Restoration Planning at the Sespe Cienega

Literature and Data Review

PREPARED FOR

California State Coastal Conservancy

&

California Department of Fish and Wildlife

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Contents

1.0 Literature and Data Review

The planning process for restoration of the Sespe Cienega (Fillmore, CA) has been initiated with funding provided by the California State Conservancy (SCC) and California Department of Fish and Wildlife (CDFW) through the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1). This memo summarizes the scientific/technical report and literature review that was conducted to determine what relevant information is available to provide a starting point for this planning exercise, and to guide 'on the ground' environmental data collection efforts and avoid unnecessary redundancy. Emphasis of the review focused on information available for the river reach that contains the extent of the historical cienega, but also considered the site within the context of the floodplain and watershed to facilitate a landscape perspective. Studies of other watersheds that can provide insight for the current planning process were also considered. Appendix 1 provides the complete bibliographic list of information reviewed.

2.0 Physical Properties

2.1 Geology and Physiography

Located in the distinctive geological province of the west-east trending Transverse Ranges, the Sespe Cienega site sits within the Santa Clara River watershed, a 4,204 km^2 watershed that retains a relatively natural state compared with other large watersheds in coastal southern California (Figure 2.1). The Santa Clara River (SCR) drains westwards from a maximum elevation of 2,700 m to sea level through four hydrogeomorphic regions (SWS 2011), with the Cienega site sitting on the right (north) river bank, approximately half-way along the downstream-most region, the Santa Clara River Valley. The SCR drains 2,980 km^2 in the vicinity of Sespe Cienega. The river valley is bounded to the north by the Topatopa Mountains, as part of the Western Transverse Ranges and, to south by the Santa Susana Mountain range. The site itself is situated a short distance upstream of the confluence of Sespe Creek, a major north bank tributary of the SCR. Here, the SCR valley is broad and underlain by extensive alluvial deposits with the mainstem river generally located towards the southern side of the valley, possibly in response to forcing from the alluvial fans that emanate from tributaries on the northern (right) side of the valley. Structurally, the Cienega sits at the boundary between the Piru and Fillmore groundwater sub-basins: here, groundwater is forced towards the surface allowing the maintenance of riparian vegetation as part of a wet meadow (*i.e.*, cienega) ecosystem through historical time, the remnants of which remain today (Beller *et al*. 2016).

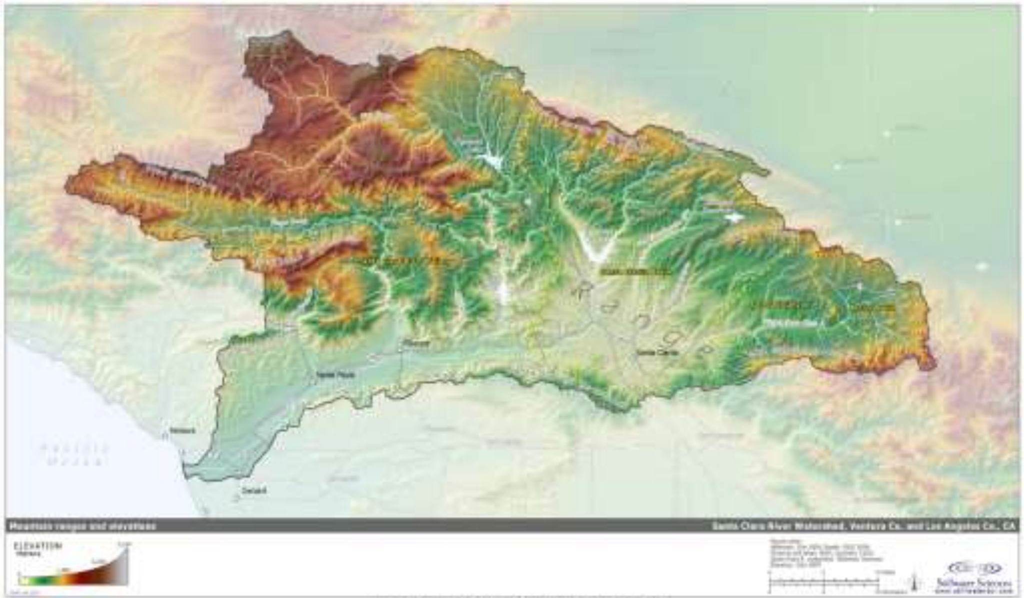

Figure 2.1: Santa Clara watershed terrain (source: SWS 2011)

The drainage network of the SCR watershed is strongly influenced by geologic structure and the location of active faults (Figure 2.2). The site sits at a constriction between the San Cayetano and Oak Ridge/Santa Susana faults. The faults trend west-east at this point, with the San Cayetano Fault forming the northern boundary of the Cienega as it breaks to steep hills and mountains to the north, while the Oak Ridge/Santa Susana Fault marks a similar break on the southern side of the valley. Regional geological instability over the last 28 M years has resulted in a wide variety of deformed, fractured, and faulted rocks types across the watershed (Yeats 1981, Rockwell et al., 1984, Rockwell 1988): the high-relief uplands of the east of the watershed are characterized by older igneous and metamorphic rocks while the west, where the Cienega is located, is characterized by younger (and more erodible) sedimentary rocks. The valley sides bordering the site comprise uplifted Miocene- and Pliocene-age marine deposits, while the floodplain sits on Quaternary-age alluvium that could be derived from most all rock types in the watershed. Rocks of the SCR valley tend to be poorly consolidated, intensely folded and steeply tilted and so are susceptible to landslides (Harp and Jibson 1996), erosion by dry ravel (Scott and Williams 1978) and debris flows. To reduce high sediment loads derived from such processes, three debris basins are situated on the northern valley side of the SCR a short distance upstream of the site.

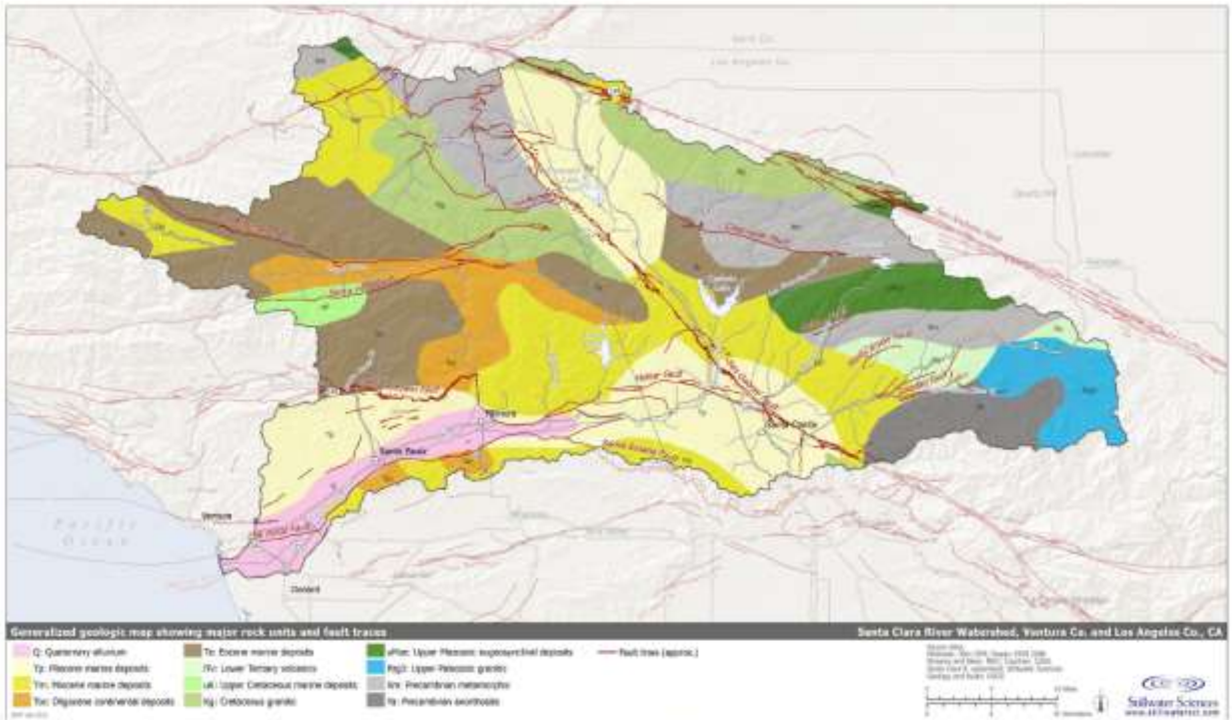

Figure 1-4. Generalized geologic map showing major rock units and fault traces in the SCR watershed.

Figure 2.2: Generalized geology of the Santa Clara watershed (source: SWS, 2011)

2.2 Climate and Hydrology

The Santa Clara River is subject to a semi-arid two-season Mediterranean climate with cool wetter winters and summers that are hot and dry – rainfall decreases progressively inland from the Pacific Ocean. The maximum average annual rainfall (1,150 mm) occurs in the uplands of Sespe Creek drainage in the north-west of the watershed while the far eastern tip of the watershed has a sufficiently low average annual rainfall (< 250 mm) to classify it as desert (Figure 2.3). Near the Cienega, average annual rainfall is approximately 490 mm (PRISM data 1971-2018 one standard deviation = 240-735 mm). Precipitation is usually concentrated in several large storms between November and March that are, on average, responsible for discharging more than half the annual flow from the lower Santa Clara River (LSCR, the SCR in Ventura County) in just a handful of days. Conversely, the rest of year is characterized by very low flows (annually, 50% of days have flows <0.3 m^3s^{-1}). High flows are very flashy (*i.e.*, they peak and subside rapidly in relation to high intensity rainfall events) with the largest storms associated with the El Niño Southern Oscillation (ENSO) phenomenon (Andrews *et al*. 2004). Near the river's mouth, there is a 70% probability that instantaneous peak flows will exceed 1,100 m^3s^{-1} in El Niño years, whereas only a 10% chance in non-El Niño years (Downs *et al*. 2013). In January 1969, the largest flood peak on record at the downstream-most gauge at Montalvo (in operation since 1952) was estimated to exceed 4,600 m^3s^{-1}. In general, large storms (and thus high flows) occur with a frequency of 5-8 years, reflecting the coincidence of

ENSO events (5.3 years) with positive phases of the Pacific Decadal Oscillation (22 years) and Jetstream and extracyclonic storms during El Niño years (2.2-2.9 years, Hanson and Dettinger 1996 in Hanson *et al*. 2003).

