NORTHERN SANTA CLARA COUNTY FISH RESOURCES

Jerry J. Smith
Department of Biological Sciences
San Jose State University
San Jose, CA 95132
25 July 2013

INTRODUCTION

Steelhead *(Oncorhynchus mykiss)* originally made extensive use of both perennial lowland and upstream portions of the streams of the Mt. Hamilton portion of the Diablo Range, on the east side of Santa Clara County, and the Santa Cruz Mountains, on the west side of Santa Clara County. However, water diversions and barriers to migration sharply reduced these populations by the 1950's. No quantitative data exist for either historical or recent populations in most watersheds. Coho (*O. kisutch)* and Chinook salmon *(O. tshawytscha)* were not reported by Snyder (1905) for streams of San Francisco Bay, but there is anecdotal information for occasional fish, especially coho, into the 1950's. Chinook salmon have been reported in some San Francisco Bay streams since the 1980's, coinciding with central valley hatchery production, net pen rearing operations in San Francisco Bay (e.g. near Mare Island), and efforts to transport juvenile fish around diversion-affected portions of the delta. Most downstream habitats have been extensively modified, accompanied by extensive urban growth, affecting not only steelhead, but native warm-water fishes as well. However, many upstream habitats are relatively unmodified and contain healthy populations of resident rainbow trout (*0. mykiss)* and other native fishes.

Steelhead generally require cool-water habitat, but can utilize warmer habitats if food availability is good, such in fast-water riffles, where the fish can feed on drifting insects (Smith and Li 1983). The result is that central coast steelhead (and resident rainbow trout) are now found in summer in two different types of habitats. Primarily they are in the shaded pools of small, cool, low-flow upstream habitats typical of much of the original steelhead habitat in the region. However, they also occur in the riffles of warm-water habitats below some dams, where summer releases for groundwater percolation provide high summer flows and fast-water feeding habitat. During summer, the habitats below dams may have originally supported steelhead only in shaded, cool, unmodified portions, or below dam reaches may have been occupied primarily (or exclusively) by warm-water fishes before upstream reservoirs provided augmented summer flows.

Unlike steelhead, which spend 1-2 years in freshwater before migrating to the ocean, fall-run Chinook salmon spawn in fall and early winter (September to early December), juveniles grow over winter and spring, and then smolts migrate to the ocean in spring. Because juveniles do not spend summer and fall in local streams, Chinook can potentially use portions of streams that are too warm or have water quality problems in summer that preclude steelhead use. Coho salmon

spend one year in freshwater, but usually require cooler water than steelhead, and utilize pools rather than the fast-water habitats that steelhead can use to meet their food demands in warmer water. Chinook and coho also die after maturing and attempting to spawn, so they require annual access and rearing success, an unlikely condition in the drier, drought-prone watersheds of Santa Clara County.

This report summarizes the general patterns of present fish distribution and status for the upper Alameda Creek system and the Coyote Creek system on the eastern side of the county, and watersheds from the Guadalupe River north to San Francisquito Creek on the west side of the county. The Pajaro River watershed in south Santa Clara County is treated elsewhere (Smith 2013). The report also generally assesses historical impacts to those systems as well as ongoing and potential restoration actions. Collections by Leidy (1984), historical collections cited by him, information in Leidy et al. (2005), collections by Scoppettone and Smith (1978), and subsequent unpublished collections by Smith provided the basis of the summary.

UPPER ALAMEDA CREEK SYSTEM

Past and Present Steelhead, Salmon, and other Native Fishes

At the present time, healthy populations of resident rainbow trout, California roach *(Lavinia symmetricus)* and Sacramento sucker *(Catostomus occidentalis)* are present in Alameda Creek in Sunol Regional Park (especially upstream of Little Yosemite); in San Antonio Creek upstream of San Antonio Reservoir; in Arroyo Mocho upstream of Livermore; in Arroyo del Valle upstream of Del Valle Reservoir; in Arroyo Hondo Creek and its two tributaries, Smith and Isabel creeks, upstream of Calaveras Reservoir (Scoppettone and Smith 1978, more recent unpublished sampling results by Smith, Leidy 1984, and Leidy et al. 2005). Steelhead would have utilized those habitats in the past. Impassable falls are now present on upper Arroyo Hondo, but the rainbow trout in Smith and Isabel creeks, upstream of the falls, are also assumed to be native, as California roach and Sacramento sucker are also present. Similarly, the falls in Little Yosemite in Sunol Regional Park on upper Alameda Creek appear to presently be impassable under most conditions to steelhead, but the presence of all three species above Little Yosemite indicates that the barriers haven't always been present or as severe.

The construction of Calaveras and San Antonio reservoirs by the San Francisco Public Utilities Commission (SFPUC) and Dell Valle Reservoir by the Alameda County Water Agency (ACWA) trapped steelhead and produced adfluvial populations of rainbow trout that live in the reservoirs and spawn in the tributaries. Many of the juveniles produced by spawning reservoir fish still show smolt (down-migrating steelhead) coloration during spring migration after rearing in the tributary streams (Gunther et al. 2000). Small dams in Niles Canyon were also barriers to steelhead. All regular steelhead access was totally blocked by an ACWA flood control drop structure in lower Alameda Creek (the "BART" weir) and ACWA seasonal inflatable dams and their footings (for in-channel percolation and diversion to off-channel percolation ponds) between the drop and the mouth of Niles

Canyon. Presently, occasional steelhead and Chinook salmon are seen downstream of the BART weir. The steelhead apparently occur from some residual smolt production by resident trout in the watershed (Wilzbach et al. 2012) or as strays from nearby South San Francisco Bay streams. The Chinook are presumably strays of central valley (hatchery-reared) fish. Coho salmon have occasionally been reported from Alameda Creek into the 1950's, but warm water temperatures in the watershed and poor adult or smolt passage during droughts would have made a sustainable population unlikely.

Speckled dace *(Rhinichthys osculus)* were collected by Snyder (1905) in Arroyo Hondo and Isabel creeks, but not by Scoppettone and Smith (1978); they are apparently gone from most of their former sites in the central coast, including Coyote Creek. Riffle sculpin *(Cottus gulosus),* a normal associate of roach, sucker, and trout in foothill streams, is absent from the Alameda Creek watershed. The only other native fish present at the upstream locations are prickly sculpin (C. *asper)* in Alameda and Arroyo Hondo creeks above and below Calaveras Reservoir, and pikeminnow (*Ptychocheilus grandis*) and Pacific lamprey (*Lampetra tridentata*) in Alameda Creek downstream of Calaveras Reservoir.

