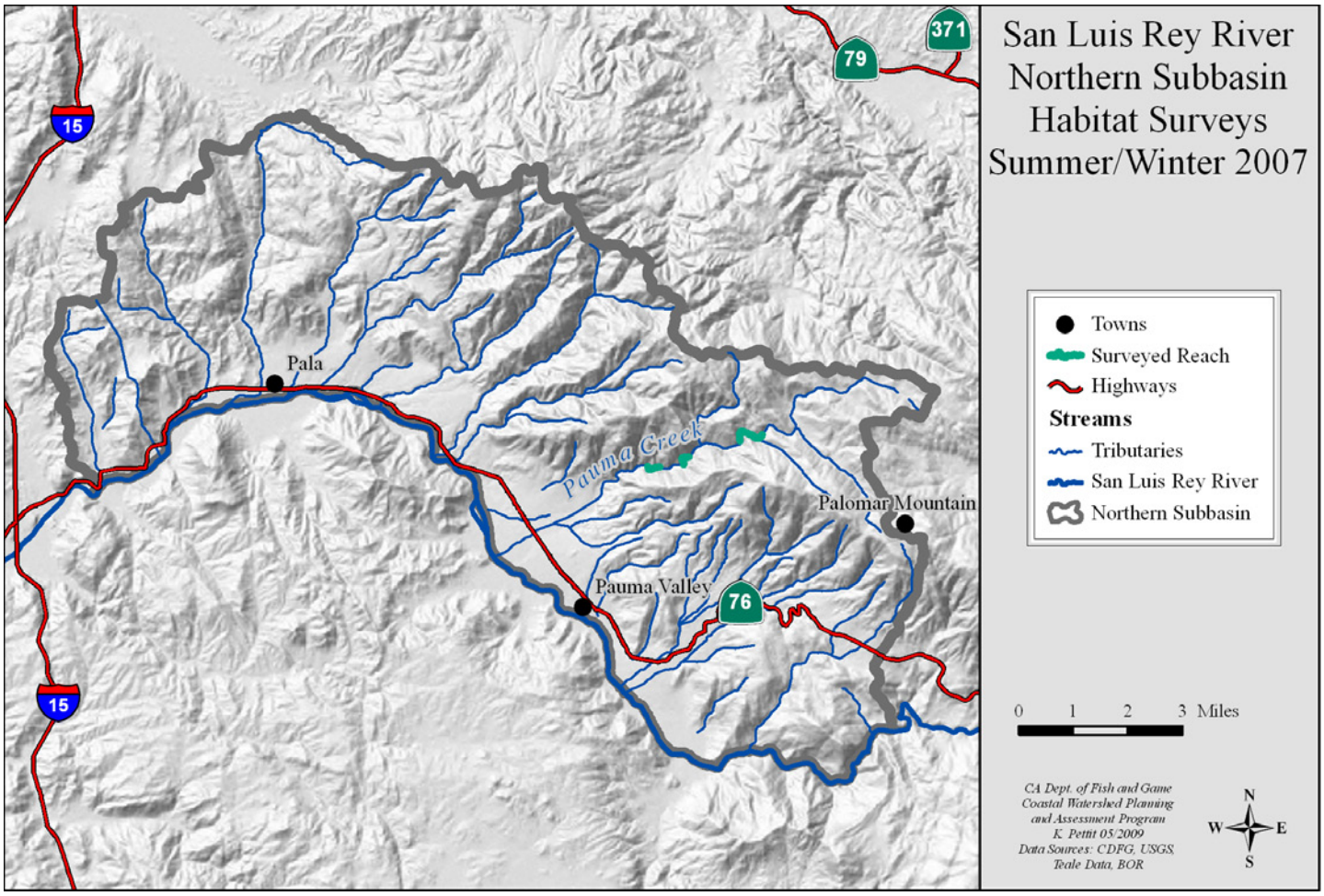

Figure 9. CDFG 2007 summer and winter habitat surveys in the Northern Subbasin.

Canopy Density

Significance: Streamside canopy density is a measure of the percentage of wetted stream that is shaded by riparian tree canopy. Stream water temperature can be an important limiting factor of salmonids, and tree canopy provides shade to reduce direct sun light from increasing water temperatures. Moreover, near-stream forest density and composition contribute to microclimate conditions that help regulate air temperature, which in turn, influence stream water temperature. Riparian vegetation also bind the stream bank soil and provide resistance to the erosive forces of water, functions as the base of the food chain for biological stream life, helps store water along the stream corridor during the raining season for slow release to the stream in drier seasons, and creates desired complex instream habitat by providing woody debris to streams (Riley 1998). Generally, canopy density less than 50% by survey length is below target values and greater than 80% fully meets target values.

Findings: Canopy density measurements in Pauma Creek obtained suitable values on all three reaches (Figure 10 & Figure 12). The overall Northern Subbasin EMDS canopy density condition truth score is fully suitable. In Reaches 1 and 2, the entire canopy coverage was provided by deciduous trees, mostly in the form of mature alders and to a lesser extent, oaks, and willow. Conifers, primarily white fir, sugar pine, and incense cedar, supplied almost 25% of the canopy in Reach 3. Reach 2 had the highest canopy density as numerous riparian trees provided cover over the majority of the creek.

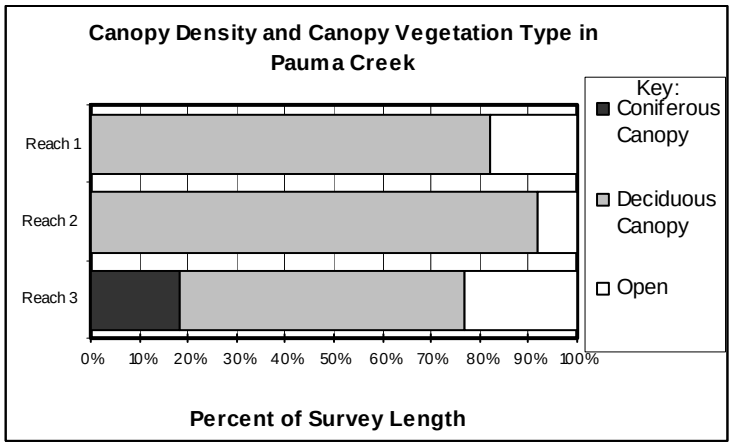

Figure 10. The relative percentage of deciduous and open canopy covering the surveyed reaches of Pauma Creek.

Averages are weighted by unit length to give the most accurate representation of the percent of a stream under each type of canopy. Pauma Creek reaches are listed from south to north within the watershed.

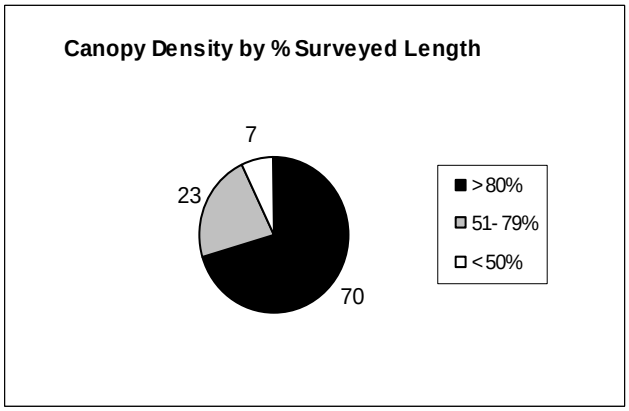

Figure 11. Canopy Density in Pauma Creek.

