Historical Ecology of South Santa Clara County: Preliminary Findings

A Technical Memorandum to the Santa Clara Valley Habitat Conservation Plan/Natural Community Conservation Plan

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Introduction

This technical memorandum was produced to provide technical support for the Santa Clara Valley Habitat Conservation Plan/Natural Community Conservation Plan (HCP/NCCP). It presents early findings of the South Santa Clara County Historical Ecology Study (funded by the Santa Clara Valley Water District and The Nature Conservancy, and scheduled for completion in spring 2008) to inform the development of conservation strategies in the HCP/NCCP.

The technical memorandum focuses on describing the historical (i.e., prior to substantial Euro-American modification) characteristics of the valley floor portion of South Santa Clara County, including Uvas, Carnadero, Llagas, and Pacheco creeks and the upper Pajaro River, and including the intervening, hydrologically connected San Felipe Lake area in north San Benito County.

Preliminary Status

It should be recognized that this assessment is preliminary to the South County Historical Ecology Study report (which will incorporate additional data, analysis, and review) and is thus subject to some adjustment and modification over the next 12 months. The scope of this document, therefore, will be limited to the more well-documented aspects of the historical landscape. This information should provide a conceptual framework for conservation planning as well as the incorporation of subsequent, more detailed information during the course of the project.

Data Sources

This assessment is based upon the examination and synthesis of a wide range of historical data sources. We consulted dozens of maps associated with the Mexican Land Grant Ranchos, including the original *diseños* (circa 1840), and reviewed court transcripts of testimony about the land grant boundaries (1850s -1860s). Along with the Public Lands Surveys of the General Land Office (1850s-1870s), these documents provided extensive evidence for landscape features prior to most Euro-American impacts. We also consulted early written accounts, soil surveys, other early maps (e.g. Thompson and West 1876), local histories, and County surveys. We created a photomosaic of the earliest available aerial imagery (1939) which, while reflecting substantial land use impacts, nevertheless provides illustration of landscape characteristics before post-World War II development.

Natural Landscape Patterns

Understanding how individual habitat types fit together to form a larger landscape is essential to a conservation plan. Documenting the landscape-level spatial patterns of the region prior to Euro-American modification can indicate functional relationships between habitats, such as the proximity of ecological support functions for target species. A map of landscape patterns can also help identify underlying physical controls on habitat formation and maintenance by revealing basic relationships to topography, soils, groundwater, and other factors. This section thus provides a landscape ecological overview of the area (Figure 1). Historical quotes and images are used to provide contemporary illustration of ecological and hydrological conditions.