Green sunfish *(Lepomis cyanellus),* a frequent component of farm ponds, is the only nonnative fish species likely to commonly occur in the headwater streams; it has been collected in Alameda Creek and Arroyo Mocho (Scoppettone and Smith 1978). Calaveras Reservoir supports largemouth bass (*Micropterus salmoides*), which prey on and compete with the rainbow trout, and the reservoir formerly supported a population of Sacramento perch (*Archoplites interruptus*), which occasionally occurred farther downstream in Alameda Creek. Sacramento perch may no longer be present.

Sacramento blackfish (*Orthodon microlepidotus*), Sacramento perch, and tule perch (*Hysterocarpus traski*) have been present in lower Alameda Creek (Scoppettone and Smith 1978), but the latter two species may longer be present in the stream. Sacramento perch in Alameda Creek downstream of the reservoir in the 1950's – 1970's were apparently depended upon spilling from Calaveras Reservoir, and tule perch are now apparently only present in off-channel ponds in the town of Niles.

Foothill yellow-legged frogs (*Rana boylei*) and California red-legged frogs (*R. draytoni*) are present in Upper Alameda, Arroyo Hondo, Smith, and Isabel creeks.

Ongoing Steelhead Restoration

Passage modifications at the ACWA weir and inflatable dams downstream of Niles Canyon will be completed in the next several years, and unused dams in Niles Canyon have already been removed. Replacement of SFPUC's Calaveras Dam for seismic safety will be accompanied by a trap and truck operation to move fish past the fluctuating reservoir to and from Arroyo Hondo, opening the accessible habitat downstream of the falls to steelhead use (SFPUC 2011). In addition, a ladder will be constructed at the diversion dam that transfers water to Calaveras Reservoir from Upper Alameda Creek, so that the partially intermittent habitat in the upper portion of the creek will be accessible to adult steelhead

that are able to successfully pass the falls in Little Yosemite. Passage will also have to be provided at a weir supporting a PG&E pipeline in Sunol. Releases from the replaced Calaveras Reservoir will improve habitat for steelhead downstream in Calaveras and Alameda creeks.

COYOTE CREEK SYSTEM

Past and Present Steelhead and Salmon

Anderson and Coyote reservoirs (operated by the Santa Clara Valley Water District, SCVWD) block access to the upstream sections of Coyote Creek and its tributaries. Downstream of Anderson Reservoir, the stream flows are heavily regulated except in winters of very wet years, when the reservoirs spill. Because of seismic concerns and investigations, the reservoirs are presently not filled to capacity, and an uncontrolled spill is very unlikely.

In summer, impounded water and water imported from the San Felipe Pipeline, are released into Coyote Creek downstream of Anderson Reservoir. Until the last decade, most of the water was subsequently diverted less than one mile downstream into a canal that parallels the natural streambed because of concerns about a high water table in some agricultural lands. This diverted water was then discharged immediately upstream of Metcalf Pond, an on-channel pond created by a flashboard dam about 6 miles downstream of Anderson Reservoir. Therefore, much of the natural channel between Anderson Reservoir and the Metcalf Pond was dry in late summer.

Presently, the canal is not used, and flows as high as 50 cfs are released from Anderson Reservoir and percolate in the stream channel downstream to near Hellyer County Park (approximately 14 miles downstream of the Anderson Dam), at the Metcalf Pond, and at off-channel ponds near Metcalf. On-channel percolation ponds upstream of Blossom Hill Road (the “Ford Road Percolation Ponds”) were seasonally installed until 1994. The streambed is dry in summer downstream of Hellyer Park, but flow resumes further downstream from perched groundwater and from inflow from Upper Silver Creek. Upper Silver Creek was realigned to discharge directly to Coyote Creek rather than to Lower Silver Creek. Coyote Creek is then perennial to San Francisco Bay, but summer stream flows are low, and water quality is generally poor.

Only in wet years does lower Coyote Creek receive substantial scouring flows from the upper watershed in winter. In many years winter and summer flow consists predominantly of runoff from the urbanized portion of the watershed, with its high biochemical oxygen demand (BOD), silt, and toxic (copper, oils) contribution from road runoff.

Upper Silver Creek has low, but perennial, warm summer flows (it flows in the Silver Creek Fault zone). The stream is relatively unshaded but natural in its upper reach, but is diverted into a new channelized channel in its lowest reach. Lower Silver Creek enters Coyote Creek farther north and drains the drier Thompson Creek watershed. Lower

Silver Creek has perennial flows in its channelized lower reaches, due to perched groundwater.

Upper Penitencia Creek (a different stream from Lower Penitencia Creek to the north) has relatively cool summer flows within, and immediately downstream of, Alum Rock Park. Much of the summer flow is from water stored in Cherry Flat Reservoir (owned by the city of San Jose) in the upstream portion of the city park. Until the 1980's this water was bypassed in a pipeline around the upper part of the park and discharged to the natural streambed at the upper picnic area of the park. Presently, the releases from the reservoir flow down the natural channel, rather than through a pipeline. Arroyo Aguague discharges to Upper Penitencia Creek from the south. Summer inflow is very low, however, the stream is located in the Calaveras Fault zone and therefore does not go completely dry, even in severe droughts (1976-77, 2007-09). The low summer stream flows from Alum Rock Park percolate rapidly in the recharge zone at the edge of the valley, and the stream is usually dry in late spring through fall near the Nobel Avenue Diversion Dam (about 0.4 miles downstream of the park). The SCVWD operates off-channel percolation ponds adjacent to Upper Penitencia Creek (about 0.3 miles farther downstream), where it percolates water imported from the South Bay Aqueduct. Water discharged from the percolation ponds is also percolated in Upper Penitencia Creek, which presently maintains a live stream with relatively warm water temperatures from the percolation ponds downstream to Coyote Creek. Until the last decade, summer flow was less and usually stopped immediately downstream of Maybury Avenue (where a small diversion to an off-channel pond is located). The SCVWD Nobel Avenue Diversion Dam formerly diverted water from the creek to the off-channel percolation ponds and was capable of drying portions of the stream in late spring. The functioning diversion dam also blocked the steelhead smolt outmigration, as there was no bypass. Screening the diversion would have prevented fish from being diverted to the percolation pond, but they would still not be able to pass the dam or the dry streambed downstream. Only during turbid flow periods in very wet years (when the diversion ceased) was smolt out-migration likely to continue into the normal April and May migration period. The diversion dam has not been used for almost a decade, and in a majority of years, the flow from the park reaches the percolation ponds and their discharge that allows smolts to migrate to Coyote Creek through most of April and May (Leicester and Smith 2013). In dry years, the flow from the park in spring may be insufficient to maintain a live stream to the percolation ponds, and smolt outmigration is blocked as early as April. In most years the smolt migration in April and May would not be possible without the augmented flows from the percolation ponds, because 3-5 cfs of stream flow is naturally percolated in the streambed.

