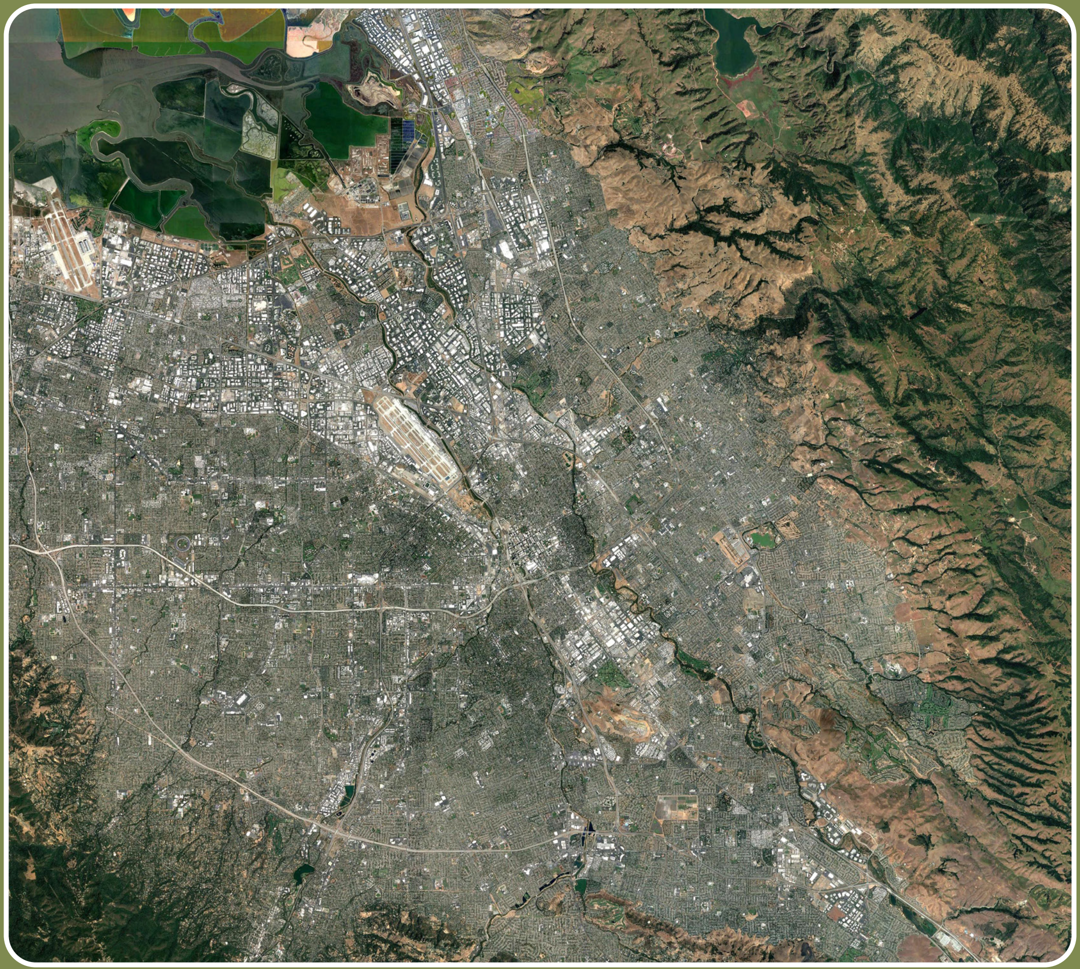
Santa Clara County Five Watersheds Assessment:

A SYNTHESIS OF Ecological Data Collection and Analysis Conducted by Valley Water



Report prepared for the Santa Clara Valley Water District (Valley Water)
Safe, Clean Water and Natural Flood Protection Program
Ecological Data Collection and Analysis Project (Priority D5)

SUBMITTED BY: **San Francisco Estuary Institute**

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List of Abbreviations

AA	Assessment Area
BAARI	Bay Area Aquatic Resources Inventory
CARI	California Aquatic Resources Inventory
CDF	Cumulative Distribution Function
CDFW	California Department of Fish and Wildlife
CPAD	California Protected Areas Database
CRAM	California Rapid Assessment Method
CWMW	California Wetland Monitoring Workgroup
GIS	Geographic Information System
GRTS	Generalized Random Tessellation Stratified
HCP	Habitat Conservation Plan
HDC	Habitat Development Curve
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
NCCP	Natural Community Conservation Plan
NWI	National Wetlands Inventory
PSA	SWAMP’s Perennial Stream Assessment Program
RipZET	Riparian Zone Estimation Tool
SCC	Santa Clara County
SFEI	San Francisco Estuary Institute
SMP	Valley Water’s Stream Maintenance Program
SWAMP	Surface Water Ambient Monitoring Program

SWRCB	State Water Resources Control Board
TAT	Technical Advisory Team (TAT) for the California Wetland and Riparian Area Protection Policy
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
Valley Water	Santa Clara Valley Water District
WRAMP	Wetland and Riparian Area Monitoring Plan

1. Introduction

Santa Clara County streams were assessed for the Santa Clara Valley Water District's (Valley Water) Safe, Clean Water and Natural Flood Protection Program, Priority D, Project D5: Ecological Data Collection and Analysis. Project D5 establishes new or tracks existing ecological levels of service for streams in five major watersheds in Santa Clara County: upper Pajaro River (within Santa Clara County), Coyote Creek, Guadalupe River, Lower Peninsula (within Santa Clara County), and West Valley watersheds (Figure 1)[1].

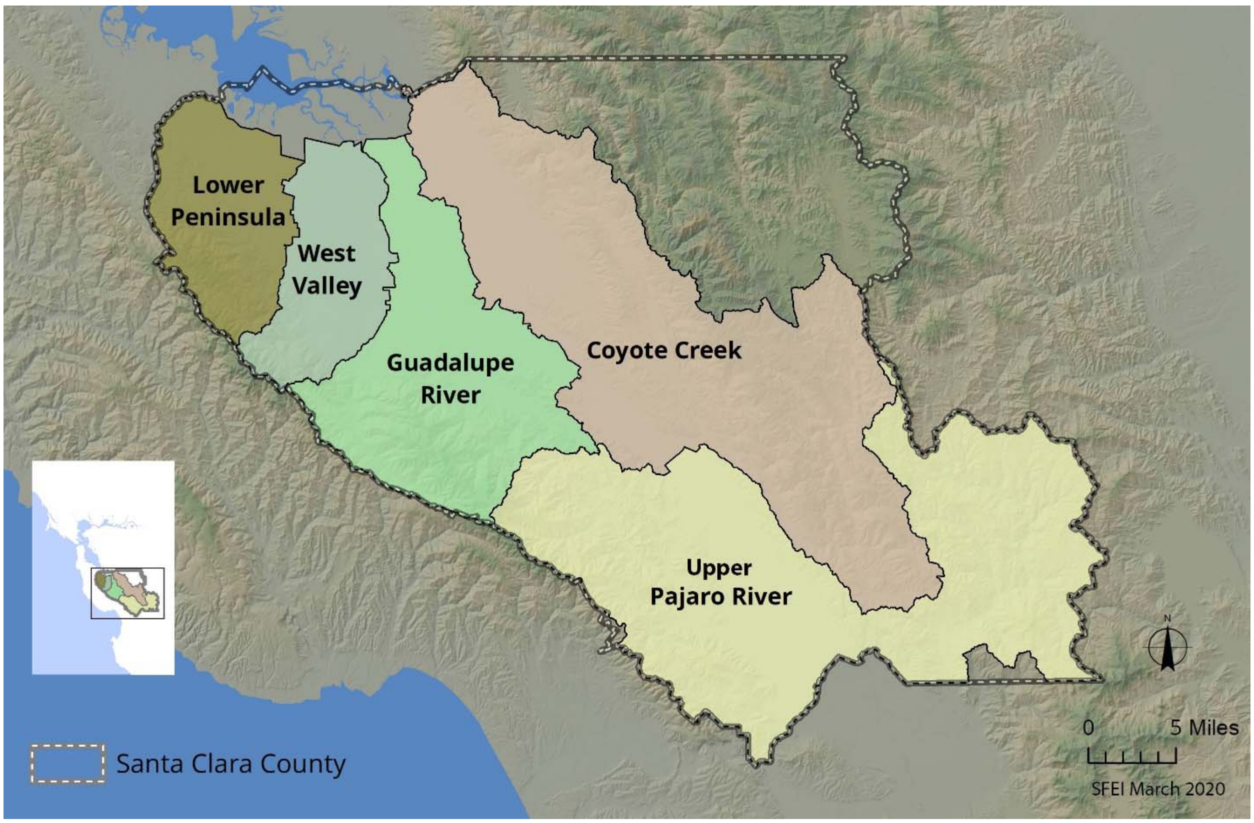

Figure 1. Map of Santa Clara County's five watersheds

Between 2010 and 2018, baseline assessments were conducted in five watersheds within Santa Clara County and included characterizing the distribution, abundance, and diversity of streams and other wetland types, stream associated riparian habitat, and the overall ecological condition of streams using the California Rapid Assessment Method (CRAM, CWMW 2013). The five individual watershed assessment reports are available on the Project D5 and San Francisco Estuary Institute (SFEI) websites (see weblinks in Appendix A).

[1] The northeast portion of Santa Clara County is part of the Alameda Creek watershed draining to Alameda County and not managed by Valley Water, thus was not part of the D5 Project. D5 did not extend into the tidal Baylands of South San Francisco Bay.

Project D5 assessment methods employ a watershed approach guided by the *Tenets of the State Wetland and Riparian Monitoring Program (WRAMP)* of the California Water Quality Monitoring Council (CWMW 2010). The WRAMP incorporates a 3-level scheme for classifying stream and wetland monitoring data, which is recommended by the United States Environmental Protection Agency[2] (USEPA). Methods are described in Appendix B.

Level 1 data consist of tables and imagery, or maps to determine the distribution, abundance, and diversity of aquatic resources. These data may be collected by remote sensing or ground surveys, but they can always can be represented by dots, polygons, or lines in a geographical information system (GIS). The California Aquatic Resource Inventory (CARI v03), Bay Area Aquatic Resources Inventory (BAARI v2.1), and Valley Water's "Creeks" GIS-layer are examples of Level 1 data. Level 2 data consist of rapid field assessments of condition based on semi-quantitative, visible indicators that do not require the collection or processing of materials from the field, but are field measures. Rapid methods provide numerical scores of conditions during field visits. CRAM is a Level 2 method to assess the overall condition of streams and wetlands. Level 3 data are generated by quantitative field methods that evaluate one or more parameters of condition relative to time or space. Quantitative flow measures, water quality testing, and number of species observed per unit area are examples of Level 3 data. Project D5's watershed assessments include six Level 1 and Level 2 parameters: five Level 1 and one Level 2 parameter at this time (Table 1).

Table 1. Parameters for Project D5

	Parameters	WRAMP Level	Data or Method
A	Streams, abundance (miles of stream channels)	1	BAARI or Valley Water "Creeks" GIS-layers
B	Stream distribution (miles of stream channel per stream order)	1	
C	Non-stream wetland diversity	1	
D	Non-stream wetland abundance by type	1	
E	Stream riparian abundance (miles of riparian per width class)	1	RipZET
F	Proportion of streams per condition class	2	CRAM

Parameters A-D are assessed for each of the five major watersheds in Santa Clara County using the best available digital maps of surface waters and riparian areas. The BAARI for the four South San Francisco Bay watersheds and Valley Water's "Creeks" dataset (for the upper Pajaro River watershed) are employed to determine the values for Parameters A-D. Values for Parameter E use CALVEG (2004) and the Riparian Zone Estimator Tool (RipZET). Parameter F is evaluated by conducting probabilistic field surveys of stream condition using CRAM.

[2] https://www.epa.gov/wetlands/wetlands-monitoring-and-assessment

This report synthesizes the baseline assessments for Santa Clara County's five watersheds to present similarities, differences, and compare ecological condition in streams across watersheds and their subregions, San Francisco Bay-Delta ecoregion, and statewide based on CRAM. It also interprets the assessment results and comparisons to identify risks to stream conditions, and opportunities for stream stewardship. Project D5's baseline assessments establish a monitoring and assessment framework for evaluating the performance of Valley Water's programs, projects, maintenance activities, and on-the-ground stewardship actions, such as protecting and restoring healthy riparian areas, floodplains, managing invasive plants, improving fish passage and spawning habitat, and stabilizing stream channels. Beginning with the Coyote Creek watershed in 2020, Project D5 will reassess streams in the five major watersheds after ten years to determine if conditions are maintained or improved, and to prioritize and adjust stewardship actions in the context of climate and land use change.

2. Geography

Santa Clara County, located in the southern end of the San Francisco Bay Area, is the sixth most populous county in California, and tenth in the United States, with a 2010 population just over 1.78 million (Figures 1 and 2). In descending order of population size, the incorporated cities are: San Jose, Sunnyvale, Santa Clara, Mountain View, Milpitas, Palo Alto, Cupertino, Gilroy, Campbell, Morgan Hill, Saratoga, Los Gatos, Los Altos, Los Altos Hills, and Monte Sereno. Several of the cities span multiple watersheds as shown in Figure 2. Dense urban areas exist through the north valley with agricultural lands in Coyote Valley, around Gilroy, and further south into San Benito County. With cities, municipalities, and County government located on multiple watersheds, and watersheds having multiple jurisdictions, cooperation and collaboration are necessary for effective resource management.

Four of the five watersheds in Santa Clara County (Coyote Creek, Guadalupe, West Valley, and Lower Peninsula) drain to South San Francisco Bay, as does the Alameda Creek watershed, which is not part of this study. The Santa Clara Valley runs approximately north-south for almost 30 miles from the southern end of San Francisco Bay in the north to the cities of Gilroy and Hollister in the south. It averages about 15 miles wide and is bounded by the Santa Cruz Mountains to the west and southwest, which separate Santa Clara Valley from the Pacific Ocean, and the Diablo or Hamilton Range to the east and northeast toward California's Central Valley. Elevations range from about 4,300 feet in the Mount Hamilton (which flows to Alameda Creek), just under 3,800 feet at Loma Prieta in the Santa Cruz Mountains, about 200 feet in Gilroy, 60 to 90 feet in San Jose, to sea-level in the tidal estuaries of South San Francisco Bay. The Lower Peninsula and West Valley watersheds are comprised of separate creeks draining from the Santa Cruz Mountains to South San Francisco Bay. The upper Pajaro River watershed drains both ranges (Uvas and Llagas creeks in the Santa Cruz Mountains, Pacheco Creek in the

Diablo Range) and south Santa Clara Valley into Monterey Bay through the Chittenden Pass, which can bring cool, moist marine air to Gilroy's agricultural lands.