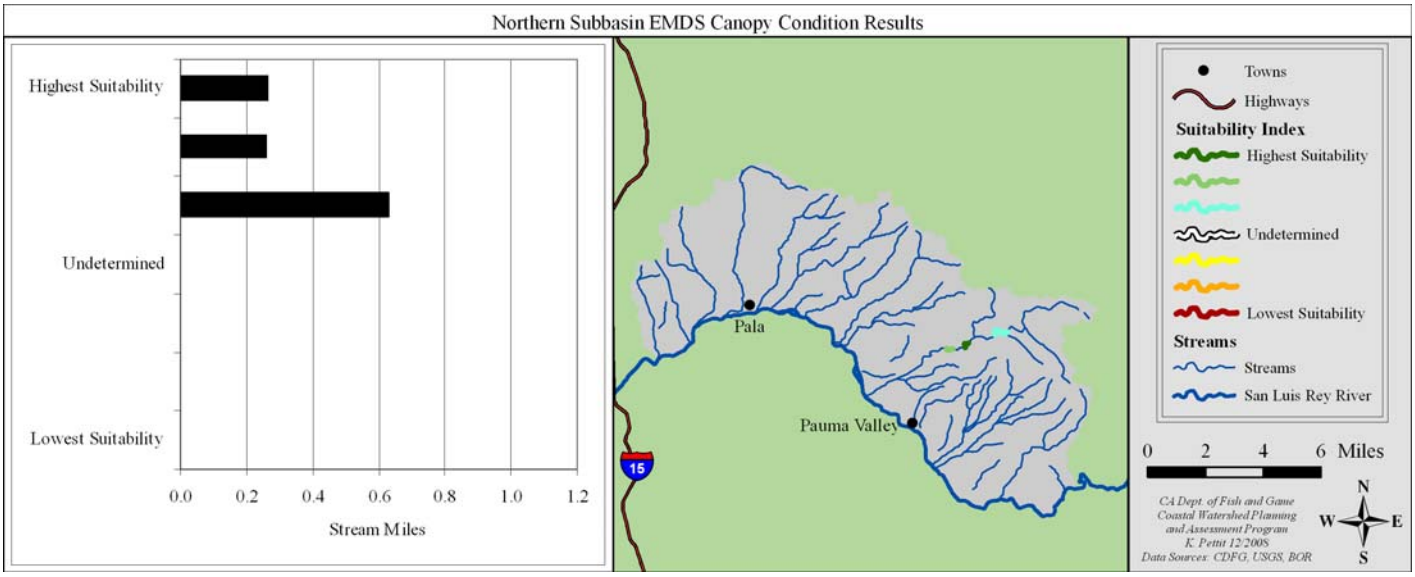

Figure 12. EMDS canopy results for Pauma Creek, Northern Subbasin by surveyed stream miles.

Habitat Categories

Significance: Productive anadromous streams are composed of a balance of pool, riffle and run habitat and each plays an important role as salmonid habitat. Pools are not only the preferred habitat for yearling and older juvenile steelhead, but also provide important resting areas during adult winter/spring migration. Looking cumulatively at pool, riffle, and run relationships helps characterize the status of these habitat types and also provides a measure of stream habitat diversity and suitability for fish. A pool: riffle ratio of approximately 1:1 is suggested as a desirable condition for most wadeable, anadromous, fish bearing streams, but it is not applicable for evaluating salmonid suitability of all stream reaches and channel types (Rosgen 1996). However, pool:riffle:run relationships showing an over abundance of riffles or runs may indicate aggraded channel conditions or lack of scour objects needed for pool formation. Additionally, pool frequency by percent length is preferable to pool frequency by occurrence because the latter may give a false impression of health if there are numerous, shallow, short pools as a result of aggradation (NMFS and Kier 2008).

Findings: Reaches 1 and 2 had a similar percent of total pools and percent of pools for the total survey length (Table 8), indicating that pool size was appropriate for the channel width of each reach, respectively. However, these reaches had a low percent of pool habitats based both on pool occurrence and overall pool habitat length. Reach 3 had a disproportional percent of pool occurrence when compared to the total percent of pool length for the reach. This would tend to indicate that pools in this reach are short and most likely shallow; therefore, these pools may lack complex instream habitat and not provide adequate protection from predators. Overall, pools occupied only 21% of the total length and 25% of the occurrence of the habitat inventory, which is much lower than the preferred amount. This would indicate poor stream habitat diversity.

Table 8. Pauma Creek percent occurrence and percent by length of pool, run, riffle, and dry habitats.

Stream	Stream Order	Survey Length (miles)	Pool, Riffle, Run Percent Occurrence	Pool:Riffle:Run Percent Total Length	Dry Percent Total
Pauma Creek Reach 1	2	0.26	30:23:40	27:23:50	0
Pauma Creek Reach 2	2	0.27	27:41:32	28:37:35	0
Pauma Creek Reach 3	2	0.63	23:48:28	15:53:32	2

Pool Depth

Significance: Pool depth and frequency are fundamental attributes of channel morphology and are largely dependent on the presence of large, roughness elements such as boulders, bedrock, root wads, and small and large woody debris in addition to channel type, stream gradient, sinuosity, and channel width. Evaluating the amount of deep pool habitat in a stream reach helps assessment of important channel characteristics for steelhead. Deep pools provide escape cover from high velocity flows, hiding areas from predators, and ambush sites for taking prey. Greater pool depth provides more cover and rearing space for older age (1+ and 2+) steelhead juveniles and creates better shelter for migrating and spawning adults. Generally, a stream reach should have 35–50% of its length in primary pools to be suitable for salmonids. Pauma Creek was evaluated as a second order stream. First and second order streams are comprised of primary pools that are greater than 2.0 feet deep.

Findings: Only 15% of overall survey length in the Northern Subbasin (Pauma Creek) was comprised of primary pools (Figure 13), which is well below the target values of 35-50%. Subsequently, none of the reaches surveyed in the Pauma Creek met EMDS pool depth target values (Table 9). Reach 2 had the most primary pools by survey length, with 25.5% (Table 9).

Reach 1 was surveyed in the winter of 2008, after the 2007 Poomacha Fire. While the number of pools and percent of pool length habitat were similar to Reach 2, located just upstream, pool depths were shallower and thus received a lower EMDS rating. As a result of the 2007 fire, Pauma Creek received large amounts of sediment input, which was readily observed throughout the stream, including the pools. In some pools, a foot or more of sediment was present, greatly reducing the overall pool depth. Barnhart (1986) states that “excessive sediment inputs that fill pools can greatly reduce a stream’s capacity to rear steelhead to smolt size.” It may take a couple of years, depending on rainfall, to push the sediment downstream, reestablishing deeper pools.

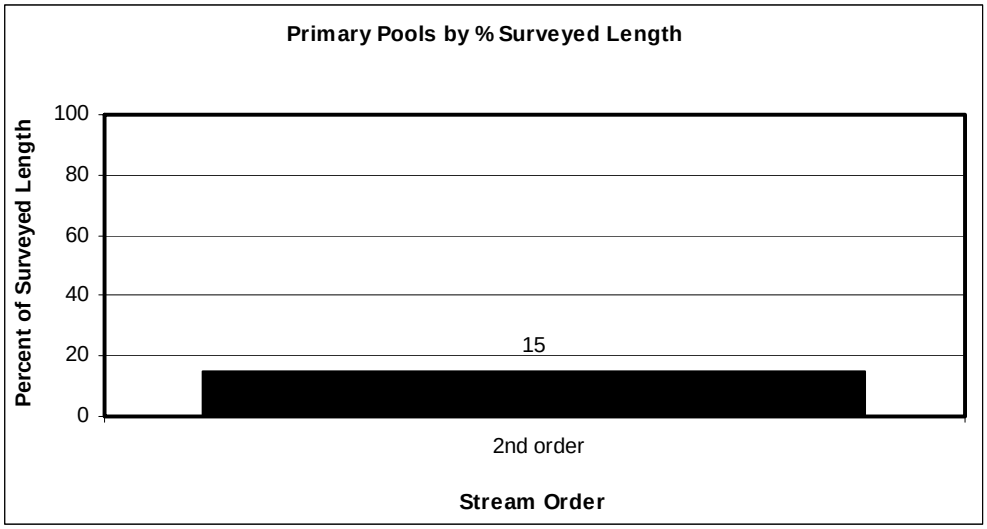

Figure 13. Primary Pools in Pauma Creek, Northern Subbasin.