Steelhead are now apparently rare in the Coyote Creek system. Although they probably used much of the watershed for rearing in the past, they now appear to be restricted to Upper Penitencia Creek, within Alum Rock Park and in the channel downstream of the percolation ponds (Leicester and Smith 2013), and in Coyote Creek itself, downstream of Anderson Reservoir.

In Coyote Creek the extent of present steelhead spawning and rearing is unknown, as no recent late-summer / fall sampling for juvenile steelhead or trapping for adult escapement

have been conducted. Juvenile sampling by the SCVWD (Moore, et al. 2008) was conducted in late May, when most smolts would have left and when most young-of-year (YOY) were too small to sample effectively. May sampling also does not indicate growth and survival of YOY fish. The lower portion of the stream (from the mouth upstream to Hellyer Park) suffers from low flows and water quality problems, although juvenile steelhead did rear in Standish Lake, behind an on-channel seasonal flashboard dam near the Bay in the mid 1980's. The modified "New Standish" seasonal dam (built as mitigation) was too warm for steelhead use because of channel widening and riparian vegetation removal for flood control. The New Standish Dam was abandoned, because it failed to replace the habitat lost, and because the large panels leaked and were difficult (and dangerous) to install and remove. Since then, no alternative mitigation has been provided. . Farther upstream, from Blossom Hill Road upstream to Anderson Reservoir, much of the steelhead rearing potential was eliminated by bypassing flows in the canal around the natural channel and by lack of fish passage at the Metcalf Pond dam. That dam has since been laddered by the SCVWD for fish passage, and percolation water now flows in the stream channel (rather than being bypassed in the canal) between Anderson Dam and the Metcalf Pond. However, the current highly regulated percolation operations restrict or block smolt out-migration in the seasonally dry reach downstream between about Hellyer Park and Capitol Expressway during April and May in all but wet years.

Two additional major problems impact potential steelhead use of the habitat between Hellyer Park and Anderson Dam. A concrete and culvert crossing at Singleton Road is a severe passage barrier to up-migrating adult steelhead (and Chinook salmon). The crossing provides access for hikers and safety vehicles to both sides of the creek. Removal and replacement by a bridge and boulder weir grade controls is necessary to substantially improve adult steelhead access to upstream spawning and rearing habitat. Closer to the dam, several of the off-channel gravel pit ponds (the Ogier Ponds) became on-channel when floods in 1998 realigned the channel. The on-channel ponds increase stream temperatures downstream (heavier cool water flows in and surface warm water flows out), which reduces habitat quality farther downstream for steelhead. In addition, the ponds support abundant predatory largemouth bass, which present a substantial predation threat to smolts migrating from upstream.

Chinook salmon have spawned in Coyote Creek since at least the mid 1980's. Most of the spawning appears to be in the lowermost reaches, but adult fish have been found almost as far upstream as Metcalf Dam. Some spawning may also occur in the lowermost reaches of Upper Penitencia Creek. The areas used for spawning by Chinook salmon mostly appear to have water temperature and water quality problems in summer, but Chinook salmon smolts emigrate in spring of their first year, before temperature and water quality conditions decline. It is presently not known if spawning/rearing is successful in Coyote Creek, but a few smolts were caught during SCVWD smolt trapping in both Coyote Creek and the Guadalupe River in the late 1990's.

Some coho salmon were apparently present in Coyote Creek as late as the 1950's, at the time Anderson Dam was constructed (L. J. Hendricks, pers. comm.). Because of their one year juvenile residence in fresh water, their requirement for cool, productive pools, and their

requirement for annual access to upstream habitat, there is now no possibility of restoring coho to the Coyote Creek system.

Current and Potential Steelhead (and Chinook) Restoration

Coyote Creek, Guadalupe River, and Stevens Creek were the subject of a threatened lawsuit against the SCVWD to increase reservoir releases under California Fish and Game code 5937. This code requires operators of dams and diversions to maintain downstream fish resources in "good condition." Good condition for steelhead should mean at least maintaining stream flows adequate for steelhead spawning and rearing. In addition, good condition for *anadromous fish* should also mean providing flows sufficient for migration to and from spawning and rearing areas. In the drier portions of central California, these migration flows, especially spring flows for smolts, are critical for steelhead. The threatened suit resulted in a collaboration (Fisheries Aquatic Habitat Collaborative Effort, FAHCE) between SCVWD, California Department of Fish and Game (now California Department of Fish and Wildlife, CDFW), the National Marine Fisheries Service (NMFS), and the Guadalupe / Coyote Resource Conservation District (RCD) to produce improved habitat conditions for steelhead and Chinook salmon. An agreement was reached, altered reservoir operations were implemented, and some passage barriers were modified. The agreement's status is now uncertain because the RCD, which threatened the suit, has a different organizational structure, and the agreement was initialed, but never signed by SCVWD.

Anderson Reservoir is large, and the releases of cool water from the bottom for percolation in the channel downstream substantially enhance the steelhead habitat downstream. The high volume of the releases reduces the rate of downstream warming and also produces the necessary fast-water feeding habitat in an otherwise low-gradient stream channel heavily dominated by pools. The major actions that can be taken to improve steelhead potential between the dam and Hellyer Park are to remove the adult passage barrier at Singleton Road and to realign the channel around the on-channel Ogier Ponds (return the stream to its pre-1998 location). In addition, stream flow needs to be provided through the seasonal reach near and downstream of Hellyer Park to support smolt outmigration in late March through at least mid-May. This area is a choke point in smolt and adult steelhead migration (it also includes the Singleton Road crossing). This area also includes extensive homeless camps, which are the source of pollution, channel obstructions, and active poaching. Intermittent removal efforts have been insufficient to address the problem.

Chinook enter the stream and attempt to spawn prior to winter rains that would provide access to the upstream portion of Coyote Creek, and therefore Chinook would usually be confined to the lower reaches of Coyote Creek. Providing fall adult passage and spawning flows for non-native Chinook would require use of substantial amounts of water that would be lost beyond the percolation zone. It would potentially also reduce water available for steelhead summer rearing (particularly cooler release volumes) and smolt out-migration flows.

At the present time, the Coyote Valley along Coyote Creek (from Anderson Dam to Metcalf Percolation Pond), is zoned against residential and industrial development, but there has been substantial pressure to open part of the area to urban development. Much

of the high potential for steelhead restoration would be lost if the area is urbanized. Sedimentation and urban runoff would degrade stream bed and water quality. Urbanization would also substantially degrade the quality of percolated ground water in and downstream of the area.