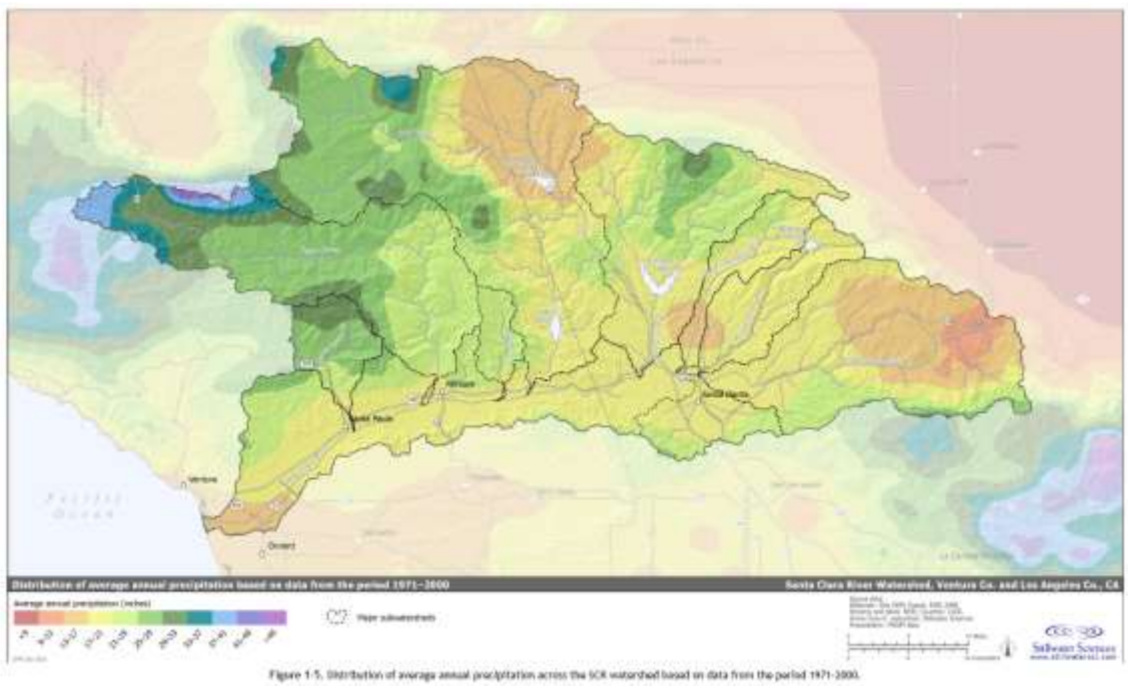

Figure 2.3: Santa Clara watershed average annual precipitation (source: SWS 2011)

While flows in the lower SCR are largely controlled by discharge emanating from wetter uplands of Sespe Creek (and to a smaller extent, from Santa Paula Creek), the Cienega site sits immediately upstream of Sespe Creek meaning that its flood flows, while still flashy, are dictated by the far lower precipitation received in the upper Santa Clara River (USCR). As such, high flows are best characterized by data from the USGS gage at the Los Angeles / Ventura County Line (USGS gage 11108500) rather than those downstream at Montalvo (USGS gage 11114000). As comparison, the estimated 1.5-year recurrence interval flow is 3.1 times greater estimated at the county line (60 m^3s^{-1}) versus Montalvo (186 m^3s^{-1}) despite only a 2.6 times increase in drainage area (URS, 2005).

Historically, the magnitude of flood flows would likely have been higher when the major tributaries of Piru and Castaic creeks were undammed. The completion of the 61-m Santa Felicia Dam on Piru Creek in 1955 (Figure 2.4) represented the first large-scale flow regulation in the SCR (for consumptive uses), with Lake Piru regulating 1,090 km^2 of the watershed (~26% of the total area). Flood flows on Piru Creek have since been regulated to below 28 m^3s^{-1} except during the 1969 flood of record when a peak flow of 816 m^3s^{-1} was released on February 25th. Pyramid Dam was completed further upstream on Piru Creek in 1971 to impound water imported to the watershed via the California Water Project. Castaic Dam, completed in 1972, also stores imported water and is operated as a run-of-river structure, affecting flow from a further 398 km^2. About 34% of the SCR watershed is regulated in total, all upstream of the Cienega site, with the proportion regulated at the site being approximately 51%.

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Figure 2.4: View looking downstream from Santa Felicia dam (source: SWS 2007)

The Cienega site was also briefly subject to regulation by the St Francis Dam on San Francisquito Creek. Construction commenced on the 56 m-high structure in 1924 but shortly after completion on 12th March 1928, the structure collapsed releasing an estimated 14,000 – 23,000 m^3s^{-1} flood wave down the lower 87 km of the Santa Clara River to the Pacific Ocean (Figure 2.5). While the flood wave would have decreased in magnitude (through attenuation and translation) as it travelled downstream, it was still estimated to be 8 m-high in Santa Paula. If correct, the estimated magnitude of the flood would make it 3 to 5 times higher than any subsequent flood on the SCR. This dam break flood would have a natural return period of 200–1,000 years (URS 2005). The dam collapse, one of the worst disasters in US history, and leading directly to dam safety protocols in the US and worldwide, resulted in significant sediment deposition downstream (Ventura recorded deposited mud to a maximum depth of 20 m). The sediment load associated with the flood is unknown. While regulated floods are typically characterized by low sediment loads (‘clear water’), the landslide into the reservoir that prompted the dam to fail may have provided a significant sediment load. As such, it is unclear whether the flood wave was sediment rich or sediment poor, and whether the main impact of the flood was channel incision or aggradation. However, the lack of flood-confining levees at this time would have allowed the flood to spread extensively across the floodplain, minimizing its impact on the channel and floodplain morphology of the SCR in the wider valley sections.

Direct evidence of the morphological impact of the flood is difficult to ascertain when comparing (relatively poor quality) aerial photographs from 1927 and 1929 (SWS 2007).

Figure 2.5: Remains of Saint Francis dam, following collapse on 12th March 1928 (above), and a downstream view of the mainstem Santa Clara River near Santa Paula the next day (photos courtesy of the Ventura County Watershed Protection District. Source: SWS 2007)

The low flow hydrology of the LSCR has historically been characterized by alternating reaches of perennial and intermittent flow – the latter occurring over about 30% of the channel length (see Beller *et al*. 2016). As indicated above, such variability is largely a function of geological controls in the Santa Clara Valley groundwater basin, which is subdivided into four groundwater ‘sub-basins’. The Cienega site straddles the boundary of the Piru and Fillmore sub-basins (see below), both of which are characterized by an upper ‘losing reach’ as the valley widens and deepens and surface flows percolate rapidly through highly permeable bed materials to deeper groundwater, and a lower ‘gaining’ reach where bedrock constrictions force groundwater towards the surface (Reichard *et al*. 1999; United Water Conservation District *unpublished data*). As flows from the upper SCR leave Soledad Canyon and enter the broadening alluvial floodplain of the LSCR (the upstream end of the Piru sub-basin), they percolate into the alluvium resulting in the ephemeral 10-km reach from Camulos to just upstream of the Cienega site (Figure 2.6) that has been recorded consistently since the first exploration of the valley in 1769 (Crespí and Brown 2001 in Beller *et al*., 2016 Table 2.1). Just upstream of the Cienega site, geological constraints force flows back towards the surface so that the SCR alongside the Ceinega is characterized by perennial flow that is suitable to support the growth of wet woodland species. This pattern remains today despite upstream releases of surface water from Santa Felicia Dam in the Fall to augment groundwater levels for downstream agriculture, numerous water withdrawals for agriculture as well as the Fillmore Fish Hatchery, and the increasing perennial runoff resulting from the significant urban expansion of the Santa Clarita area of the upper SCR.

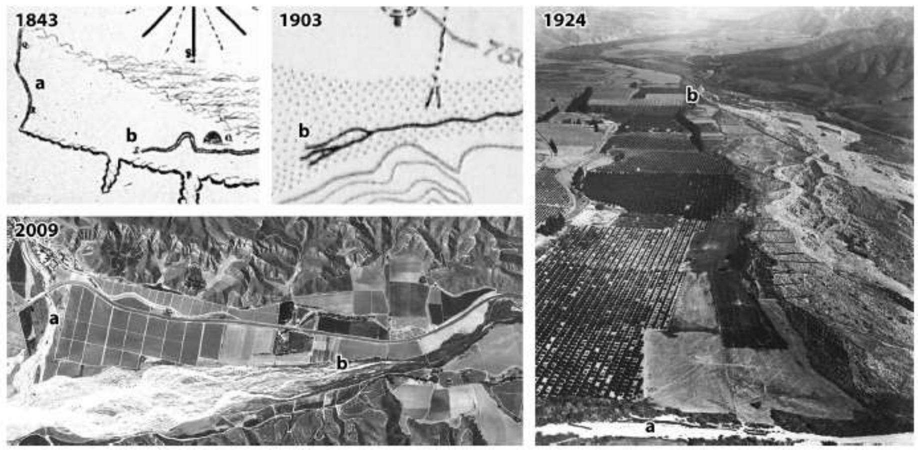

Fig. 6 A number of sources depict the transition between perennial and intermittent flow (marked on each image with '*b*') east of Piru Creek (marked with '*a*'), where Spanish explorer Crespí noted the river "stopped flowing amid the great amounts of sand" in August 1769. A photograph of the LSCR in September 1924 looking east from the Piru Creek confluence (far right) shows the transition from a perennial reach flanked by riparian forest to an intermittent reach supporting alluvial scrub. This same transition from perennial to intermittent surface flow is shown 80 years earlier on a ca. 1843 Mexican *diseño* (*top left*), which depicts the LSCR abruptly stopping at the same point, as well as on a 1903 topographic quad (*top middle*). This break in surface hydrology and riparian ecology has persisted to the present day (2009 photograph, *bottom left*), driven by underlying geologic controls. (Unknown ca. 1843, courtesy of John Johnson and Santa Clarita Valley History; USGS 1903, courtesy of the CSU Northridge Map Library; Spence Air Photos 1924, courtesy of Benjamin and Gladys Thomas Air Photo Archives, Spence and Fairchild Collections, UCLA Department of Geography; NAIP 2009)

Figure 2.6: Zone of consistently intermittent flows just upstream from Sespe Cienega (Source: Beller *et al*. 2016)

2.3 Groundwater

The groundwater sub-basins of the Santa Clara Valley (and those of the Oxnard Plain) are illustrated in Figure 2.7. The historical extent of the riparian wetland area of the Cienega deduced from extensive historical research (Beller *et al*. 2011) is illustrated in Figure 2.7 (top), with the remnant extent and contemporary fish hatchery illustrated in Figure 2.7 (bottom). Figure 2.7 indicates that the Cienega straddles the Piru and Fillmore groundwater sub-basins, the boundary of which is noted as 'rather arbitrary' in an early study (Mann 1959). The majority of the land parcels in the Cienega property extent sit within the Fillmore sub-basin, but groundwater dynamics at the site are best documented as those for the western end of the Piru sub-basin.