Primary pools are pools greater than 2 feet deep in 1st and 2nd order streams

Table 9. Percent length of a survey composed of pools in Pauma Creek, Northern Subbasin.

Stream	Stream Order	Percent all measured pools by survey length	Percent pools of depth 2.0-2.49' by survey length	Percent pools of depth 2.5' - 2.9 by survey length	Percent pools of depth >3' by survey length	Percent pools within target range (>2.0') by survey length
Pauma Creek Reach 1	2	27.2	13.6	2.7	0	16.3
Pauma Creek Reach 2	2	28.2	7.2	18.3	7.1	25.5
Pauma Creek Reach 3	2	15.5	6.4	1.2	1.7	9.3

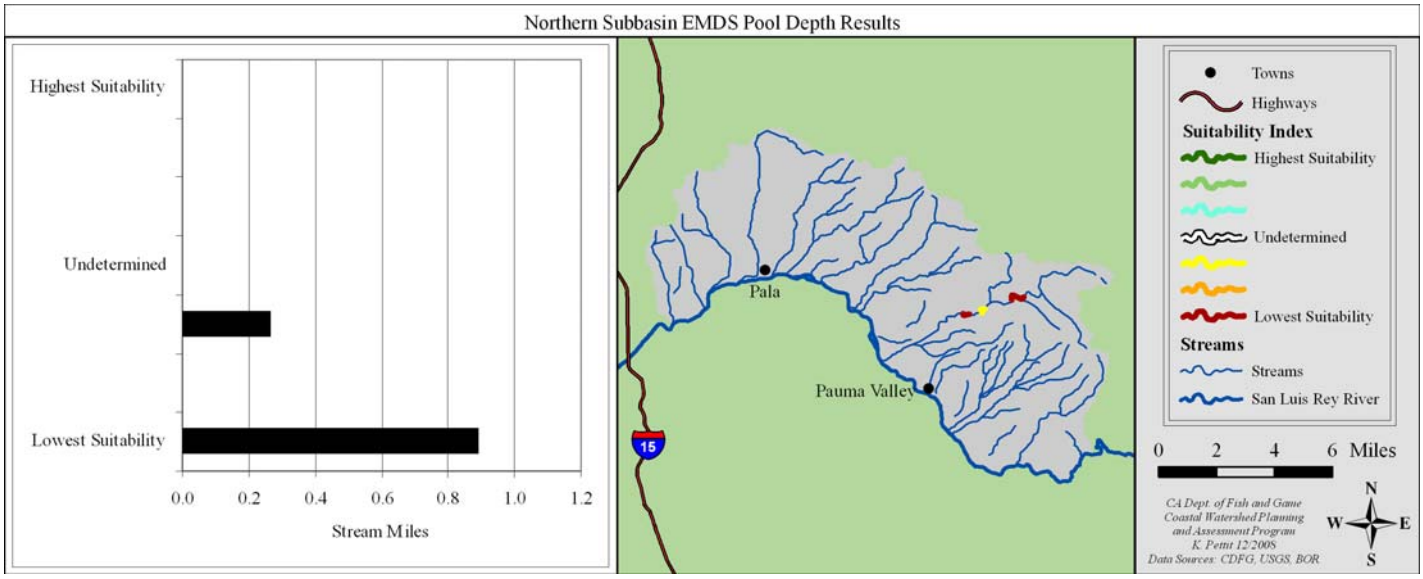

Figure 14. EMDS pool depth results for Pauma Creek, Northern Subbasin by surveyed stream miles.

Pool Shelter

Significance: The pool shelter rating is a relative measure of the quantity and percent composition of small woody debris, root wads, boulders, undercut banks, bubble curtains, and submersed or overhanging vegetation in pool habitats. These elements serve as complex instream habitat with protection from predation, rest areas from high velocity flows, and separate territorial units to reduce density related competition. Shelter ratings of 100 or less indicate that shelter/cover enhancement should be considered. Large woody debris generally does not play a significant role in the habitat functions concerning steelhead/trout in southern California Rivers and streams; therefore its presence/absence is not relevant in this assessment.

Findings: Pool shelter ratings for surveyed reaches of Pauma Creek in the Northern Subbasin were all well below the target value of 100%, thus they received low EMDS suitability ratings (Figure 15 & Figure 18). There were only a few pools located throughout the survey that had a shelter rating greater than 100.

In addition to shelter complexity rating, instream shelter composition, divided into eight cover types, was also collected during habitat inventories (Figure 17). Boulders were the dominant shelter cover type comprising 67% of the shelter in pools. Whitewater and small woody debris were the only other significant cover types having provided 21% and 8% respectively of the pool shelter. The remaining pool shelter was divided equally between bedrock ledges, terrestrial vegetation, root mass, and undercut banks. Aquatic vegetation was rarely observed in the surveyed reaches and did not play a role in providing cover in pools.

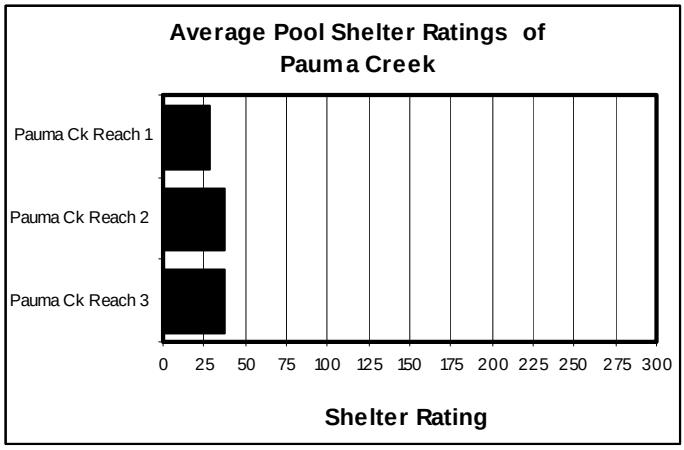

Figure 15. Average pool shelter ratings from CDFG stream surveys in Pauma Creek, Northern Subbasin.

Stream reaches are listed from lower Pauma to upper Pauma.

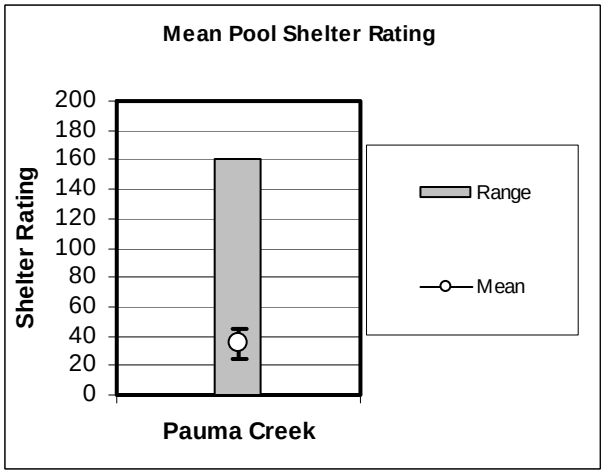

Figure 16. Pool shelter in the Pauma Creek, Northern Subbasin.

Error bars represent the standard deviation. The percentage of shelter provided by various structures (i.e. undercut banks, woody debris, root masses, terrestrial and aquatic vegetation, bubble curtains, boulders, or bedrock ledges) is described and rated in CDFG surveys.

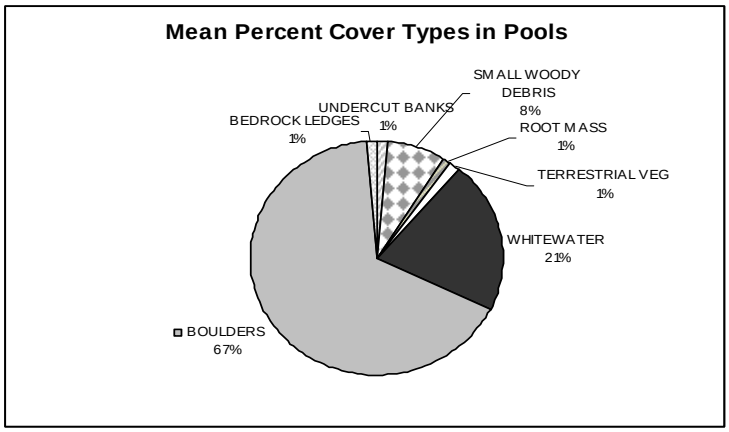

Figure 17. Mean percent of shelter cover types in pools for surveyed reaches of Pauma Creek, Northern Subbasin.