Upper Penitencia Creek presently supports both steelhead and resident rainbow trout that depend upon releases from Cherry Flat Reservoir and upon percolation releases of imported water from the South Bay Aqueduct (Leicester and Smith 2013). In recent years resident trout appear to have more abundant than steelhead, so problems for steelhead adult and/or smolt passage appear to be important. In dry years, the small stream flow in April and May from Alum Rock Park is lost to percolation before reaching the augmented stream flow from the percolation ponds. In those types of years, a brief period of increased releases from Cherry Flat Reservoir would help maintain the connection and allow smolts to migrate; smolt flow releases would somewhat reduce water available for summer/fall rearing. In dry years, when there are few storms to support easy adult passage, poaching by homeless and others on the lower reaches of Upper Penitencia Creek may be a significant problem. A partial adult barrier in Alum Rock Park (the YSI weir) was modified for passage in 2012.

Other Existing and Potential Fish Resources,

Even without steelhead access, Upper Penitencia Creek in Alum Rock Park maintains resident rainbow trout. Other fish species present in the park and immediately downstream include California roach, riffle sculpin, and Sacramento suckers. In the reaches downstream of the percolation pond discharge, California roach, Sacramento suckers, and Pacific lamprey larvae are common. Because of the warmer water and their presence in the percolation ponds, prickly sculpin replace riffle sculpin. The off-channel percolation ponds have also been a source of mostly juvenile introduced fishes, including green sunfish, largemouth bass, and goldfish *(Carassius auratus).* The primary (upstream) discharge has recently been screened by SCVWD.

The natural portion of Upper Silver Creek contains California roach and threespine stickleback *(Gasterosteus aculeatus*). This small, shallow stream runs in the Silver Creek fault and is perennial, even in severe droughts (1976-77). The presence of these two species in a perennial stream too small to support larger species is unusual in this region.

Between Anderson and Coyote reservoirs and upstream of Coyote Reservoir, Sacramento pikeminnow, California roach, Sacramento sucker, and occasionally prickly sculpin are present at most of the warm-water sites. Hitch are also present between the two reservoirs. Rainbow trout and riffle sculpin are present at cooler, perennial sites within the uppermost reaches within Henry Coe State Park. San Felipe Creek, a perennial Calaveras Fault line tributary to Anderson Reservoir, contains healthy populations of rainbow trout, California roach, Sacramento sucker and riffle sculpin; fault line seepage maintains the stream, even during severe droughts (1976-77).

Coyote Creek upstream of Coyote Reservoir and San Felipe Creek upstream of Anderson Reservoir contain California red-legged frogs (*Rana draytonii*) and foothill yellow-legged frogs (*R. boylei*). Habitat in San Felipe Creek is perennial, but most of upper Coyote Creek has intermittent habitat, with wide variation in summer stream flow.

From Anderson Reservoir downstream to the Metcalf Ponds, Sacramento sucker, hitch and prickly sculpin are common. Sacramento pikeminnow, Sacramento blackfish, California roach, and threespine stickleback are less common and only occasionally present in most stream sections (Leidy 1984 and Smith unpublished). All of the above, except Sacramento pikeminnow and California roach, have also been collected in Fisher Creek, a small tributary from the west. Speckled dace were apparently eliminated during stream flow cutbacks during fall 1977, when only pools below Anderson Reservoir and a portion of the Metcalf percolation pond survived. Nonnative fish species are often common in the stream and on-channel percolation ponds, partially as spill from Anderson Reservoir or from the San Felipe Pipeline. These may include sunfishes, largemouth bass and catfishes, and also threadfin shad *(Dorosoma pretenense}* and inland silverside *(Menidida beryllina).* Catchable-sized, hatchery-reared rainbow trout used to be planted by the California Department of Fish and Game (Wildlife) immediately downstream of the dam, and some fisherman released trout caught in Parkway Lakes (a pay for fishing percolation pond) into adjacent Metcalf Pond. Hatchery plants and the operation of Parkway Lakes no longer occur.

Presently, in the reaches of Coyote Creek downstream of Hellyer Park the native fishes are hitch, California roach (and hitch x roach hybrids), prickly sculpin and Sacramento sucker, but only hitch are common. Because of the poor water quality, tolerant exotic fishes are often the most common species. These include goldfish, red shiner *(Notropis lutrensis),* fathead minnow *(Pimephales promelas*), and mosquitofish *(Gambusia affnis).* During Snyder's (1905) original surveys, Sacramento splittail *(Pogonichthys macrolepidotus),* thicktail chub *(Gila crassicauda; now extinct),* tule perch and Sacramento perch were present in lower Coyote Creek. The first two species have not been collected in the stream since the 1920's (Aceituno, et al. 1976; Leidy 1984), but a few Sacramento perch were present in Coyote Creek into at least the late 1950's and in Cottonwood Lake, an artificial pond in Hellyer Park, in the 1960's (L. J. Hendricks, pers. comm.). Tule perch are now present in the Ogier Ponds (Moore et al. 2008), having re-entered Coyote Creek from the San Felipe Pipeline, which brings Central Valley water from San Luis Reservoir to near Anderson Reservoir.

GUADALUPE RIVER SYSTEM

Past and Present Steelhead and Salmon

The construction of Vasona Reservoir, Guadalupe Reservoir and Almaden Reservoir in the 1930’s blocked the upper reaches of Los Gatos, Guadalupe and Alamitos creeks. The extreme upper portion of Arroyo Calero was blocked by Calero Reservoir, but this dry watershed probably had less cool, perennial habitat and less regular steelhead use. Lexington Reservoir, upstream of Vasona Reservoir, was added in the 1950's, increasing

storage in the Los Gatos Creek system. Water from all reservoirs is released for groundwater percolation downstream in the natural stream channel and also in off-channel percolation ponds on Guadalupe and Los Gatos creeks. On-channel, seasonal percolation ponds, formed by gravel/earth dams, were used for percolation in Guadalupe Creek, Guadalupe River and Los Gatos Creek until the Army Corps of Engineers Section 404 permits lapsed in 1994.

A 13 foot high drop structure on the Guadalupe River, upstream of Blossom Hill Road, was installed in the early 1970's and blocked steelhead or salmon access to Guadalupe and Alamitos creeks and Arroyo Calero. It was laddered in 1999. Two smaller barriers downstream, the San Jose Water Company low-flow crossing and the bridge apron at Hillsdale Avenue, were partial barriers until modification in 1998. The Hillsdale apron was later removed. Mason Dam, a diversion dam on Guadalupe Creek was laddered in 2000. A 20-foot high drop structure on Los Gatos Creek near Camden Avenue blocks access to the limited, marginal quality habitat between the drop and Vasona Reservoir. Releases from shallow Vasona Reservoir are normally of warm water.