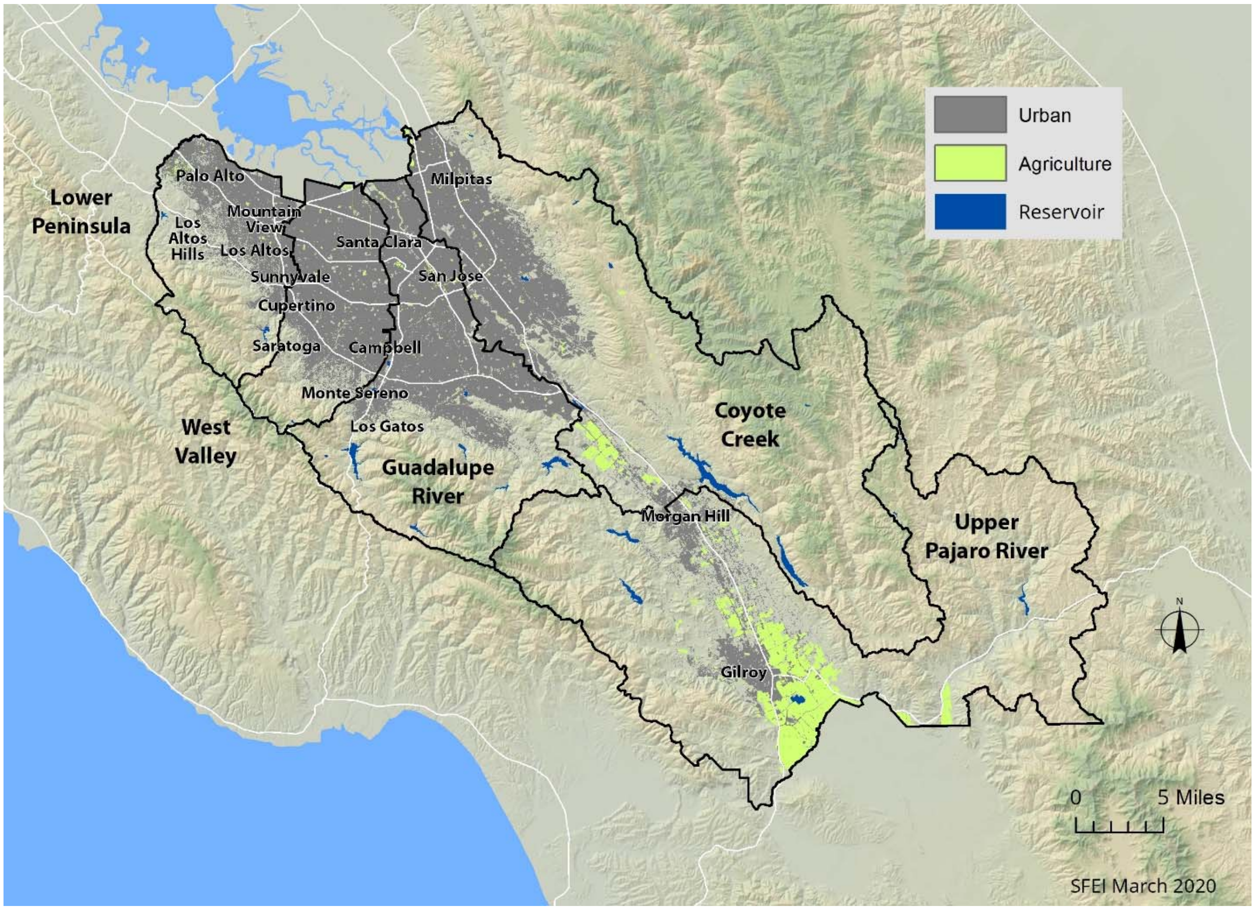

Figure 2. Map of urban and agricultural areas within the five watersheds in Santa Clara County and approximate locations of major cities and municipalities, which can span across watersheds with multiple jurisdictions.

The watersheds have a Mediterranean semi-arid climate. The valley lies in the rain shadow of the Santa Cruz Mountains, thus average annual rainfall is largely dictated by topography, gradually decreasing from south to north, and from upper elevations to the valley floor. Downtown San Jose averages around 15 inches per year, about one fourth of the rainfall received in the mountains, increasing to about 24 inches per year near Los Gatos. Gilroy in south Santa Clara County averages approximately 21 inches per year. The majority of rain falls from November to April. June through September are dry. Generally mild temperatures average around 40 at night to 60 degrees Fahrenheit (^{o}F) in winter and 70 to 85^{o}F in summer, but can exceed 100^{o}F. Droughts and floods are relatively common.

Headwater areas of the Santa Cruz Mountains draining to the Valley tend to be dominated by mixed evergreen (Douglas fir-redwood) forests, interspersed with oak-broadleaf woodland forests. Headwater areas of the Diablo Range tend to be dominated by oak-broadleaf woodland forests in the ravines, with oak savannah and annual grasslands on the more exposed slopes. The mountain slopes are generally steep, and therefore headwater channels tend to be narrow with steep gradients. In mid-elevations of the watersheds, as the mountains transition to foothills, grasslands and oak savanna dominate. As the streams flow out of the foothills and onto the alluvial plains around the Valley, they become wider and less steep.

The historical geography and land use history of the Santa Clara Valley and its surroundings is not unusual for the central regions of the California Coast Range. The larger streams draining to the valley supported broad riparian forests. Many of the smaller streams disappeared into their alluvial fans, rather than reaching the main streams of the valley. The valley had a very high water table. Artesian springs, ponds, and wetlands were common on the valley floor (SFEI 2010). Between the time of statehood and World War II, springs were capped and the valley was drained to create arable lands for agriculture. Overdraft of the water table caused the valley floor to subside, especially in its northern reaches. This caused some stream channels to incise headward from the valley margins. After World War II, orchards marking the Valley of Hearts Delight and other agricultural lands were largely converted to urban and suburban land uses, becoming Silicon Valley. The cessation of agriculture and groundwater management by Valley Water allowed the water table to rise relative to the subsided valley floor, while increased runoff from valley urbanization and foothill grazing caused almost all streams to incise. Many streams in the foothills and valley are now entrenched, having incised enough to abandon their historical floodplains. Today, only remnants of the riparian forests remain in the valley. Flood control, groundwater recharge, and water supply are primary reasons for channel management. Santa Clara Valley is now largely urbanized, although its southern regions (farms) and parts of the foothills (ranching) remain agrarian.

3. Distribution, Abundance, and Diversity of Aquatic Resources

Knowing the locations, amounts, and types of habitats is essential for resource protection and management. According to the WRAMP, which guides the D5 Project methods, the distribution, abundance, and diversity of aquatic resources are Level 1 monitoring parameters that may be collected by remote sensing or ground surveys, then represented in GIS. Figure 3 shows the distribution of streams and wetlands in the five watersheds within Santa Clara County. The inset map in Figure 3 shows boundaries of three subregions for which some of the assessments in this report are separately summarized: developed Lowlands (Lowland Valley), undeveloped Foothills (Foothills), and the more mountainous Headwaters.

The Lowland Valley region generally identifies the extent of urban, residential, and agricultural land uses within Santa Clara Valley (upstream of the Baylands) and extends into the lower

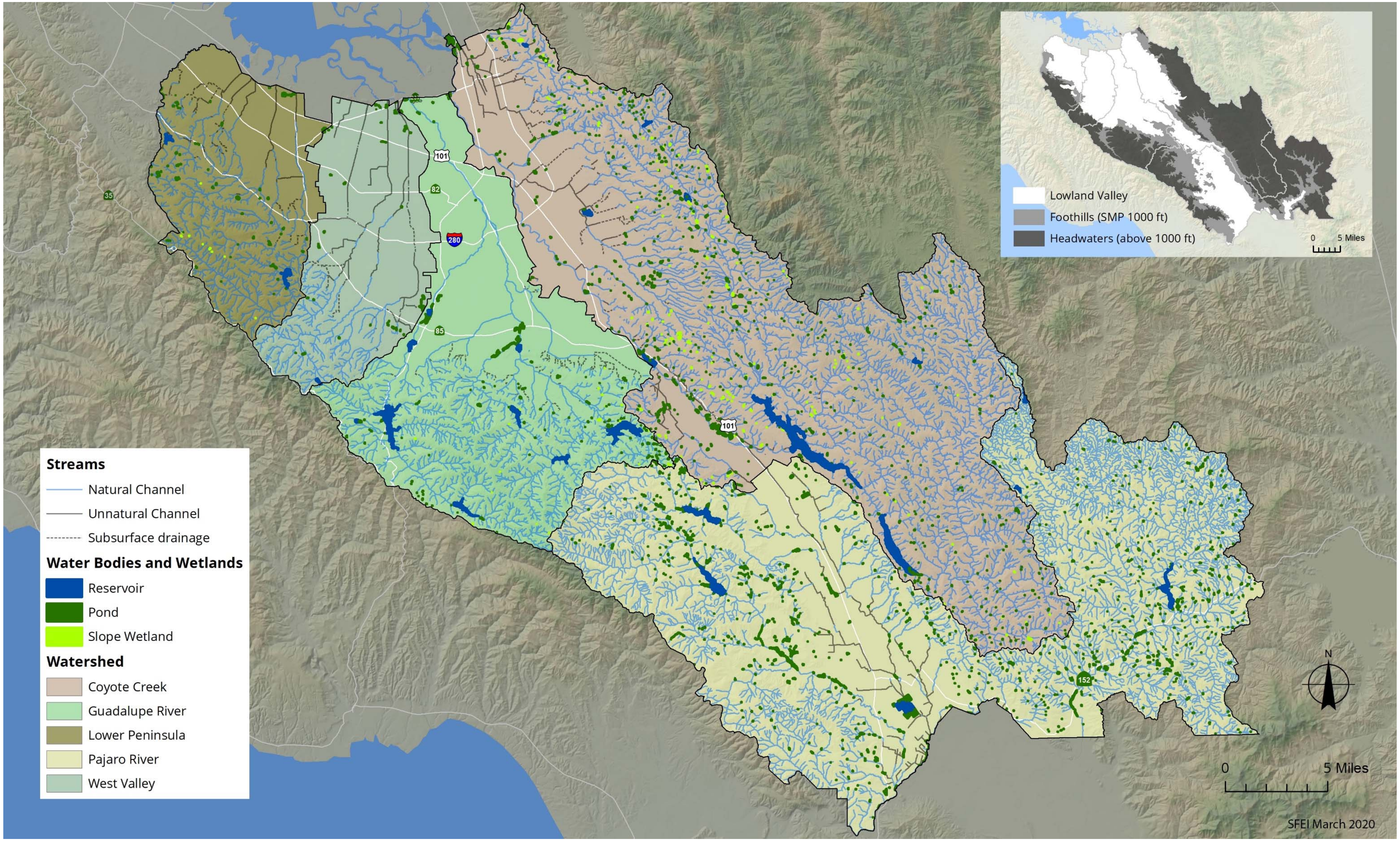

Figure 3. Aquatic resources including 2nd-order and higher streams (per BAARI's mapping protocols), wetlands, and reservoirs within the five watersheds in Santa Clara County (source BAARI v2.1, Valley Water's Creeks GIS, and CARI v03). The wetland areas are not to scale, but have been increased to make them visible. The upper Pajaro River watershed drains to Monterey Bay, while the other watersheds drain into South San Francisco Bay. The developed Lowland Valley, Foothills, and Headwaters subregions are presented in the inset map.

foothills to include low-density residential areas, golf-courses, quarries, or other anthropogenic land uses. The Foothills extend from the upper boundary of the Lowland Valley to the 1,000-foot elevation contour that represents the upper extent of Valley Water's Stream Maintenance Program's (SMP) management zone. The Headwaters are above the 1,000-foot elevation contour in the Santa Cruz Mountains (west) and Diablo or Hamilton Range (east). Summaries based on these subregions compare the amount, distribution of streams and wetland, and the overall condition of the streams based on land use and position within the watersheds. While the Foothills region is similar in land use and position to the Headwaters, it is considered separately in this report because it is within Valley Water's SMP's management zone. Headwaters are not, and land use is different from the Lowland Valley region (also within the SMP's management zone).

Figure 3 does not show the smallest headwater steam reaches, termed 1st-order streams. With the exception of Table 2, 1st-order streams as mapped in BAARI, defined by Strahler (1957), and explained further in the next section were not included in the Level 1 summaries in this report in order to standardize and compare the stream GIS datasets across all five watersheds. The upper Pajaro River watershed GIS data layer for streams did not include the same level of detail as the other four watersheds (see Appendix B - Methods section for more information). Storm drains were also not included in Figure 3 and the constructed underground drainages shown on the map as dashed lines (subsurface drainage), are the main connectors of the overall stream network.

3.1. How big are the watersheds and how many miles of streams are there in each?

Table 2 lists the approximate drainage areas (watershed size), stream lengths, and density (miles of stream length divided by square miles of watershed area) for each of the five watersheds in Santa Clara County and their combined total (Total SSC 5 watersheds). The percent (%) contribution of 1st-order streams are shown for four of the five watersheds that were mapped using BAARI mapping methods.

The upper Pajaro River and Coyote Creek watersheds are comparable in size (about 361 and 350 square miles (mi^2), respectively), and are the largest of the five watersheds. Together they comprise about 70% of the total area and about 75% of the total length of streams across all five watersheds (approximately 1,475 and 1,225 miles of streams, respectively). Streams of the upper Pajaro River watershed drain to the Pacific Ocean through Monterey Bay, while the other four watersheds drain to South San Francisco Bay. The Guadalupe River watershed is the third largest (about 170 mi^2), less than half the size of the Coyote Creek and the upper Pajaro River watersheds. It has about 440 miles of streams (roughly 1/3 of the total length of the Coyote Creek or upper Pajaro River watersheds). The Lower Peninsula and the West Valley watersheds are comparable in size, each comprising less than 10% of the combined total area of the five watersheds, and about half the size of the Guadalupe River watershed (85 and 78 mi^2, respectively). There are almost 240 miles of streams in the Lower Peninsula watershed, which is 7% of the total stream miles, and about half the total length of streams in the Guadalupe River watershed. The West Valley watershed has only 140 miles of streams, comprising less than 5% of the total stream miles in the combined five watersheds.

Table 2. Total watershed area and miles of surficial, freshwater streams in the five watersheds

Watershed	***Watershed Size***			***Stream Length and Density (2nd Order Streams & higher*)***			***Additional Miles Contributed by 1st Order Streams (% of Total Stream Network)***
	Square Miles	***Acres***	***% of Total***	***Length (miles)***	***% of Total***	***Density***	
upper Pajaro River	361	230,922	35	1,473	42	4.08	NA*
Coyote Creek	350	224,228	34	1,225	35	3.50	1,593 (57%)
Guadalupe River	170	108,694	16	441	13	2.60	581 (57%)
Lower Peninsula	85	54,144	8	238	7	2.80	276 (54%)
West Valley	78	49,787	7	136	4	1.74	105 (44%)
Total SCC 5	1,042	667,775	100	3,513	100	3.37	2,556*

*The length of 1st-order channels was not available for the upper Pajaro River watershed.

Stream density (i.e., total stream length divided by drainage area) generally decreases with watershed size. Two factors help explain this trend. As seen in Figure 3 (above), the smaller watersheds (Guadalupe, Lower Peninsula, and West Valley) involve less Headwaters and therefore have fewer low-order channels, which decreases their total length of the streams. The smallest watersheds (Lower Peninsula and West Valley) have the most unnatural, constructed channels that lack tributaries.

Low-order channels comprise most of the total stream length. Stream order denotes the position of a stream within a stream network (Strahler 1957). First-order streams have no tributaries. The confluence of two or more 1st-order streams mark the upstream beginning of a 2nd-order stream; the confluence of two or more 2nd-order streams mark the upstream beginning of a 3rd-order stream; and so on. The order of a network is based on its highest-order stream. Most 1st-order streams occur in the headwater regions (uppermost or highest elevations) of natural drainage systems and their importance is well recognized. These streams represent the greatest amount of hydrological connection of the stream network to its contributing drainage basin and contribute a substantial amount of sediment and nutrients to downstream higher-order channels (USEPA 2015). First-order streams comprise about half of the total stream length in each of the watersheds where data were available (range 44 to 57%, see Table 2 above).

When the BAARI 1st -order streams are excluded from the analysis, 2nd-order streams comprise between 37 and 56% of the total remaining steam miles in each watershed (Figure 4). The three largest watersheds are 8th-order fluvial systems: upper Pajaro River, Coyote Creek, and Guadalupe River although there is less than 0.1 mile of fluvial 8th-order stream channel in the Guadalupe River watershed (<0.01% of the total stream network that is not visible in Figure 4). The Lower Peninsula and West Valley watersheds are 6th-order systems.

Figure 4. Proportion (or percent) of total stream miles by Strahler Stream Order 2-8 for the five watersheds in Santa Clara County and combined (SSC 5).

3.2. How many acres of non-riverine wetlands are there in the five watersheds in Santa Clara County?

There are about 9.6 mi^2 (~6,000 acres) of non-riverine wetlands and open water areas (primarily reservoirs) mapped within the five watersheds in Santa Clara County (Figure 3, above). The majority of wetlands are ponds and the vegetated margins of reservoirs. There are 11 major reservoirs, in order of descending area: Anderson, Coyote, Lexington, Calero, Uvas, Chesbro, Pacheco, Stevens, Guadalupe, Almaden, and Vasona. Valley Water operates ten of the reservoirs and is exploring expanding Pacheco[3]. There is at least one reservoir in each of the five watersheds, although Lake Ranch Reservoir (not operated by Valley Water) in the West Valley watershed is relatively small (<20 acres). Other notable reservoirs and waterbodies are Calaveras Reservoir draining to Alameda Creek (not in the study area), Cherry Flat Reservoir, Lake Almaden, Lake Cunningham, Lake Elsman, Lake Silveira, and San Felipe Lake. The Searsville Reservoir is in San Mateo County despite being in the San Francisquito Creek watershed. Valley Water also maintains approximately 400 acres of groundwater recharge or percolation ponds across the County.