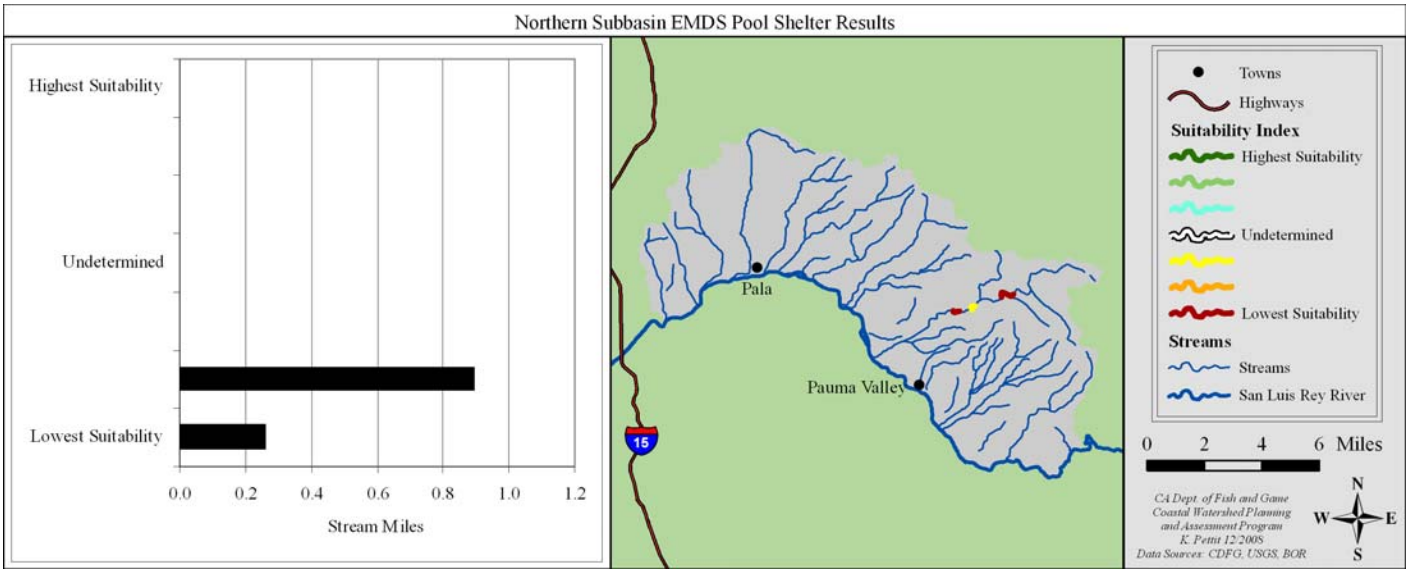

Figure 18. EMDS pool shelter results for Pauma Creek, Northern Subbasin by surveyed stream miles.

Cobble Embeddedness

Significance: Salmonid spawning depends heavily on the suitability of spawning gravel; fine sediments decrease successful spawning and incubation. Cobble embeddedness is the percentage of an average sized cobble piece at a pool tail out that is embedded in fine substrate. Category 1 is 0-25% embedded, category 2 is 26-50% embedded, category 3 is 51-75% embedded, and category 4 is 76-100% embedded. Generally, cobble embeddedness of 0-25% is considered good quality for spawning (Flosi et al. 1998). Excessive accumulations of fine sediment (>50%) reduce water flow (permeability) through gravels in redds which may suffocate eggs or developing embryos. Excessive levels of fine sediment accumulations over gravel and cobble substrate also may alter insect species composition and food availability for growing fish. Consequently, cobble embeddedness categories 3 and 4 are not within the fully supported range for successful use by salmonids. Category 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate like bedrock, log sills, boulders or other considerations. Southern California steelhead also utilize riffles as potential spawning grounds. This survey methodology, which measures only pool tail-outs, did not take this into account and thus did not record/evaluate these areas.

Findings: Pauma Creek possessed suitable spawning gravels for the majority of reach 1 and reach 3 surveyed areas (Figure 19 & Figure 21). Reach 2 received an unsuitable rating due to the amount of pool tail outs that had a greater than 50% embeddedness rating (Figure 20). It is important to note that reach 1 was surveyed in the winter of 2008 after some of the impacts of the 2007 Poomacha Fire had occurred. Even though the 2007 Poomacha Fire deposited large amounts of fine sediments, Pauma Creek still had suitable spawning gravels as evident by the survey results of reach 1. Given the high gradient nature of the stream, sediments appear to be moving through the system. Additional suitable spawning gravels were observed in numerous riffles throughout the surveyed area.

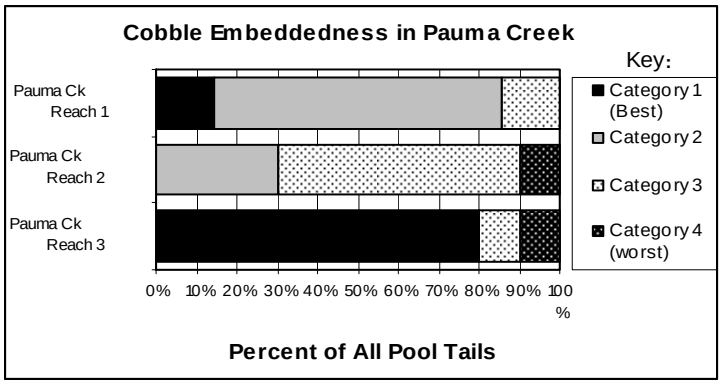

Figure 19. Cobble embeddedness categories as measured at every pool tail crest in Pauma Creek.

Stream reaches are listed in from lower Pauma to upper Pauma Creek.

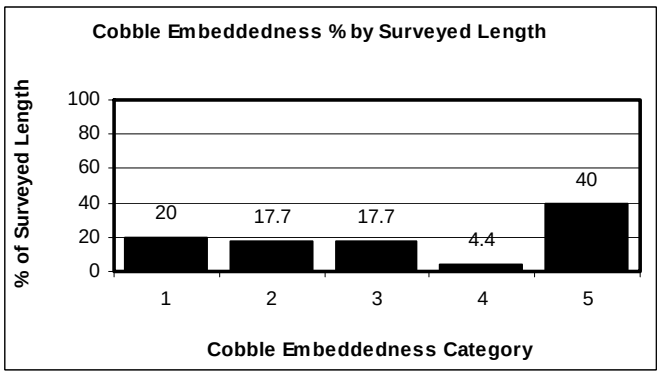

Figure 20. Cobble Embeddedness in Pauma Creek.

Cobble Embeddedness was measured only in pool tail-outs and did not take into account the steelhead may spawn in riffle habitat.

