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Southern Subbasin

The Southern Subbasin includes the watershed area along the SLR River from Rice Canyon, approximately one mile east of Interstate 15 (RM 19) to just upstream of the Escondido Canal diversion dam (RM 40) (Figure 1). Stream elevations range from near sea level in the lower mainstem to approximately 3,400 feet in the headwaters of the tributaries. The Southern Subbasin occupies approximately a quarter of the total basin at 134 square miles. This assessment area is mostly rural with the exception of the expanding city of Valley Center. Pauma Valley and portions of the communities of Bonsall and Pala are also located within its boundaries. The Rincon Indian Reservation and to a lesser extent, the Pala Band of Luiseño Indians and San Pasqual Indian Reservations, reside within the subbasin. The majority of the subbasin is held in larger private parcels managed for agricultural crop production.

With the exception of the SLR River canyon (RM 37-39.5), the majority of the Southern Subbasin provides little suitable habitat for steelhead as the mainstem and many of the tributaries are dry for the majority of the year with seasonal flows limited to the precipitous periods of the winter and early spring. The SLR River canyon, located in the eastern portion of the subbasin, provides perennial flows with potentially cool water temperatures and deep pools. The mainstem SLR River was most likely used mainly as a migration corridor for adult steelhead to more extensive spawning and rearing habitat located in the Northern Subbasin tributaries and possibly in the mainstem within the SLR River canyon. Juvenile steelhead may have used the mainstem for rearing habitat during their downstream migration to the estuary and thus the ocean. Located in the SLR River canyon at RM 39.5 (approximately ½ mile downstream of the Escondido Canal diversion dam; Luiseño place name "Kye"), is a 50 foot high natural waterfall (Figure 10). This waterfall is broken up into a series of steps; with the largest lowermost step approximately 13 feet, and a narrow steeped crevasse above the first step extending to the top of the waterfall (M. Capelli, personal communication 2010). Considering the altered flow regime with the majority of the stream water being diverted approximately ½ mile upstream at the Escondido Canal diversion, steelhead are very unlikely to navigate through this feature.

Historical evidence of the presence of steelhead in this subbasin is mainly attributed to anecdotal accounts from local tribal elders who spoke of annual runs (USFWS 1998) and the presence of steelhead "…coming up from Oceanside" (Soto 2008). There is limited direct documentation of steelhead in the mainstem or in its tributaries. This is due, in part, to the lack of coordinated survey efforts by CDFG or any other organization. Prior to the 2007-2008 CDFG watershed assessment surveys, CDFG had not surveyed the SLR River in the Southern Subbasin since the 1940s. The CDFG performed this reconnaissance level survey effort in 1946. This survey contained the last documented report of non-hatchery rainbow/steelhead trout in the river (near Pala) within the Southern Subbasin. It is unknown whether these fish had become resident rainbow trout or if they could potentially migrate downstream to the ocean. Another reconnaissance level survey was performed by a fisheries biologist in 1975, but it provided little quantitative or qualitative information about the SLR River within the Southern Subbasin.

For a brief period in the 1990s rainbow trout were stocked in the SLR River within the Wilderness Gardens Preserve boundaries by schools that were provided fish from the CDFG's Mojave Hatchery. Water quality monitoring and sampling of aquatic insects indicated at the time of the releases that conditions were favorable for trout survival. Since the termination of the trout release program information collected in the river within the subbasin has been mostly limited to water quality monitoring performed by the Pala Band of Mission Indians.

Hydrology

The Southern Subbasin is made up of four complete CalWater Units: Moosa, Valley Center, Rincon, Woods, and portions of the Bonsall, and Pauma CalWater Units (Figure 2). There are four named tributaries (Table 1) and 167.4 permanent and intermittent (limited seasonal flows) stream miles in this subbasin. The vast majority of these stream miles are intermittent (See Figure 9 in the Basin Profile). During typical rainfall years, the SLR River in the Southern Subbasin will retain surface flows in the winter and spring after significant rainfall events. Large tributaries in the Northern Subbasin such as Pauma Creek, Agua Tibia Creek, and Frey Creek play an important role in maintaining surface flows in the mid to lower river during this time of the year, but usually become intermittent and contribute little to no water during the summer. Important tributaries in the Southern Subbasin include Keys Creek, Moosa Canyon, Paradise Creek, and Hell Creek. For the most part, flows in these tributaries are influenced by agricultural, landscaping, and urban runoff. Keys Creek, for example, has become a perennial stream in its lower and middle sections due to the large amount of

agricultural runoff. While Moosa Canyon and Hells Creek contain small sections of year round flow, these and other unnamed tributaries in the subbasin are mostly intermittent streams. Drainage areas range from less than 3 miles to the 133.8 square mile drainage area of the SLR River within the subbasin.

Currently, there is one operating river gauge (USGS ID 11036700) in the Southern Subbasin. This gauge, located 0.07 miles south of Cole Grade Road, near Pauma Valley, has been in operation since March of 2008 and is recording river gauge height and discharge. Two other gauges operated from March 2008 to October 2008 in the Pauma Valley recording discharge but have since discontinued data collection.

Figure 1. SLR River in the Southern Subbasin near the Wilderness Gardens County Park (approximately RM 27).

Table 1. Major streams in the Southern Subbasin.

Stream	Tributary to	River Mile	Drainage Area (square miles)	Stream Order	Permanent (miles) (in Subbasin)	Intermittent (miles)
San Luis Rey River	Pacific Ocean	--	133.8	1[1]	3.9	18.5
Moosa Canyon	SLR River	13.7	40.8	1[1]	4.5	4.7
Keys Creek	SLR River	18.7	38.2	1[2]	7.8	5.4
Paradise Creek	SLR River	36.9	13.9	n/a	0.0	6.2
Hell Creek	Paradise Creek	2.3	5.4	1[1]	1.1	3.4

[1] Only portions of the SLR River, Moosa Canyon, and Hell Creek retain perennial flows

[2] As mentioned above, the majority of Keys Creek now runs year round due to large amounts of agricultural runoff, but historically was labeled as an intermittent stream for the lower 2.2 miles on USGS 7.5 Bonsall quadrangle maps.

n/a Not applicable due to intermittent flows.

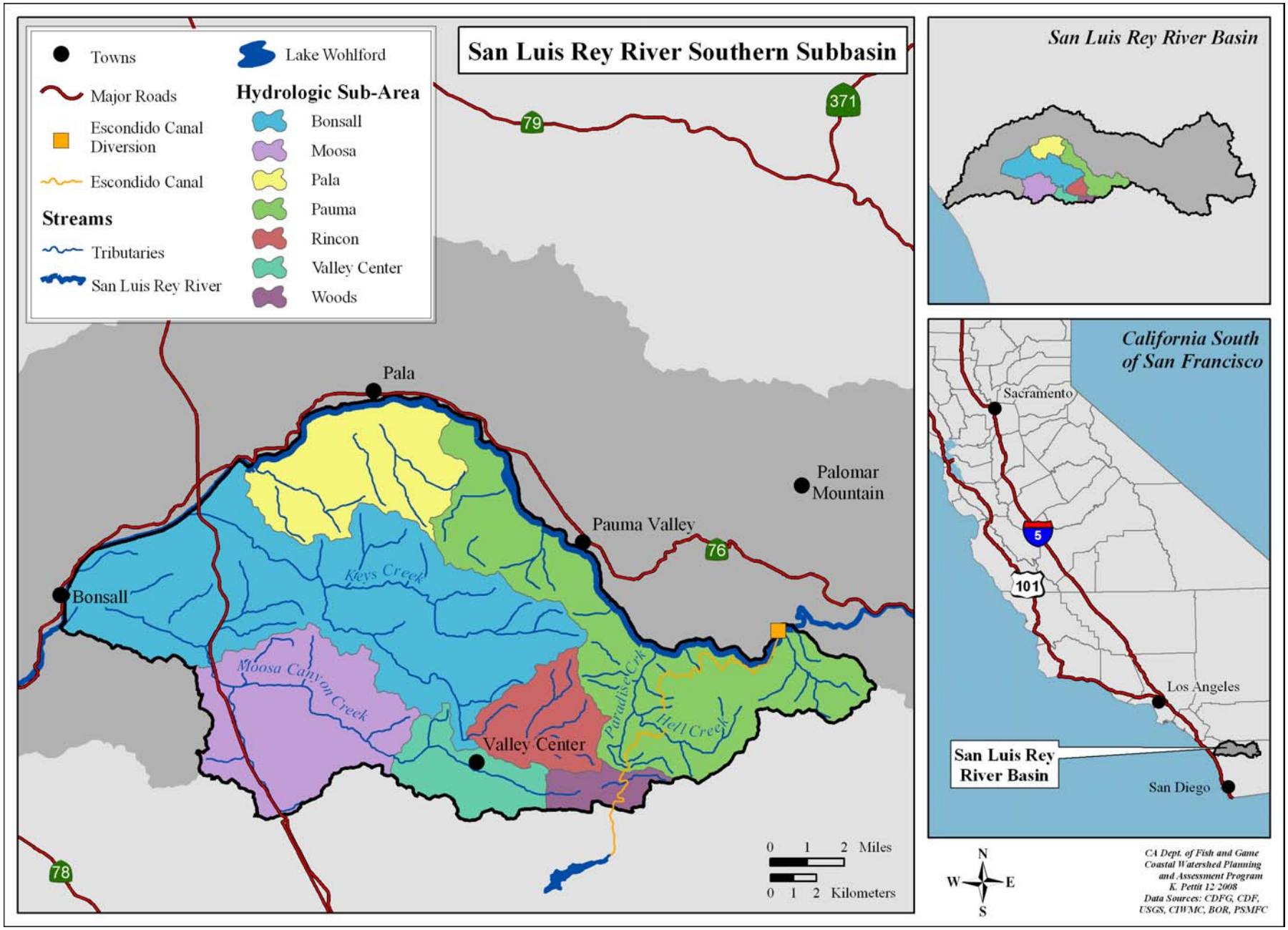

Figure 2. Southern Subbasin locator map and CalWater Units.

Geology

The Southern Subbasin is predominately underlain by granitic rock types of the Peninsular Range Batholith that intruded into older sedimentary, marine, rock types between 90 and 140 million years ago 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.

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. They occupy approximately 83% of its surface area. They are predominantly Cretaceous (154.5 million through 65.5 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 made of individual mineral grains disaggregated from the granitic parent rock. These sands are predominantly comprised of quartz and feldspar and are highly susceptible to erosion, sliding, and fluvial transport.