Table 3 and Figure 5 summarize the total acres of non-riverine wetlands in each of the five watersheds in Santa Clara County by wetland type. Depressional ponds are the most abundant non-riverine wetland type within the watersheds. The upper Pajaro River and Coyote Creek watersheds have the majority of the non-riverine wetland area (83%). Guadalupe River watershed has 10%, and the Lower Peninsula and West Valley watersheds have the remaining 7%. The upper Pajaro River watershed has the largest amount of palustrine or depressional

[3] https://www.valleywater.org/pachecoexpansion

wetlands (a.k.a. ponds), and Coyote Creek watershed has the largest amount of lacustrine wetland (vegetated shores and shallows of lakes or reservoirs), and the most open water reservoir area within the Anderson and Coyote Reservoirs. The abundance of slope wetlands (i.e., springs, seeps, and other wetlands caused by the emergence of groundwater) is underestimated across the watersheds due to the difficulty in detecting and mapping them.

Table 3. Total amount (acres) of non-riverine wetlands and open water area within the five watersheds and combined (SCC 5) based on BAARI v2.1 and CARI.

Watershed	*Slope and Seep Wetlands*	*Ponds*	*Lake and Reservoir Wetlands*	*Total Wetland*	*Proportion of Total Wetland Area (%)*	*Lake and Reservoir Open Water**
upper Pajaro River	0	1,067	47	**1,114**	**49**	829
Coyote Creek	63	639	83	**785**	**34**	1,867
Guadalupe River	5	211	15	**231**	**10**	1,005
Lower Peninsula	2	100	0	**102**	**4**	127
West Valley	0	65	0	**65**	**3**	16
Total SCC 5	**70**	**2,083**	**144**	**2,297**	**100**	**3,844**
Proportion of Total by Wetland Type (%)	**3**	**91**	**6**	**100**		

* Open water associated with lakes and reservoirs are not wetland areas, but listed here to show the acreage in each watershed.

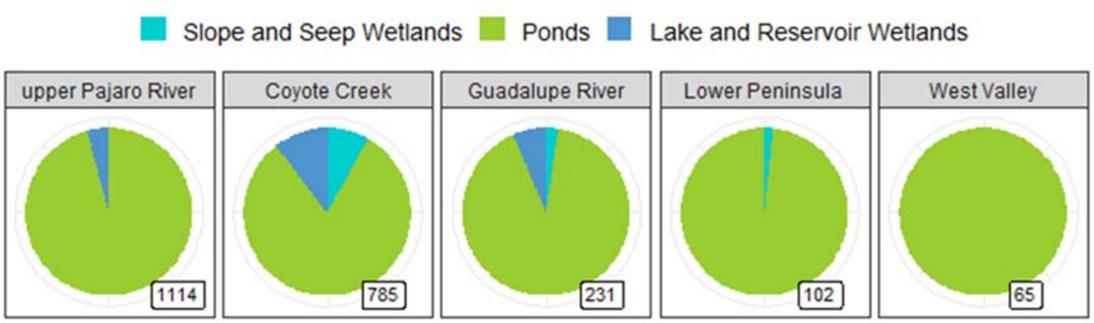

Figure 5. Pie charts showing the proportions of non-riverine wetlands by wetland type in each of the five watersheds in Santa Clara County. Ponds (depressional wetlands) are the most abundant non-riverine wetland type. The total wetland acres (listed in the boxes at the bottom right corner of each chart and in Table 5 above) do not include open water areas of lakes and reservoirs. The size of the pies do not reflect the relative amounts of wetlands in each watershed. Slope and seep wetlands are generally under estimated.

3.3. What is the extent and distribution of stream riparian areas in the five watersheds in Santa Clara County?

Riparian areas are where surface and subsurface hydrology connect water bodies and waterways, including rivers, creeks, wetlands, and lakes, with their adjacent uplands. From

CDFW's Notification of Lake or Streambed Alteration instructions and process, the riparian zone is the area that surrounds a channel or lake and supports (or can support) vegetation that is dependent on surface or subsurface water. Riparian areas include portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (SWRCB TAT 2012). Table 4 summarizes the relationship between riparian width class and the functions provided either by riparian vegetation or riparian hillslope processes. Wider riparian widths support more functions as shown by darker grey shading in Table 4. These riparian width classes generally reflect natural demarcations in the lateral extent of major riparian functions (Collins *et al.* 2006).

Table 4. Riparian width classes reflect the lateral extent of major riparian functions

Functional Riparian Width Class		Riparian Functions						
		Hillslope Function / Vegetation Function						
Code	**Width (m)**	**Bank Stabilization**	**Shading**	**Allochthonous Input**	**Runoff Filtration**	**Floodwater Dissipation**	**Groundwater Recharge**	**Wildlife Support**
A	0-10							
B	10-30							
C	30-50							
D	50-100							
E	>100							

Figure 6 shows the riparian area modeled for 2nd-order streams or higher in the five watersheds in Santa Clara County using the Riparian Zone Estimator Tool (RipZET, see Appendix B for more information). Areas modeled for "vegetation riparian" functions are based on vegetation height (CALVEG 2014) and steepness of topographic slopes. Areas modeled as "hillslope riparian" functions are based on the steepness of topographic slopes. Thus, steepness of topographic slopes apply to both.

Table 5 summarizes the total miles of streams by riparian functional width class across all five watersheds. The most abundant riparian width class is B (10-30 m) followed by A (0-10 m) and C (30-50 50 m). Only about 15% of the riparian habitat adjacent to streams is wider than 50 meters.

Table 5. Total stream miles by riparian functional width class across the five watersheds in Santa Clara County.

Code	Width (m)	Vegetation Functions (miles)	%	Hillslope Functions (miles)
A	0-10	970	28	397
B	10-30	1,061	31	1,228
C	30-50	879	26	835
D	50-100	309	9	169
E	>100	217	6	0.1

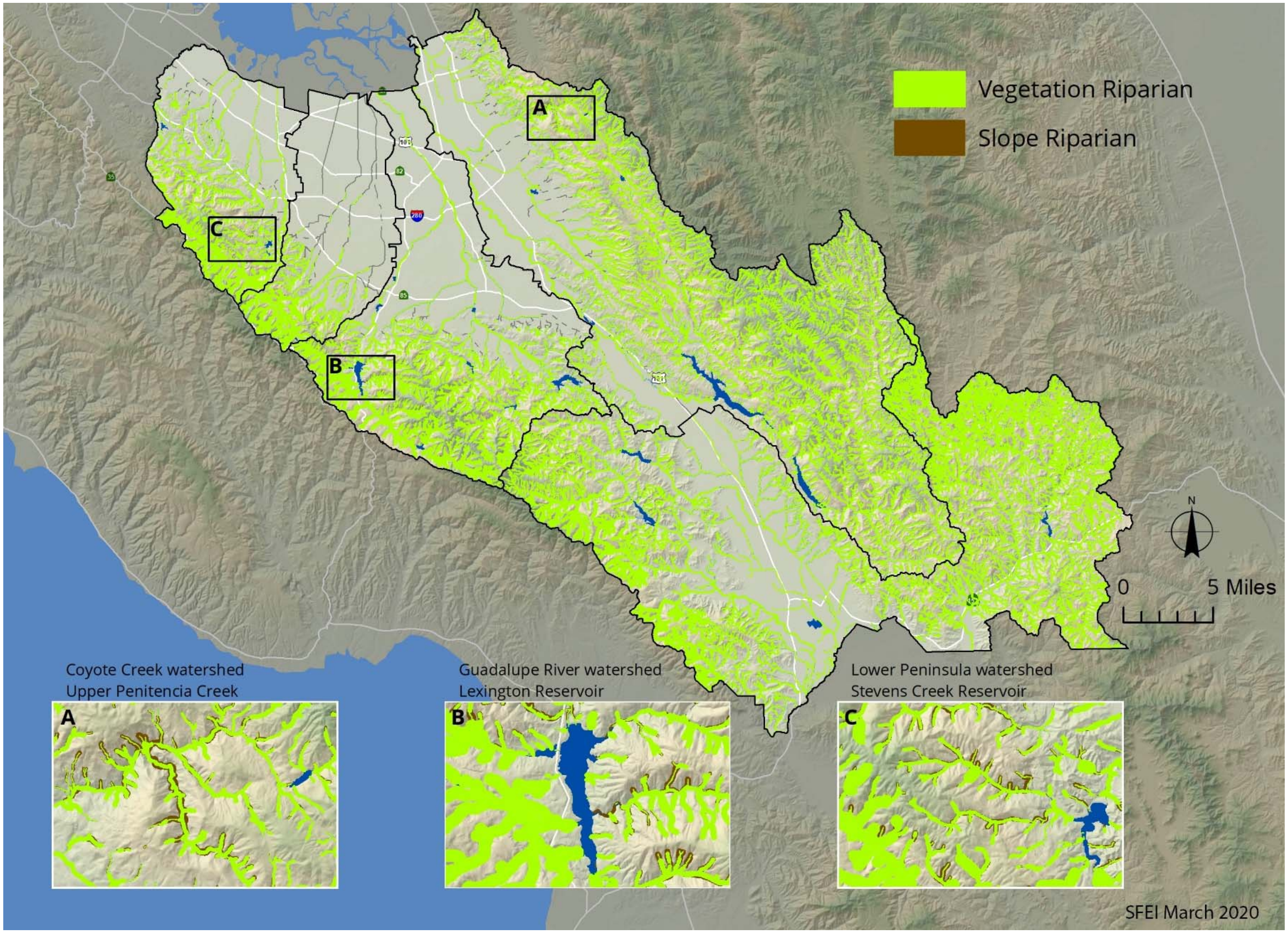

Figure 6. Modeled distribution of riparian areas adjacent to streams within the five watersheds in Santa Clara County determined using RipZET. Areas of hillslope functions (brown) are largely encompassed by vegetation functions (green layer, which was overlaid on the hillslope layer), except in steep terrain dominated by short vegetation (chaparral or grasslands). Riparian width is constrained in the Lowland Valley by urban or suburban development, and past or present agriculture.

Figures 7 and 8 summarize the miles of streams with adjacent riparian areas by riparian functional width class among the five watersheds in Santa Clara County and the three subregions, respectively. As expected, the amount of riparian areas adjacent to streams in the five watersheds in Santa Clara County corresponds to the size of the watersheds and amount of streams in each watershed.

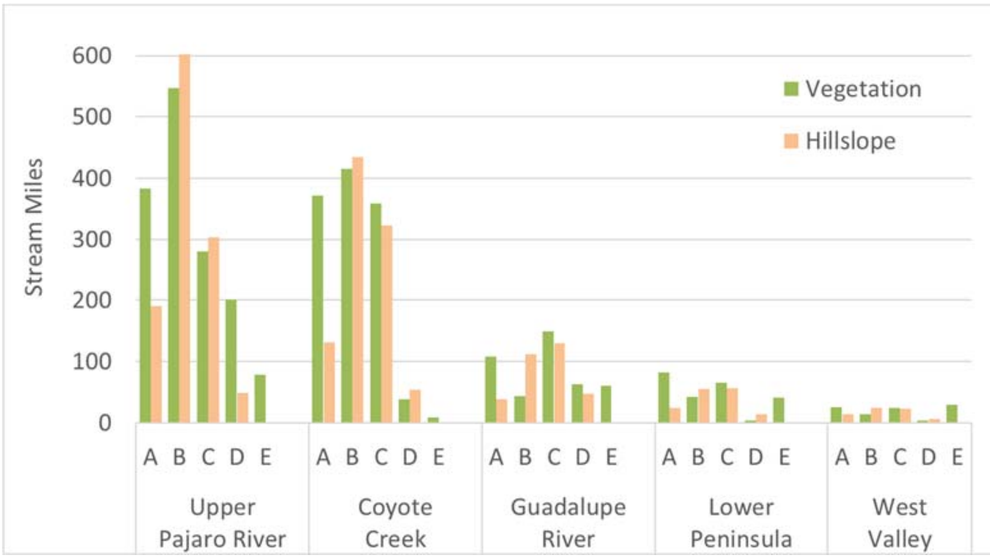

Figure 7. Miles of stream with adjacent riparian habitat by riparian functional width classes A-E for each of the five watersheds in Santa Clara County. See Table 4 for the range in width of each class and their associated vegetation and hillslope functions.

The upper Pajaro River and Coyote Creek watersheds are the largest watersheds with the most steam miles with adjacent riparian areas, and Lower Peninsula and West Valley Watersheds the smallest watersheds with the fewest miles of adjacent riparian areas (see Table 2 on page 8). The upper Pajaro River and Coyote Creek watersheds each have the most miles of streams with riparian buffer width class B (10-30 m), followed by A (0-10 m) and C (30-50 m). Guadalupe watershed has more stream miles with adjacent buffer width class C (30-50m) followed by A (0-10 m), D (50-100 m), and E (>100 m). Lower Peninsula and West Valley watersheds have a mixture of riparian buffer widths with a significant proportion of stream miles having zero or little buffer (width class A, 0-10 m) followed by C (30-50 m) and B (10-30 m). Tall stands of Redwood forest in the uppermost reaches of the watersheds in the Santa Cruz Mountains contribute to the miles of streams with the widest vegetation based riparian buffer widths class E (>100 m) in the upper Pajaro River (Uvas and Llagas creeks), Guadalupe River, West Valley, and Lower Peninsula watersheds (see Figure 6 above).

Most of the riparian areas adjacent to streams in the Lowland Valley have narrow riparian widths (0-10 meters), due to the lack of tall vegetation and encroachment of urban or agricultural land uses (Figure 8). Most of these riparian areas are too narrow to strongly support riparian functions such as floodwater dissipation, groundwater recharge, or riparian wildlife. As the slopes of the channels steepen in the Foothills, riparian areas based on slope widen, and in very steep terrain (Headwaters), they can be wider than the other subregions based on vegetation processes, especially in forested areas with very tall trees such as the redwood forests in the Headwaters region of the Santa Cruz Mountains (as mentioned above). Riparian widths are more diverse in the Foothills, due to the spatial variations in hillslope and vegetation types adjacent to streams including grasslands, chaparral, mixed and conifer forests. The Foothills may be an important region for future preservation of riparian areas along the streams as land uses change due to ongoing urbanization. The Headwaters region is relatively unimpacted. The distribution of stream riparian functions by riparian width are assumed to reflect mostly natural conditions for the upper reaches of Bay Area watersheds.

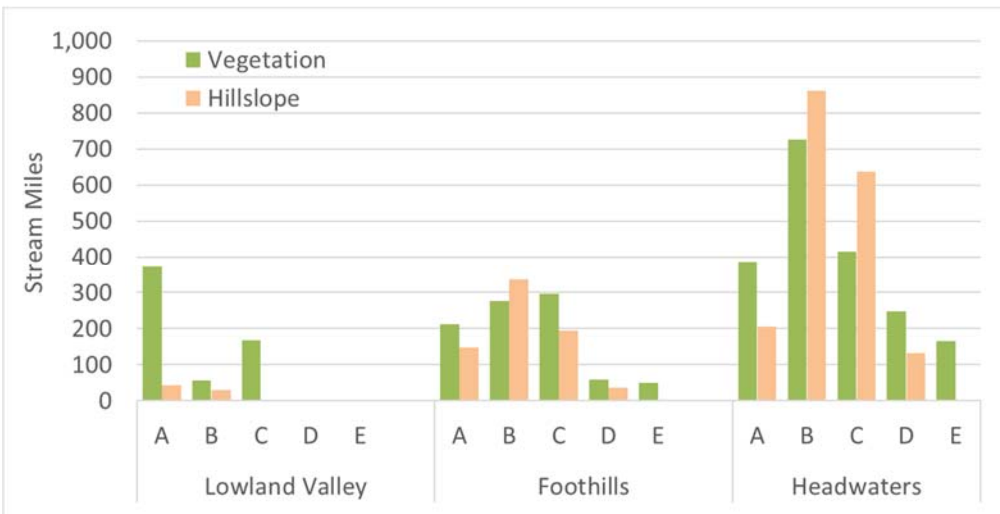

Figure 8. Miles of stream with adjacent riparian habitat by riparian functional width classes A-E for each of the three subregions in Santa Clara County. See Table 4 for the range in width of each class and their associated vegetation and hillslope functions.