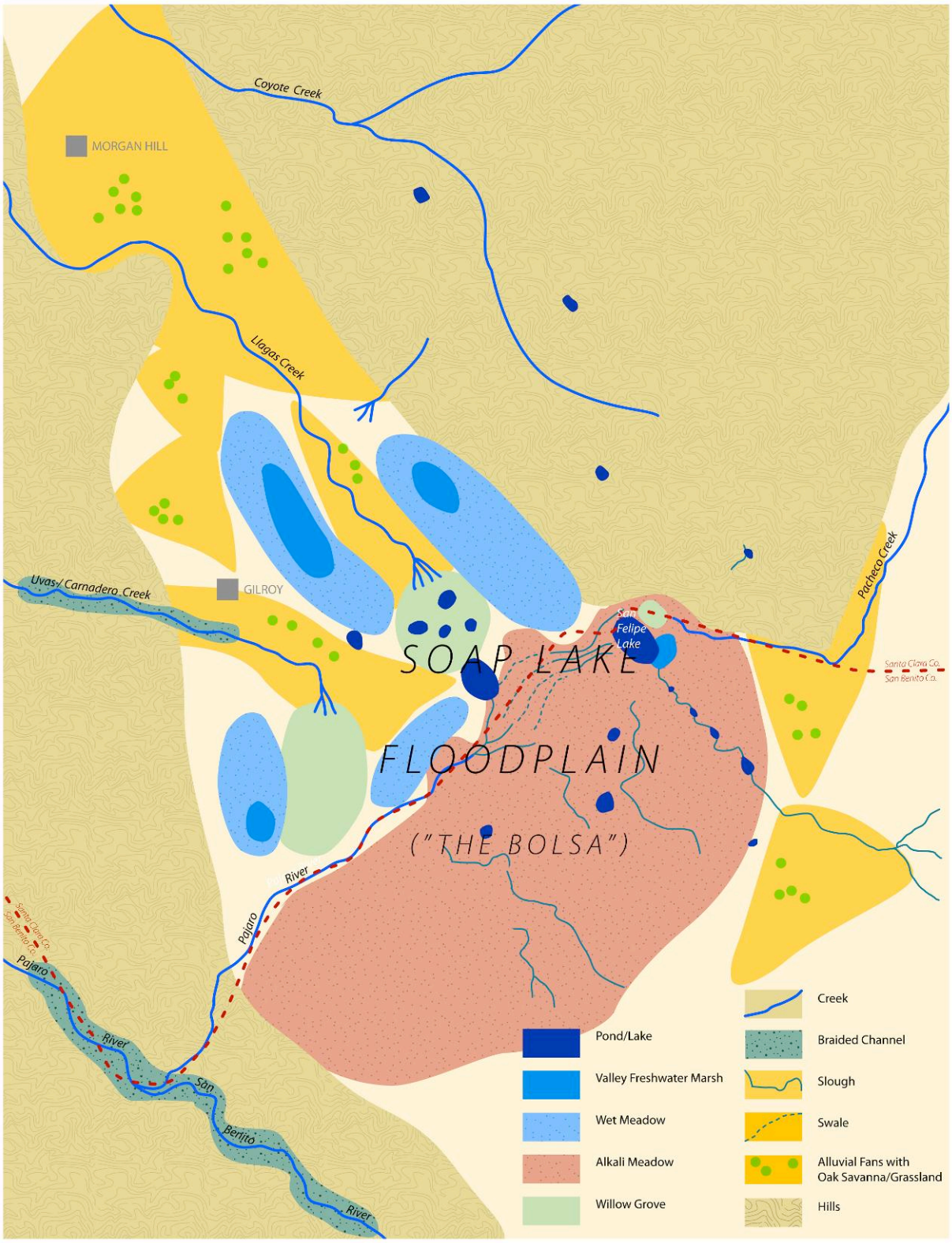

Figure 1. Conceptual model of landscape-level habitat patterns in south Santa Clara and north San Benito counties prior to significant Euro-American modification (simplified and not to scale).

The defining feature of the south Santa Clara County/north San Benito County landscape is a broad, unusually flat lowland area that bridges the two counties and gave rise to a diverse array of wetland habitat types. Covering 14 miles between Gilroy and Hollister, this natural basin was referred to as the Bolsa (literally meaning a bag or "pocket-like" area), and is traversed by Bolsa Road (Broek 1932: 144). Today the general area is referred to as the Soap Lake floodplain or Soap Lake (RMC 2005), referring to the natural ingredients for soapmaking that were deposited through the seasonal evaporation of flood waters. The names are used interchangeably here.

The Bolsa is surrounded by converging alluvial fans, the Diablo Range, and the Santa Cruz Mountains. Gilroy and Hollister – the two dominant town centers – each lie at the basin's margin, on the edges of alluvial fans.

On the northwestern, Santa Clara County side of this floodplain, well-drained alluvial soils (deposited by Llagas Creek, Uvas/Carnadero Creek, smaller creeks, and Coyote Creek when it flowed south) covered most of the valley floor from Morgan Hill to Gilroy. These higher-lying soils supported a mosaic of valley oaks and grassland, in varying patterns of woodland, savanna, and open prairie. The fertility and drainage characteristics of the alluvial fans led them to largely be converted to orchards. Town sites were also located among the stately trees on the fans, above flooding.

> "[Gilroy] was formerly covered with groves of magnificent oak trees, many of which yet remain, giving to the locality a natural park-like appearance...The streets are broad, and the natural drainage, owing to the porosity of the soil, is excellent, so that the streets are neither muddy or sticky in the winter, and in summer they are kept well sprinkled." (Shortridge 1896: 86)

On the San Benito County side of the floodplain, similar patterns of native habitat and cultivation characterized the smaller alluvial fans associated with Pacheco Creek, Arroyo de los Vibras, Santa Ana Creek, and other streams.

As the streams left their steeper alluvial fans and converged into the Bolsa, they tended to have much less well defined channels than today. Water spread into an array of wet meadows, freshwater marshes and ponds, and willow swamps, and eventually coalesced again into a well-defined channel – the origin of the Pajaro River. Flooding could cover much of the area, forming a "great bottom-land lake" (Stimson 1944).

> "In the great district where these various streams converge, within a radius of several miles, there is a great artesian basin." (Shortridge 1896: 84)

Seasonally flooded wet meadows covered large areas, especially in the Santa Clara County portion of the study area. These areas stayed relatively moist into the summer and were central to Gilroy's rise to prominence as a center of California's dairy industry (1.3 million pounds of cheese/year in 1896, 20% of the state's production), which was ascribed to the productivity of the "native meadow grasses" in the wet meadows to the south.

> "…the succulent grasses which flourish along the creeks and in the low lands at the confluence of the several streams in the center of the valley." (Shortridge 1895: 84)

Salt-affected, wet meadows covered large areas of northern San Benito County, comprising a major portion of the Soap Lake floodplain. These lush but agriculturally limited areas were important to the growth of Hollister's cattle industry, providing late-summer pasture when the hills were dry.

Except for several large, dense groves of willows, the Soap Lake floodplain supported few trees. Valley oaks, a dominant feature in other parts of the alluvial plain, were almost completely excluded by the poorly drained clay soils.

> "…the Bolsa presents only a grass vegetation, mostly salt grasses…" (Broek 1932:144)

Repeating mosaics of wet meadow, freshwater marsh, open water, and willow groves were found in varying proportion, contributing to a regionally unusual large amount of valley freshwater marsh.

> "A central zone of open water was surrounded by a dense growth of tule, with an outer fringe of willows." (Cosby and Watson 1927a, describing Laguna Seca in the neighboring Coyote Creek watershed)

At the downstream end of Carnadero and Llagas Creeks, large willow groves were the dominant wetland feature with a significant freshwater marsh component. In the case of Llagas Creek, whose outlet was naturally blocked by the alluvial levees of Carnadero Creek, there were also large areas of open water. Open water appears to have dominated the fault-controlled San Felipe Lake, with fringing marshes and willow swamps, much like today.

Substantial effort went into creating artificial channels through these wetland areas, including Millers Canal, lower Carnadero Creek, and lower Llagas Creek (Stimson 1944). Historical accounts describe both the original habitats and modifications for drainage.