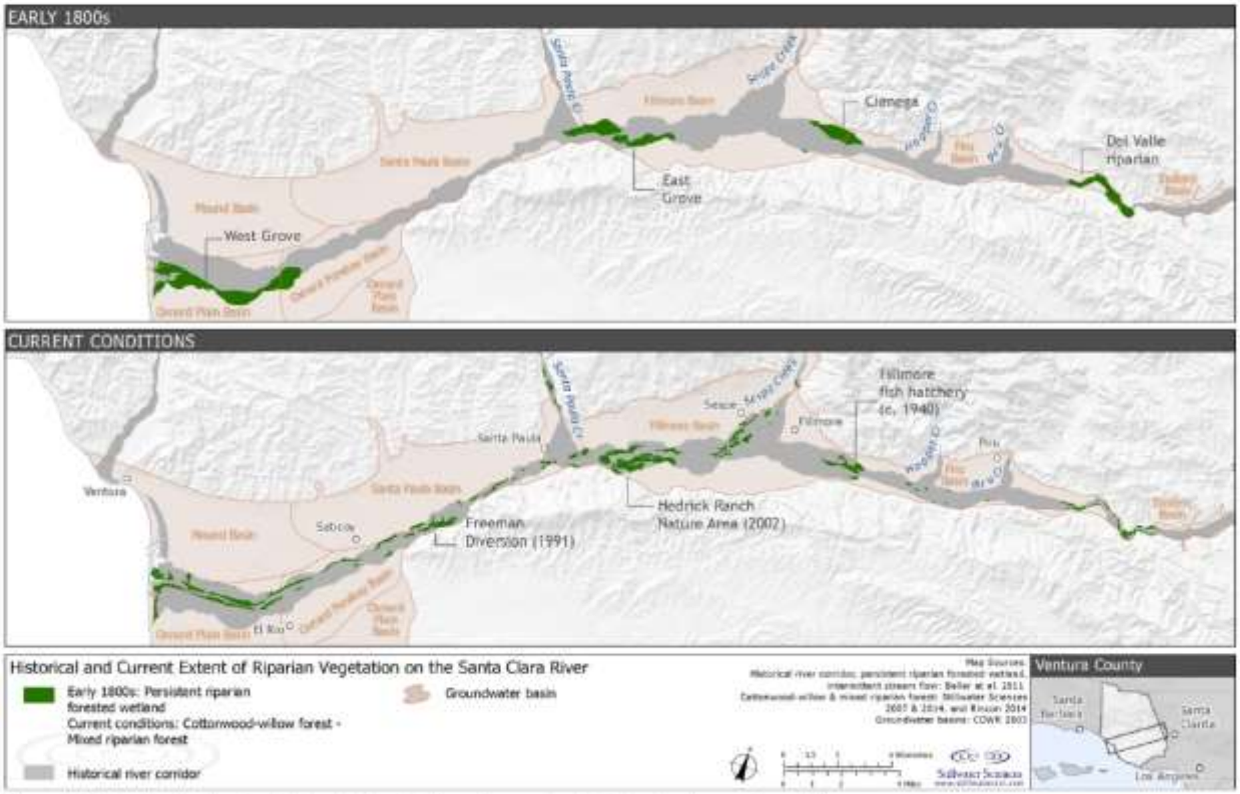

Figure 2. Riparian forest extent along the Santa Clara River under historical and current conditions.

Figure 2.7: Groundwater sub-basins of the Santa Clara valley, indicating (a) historical and (b) current (b) extent of riparian zones. Parenthetical dates indicate commencement of use/construction date (Source: SWS 2016)

In general, the Piru groundwater sub-basin consists of an upper aquifer of coarse sand and gravel Quaternary alluvium that ranges from 18–30 m deep, underlain by a lower aquifer of permeable sands and gravels from the Pleistocene aged San Pedro Formation (United Water 2016). The latter can attain depth of up to 2,400 m (Mann 1959). Clay layers within the aquifers provide occasional aquitards but none are continuous. Groundwater inputs from the upper SCR River and Piru Creek percolate into the widening valley and are the greatest volume of recharge to the Santa Clara Valley basin (Reichard *et al*. 1999, and see Figure 2.6): surface water gauging at the 'County Line' gauge (USGS gage 11108500) indicates that dry season inflows to the Piru sub-basin average approximately 0.6–0.8 m^3s^{-1}, (20–28 cfs; United Water 2016). The trend for percolation continues until around Hopper Creek when valley constraints cause flow to start 'rising' towards the western end of the sub-basin (*i.e.*, close to the Cienega). The valley constraints arise from recent (Tertiary) thrusting of relatively impermeable rocks related to the San Cayetano Fault (to the north) and Oak Ridge Fault (south) over the San Pedro Formation (Reichard *et al*. 1999). The proximity of the faults near the Cienega site thus creates the so-called 'Piru Narrows': the functionally narrower cross-section of the valley reduces the capacity of groundwater flow in the upper aquifer, forcing groundwater elevations closer to the valley surface. Consequently, the intermittent flow at the eastern end of the sub-basin gives way to perennial flows in all but the driest of years at the western end.

Detailed groundwater investigation in the vicinity of the Cienega began in the late 1950s when concerns were raised that near-surface groundwater elevations were hindering efforts to develop citrus groves to the south-east of the fish hatchery (Mann 1958, 1959). The thickness of upper alluvium was established to be approximately 18 m near the hatchery (Mann 1958, see Figure 2.8), with no older alluvial layer beneath. Instead, the upper alluvium sits directly on the San Pedro Formation, separated by a thick clay layer that may represent an old soil surface (Mann 1958). This clay layer disappears about 0.5 km upstream of the hatchery. Existence of the shallow impermeable layer near the hatchery may assist in forcing groundwater towards the surface as it provides a depth constraint on groundwater flow capacity in addition to the narrowing of the valley. To the south, towards the SCR mainstem river, the upper alluvial layer increases in depth towards 30 m with the addition of some older alluvium at depth (Mann 1959).

Piezometer data from Mann's study confirmed the high elevation of the groundwater table at the Cienega (Figure 2.9), that during alternating wet and dry periods from 1927-1959 the western end of the Piru basin was subject to far smaller fluctuations in groundwater level than further east (*i.e.*, upstream), and established the linear east-west orientation of groundwater flow. Such trends are still reflected in recent studies (*e.g.*, United Water 2016, Figures 2.3-2.7). Groundwater flows are now sustained by Fall 'conservation releases' from Lake Piru designed primarily for the benefit of agriculture in areas downstream of the Cienega site. Dye tests indicate that flow releases from Lake Piru take approximately 18 hours to reach the abstraction point at the Freeman Diversion (Paybins *et al*. 1998, Nichikawa *et al*. 1999). The releases make appreciable differences to groundwater elevations in the western end of the Piru sub-basin, seasonally sustaining the shallow depths to groundwater at the Cienega site even in the absence of precipitation. Illustrating this point, recent severe drought in the area prevented Lake Piru releases being made from 2012 to 2015 and resulted in groundwater elevations dropping by approximately 1.2 m per year at the downstream end of the Piru basin (United Water 2016).

Figure 2.8: North-South cross-sectional stratigraphy in the vicinity of the fish hatchery (Source: Mann 1958).

Figure 2.9: Isohyets of depth to groundwater (in feet) at the Sespe Cienega site, September 1958 (Source: Mann 1958)

Early releases from the recently completed Santa Felicia dam (1955) were demonstrated to rapidly increase rising groundwater levels (Figure 2.10). The study also indicated the presence of some inflow from north-east of the hatchery and the role of the river level in controlling groundwater elevations. Excavating of the river by 1.5 m in September 1958 to counteract perceived bed aggradation during the 1950s resulted a reduction in groundwater levels from north to south of 0.3 to 0.9 m across the Cienega site. Conversely, overspill from the hatchery's use of water from deeper wells (*i.e.*, from the San Pedro aquifer) may have contributed a net inflow to the shallow aquifer.

Such trends provide an indication of groundwater dynamics in the vicinity of the Sespe Cienega site during the period of the maximum agricultural water use (Hanson, *et al.* 2003) but prior to the modern schedule of flow releases from Lake Piru and the receipt of additional perennial flow effluent subsequent to urban development in the upper Santa Clara basin.

Overall, the structural controls on groundwater dynamics at the west end of the Piru sub-basin cause the abundant and continuous availability of shallow groundwater to support the existence of riparian wetland species at the Sespe Cienega, in contrast to areas immediately upstream and downstream.

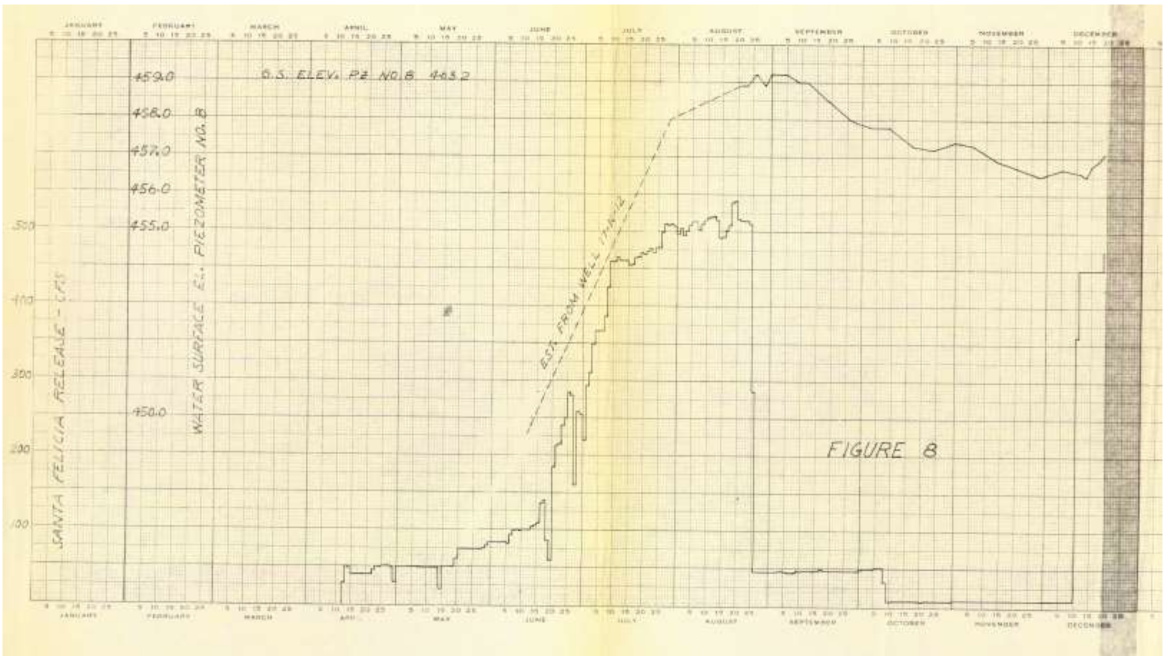

Figure 2.10: responsiveness of groundwater levels in the Piru basin to early flow releases from Lake Piru (Source: Mann 1958)

2.4 Fluvial Geomorphology

The dynamics of fluvial geomorphology in the Santa Clara River is driven by sediment transport processes that result from the ENSO-dominated flood hydrology in the watershed. There are two primary distinguishing characteristics. First, the arid hydroclimate that means that the fluvial system is driven by large flood events, typically those that occur with ENSO events every 5-8 years (Andrews *et al*. 2004). However, the strength of the ENSO phenomenon itself also varies on multi-decadal timescales according to variations in the Pacific Decadal Oscillation such that some decades see greater intensities of ENSO than others (Mantua *et al*. 1997, Kirby *et al*. 2010). Second, the SCR watershed produces extremely large sediment yields, as a function of being bounded by rapidly uplifting western Transverse Ranges to the north (where most of the tributaries originate on relatively weak sedimentary rocks), periodic earthquake-induced landslides, and frequent wildfires. Sediment supplies are now likely supplemented by significant land disturbances related to human activity. Sediment supply from the western Transverse Ranges is estimated in the range of 740–5,300 t km^{-2} a^{-1} (Warrick and Mertes 2009), that is, some 2 to 10 times greater than in surrounding areas. Combined with the reliance for sediment transport on high-intensity, short-duration El Niño storm events, the majority of transport occurs in just a few days. For example, Warrick (2002) estimated that 25%

of the total sediment discharge of the SCR from 1928-2000 occurred in just four days, and Williams (1979) estimated that 55% of the 57.6 M t of sediment passing through the Montalvo gauging station 1968-1975 occurred in two days of high flows (*i.e.*, related to the flood of record in 1969).