3.4. How have the distribution and abundance of aquatic resources changed with urbanization and agriculture?

Figure 9 shows the historical (circa 1850) and current (circa 2008 BAARI v2.1) aquatic resources within the Santa Clara Valley. The area of overlap for this comparison was based on the historical ecology studies of the region (SFEI 2008, Beller *et al.* 2010), which defined the Valley floor extent based on geologic alluvial soils. The geographic history of the Valley was briefly described in section 2 (above).

The comparison of past and present conditions highlights the degree to which the Valley has been modified to increase drainage. The historical valley had many more ponds (depressional wetlands), willow sausals, wet meadows, and slope wetlands. Many of the ponds were located on the floodplains of streams and functioned to dissipate and store floodwaters, and recharge groundwater. These features were likely very important for supporting resident and migratory wildlife, especially amphibians and waterfowl.

The current landscape has lost large areas of near-surface and emerging groundwater (springs and seeps) to development. Impervious surfaces and increased drainage of the Santa Clara Valley floor have changed the shallow groundwater regime. Past agricultural use and domestic water supply over-pumped groundwater tables, resulting in land subsidence. Valley Water's groundwater recharge program and diversifying water supplies arrested land subsidence in the late 1970s. The modern-day ponds are mostly man-made for groundwater recharge, irrigation, or aesthetic value (e.g., ponds in golf courses or parks). They are not located where the natural ponds were and lack some of the wildlife support functions of the historical ponds.

Major reservoirs that were built for water supply, and partly function to manage flooding, have dramatically altered water and sediment conveyance through the Foothills to the Lowland Valley. Historically, many tributaries did not have well-defined channels connecting the upper watersheds to the mainstem channels on the Valley floor. Instead, they distributed their flows and sediment loads across broad alluvial fans, and permeable valley soils allowed stormwater runoff and floods to recharge the local underground aquifers (Grossinger et al. 2006, SFEI 2010). Flow from these tributaries probably reached the mainstem channels through multiple distributaries and as overland flow during major floods. There is also evidence that groundwater would emerge along the northern limits of the Valley as springs and seeps, coalescing into more defined channels that drained to the baylands, in some cases connecting to tidal sloughs (see Figure 9). Only the mainstem channels of Coyote Creek, Guadalupe River, and San Francisquito Creek were continuous surficial channels from the Headwaters through the Foothills and Valley to the Bay. Though even the Guadalupe River was braided through Willow Glen and ultimately connected by dredging.

The Valley was extensively ditched throughout the late 1800s and early-mid 1900s to increase the amount of arable land. The alluvial fans were ditched to permanently connect their streams to the mainstem channels on the Valley floor. The modern drainage system is comprised of drainage ditches, engineered flood control channels, and subsurface storm drains. Some natural channels were straightened or completely replaced with straight channels to accelerate drainage, especially to reduce flood risks. These modifications greatly increased the conveyance of runoff and sediment from the Headwaters to the Bay. All of the tributaries are now connected to the Bay, either directly or via their confluences with the mainstem channels on the Valley floor.

The overall result of these modifications is a net increase in total miles of channels in the Valley floor portion of the five watersheds in Santa County and a significant decrease in the total amount of natural streams (Figure 10).

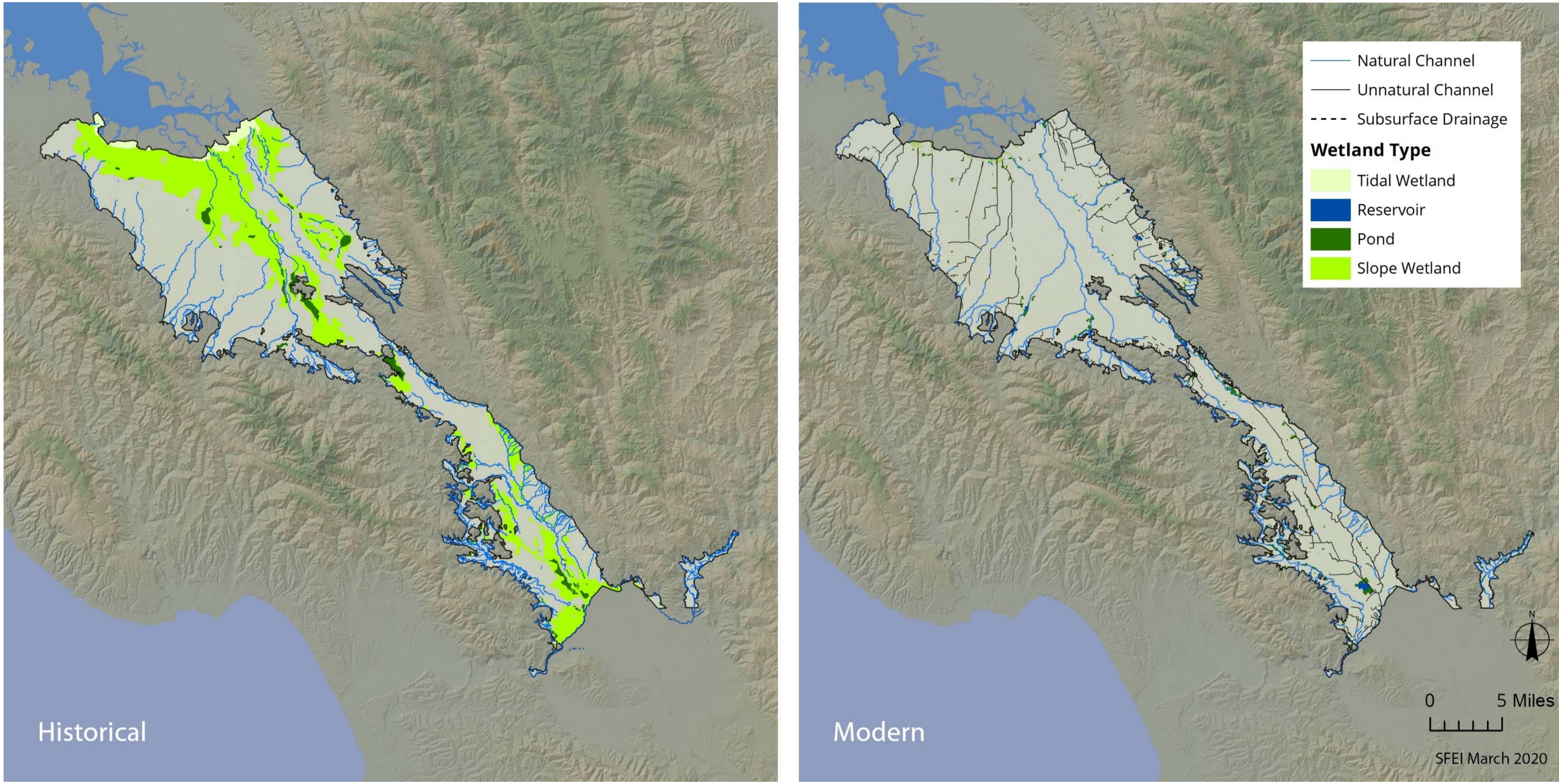

Figure 9. Map of the historical (circa 1850) and current (circa 2008) aquatic resources in the Santa Clara valley floor for which there is overlapping historical GIS data.

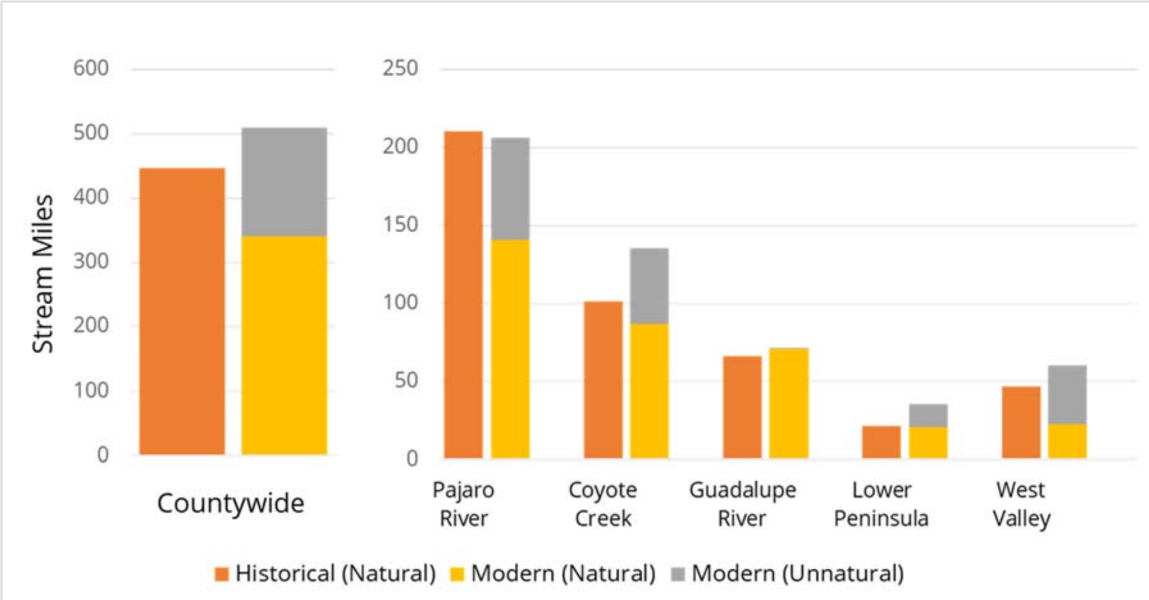

Figure 10. Comparison of historical (circa 1850) and modern (circa 2008) stream length in the Valley portion of the five major watersheds, and combined. This compares surface channels only; subsurface drainage that was or is part of the stream network is not included.

Increased hydrologic connectivity between the channels in the Foothills and Valley has a number of important consequences. For example, unnatural connectivity caused significant changes in the form and function of channels throughout their watersheds. Ditching the alluvial fans lowered base elevations of channels in the Foothills, causing them to deepen, relative to their original banks. This increased the heights of channel banks, destabilizing them, resulting in increased erosion with sedimentation downstream. Ditching also decreased the frequency of overbank flooding and groundwater recharge, and increased the amount of drawdown of the water table near the channels. Channel incision in the Foothills progressed upstream into the Headwaters, increasing flow capacity of the channels, which in turn increased the amounts of sediment and water delivered to the Valley, where channel beds aggraded and flooding increased. This led to the construction of stormwater drains and flood control channels to convey the increased flows to the Bay.

3.5. Where does Valley Water own the streams? Where are the protected areas such as county and state parks, and open space districts?

Figure 11 shows Valley Water's fee title and easement areas in the five watersheds (unpublished 2009, updated by Valley Water and provided to SFEI in August 2019), as well as protected areas from the California Protected Areas Database (CPAD, GreenInfo Network 2018).

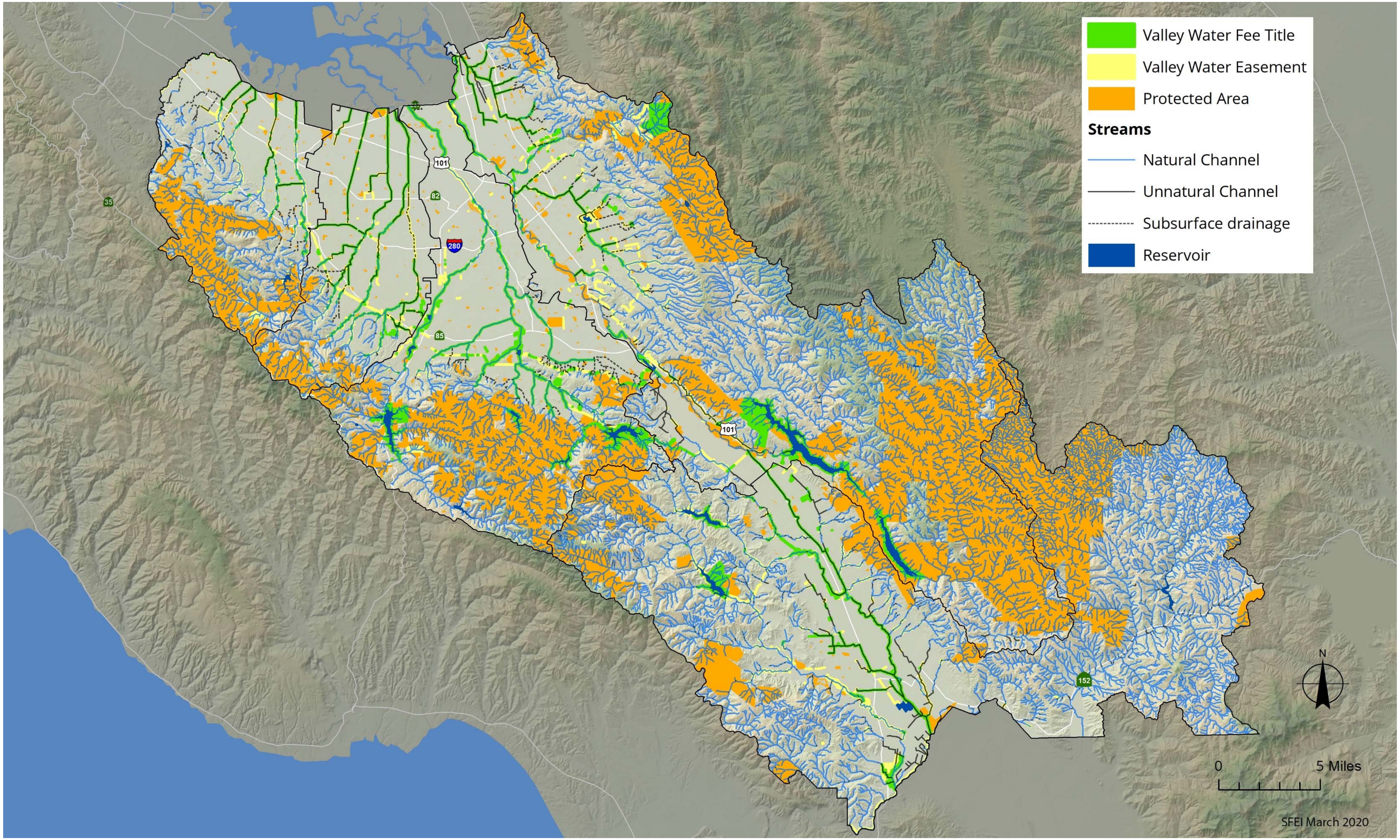

Figure 11. Map of Valley Water fee title and easement and other protected areas (CPAD 2018)

Table 6 summarizes the amount and proportion (%) of streams that are within Valley Water fee title and easement areas by watershed and subregions, and the amount of streams that are in protected areas based on CPAD. The result shows that Valley Water owns a significant portion of streams in the Lowland Valley, including natural and unnatural channels. Most of those streams are located downstream of protected areas, which include parks, open space, and other public conservation areas owned and managed by Santa Clara County Parks and Recreation, Midpeninsula Regional Open Space District, or California Department of Parks and Recreation. The majority of Foothill and Headwater streams are privately owned. For effective and sustainable natural resource and watershed management, Valley Water needs to collaborate with agencies and private land owners.

Table 6. Summary of the amount and proportion of streams in the five watersheds in Santa Clara County (SSC 5) owned or under easement by Valley Water by watershed and subregion including unprotected and protected areas (CPAD 2018). Note: lengths do not include 1st-order streams as mapped in BAARI, Alameda Creek, or the Baylands.