> "The land was at that time covered with a dense growth of willows. Mr. Rea cleared the land and opened a channel for Carnadero Creek..." (Shortridge 1895: 88)

> "In spite of a drainage ditch more than a mile in length which was constructed recently, the water table in this vicinity is usually within 3 feet of the surface during the drier part of the year, and during the rainy season the surface is inundated in places to a depth of 6 feet. Sedges and water loving plants are the main vegetation..." (Cosby and Watson 1927a: 639, describing lower Llagas Creek)

Historical Land Cover Types

This section describes major land cover or habitat types that characterized the study area prior to significant Euro-American modification, including general spatial characteristics (relative extent and location) and, to the extent available, ecological or hydrogeomorphic

characteristics relevant to conservation planning. We also suggest some potential species support functions.

Valley oak woodland/savanna

Historical evidence indicates that valley oak woodland/savanna was a dominant, if not the dominant, land cover type of the southern Santa Clara Valley. Mid 19th-century General Land Office surveys record numerous "white oaks" as bearing trees, referring to valley oak (*Quercus lobata*). They also note the presence of "evergreen" or live oaks (e.g. *Quercus agrifolia)* and black oak (*Quercus kelloggii)*. Federal surveyor Thompson (1857) provides a number of typical descriptions ranging from "scattered oak timber" to "The land is about second rate bearing a heavy growth of evergreen and White Oak of inferior quality". We expect that the understory was predominantly low, likely as a result of indigenous fire management, although near Morgan Hill surveyors encountered a heavy growth of poison oak: "open timbered oak land... Plenty of poison oak" (Howe 1851).

We have not assessed stand density at this time, but it is likely that the density of trees in well-defined groves was similar to that observed by Sork et al. (2002) in Santa Barbara County and by SFEI (unpublished data) in Napa Valley, in the range of 0.75-1.5 trees/hectare. There would also have been areas of greater and lesser density, as suggested by Thompson's descriptions.

Valley oaks were most common on the well-drained alluvial soils extending across the valley floor from Morgan Hill to about Gilroy, but were mostly excluded from the seasonal and perennial wetland areas of the Soap Lake floodplain.

About 2,000 large (>12 m canopy diameter), probable valley oak trees can be identified in the study area circa 1939 from aerial imagery, presumably a large reduction from the 19th century total. A preliminary estimate of those of that vintage remaining, based upon contemporary (2005) imagery, would be less than half. Significant remnants can still be found in places (Figure 2).

Native grassland

There do appear to have been occasional, smaller areas on the alluvial plains with open grassland and little tree cover. For example, Thompson (1857) described "a glade or prairie" at the edge of "oak woodland," while Howe (November 5, 1851) described an "open prairie" east of the present-day South County Airport covered with "wild geese by the thousands." Open grasslands stood out as distinct openings on the otherwise oak-dominated alluvial fans, although we have not yet ascertained their spatial extent.

Wet meadow/Seasonal wetland

A substantial portion of the study area can be described as seasonal wetlands, seasonally flooded grasslands, or seasonally wet meadows. These areas were characterized by poor drainage conditions associated with heavy clay soils and nearly flat topography, and flooded for days or weeks depending upon rainfall events and their landscape position.

Figure 2. A grove of valley oak trees in agricultural fields in 1939, above, and 2005, below. Remnant meanders and riparian forest of Llagas Creek can also be seen in the contemporary image.

Seasonal wetlands/wet meadows covered thousands of acres in the South County area, including large areas east of Morgan Hill and, in particular, east and south of Gilroy extending into northern San Benito County. Within these vast seasonal wetlands were smaller areas of perennial wetland.

Alkali meadow

A substantial portion of the seasonally wet meadow lands was affected by the accumulation of soluble salts. While seasonal wetlands extended widely on both sides of the Santa Clara-San Benito County line, the alkali-affected portion was confined almost exclusively to the San Benito County side – the "Llano del Tequisquita." This area (the Hollister plain west from roughly the Hollister Airport to the County line, and across into Santa Clara County in several places) was known as "the land of alkali" – a broad, open plain with an unusual mosaic of saline and non-saline wetland habitat types (Figure 3).

Historical data describe ecological and hydrological characteristics that we would ascribe to alkali meadow (or alkaline grassland), including salt-tolerant vegetation associated with inland *playas* and saline marshes. Common species were saltgrass (*Distichlis* sp.) and pickleweed (*Salicornia virginica*). Numerous now-rare plant species were also probably found. Jepson (1896) reported San Joaquin saltbush (*Atriplex joaquiniana*) in the area. Day (1854) noted a clover, likely saline clover (*Trifolium depauperatum var. hydrophilum*), which has been found in the vicinity as recently as 1995 (Hillyard 1995) – suggesting some persistence of alkali conditions despite agricultural drainage and flushing. A white alkali crust was common on the surface after rains (Broek 1932: 144); these areas may have had shorebird habitat value similar to the *playa*-like salt pans found along the edge of South San Francisco Bay (Goals Project 1999). In the alkali meadows on the Santa Clara County side of the county line, Cosby and Watson (1927: 641) described "a great deal of common spikeweed (*Hemizonia pungens*)," which is presently common in alkaline seasonal wetlands in the Central Valley. Broek (1932:144) emphasized saltgrass as the dominant vegetation in the larger alkali plains of the Bolsa.

Within the alkali meadow matrix there were scattered freshwater ponds and marshes. For example, about a mile west of the Frazier Lake Road-Shore Road intersection, Day (1854) struck a "*tulare* pond" about 30 feet in diameter within a "wet marsh with *tulares*" over 500 feet wide. This chance encounter suggests that there were likely other similar features distributed within the alkali meadow. Additionally, freshwater ponds and marshes were found along the fault trace in the Tequisquita Slough area. Seasonally wet swales and sloughs and a few perennial freshwater sloughs (e.g. Tequisquita) coursed through the alkali meadows.