As a consequence, the dynamics and responsiveness of channel morphology in the SCR reflects the impact of large and infrequent flood events rather than the 'moderate, frequent' flood that forms the 'dominant discharge' in humid region alluvial rivers (Wolman and Millar, 1960). In arid, high-sediment load rivers such as the SCR, the large size variation in flood events combined with the non-linear nature of sediment transport concentrations means that the dominant discharge can in fact be the largest flood of record (Wolman and Gerson 1978). This attribute is indeed the case in the SCR (SWS 2007, Downs, *et al*. 2013, Figure 2.11). The responsiveness (or *sensitivity*) of river channels will also reflect human actions such as flow and sediment regulation by dams, changes in land use and land cover, existence of structure that constrain lateral or vertical movement of the channel (*e.g*., levees and grade control, respectively), and mechanical modifications such as instream aggregate extraction. Warrick (2002) estimated that dams in the SCR have reduced flow to the mainstem by 26% and suspended sediment transport by 21% - changes that may be keenly felt in areas such as the Cienega that are upstream of the moderating impact of the unregulated Sespe Creek water and sediment inflows. Conversely, wildfire has probably increased with increasing watershed population, can increase sediment supply be several orders of magnitude until vegetation re-establishes (e.g., Shakesby and Doerr 2006), giving particular risk if a large storm event happens in the winter following a burn.

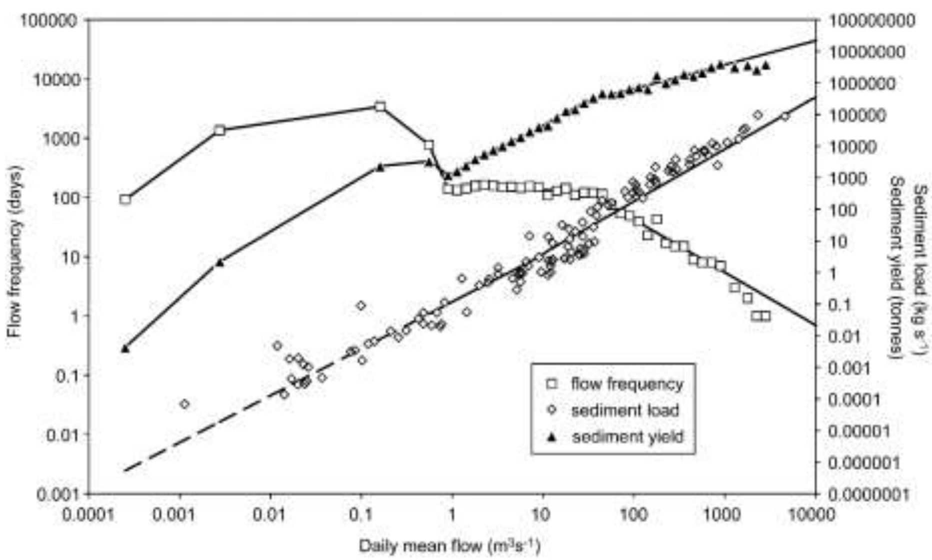

Figure 2.11: Dominant discharge characteristics, lower Santa Clara River (Source: Downs *et al*. 2013)

Based on differences in flow, planform pattern, the degree of valley confinement and the confining presence of levees, the LSCR was split into 11 'geomorphically homogenous' reaches by SWS (2007, and see Downs *et al*. 2013). Adjacent to Cienega site is reach 8, a 5.7-km reach characterized by mild aggradation and channel narrowing in the modern period (1938–2005) with similar trends experienced by the two reaches immediately upstream. Immediately downstream, reach 7 is subject to backwater effects from Sespe Creek during large floods, while downstream of Sespe Creek to Santa Paula Creek, reaches 5 and 6 retain the greatest degree or naturalness on the LSCR. Reaches 1-4, from the Pacific Ocean up to Santa Paula Creek have been characterized by moderate to severe incision prompted by in-channel and floodplain aggregate extraction and lateral constraints by embankments and are currently held static in a disequilibrium form (Downs *et al*. 2013). Reach 8 is not subject to extensive embanking or significant historical aggregate extraction. A summary tabulation is provided in Table 2.1.

Reach 8	**Attributes**
Downstream extent	1 mi east Cham'berg Rd
Upstream extent	Hopper Creek
Centerline reach length	5,710 m
Reach-average slope	0.0055
Active channel width 2005	422 m
Fully scoured width 2005	394 m
Width at 1.5-year recurrence interval flood	317 m
Depth at 1.5-year recurrence interval flood	0.60 m
Magnitude of 1.5-year recurrence interval flood	60.0 m^3s^{-1}
Local characteristics	Wide floodplain floor. Upstream left bank close to mountains. Sinuous and braided. Inflow from Hopper Canyon

Table 2.1: Attributes of 'Reach 8' of the lower Santa Clara River, adjacent to the Sespe Cienega site (SWS 2007).

Channel pattern adjacent to the Cienega site is predicted by most 'discriminant' functions (*e.g*., Wolman and Leopold, 1957; Parker, 1976; Ferguson, 1987; Knighton and Nanson, 1993) to be mixed-load (*i.e.*, carrying both sand and gravel) braided, but field evidence is for a rather transitional channel that defies simple categorization. At low discharges the channel consists of multiple threads although one primary thread carries the majority of flow, while during flood events, the various threads coalesce and can prescribe a large meandering planform (Figure 2.12). Such attributes are perhaps best represented as the 'compound' type in Graf's (1988) classification of dryland rivers, although here the flood channel is retained within reasonable competent channel banks, unlike Graf's Arizonan examples.

Figure 2.12: Meandering pattern dynamics of the Santa Clara River just downstream of reach 8 as flows recede following the 2005 flood. Receding flows are beginning to expose alluvial bars that will define multiple flow threads during low flows (Source: CCC 2005).

Two attributes of this channel form are of vital importance to riparian ecosystems. First, as a dryland river subject to episodic large floods, the width of the active channel bed should vary proportionately with the magnitude of the last flood event (Graf 2000), with the channel bed widening and consuming part of the riparian area for some years following the flood. However, as a suspected consequence of human actions, many reaches in the LSCR have been getting progressively narrower in time (Downs *et al*. 2013). Downstream of Santa Paula Creek, this reflects channel bed incision due to aggregate mining and lateral constraints by levees, whereas upstream of Sespe Creek including reach 8, it may relate to flow regulation. Reaches 5 and 6 between Sespe Creek and Santa Paula still possess this natural width variability. Second, because the river operates as a pseudo-meandering channel during large floods, river bends can migrate laterally for tens if not hundreds of meters during an individual flood event, eroding large extents of riparian floodplain and, conversely, leading to floodplain gain on the opposite bank. Overlays of aerial photographs 1969-2005 in GIS (methods based on Graf 2000, Tiegs and Pohl 2005, and Tiegs *et al*. 2005) illustrate several ‘migratory’ characteristics of reach 8 (Figures 2.13 and 2.14). First, by plotting the proportion of time that the active river bed has occupied individual a fine grid of areas within the SCR valley, it is apparent that reach 8 possesses a ‘central tendency’ of consistent channel occupation (red areas of Figure 2.13), but also that significant extents of the current Cienega riparian area have been active river bed during recent history. Second, using chronological overlay of the extent of active river bed (most recent on top), Figure 2.14 illustrates that reach 8 is both narrower (see above) and occupies a more southerly position than in recent history. Channel width of the SCR at reach 8 averaged 480 m ± 163 m from 1969-2005.

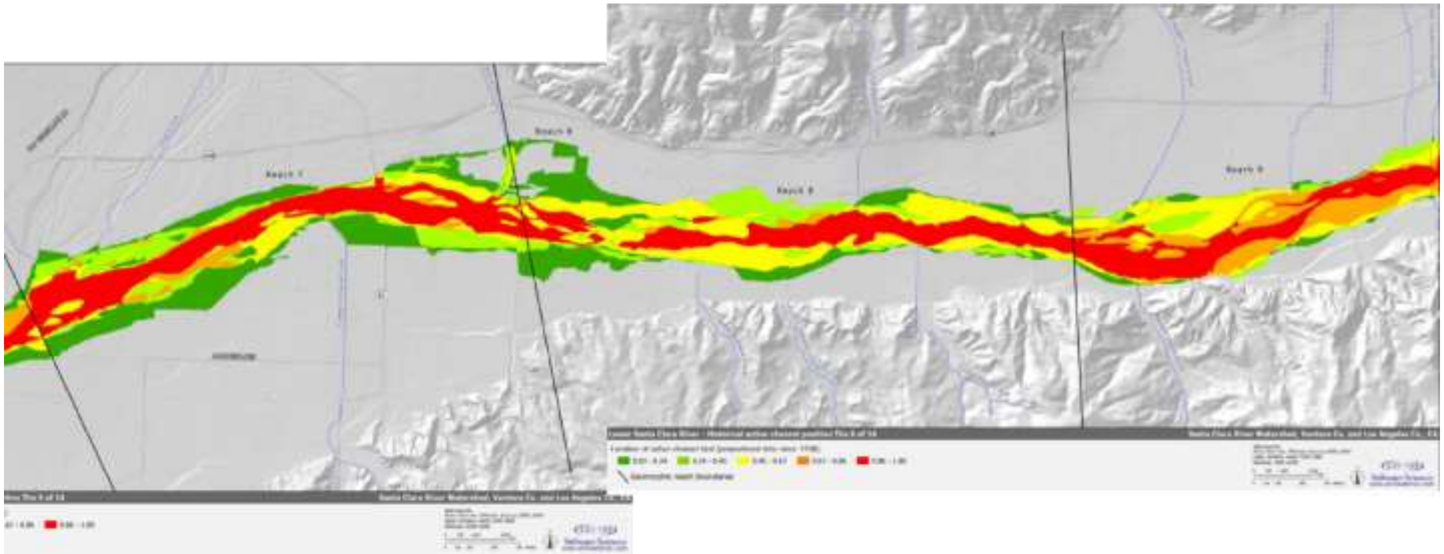

Figure 2.13: Variability of planform position of the Santa Clara River in the vicinity of the Sespe Cienega site (Source: SWS 2011)