Quaternary Alluvium

Alluvium covers about 14.3% of the basin. It consists of unconsolidated sediments that range from clay to boulders. Alluvium is transported and deposited by the 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."

Alluvium is generally deposited in low lying areas and in flood plains producing a relatively flat landscape.

Mesozoic Sedimentary

Mesozoic sedimentary rocks make up around 3% 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 Alluvial Fan Deposits

Fan deposits make up less than 1% 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 there source and therefore consist of sediments made from the bedrock of the mountains from which they come.

Table 2. Rock types in the Southern Subbasin.

Lithologic Unit	Percent of Basin
Mesozoic Granitic	83.02
Quaternary Alluvium	14.30
Mesozoic Sedimentary	2.68
Quaternary Alluvial Fan Deposits	.01

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

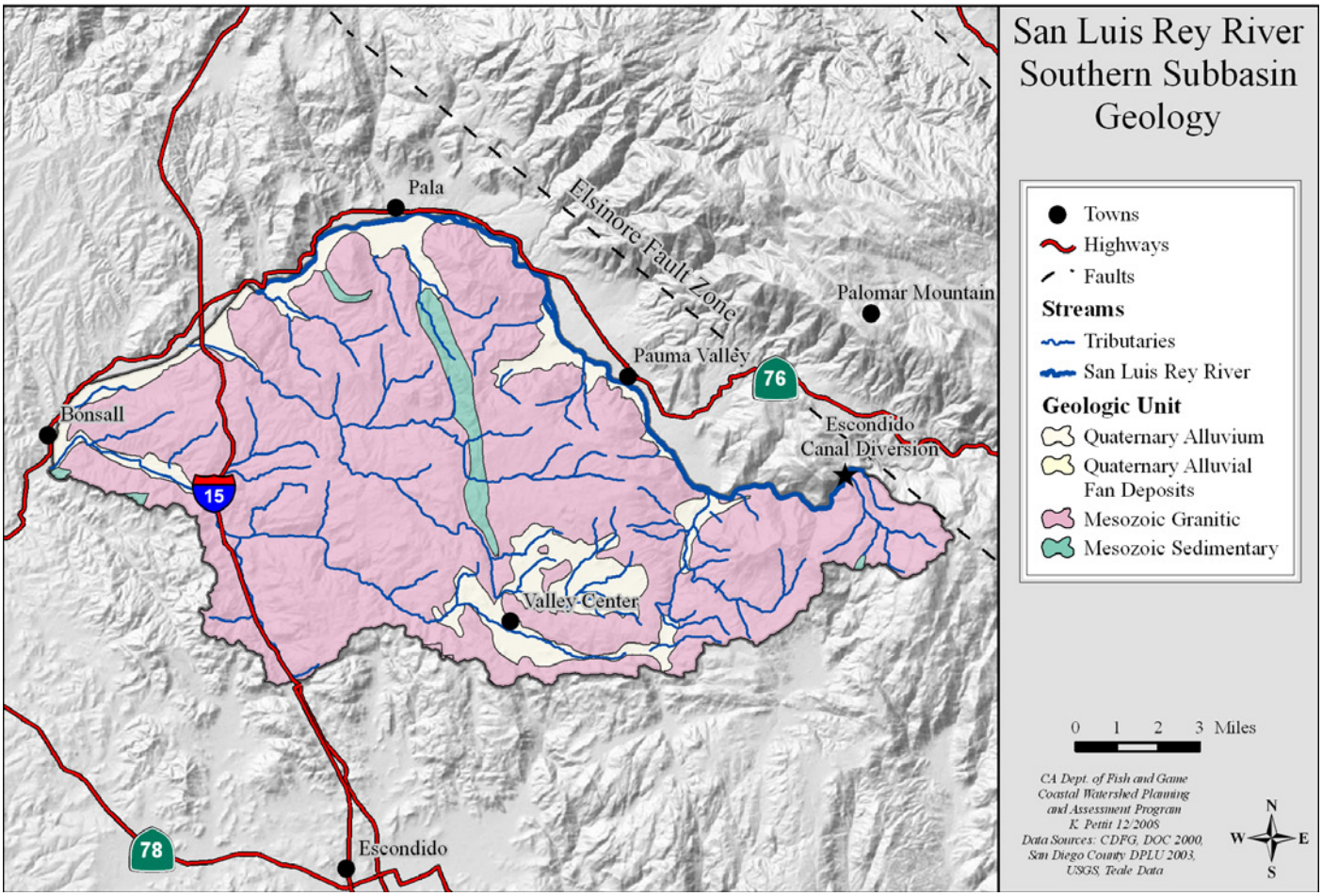

Figure 3. Geology of the Southern Subbasin.

Soils

The underlying bedrock is generally responsible for a soil's texture and erodability characteristics. The sediment contribution from soils found in the Southern Subbasin is dependant 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 Southern Subbasin.

Soil Type	Percent of Southern Subbasin	Parent Material
Sesame-Rock Outcrop-Cieneba (s1010)	60.12	Weathered granite
Vista-Fallbrook-Cieneba (s1011)	20.7	Weathered granite
Tujunga-Salina-Elder (s1001)	10.6	Weathered granite, sandstone-shale, alluvium
Rock Outcrop-Las Posas (s1012)	4.98	Basic igneous
Hotaw_Crouch_Boomer (s1015)	2.53	Weathered granite, metavolcanic
San Miguel-Friant-Exchequer (s1013)	1.07	Schist-gneiss, metavolcanic

Percent of basin represents a rough approximation based on GIS mapping

Earthquakes and Faults

The San Luis Rey River Basin is tectonically and seismically active and the possibility of seismic activity occurring in the subbasin should be considered similar to the southern California region as a whole. Due to nearby active faults, such as the Elsinore Fault, the subbasin has the potential for strong seismic movement. The Elsinore Fault Zone (currently established Alquist-Priolo Earthquake Fault Zone) runs northwest along the easternmost extent 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 M6.5 – 7.5 and has an average recurrence interval of approximately 250 years (SCEDC). The most recent major earthquake was a M6.0 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 (M6.7), triggered in excess of 11,000 landslides in a 6,200 square mile area (USGS) in similar terrain.

Landslides

Like the other SLR River subbasins, the Southern Subbasin is partially mantled with unstable soils. The mainstem and its floodplain in the Southern Subbasin consist predominately of alluvial material, while the hillsides are often composed of granite, weathered granite, as well as some 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 and the result is usually 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.

Fluvial Geomorphology

On average the Southern Subbasin should act as both a sediment transport reach, delivering sediments to the coastal basin, and a depositional reach, storing sediments in its flood plain. The slope of the mainstem was calculated to be 5% or less based on GIS mapping. Sediment erodes from the steeper hillsides and is brought by tributaries to the mainstem as well as being transported by the mainstem from the upper reaches.

The most recent stream surveys of the two reaches in the Southern Subbasin found DA5 Rosgen channel types (Table 4). These reaches were on the mainstem of the SLR River and in Keys Creek. Type DA reaches have multiple channels that typically are narrow and deep with expansive well vegetated floodplain and generally have associated wetlands. They have very gentle relief with highly variable sinuosities and stable stream banks (Flosi, et al., 1998).

Alluvium, which consists of unconsolidated sediment within the active influence of the stream channel, is relatively deep in places within the mainstem valley. The course, unconsolidated nature of these sedimentary deposits makes them excellent mediums in which to accommodate the subsurface flow of water. This can cause surface reaches of the mainstem as well as tributaries to go dry during times of low flow.

Table 4. Channel types in surveyed streams, Southern Subbasin.

Stream	Reach	Length (feet)	Channel Type
San Luis Rey River	1	51,142	DA5
Keys Creek	1	11,690	DA5

Vegetation

The predominant vegetation cover type as described by the U.S.F.S. CALVEG data is chaparral/scrub, covering 43.2% of the Southern Subbasin (Figure 4, Table 5). This cover type is split primarily between lower montane/mixed chaparral and California sagebrush vegetation types. Agriculture, consisting of orchards, pastures, crops, and nurseries is the second most abundant cover type at 28.6 %. Agriculture is the dominant land use throughout the subbasin as a great deal of native habitat has been converted to agricultural practices. Moreover, similar to the Coastal Subbasin, this figure does not reflect the overall percentage of acres dedicated to the growing of crops or livestock. Within the Southern Subbasin, pastures used for grazing of livestock 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 herbaceous cover type, composing 9% of the subbasin, most likely contains acres of agricultural related land as almost 90% of this herbaceous cover type consists of the annual grasses/forb alliance.

The only significant urban/residential area in the subbasin consists of Valley Center, located in the southern portion of the subbasin. Although, urban and residential areas continue to expand, especially around Valley Center, which has led to a reduction in the amount of farm land and native areas in the subbasin.

The impact of agriculture and urban/residential areas in the subbasin are described further in the Land Use Section below.

Non-Native Plants

Many non-native plants first became established in the coastal areas of California. They tend to decline with increasing distance from the coast (Stephenson and Calcarone 1999); however, anthropogenic activities have allowed non-natives to extend eastward in the SLR River Basin. Exotic plant species are most dominant to the lower elevations of the Coastal Subbasin, but have easily spread into the western portion of the Southern Subbasin, RM 19 to RM 24 (Basin Profile, Figure 17 & 18). Hydrologic changes to the SLR brought on by the dams and diversions appear to reduce the ability of native riparian plants to survive, creating conditions that promote the establishment of exotic species. High levels of disturbance and habitat modification tend to favor a non-native flora (Stephenson and Calcarone 1999). Currently, giant reed (*Arundo donax*) represents the greatest threat to the Southern Subbasin in terms of area occupied, potential to spread, impact to the quality and quantity of native habitat, and problems they pose to land managers. *Arundo* is widespread in the SLR River and some of its tributaries within the western portion of the Southern Subbasin. See Invasive Species Management section in Basin Profile (p.32) for a more detailed discussion of *Arundo*.