Watershed or Subregion	*Other Ownership Stream Miles*	*Valley Water Fee Title Stream Miles*	*Valley Water Easement Stream Miles*	*Valley Water % Fee Title & Easement*	*Total Miles*
upper Pajaro River	1,394	44	35	5	1,473
Unprotected areas	1,038	32	32	6	1,103
Protected areas	356	12	3	4	370
Coyote Creek	1,124	75	25	8	1,225
Unprotected areas	639	23	13	5	675
Protected areas	485	53	12	12	550
Guadalupe River	361	64	17	18	441
Unprotected areas	150	22	8	17	180
Protected areas	210	42	9	20	261
Lower Peninsula	211	13	14	11	238
Unprotected areas	112	10	12	17	134
Protected areas	100	3	2	4	104
West Valley	90	36	10	34	136
Unprotected areas	61	35	9	42	105
Protected areas	29	1	1	7	31
Lowland Valley	352	155	86	41	593
Unprotected areas	306	120	66	38	492
Protected areas	46	35	20	55	101
Foothills	882	69	10	8	961
Unprotected areas	635	2	8	1	644
Protected areas	247	67	3	22	317
Headwaters	1,946	9	4	1	1,958
Unprotected areas	1,060	0	0	0	1,060
Protected areas	887	9	3	1	899
Total SCC 5 Watersheds	3,180	232	100	9	3,513

4. Stream Condition Assessment

The D5 Project employed CRAM and USEPA's Generalized Random Tessellation Stratified (GRTS) survey design and analysis methodology to assess baseline condition of streams within each of the five watersheds. These surveys are consistent with WRAMP and USEPA Level 2 monitoring; re rapid field assessments of condition based on semi-quantitative, visible field indicators that do not require the collection or processing of materials from the field, but provide a numeric score of condition. The D5 Project applies the CRAM Riverine field book (January, 2013) to assess watershed streams and their banks, wetlands, riparian habitats, and buffers. Individual CRAM study sites selected by applying GRTS are called Assessment Areas (AAs).

CRAM yields numerical scores that represent the overall potential of a stream or other wetland type to provide high levels of its expected suite of functions. CRAM scores are based on visible indicators of physical and biological form and structure relative to statewide reference conditions. CRAM generates an Index Score for overall ecological condition and component Attribute Scores for Buffer and Landscape Context, Hydrology, Physical Structure, and Biotic Structure. The four Attribute Scores are based on separate evaluations of metrics and submetrics (Table7) that are averaged into the overall or Index Score for each CRAM site.

Table 7. CRAM Index, Attributes, Metrics, and Submetrics

	Attributes	***Metrics and Submetrics***
Overall or Index Score	Buffer and Landscape Context	Steam Corridor Continuity
		Buffer:
		Percent of AA with Buffer
		Average Buffer Width
		Buffer Condition
	Hydrology	Water Source
		Channel Stability
		Hydrologic Connectivity
	Physical Structure	Structural Patch Richness
		Topographic Complexity
	Biotic Structure	Plant Community Composition:
		Number of Plant Layers
		Number of Codominant Species
		Percent Invasion
		Horizontal Interspersion
		Vertical Biotic Structure

Stream condition scores (CRAM scores) can be classified into condition classes from the maximum range of scores, which is 25-100. The standard classes are a subdivision of the range of scores into three equal subranges of 25 points each representing poor condition (25-50), fair condition (51-75) and good condition (76-100).

For more information about the D5 Project's steam condition survey methods, including CRAM, refer to the Methods in Appendix B.

4.1. What is the baseline ecological condition of streams in the five watersheds within Santa Clara County?

Since this was the first assessment of its kind in each watershed, CRAM scores for the D5 Project's ambient surveys serve as the baseline measure of stream condition in the five major watersheds within Santa Clara County. Table 8 sums the number of AAs for the three condition classes in each watershed, the five watersheds combined (SCC 5), and the subregions analyzed in this report based on their CRAM Index Score (poor 25-50, fair 51-75, good 76-100).

Table 8. Number of CRAM sites (AAs) in each of the five watersheds within Santa Clara County, total across the five watersheds (SCC 5), and in the three subregions in poor, fair, and good condition based on their CRAM Index Scores.

Watershed / Condition	*Poor*	*Fair*	*Good*	*Total*
Upper Pajaro River	1	48	32	81
Coyote Creek	1	35	41	77
Guadalupe River	9	30	14	53
Lower Peninsula	7	34	13	54
West Valley	24	34	2	60
Total SCC 5 Watersheds	**42**	**181**	**102**	**325**
Lowland Valley	42	105	16	163
Foothills	0	49	33	82
Headwaters	0	27	53	80

Figures 12 and 13 show the distribution of CRAM AAs across the five watersheds in Santa Clara County, color-coded by their condition class for their respective CRAM Index and Attribute Scores. At the regional scale, good condition sites exist across the three regions with the majority located in the Headwaters. Poor condition streams are all located in the developed Lowland Valley (see Table 8, and Figures 12 and 13). At the watershed scale, good and poor condition sites are found in all five watersheds. However, these sites are not evenly distributed. The upper Pajaro River and Coyote Creek watersheds both have only one poor condition site. The Guadalupe River and the Lower Peninsula watersheds have a nearly equal mix of good and poor condition sites. And the West Valley watershed only has two good condition sites. The overall number of good condition sites within each watershed is partly related to the proportion of channels in the undeveloped upper watershed: watersheds with greater amount of channel length in the Headwaters will have a greater total number of good condition sites.

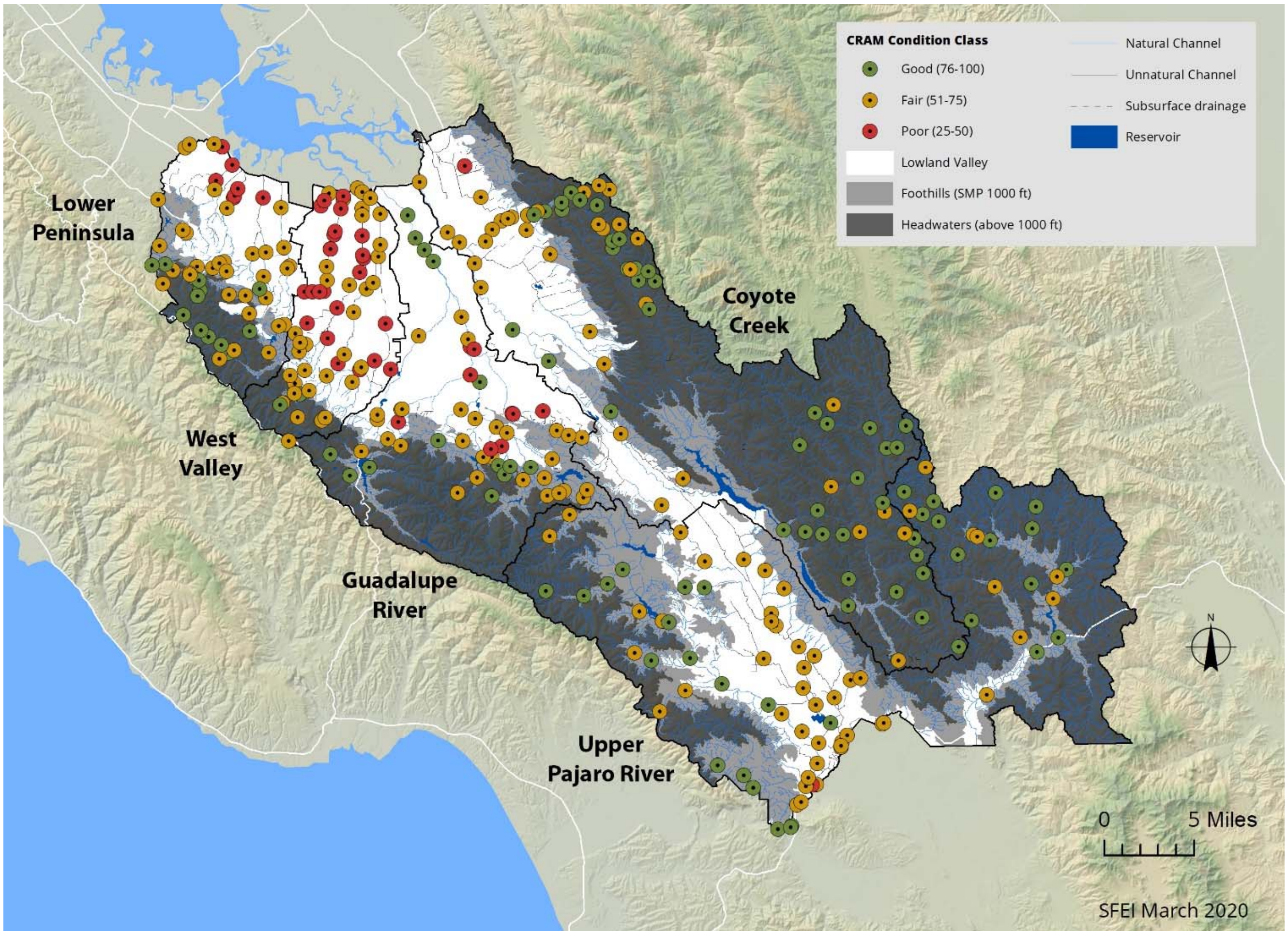

Figure 12. Map showing the distribution of CRAM AAs for the baseline surveys of steam condition in the five watersheds in Santa Clara County. The AAs are color-coded by their condition class based on their CRAM Index Score (red = poor 25-50, yellow = fair 51-75, green = good 76-100).

Figure 13 shows the component CRAM Attribute Scores by condition class and distribution of core stream functions (Buffer and Landscape Context, Hydrology, Physical and Biotic Structure) in good, fair, and poor condition. In general, Buffer and Landscape Context and Hydrology scores follow a similar pattern as the Index Score with the Headwaters and Foothills regions in better condition than the Lowland Valley; upper Pajaro River and Coyote Creek watersheds in good to fair condition, Guadalupe River and Lower Peninsula watersheds having more AAs in poor condition, and the West Valley watershed having the most AAs in poor condition.

Physical Structure scores (Figure 13, bottom left) are largely in fair to poor condition across the five watersheds within Santa Clara County, including the Headwaters region in the upper watersheds. The large number of AAs having poor Physical Structure warranted more discussion and is addressed below. Biotic Structure scores are largely in fair condition across the watersheds with more AAs in the Headwaters and Foothills in good to fair condition, and AAs in poor condition largely

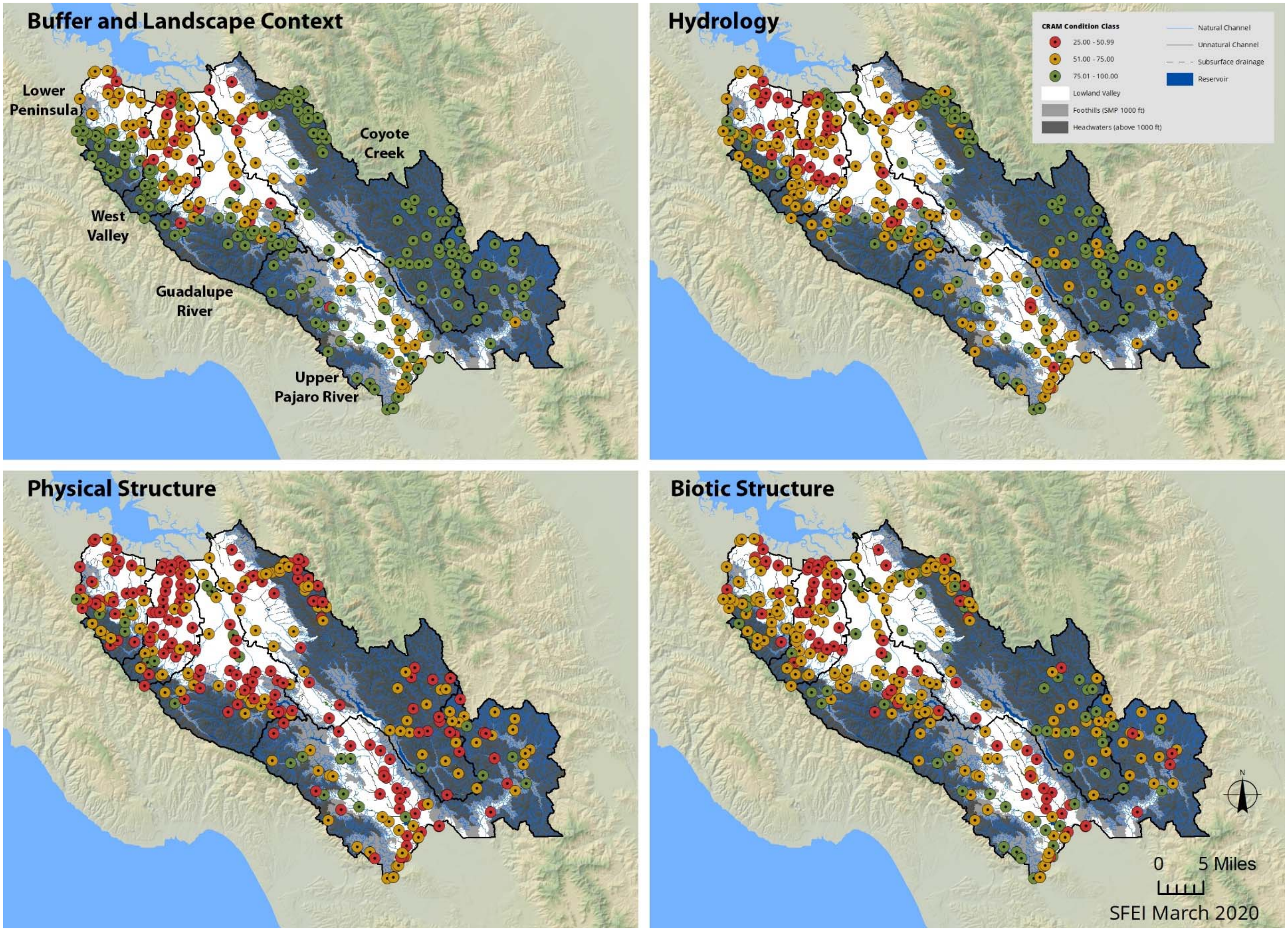

Figure 13. Map showing the distribution of CRAM AAs for baseline surveys of steam condition in the five major watersheds in Santa Clara County. The AAs are color-coded by their condition class based on their CRAM Attribute Scores (red = poor 25-50, yellow = fair 51-75, green = good 76-100).

located in the Lowland Valley. The main factors contributing to good and poor stream condition are discussed in more detail below.

4.1.1. WHICH STREAM REACHES ARE IN GOOD AND POOR CONDITION AND WHAT ARE THE MAIN FACTORS CONTRIBUTING TO THEIR RESPECTIVE CONDITIONS?

Reviewing the underlying CRAM Metric scores and stressors reveals the drivers behind good and poor condition, and can help inform management actions that could be implemented to improve areas that are in poor condition, and preserve (or enhance) areas that are in good condition. Individual CRAM Metrics largely reflect the channel type, its history, management, and surrounding land use. Looking more closely at the metric level will elucidate the similarities among sites with good or poor overall ecological condition.

Good condition sites located in the Headwaters and Foothill regions tend to be located in protected open space or privately owned areas with little surrounding development. These sites have very few to no anthropogenic stressors, although some sites have a history of past land use (e.g. logging), which likely contributed to observations of channel incision. Because these sites are located in undeveloped areas, they have good Buffer and Landscape Context Attribute scores, reflecting the longitudinal continuity of the riparian corridor, buffer amount and condition surrounding the site. Hydrologically, these sites also have good Water Source Metric scores because there is little to no development in their watershed and the hydrology has not been modified. Channel Stability Metrics show some signs of incision, largely driven by the tectonic uplift, response to downstream incision, or past land uses such as logging. Because Foothill and Headwater channels tend to be narrow drainages within steep hillslopes, the Hydrologic Connectivity Metric scores may be low because they simply do not have the flow or the space to develop significant floodplains or benches. These same factors also affect the Structural Patch Richness and Topographic Complexity scores, resulting in many of the Headwaters sites having fair to poor Physical Structure Attribute Scores. The Biotic Structure Attribute Scores were largely in fair condition because many sites are located on low order headwater channels, which are narrow and surrounded by forest or chaparral. Forest habitats tend to support a simple plant community, resulting in lower Metric scores than might be found in higher order channels with a diverse plant community.