Summer/fall reservoir releases usually maintain flows in Los Gatos Creek downstream to between Meridian and Lincoln avenues and in the other three streams downstream to their confluences as the Guadalupe River. Imported water (San Felipe Pipeline) is also transferred to Calero Reservoir and directly to the stream channels for percolation. Continuous summer flow is now maintained in the Guadalupe River downstream to the bay, but prior to an agreement with the California Department of Fish and Game in 1996, the river was dry in summer between about Hillsdale Avenue and Almaden Expressway/Canoas Creek; a minimum of 1 cfs is now provided to that section of stream. In the 1980's, cleanup of groundwater contamination resulted in the discharge of more than 40 cfs to Canoas Creek, which discharges to the Guadalupe River near the Almaden Expressway crossing. Canoas Creek is a long, unshaded, channelized stream and afternoon temperature of summer flows exceeded 78 degrees. Groundwater discharge to Canoas Creek was phased out during the 1987-1991 drought. The downstream reaches of the Guadalupe River have benefited from increased streambed percolation due to recent wet years and imported water, and a perched water table is a source of summer stream flow. Groundwater pumping at buildings with basements and at the San Jose Airport provide additional stream flow. At the San Jose Airport, intermittent pumping results in multiple spikes of stream flow throughout the day. Because of ground water percolation operations and the perched water table in downtown San Jose, there is currently no impediment to smolt out-migration in spring, unlike many of the other south Bay streams.

Originally steelhead would have used most of the habitat on Guadalupe, Alamitos and upper Los Gatos creeks, and probably would have made use of Arroyo Calero in wetter years. It is uncertain what the natural conditions were like in the Guadalupe River and lower Los Gatos Creek. Their flat gradients could have contained large pools, likely to be only partially shaded and with relatively warm summer water temperatures. However, the fish collected by Snyder (1905) in 1895 within the downstream portion of the Guadalupe River in the city of San Jose, included only species that can be associated with cool, tributary-type conditions (rainbow trout, California roach, Sacramento sucker, threespine stickleback, and prickly sculpin). Sacramento

pikeminnow were not collected, but should have been common if larger, warmer pools were present. Only a single juvenile pikeminnow was collected by Hubbs in 1922 (cited in Leidy 1984). Other species associated with slow water, downstream habitats were also apparently absent from the Guadalupe watershed (Snyder 1905), although the full complement of downstream species was present in adjacent Coyote Creek. Hitch were collected in the lower Guadalupe River in 1986, following wet years that probably allowed their transfer through the bay from Coyote Creek. At the present time, most of the un-channelized habitat of the Guadalupe River and lower Los Gatos Creek is in narrow, incised, well-shaded channels. Based upon historical fish records, it seems likely that most of the channel on the two streams was originally narrow and well-shaded and often provided cool-water summer habitat suitable for heavy steelhead use. However, riffle sculpin were not collected in the lower Guadalupe River (Snyder 1905), and should have been present if relatively cool stream flows were present in all years. Therefore, it is possible that portions of the lower stream channels went dry in drier years, and that poorly dispersing riffle sculpin and consistently perennial habitat were confined to upstream reaches within the watershed.

At the present time, with barriers removed and stream flows increased, steelhead have probably replaced the resident trout downstream of Calero, Almaden and Guadalupe reservoirs. The cooler, more natural habitat above the formerly inaccessible drop structure upstream of Blossom Hill Road probably provides most of the steelhead spawning and rearing. Downstream of the drop structure, portions of the channel have been widened for flood control, and summer flows are relatively low and warm in most years. It provides only marginal steelhead rearing habitat. Any juvenile steelhead present would be confined to riffles or other fast-water habitats where feeding on drifting insects would provide enough food to meet the high metabolic demands of the warm summer water temperatures (Smith and Li 1983). In addition, most of the channel is subjected to severe flood peaks and channel scour from the runoff from the surrounding impervious urban surfaces. Spawning success is likely to be poor in many years, because of redd (nest) destruction from urban storm flows. This should especially be a problem downstream of Ross and Canoas creeks, which drain large urbanized areas. Steelhead also spawn and rear in Los Gatos Creek downstream of the Camden Drop Structure.

Chinook salmon were never reported by early biologists (Snyder 1905; Leidy 1984), and are largely a species of large north coast or Central Valley rivers. However, up to several hundred salmon per year have been entering the Guadalupe River to spawn since at least as early as 1986. The lack of historical records, and the salmon's attempts to enter the river months before stream flows and water temperatures are suitable for spawning (often earlier than September), indicate that the runs originated as fall-run strays from Central Valley streams. However, some successful spawning apparently now occurs, despite the flashy urban channels that they use for spawning. In 1998, Chinook smolts were captured during spring trapping on the lower Guadalupe River by the SCVWD, so the adult runs may now consist of a mixture of continuing strays and naturalized production from the watershed. In years when successful hatching occurs, the juvenile Chinook can migrate to the bay after only several months in the stream. This allows them to avoid the stressful summer conditions presently faced by the steelhead, which must spend at least one full year in the river.

Current and Potential Steelhead (and Chinook) Restoration

Portions of Guadalupe and Alamitos creeks presently support reasonably good populations of steelhead/resident rainbow trout, although fish are generally less abundant in the unshaded, warm section of Guadalupe Creek downstream of Camden Avenue. Substrate is generally silty in Arroyo Calero; trout were relatively scarce in the 1980's and may have been primarily fish moving upstream from Alamitos Creek. In the warmer sections of all three streams, the steelhead/trout are generally confined to riffles, where feeding on drifting insects can provide them enough food. All three tributaries receive continuous summer releases from their upstream reservoirs, although flows may be very low in drought years or even subject to a cutoff in releases. Even without apparent access prior to laddering the Blossom Hill Drop Structure, some smolts were produced in Alamitos and Guadalupe creeks (Smith, unpublished), and may have maintained the small, residual steelhead run downstream of the barrier. Either these smolts represented a degree of residual anadromy more than 30 years after construction of the barrier (Wilzbach et al. 2012), or occasional adults were able to pass the barrier or perhaps some adults were transported upstream over the barrier by illegal fisherman (the stream was closed to fishing during the steelhead migration period). Presently, most of the fish are assumed to be steelhead derived from this residual run.