The Mission Resource Conservation District, working with the Santa Margarita–San Luis Rey Weed Management Area, as of August 1, 2007, had treated approximately 292 acres of 607 acres of *Arundo* in the watershed, mainly in the mainstem and some tributaries (http://smslrwma.org/). Although, due to the Corps long-term Operation and Maintenance Plan in Oceanside, within the concrete-lined channel (RM 1 to RM 7), a much larger area of exotic and native plant species have been and will continue to be treated, adding to these totals. The Weed Management Team has plans to remove/treat 100 acres of *Arundo* along Keys Creek. *Arundo* is widespread along its stream banks from half a mile upstream of its confluence with the SLR River to approximately 2.2 miles (RM 2.2) upstream. At RM 2.2 the creek increases in gradient and moves out of the alluvial floodplain with native species becoming the dominant vegetation. Additional treatments of *Arundo* are needed in Moosa Canyon and along the lower mainstem in the subbasin.

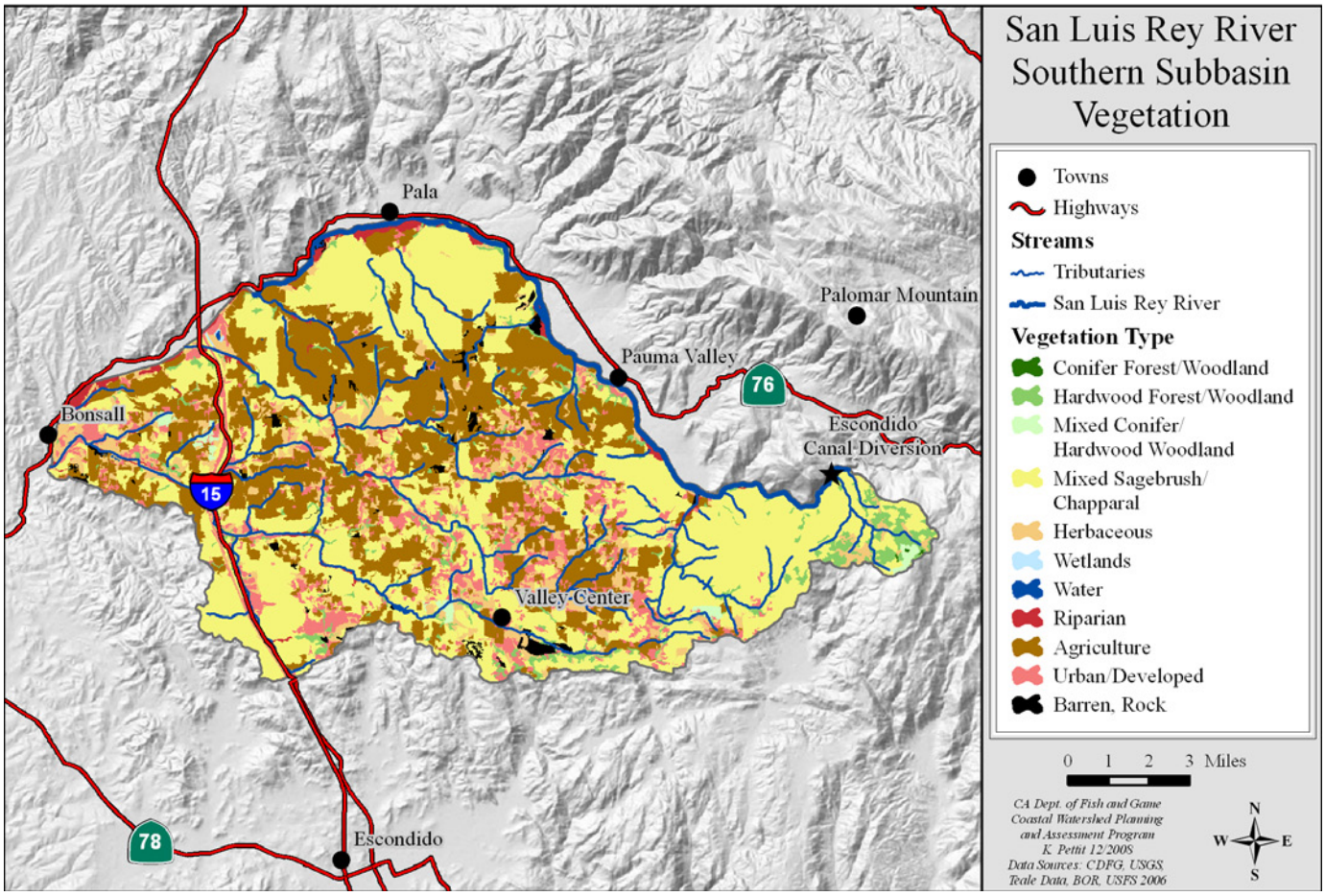

Figure 4. Vegetation of the Southern Subbasin.

Table 5. Vegetation of the Southern Subbasin.

Vegetative Cover Type	Percent of Basin	Primary Vegetation Type	Percent of Cover Type
Chaparral/Scrub	43.2	Basin Sagebrush	0
		Buckwheat	0
		California Sagebrush	41.8
		Ceanothus Mixed Chaparral	2.8
		Chamise	0.5
		Lower Montane Mixed Chaparral	54.8
		Manzanita Chaparral	0
		Red Shanks Chaparral	0
		Upper Montane Mixed Chaparral	0
		Other	0.1
Agriculture	28.6	Agriculture	0
		Orchard Agriculture	85.1
		Pastures and Crop Agriculture	14.9
Herbaceous	9.2	Annual Grasses/Forb Alliance	89.3
		Non-Native/Ornamental Grass	10.3
		Perennial Grasses and Forbs	0.4
Urban/Development	8.6	Urban/Development	100
Hardwood Forest/Woodland	5.1	Black Oak	0
		California Sycamore	1.7
		Canyon Live Oak	0
		Coast Live Oak	80.3
		Engelmann Oak	28.2
		Eucalyptus	2.3
		Interior Mixed Hardwood	0
		Non-native/Ornamental Hardwood	0.8
Riparian	2.5	Baccharis (Riparian)	31.9
		Fremont Cottonwood	0.2
		Riparian Mixed Hardwood	33.7
		Riparian Mixed Shrub	16.0
		Willow (Shrub)	16.0
Barren/Rock	1.2	Barren	7.7
		Tilled Earth	47.0
		Urban related bare soil	45.3
Mixed Conifer/Woodland	0.65	Bigcone Douglas - Fir	0
		Coulter Pine	23.9
		Mixed Conifer – Fir	0
		Mixed Conifer - Pine	0
		White Fir	0
		Nurseries	76.1
Water	0.20	Water	100
Wetlands	0.03	Tule – Cattails	50.0
		Wet Meadows	50.0
Conifer Forest/Woodland	0.02	Coulter Pine	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 Southern 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. As described in the Basin Profile, the San Luis Rey River was a prominent natural feature of the Luiseño territory providing the residents with subsistent food sources that included ocean and freshwater fish, a wide variety of plants and seeds, birds, and small and large mammals. The Spaniards were the first Europeans to arrive in the basin, in late 1760s. They entered in the Coastal Subbasin and began moving and settling throughout the basin. One of the earliest settlements near the Southern 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 on June 13th, 1816. 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. These ranchos were phased out by the late 1830s.

The area's attractions were common knowledge by the 1850s as a greater number of homesteaders continued to populate the area and eventually forced Indian tribes off of their lands and onto reservations. The first lands set aside were for the Pala Reservation in 1875 (SLR Watershed Council 2000). The Luiseño people were placed on this 10,000-acre reservation in what is now the town of Pala. Shortly afterwards, in the early 1900s, the Cupeños Indian tribe were removed from their residence in Warner Valley in the Upper Subbasin, and relocated to the Pala Indian reservation. This act herded two distinct Indian tribes together onto one reservation (http://www.palatribe.com/). In 1881, the smaller Rincon Indian Reservation was established. Both the Pala and the Rincon Reservations were formed alongside the SLR River with the Pala reservation situated downstream of the Rincon reservation.

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; however, the Southern Subbasin experienced minimum growth. Aside from the agriculture that was occurring in the subbasin throughout the 20th century, it wasn't until the housing boom of the whole county in the 1990s to the present that the Southern Subbasin gained a moderate population growth. This growth occurred mainly around the city of Valley Center.

Agriculture

Agriculture was the most significant historic land and resource use in the Southern Subbasin. Beginning with the grazing of cattle, sheep and horses, agriculture grew throughout the basin. As annual grasses became established, replacing perennial native grasses, livestock numbers declined dramatically. Farming of grain and hay developed and expanded on homestead lands in the subbasin. The first commercial mill in Northern San Diego County was a grist mill located in the area of the Wilderness Gardens. Powered by the SLR River, this successful mill operated from 1881 till the early 1890s, grinding corn and wheat into flour provided by farmers throughout the region. As agricultural operations expanded in the watershed, 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 provided the needed resources for many intensive agricultural enterprises in the Southern Subbasin and throughout the watershed such as truck crops, flowers, and nurseries.

Gravel Mining

Gravel mining operations have established an important industry in the basin. Most sand mining operations occurred in the Southern and Northern subbasins. While the effects of these operations were evident in the SLR River in the Southern Subbasin, they also contributed to a range of significant environmental impacts downstream in the Coastal Subbasin. Therefore, this report has discussed mining operations at greater lengths in the Basin Profile and Coastal Subbasin sections of the report.

At one time there were thirteen active mining operations, and gravel mining was the most economically important industry in the watershed in the 1980's. The last operating mine in the subbasin and the overall basin 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. Their major use permit expired in 2005 and the site was dedicated to open space. The reclamation and mitigation that occurred is mostly in the form of several large ponds just east of Pala on the south side of Highway 76. These ponds currently contribute seasonal runoff into to the river.

The current condition of the SLR River, particularly in

the Coastal and Southern subbasins, demonstrates that the previous traditional approaches to regulating in-stream mining have failed to adequately protect river resources over the long term. For a more detailed discussion of mining operations and their impacts on the watershed, please refer in the Coastal Subbasin and Basin Profile mining sections.

Escondido Canal

The Escondido Canal is located approximately ten miles below Henshaw Dam, just downstream of the divide between the Middle Subbasin and the Southern Subbasin (RM 40). The canal was constructed in 1895 for the purposes of supplying water for expanding agricultural needs and urban development to what is known today as the City of Escondido. This water diversion is made possible by a concrete dam approximately 150 feet long and 12 feet high across the main channel, creating a complete barrier to fish passage (Figure 5). Shortly after its completion the canal diverted approximately 45 cfs of SLR River water into the man-made canal that transferred it out-of-basin into Lake Wolford near the City of Escondido. Historically, the canal has diverted approximately 90% of the SLR River water away from the five Indian Tribes (Pala, Pauma, Rincon, La Jolla, and San Pasqual) to the Local Entities (City of Escondido and the Vista Irrigation District) (R. Smith, Chairman of Pala Band of Mission Indians, personal communication 2009). This drastic reduction of river flows below the diversion to the rest of the basin consequently altered the landscape and habitat of the riverine area.