Valley freshwater marsh

Large and small perennial freshwater marshes were found throughout lower Santa Clara County and northern San Benito County. For example, Surveyor Dyer (1861), writing in September, recorded "low marshy land covered with tule and flags" in the area of the present day Llagas Creek flood control channel and South County Regional Wastewater Plant. A map of the Las Animas Rancho confirms tule swamps here (Figure 4). Healy

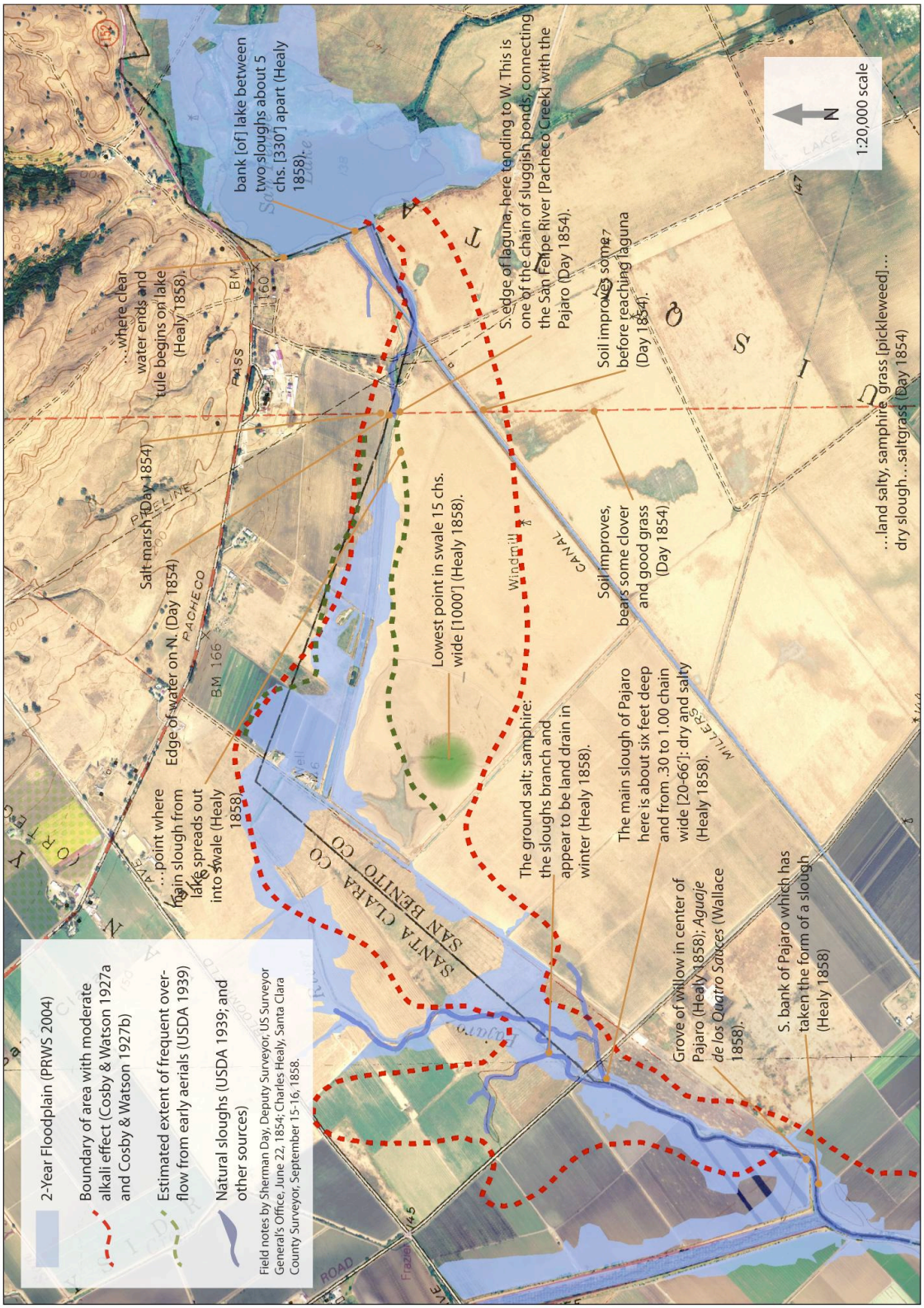

Figure 3. Selected historical evidence for the historical hydrology, ecology, and alignment between San Felipe Lake and the Pajaro River.

Figure 4. Freshwater wetlands and willow swamps at the confluences of Llagas Creek and Carnadero Creek with the Pajaro River. Llagas Creek enters a "Willow and Tule Swamp" with significant freshwater ponds at top; Carnadero Creek spreads into a "Willow Swamp" below. The Pajaro River flows from top to bottom at right. U.S. District Court, Northern District, 186-?. Courtesy of The Bancroft Library, UC Berkeley.

(1858) confirms freshwater marsh on the margins of San Felipe Lake: "... where clear water ends and tule begins on lake" (Healy 1858).

Pond or lake
The Soap Lake floodplain is noteworthy for the amount of perennial open water historically present, a rare feature in semiarid central California. Relatively large lakes were found at San Felipe Lake and between Llagas Creek and the Pajaro River. Smaller ponds were also shown scattered among the willow swamps and tule marshes slightly farther upstream (Figure 4). Occasional "*lagunas*" or ponds were noted in the wet meadows and alkali meadows, as well as the sag ponds along the Calaveras Fault.