Chinook salmon spawning has usually been throughout the downstream reaches of the Guadalupe River. Part of that restriction was because of former barriers to passage, and part was because they have entered the stream in early fall (September or earlier) before winter rains would have provided flows for passage. When flows are available, Chinook salmon can also ascend the new fish ladders and spawn in the tributaries. Since winter flows above the ladder are primarily from unpaved portions of the watershed, spawning success should be greatly increased, potentially increasing both the size of the adult run and the portion of the run which comes from production within the watershed. However, since storage in Almaden and Guadalupe reservoirs is quite limited (slightly more than 5,000 acre-feet), providing flows for adult Chinook access in late summer and early fall would greatly reduce water available in this watershed for summer/fall steelhead rearing. Passage flows for adult Chinook would also be lost past the percolation zones and reduce the urban water supply.

At this point there are no major feasible actions that can be taken to increase steelhead and Chinook in the watershed. Relocating the Alamitas Creek channel around Almaden Lake would reduce the temperature impact and predation threat to smolts from the upstream watershed (similar to Ogier Ponds on Coyote Creek), but would be major undertaking. However, the major justification for the potential effort is to reduce the generation of toxic methyl mercury from inorganic mercury in the lake, due to the lake's anaerobic bottom waters. The need for methyl mercury reduction may make the project feasible.

Other Existing and Potential Fish Resources

In addition to resident rainbow trout in the upper tributaries (Guadalupe, and Alamitos creeks, and Los Gatos Creek upstream of Lexington Reservoir) native California roach and Sacramento sucker are present. Riffle sculpin are present in Guadalupe Creek, but generally decline downstream of Camden Avenue, where shading is scarce and summer water temperatures progressively warm. They are also present in headwater portions of Los Gatos Creek. Prickly

sculpin are present in Calero Reservoir, and are present in Arroyo Calero and lower Alamitos creeks, as well as in the Guadalupe River. Calero Reservoir receives imported water (San Luis Reservoir/San Felipe Pipeline) and contains tule perch and bigscale log perch *(Percina macrolepida*) (Abel, SCVWD, pers. comm.), which have come in with pipeline water. Threespine stickleback have been collected in Calero Reservoir in the past, but the lake was drained in 1981. There are no recent collections of them in Arroyo Calero or Alamitos creeks. Nonnative fish, including largemouth bass, carp, and sunfishes *(Lepomis spp.),* spill from the reservoirs in wet years and can be common in spring, but do not appear to reproduce or persist in significant numbers in the natural stream sections.

Almaden Lake on Alamitos Creek, located just upstream of its confluence with Guadalupe Creek, contains native Sacramento sucker and prickly sculpin, and also some rainbow trout, until the lake warms up in late spring and summer. Nonnative largemouth bass, sunfishes, catfishes *(Ictalurus catus* and *I. nebulosus),* carp, and inland silverside are apparently common in the lake. The on-channel, seasonal percolation ponds that used to be operated upstream of Branham Avenue on the Guadalupe River, and on Los Gatos Creek downstream of Highway 17, often contained sizable numbers of some of these nonnative fish. However, in the flowing portions of the Guadalupe River and lower Los Gatos Creek, native Sacramento sucker, California roach and prickly sculpin are generally the dominant species. Hitch have been present in the Guadalupe River downstream of the Los Gatos Creek confluence and the weir at St. John Street, since at least the early 1980's. However, hitch have apparently not been able to expand upstream, possibly because of difficulty passing the weir or the lack of very large "flood-proof" pools upstream. Anadromous Pacific lamprey make some use of the Guadalupe River and lower Los Gatos Creek for spawning and rearing. Tule perch were captured in the Guadalupe River in the late 1990's downstream of Hillsdale Avenue; they presumably entered the watershed with pipeline transfers of imported (San Felipe) water.

SARATOGA / SAN THOMAS AQUINO CREEKS

Past and Present Steelhead and Salmon

Prior to development of Santa Clara Valley, and the accompanying extensive groundwater pumping, Saratoga, Calabazas and San Thomas Aquino creeks probably supported steelhead, but San Thomas Aquino Creek, and especially Calabaza Creek, have small foothill watersheds and were probably dry in some years. Saratoga Creek has a large, wet watershed with headwaters in the San Andreas fault zone and has consistent, high summer stream flows; it would have continuously supported large steelhead populations.

The lower portions of all three streams are presently channelized and join before entering San Francisco Bay, although the junction with Calabazas Creek is very near the Bay. Several grade control drop structures are present and extensive portions of the channel are concrete-lined. These conditions prevent upstream migration of steelhead, except at very high flows. An impassable inclined drop structure and box culvert are also present in Saratoga Creek upstream of the town of Saratoga (at and along Highway 9). However, even if adults could access the perennial headwaters of Saratoga Creek, spring flows for

smolt out-migration are lacking, even in most wet years. Some smolts could emigrate in winter, but that is prior to the spring growth period, and winter is normally a small part of the steelhead smolt migration period. Without regular smolt emigration, any steelhead population would be small or intermittent. Occasional adult steelhead have been reported to be blocked by drop structures on lower San Thomas Aquino Creek far downstream of its junction with Saratoga Creek, so some residual smolting from the resident trout population may occur (Wilzbach et al. 2012) and/or some adult steelhead occasionally access upper Saratoga Creek. However, I investigated a report of steelhead spawning in lower San Thomas Aquino Creek in 2011 and found only large spawning Sacramento suckers.

Chinook salmon carcasses were reported from lower Calabazas Creek (near Highway 101) in the early 1980's, therefore some spawning apparently occurred by stray fish. Since Chinook fry or smolts could easily migrate the short distance to the Bay in spring before water temperatures increased. Egg survival during the winter storms is probably the main factor limiting Chinook success. However, because of the large urbanized watershed upstream, winter flows should often destroy the eggs of any spawning salmon.

Other Existing and Potential Fish Resources

Resident rainbow trout are abundant in Saratoga Creek in and upstream of the town of Saratoga. Trout numbers decline downstream with reduced stream flows and warmer temperatures, but trout have occurred as far downstream as the on-channel, seasonal percolation ponds formerly (until the mid-1990's) installed as far downstream as Bollinger Road. The water percolated in the on-channel ponds came from releases from the Transvalley Pipeline and was subject to seasonal shutoffs, drying the ponds and killing the fish which moved downstream that far. California roach and Sacramento sucker are also present in Saratoga Creek, but riffle sculpin are apparently (and inexplicably) absent.

Calabazas Creek also receives seasonal discharges of pipeline water for streambed percolation up and downstream of Highway 85, but apparently has no permanent fish populations. California roach might be expected to persist under present conditions, but may have been eliminated by dewatering during past droughts. California roach, Sacramento suckers, and some rainbow trout are present in the upper reaches of San Thomas Aquino Creek, but may require periodic re-establishment from Saratoga Creek.

Current and Potential Steelhead Restoration

The presence of numerous barriers to adult passage in the channelized lower portion of the stream and the lack of spring smolt out-migration flows apparently makes restoration of a steelhead run infeasible.