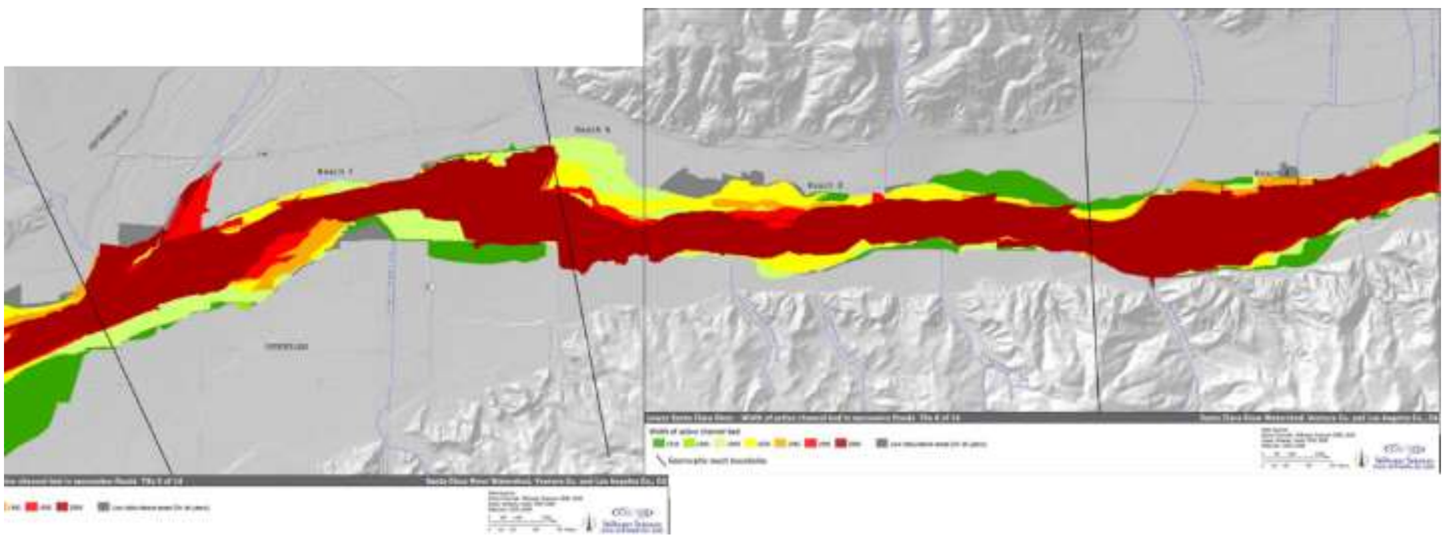

Figure 2.14: Historical evolution of planform position of the Santa Clara River in the vicinity of the Sespe Cienega site (Source: SWS 2011)

In addition to variable widths, repeat thalweg elevation surveys indicate the extent of changing river bed elevation adjacent to the Cienega. Surveys in reach 8 taken between 1929 to 1967-71 and then again in 1993 were compared to LiDAR imagery from 2005 (SWS 2007). During this period, the reach displayed mild net aggradation overall (0–1.5 m, Figure 2.15) but had changed behaviors from overall mild incision from 1929-49 (after St Francis Dam failure but prior to Santa Felicia Dam), upstream incision grading into downstream aggradation 1949-1969, and overall mild aggradation thereafter. Given the general increase in overall net aggradation from reach 10 downstream to reach 7 at the confluence with Sespe Creek, one explanation is plausibly that decreased flood flows into the reach caused by flow regulation has caused a progressively greater backwater effect from Sespe Creek that has promoted increased sediment deposition.

Overall, the LSCR adjacent to the Cienega site has become somewhat less dynamic and narrower in recent history, while bed elevation has increased. The site's watershed influences suggest that the primary causes may be related to upstream flow regulation (and especially the increasing differential with flow entering downstream from Sespe) but an additional cause may be extra sediment into the reach caused by wildfire and landslide activity upstream (see SWS 2007).

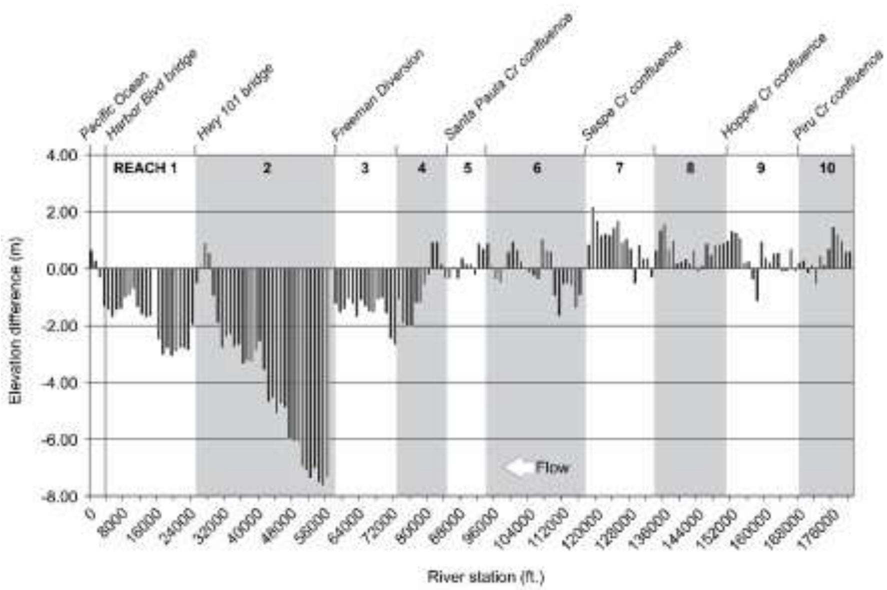

Figure 2.15: Bed level variations in the Santa Clara River 1949-2005 (Downs *et al*. 2013).

Available data:

2015 Lidar, T. Dudley/SCR Trustee Council

2019-2020 Seasonal surface water shapefiles, UCSB (ongoing)

2019-2020 Groundwater observation well measurements, UCSB

2018 USGS LiDAR (1ft) and relative elevation DEM (generated by Stillwater)

1969-2005 Historical Flood Reset Areas, Stillwater

Historical Active Channel Location Probability (Flood Frequency), Stillwater

2004 2010 Levee Inventory, URS & Ventura County WPD

Data needs:

Scour zones map

Current Levee structures (proposed, new, removed)

Seasonal groundwater (expand well array across site and longer term monitoring)

Seasonal surface water features (longer term needed)

Soils characterization (texture, bulk density, water holding capacity, salinity, pH)

3.0 Biological Properties

3.1 Vegetation communities in the SCR

Historically, the SCR valley supported biologically diverse habitats including marshes, vernal and freshwater wetlands, willow-cottonwood riparian forests, extensive oak woodlands, and riparian scrub (Figure 3.1). Many of these habitats have been converted for agriculture and rangelands, and more recently lost to urban development. The predominant vegetation types in the river are driven by the distribution of gaining and losing reaches. Because these system properties are related to the underlying geologic formations, the general locations suitable for forested wetlands are unchanged from historical conditions, although surface water and shallow groundwater conditions are now influenced by surface water diversions, managed water releases, and treated wastewater releases. Despite dramatic changes to the valley and floodplain over time, remnants of the four historically persistent riparian-forested wetlands that were dominated by willow-cottonwood forests and other obligate wetland vegetation types are still present (Orr et al. 2011, Beller et al. 2015). The Cienega is described in Beller et al. (2011) as historically being an extensive wetland complex approximately 340 acres in size consisting of freshwater marsh, tules, and willow groves. Alders, box elders, sycamores, and cottonwoods were also listed as occurring at the site. As early as 1880, the site was experiencing drying and changes in species composition. Land use gradually shifted to agriculture with alfalfa production occurring in the 1920’s and some areas converted to orchards by 1938.

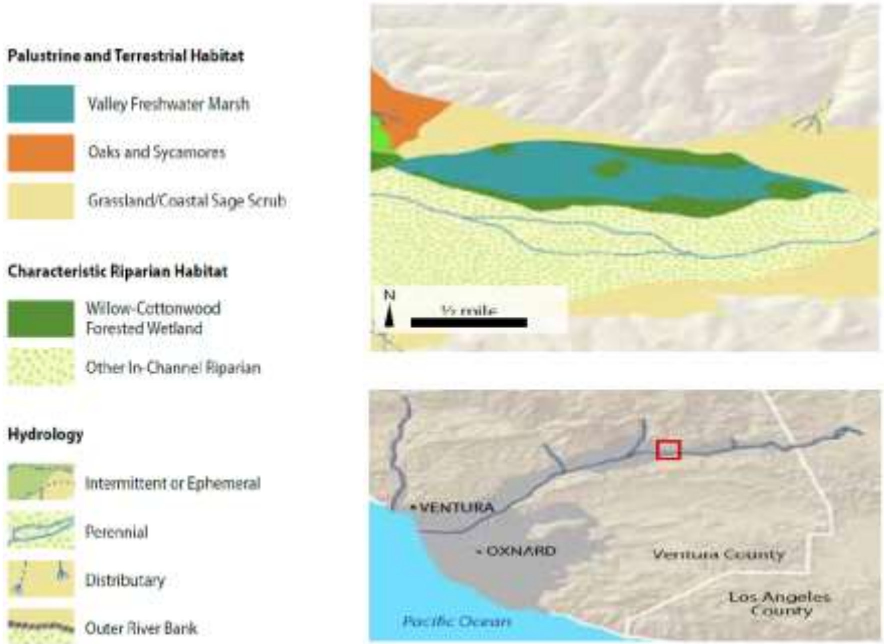

Figure 3.1. Generalized habitat and hydrological characteristics of the Sespe Cienaga in the early 1800s (from Beller et al. 2011).

Vegetation surveys of the site were conducted in 2006, 2014, 2018, and 2019. Vegetation was assessed in 2006 as part of a SCR Parkway effort led by Stillwater Sciences and broadly mapped plant associations throughout the floodplain (Stillwater Sciences and URS Corporation 2007), including the Cienega site. The classification and vegetation mapping effort followed the State of California standard vegetation classification system developed under the auspices of the Vegetation Program of the California Native Plant Society and described in *A Manual of California Vegetation* (2009). A combination of field-based mapping and traditional aerial photography interpretation were used to produce the vegetation map within a GIS (Figure 3.2)--data available at http://parkway.scrwatershed.org/wkb/projects/lowerscrvegmap.html.

Figure 3.2. Vegetation community overview of the Sespe Cienaga.