These freshwater marshes and ponds likely provided habitat for the California red-legged frog (*Rana aurora draytonii*), tricolored blackbird (*Agelaius tricolor*), southern Pacific pond turtle (*Actinemys marmorata pallida*) [formerly southwestern pond turtle (*Clemmys marmorata pallida*)], and other special status species. These off-channel, floodplain areas also probably supported a number of fish species now rare or extirpated from the watershed, such as the thicktail chub (*Gila crassicauda;* now extinct), hitch (*Lavinia exilicauda*), Sacramento blackfish (*Orthodon microlepidotus*), Sacramento sucker (*Catostomus occidentalis*), Sacramento perch (*Archoplites interruptus*), and tule perch (*Hysterocarpus traskii*) (Gobalet 1990, 1993, Smith 1986).

Willow grove
Large willow groves, or *sausals*, were documented at the mouth of Llagas Creek (e.g. "dense willow thicket", Wallace 1858; Figure 4), the mouth of Carnadero Creek ("Willow Swamp"), and the eastern side of San Felipe Lake. The area's willow groves may have been important habitat for the willow flycatcher (*Empidonax traillii*), and least Bell's vireo (*Vireo bellii pusillus*). Substantial remnants of the willow grove at Llagas Creek were present as recently as 1939 (Figure 5).

Riparian forest
Information about riparian habitat is less complete at this time. It appears that braided channels supporting sparse riparian forests with relatively open canopy structure were common on the valley floor portion on streams such as Pacheco, Uvas, and Llagas, upstream of their dissipation into wetlands (Figure 6; Kondolf et al. 2001). Bearing trees in GLO surveys and early aerial photography, as well as present-day remnants, suggest that sycamore alluvial woodland was common (Figure 6).

More dense riparian forest or woodland appears to have been found on the Pajaro River between the Llagas and San Benito confluences (a "string of sycamores and willows forms a landmark clearly seen at a considerable distance;" Broek 1932: 144). But there is no evidence of trees between the small grove of four willows found near the Llagas confluence and San Felipe Lake (Figure 3). The fact that the *"Aguaje de los Quatro Sauces"* was such a significant landmark suggests that there were not very many trees in the vicinity. No trees were used as survey points for the county boundary between this point and the lake; their absence probably contributed to the difficulty of locating the boundary precisely.