STEVENS CREEK

Past and Present Steelhead

The construction of Stevens Creek Reservoir in the 1930's blocked steelhead access to much of the perennial habitat of the stream, sharply reducing the potential steelhead population. Stored water is percolated in the streambed downstream of the reservoir, but in dry years the small (3,130 acre-foot) reservoir was nearly drained by September or October, resulting in low and warm releases or flow cutoffs. Even in wetter years, releases from the drawn down reservoir were relatively warm in late summer and fall, largely restricting steelhead to fast-water feeding habitats. Pipeline releases (near Highway 280) have been used in the past to extend surface flow downstream of Highway 280 in summer for percolation in the streambed or in two on-channel, seasonal percolation ponds. When summer dams were installed, the streambed was dried to allow their installation, and apparently few fish moved into the lower channel and percolation ponds for summer rearing. The use of seasonal on-channel ponds ended in the mid-1990's.

As seen in many other regulated, urbanized streams, smolt outmigration in spring is a significant problem for maintaining and enhancing the present steelhead run. The lower channel of Stevens Creek depends upon releases or spilling from the reservoir to maintain surface flow for smolt passage in late March through May, when a large portion of steelhead smolts attempt to out-migrate. In all but the wettest years, surface flow was interrupted before many smolts migrated.

Under the FACHE agreement, reservoir operations were altered to reduce the amount of water released from the reservoir, so that only cooler bottom water was released in spring through fall. This resulted in smaller releases, especially in drought years, and reduced the amount of fast-water feeding habitat for juvenile steelhead. There is also a substantial carryover of stored water, which reduces the total water supply benefit of the reservoir, but helps maintain the cool pool of bottom water and ensures there is some water available for the next season in case of drought. In attempting to balance different life history requirements, a portion of the stored water is also allocated to passage flows for adult steelhead, but relatively little consideration was given to maintaining flows in late March through May for smolt out-migration. The stream bed normally has a dry reach in spring between Fremont Avenue and Middlefield Road (a perched water table restores stream flows near Middlefield). Especially in dry years, there is insufficient water available to meet all life history requirements.

Multiple grade control structures are present, including at Moffett Boulevard, Evelyn/Central Expressway, and along Highway 85 near Fremont Avenue, which are equipped with partially effective fish ladders. At high flows, the lower two drops are passable without the ladders, but the upper drop (along Highway 85), is over 12 feet high and requires the narrow denil fish ladder for passage at all flows. The ladders have multiple problems: a) clogging with debris during the winter; b) providing sufficient passage flow during low flow periods; c) sediment deposition that blocks access to the ladders; and d) attraction of fish to the ladder during high flows. The upper ladder is on an inside bend, where deposition can produce a point bar restricting flow into the ladder. Recent modifications to the top of the drop structure have somewhat improved diversion of low flows down the ladder. In 2010-2013, the ladder near Central Expressway suffered from sediment deposition which then diverts much or all of the water through a concrete, flat-bottomed box culvert rather than down the ladder. The

culvert is not passable except during storms. Despite these problems some steelhead are able to access spawning areas in most years. Several other grade control structures are also present, but are passable at high flows and present less severe individual problems, but cumulatively affect passage during the brief available storm periods, especially in drier years.

The habitat downstream of the reservoir supports a good population of fish, including steelhead, but a substantial portion of the fish appear to be resident rainbow trout. Smolt trapping by the SCVWD in the late 1990's and in 2013 captured relatively few fish, despite the abundance of trout/steelhead in the stream. The age structure and spawning checks on scales of fish captured at most sites by the SCVWD in 2010 (Abel 2011; Smith 2011) indicates that resident trout are common. This suggests that a major limiting factor for steelhead in the stream is adult access and/or smolt out-migration success; this limitation favors resident rainbow trout.

An analysis of limiting factors, primarily associated with sediment, in the Stevens Creek watershed concluded that sediment, including embeddedness (burial) of cobbles, may limit overwintering survival of steelhead (and rainbow trout) in Stevens Creek (Stillwater Sciences 2004).

Other Existing Fish Resources

In additional to the steelhead and rainbow trout downstream of the reservoir, California roach and Sacramento suckers are common. Threespine stickleback and some prickly sculpins are present in downstream reaches of the creek. Introduced fish from Stevens Creek Reservoir, including largemouth bass, sunfishes, and goldfish, spill from the reservoir in wet years and are occasionally found. They are not common (Abel 2011).

Upstream of the reservoir, rainbow trout, Sacramento suckers and California roach are present. However, as with Saratoga Creek, riffle sculpin are absent, even though habitat above the reservoir is suitable for them. Large Sacramento suckers from the reservoir ascend upstream several miles to spawn in April. Adjacent Permanente Creek also has rainbow trout, California Roach and Sacramento suckers. A bypass canal transfers a portion of the flood flows in Permanente Creek to Stevens Creek during wet winters.

The apparent low smolt production and high relative abundance of resident rainbow trout downstream of the reservoir suggests that adult passage at barriers and smolt out-migration in spring are limiting steelhead production in the watershed. Barriers to adults need to be assessed and passage improved. Passage for smolts in late March through at least mid-May needs to be improved by allocating more of the limited available storage in the reservoir to smolt passage. Transvalley Pipeline water might be used to improve smolt migration flows. Water for smolt passage extends downstream beyond the water supply percolation zone and is lost to both summer/fall rearing and to water supply.

Present rearing success appears to be regulated by a combination of stream flow, water temperature, turbidity, food production (substrate quality and algal growth), and feeding efficiency (visibility) (Smith 2011). The present dominance of water temperature in the

setting of summer/fall releases under the FAHCE agreement may have to be reassessed by experimenting with different release strategies.

Sediment and turbidity problems seem to have increased in recent years; the source(s) of the problems should be investigated.

The transfer of winter flood flows from Permanente Creek to Stevens Creek may offer the potential for adult steelhead access to Permanente Creek for additional spawning and rearing. An initial assessment of the possibility should look at the potential quality of Permanente Creek, the feasibility of providing adult access, and of providing smolt out migration through the bypass canal. If the assessment indicates feasibility, an additional requirement would be to jump start the steelhead run in Permanente Creek with a transfer of fish from Stevens Creek.