UCSB completed vegetation surveys of the Cienega site in August 2014 when the property was owned by the Beserra family (California Watercress), as well as the adjacent TNC Shiells property, to assess the extent of giant reed (*Arundo donax*) infestation and the status of native vegetation among these sites. Vegetation data provide a ‘snapshot’ of community composition and cover of dominant species. Observations occurred at the midpoint in the 2012-2016 drought and vegetation at the site was not yet experiencing the mass die-off that occurred by 2016.

In 2018, WFVZ and partners created a comprehensive vegetation map representing current conditions in the Santa Clara River through a Section 6 ESA grant for assessing trends in listed avian species associated with vegetation conditions (Stillwater Sciences 2019, Hall et al. 2020). Classification and mapping followed current California and National Vegetation Classification standards. Stillwater Sciences compiled previous vegetation maps in GIS, including the 2006 mapping of the Ventura County river reaches (Stillwater Sciences and URS Corporation 2007, Orr et al. 2011) and a 2015 map of *Arundo donax* cover on TNC properties in Ventura County. Contemporary aerial imagery was used to interpret the boundaries of polygons of discrete vegetation types that were not covered by the compiled maps or that had clearly changed since the maps were produced. Aerial imagery interpretation and previous vegetation surveys on the river were also used to assign vegetation types using *The Manual of California Vegetation* (2009) classification system (CNPS 2019), and *Arundo donax* (Arundo) percent cover category to all map polygons.

In June 2019, SCRC and UCSB completed systematic vegetation surveys at the Cienega to assess baseline conditions and track ecological changes from restoration activities. The project area was stratified into three sampling areas based on management histories resulting in distinct vegetation communities: historic agricultural (160 acres), monotypic arundo (50 acres), and river channel areas on the CDFW (80 acres) and TNC (100 acres) properties. In total, 22 permanent 50-meter transects were installed throughout the project area, including five transects at the neighboring TNC property (Figure 3.3). Cover and frequency of annual and perennial taxa were documented using a combination of quadrat, line-intercept, and point-intercept sampling methods. Permanent photo points were established to visually document changes in vegetation cover over time. These data provide a comprehensive assessment of cover, species richness, and abundance within each habitat type.

Figure 3.3. Overview of the 22 permanent vegetation transects installed for the Sespe Cienaga project across the three vegetation communities: historic agriculture (green), monotypic arundo (red), and river channel (light blue). The river channel system was also sampled on neighboring Nature Conservancy property (dark blue).

3.1.2 Willow-Cottonwood Forest

Remnants of willow-cottonwood forests occur along the riverbank, side channels, and terrace where adequate soil moisture is present and flooding disturbance is infrequent. This vegetation community consists of willows (*Salix laevigata, S. exigua*, *S. lucida* ssp., *S. lasiandra*, and *S. lasiolepis*) and cottonwoods (*Populus fremontii, P. trichocarpa*), mule fat (*Baccharis salicifolia*), sycamore (*Platanus racemosa*), blackberry (*Rubus ursinus*), mugwort (*Artemisia douglasiana*), and other understory species. However, much of the potential riparian forest habitat is heavily invaded by *Arundo*, and to a lesser degree, castor bean (*Ricinus communis*) and tamarisk (*Tamarix ramosissima, T. parviflora*). Vegetation data from 2019 surveys indicated that very little of this community is present on the project site. Although over half of the transects sampled in the historic agricultural and monotypic arundo sites had dominantly moist or saturated soils in late summer, one characteristic favorable to recruitment and establishment of both willows and cottonwoods, no related taxa were documented during our sampling. Instead, these moist upper terraces were dominated by introduced taxa (canopy cover: historic agriculture 54%, monotypic arundo 64%), and of primarily herbaceous and grass functional groups (canopy cover: historic agriculture 94%, monotypic arundo 66%) (Figures 3.4 and 3.5).

Figure 3.4. A characteristic example of the historic agricultural vegetation community, dominated by herbaceous, largely introduced taxa (transect AGR5).

Figure 3.5. Looking into a previously untreated area of the monotypic arundo community, dominated by arundo and introduced herbaceous species (transect ARU4).

3.1.3 River Channel

Riparian scrub is a major component of the “river channel” vegetation community within the project area. This vegetation community, including the active river channel, is highly dynamic and diverse, and vegetation associations are dependent on the level of flooding disturbance, sand/silt deposition, and soil moisture. Unvegetated open space makes up a large proportion of this system, approximately 41% of areas sampled in 2019. Sand bars with relatively low levels of disturbance support riparian forest species, including cottonwoods, willows (especially sandbar willow; *S. exigua*), and mule fat (*Baccharis salicifolia*). Alluvial scrub areas can contain sage-scrub/riparian-scrub (*Salvia* spp., *Artemisia californica, Acmispon glaber, Hazardia squarrosa, Heterotheca sessiliflora, Croton californicus, Eriodictyon crassifolium*), chaparral (*Artemisia tridentata, Opuntia littoralis, Cylindropuntia californica, Atriplex lentiformis*), and wetland plant associations (Figure 3.6). Native shrubs and trees made up approximately 17% of the areas sampled during the 2019 survey. Arundo, although abundant, does not reach monotypic levels in these areas due to the frequent flooding/scouring regime (approximately 8% canopy cover) and low productivity owing to dessication in this often sandy environment. Tamarisk, short-pod mustard (*Hirschfeldia incana*), perennial pepperweed (*Lepidium latifolium*), and invasive annual grasses are also present at low to moderate densities.

Figure 3.6. A characteristic section of the river channel vegetation community, dominated by native shrubs and open space (transect RCC1).

An assortment of plant species, often thought of as growing in xeric or upland habitats, are included in the SCR plant communities (particularly on higher terraces) and their presence is often facilitated by propagule movement with sediments derived from upland soils into the river during rain events. This is a natural component of the SCR vegetation and includes a variety of woody species such as California sagebrush (*Artemisia californica*), bush monkeyflower (*Diplacus aurantiacus*), and salvia (*Salvia* spp.), and many other native annuals and perennials. These species are an important component of the vegetation and increase plant diversity and pollinator diversity within the SCR. It is also an important part of the fluctuation in vegetation within the river between periods of drought and periodic flooding. During high precipitation years this vegetation may be replaced by riparian species, though severe scouring events may facilitate temporary establishment of upland vegetation. During droughts, such as the current one, this vegetation does particularly well.

3.1.4 Invasive species and management

The various mapping efforts described above have documented changes in invasive plant populations at the site over time. Arundo is the primary weed of concern, but as removal continues, other weeds including perennial pepperweed, tamarisk, short pod mustard, and annual grasses are likely to increase in abundance until reestablishment of native vegetation (Lambert et al. 2010a).

Arundo is the most problematic non-native plant species in coastal California rivers (Lambert et al. 2010b). It is widespread throughout the SCR floodplain and reaches greatest densities on moist riparian terraces where flooding deposits rhizomes from upstream populations. Human additions of nitrogen and water to agricultural watersheds such as the SCR strongly increase the productivity of this species (Lambert et al. 2014). *Arundo* invasion has wide ranging ecological and environmental impacts (Bell 1997, Dudley 2000) and is listed among the top five invasive species degrading natural ecosystems in the state by the California Invasive Plant Council (Cal-IPC 2006). Invasion in riparian areas alters the native vegetative structure (Herrera and Dudley 2003), and rapid growth following floods or wildfires leads to competitive displacement of native riparian vegetation such as cottonwood-willow woodlands (Coffman et al. 2010, Lambert et al. 2010b). This dominance reduces arthropod diversity and abundance (Herrera and Dudley 2003) and also leads to decline in avian diversity and abundance (Kisner 2004). Hardesty-Moore et al. (2020) found mammalian carnivore detections in the SCR floodplain were significantly lower in dense *Arundo* stands compared to native vegetation. Even moderate amounts of *Arundo* reduced carnivore presence, and animals most likely avoided these areas because of the increased energetic costs of moving through the dense vegetation. However, small mammal populations were higher in *Arundo*, likely due to lower predator abundance.

Measures to control *Arundo* have been widely implemented in California, including herbicidal control, cutting and removing biomass, and prescribed fire (Bell 1997). When done properly, *Arundo* abundance can be effectively reduced. Appropriate control methods are based on density, associated flora and fauna, and hydro-geomorphic position (Stillwater Sciences 2011). Biological control also offers potential for arundo reduction, as implemented in Texas (Racelis et al. 2009, Goolsby et al. 2011), although these insect agents were shown to already be present at the Santa Clara River and not causing major damage (Dudley et al. 2008).

With funding from the Wildlife Conservation Board (Proposition 1), UCSB and SCRC are removing *Arundo* from the entirety of the 265-acre Cienega property, as well as clearing any remaining *Arundo* from 100 acres of the adjacent TNC Shiells/Sommers property. *Arundo* removal is the first phase of implementation that will re-create a fully functioning riparian ecosystem necessary for native species, while decreasing the risk of detrimental fires. Preliminary data from a nearby site indicated *Arundo* uses approximately 3 to 4 times more water for evapotranspiration than native species (Alex Pivovaroff, unpublished data, Giessow et al. 2011). Thus, *Arundo* removal will increase water availability for sensitive terrestrial and aquatic species. As an additional benefit, *Arundo* removal will allow native vegetation to recover and sequester excess nutrients discharged from the fish hatchery, thereby improving water quality before it enters the main channel of the Santa Clara River. Collectively, these changes will be long lasting and will contribute to the resilience of the ecosystem along the Santa Clara River in the face of potential climate change and natural disturbances.

Available data:

2006 Vegetation alliances polygon shapefiles (coarse scale), Stillwater Sciences

2014 Vegetation data (releve), excel, UCSB

2018 Vegetation alliances polygon shapefiles, Stillwater Sciences

2019 Vegetation data (relative canopy and absolute cover, frequency, species richness, diversity stratified by plant community), Excel, UCSB/SCRC

Data needs:

Update 2018 Stillwater vegetation alliances polygon shapefiles

High resolution aerial orthoimagery

2020 Vegetation data (relative canopy and absolute cover, frequency, species richness, diversity), Excel, UC Santa Barbara/SCRC

3.2 Wildlife at the Sespe Cienaga

The highly productive and diverse habitats in the project area provide critical resources for wildlife and are a vital link in the landscape-scale corridor connecting transverse and coastal mountain ranges, and over 100 linear miles of watershed from inland mountains to the ocean. A variety of local assessments have been made to quantify faunal biodiversity at the Cienega, including wildlife camera traps, avian point-count surveys, avian nest searches and monitoring, herpetofauna array sampling, invertebrate monitoring, and pollinator surveys. Regional studies outlining historic, current and potential wildlife associations in this area are an additional resource: Guthrie 1995, The Nature Conservancy 2008, Court et al. 2000, Kelley 2004, Taylor et al. 2019, Hall 2017, Hall et al. 2020, South Coast Wildlands 2006.