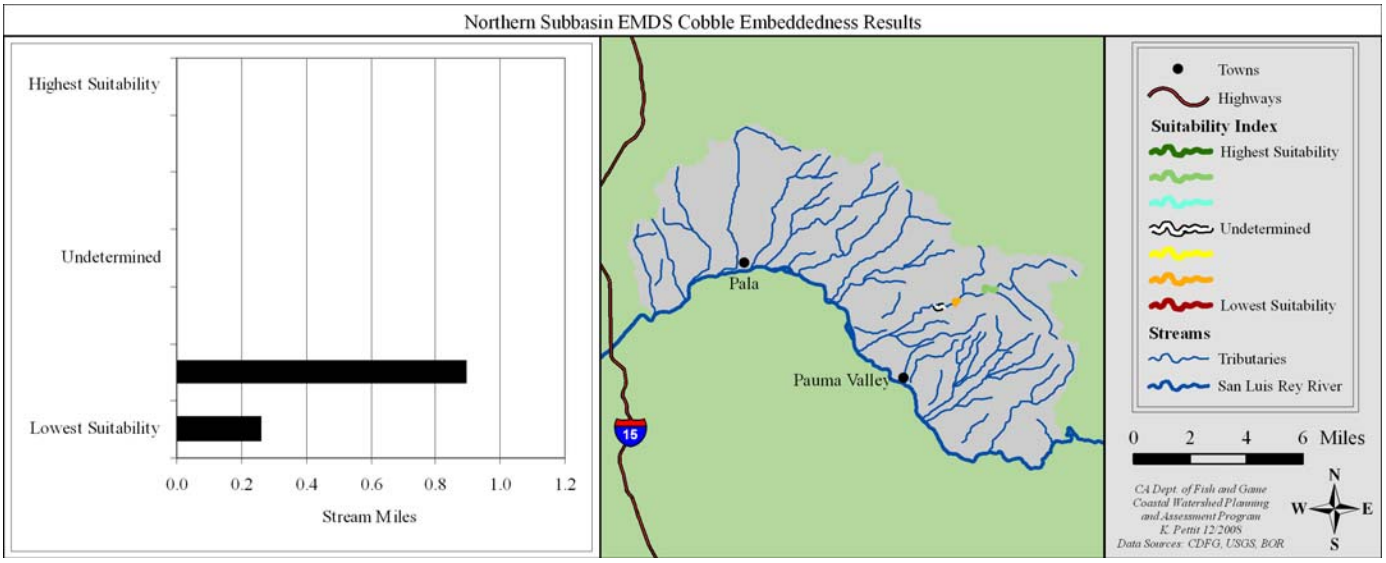

Figure 21. EMDS cobble embeddedness results for Pauma Creek, Northern Subbasin by surveyed stream miles.

Habitat Discussion and Conclusions

Due to time constraints and access issues, CDFG stream inventories in the Northern Subbasin were limited to Pauma Creek. Unfortunately, prior to the CDFG 2007-2008 Pauma Creek stream inventories and post-fire, general habitat assessments, little information is available on historic conditions of the creek and its watershed. Generally, data from older stream surveys provide a snapshot of the conditions at the time of the survey, but these are unavailable. Historic information is limited to genetic sampling of trout from the creek and brief, anecdotal accounts of fishing on Pauma Creek.

At the time of the 2007 and 2008 CDFG Pauma Creek habitat inventory surveys instream habitat conditions were considered poor to good depending on the habitat category. In the three surveyed reaches pool quality, pool depth, and pool shelter habitat characteristics fell below EMDS target values and were evaluated as unsuitable for steelhead trout. Conversely, canopy density and cobble embeddedness met EMDS target values and were evaluated as suitable conditions for steelhead (Table 10).

Canopy density was suitable on all surveyed reaches of Pauma Creek (Table 10). Current canopy density measurements do not take into account differences between smaller, younger riparian vegetation versus the larger microclimate controls that are provided by deep, narrow canyon canopy conditions. Water temperature measurements, recorded every hour on the hour during the surveys, were considered suitable for steelhead, but more long-term data is needed to determine water temperature suitability throughout the high temperature extremes of the summer months.

Cobble embeddedness was suitable on reaches 1 and 3 in Pauma Creek (Table 10). Even though large amounts of fine sediment were deposited as a result of the 2007 Poomacha Fire, reach 1 (surveyed in January 2008) displayed suitable cobble embeddedness conditions. Pool quality, depth, and pool shelter were unsuitable on all surveyed reaches, thus these habitat factors are likely limiting to steelhead trout populations. Pool depths were adversely impacted (decreased) by the sediment input from the 2007 Poomacha Fire. Due to the steep gradient and potentially significant winter precipitation, the sediment will most likely be flushed downstream over the course of several years and deeper pool depths will be restored.

Although macroinvertebrate data indicate that Doane Creek, tributary to Pauma Creek, is a healthy system, with the greatest taxonomic diversity of the sites tested in San Diego County, there is not enough data to determine whether water chemistry is a limiting factor in other tributaries in this subbasin. Doane Creek may be representative of the Pauma Creek watershed where limited human activities occur; it may not, however, be indicative of conditions in other streams in the subbasin where agricultural activities could have more of an impact on water quality. Current water quality monitoring being conducted on Gomez Creek should provide insight to water quality conditions that are more typical of streams in the subbasin where residential housing and farming operations dominate the lower to middle elevations of streams.

Prior to the 2007 Poomacha Fire, numerous trout of all age classes (young of the year to 3+ fish) were

observed in reaches 2 and 3 of Pauma Creek. No fish were observed in reach 1 during the January 2008 habitat inventory, though trout are generally inactive and difficult to identify during the winter months with colder stream temperatures. In May of 2008, a CDFG fisheries biologist and PSMFC fisheries technician surveyed Pauma Creek from reach 2, (approximately 4.3 miles upstream its confluence with the SLR River) upstream 3.2 miles to its origination at the confluence of French Creek and Doane creeks. No trout were observed until near the confluence of French and Doane Creek; however, deep pools were not snorkeled and runs and riffles were not electro-fished to ascertain the presence/absence of trout. The biologist noted large amounts of sediment input as a result of the 2007 Poomacha Fire. Moderate quality spawning and rearing habitat were still present even with this sediment input and lack of fish observations.

If fish passage modifications occurred at the Highway 76 Bridge, approximately ¾ to a mile of suitable spawning and rearing habitat would become available to steelhead trout. This potentially suitable habitat is located downstream of the Forest Service property boundary (approximately 1.5 miles upstream of Highway 76) and extends into the canyon within FS proper. This reach retains perennial flows, deeper pools, potential cover, suitable spawning gravels and potentially suitable water temperatures (based on water temperatures recorded a short distance upstream, during the July 2007 habitat inventory). The potential habitat terminates at a ten-foot high, concrete wall located 2.4 miles above Highway 76; this concrete wall is a complete barrier to fish passage (Figure 8). Additional suitable habitat is located above this wall; however multiple partial to most likely complete barriers are located within a ¼ mile upstream of this wall. Depending on flow conditions, several potential partial, natural barriers (bedrock chutes) exist just downstream of this man-made structure.

A small section of Gomez Creek, approximately 2.8 miles upstream of its confluence with the SLR River, was examined in June of 2008 for general habitat conditions. Low flow conditions (less than 1cfs) were present at the time of the survey. Canopy cover appeared to be excellent and stream water temperatures were cool. The stream had very little pool formations and the pools that were present were relatively shallow (maximum pool depth was 1.3 feet). Spawning gravels were sparse and appeared to be 50% embedded. A landowner downstream may currently be stocking Gomez Creek with rainbow trout. In the recent past (2005) these trout were washed downstream during significant winter rain events, but appeared to survive throughout the spring and summer as they were caught the following September. This may indicate instream habitat conditions are suitable for supporting trout populations.

Table 10. EMDS reach condition results for the Northern Subbasin.