SAN FRANCISQUITO CREEK

Past and Present Steelhead

Searsville Dam blocked steelhead access to the upper portion of the watershed, including Corte Madera Creek, in 1902. Unlike the larger SCVWD reservoirs to the south, summer "releases" provided from this small, mostly filled in, reservoir, are due to overflow and seepage at the dam. Also, unlike the stream channels downstream of SCVWD reservoirs, there is only a very narrow band of percolating alluvial channel and aquifer. Stream flow downstream of Searsville is relatively low in summer. Water diversions, including numerous small ones and two larger ones by Stanford University on Los Trancos Creek and on the main stem of San Francisquito Creek, take a major portion of the spring and summer flow. The stream is usually dry in its lower reaches by late spring (downstream of El Camino), and smolt out-mitgration is curtailed early in most years. Bear Creek, which enters San Francisquito Creek from the north immediately downstream of Searsville Lake usually has very low summer flows. Bear Gulch and West Union Creeks, which join to form Bear Creek immediately downstream of the Highway 84 crossing have very low stream flows or intermittent flows even in average or wetter years (Smith and Harden 2001). A water supply diversion (and impassable dam) on Bear Gulch takes most of the summer stream flow, and homeowner streamside wells take most of the rest. If fish are able to pass the water supply dam, they can access 0.7 miles of relatively good habitat with good summer stream flow; a boulder falls would normally block further access (Smith and Harden 2001). Private wells on West Union and Bear creeks severely reduce spring through fall stream flow. However, even the upstream portions of West Union Creek watershed in and upstream of Huddart County Park have intermittent or low late summer stream flow, although Squealer Gulch is perennial. Los Trancos Creek enters San Francisquito Creek downstream of Highway 280 and provides a significant part of the summer flow.

A concrete dam on lower Bear Creek and one on West Union Creek were modified following the Smith and Harden (2001) study, by notching the dams to reduce height and to direct the spill to the deepest part of the downstream pools. The major barrier, an

unused concrete dam on lower Bear Creek, was not removed until 2012. A box culvert at Fox Hollow Road could be substantially improved for steelhead passage with inexpensive baffles (Smith and Harden 2001), but an expensive full solution (a riffle ramp) has never been able to justify grant money. Although steelhead regularly pass the box culvert, Sacramento suckers and California roach are apparently absent upstream.

A fish ladder was constructed on the Stanford diversion on San Francisquito Creek, so regular adult access has been available to the perennial portion of San Francisquito Creek and to Bear Creek. The Los Trancos Creek diversion was passable only at very high flows until a ladder was installed in 1997; a more elaborate replacement ladder marginally improved passage. Now Los Trancos Creek is accessible during even moderate storms.

San Francisquito Creek probably produces significant numbers of juvenile steelhead because of the amount of apparent habitat, but the low stream flows result in low densities and growth. The slow growth probably results in delayed smolt out-migration in spring in order to feed and grow. Unfortunately, flows for smolt out migration on San Francisquito Creek are probably a problem in most years by early to mid-spring.

Other Existing and Potential Fish Resources

Resident rainbow trout are present upstream of Searsville Reservoir. Sacramento sucker, California roach, prickly sculpin, and threespine stickleback are present in San Francisquito Creek downstream of the reservoir, and the first three are present in Bear Creek upstream to Fox Hollow. Only resident rainbow trout were present in upper Los Trancos Creek prior to installation of the fish ladder. Sacramento pikeminnow were collected by Snyder (1905) in 1895, and Sacramento perch were apparently collected by Agassiz in 1860 (cited in Leidy 1984). No suitable habitat presently exists for either species. As in Saratoga and Stevens creeks, riffle sculpin is apparently absent, although habitat is suitable.

Nonnative largemouth bass, mosquitofish and sunfishes are present in Searville Lake and spill into the creek in wet years. The stream habitat is unsuitable for their reproduction, so their presence and abundance depends upon the introduction from spill and flushing by flood flows.

Current and Potential Steelhead Restoration

As there is no reservoir with stored water in the watershed, there is no potential easy source of water to improve either summer/fall rearing conditions or spring smolt out-migration.

Removal of Searsville Dam has been proposed and discussed for 15 years as a way to increase available steelhead habitat. The reservoir is nearly filled with sediment and provides neither significant water supply or flood protection.

LITERATURE CITED

Abel, J. 2011. Juvenile steelhead/trout index sampling, Stevens Creek, 2010. Unpublished SCVWD report. 18 November 2011. 24 pp.

Gunther, A. J., J. Hagar, and P. Salop. 2000. An assessment of the potential for restoring a viable steelhead population in the Alameda Creek watershed. Applied Marine Science, Livermore. 94 pp.

Leicester, M. A. and J. J. Smith. 2013. Upper Penitencia Creek Fish Resources in 2012. Department of Fish and Game unpublished report. 22 pp.

Leidy, R. A. 1984. Distribution and ecology of stream fishes in the San Francisco Bay drainage. Hilgardia, 52(8): 1-177.

Leidy, R. A., G. S. Becker and B. N. Harvey. 2005. Historical distribution and current status of steelhead/rainbow trout (*Onchorhynchus mykiss*) in streams of the San Francisco Estuary, California. Center for Ecosystem Management and Restoration, Oakland, CA.

Moore, M., L.Porcella, D. Salsbery, and V. Stevens. 2008. Mid-Coyote Flood Protection Project. Baseline Fisheries Monitoring Report, Year 2. Santa Clara Valley Water District Report.

SFPUC. 2011. Calaveras Dam Replacement, Final Environmental Impact Report.

Smith, J. J. 2011. Santa Clara County steelhead ecology. Power point presentation with text. Santa Clara Creek Coalition's Creeks and Watershed Conference, Santa Clara, CA. November 2011.

Smith, J. J. 2013**.** Steelhead distribution and ecology in the upper Pajaro River system and mainstem Pajaro River (with stream descriptions, habitat quality ratings and limiting factors by reach for the Pajaro River and for the upper Pajaro River tributaries). Unpublished revised report. 40 pp.

Smith, J. J. and H. W. Li. 1983 Energetic factors influencing foraging tactics of juvenile steelhead trout, *Salmo gairdneri*. in Predators and Prey in Fishes. D. L. G. Noakes et al. (eds.). W. Junk Publishers, Netherlands. pp. 173-180.

Smith, J. J. and D. R. Harden. 2001. Adult steelhead passage in the Bear Creek watershed. Report for the San Francisquito Watershed Council, c/o Acterra. 76 pp.

Snyder, J. O. 1905. Notes on the fishes of the streams flowing into San Francisco Bay, California. U.S. Bur. Fish Rep., (1904): 327-338.

Stillwater Sciences 2004. Final Stevens Creek limiting factors analysis. Technical Report

prepared for Santa Clara Valley Urban Runoff and Pollution Prevention Program.

Wilzbach, M. A., M. J. Ashenfelter, and S. J. Ricker. 2012. Movement of resident rainbow trout transplanted below a barrier to anadromy. Transactions of the American Fisheries Society, 141: 294-304.