Current Land Use

Many of the land use issues impacting the natural resources and riverine habitat in the Coastal Subbasin are also present in the Southern Subbasin. Some of these impacts are due to the same types of anthropogenic activities or proposed projects that will have a detrimental effect on the natural resources of the subbasin.

Agriculture

Agriculture plays a significant role in the San Diego County economy and the SLR Basin is a major area of agricultural production. Numerous small and large-scale farms populate the subbasin including land adjacent to the river and its tributaries. The warm climate of the Southern Subbasin makes it ideal for the growing of avocados, citrus fruit, nursery stock, and ornamental varieties of plants and flowers. The majority of these nursery operations ship their plants to overseas markets. Cattle and other livestock operations persist in the subbasin as well.

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 pumps were observed during CDFG 2007 field surveys in or near the flood plain within the Southern Subbasin. These pumps likely divert groundwater, which normally contributes to SLR River flows, to assist crop production. 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, which would reduce potential surface flows and place additional stress on the water demands of riparian plant species.

The use of pesticides in San Diego County is closely scrutinized by the local Agricultural Commissioner's office, and 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 practice 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 for further details of the impacts of agriculture to water quality and quantity (p.43).

The recent impact of rising water prices has caused a number of farmers to remove some crops such as citrus and avocados. About 10 to 15% of the 24,000 acres of tree crops in Valley Center have been taken out of production since 2005 (Fikes, 2008). Due to competition from Mexico, rising 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 of these rising costs, and agriculture and its benefits to the local and regional economy will lost.

Mining

Currently there are no mining operations occurring in the subbasin. The Rosemary's Mountain Quarry site, which is set to begin operations sometime between 2009 and 2010 is located primarily in the Coastal Subbasin, but portions of the mine extend into the western end of the Southern Subbasin. This mining operation is discussed in further detail in the Coastal Subbasin Current Land Use section.

Urbanization

The only major population center in the Southern Subbasin is located in the southern portion of the subbasin in Valley Center. The 2000 population census indicated that 15,639 people lived within the Community Planning Areas (CPAs) of Valley Center. This figure is expected to more than double to 33,006 by the year 2020 (SANDAG 2002). This substantial increase in populations will put additional stress on the natural resources and further encroach on native habitats as additional developments will occur to provide the necessary services and infrastructure to accommodate the increased population in the subbasin. There are also projects currently in the planning stages that will have considerable impacts on the subbasin's natural habitats.

Gregory Canyon Landfill

The proposed Gregory Canyon Landfill, which was also discussed in the Coastal and Northern subbasin's Urbanization section, is located in the Southern and Northern subbasins, a couple of miles east of Interstate 15 (approximately RM 21). Most of the landfill project site would be just south of California Highway 76, with a slight portion extending north of Highway 76 into the Rice Canyon watershed). This 1,770 acre landfill, which is currently in the permitting stages, is due to the increased need for waste storage as primarily a result of the growth that has and will be occurring in San Diego County including the urban areas of the Coastal and Southern Subbasins.

Currently, approval of the proposed landfill depends largely on whether the court decides if water supply for the landfill has been properly addressed. In order to operate the landfill, nearly 200 acre-feet of water per year is needed to help control dust and odor. Gregory Canyon Ltd. has contracted with Olivenhain Water District in Encinitas to provide those millions of gallons in the form of recycled water delivered via trucks on a daily basis (Pfingsten 2008). This agreement would require the water district to continue delivering large amounts of water over a 60-year period, regardless of drought conditions or increased demand from other customers in Encinitas.

Escondido Canal

The Escondido Canal continues to provide an important source of water for the City of Escondido as well as Vista. Upgrades to the canal and expansion of Lake Wohlford have increased the diversion potential of the canal as it is capable of diverting up to 70cfs of river water, an annual average of 14,000 acre-feet of water. Thus, under normal conditions, little to no flow passes the diversion point; therefore, the SLR River is generally dry (except following periods of sufficient precipitation) from the diversion dam (RM 40) to 19 miles downstream where a higher water table creates minimal year round surface flows.

Figure 5. Escondido Canal diversion dam (RM 40).

Tribal Indian Reservations

In conjunction with altering the ecosystems below the Escondido Canal diversion dam, the diversion of the river water was devastating to the way of life of the La Jolla, Rincon, Pala, Pauma, and San Pasqual Band of Mission Indians (http://www.slriwa.org/history). These tribes relied on the flowing river for farming, subsistence, ceremonies, and other culturally significant activities (see Basin Profile, Water Use: Diversions, Dams, and Water (pp. 48-50) for a further discussion of the appropriation of the SLR River water.

The Rincon Luiseño Band of Mission Indians consists of approximately 1,500 tribal members on nearly 4,000 acres of land (http://www.sandiego.edu/nativeamerican/reservations.html). This reservation is located predominately within the Southern Subbasin, along the SLR River and in the lower Paradise Creek watershed. A portion of the reservation extends into the Northern Subbasin on the north side of the river, approximately 4 miles downstream of the Escondido Canal diversion dam. The Rincon Indians operate a large, 55,000 square feet gaming casino (Harrah's), including a 21-story hotel, along the SLR River (RM 35), just downstream the Paradise Creek/SLR River confluence.

The San Pasqual Band of Indians is a smaller tribe whose reservation area consists of five non-contiguous tracts of land. Some of these tracts extend into the southernmost area of the subbasin.

The Pala Band of Mission Indians tribal lands extend almost equally between the Northern and Southern subbasins, with slightly more of their lands occupying the Southern Subbasin. However, due to the town of Pala, situated in the Northern Subbasin, the assessment chose to discuss the Pala Indians in the Northern Subbasin profile. The Pauma Band of Mission Indians (reservation almost entirely within the Northern Subbasin) is also discussed in the Northern Subbasin; whereas, the La Jolla Band of Luiseño Indians overview is located in the Middle Subbasin profile.

Recreational

Due to the majority of land being held in private or Indian Reservation lands, few recreational opportunities exist in the Southern Subbasin. One historically and ecologically significant public park is the Wilderness Gardens Preserve (RM 27), located along the SLR River, east of Pala. This is a 584-acre county park consisting of oak woodlands, chaparral, and riparian habitats. The park was the site of a former ranch and a commercial grist mill as described in the Historic Land Use (Agriculture, pg. 8) section. Aside from this park, the Hellhole Canyon Open Space Preserve, located east of Valley Center in the southern portion of the subbasin, provides hiking and horseback riding trails on 1,900-acres in mixed chaparral vegetation communities. There are also a few golf courses in the Southern Subbasin. These golf courses can contribute to water quality problems with the large amount of pesticide and fertilizers that go into the management of these large turf areas. Golf courses also tend to use large amounts of water, depleting groundwater levels and can exacerbate erosion or water quality problems with runoff from these courses.

Fish Habitat Relationship

Fishery Resources

Steelhead trout were historically found in the SLR River, including the Southern Subbasin, in sufficient numbers to provide the Indian Tribes with a subsistence food source and subsequently the local region with recreational fishing opportunities (USFWS 1998). Adult steelhead most likely used the SLR River in Southern Subbasin as a migration corridor for accessing more extensive habitat in tributaries of the Northern Subbasin and possibly mainstem habitat in the SLR River canyon (Figure 6 & 7) below natural barriers. Juvenile steelhead could have utilized the mainstem in the SLR River canyon as over-summering habitat and the rest of the river to migrate to the ocean and possibly for rearing habitat.

For a brief period in the 1990s, rainbow trout were successfully reared in the SLR River near the Wilderness Gardens Preserve boundaries. Local schools were provided fish from the CDFG Mojave Hatchery for release into the SLR River. At the time of their release water quality testing and sampling of aquatic insects indicated that conditions were favorable for trout survival.

In recent years, steelhead/trout have not been detected in the Southern Subbasin. It seems unlikely that steelhead/trout could utilize the majority of mainstem (below the canyon) or tributaries in the Southern Subbasin due to insufficient stream flows, passage barriers, the lack of suitable habitat, potentially high water temperatures, and water quality issues. Nonetheless, field surveys utilizing appropriate protocols are necessary to confirm the presence or absence of steelhead/trout.

Habitat Overview

Historic Conditions

As with most of the basin, there has been a limited

amount of stream surveys conducted in the Southern Subbasin. Early stream survey efforts performed by CDFG were neither specific nor standardized until 1990 when the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998) was published. Most observations in the historic stream surveys are not quantitative and have limited use in comparative analysis with current habitat inventories. However, data from these stream surveys provide a snapshot of conditions at the time of survey (Table 6).

The earliest stream survey in this subbasin was conducted by CDFG in 1946 in the SLR River. Most of the river flows had been continuously diverted for the prior 50 years and habitat conditions observed most likely reflected the effects of drastically reduced surface flows. This survey generally indicated that the river within the Southern Subbasin was unsuitable for trout, except for a small stretch of river around Pala where rainbow trout were observed. The report described a predominantly dry riverbed, with numerous extraction pumps in or near the river.

Prior to the completion of Escondido Canal diversion, Henshaw Dam and other major water diversions projects in conjunction with conversion of the riparian and surrounding areas to agricultural production, the SLR River possessed considerably different instream and riparian conditions. Leo Calac, a Rincon elder stated: "The riverbed was full of sycamores and willows… the old-timers say in Pauma Valley that steelhead used to come up from Oceanside" (Soto 2008). See Stream Flow (pp. 11-15) and Historic Conditions (pp. 57-58) in the Basin Profile for further historical stream flow data and anecdotal information. During normal to wet rain years, perennial surface flows would have facilitated upstream adult migration and smolt migration to the ocean. The SLR River with year-round flows and an extensive riparian habitat may have also provided some rearing habitat for emigrating juvenile steelhead. A recent report by Boughton et al. (2006) compiled historical evidence on central and southern California streams to suggest that the low gradient areas, such as the SLR River in the Southern Subbasin, "may once have been suitable for steelhead before alteration in the form of 1) widespread clearing of riparian cottonwoods and willows, 2) down-cutting of channels, and 3) loss of perennial flow."