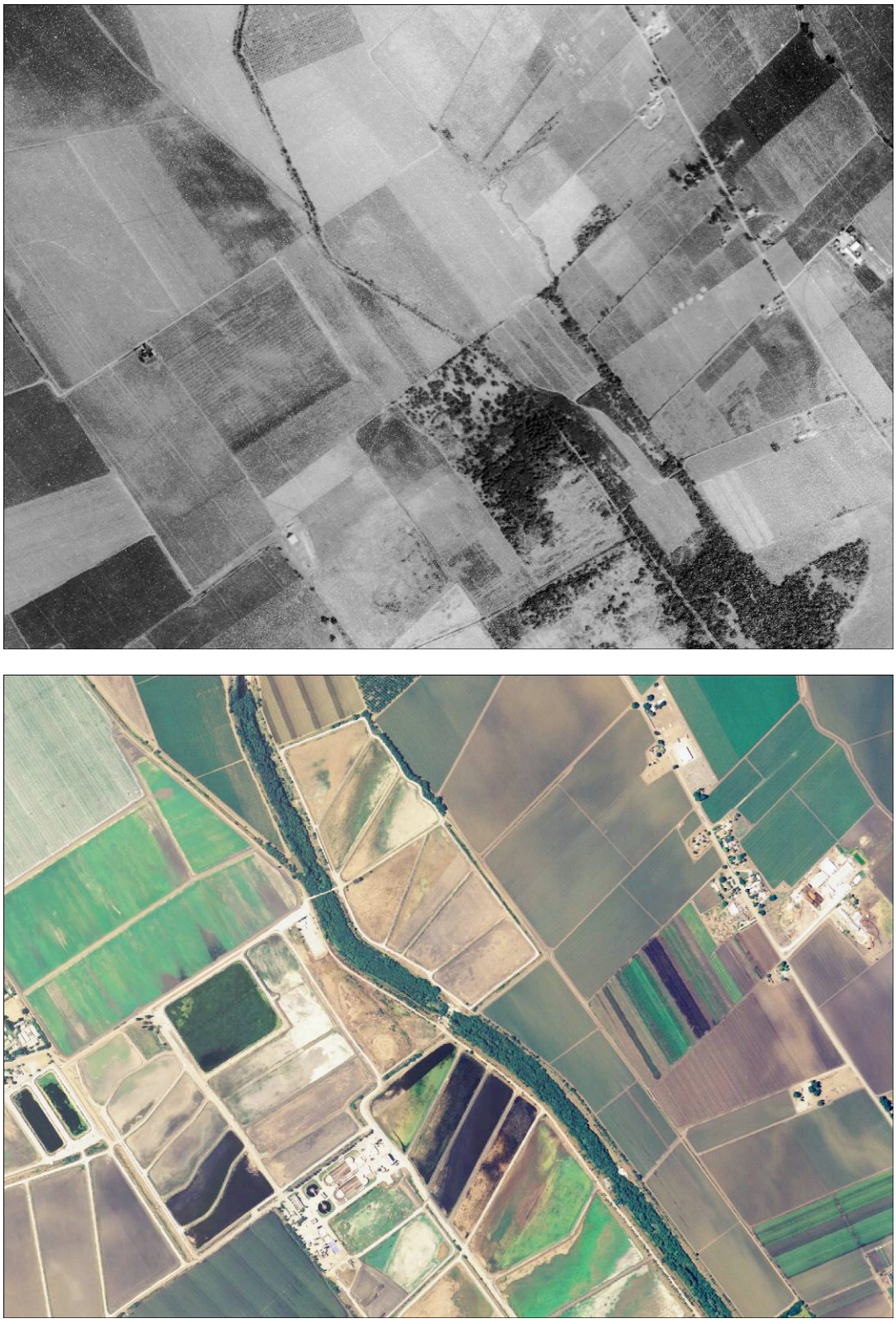

Figure 5. Lower Llagas Creek in 1939, above, and 2005, below. Remnants of the earlier willow grove can be seen in 1939; there are relatively few trees along the creek in the cleared area to the north. In the contemporary image, willow riparian forest has expanded within the flood control channel. The South County Regional Wastewater Plant occupies the lower left portion of the 2005 image.

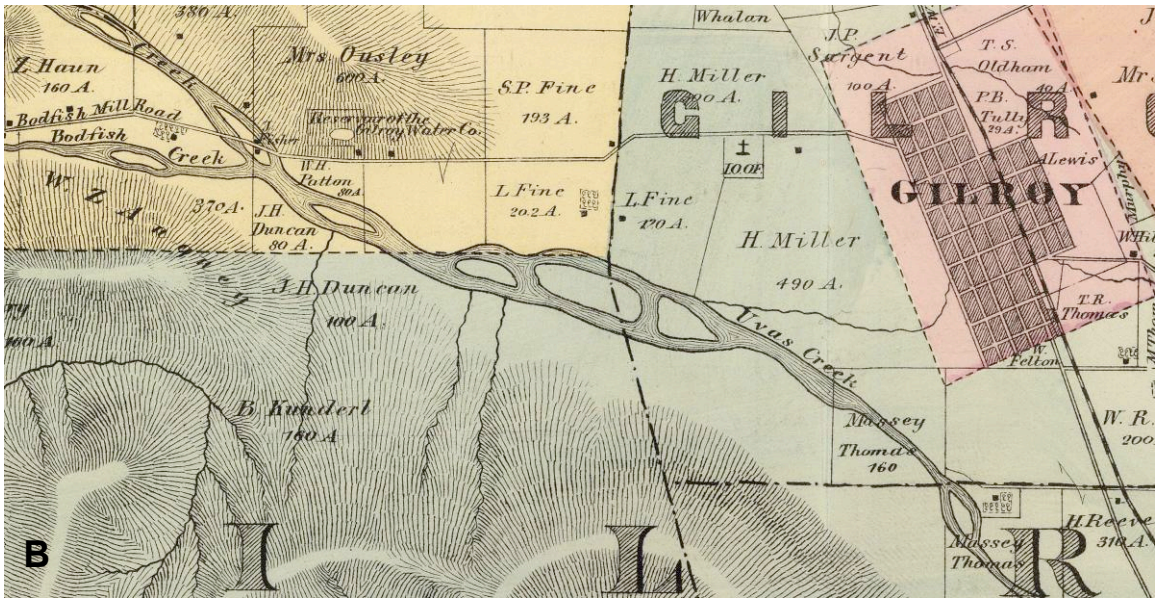

Figure 6.
A. Llagas Creek near the Highway 101 and railroad crossings, circa 1895. This view shows a broad and shallow, gravel-bedded channel with occasional sycamores on gravel bars and terraces. (Hill circa 1895, courtesy of California Room, San Jose Public Library)

B. Uvas Creek near Gilroy, 1876. This commercial atlas engraving, while not a precise map of channel plan form, indicates a multi-threaded, braided morphology. (Thompson and West 1876, courtesy of David Rumsey Associates)

Connection between San Felipe Lake and the Pajaro River

There has been substantial interest in understanding the hydrologic connection between San Felipe Lake and the Pajaro River before the construction of Millers Canal, so some detail is provided here. The general nature of the connection between the lake and the river, as well as a number of specifics, is fairly well-documented by historical data. In particular, two mid 19th-century surveys described the area. Sherman Day, Deputy Surveyor in the US Surveyor General's Office crossed the area in late June 1854, on the north-south course of a sectional boundary in the Public Land Survey. Four years and three months later, Santa Clara County Surveyor Charles Healy established the Santa Clara County/San Benito County (Monterey County at the time) line. This latter survey clearly attempted to follow the hydrological connection between the Pajaro River and San Felipe Lake. A number of maps and other sources provide additional evidence.

These sources describe a series of seasonal and perennial wetland habitats that connected San Felipe Lake to the more well-defined reach of the Pajaro River. Morphology can be considered to have had the following sequence, from the lake to the river: *lake to perennial freshwater sloughs to seasonally dry swales/meadows to seasonally dry sloughs to perennial river* (Figure 3).

Water overflowed San Felipe Lake into a well-defined freshwater slough. The term "slough" is probably indicative of relatively shallow channel geometry and wetland margins. Day's report of surface water (and the term "*laguna*") about 2000 feet downstream of the southwest margin of the lake in late June suggests substantially perennial character at this end of the system. This slough is still substantially intact, apparently with largely original shape, for several thousand feet from the lake outlet. Day reported a width of about 100 feet, also similar to the present-day form.

The point at which this feature presently shifts from a sinuous to a straight alignment is very close to the location where Healy (1858) reported that the "main slough from lake spreads out into swale" (Figure 3). The swale was probably ditched to confine flow where it began to spread broadly.