The small number of good condition sites located in the Lowland Valley (see Table 8 and Figure 12) are good for very different reasons than the good condition sites in the Headwaters and Foothills. These sites tend to be located on mainstem channels or large mainstem tributaries that have wide channel corridors or are surrounded by undeveloped land adjacent to the channel. Historically, many of these sites were natural surficial streams that have maintained fair to good Buffer and Landscape Context Attribute Scores because they have few road crossings (because the streams are large) and dedicated buffer adjacent to the channel (although it may be narrow at times). Hydrologically the sites all have low Water Source Metric scores because their upstream watersheds are heavily developed, but they have good Channel

Stability and Hydrologic Connectivity Metric scores. Although these channels are historically incised due to subsidence and hydromodification, they have stabilized over time and are now in equilibrium. The channels are large and therefore tend to have active floodplain or higher elevation inset surfaces for flood waters to spill out to. The size of the channel and the complexity of the adjacent floodplains support a complex topography and structural diversity. These sites have been managed to allow a fairly complex riparian corridor to develop and remain, as reflected in the good to fair Biotic Structure Attribute Scores. Regardless of the presence of invasive species, the vegetation is diverse, and is horizontally and vertically complex. The mainstem channels that have good overall CRAM Scores provide both flood conveyance and fairly good ecological habitat. Future projects in those areas should aim to maintain or improve both these functions.

Poor condition sites in the Lowland Valley are located mostly in the West Valley and Lower Peninsula watersheds. These sites have poor overall condition largely because of their channel type and surrounding land use. They tend to be constructed and engineered flood control channels that are connectors and not present historically. The channels were constructed with flood conveyance as their primary function, are maintained for that purpose, and therefore tend to have low Physical Structure scores. They tend to have reduced structural complexity in the channel bed and along the banks, decreased hydrologic connectivity between the channel and adjacent riparian areas, and (because of the constructed shape and maintenance) they typically lack large woody debris or other allochthonous material, which results in a lack of micro-topographic relief. A handful of the poor condition sites are located on historical stream channels that have been significantly impacted by encroaching land use and have little to no buffer. Hydromodification (associated with the early land use practices to drain the Lowland Valley as mentioned in section 3.4) is the most evident impact. It has caused channel incision, which reduced the Hydrologic Connectivity and Topographic Complexity Metric scores. Entrenched channels do not support complex habitat for aquatic or riparian species and therefore have low Structural Patch Richness Metric scores, as well as vegetation complexity simply due to the narrowness and relatively high stream power within the channel.

The most common stresses to Lowland Valley channels with poor CRAM scores are encroachment from residential back yards extending right up to the channel banks, the high number of transportation crossings, and the hydrologic and water quality effects of intense urban runoff. Future projects that aim to improve the overall condition of poor condition stream reaches could focus on providing more width for the channel, stabilizing incision, allowing the banks to set back (creating more complexity within the channel), and attenuating urban runoff by installing permeable pavement, bioswales, or other green infrastructure to reduce adverse stream impacts.

4.1.2. WHAT IS THE RELATIVE CONDITION OF STREAMS AMONG WATERSHEDS?

The D5 Project's ambient stream condition results were analyzed using the GRTS survey analysis tools that outputs Cumulative Distribution Function (CDF) estimates of condition. Each AA is weighted to represent a proportion of the stream resources assessed, so the CDFs show the proportion of stream miles that are likely to have a specific CRAM condition score or lower (since it is a cumulative estimate) with a known level of confidence. Because the survey outputs are proportional, it is possible to compare the condition of streams between watersheds, regions, and statewide as long as the survey design and field assessment methods used in each of these areas are the same. This section graphically compares the ambient stream condition assessment results among Project D5's five watersheds, and the combined five watersheds within Santa Clara County (SCC 5) to the Bay/Delta ecoregion and statewide riverine surveys that employed the same GRTS survey design and CRAM.

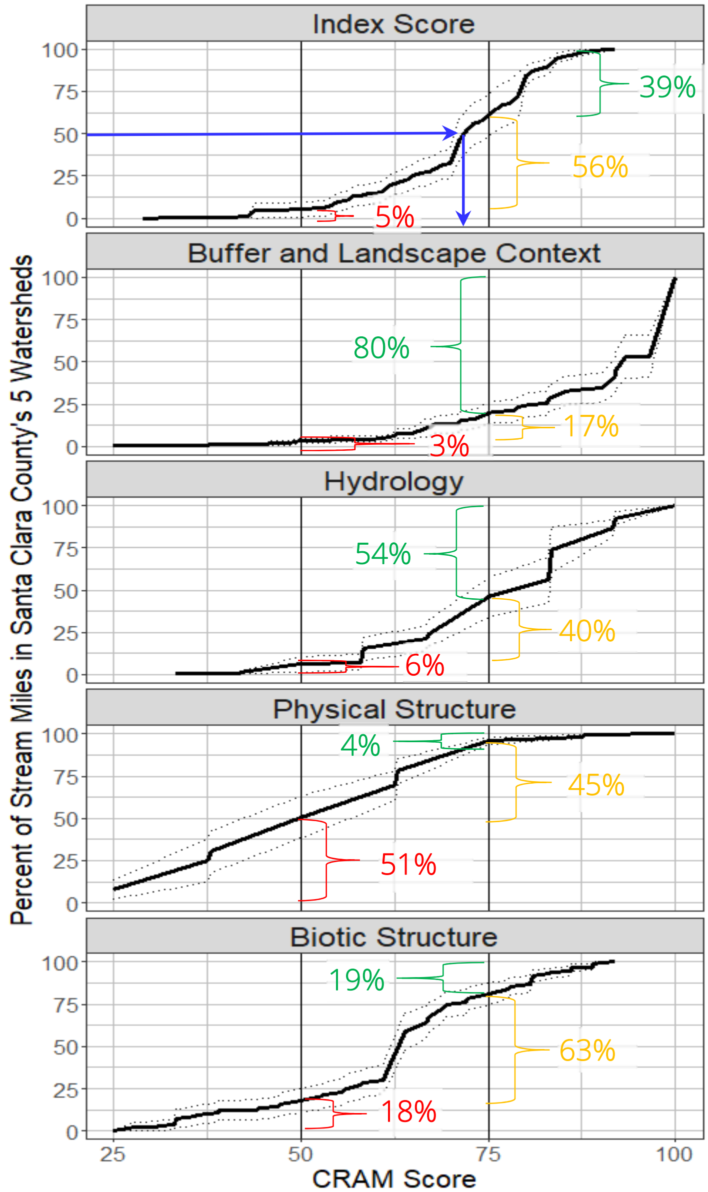

Figure 14. Baseline condition assessment cumulative distribution function (CDF) curves for the five watersheds in Santa Clara County combined (SCC 5). The overall CRAM Index Scores and component Attribute Scores provide an estimate of the proportion of streams (y-axis, percent of total stream miles surveyed) that are in poor, fair, or good condition (x-axis). The dotted lines around the curves are the upper and lower 95% Confidence Intervals. The two black vertical lines on each plot indicate the thresholds between poor-fair and fair-good condition classes. For each plot, n=325.

Figure 14 presents CDFs of the CRAM Index and component Attribute Scores for the combined five watersheds in Santa Clara County (SCC 5). According to the Index Score CDF (top figure reading across and down along the blue arrows), 50% of the streams have an Index Score of about 72 or less. 39% of the streams are in good condition (Index Scores >75); 56% of the streams are in fair condition (Index Scores 51-75); and 5% of the streams are in poor condition (Index Scores ≤50).

The CRAM Attribute level CDFs can be similarly evaluated. The proportions of stream miles in good, fair, and poor condition can be further summarized as staked bar charts, which simplifies the CDF estimates to compare the overall ecological condition of streams among watersheds, regions, and statewide (see Figure 15). CDFs and stacked bar charts are presented in the remainder of this chapter. Refer to the Methods section (Appendix B, page 71) for additional information on how to read a CDF curve from a GRTS ambient survey.

Figure 15 compares the ecological condition of streams in the five watersheds in Santa Clara County combined (SCC 5) and within each watershed based on CRAM condition classes. The Coyote Creek watershed is in good to fair condition, while the other four watersheds mostly have fair conditions. Figure 15.A overlays the CDFs of the CRAM Index and component Attribute Scores for each of the five watersheds in Santa Clara County. The CDF curves show comparatively better ecological condition moving from the left (West Valley) to right (Coyote Creek) watersheds. Figure 15.B compares the proportions of stream miles in good, fair, and poor condition for the five watersheds within Santa Clara County and all the watersheds combined (SCC 5) based on their Index and component Attribute Scores.

Looking at Figure 15B, the upper Pajaro River and Coyote Creek watersheds have the largest proportion of streams in good overall ecological condition (38 and 60% of their streams have CRAM Index Scores >75, respectively). The Guadalupe River watershed has the next highest proportion of streams in good condition (29%). The Lower Peninsula and West Valley watersheds have the smallest proportions of streams in good condition (21% and 7%, respectively). The lower proportion of streams in good condition for these two watersheds are due (in part) to the relatively greater proportions of their streams having poor to fair Attribute scores for Hydrology and Physical Structure in the Lowland Valley regions of their watersheds (as mentioned in the previous section). And, because these two watersheds have relatively fewer stream resources in their Headwater regions (refer to the map of aquatic resources, Figure 3 on page 6).

The large proportion of streams in each major watershed having poor Physical Structure warranted discussion. By design, CRAM scores increase with structural complexity. The statewide validation of CRAM revealed that a significant proportion of streams in each ecoregion has good condition for all four CRAM Attributes. However, the validation and subsequent experiences with CRAM have indicated that low-order streams naturally tend to be structurally less complex than higher-order streams, and therefore tend to have lower Physical Structure Attribute scores. Thus (as noted previously), 1st-order stream reaches (as mapped by BAARI) were excluded from the ambient stream surveys. Two other factors contribute to the low Physical Structure scores: 1. the predominance of 2nd- and 3rd-order streams in the

Headwater regions, which like 1st-order streams tend to score low; and 2. as mentioned in section 4.1.1 above, the amount of constructed and engineered channels in the Lowland Valley region also tend to have low Physical Structure scores.

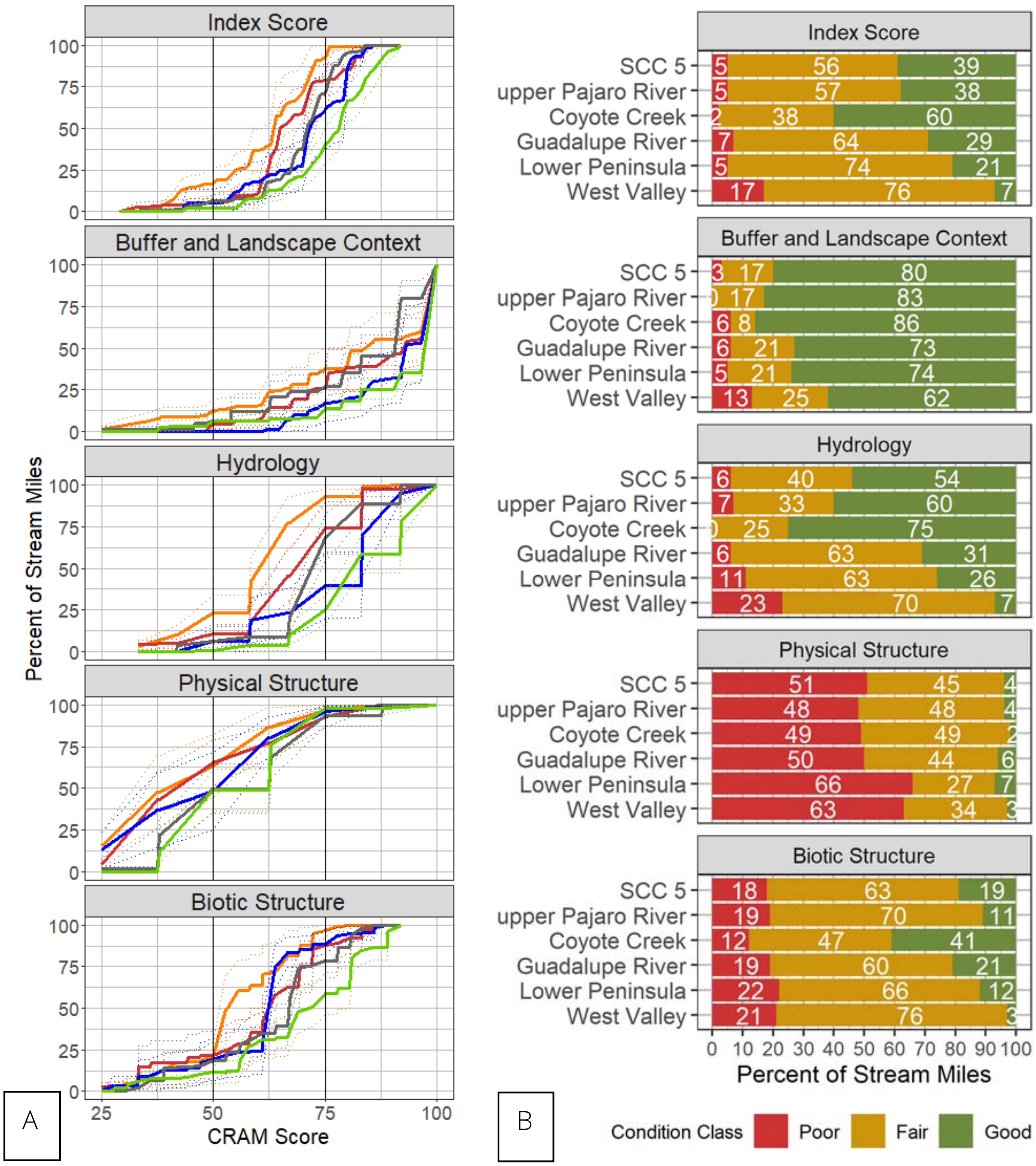

Figure 15. CDFs (A) and stacked bar charts (B) compare ecological condition of streams in the five watersheds in Santa Clara County (SCC 5) and for each watershed by condition class. CDF curves: Blue = upper Pajaro River 2015, Green = Coyote Creek 2010, Grey = Guadalupe River 2012, Red = Lower Peninsula 2016, and Orange = West Valley 2018.

4.2. How do the Lowland Valley, Foothills, and Headwater regions differ?

Figure 16 compares Index and Attribute Scores for the three subregions (Lowland Valley, Foothills, and Headwaters) and the combined five watersheds within Santa Clara County (SCC 5). In general and as expected due to land use, condition decreases with distance downstream from the Headwaters through the Foothills to the Lowland Valley. Good stream conditions exist in all three subregions, but the majority of good condition streams are located in the Headwaters.

As noted before (see section 4.1), most of the streams in good condition are located in designated, public open space areas in the Headwaters and Foothills. These areas have very few anthropogenic stressors. Since they are mostly undeveloped, these areas tend to have good longitudinal connectivity, with wide and continuous riparian buffers of mostly native vegetation and minimal anthropogenic impacts (in other words, good buffer and landscape context). Streams in these areas also tend to score well with regard to water source, since there is little to no upstream development. Biotic structure tends to be good, except where the riparian area consists of relatively homogenous grasslands or chaparral.

The relatively few good condition AAs in the Lowland Valley (n=13, see Table 8, and map Figures 12 and 13) have either wide riparian areas that are mostly natural, or adjacent undeveloped areas that provide good buffer and landscape context. They all have low Water Source metric scores because their drainages include heavily developed areas. These AAs are on high-order, low-gradient streams that are not subject to ongoing incision, and have equilibrated to past incision. They either have remnants of historical floodplains or formed new floodplains within their historically incised channels. Therefore, they have fairly stable channels with good hydrologic connectivity. These AAs are in stream reaches that are managed for fairly complex riparian forests, resulting in good biotic structure, despite the presence of invasive species.

The poor condition of AAs in the Lowland Valley and especially in West Valley and Lower Peninsula watersheds are due to channel type and surrounding land uses: i.e., mostly constructed flood control channels in areas that lacked channels historically. The channels are structurally homogenous and lack either biotic or physical structural complexity. Many of the AAs on remnants of historical natural channels are significantly impacted by surrounding land uses and have little to no buffer or hydrologic connectivity. Urban runoff destabilizes the channels, causing chronic incision. The narrowness and relatively high stream power of the entrenched channels decreases their physical structural complexity.