It is unknown whether steelhead utilized any of the tributaries within the subbasin. While several large tributaries exist, such as Keys Creek and Moosa Canyon, there is a lack of recorded or anecdotal information regarding the presence of steelhead in these streams. According to the USGS 7.5 Bonsall quadrangle, Keys Creek was an intermittent stream for the lower 2.2 stream miles. Because of extensive agriculture production within the watershed, resulting in large amounts of runoff, the majority of Keys Creek now appears to flow year round. This was witnessed during several site visits in the late summer of 2007 as the creek maintained moderate summer flows (approximately 1 cfs). Other streams within the subbasin that may have contained sufficient flows to support the freshwater lifecycle stages of steelhead were probably very limited. Moosa Canyon is one of the few creeks in the subbasin which contained stream reaches with perennial flows, according to the USGS 7.5 Bonsall, San Marcos, and Valley Center quadrangles. The middle and upper reaches were denoted as having perennial flows, as the lower eight miles is labeled as an intermittent stream. With that many miles of intermittent flows, combined with a low gradient, alluvial streambed, it seems unlikely that Moosa Canyon was utilized by steelhead in most years.

Table 6. Habitat observations made in the Southern Subbasin from 1946-2007.

Stream	Date Surveyed	Source	Habitat Comments	Barrier Comments
San Luis Rey River	09/04/1946	CDFG 1946	Surveyed east of Oceanside to just upstream of Pala Creek (RM 25). Stream flow was low with an average depth of 8-10 inches and an average width of 4-5 feet. The water temperature was 68F. The surveyor reported of numerous pumps in the river and much of the river was dry except for the upper 4-6 miles. Rainbow trout, mosquito fish, and small cyprinids were present; however the trout were most likely observed in the vicinity of the Pala Indian Reservation. The survey indicated the area with the exception of a small stretch of river around Pala that the subbasin was unsuitable for trout.	Escondido Canal diversion dam (RM 40) was described as a complete barrier to fish passage.
	6/20/1975	Swift 1975	"The streambed mainly is sand in the lower reaches. The river is intermittent (from the Escondido Canal, RM 40) to the vicinity of Bonsall (RM 14) where the flow appears to be permanent. Mosquitofish and a few green sunfish were caught near the Oceanside Airport. Water temp at 3:30 pm was 20C; dissolved oxygen (ppm) was 5; pH was 7.5; and turbidity (J.U.) was 51.	Escondido Canal diversion dam

Current Conditions

In the Southern Subbasin, full instream habitat inventories were limited to the SLR River (Table 7 and Figure 8). A CDFG/PSMFC fishery crew conducted this inventory in August of 2007; the crew surveyed nearly 10 miles of the SLR River from the Coastal Subbasin border upstream to Cole Grade Road. The entire river in the subbasin was not surveyed due to denied landowner access. Keys Creek was surveyed in the winter of 2007, but full habitat inventory protocols were not performed because of human alterations to the stream channel and the stream channel/habitat uniformity. Other than Keys Creek, all other tributaries in the subbasin contained little to no surface flows during the majority of the field survey period and appeared to have very little potential suitable habitat for steelhead/trout.

The majority of the habitat characteristics assessed in CDFG's standardized stream inventory protocol are based on the presence of water; therefore, instream habitat conditions in the mainstem SLR River within the Southern Subbasin were difficult to quantify due to the lack of surface flows at the time of the survey. Only the western portion of the river, downstream of Gomez Creek, contained reaches with low flows and/or stagnant water. These surface flows appeared to be aided by runoff from the adjacent detention ponds located between the river and Highway 76. An elevated water table/alluvial aquifer may have also contributed to presence of surface water. Within this area, there is a shift in stream bank vegetation going from grasses and drought tolerant shrubs to moisture-depended flora, such as willows, sedges, bulrush, and *Arundo donax*. The volume of flow seems to increase further downstream, on the western edge of the subbasin and continuing into the Coastal Subbasin. The remaining approximately 9 miles of surveyed riverbed was dry (Figure 8).

Even if surface flows were present, habitat conditions would have been unsuitable for steelhead/trout. Much of the area surveyed exhibited limited instream habitat diversity, sparse riparian vegetation, and potential spawning gravels were absent as the streambed was predominantly composed of sand. Few existing or potential pools were observed, and the broad, alluvial riverbed was also lacking potential instream cover. The combination of the high sediment transport and low stream gradient of the area would prevent deep pool formation. As described in the Geology Section (p. 4), the alluvium nature of the mainstem stream channel creates excellent mediums in which to accommodate the subsurface flow of water. This causes surface reaches of the mainstem as well as tributaries in the subbasin to usually remain dry from the late spring to late fall (May through November).

The majority of the unsurveyed portion of the SLR River, prior to entering the mountainous, canyon area (RM 36) and with the exception of its traverse through the Pauma Valley Country Club (RM 33), appeared to be characterized by similar habitat conditions: dry, sandy river channel with chaparral and non-native and native grasses along the streambanks. Within the Pauma Valley Country Club the river has been channelized by means of a concrete-lined channel for the entire length of the golf course, approximately two-thirds of a mile. This concrete-lined channel has completely altered the streambed and habitat of the riverine area to the point where the channel now merely acts as a means to convey water flows (Figure 9). The golf course and lined channel also contains two road crossings, which are, at minimum, low flow barriers.

In June of 2009, tribal members and a consultant performed a reconnaissance level survey downstream of the Escondido Canal diversion dam into the SLR River canyon. The La Jolla Tribe refers to this area by its Luiseño place name – "Kye". Approximately ½ mile downstream of the diversion dam, RM 39.5, the crew observed a natural bedrock waterfall (Figure 10). While the overall height of the waterfall is about 50 feet, it is broken up into a series of steps, with the largest lowermost step approximately 13 feet, and a narrow steeped crevasse above the first step extending to the top of the waterfall (M. Capelli, personal communication 2010). Under most flow conditions steelhead are very unlikely to navigate through this feature. The survey report described the river flowing through several narrow chutes before reaching the falls (L. Musick, La Jolla Band of Luiseño Indians, personal communication 2009). At the time of the survey, flows were aided by water releases at the Escondido Canal diversion.

Following the June survey to the waterfall a separate reconnaissance level survey was performed in August of 2009 with tribal members and a NMFS fisheries biologist with the intent of examining the waterfall and the habitat conditions below the waterfall. While there was no surface flows directly below the diversion dam, the NMFS fisheries biologist noted flow (1.0+cfs) commencing in the inner gorge about 0.25 miles below the diversion and extending downstream for the duration of the survey (less than one mile below the waterfall). The low flow was attributed to rising ground water, as well as small side tributaries and springs below the Escondido Canal diversion (M. Capelli, personal communication 2009).

Recorded air temperatures were in the mid to high 90's during the day, while water temperature below the waterfall was 66°F. The biologist described the stream morphology consisting of large granite boulders with some deep pools and a number of step pools (Figure 6). The stream bottom was dominated by decomposed granite with little fine/silty material. While the riparian was limited by the steep, narrow nature of the canyon, there were some riparian trees consisting of mostly cottonwood and to a lesser extent sycamores. The biologist concluded, "there appears to be a considerable amount of suitable *O. mykiss* habitat below the waterfall within the inner gorge" (M. Capelli, personal communication 2009).

Keys Creek was surveyed in December of 2007 by PSMFC/CDFG fisheries crews from its confluence with the SLR River to 2.3 miles upstream. At the time of the survey stream flows were approximately 2 cfs. Beginning with its confluence with the SLR River and moving upstream, the first ¼ mile of Keys Creek consisted of a u-shaped, concrete lined channel. The bottom of the concrete channel had been filled in with a thin layer of sand as a result of upstream sediment transport. At approximately 2.2 miles the creek goes from an alluvial, low gradient stream channel to a boulder/bedrock canyon for approximately 400 feet. This short canyon reach contains multiple drops of 5 feet or greater without any potential jump pools for fish. Moreover, the creek appears to go subsurface, flowing through the bedrock layer. This area was classified as a complete barrier to steelhead migration. Below this barrier, Keys Creek has very little suitable habitat for steelhead/trout. While Keys Creek appears to retain year-round flows (surface flows were observed throughout the summer of 2007 and 2008) aided by agricultural irrigation runoff, the creek is almost completely devoid of pools and riffles. Flatwater (runs) are the dominate stream habitat type, occupying over 95% of the stream habitat downstream of the bedrock chute barrier. *Arundo* has overtaken the native riparian and has nearly formed a vegetation monoculture along the stream banks. Sand is the dominant substrate, as few, if any, potential spawning gravels were noted. Above the barrier, the habitat improved moderately as native vegetation was present along the stream banks and more pools and riffles were noted. However, the survey above the canyon was too limited to verify its potential to support trout.

Stream habitat characterization charts and EMDS maps were not produced for the Southern Subbasin due to the lack of surface flows, which are required in order to complete CDFG's standardized stream inventory protocols.

Table 7. Southern Subbasin streams surveyed in 2007 by CDFG.

Stream	Year of Survey	Survey Length (miles)	Percent of Permanent Stream Surveyed	Number of Reaches
San Luis Rey River	2007	9.74	43	1
Keys Creek*	2007	2.3	Unknown	1

* A full habitat inventory was not performed on Keys Creek. A natural bedrock chute passage barrier was encountered at 2.2 miles upstream of its confluence with the SLR River.

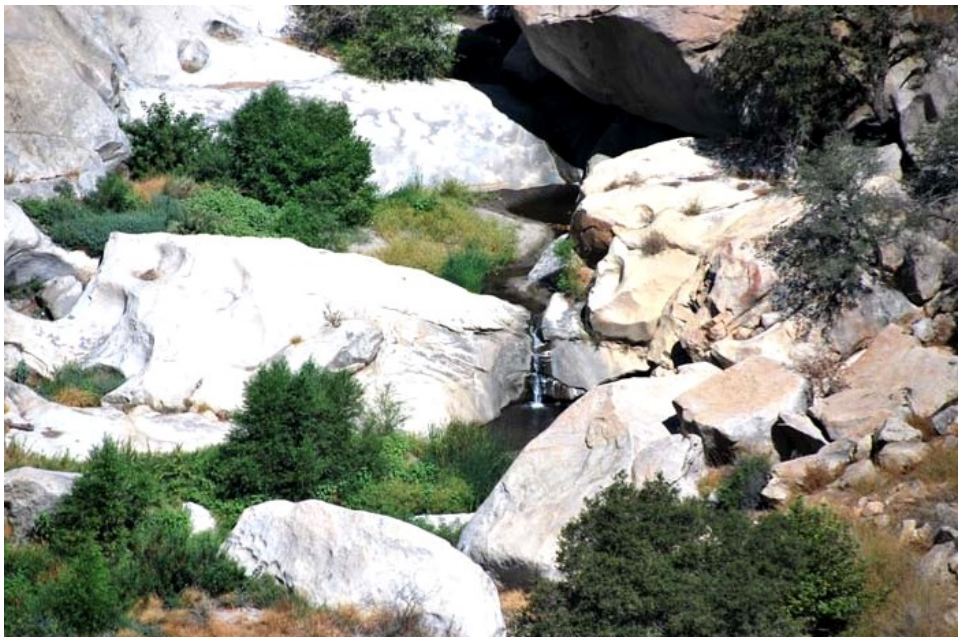

Figure 6. SLR River canyon below the waterfall, approximately RM 39, August 2009 (NMFS 2009).