3.2.1 Fish

A variety of fish species have been known to occur in the perennial and seasonal aquatic habitats of the SCR (South Coast Wildlands 2006, Swift et al. 1993), including at least eight native California fish, most with some level of protected status: Arroyo chub (*Gila orcutti*), southern steelhead/rainbow trout (*Oncorhynchus mykiss irideus*), Santa Ana sucker (*Catostomus santaanae*), and Owens sucker (*Catostomus fumeiventris)*. Pacific lamprey (*Entosphenus tridentatus*), prickly sculpin (*Cottus asper*), and a short distance upstream of the project area, the resident unarmored sub-species of threespine stickleback (*Gasterosteus aculeatus williamsoni*) are also regional residents. Sticklebacks have been recently maintained at the CDFW hatchery for a 'conservation nursery' as mitigation for potential disruption by debris flows following wildfire (Sand Fire) in the watershed (Gerstenslager 2017). Some of these taxa are likely present in the Cienega wetlands, including escaped trout from the rainbow trout hatchery or others from intentional translocation or opportunistic in-migration from the mainstem SCR during higher flow periods when there is surface-water connectivity between these habitat elements. Numerous non-native fish are also present in the SCR mainstem, and possibly occasionally in the Cienega area, including catfish/bullheads (mostly black bullhead, *Ameiurus melas*), carp (*Cyprinus carpio*), red shiner (*Cyprinella lutrensis*), threadfin shad (*Dorosoma petenense*), green sunfish (*Lepomis cyanellus*), and likely many others (Howard and Booth 2016, South Coast Wildlands 2006, Swift et al. 1993).

3.2.2 Birds

Multiple years of seasonal point count surveys and other avian projects have been conducted at the Sespe Cienega and adjacent areas, revealing a diverse assemblage of species and dynamic variation in interannual abundance (e.g., Kisner datasets 2018-2020; Hall datasets 2010-2020). Approximately 125 bird species have been documented using the project area.

The property retains small remnants of riparian-woodland habitat suitable for the state and federally endangered least Bell's vireo (*Vireo bellii pusillus*). At least 10 territories have been documented at the Cienaga since 2013 (Griffith Wildlife Biology reports, ~2008-2017). Several California Species of Special Concern (SSC) breed on the property, including yellow-breasted chat (*Icteria virens*) and yellow warbler (*Setophaga petechia*), and avian raptors including Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), and red-shouldered hawk (*Buteo linearis*). White-tailed kite (*Elanus leucurus*) use the property for roosting and foraging, and in both 2019 and 2020, a pair of white-tailed kites was observed nesting on the property adjacent to the Cienaga, and the fledglings wintered on the property. In winter 2019/2020, a family group of peregrine falcons (*Falco peregrinus*), and a golden eagle (*Aquila chrysaetos*) were observed foraging on the property.

With restoration, the threatened tricolored blackbird (*Agelaius tricolor*), southwestern willow flycatcher (*Empidonax traillii extimus*), and western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) could use this area for breeding. This area was historically a dependable breeding location for the endangered southwestern willow flycatcher (i.e., GWB reports; historic egg records of the WFVZ), and historic egg records for the blackbird and cuckoo also exist for this section of the Santa Clara River (i.e., WFVZ archives). Extensive mature woodland historically contained a complex mix of native and non-native vegetation suitable for many regionally declining bird species. Unfortunately, this woodland all but disappeared on the property by spring 2017, due to the widespread decline and mortality of woody vegetation in the project area during the historic drought combined with groundwater draw-down associated with the draining of the Beserra/California Watercress ponds. Migrating willow flycatchers (*E. t. traillii*) have been detected annually in low numbers in the intervening years, but these birds have not stayed to breed. However, the history of usage of the property by breeding southwestern willow flycatchers suggests that habitat restoration of the Cienaga would have a high probability of again supporting this species.

In addition to these special status species, species, migratory Neotropical migratory bird species are already present and breeding on the property, but their breeding will be greatly enhanced with restoration of the riparian woodlands. These species include: tree swallow (*Tachycineta bicolor*), ash-throated flycatcher (*Myiarchus cinerascens*), and Pacific-slope flycatcher (*Empidonax difficilis*). Resident cavity-nesting species will be benefited greatly as well, such as oak titmouse (*Baelopholus inornatus*; also a SSC), western bluebird (*Sialia mexicana*), and several woodpecker species.

The wetlands on the property already support wintering waterfowl species, as well as rails and other wetland-obligate species, but similarly will be enhanced by restoration of native, healthy emergent marshes. For example, wood duck (*Aix sponsa*), white-faced ibis (*Plegadis chihi*), cinnamon teal (*Spatula cyanoptera*), blue-winged teal (*Spatula discors*), sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), purple gallinule (*Porphyrio martinica*), marsh wren (*Cistothorus palustris*), and egrets and herons, breed in small numbers and winter in very large numbers when the artesian water flow is available. Juvenile black-crowned night-heron (*Nycticorax nycticorax*) were observed on the property in spring 2020, and likely are also breeding on the property, and would similarly benefit from reestablishment of the mature willow vegetation they would need for a larger colony.

Drier and more sparsely vegetated zones in the project area have the potential to support another distinct suite of species, including SSC like horned lark (*Eremophila alpestris*), and possibly, long-eared owl (*Asio otus*) in the winter. Other California special status species currently using this vegetation include Costa's hummingbird (*Calypte costae*), which breeds in small numbers on the property, and Loggerhead Shrike (*Lanius ludovicianus*), which winters on the property -- both of which could have their populations enhanced by restoration of the native vegetation and ecological function for this property.

3.2.3 Mammals

Comprehensive mammal surveys of the Cienaga have not been conducted, however, two wildlife camera traps installed in July 2019, in addition to anecdotal observations, indicate an abundance of mammal species utilizing and passing through the site. Coyote (*Canis latrans*), mountain lion (*Puma concolor),* black bear (*Ursus americanus*), bobcat (*Lynx rufus*), mule deer (*Odocoileus hemionus*), striped skunk (*Mephitis mephitis*), Virginia opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), brush rabbit (*Sylvilagus* spp./*S. bachmani*), black-tailed jackrabbit (*Lepus californicus bennettii*), California ground squirrel (*Otospermophilus beecheyi*), and several rodents including woodrat (*Neotoma macrotis*), deer mice (*Peromyscus maniculatus*, *P. boylii*), and Pacific kangaroo rat (*Dipodomys agilis*) have been observed. In nearby riparian areas with habitat similar to the Cienega, Hardesty-Moore et al. (2020) used motion-sensitive videography to detect several species listed above, in addition to long-tailed weasel (*Mustela frenata*) and gray fox (*Urocyon cinereoargenteus*).

Preliminary bat detection surveys identified the presence of a minimum of 12 species in the general vicinity of the Cienega, over half of which are considered federal and/or state Species of Special Concern (Devyn Orr, UCSB, unpublished data), including pallid bat (*Antrozous pallidus*), Townsend's big-eared bat (*Corynorhinus townsendii*), western mastiff (*Eumops perotis*), western red (*Lasiurus blossevillii*), western small-footed (*Myotis ciliolabrum*), western long-eared (*M. evotis*), and Yuma bat (*M. yumanensis*). These species use riparian trees for roosting and foraging. These surveys also indicated reduced detections in association with arundo-dominated stands (Devyn Orr, UCSB, unpublished data).

3.2.4 Reptiles and Amphibians

In November 2019, SCRC and UCSB began systematically monitoring herpetofauna on the project site with 3 arrays consisting of 5 coverboards, in each of the three management units--historic agriculture, monotypic arundo, and river channel (Figure 3.7). Arrays have been monitored quarterly with increased sampling planned for summer 2020.

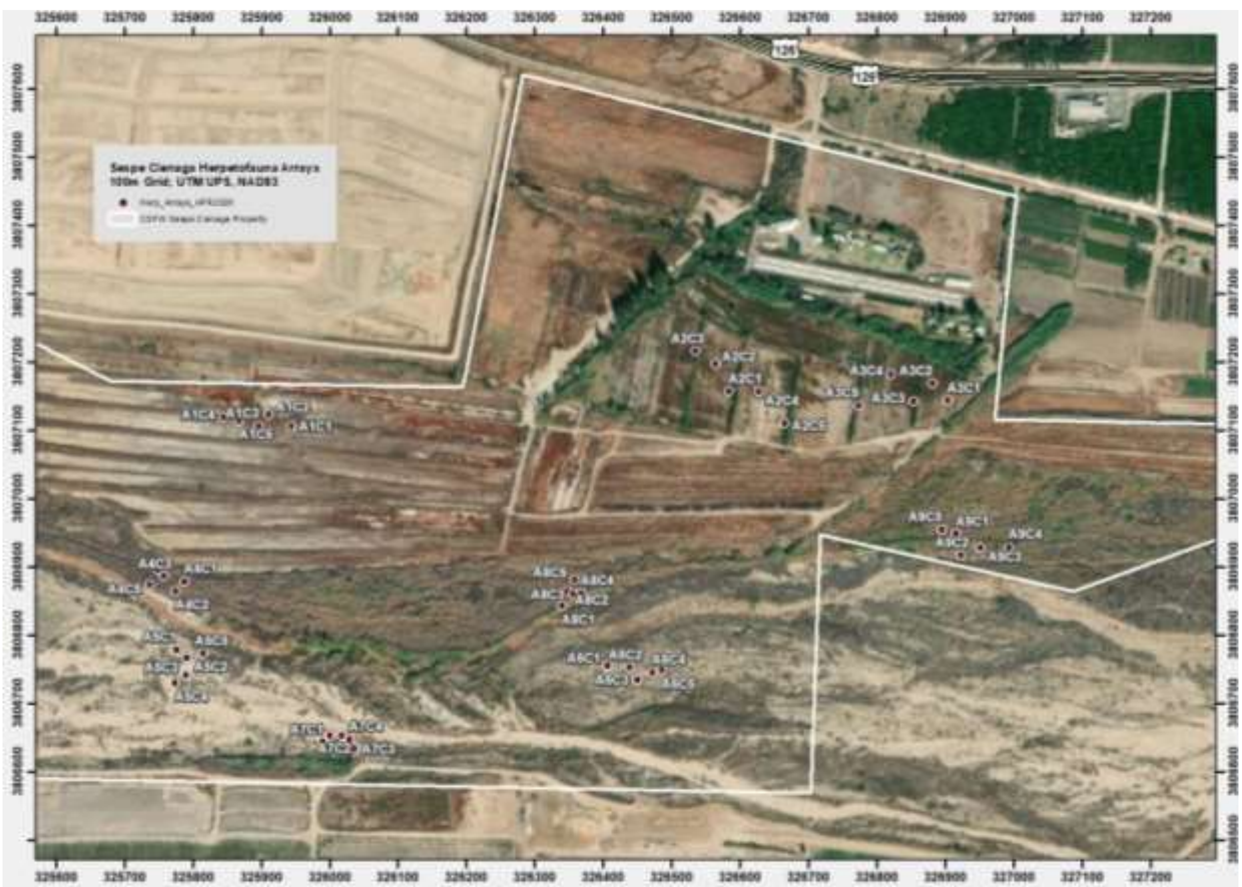

Figure 3.7. Overview of the nine herpetofauna sampling array sites at Sespe Cienaga--three in each of the vegetation communities (historic agriculture A1-A3, monotypic arundo A4, A8, A9, and river channel A5-A7).