Stream	Year	Canopy	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Pauma Creek - Reach 1	2007	++	---	---	---	+
Pauma Creek - Reach 2	2007	+++	-	-	--	--
Pauma Creek - Reach 3	2007	+	--	---	--	++
Northern Subbasin		++	--	--	--	+

Key: +++ = Highest Suitability U Insufficient Data or Undetermined - - - = Lowest Suitability

Stream Habitat Improvement Recommendations

In addition to presenting habitat condition data, all CDFG stream inventories provide a list of recommendations that address those conditions that did not reach target values presented in CDFG's *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998) and in *NMFS's Guide to reference values used in south-central/southern California coast steelhead conservation action planning workbooks* (2008) (see the Current Conditions pp. 20-25). Stream habitat improvement recommendations were developed based on results from stream surveys conducted along potential salmonid bearing stream reaches in 2007. Full habitat inventories were conducted on Pauma Creek and general stream observations were recorded on sections of Gomez Creek. Even though the majority of Pauma Creek is currently inaccessible to steelhead due to the Highway 76 Bridge crossing on Pauma Creek, CDFG wished to qualify/identify the potential habitat available to steelhead if fish passage improvement projects were implemented at this crossing and other locations in the lower SLR River. In addition to presenting habitat condition data, all CDFG stream inventories provide a list of recommendations that address those conditions that did not reach target values (see the Fish Habitat section of this subbasin). A CDFG biologist selected and ranked habitat improvement recommendations for the survey

conducted in Pauma Creek, in the Northern Subbasin (Table 11). Because other tributaries in the subbasin were not accessible to fish or could not be surveyed due to landowner access issues, these creeks were not included in stream habitat improvement recommendations. The SLR River was evaluated in the Southern Subbasin, so it was not incorporated in these recommendations.

In order to compare recommendations within Pauma Creek, the recommendations of each reach were collapsed into five target issue categories: Surface Stream Flow; Fish Passage; Riparian/Water Temperatures; Instream Habitat; and Sediment Delivery (Table 11). These target issues were then paired with the appropriate recommendation category. For example, the target issue "Instream Habitat" was divided into the recommendation categories of: Pool, Cover, and Spawning Gravels. CDFG/PSMFC biologists selected and ranked habitat improvement recommendations based on survey inventory results collected in Pauma Creek. The top three recommendations of each reach are considered to be the most important, and are useful as a standard example of the stream. When examining recommendation categories by number of reaches, the most important target issue in Pauma Creek is fish passage. High priority should be given to restoration projects that emphasize fish passage modification, sediment reduction, and pool enhancement and formation. This could apply to other potential fish bearing streams in the subbasin such as Gomez Creek, Agua Tibia Creek, Frey Creek, and Pala Creek.

Table 11. Recommendation categories based on basin target issues.

Basin Target Issue	Related Table Categories
Surface Stream Flow	Stream Flow
Fish Passage Barriers	Fish Passage
Riparian / Water Temp	Canopy / Temp
Instream Habitat	Pool / Cover / Spawning Gravels
Sediment Delivery	Bank / Roads / Livestock

Table 12. Occurrence of stream habitat inventory recommendations for different reaches of the SLR River of the Northern Subbasin.

Stream	Survey Length (mile)	Stream Flows	Fish Passage	Riparian/Water Temps		Instream Habitat			Sediment Delivery		
				Temp	Canopy	Pool	Cover	Spawning Gravel	Bank	Livestock	Roads
Pauma Creek Reach 1	0.27		1			2	3	4			
Pauma Creek Reach 2	0.27		1			2	3	4			
Pauma Creek Reach 3	0.63		1			2	3	4			
Gomez Creek	0.1	1	2	unk		3	5	4			

Restoration Projects

Restoration projects within the subbasin have been limited to those done by local landowners, the Mission RCD, San Diego Trout, and Golden State Flycasters/Trout Unlimited. Considering that few trout have been observed within the subbasin, there has been little emphasis on implementing fisheries based restoration projects, with the exception of a few projects in the Pauma Creek watershed. The CalFish website, http://www.calfish.org/, (CalFish is a multi-agency program for collecting, standardizing, maintaining, and providing access to quality fisheries data and information for California), it did not list any agency or organization funded stream restoration projects in the subbasin.

Most recently, San Diego Trout, in conjunction with San Diego Fly Fisherman's Club and CDFG, installed a downstream catchment weir at the outlet of Doane Pond in Mount Palomar State Park. Historically, Doane Pond, located upstream of Pauma Creek on a portion of Doane Creek, has been stocked with rainbow trout and catfish to provide recreational fishing opportunities. The purpose of the weir is to protect the genetic gene pool of the downstream wild, native trout populations in Doane and Pauma Creek, and prevent the downstream movement of exotic game fish (bluegill and catfish), crayfish, and bullfrogs from potentially populating Doane Creek and Pauma Creek.

Past or current projects that have improved stream habitat conditions or contributed to the monitoring of the stream habitat conditions include the following:

- Spring 2008 to December 2009 water temperature monitoring by the Department of Fish and Game in

conjunction with Trout Unlimited;

- Spring 2008 to December 2009 water chemistry analysis and bioassessment by Trout Unlimited in conjunction with the San Diego Coastkeeper;
- Water quality control via animal waste improvement projects;
- Mission RCD working with area farmers on Best Management Practices for pesticide and erosion control and prevention.

Information on other watershed stream restoration projects can be found on CalFish (www.calfish.org) or on the Natural Resources Project Inventory online database (www.ice.ucdavis.edu/nrpi/).

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Northern Subbasin by using professional judgment and criteria developed for southern coastal watersheds. The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, stream flows, agriculture and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by the EMDS at the stream reach scale.

The most complete data available in the Northern Subbasin was for Pauma Creek, which was surveyed by CDFG during the summer of 2007 and in the winter (January) of 2008 during higher water flows. The SLR River was designated completely within the Southern Subbasin; therefore, it is not discussed in this subbasin. Salmonid habitat conditions in the Northern Subbasin on surveyed streams are generally rated as medium potential refugia.

Full instream habitat inventories were performed on French and Pauma creeks, while Doane and Gomez creeks had general reconnaissance level surveys to determine habitat suitability for steelhead. Resident, rainbow trout were found in Pauma, French and Doane creeks. Gomez Creek may currently be stocked with rainbow trout on a private landowner's property, immediately downstream of the surveyed section. Pauma Creek most likely contains the best habitat within the SLR River Basin that could be made available to steelhead with a barrier modification of the culvert below Highway 76.

In Gomez Creek, full habitat inventory was not performed due to limited landowner access; therefore only a relatively short section of the creek was access for habitat suitability. This section of Gomez Creek provided marginal habitat that could be utilized by steelhead/trout. Spawning habitat was limited and complex instream habitat was generally lacking. However, more of the creek would need to be surveyed to draw further conclusions on its overall habitat suitability. Other tributaries in the subbasin such as Agua Tibia Creek, Frey Creek, and Pala Creek were not surveyed and habitat conditions are relatively unknown. A literature review contained references to steelhead/trout in Agua Tibia Creek, Frey Creek, and Pala Creek. These tributaries are labeled on USGS 7.5 quadrangle maps as containing small to moderate reaches of perennial flows. Further field studies are needed to determine the habitat suitability and limiting factors for steelhead/trout production in these streams. The following refugia area rating table summarizes subbasin salmonid refugia conditions.

Table 13. Refugia rating table for the Northern Subbasin.

Stream	Refugia Categories				Other Categories		
	High Quality	High Potential	Medium Potential	Low Quality/Low Potential	Passage Barrier Limited	Critical Contributing Area	Data Limited
Gomez Creek			X		X		X
Pala Creek				X	X		X Needs survey
Magee Creek	Not enough information to classify						X Needs Survey
Agua Tibia Creek	Not enough information to classify						X needs Survey
Frey Creek	Not enough information to classify				X		X Needs Survey
Pauma Creek			X		X		

Key Subbasin Issues

- The lack of hydrologic connectivity in the SLR River hinders the potential for steelhead/trout to access streams in the Northern Subbasin;
- Numerous unregulated wells throughout the subbasin have a negative impact on stream flows in the tributaries;
- Access to extensive habitat located in several of subbasin's streams is currently blocked by man-made barriers;
- Agricultural wastewater runoff poses a potential problem to aquatic ecosystems in the tributaries;
- Increased sediment levels in streams degrade instream habitat and creates a multitude of problems for fish.

Responses to Assessment Questions

What are the history and trends of the sizes, distribution, and relative health and diversity of salmonid populations in the Subbasin?