Figure 7. SLR River canyon, below the waterfall, August 2009 (NMFS 2009).

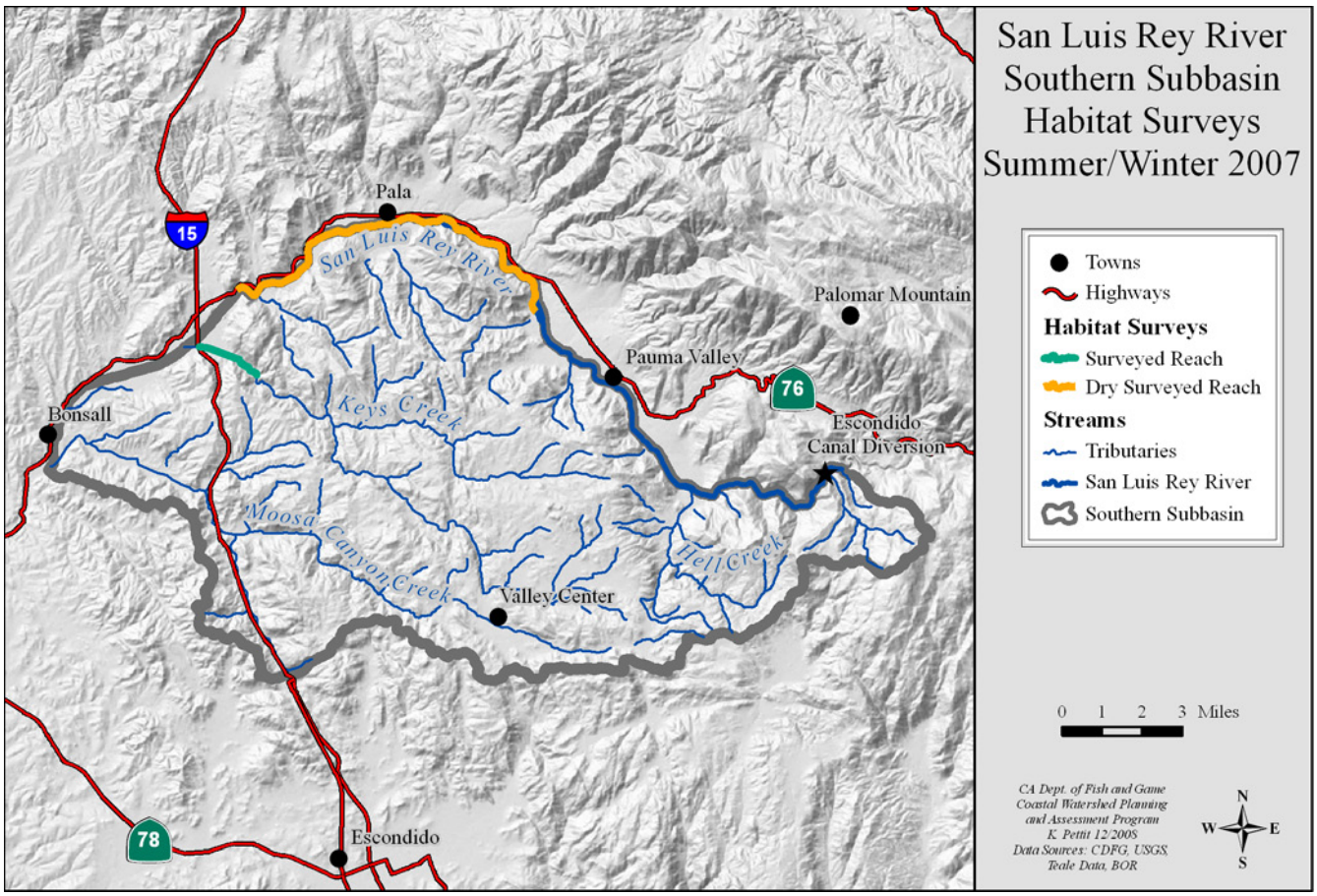

Figure 8. CDFG 2007 summer and winter stream habitat surveys in the Southern Subbasin.

Figure 9. SLR River flowing through the Pauma Valley Country Club (RM 32.7).

Figure 10. SLR River waterfall at "Kye" (RM 39.5), June 2009. (photo courtesy of La Jolla Indian Tribe).

Habitat Conclusions

The SLR River has undergone dramatic changes since European settlers first moved into the basin. Historically, the SLR River in the Southern Subbasin was most likely a perennial river, except during drought years. Water from the upper watershed and large tributaries such as Pala Creek, Agua Tibia Creek, and Pauma Creek (among others) would have most likely retained flows in the SLR River through hot, dry periods in the summer and fall (discussed further in Basin Profile, Hydrology, pp. 11-14). With the completion of dams, water diversion projects and other anthropogenic activities the river's surface flows have nearly disappeared and the riverine habitat has deteriorated.

Prior to the 2007 CDFG habitat inventory, very few surveys had been completed on the river, detailing the habitat conditions (Table 8). Previous CDFG surveys performed in 1946 and subsequently in 1975, noted that the river was dry, except around the Pala area (CDFG 1946 & 1975). The 1946 report indicated only the Pala area had suitable trout habitat. Considering the river has lacked hydrologic connectivity to the middle and upper watershed since the 1920s, it is not surprising that suitable steelhead/trout habitat conditions are currently limited to the SLR River canyon within the subbasin.

Presently, most of the riverbed channel in the subbasin is dry or is composed of "losing reaches" from the spring till the late fall; therefore, instream habitat conditions are difficult to quantify and qualify with instream habitat inventory protocols that require surface flows for evaluation. Even in the absence of quantifiable data, it is reasonable to conclude that stream habitat conditions appear unsuitable for *O. mykiss* spawning or rearing activities in the areas surveyed by CDFG during the assessment. Even if a survey was conducted during a period of surface flows, the river most likely would have still displayed unsuitable habitat conditions. Much of the area surveyed had minimal riparian vegetation, potential spawning gravels were absent, and the high sediment input and transport of the area would hinder deep pool formation and instream habitat diversity. The broad, alluvial riverbed was also lacking potential instream cover. Even though the survey was performed during one of the driest years on record, it is unlikely that stream habitat conditions would have varied much under normal flow conditions in the river. Cobble embeddedness, pool depth, and pool shelter were unsuitable on all surveyed reaches (Table 9), thus these

habitat factors are likely limiting to potential steelhead recovery. Cobble embeddedness and pool depth are affected by the natural geology of the area as well as the subbasin's lack of hydraulic connectivity to the Middle and Upper subbasins. The only instream habitat component that appeared meet the preferred suitable values within the subbasin was the extensive canopy cover on Keys Creek. Unfortunately, this canopy cover was composed almost entirely of the exotic *Arundo donax* as very little native riparian tree species remained along its stream banks.

Contrasting the CDFG surveyed areas within the subbasin, the SLR River in the SLR canyon appeared to maintain perennial flows with suitable water temperatures and deep pool habitat. This section of river could serve as over summering refugia habitat for *O. mykiss* (M. Capelli, personal communication 2009).

CDFG, with grantee Trout Unlimited, conducted water quality studies in the SLR River near Couser Canyon (RM 21) in the summer and fall of 2008 and 2009. This small section (approximately 500 feet) of perennially flowing river seems to benefit from a high water table and potential runoff from the reclamation ponds (mitigation for prior mining activities) adjacent to the river. The data from 2008 indicated low enough dissolved oxygen levels during August through December to consider this a threat to long-term survival of *O. mykiss* (S. Jacobson, Trout Unlimited, personal communication 2009). Other water quality parameters, such as specific conductivity, pH, phosphates and nitrate levels were within acceptable ranges for steelhead survival.

Table 8. Comparison between historic habitat conditions with current habitat inventory surveys in the Southern Subbasin.

Stream	Canopy Cover		Spawning Conditions		Pool Depth/Frequency		Shelter/Cover		Summary of Changes from Historic to Current
	Historic	Current	Historic	Current	Historic	Current	Historic	Current	
SLR River	ND*	Fully unsuitable	Poor	Fully unsuitable	ND	Fully unsuitable	ND	Fully unsuitable	Pool habitat decreased

Where multiple years of historic streams surveys were available, the oldest surveys were used.

Table 9. EMDS reach condition results for the Southern Subbasin.

Stream	Year	Canopy	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
SLR River - Reach 1	2007	---	---	---	---	---
Southern 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). 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 limited to reaches in the SLR River that contained surface flows; otherwise, detailed habitat conditions were recorded in the SLR River and in Keys Creek.

In order to compare SLR River reach recommendations within the subbasin, 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 10). 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. A CDFG biologist selected and ranked habitat improvement recommendations for the SLR River and in Keys Creek, in the Southern Subbasin (Table 11). The top three recommendations of each reach are considered to be the most important, and are useful in guiding restoration priorities.

Table 10. Recommendation categories based on subbasin target issues.

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

Other tributaries in the subbasin were not included in stream habitat improvement recommendations because: a) they were not accessible to steelhead/ trout; b) they did not appear suitable for steelhead/ trout, including lacking stream flows; or c) they could not be surveyed due to landowner access issues.

When examining recommendation categories by stream reach in the SLR River, the most important target issue is stream flow (Table 11). The SLR River streambed in this subbasin remains dry for much of the year. Fish passage ranked second, as four partial barriers and two complete barriers (the natural waterfall in the SLR River canyon, "Kye", and the Escondido Canal diversion dam) were observed during the 2007 CDFG habitat inventory or documented after the field surveys. The reduced stream flows have in turn adversely affected the riparian/water temperatures and instream habitat; therefore, the other top recommendations reflect these altered conditions.