There was also a secondary slough outlet from the lake noted by Healy (1858) , 330 feet northwest of the main outlet. This location corresponds closely with the present-day opening to Millers Canal. It is not known how exactly the upper slough connected to the lower.

The morphology through the vicinity of the present-day Wildlands, Inc. was described as a "swale" repeatedly by Healy, in explicit distinction from the "sloughs." This term presumably refers to a very broad and shallow cross-section; he notes a swale 1000 feet wide at one point. Despite the diffuse shape, however, these features still were distinct in the field. Lying at the low point of the surrounding floodplain, these drainage swales were probably flooded for weeks or even months at a time in the winter.

As the system turns south, the swales coalesced again into narrower, more well-defined sloughs. Near the Frazier Lake Road crossing, Healy described the "main slough" as six

feet deep and only 20-66 feet wide. By the confluence with Llagas Creek, Pajaro was finally considered a river, presumably because of the formative flow contributed by the Llagas Creek watershed.

Broek (1932: 145) summarized this system, and its modification: “the Millers Canal which, in place of the shallow winding beds which is the beginning of the Pajaro River, now affords an adequate outlet for the San Felipe Lake.”

Upland wetlands

Wetlands were not uncommon in the hills of south Santa Clara County. While this topography is not a focus of the historical ecology study, we encountered a number of descriptions of seasonal and perennial wetland features in the hills, particularly the Diablo Range.

Cosby and Watson (1927a), in the USDA soil survey of the Gilroy area, note poorly drained, depressional areas in the hills supporting seasonal wetlands or vernal pools east of the Morgan Hill-Madrone area (Figure 7). These areas were notable in contrast to the generally well-drained upland soils. Describing Altamont Loam, they state that:

> “The soil is well-drained on the whole... [h]owever, the drainage is poor in the basin-like depressions of the bodies of this soil east of the town of Madrone. These are flooded during the rainy season, and the water disappears largely through evaporation (Cosby and Watson 1927a: 632).”

They describe Olympic Clay Adobe soils similarly (Figure 7):

> “This soil is generally well-drained, but a few structural depressions or basins occurring in the region east of Morgan Hill are flooded with storm waters during the rainy season and, having no outlet, form intermittent lakes or ponds (Cosby and Watson 1927a: 629).”

In their summary of drainage conditions for the region, Cosby and Watson (1927a: 640) further affirm this pattern of vernal pool-like conditions in upland clay-rich soils: “numerous basinlike depressions occur in which the storm waters tend to become impounded, resulting in small temporary lakes or ponds.”

Several perennial wetland features were documented by other sources in the Altamont Loam areas described by Cosby and Watson. Immediately east of Anderson Lake, near the dam, the Twin Lakes are still present, a historical chain of ponds and wetlands in a small valley (Figure 8; USGS 1917). Current maps ascribe the site to the Turnbull Learning Academy.

These moist, upland valleys were commonly chosen for reservoir sites. For example, Halls Valley, on Mount Hamilton Road at the top of the San Felipe Creek watershed, had two sizable *lagunas* (probably perennial ponds with surrounding perennial wetland), which now appear to be under a reservoir (Figure 8; Thompson and West 1876). Similarly, "El Paso de Lagunitas," which also had prominent perennial surface waters (Thompson and West 1876), now lies under Anderson Lake. Two significant *lagunas*

recorded by Day (1854) just north and west of San Felipe Lake appear to still be intact, based upon contemporary aerial photography (Figure 8).