Further examination of the Metrics for the Physical Structure Attribute in the Lowland Valley region in the previous section (4.1.1) suggests that two factors affect the low scores. First, many of these streams in the Lowland Valley lack topographic benches, which is likely a consequence of historical chronic channel incision (downcutting or degradation) and/or modification for flood control. Second, many of the streams lack large woody debris and other allochthonous material, which results in a lack of micro-topographic relief, and reduced structural complexity in the channel bed, along the banks, and floodplains. Channel degradation also decreases hydrological connectivity between the channel and its riparian areas, which can be reflected in lower scores for the Hydrology Attribute. There is evidence of this in the Hydrology Attribute scores for the streams of the Lower Peninsula and West Valley watersheds (see Figure 15 A and B above).

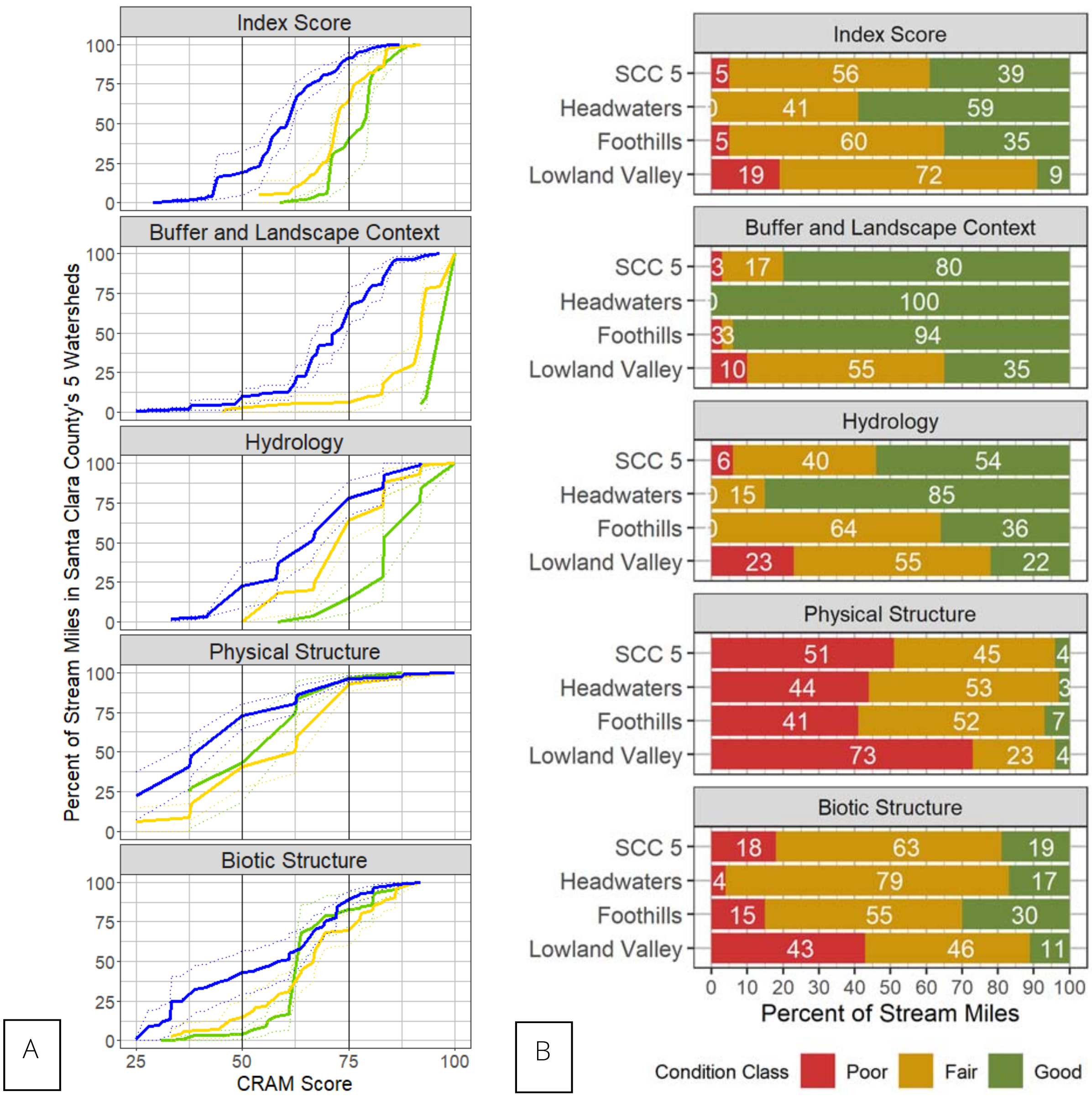

Figure 16. CDFs (A) and stacked bar charts (B) compare the ecological condition of streams in the Lowland Valley, Foothills, and Headwater regions of the five major watersheds in Santa Clara County based on CRAM. CDFs: Green= Headwaters (n=80), Yellow = Foothills (n=82), and Blue = Lowland Valley (n=163)

4.3. How do streams in the five watersheds in Santa Clara County compare to streams in other regions?

The D5 Project's ambient stream condition surveys were compared to the statewide Perennial Stream Assessment (PSA) of the California Surface Water Ambient Monitoring Program (SWAMP 2016). Between 2008 and 2013 the PSA employed the same probability based survey design and CRAM assessment methods to assess 765 riverine AAs (statewide). CDFs and stacked bar charts of the proportion of stream resources in good, fair, and poor condition are presented and compared in Figure 17 based on the standard CRAM condition classes. The San Francisco Bay/Delta Ecoregion CDF is a subset of AAs from the statewide PSA survey (n=40).

Based on CRAM Index Scores, the proportions of streams in poor, fair, and good ecological condition in the five watersheds in Santa Clara County (SCC 5) and the Bay/Delta Ecoregion are similar (5% and 13% poor condition, 56% and 52% fair condition, and 39% and 35% good condition, respectively). In general, overall stream condition tends to be a bit better in the SCC 5 than the Bay/Delta Ecoregion, but worse than statewide. With regard to the Buffer and Landscape Context and Hydrology Attributes, SCC 5 streams are in generally better condition than streams elsewhere in the Ecoregion, and have similar condition to steams statewide. However, there is a greater proportion of streams with poor Physical Structure in the SCC 5 than in the Ecoregion (52% and 34%, respectively): SCC 5 CDF for the Physical Structure Attribute is shifted to the left of the Ecoregion CDF, although their confidence intervals overlap. There is a lesser proportion of streams with good Biotic Structure in the SCC 5 than elsewhere in the Ecoregion (19% and 39%, respectively), and Biotic Structure CDF for the SCC 5 is shifted left of Ecoregion CDF, although the shift is less pronounced than for Physical Structure.

Stream conditions are better statewide than for the Ecoregion and the five watersheds in Santa Clara County. These findings may reflect the general inverse correlation between human population density and stream condition. Most of the state is rural and undeveloped. Rural watersheds are commonly subject to mainly silviculture and ranching, both of which are governed by environmental policies that protect streams, and the statewide PSA data reflect that. The Bay/Delta Ecoregion is much more densely populated than the state as a whole and areas assessed by the D5 Project are more densely populated than the Ecoregion. Both the County and Ecoregion have many different land uses that, in aggregate, tend to impact streams, despite various policies and practices intended to prevent or minimize the impacts. This is reflected in both the Ecoregion PSA and D5 Project data. The findings may also reflect the general fact that low-order streams tend to have better condition than high-order streams. The condition of high-order streams tends to reflect the cumulative impacts of upstream land uses on flow, sediment supply, water chemistry, and greater urban development closer to the channels.

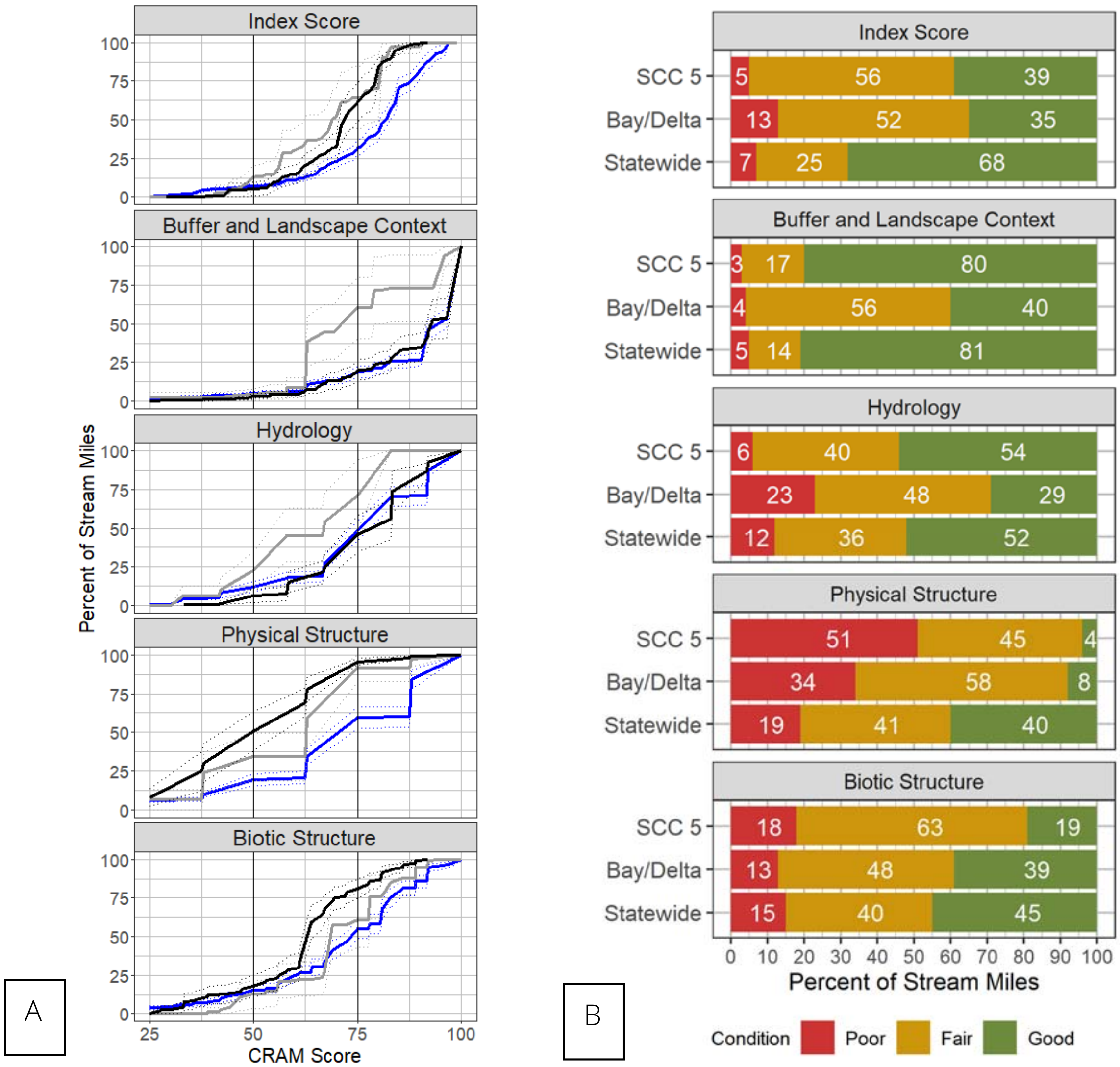

Figure 17. CDFs (A) and stacked bar charts (B) of CRAM Index and Attribute Scores compare the relative conditions of stream resources in three different regions: five watersheds in Santa Clara County combined (SCC 5; assessed 2010-2018 by Project D5; n=325, black CDF curve), statewide Perennial Stream Assessment (PSA) of the California Surface Water Ambient Monitoring Program (SWAMP 2016); assessed 2008-2013; n=765, blue CDF curve), and Bay/Delta Ecoregion (a subset of the statewide PSA; n=40, grey CDF curve).

The scarcity of streams in the D5 Project watersheds and elswhere in the County with good Physical and Biotic Structure has no certain explaination at this time. As suggested previously, this may reflect the severity of historical channel incision within the County, as well as the high population density that has led to the modifcation of many high-order streams to improve drainage and flood control, land use encroachment into riparian areas, and riparian invasion by nonnative vegetation. The Metric scores for the Physical and Biotic Structure Attributes support this interpretation (see section 4.1).

5. Employing a Watershed or Regional Approach

Federal and State resource agencies continue to move toward watershed-based environmental regulation, permitting, and management (USEPA and United States Army Corps of Engineers (USACE) 2008, SWRCB 2019). Valley Water's One Water Plan and D5 Project align with the watershed approach. The individual Project D5 watershed assessments and future reassessments provide information on the amount and distribution of streams and wetlands within the five watersheds in Santa Clara County, stream conditions to support a watershed and regional scale approach, coordinated resource management, and mitigation/restoration planning.

The WRAMP framework and toolset is designed for assessing the condition of streams (and other wetland types) at multiple spatial scales, ranging from individual wetlands or stream reaches to watersheds, regions, and statewide. CARI and CRAM are commonly used WRAMP tools. The CRAM Technical Bulletin v.2.0 (Technical Bulletin) is the statewide document produced by the California Wetland Monitoring Workgroup (CWMW 2019) of the California Water Quality Monitoring Council to guide the use of CRAM. Based on the Technical Bulletin, CARI and CRAM can be used to evaluate the performance of stewardship actions and programs. The USACE South Pacific Division issued guidance in 2015 and has standard operating procedures[4] that employ CRAM for impact assessment and mitigation. Guidance applies to both the USACE San Francisco and Sacramento Districts.

The following illustration focuses on streams in the developed Lowland Valley region in Santa Clara County because they are the subject of most of the stewardship actions, such as stream restoration, mitigation, and maintenance that directly involves Valley Water. It covers the identification of streams in different condition classes, development of performance targets for streams, and assessing the performance of on-the-ground actions intended to achieve the targets. Further information about these and other applications of CRAM is available in the Technical Bulletin (CWMW 2019).

5.1. How can CRAM data be used to identify streams in poor, fair, or good condition?

All CRAM scores should be uploaded into the online statewide CRAM database (eCRAM at www.cramwetlands.org) assuring the quality and security of the scores, and facilitating their visualization and access in EcoAtlas (www.ecoatlas.org). The dataset for this illustration was compiled from eCRAM (downloaded in April 2019), and includes all of the existing CRAM scores for Lowland Valley streams generated by the D5 Project's ambient stream surveys, plus other

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[4] https://www.spd.usace.army.mil/Portals/13/docs/regulatory/qmsref/ratio/12501-SPD.pdf

CRAM assessments from other efforts, including the Regional Monitoring Coalition, SWAMP, and individual restoration or mitigation projects. Figure 18 shows the spatial distribution of AAs for these scores (n=283), colored-coded for their condition class based on their Index Scores.