Differing from the mainstem SLR River, Keys Creek maintains sufficient water flows, aided by agricultural runoff; however, a complete barrier (bedrock chute) is located 2.2 miles upstream of its confluence with the SLR River. This barrier prevents steelhead from accessing more suitable habitat upstream. Below the barrier, the instream habitat is devoid of spawning gravels and offers little to no rearing habitat as it lacks any instream habitat diversity. These poor conditions are reflected in the recommendations of Table 11.

Based on these subbasin target issue recommendations, high priority should be given to restoration projects that emphasize increasing seasonally appropriate flows, removal of passage barriers, riparian vegetation plantings, water temperature monitoring, improving spawning gravels, and pool formation projects.

Table 11. Occurrence of stream habitat inventory recommendations for different reaches of the SLR River of the Southern 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
SLR River	9.7	1	2	N/A	3	4		5			
Keys Creek	2.2		1	N/A		3	5	2	4		

N/A: Long term stream temperature data was not available.

Restoration Projects

Few projects have been initiated to improve or restore steelhead habitat in the SLR River or its tributaries. 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.), does not list any agency or organization funded stream restoration projects in the subbasin. However, several projects, while not conceived as fisheries restoration projects have either been completed or are in progress, and they will benefit and/or improve the overall habitat conditions for steelhead in the SLR River or potential tributaries.

One of these projects is the on-going exotic vegetation removal in the basin. Viewed as increasing flood and fire risk, degrading crop and rangelands, consuming large quantities of water, and displacement of native species and habitat, invasive plants have been targeted as a priority for removal and management in the watershed, with some removal occurring within the Southern Subbasin. Eradication of *Arundo* in the lower river (Coastal Subbasin) will only be successful if its seed source is completely removed from the upper portions of the watershed (i.e. Southern Subbasin). While improving overall canopy cover, the removal of exotics and revegetation with native stock could also improve flows and help fish to navigate through the mainstem more easily. The Mission Resource Conservation District (Mission RCD) in conjunction with the Santa Margarita and San Luis Rey Watersheds Weed Management Area is slated to treat 100 acres during the 2007/2008 season, mostly along lower Keys Creek (http://smslrwma.org/). These treatment efforts will be an on-going project in the subbasin.

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/). Projects that have occurred or are currently underway that have contributed to the monitoring of water quality and stream habitat conditions and improved water quality conditions include the following:

- Spring 2008 to December 2009 water temperature monitoring by the CDFG 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 monitoring conducted by the Pala Indian Tribe;
- Mission RCD working with area farmers on Best Management Practices for pesticide and erosion control and prevention;
- Collectively, the San Luis Rey Watershed Copermittees hosted and participated in numerous cleanup and outreach events, including creek and coastal cleanups and regional event presentations at which watershed concepts were emphasized (PBSJ 2003);
- The San Luis Rey Watershed Copermittees delivered formal presentations to approximately 1,035 students throughout the watershed. Learning tools used in these presentations include the Enviroscape watershed model, outdoor field trips puzzles, water quality posters, videos, and PowerPoint presentations (PBSJ 2003).

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Southern 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 dataset available for streams in the Southern Subbasin was for the SLR River, which was surveyed by CDFG/PSMFC fishery crews in the summer of 2007. The lack of surface flows in the river resulted in low EMDS stream reach scores. However, the entire river within the subbasin was not surveyed: the entire portion of the river upstream of Cole Grade Road could not be surveyed due to denied landowner access. Moreover, the dry conditions at the time of the survey limited the type of data that could be collected. Stream temperatures and water quality, important components in determining refugia categories, were not evaluated due to the absence of stream flows.

When considering the suitable stream habitat conditions encountered by a NMFS biologist during a summer of 2009 reconnaissance survey in the SLR River canyon, the refugia potential of the SLR River within the Southern Subbasin can be labeled as Medium Potential rating (Table 12). The biologist described the area river below the natural waterfall as having, “a considerable amount of suitable *O. mykiss* habitat” and “would serve as over summering refugia habitat…” (M. Capelli, personal communication 2009). Historically, the SLR River in the Southern Subbasin was most likely used as a migration corridor for steelhead to more extensive habitat in Northern Subbasin tributaries and/or the habitat upstream within the SLR River canyon. With year round surface flows and an extensive riparian area, portions of the subbasin may have also offered suitable rearing habitat for juvenile steelhead trout.

Other streams in the subbasin appeared to contain minimum suitable habitat for *O. mykiss* and thus were rated as Low Quality/Low Potential. Keys Creek was the only tributary surveyed extensively in the subbasin. A limited, general reconnaissance of Moosa Canyon showed little habitat available for steelhead as well as a potential barrier near the confluence with the SLR River. A habitat inventory on Keys Creek was initiated but not fully completed based on the following reasons: just upstream of its confluence with the SLR River, the streambed has been concrete-lined for approximately ½ mile; after this concrete channel ends, *Arundo donax* lines the stream banks, preventing continuous upstream access to portions of the stream; and little variance in habitat types (stream channel primarily consisted of long runs) to the fish passage barrier located 2.2 miles from the confluence with the SLR River. The creek provided very little if any suitable habitat that could be utilized by steelhead/trout. No potential spawning areas were observed and complex instream habitat was absent. Other tributaries in the subbasin such as Paradise Creek and Hell Creek were not surveyed and habitat conditions are relatively unknown. A thorough literature review contained no references to steelhead/trout in any of the tributaries in the Southern Subbasin. With the exception of small perennial sections of Hell Creek and Moosa Canyon, all tributaries in the subbasin are labeled on USGS 7.5 quadrangle maps as being intermittent streams. Table 12 summarizes current subbasin salmonid refugia conditions/ratings.

Table 12. Salmonid refugia ratings in the Southern Subbasin.

Stream	Refugia Categories				Other Categories		
	High Quality	High Potential	Medium Potential	Low Quality/Low Potential	Passage Barrier Limited	Critical Contributing Area	Data Limited
SLR River			X		X		X Needs survey
Moosa Canyon				X	X		X Needs survey
Keys Creek				X	X		
Paradise Creek	NOT ENOUGH INFORMATION TO CLASSIFY						X Needs Survey
Hell Creek	NOT ENOUGH INFORMATION TO CLASSIFY						X Needs Survey

Key Subbasin Issues

- The SLR River in the Southern Subbasin is not hydrologically connected to flows in the Middle and Upper subbasins. With the exception of the SLR River canyon, the majority of the river is dry from late spring until the occurrence of significant rains in the fall or winter;
- Numerous unregulated wells throughout the subbasin most likely have a negative impact on stream flows in the SLR River and some of its tributaries;
- Sediment level in streams is high and creates a multitude of problems for fish habitat;
- The river's streambed is most likely still negatively impacted by previous upstream gravel mining practices;
- Multiple partial barriers are located in the SLR River within the subbasin, hindering the potential upstream movement of steelhead and any potential emigration of juvenile trout down into the estuary and eventually into the ocean;
- Non-native plants, such as *Arundo donax* occupy large areas along the SLR River and in a couple of its tributaries, particularly in the western portion of the subbasin;
- Agricultural wastewater runoff poses a potential problem to aquatic ecosystems in the SLR River and its tributaries.

Responses to Assessment Questions

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

Findings and Conclusions:

- Southern California Coast Steelhead (DPS) are federally listed as endangered;
- Historically, adult steelhead most likely used the lower to mid SLR River in the Southern Subbasin as a migration corridor to more extensive spawning habitat in the tributaries located in the Northern Subbasin and possibly in the SLR River canyon within the upper end of the subbasin;
- Juvenile trout could have utilized the mainstem in the Southern Subbasin as over summering habitat within the SLR River canyon and downstream as an outmigration route to the estuary and eventually the ocean. Very few steelhead/trout have been observed in the subbasin since the 1940s;
- There is also a lack of historical information on steelhead using any of the tributaries in the Southern Subbasin;
- Contributing to this lack of information has been the inadequate number of general and focused surveys necessary to detect the presence or absence of steelhead/trout in the subbasin and overall basin.

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

Findings and Conclusions:

Flow and Water Quality:

- The SLR River in the Southern Subbasin is not hydrologically connected to flows in the Middle and Upper subbasins as the river water is diverted to the Escondido Canal. Water flows are also seriously impacted by numerous extraction pumps and other anthropogenic uses located throughout the subbasin;
- The lack of flows or sufficient flows in the SLR River most likely would impede the passage of steelhead to more suitable tributaries located in the Northern Subbasin and potential habitat in the SLR River canyon;
- Water quality is being impacted by agricultural runoff that have direct access to streams.

Erosion/Sediment:

- Without significant, channel altering flows, the movement of bedload materials in the SLR River is severely limited;
- The river's lack of hydrologic connectivity with the Middle and Upper subbasins also most likely hinders potential gravel recruitment;
- Removal of native vegetation for crop production has increased the amount of fine sediments entering tributaries and the SLR River during or after rain events;
- Livestock have unrestricted access to some tributaries, resulting in stream bank erosion;
- Soils (and bedrock) in streams of the Southern 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 is not suitable for salmonids. The SLR River has wide stream banks with generally sparse canopy. What canopy is available over streams is composed mostly of shrubs and grassland vegetation;
- The vegetation communities along the river have been significantly altered due to the severely diminished surface flows and conversion to agriculture. Riparian vegetation once consisting of willows, cottonwoods, oaks and other typical southern California riparian tree and shrub species have largely been replaced with agricultural crops, mixed sagebrush/chaparral and herbaceous vegetation communities;
- Invasive, exotic plant species, specifically *Arundo*, is widespread in the western portion of the subbasin in the mainstem and along some of the tributaries;
- Water temperature data collected by CDFG during summer habitat inventories are limited, and therefore inconclusive.

Instream Habitat:

- Due to the lack of sufficient surface flows, moderate to high quality salmonid habitat is lacking in the majority of the SLR River within the subbasin. The river is mostly devoid of riparian vegetation, contains high sediment levels, lacks potential spawning gravels, and displays minimum instream habitat diversity;
- The exception being is in the SLR River canyon where perennial flows coupled with cool water temperatures and deep pools provide a considerable amount of suitable *O. mykiss* habitat;
- The one tributary that was surveyed, Keys Creek, did not contain suitable steelhead/trout habitat below a natural bedrock chute barrier at RM 2.2. The first half mile of the creek contained a concrete-lined channel, which gave way to dense stands of giant reed that dominated the left and right banks.