Findings and Conclusions:

- Southern California Coast Steelhead (DPS) are federally listed as endangered;
- The Northern Subbasin once supported steelhead runs in its streams but have since been extirpated. Historically, steelhead utilized some of the tributaries in the subbasin for spawning and rearing habitat before returning to the SLR River and eventually the ocean as adults or out-migrants (juvenile fish);
- The following tributaries were reported to have steelhead at one time: Pauma Creek, Pala Creek, Agua Tibia Creek, and possibly Frey Creek. There is a lack of historical information available for size of runs in these tributaries;
- Within the past several decades, steelhead have not been observed in these tributaries listed above, but focused surveys have not occurred to document the presence/absence of steelhead potentially utilizing these streams;
- The Pauma Creek watershed retains a population of native, self-reproducing rainbow trout. During the July 2007 CDFG habitat inventory, trout were observed in abundant numbers in the middle and upper reaches of Pauma Creek, French Creek, and Doane Creek. However, a CDFG May 2008 post-fire general reconnaissance-level survey, reported observing trout only in the upper portions of Pauma Creek (trout were still observed in French Valley Creek and Doane Creek);
- Introduced brown trout (*Salmo trutta*) are also found in the upper portions of Pauma Creek as well as in French Creek and Doane Creek.

What are the current salmonid habitat conditions in the Northern Subbasin? How do these conditions compare to desired conditions?

Findings and Conclusions:

Flow and Water Quality:

- Nearly all of the streams containing suitable habitat for steelhead/trout have to some extent, on-going water extraction activities for anthropogenic uses. This reduction of surface flows minimizes the available habitat for rearing fish, hinders upstream and downstream fish movement, and affects water temperature and water quality;
- Pauma Creek contains perennial flows from its headwaters downstream to the Pauma Indian Tribe's water diversion, which is located approximately 1/3 of a mile downstream of the Cleveland National Forest Service boundary. Thereafter, the stream loses surface flows during the mid to late summer months;
- Gomez Creek, Pala Creek, Agua Tibia Creek, and Frey Creek contain only sections of perennial surface

flows during the summer and early fall months. These sections may be sufficient to support small trout populations;

- The lack of flows altogether or insufficient flows in the SLR River most likely would impede the passage of steelhead to these more suitable streams in the Northern Subbasin;
- Water quality is being impacted by agricultural runoff that have direct access to streams;
- There is a lack of water quality data on the streams in the Northern Subbasin. Results of a fall 2005 and spring 2006 bioassessment in Doane Creek indicated an Index of Biotic Integrity quality rating of "good" and "very good," respectively.

Erosion/Sediment:

- The 2007 Poomacha Fire resulted in a large amount of sediment input to Pauma Creek that filled in deep pools as well as covered potential spawning gravels. In addition to fine sediment, log jams had formed from woody debris being carried downstream during significant rain events;
- Other streams such as Agua Tibia Creek and Frey Creek, which were also within the burned area of the Poomacha Fire, may have experienced similar sediment inputs;
- Large agricultural production has resulted in numerous terraced, steep hillsides. Although best management practices are in place, erosion from these hillsides most likely contributes fine sediments to the streams in the Northern Subbasin;
- Livestock have unrestricted access to some tributaries, resulting in stream bank erosion;
- Soils (and bedrock) in streams of the Northern Subbasin are prone to erosion, and slides and streambank failures have been observed to contribute fines to the streams.

Riparian Condition/Water Temperature:

- Canopy cover on Pauma Creek and its tributaries (French Valley Creek and Doane Creek) was suitable for salmonids. In general, the Poomacha Fire did not adversely affect the canopy, as the fire, for the most part, did not burn in the riparian areas and remained a ground fire;
- Canopy cover in Pauma Creek is also aided by the steep, canyon walls along much of the middle and upper portions of the creek and similar conditions may exist in other subbasin streams;
- Water temperature data collected by CDFG during summer habitat inventories indicate suitable stream temperatures. However, these data are limited, and therefore inconclusive.

Instream Habitat:

- At the time of the 2007 and 2008 CDFG Pauma Creek habitat inventory surveys instream habitat conditions were considered poor to good depending on the habitat category. In the three surveyed reaches pool quality, pool depth, and pool shelter habitat characteristics fell below EMDS target values and were evaluated as unsuitable for steelhead trout. Conversely, canopy density and cobble embeddedness met EMDS target values and were evaluated as suitable conditions for steelhead;
- Lower Pauma Creek has been modified as the creek has been straightened, lined with boulders, and all vegetation has been removed;
- Marginal trout habitat was present in a small, surveyed portion of Gomez Creek, approximately 2 miles upstream of its confluence with SLR River. This area retained perennial flows with a robust canopy and a few potential spawning areas. It lacked deep pools and sufficient instream cover;
- Similar habitat may be available in Agua Tibia, Frey Creek, and Pala Creek. Agua Tibia Creek appeared to retain surface flows for a longer duration, as witnessed during the summer of 2007 and late spring of 2008.

Gravel/Substrate:

- Suitable salmonid spawning areas were available in the surveyed reaches of the Pauma Creek and to a lesser extent Gomez Creek. In Pauma Creek, overall numbers of potential spawning gravels were moderate and embeddedness measurements met suitable EMDS target values;
- The effects of the 2007 Poomacha Fire increased sediment input into the creek and most likely resulted in the burying of potential spawning gravels; nevertheless, numerous additional spawning areas were readily observed in a stream survey following the fire;
- The accumulation of sediments as a result of the fire may require a series of winter storms in order to flush out these fine sediments and restore suitable spawning grounds throughout Pauma Creek.

Refugia Areas:

- Salmonid habitat conditions in Pauma Creek are rated as moderate potential refugia. In general, if fish passage modifications occurred at the Highway 76 Bridge, approximately ¾ of a mile to one mile of suitable spawning and rearing habitat would become available to steelhead trout. The potential habitat terminates at a ten-foot high, concrete wall located 2.4 miles above Highway 76;
- Gomez Creek appeared to have a small stream reach of potential steelhead habitat, but without surveying downstream of this habitat it is not known if steelhead could access this area;
- There are a few other tributaries, Agua Tibia Creek, Pala Creek, and Frey Creek, whose current habitat status is relatively unknown, but anecdotal records describe them as containing steelhead/rainbow trout habitat that was formerly utilized by these fish. Due to issues with accessibility and water extractions, available habitat may be more limited in these streams.

Barriers:

- Several partial fish barriers exist along the lower SLR River that hinders/limits the potential for steelhead to utilize streams in the Northern Subbasin;
- Fish passage barriers are present in Pauma Creek at the Highway 76 Bridge (RM 0.8) and 2.4 miles upstream of the Highway 76 bridge in the form of a 10-foot high concrete wall.
- Other known barriers include the Pala Mission Road crossing in Pala Creek and in Gomez Creek at a road crossing 3.7 miles upstream its confluence with the SLR River. Additional barriers are most likely present in lower Gomez Creek, Frey Creek, and Agua Tibia Creek north of Highway 76.

What are the impacts of geologic, vegetative, fluvial, and other natural processes on watershed and stream conditions?

Findings and Conclusions:

- Severely erodible soils comprise 95% of the watershed, including the Northern Subbasin. Slides from the stream banks and roads have been observed to contribute fines to the stream;
- Weathering of the granitic rocks has created younger unconsolidated sediments that are very susceptible to enhanced erosion and mass movement such as landslides and debris-flows;
- The Northern Subbasin is a potentially seismically active area as several faults cut through this basin, including the Elsinore Fault Zone. Large seismic events, especially when coupled with significant storm events, can trigger large landslides and mudflows increasing sediment delivery to the streams and altering their hydrologic condition;
- Uplift has increased the erosion potential of the area;
- Large areas of native vegetation along the tributaries have been displaced by agricultural crop production, which require irrigation. This watering lowers the ground-water table and reduces, or in some cases, eliminates surface flows altogether in the tributaries;
- The 2007 Poomacha Fire that burned within the Northern Subbasin resulted in an increase in sediment input as witnessed in Pauma Creek during CDFG reconnaissance level surveys. The increased sediment

input filled in pools, reduced potential spawning areas, and led to trout mortality;

- Other streams such as Frey Creek and Agua Tibia Creek were also located in the burned area and may have experienced similar effects of the fire.