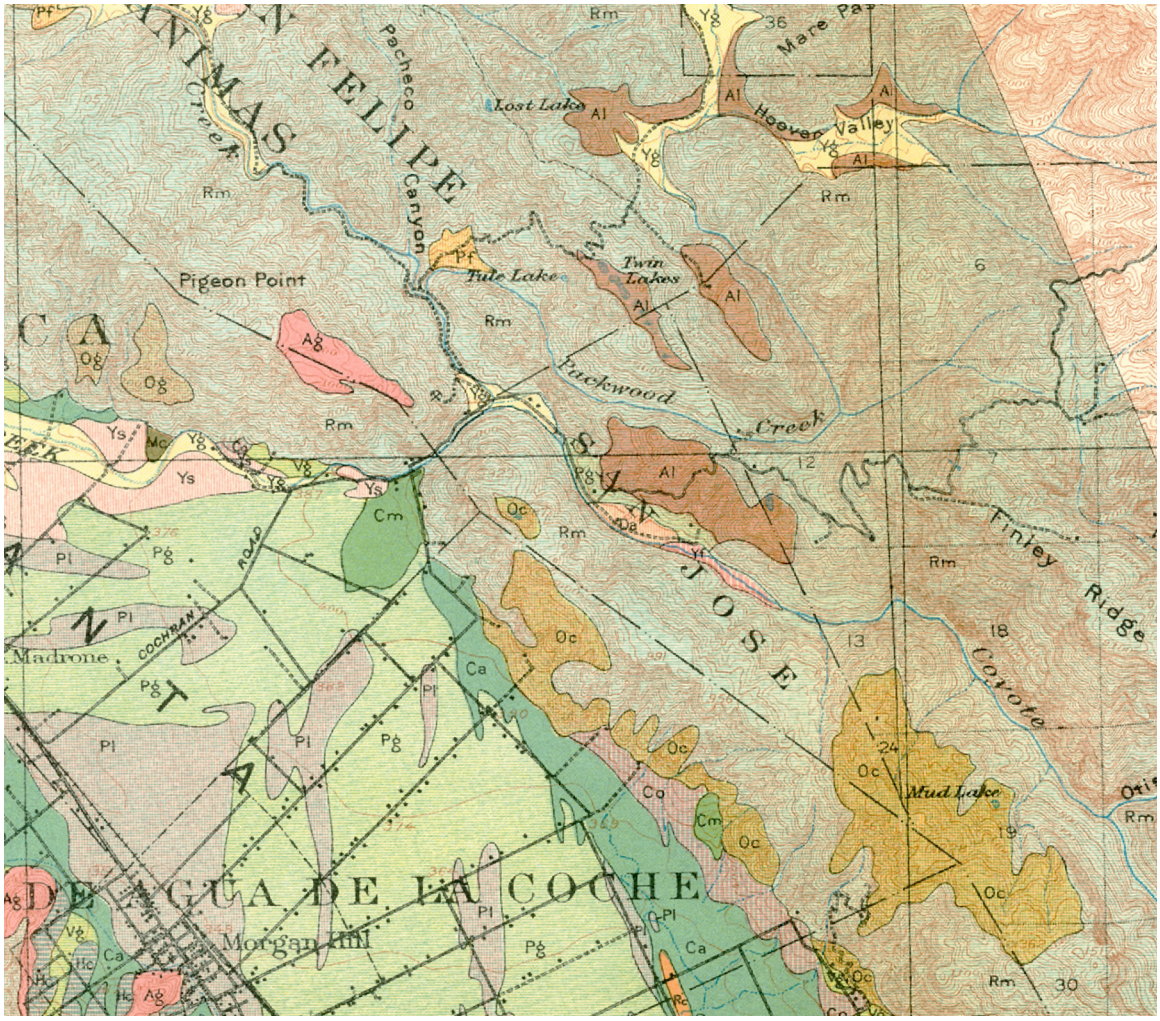

Figure 7. Portion of the early USDA soil survey (Cosby and Watson 1927a) showing the hills east of Madrone and Morgan Hill , in south Santa Clara County. The survey report noted depressional wetland features in the Olympic Clay Adobe (Oc, orange-brown color on the map) and Altamont Loam (Al, reddish-brown) soil units in this area. Coyote Creek, labeled at lower right, is now the site of the reservoir Anderson Lake. Several small natural lakes, including Twin Lakes, Tule Lake, and Lost Lake, can be seen at upper center.

Figure 8. At upper left, USGS (1917) shows Twin Lakes and surrounding wetlands. At upper right, Thompson and West (1876, courtesy of David Rumsey Associates) document lagunas along Mount Hamilton Road. The bottom image shows two wetland features near San Felipe Lake that were documented by Sherman Day (1854) and appear to still be present.

Conservation Opportunities
Some potential conservation implications of the historical landscape findings are discussed below, as possible discussion points for further consideration and review.

- Alkali conditions can persist in soils despite surrounding modifications and drainage efforts (e.g. alkali features at Lake Cunningham in the Coyote Creek watershed, Grossinger et al. 2006). It is likely that there is potential for restoring or enhancing alkali meadow habitat in the study area. While most of these areas would be in San Benito County, there were smaller alkali areas in Santa Clara County just north of the County line between Llagas Creek and Highway 152, and in the vicinity of the railroad crossing. Since the same conditions that favored alkali meadow tend to hinder agricultural productivity, there may be some areas amenable to conservation easement.

- Many of the historical ponds and freshwater wetlands in upland valleys have likely been submerged beneath reservoirs or drained for agricultural purposes, but some may be relatively intact and amenable to acquisition and/or restoration of original hydrology. Sites identified through the use of historical data may be viable places for reestablishing natural seasonal/perennial wetland values (e.g. California tiger salamander (*Ambystoma tigrinum californiense*), California red-legged frog, waterfowl).

- Valley oaks were a dominant ecological and cultural component of the valley floor landscape, but are in significant decline. Because of their naturally open spacing, it would be possible to substantially increase the number of valley oak trees through strategic planting and stewardship, without specific land acquisition. The existing distribution pattern, oriented largely along fence lines, roadways, yards, and public spaces, suggests that valley oaks could be re-established on the valley floor to a substantial degree in the context of contemporary land use. While restoring valley oak trees would not be synonymous with restoring valley oak savanna, stand density of one tree per two to three acres could benefit the preservation of the genetic diversity of the local population (Sork et al. 2002) and support a number of oak-associated birds (Rottenborn personal communication).

- There are also several noteworthy sites that have preserved substantial valley oak groves. These landowners should be recognized for preserving a valuable component of the valley's natural heritage. Consideration might be given to long-term preservation and stewardship of the groves.

- Contemporary least Bell’s vireo observations (Padley 2001) in the dense willow riparian forest on lower Llagas Creek coincide with the several hundred acre historical willow grove into which Llagas Creek historically discharged. It might be considered whether additional habitat could be created adjacent to the flood control channel in the form of a restored willow grove. Such a feature would be less narrow, potentially limiting negative “edge effects.” It might also alleviate pressure on the flood control channel to sustain endangered species habitat.

- Coordinated restoration of streams and associated valley wetlands could potentially benefit a range of native floodplain fish species. Opportunities to restore habitat for these species in central California valleys are rare.

- As the historical ecology study completes more detailed mapping later this year, overlay with contemporary imagery may help identify specific sites with potential for wetland restoration. These sites, particularly those in public ownership, could be investigated for favorable topographic conditions, groundwater levels, existing springs, etc.

Acknowledgments

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