Several Species of Special Concern reptiles and amphibians have been observed both anecdotally and in the systematic monitoring efforts. Wetlands and adjacent mesic areas host two-striped garter snake (*Thamnophis hammondii*), south coast garter snake (*Thamnophis sirtalis*), and southwestern pond turtle (*Actinemys pallida*). Along the sandy, open, river channel and drier upper terrace habitats, silvery legless lizard (*Anniella sp.*), Blainville's horned lizard (*Phrynosoma blainvillii*), and coastal western whiptail (*Aspidoscelis tigris stejnegeri*) have been confirmed or are assumed.

The federally threatened California red-legged frog (*Rana draytonii*) is associated with shallow slow-moving stream habitats and likely would have been found at the Cienaga historically, but is thought to have been regionally extirpated. Its recent detection via environmental DNA surveys in nearby tributaries suggest this species could be recovered if predators are controlled, and successful re-introductions in this region further support its potential recovery (Backlin et al. 2017). Federally endangered arroyo toad (*Anaxyrus californicus*) may have been present in the area historically, but is now restricted to undisturbed locations in nearby tributaries (USFWS 2014). Suitable seasonal pond habitat also persists on the project area for SSC western spadefoot toad (*Spea hammondii*) that has maintained a foothold in similar habitat between the project area and Santa Clarita but has not been documented on site (Compliance Biology 2010).

Several common species are regularly encountered in the project area, including Baja California chorus frog (*Pseudacris hypochondriaca*), western toad (*Anaxyrus boreas*), gopher snake (*Pituophis catenifer annectens*), southern Pacific rattlesnake (*Crotalus oreganus helleri*), red racer (*Coluber flagellum piceus*), western fence lizard (Sceloporus occidentalis), and western side-blotched lizard (*Uta stansburiana elegans*). Also commonly observed, introduced invasive amphibians that are known predators on native fauna are present such as American bullfrog (*Lithobates catesbeianus*) and African clawed frog (*Xenopus laevis*). Future habitat management will require plans for controlling non-native species that jeopardize potential recovery of native fauna.

3.2.5 Invertebrates

UCSB has been monitoring ground dwelling arthropod diversity and abundance across the site since 2018. Seventeen permanent transects have been located in six microhabitats, including riparian forest, riparian scrub, former agricultural land, and Arundo monoculture, and were sampled in the winters of 2018 and 2019, as well as the spring of 2020. The surveys aligned with vegetation monitoring where possible to assess the effect of invasive plant management on insect community recovery. Pitfall trapping, leaf litter collection, and baiting collected >25 species of ants, which are often used as indicators of restoration and ecosystem health. Ant species richness indicates a diverse and recovering insect assemblage, even though the only management action to date has been *Arundo* removal. The highly invasive Argentine Ant *Linepithema humile* comprised less than 5% of collected samples, suggesting that it is not widespread at the site. Open sandy areas appear to have insect communities influenced by *Baccharis spp.,* while in forested areas, ant assemblages were influenced by *Rubus ursinus*.

The role of *Arundo* mulch as ground cover was also investigated. While the species composition differed in areas where *Arundo* mulch was the dominant ground cover compared to areas where leaf litter was the dominant ground cover, the species richness and diversity was similar in both areas, implying the mulch does not hinder and may help facilitate the return of ground dwelling insects like ants.

In April 2019, UCSB began monitoring pollinators across the site using pan trapping methods to better understand pollinator abundance and diversity. Surveys are conducted monthly by placing four pan trap arrays, consisting of 4 yellow pans, 1 white pan and 1 blue pan, within different vegetative communities, including abandoned agricultural fields, monotypic *Arundo*, alluvial scrub, and the active river channel. Monthly pan trap monitoring will continue and could be supplemented in the future with additional pan trap arrays and sweep netting. Survey sites are located near vegetation monitoring transects to better assess the effects of invasive plant management and restoration techniques on pollinator abundance, diversity and potential nectar sources. Specimens are identified down to species when possible, genus at minimum, with a number of specimens backlogged; further identification is ongoing. The Western Honey Bee, *Apis mellifera,* has been the most abundant pollinator species found so far, which could partly be due to the high presence of neighboring agricultural fields nearby, but many other genera have been observed, collected and identified, including *Agapostemon sp.*, *Xylocopa sp.*, *Lasioglossum sp.*, and *Osmia sp.*

Available Data:

2018-2019 Winter Ground-dwelling Arthropod Survey data

2019 Summer Ground-dwelling Arthropod Survey data

2019-2020 Winter Ground-dwelling Arthropod Survey data

2019 Herpetofauna data (date/time/temperature/species per coverboard), Excel, SCRC

2019 Pollinator data, Excel, UCSB

2019 Invertebrate assessment data, Excel, UCSB

2019 Wildlife camera data (species presence), Excel, SCRC

2018-2020 Avian survey data, Western Foundation for Vertebrate Zoology and David Kisner Consulting

WFVZ historical egg and nest datasets for the Santa Clara River

4.0 Human influences and Public Access

4.1 History of the Santa Clara River: Recreation and other Human Uses

Regional history surrounding the Santa Clara River valley has been defined broadly as falling within a handful of distinct chronological eras: Pre-Historic, Spanish Settlement, Mexican Rancho, Commercial Agriculture, and Industrial (SCREMP Historical Report 1995, McGrath Resources Management Plan 2003, Cleland 1953). These eras represent critical shifts in land use, demographics and ecological impacts which have shaped the physical, socio-cultural and ecological landscape present today. These historical changes have taken shape as both human response to natural events, such as floods and climate change, and intentional human alteration of the surrounding ecosystem for resource management and development (McGrath Resources Management Plan, 2003). The history of the Santa Clara River valley and its people are defined by their relationship to the river itself. Patterns of settlement and industry have been directly shaped by the river for millennia. While the valley has many historic sites, and residents take pride in their local history, only through the lens of the Santa Clara River do all these histories come together. For this reason, the Santa Clara River should be recognized and celebrated for its role in shaping the history of the valley and what it has become today. Developing public access and education which brings this history, and the remnant historic sites, together is a significant opportunity.

Recreational uses along the river have varied widely in the past. Fishing was an intermittent pastime possible along the Santa Clara at least in the early part of the twentieth century and before. The continued presence of steelhead in the river and in the Sespe Creek has been a source of environmental controversy in the past two decades. Areas along the river have also been maintained as duck ponds, and a number of duck clubs were located near the mouth of the river in the first half of the twentieth century. Private families also maintained duck blinds as well.

Some of the earlier “grand plans” for the watershed involved recreational use, although no one of these plans were carried out. An electric road to accompany a massive hydropower project on the Sespe was proposed in the early 1900s. A monorail to the Sespe Hot Springs was suggested in the 1920s but never built (Freeman 1968).

A number of golf courses, public and private, are adjacent to the river. Recreational vehicle parks also are scattered along the Santa Clara upstream from Piru and into Los Angeles County.

Increased recreational demands have directly affected the river. All-terrain vehicles and other motor vehicles have been frequent and illegal 19intruders on the river bottom and surrounding lands. Tire marks in the river bottom from illegal vehicle traffic have been evident on visits to the river bottom at the Sespe Cienega site. Recreational facilities have existed on private lands. A motorsports park known as Indian Dunes was run by Newhall Land and Farming. At Indian Dunes, which apparently operated in the 1960s and through the early 1970s, motocross racing in the river bottom was a popular sport. Some of this land was apparently used for motion picture filming in subsequent years. Other entrepreneurs have run recreational activity centers such as trail rides through the Upper Santa Clara River bed. The reservoirs at Piru, Pyramid, Bouquet Canyon, and Castaic dams provide recreational activities ranging from fishing and boating to camping and swimming.

Municipalities have included river plans in their general recreational plans since the 1960s, but few of the extensive plans have come to fruition. The City of Oxnard, for example, drew up plans for an inland waterway in one of its general plans. Along the upper river, some communities have used the river as a center of recreational areas.

The riverbed has provided a de facto housing community for many years. Stories of the St. Francis Dam failure describe how homeless who lived under local bridges were warned of the coming flood. Homeless encampments persisted throughout the middle of the century and the homeless continue to reside in the Santa Clara River bottom. Probably more than one semi-permanent housing structure (trailer, etc.) is or as been illegally located in the riverbed area.

4.2 Santa Clara River Parkway Concept

In 2000, the California State Coastal Conservancy proposed the establishment of the Santa Clara River Parkway after discussions with river corridor landowners and local governments. The primary goal of the Santa Clara River Parkway Project is the acquisition, conservation, and restoration of floodplain lands within the Santa Clara River corridor. Governor Gray Davis provided initial funding of $9.2 million, as appropriated by the legislature, to the Coastal Conservancy for land acquisition and planning. Land acquisition is being conducted on a willing seller basis, with the initial focus of the project on the lower river.

As currently envisioned, the Parkway project will result in the acquisition and restoration of a 25 mile-long, or 6,000-acre, corridor from the mouth of the Santa Clara River to the Sespe Creek confluence.

The Parkway was established to achieve three goals:

1. conserve and restore aquatic and riparian habitat for native species, and the hydrologic and geomorphic processes that create and maintain those habitats;
2. provide enhanced flood protection for adjacent private land and public facilities;
3. provide public access and environmental education, including the creation of a continuous public trail system along the length of the Parkway.

4.3 CAUSE Survey on Public Access and Recreation Needs in Santa Paula

CAUSE works for a fair economy, inclusive society and healthy environment in Ventura and Santa Barbara Counties. SCRAP is CAUSE's effort to organize, educate, and mobilize residents in Santa Paula and along the Santa Clara River. A key component is building the stewardship of communities along the river to protect and restore the river including through low impact public access. CAUSE completed a 206 in-person survey in June and July of 2016 in Santa Paula.

•People are physically active in Santa Paula; 61% do recreational activities once a week or more.

•Use of natural areas is highest when there is clear public access and the natural area is close in proximity. In the last year, Santa Paula residents surveyed had visited:

- •River at Steckel Park 69.3%
- •Lake Casitas 47.5%
- •Punch Bowl 40.8%
- •Lake Piru 37.4%
- •Sespe Creek 21.2%
- •Piru Creek 17.3%

• The Santa Clara River is not accessible to Santa Paula Residents

•Only 39% of Santa Paula residents surveyed have been to the Santa Clara River.

•The majority who have visited the river, access it at the 12th street bridge.

•35% of Latinos had visited the River while 49% of Whites had visited the River.

•Strong support for a Santa Clara River Public Parkway vision with hiking trails and educational signs; 94% of the 206 people surveyed said they would utilize public access along the Santa Clara River as envisioned in the Santa Clara River Public Parkway project.

Available data:

Ventura County Parcel Shapefiles, Ventura County WPD

Data gaps/needs:

Nearby Park Visitorship rates

Outreach to local communities to determine visitorship/recreation needs related to the Cienega Property