How has land use affected these natural processes?

Findings and Conclusions:

- Agricultural runoff has affected the water quality and quantity of some of the subbasin's streams;
- Disturbance of the basin's already unstable soils by land use activities has altered runoff rates;
- Water extraction to supply large and small scale agricultural operations has reduced or eliminated surface flows, lowered the groundwater table, and thus reduced the habitat available to trout in many of the streams in the Northern Subbasin;
- As less water is available for shrubs and trees, the vegetation along these streams may be altered from riparian trees to more drought tolerant chaparral species. The potential shift in vegetation could affect instream habitat conditions and increase water temperatures;
- The possible expansion of large gaming casinos could further impact the subbasin's water resources.

Based upon these conditions, trends, and relationships, are there elements that could be considered to be limiting factors for steelhead production?

Findings and Conclusions:

Based on available information for the Northern Subbasin, it appears that salmonid populations are limited by:

- Lack of hydrologic connectivity in the SLR River, which would inhibit passage of seasonally appropriate migrations of adult and juvenile fish to suitable habitat in the Northern Subbasin streams;
- Fish passage barriers;
- High levels of fine sediments in streams due to the 2007 Poomacha Fire;
- Loss of habitat area and complexity due to anthropogenic water extraction;
- A shortage of areas with suitable spawning gravel in tributaries.

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

Habitat improvement activity recommendations are limited to the Pauma and Gomez creeks since they were the only streams surveyed during the assessment. Other streams, Agua Tibia, Frey, and Pala creeks, may have the potential to support steelhead/trout, but further studies are needed in order to make suitable habitat improvement recommendations for those individual watersheds. All of these creeks have fish passage barriers that would need to be addressed for steelhead to access potentially suitable habitat.

Barriers to Fish Passage

Streams	Recommended Actions XXX: Highest Priority		
	Improve fish passage to streams in Northern Subbasin by modifying partial passage barriers in the SLR River.	Continue efforts to identify and alleviate fish passage impediments at culverts or other public or private road crossings.	Improve fish passage by removing structures on private lands that are currently partial barriers.
Pauma Creek	XXX		XXX
Gomez Creek	XXX	XXX	XXX

Flow and Water Quality

Streams	Recommended Actions XXX: Highest Priority			
	Insure that water diversions used for domestic or irrigation purposes bypass sufficient flows to maintain all needs of fishery resources. Considering purchasing water rights if necessary to accomplish this.	Reduce water temperatures	Plant willows, cottonwoods, or alder trees in lower reaches to help reduce water temperature and improve overall habitat.	Remove and prevent excessive agricultural or urban runoff contributions to aquatic ecosystems
Pauma Creek	XXX		X	
Gomez Creek	XXX		X	XX

Erosion and Sediment Reduction

Streams	Recommended Actions XXX: Highest Priority			
	Continue to identify and reduce sources of sediment delivery to stream channels from road systems.	Re-vegetate exposed stream banks and/or install structures to increase bank stability.	Build livestock exclusionary fencing along creeks and create offsite watering areas.	Install instream structures that enhance natural sorting of spawning gravels.
Pauma Creek		X		X
Gomez Creek	X	X		X

Riparian and Instream Habitat

Streams	Recommended Actions XXX: Highest Priority			
	Increase depth, area or shelter complexity in pools, by adding boulders, or if possible, woody debris.	Develop and implement a plan to restore natural channel features where feasible.	Continue to remove non-native exotic plant species such as *Arundo donax* and replant with native trees and shrubs.	Consider planting barren nearstream areas in lower reaches with willow, cottonwood or sycamore trees to increase streamside shade canopy and allow for woody recruitment.
Pauma Creek	X	XX		X
Gomez Creek	X	XX		X

Education, Research, and Monitoring

Streams	Recommended Actions XXX: Highest Priority		
	Continue, expand, or develop education programs concerning water conservation, water quality, and importance of watershed/riverine ecosystems.	Conduct further habitat surveys and/or presence/absence surveys.	Water quality and temperature monitoring should be conducted over several years to characterize conditions in streams.
Pauma Creek	X	X	XX
Gomez Creek	XXX	XX	XX

Subbasin Summary and Conclusions

The Northern Subbasin contains potentially suitable habitat for steelhead in several streams, but fish passage issues must be resolved both in the lower SLR River and in these tributaries in order to provide access to this habitat. Currently, a population of native rainbow trout persists in the Pauma Creek watershed. Genetic sampling performed on these fish concluded that "it seems more than likely that these fish are part of a native coastal *O. mykiss* lineage." Furthermore the report stated, "these populations may be reasonable choices to consider in efforts to re-establish anadromous runs in their respective streams" (NOAA 1999). However, these trout are currently blocked from accessing the SLR River due to the impassible crossing located under the Highway 76 Bridge on Pauma Creek. The NMFS Southern California Steelhead Recovery Plan (2009 *Draft*) recognizes the importance of these resident trout populations above barriers because they may produce progeny, with smolt-like characteristics, that emigrate downstream to the ocean.

Others streams in the subbasin were historically utilized by steelhead, but also have fish passage problems that may prevent steelhead from accessing suitable spawning and rearing habitat. Gomez Creek could support a population of steelhead, but most likely contains a couple of man-made, temporary fish passage

barriers, limiting steelhead access to upstream habitat. A local landowner approximately 2.7 miles upstream of the confluence with the SLR River most likely stocked rainbow trout on his property. It is assumed that these fish are able to survive year-round in Gomez Creek. In order to retain these planted fish on the property, the stream channel was probably modified and these modifications may pose as fish barriers problems to ocean run fish. The potential mixing of hatchery strain with wild fish would also be detrimental to the gene pool of ocean run fish.

Pala Creek was a former steelhead breeding stream, but due to multiple water extractions, only a small perennial reach remains. This reach, located upstream of the Pala Indian Reservation, is comprised of minimal pool and riffle habitat. Fish passage is hindered, possibly blocked altogether, at the Pala Mission Road stream crossing.

Agua Tibia Creek was also historically a steelhead rearing stream and may contain suitable spawning and rearing habitat in the Cleveland National Forest, approximately one and half miles upstream its confluence with the SLR River. Frey Creek may fit this description as well. Further habitat surveys are needed to determine access and habitat suitability on these streams.

The 2007 Poomacha Fire burned a large portion of the Northern Subbasin, including areas of the Pauma Creek, Frey Creek, and Agua Tibia Creek watersheds. Reconnaissance-level surveys in Pauma Creek indicated significant sediment input into the creek, which reduced pool depths, buried potential spawning gravels, created debris jams, and led to trout mortality. Trout survived in the upper portion of the watershed and eventually could reseed lower portions of the creek. Agua Tibia Creek and Frey Creek were not surveyed after the fire, but may have experienced similar results from the fire.

Large and small scale farming operations located in the southern portions of the Northern Subbasin rely on local water sources to help supplement these operations. Reductions in water deliveries, and increased water prices have forced many farmers to scale back their operations, and possibly become more dependent on local water sources for crop production. Even prior to these cuts in water deliveries, surface flows in Northern Subbasin streams were already reduced or completely eliminated during the summer and early fall due to water extractions. The potential expansion of large gaming casinos would likely put further stress on the available water resources. Reduced surface flows in Northern Subbasin streams would minimize the movement of steelhead and available habitat. If fish passage modification projects in the SLR River and in these streams are undertaken, one must also consider the supply of water and habitat available in order to sustain the freshwater stages of the steelhead life history.

While the prospects for steelhead to succeed in the Northern Subbasin are moderate to difficult, opportunity exists for successful steelhead production in these streams. Restoration measures are needed to provide access into and out of the available spawning and rearing habitats. Maintaining adequate stream flows in these streams would be essential in facilitating fish movement and improving their overall success rate.