Gravel/Substrate:

- Suitable salmonid spawning areas were very limited in surveyed reaches of the SLR River and Keys Creek. Overall numbers of potential spawning gravels were low and embeddedness measurements did not meet target values, confirming that sediment levels in the subbasin are high;
- The few potential spawning gravels are a result of the natural channel morphology, lack of hydrologic connectivity from the middle and upper watershed, which prevents gravel recruitment, and past and present human related activities.

Refugia Areas:

- A NMFS biologist who surveyed a portion of the mainstem within the SLR River canyon in the summer of 2009 concluded that the habitat below the waterfall (RM 39.5) within the inner gorge could serve as over summering refugia habitat for O. mykiss (M. Capelli, personal communication 2009);
- Salmonid habitat conditions in the CDFG surveyed portions of Keys Creek are generally rated as low potential refugia;
- Current habitat status is relatively unknown for a few other tributaries, such as Hells Creek and Paradise Creek, but no historical records exist of steelhead/trout utilization of these streams. Considering the majority of these streams' reaches are labeled as intermittent streams on USGS 7.5 quadrangles, it seems unlikely that they would contain even moderate quality habitat.

Barriers:

- The Escondido Canal diversion dam (RM 40) is a complete barrier and the natural waterfall in the SLR River canyon at "Kye" (RM 39.5) is most likely impassible due to the altered flow regime. Both of these barriers are located along the SLR River in the eastern portion of the subbasin;
- Partial barriers that would significantly hinder the passage of steelhead/trout in the SLR River include Arizona Road crossing at Cole Grade Road and two road crossings in the Pauma Valley Country Club Golf Course;
- Several other roads crossing exist on the SLR River containing either culverts or concrete-lined channel bottoms with significant gradient changes, which create seasonal/temporary fish passage problems;
- Keys Creek contains a natural boulder chute approximately 2.2 miles upstream its confluence with the SLR River and appeared to be impassible to steelhead/trout;
- Moosa Canyon also has a small, man-made dam approximately 1 mile upstream from its confluence with the SLR River that trout are unlikely to successfully pass.

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

Findings and Conclusions:

- The dominant material in the Southern Subbasin from Pala downstream is medium sand, which is highly transportable during floods and lacks gravel and cobble sized substrate need for spawning;
- The alluvium nature of the mainstem stream channel creates excellent mediums in which to accommodate the subsurface flow of water. This causes surface reaches of the mainstem as well as tributaries in the subbasin to go dry during the mid-spring to mid-fall months (May through October);
- Severely erodible soils comprise 95% of the watershed, including the Southern 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 Southern Subbasin is in a potentially seismically active area as several faults cut through this basin,

including the Elsinore Fault Zone located on the eastern edge of the subbasin;

- Large seismic events, especially when coupled with large 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;
- The Rice and Poomacha wildfires that occurred within the watershed during the fall of 2007 most likely resulted in an increase in sediment input into the SLR River and in tributaries such as Hell Creek, Paradise Creek and the upper watershed of Keys Creek.

How has land use affected these natural processes?

Findings and Conclusions:

- The lack of hydrologic connectivity from the Middle and Upper subbasins as well as numerous other water withdrawals has reduced or eliminated surface flows and lowered the groundwater table in the SLR River. As less water was available for shrubs and trees, the formerly lush riparian was replaced by drought tolerant chaparral species and other non-native grasses;
- Reduced water flows also hinders the recruitment of cobbles and gravel from the upper portion of the subbasin as well as diminishing flushing flows needed to scour and transport fine sediments downstream;
- Large areas of native vegetation along the mainstem and in tributaries have been displaced by non-native plants such as *Arundo* and *Tamarisk sp*. These non-natives have altered the channel morphology of the river and tributary streams. Efforts have been undertaken to remove these exotics and replace them with native vegetation;
- Invasive plants occupy habitat that normally has little vegetation, for example, the SLR River's sandy channel bed. Their presence changes the habitat in a manner that is potentially detrimental to the native fauna, such as the endangered arroyo toad that utilizes open areas;
- 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.

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 this subbasin, it appears that salmonid populations are limited by:
  - Lack of hydrologic connectivity, which hinders surface stream flows and inhibits adult upstream migration and downstream juvenile movement to the lagoon and thus the ocean;
  - Fish passage barriers;
  - High levels of fine sediments in streams;
  - Loss of habitat area and complexity;
  - The presence of invasive plants, such as *Arundo donax* in the SLR River and tributaries, which degrades habitat quality and reduces surface flows;
  - A shortage of areas with suitable spawning gravel in tributaries;
  - Competition with bullfrogs and crayfish in some of the 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 SLR River and Keys Creek since they were the only streams extensively surveyed during the assessment. Other streams, Hell Creek and Paradise Creek, 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. Moosa Canyon has a fish passage

barrier only a mile from its confluence with the SLR River and seems unlikely to be utilized as steelhead/trout habitat.

Barriers to Fish Passage

Streams	Recommended Actions XXX: Highest Priority		
	Continue efforts to identify and alleviate fish passage impediments at culverts or other public or private road crossings.	Improve fish passage by modifying Arizona road crossings.	Improve fish passage by removing structures on private lands that are currently partial barriers.
SLR River	XX	XXX	XX
Keys Creek	X		X

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.	Provide seasonally appropriate, pulse flow releases from the middle and upper watershed during adequate water years.	Reduce water temperatures	Plant willows, cottonwoods, and/or sycamore trees to restore riparian habitats and help reduce water temperature in areas with insufficient shade.	Remove and prevent excessive agricultural or urban runoff contributions to aquatic ecosystems
SLR River	XXX	XXX	XX	XX	XX
Keys Creek	X			XXX	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.
SLR River	XX	X	X	X
Keys Creek	X			X

Riparian and Instream Habitat

Streams	Recommended Actions XXX: Highest Priority			
	Increase depth, area or shelter complexity in pools, by adding boulders.	Increase the number of pools, design and install pool forming structures.	Continue to remove non-native exotic plant species such as *Arundo donax* and replant with native trees and shrubs.	Consider planting barren nearstream areas with willow, cottonwood, or sycamore trees to increase streamside shade canopy and allow for woody recruitment.
SLR River	X	X	XXX	XXX
Keys Creek		X	XXX	XX

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.
SLR River	X	XX	XXX
Keys Creek	X		X

Subbasin Conclusions

Although there has been limited biological and habitat surveys conducted on the SLR River and its tributaries in the Southern Subbasin evidence suggests that steelhead once utilized this section of the river. Anecdotal accounts from a Pauma Indian Tribal elder spoke of annual runs and ceremonies associated with large fish, presumably steelhead, on SLR River (USFWS 1998). A 1946 reconnaissance level survey noted the presence of trout in the river around the Pala area. Further evidence is discussed in the Basin Profile, Historical Accounts of Steelhead Runs, p. 51.

When comparing anecdotal accounts as well as the few historical stream surveys and scientific studies on the riparian and river channel to the present conditions observed during the 2007 CDFG habitat inventory, it is easy to conclude that there has been a deterioration of instream habitat due to an assortment of historical and on-going anthropogenic activities within the subbasin and throughout the basin. Lack of hydrologic connectivity, water extractions, riparian vegetation removal, invasion of exotic plant species, previous sand and gravel mining operations, agricultural practices, and urban development have all played a role in changing the natural function of the river, water quality and quantity and thus instream habitat for fish. The geology of the area also contributes to fluctuating riverine conditions. Soils in this subbasin and upstream are susceptible to erosion and enter the streams through the road related and stream bank slides. High amounts of sediment are present in the river and its tributaries. Steelhead spawning areas are nearly absent as sand is the predominant substrate in the riverbed. Currently, suitable *O. mykiss* habitat is available within the SLR River canyon. This section of river, below the natural waterfall (RM 39.5), provides perennial flows with rising ground water to moderate water temperatures and pool habitat with boulder cover.

Fish passage in the Southern Subbasin is very limited due to the dry or "losing" reaches present in the SLR River and its tributaries for most of the year. Additionally, there are several partial barriers that hinder fish passage/movement in the river. These barriers are the result of humans and vary in their degree of difficulty for steelhead/trout to pass. Specifically, the following barriers are present along the SLR River in the Southern Subbasin (described from east to west): a private road near Couser Canyon constructed with fill and utilizes small circular culverts that inadequately facilitate mainstem flows (RM 20); a concrete bridge situation within the channel of the SLR River (RM 28 on a water district road); the Arizona road crossing at Cole Grade Road (RM 30); and several road crossings in the Pauma Valley Country Golf Course (RM 32.7). Upstream of all these partial barriers in the SLR River canyon (RM 39.5) is a 50 foot high natural bedrock waterfall that is broken up into a series of steps. Taking into account the altered flow regime with the majority of the stream water being diverted approximately ½ mile upstream at the Escondido Canal diversion, steelhead are very unlikely to navigate through this feature. The Escondido Canal diversion dam (RM 40) is a complete barrier to fish passage.

Considering the river is located in a dry, alluvial area, it seems likely that steelhead used this portion of the river as a migration corridor to more suitable spawning and rearing areas either in the SLR River canyon or in the streams of the Northern Subbasin. However, having perennial river flows prior to the completion of the Escondido Canal diversion and the Henshaw Dam, the SLR River instream habitat conditions would have been quite different than their current state. While being more conducive to upstream adult migration and downstream smolt migration to the ocean, the river would have also contained a diverse, lush riparian and potentially more complex instream habitat.

It is unknown whether steelhead used any of the tributaries within the subbasin. While several large tributaries exist, such as Keys Creek, Paradise Creek, and Moosa Canyon, there is a lack of recorded or anecdotal information regarding the presence of steelhead in these streams. Whether any of these streams retained perennial flows to provide potential rearing habitat is also unknown.

Implementing seasonally appropriate, pulse release flows are necessary during adequate water years and would greatly facilitate the migration of adult fish and out migration of juvenile fish. These increased flows could also help to restore riparian and complex instream habitat conditions. Without adequate pulse release flows, in conjunction with fish passage and other habitat improvement projects there is little hope of improvement of overall conditions to support the survival of southern steelhead in the Southern Subbasin.