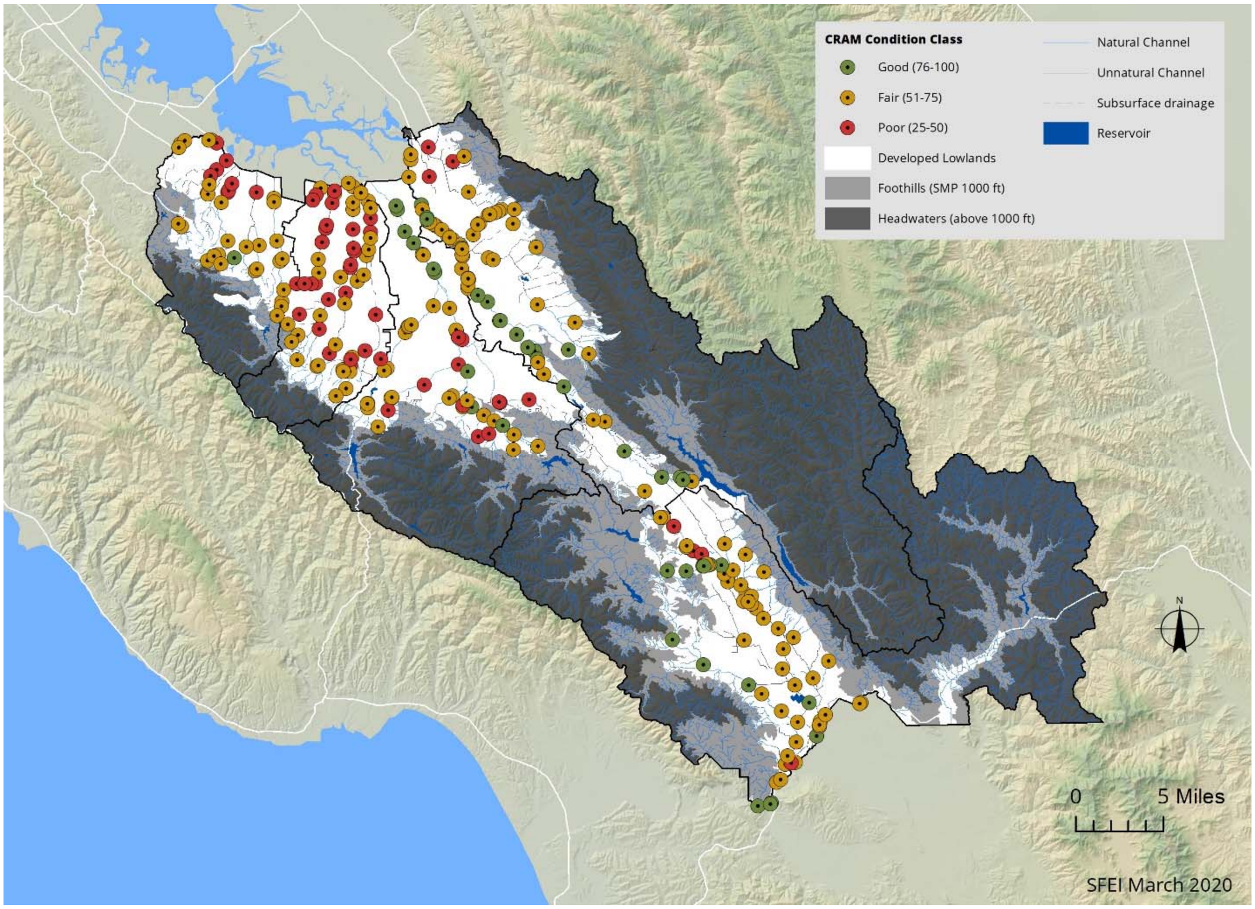

Figure 18. Map of all the available CRAM assessments within the Lowland Valley region of the five watersheds within Santa Clara County (n=283, data accessed from eCRAM April 2019). The AAs are color-coded by their condition class based on their CRAM Index Score (red = poor 25-50, yellow = fair 51-75, green = good 76-100).

The CRAM dataset is large enough and coverage is adequate to examine Lowland Valley stream conditions across one or more of the five watersheds in Santa Clara County for overall condition, as well as the four underlying Attributes Scores and component Metrics. The scores can be used to guide resource management actions. For example, stream reaches that are in good ecological condition might be preserved, poor condition stream reaches restored, and fair condition reaches enhanced. Drilling down to the Attribute and Metric scores will help resource managers identify specific ecological conditions that can be improved (section 4.1.1).

As mentioned above, CRAM data can be accessed and explored on EcoAtlas, which displays CRAM sites on an interactive basemap of CARI. A user can access the Index, Attribute, and Metric scores for each AA by clicking on its location on the map, and can view the CRAM AAs in their landscape context along with a variety of environmental data layers, which can assist in the interpretation of the scores. Users can also download the spatially referenced CRAM data into spatial or tabular formats for further analyses or to use on their own GIS to visualize scores in the context of other environmental information that may not be available in EcoAtlas (see the Data Management and Access section in Appendix B for more information).

5.2. How can CRAM be used to evaluate Project performance?

CRAM can be used to set targets and evaluate performance of on-the-ground mitigation or restoration projects that alter the form, structure, or landscape setting of a stream or wetland. The performance of projects can be evaluated in the following regards:

- condition of the affected stream or wetland relative to its expected project performance (e.g. relative to a suitable CRAM habitat development curve (HDC)),
- relative to its project-specific desired or target CRAM condition score, and
- compared to baseline or ambient conditions within its surrounding watershed context.

These approaches to project performance evaluation (as discussed here) require assessing the project site over time using CRAM, and two of them require plotting the scores on a suitable CRAM HDC or CDF of the same wetland type as the project.

HDCs are plots of CRAM scores for natural wetlands and projects of different ages. The best-fit regression curve relating condition (CRAM scores) to age can be used to forecast future expected conditions and the rate at which they might develop. There can be different HDCs for different wetland types and, for each type, there can can be regional or statewide HDCs. By plotting the CRAM Index and Attribute Scores for a project on its appropriate HDC, its likely future condition scores can be estimated. A useful performance target or criterion is that project CRAM Index Scores should fall on or above the HDC of the same wetland type, or the trend in scores should intercept the HDC within a reasonbale period, as evidenced by project monitoring over time. Attribute Scores and their component Metric Scores can be evaluated to guide enhancements of poorly performing projects.

HDCs have been developed for estuarine (tidal marsh) and depressional (pond) wetland types based on CRAM assessments across California.   They are available online through the Project Information Page on EcoAtlas and project CRAM scores are plotted on the curve only after the project is complete and the project-end-date has been entered into Project Tracker. There is no finalized statewide or regional HDC for streams that can be incorporated into the D5 Project at this time. A regional stream HDC for Southern California’s Coast Range was developed that employed a slightly different methodology. It is not applicable to Santa Clara County, or the greater Bay Area due to major differences in climate and geology. An example of how project Index Scores are plotted on an the statewide HDC for tidal estuarine wetlands available through EcoAtlas is presented in Figure 19.

A project's Index Scores that consistently plot below the curve is not performing as expected and may warrant further intervention to succeed. Review of the Attribute and Metric Scores in conjunction with other environmental data can be used to guide changes in the project design, or management to improve poorly performing ecological functions, and overall condition.

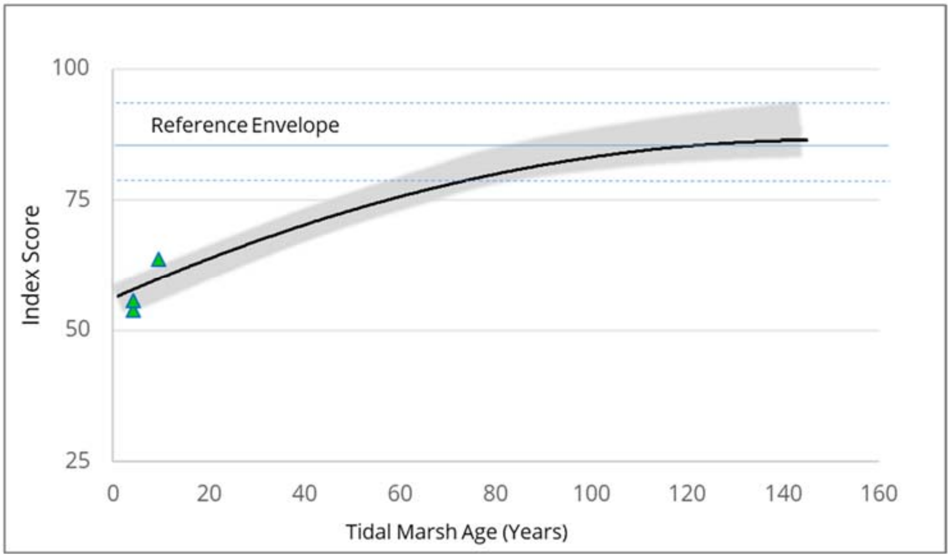

Figure 19. Statewide Habitat Development Curve (HDC) for tidal marsh based on CRAM Index Scores. The shaded area is the 95% Confidence Interval around the curve. The light blue solid and dashed horizontal lines represent the mean and standard deviation of reference site scores (also called a reference envelope). Sites that plot within the reference envelope have achieved reference (target / desired / successful) condition. Sites plotting above the curve, but below the reference envelope are likely to eventually achieve reference condition. Sites scoring below the curve either will not achieve reference condition or may achieve it more slowly, perhaps with intervention. Post-project CRAM scores from an example restoration project assessed at 5- and 10-years after project completion are overlaid in the HDC (green triangles). After 5 years, project condition was slightly below the curve, but within the confidence interval as evidenced by the two CRAM assessments conducted on the project site at year-5. After 10 years, the project condition plotted slightly above the curve. If additional assessments over time plot above the curve, the project is predicted to achieve reference condition, and is performing as desired.

Please refer to the CRAM Technical Bulletin (CWMW 2019) for more information on ways to assess project performance.

The CDF/HDC is instrumental in project planning and tracking in a watershed context using CRAM. It serves to visualize and quantify the status of a project (both pre- and post-project) relative to ambient baseline conditions, which helps evaluate the project's potential contribution to watershed stewardship goals, mitigation performance, other targets of desired condition. The CDF/HDC allows project managers to set reasonable and quantitative performance targets in the design phase, and when tracking performance over time. It is a valuable tool for adaptive management and performance of multiple projects can be analyzed to evaluate the effectiveness of watershed plans.

The following hypothetical project in the Sunnyvale West Channel, West Valley watershed, illustrates tracking performance over time based on a watershed CDF, with considerations for setting targets, and evaluating project performance in a watershed context.

For this hypothetical project, two CDFs were selected for performance evaluation: CRAM Index CDF for the West Valley watershed, and CDF for the Sunnyvale East and West Channel subwatershed. The CDFs were generated from the D5 Project's ambient stream condition survey completed in 2018. The hypothetical project assessment data represent pre-project conditions and post-project, year-5 conditions. The CRAM assessment scores are presented in Table 9 and plotted on the CDFs in Figure 20 below.

Table 9. Pre-and post-project CRAM scores for hypothetical Project A on the Sunnyvale West channel

Assessment Period	***Project A CRAM Scores***				
	Index	***Buffer and Landscape Context***	***Hydrology***	***Physical Structure***	***Biotic Structure***
Pre-project	49	62.50	66.67	37.50	30.56
Post-project Year-5	61	62.50	66.67	50.00	64.00

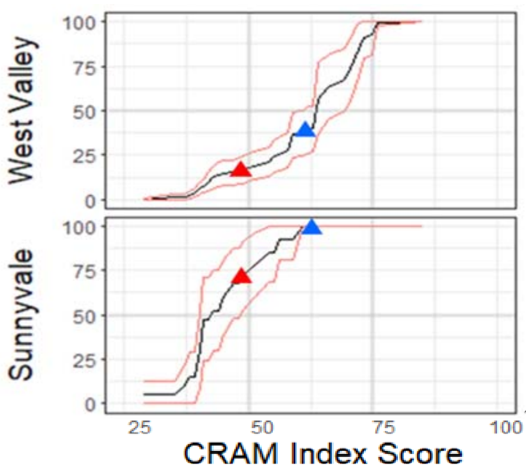

Figure 20. Pre-project (red triangle) and 5-year post-project (blue triangle) CRAM Index Scores for hypothetical Project A plotted on the CDFs for the West Valley watershed and Sunnyvale subwatershed

Improving the Physical and Biotic Structure to the scores shown in Table 10 would have been accomplished by establishing site features in hypothetical Project A designed from descriptions in the CRAM Riverine field book. Plotting pre and post-project (year-5) CRAM Index Scores on the CDF for the West Valley watershed (as a whole) indicates that in the five years since its completion, the project improved overall ecological conditions within the project AA from being in the 20th percentile (poor condition) to the 40th percentile (fair condition). Plotting the same pre- and post-project Index Scores on the Sunnyvale subwatershed CDF indicates that the project has improved conditions of the AA from the 67th percentile to the top of the CDF (best observed condition wthin the subwatershed).

The two plots yield different performance evauations. This signifies the importance of CDF selection for setting performance targets and evaluating project performance. Selecting a CDF that does not include most of the full range of possible CRAM scores (between 25-100) will bias the evaluation, may lower the performance bar, and will grade on the curve. For example, since the CDF for the Sunnyvale subwatershed does not include scores above 60, actions that achieve that score match the best observed conditions, and might therefore be falsely evaluated as good, even though Index Scores of 60 are considered fair ecological condition. It is important to consider both a subwatershed and larger watershed CDF, and the full range of possible CRAM scores (between 25 and 100) when setting and evaluating project performance expectations. When evaluating project performance in relation to local CDF curves, it is important to bear in mind that good ecological condition scores must be above 75. The use of either CDF does not preclude establishing reasonable and attainable stewardship targets, and improving overall conditions from very poor to fair condition can represent a significant lift for some site-specific streams and wetlands.

Another way to use CRAM and baseline ambient stream conditon survey CDFs in project planning and performance tracking is to aim to increase the proportion of streams in good overall ecological condition. Targeting poor, or low-scoring fair condition sites, and improving their condition to above the 50^{th} percentile score of the local watershed (or regional) CDF should eventually shift the CDF curve to the right (reflecting a higher proportion of stream miles in better overall condition). Raising the 50^{th} percentile CDF score is a watershed- or regional-scale performance target that translates directly into a project-scale target. Each project must score above the 50^{th} percentile of the selected CDF for the corresponding score of the CDF to eventually increase. Targetting the lowest scoring stream reaches for stewardship (i.e., restoration or enhancement) should more rapidly increase the 50^{th} percentile score of future ambient condition assessments, while decreasing the percentage of the stream miles with poor scores.

Over time, the focus of stewardship can shift from improving poor condition streams to improving fair condition streams, as poor conditon streams are improved. Stewardship should also include preserving and enhancing good condition streams. On the way to success, a stewardship program can use this scientific framework and monitoring data to prioritize stewardship actions.

Valley Water's One Water Plan is employing CRAM to track performance of some core objectives for the Coyote Creek watershed. CRAM's internal reference range of scores set and track targets, such that projects should achive CRAM Attribute Scores above 75 in the future. In addition, a watershed-wide resilient habitats goal is set to increase the percentage of stream miles in good ecological condition compared to the current D5 Project's baseline ambient surveybased on CRAM (https://www.valleywater.org/your-water/one-water-plan).

5.3. Reference Sites

Reference sites are stream reaches and wetlands that exhibit high quality, best achievable, or desired conditions; ideally, completely natural or pristine conditions. Reference sites are sometimes interpreted from historical conditions, when there was less human alteration. This can be risky based on the availability of past site condition data, changes in land use, water supplies, drainage, and climate. Stream reaches and wetlands with good condition CRAM Index Scores ($\geq$76) are potential reference sites. In addition, high scoring Attributes, Metrics and submetrics (with A ratings) show desirable reference habitat characteristics and features. CRAM scores $\geq$76 and A ratings may not be achievable based on a variety of environmental conditions, thus relative comparisons to ambient watershed-specific CRAM surveys are more appropriate. Use of a reference range from multiple sites, when available, is preferred to using one site.

Reference sites and measures of reference condition can have important roles in habitat conservation, creation, restoration, and enhancment design, and project performance tracking. The meaning of reference condition for CRAM has evolved in recent years to emphasize two things: a *statewide endpoint* that defines the best possible condition of a wetland that has not been antropogenically altered; and an *interim condition* that indicates adequate mitigation or restoration progress given its regional and landscape setting. In either sense, the reference condition is represented by a range of acceptable conditions, referred to as the reference envelope, rather than a single case or numerical value. The reference envelope can be determined as the mean and standard deviation in condition among reference sites. The selection of reference sites should be based on a set of criteria that clearly explain the rationale for site selection and usage. For tracking project progress, the interim reference range should be comprised of reference sites that at a minimum have CRAM Index Scores above 75 (CWMW 2019).

Reference envelopes for the statewide endpoint of best achievable condition can be fitted to CDFs for areas lacking such conditions at the time (i.e., no sites are available with a CRAM score >75). For example, the reference envelope from the statewide stream condition survey (CWMW 2008) could be used to define success for stewardship in the Sunnyvale and West Valley watersheds, where best achievable conditions are not evident at this time (Figure 21).

Actual sites can be used to see what real, on the ground reference conditions are at a local scale. The CRAM database can be accessed through EcoAtlas to locate CRAM sites within a planned project's watershed (or within Santa Clara County for Valley Water projects) that have Index and/or Attribute Scores that fall within the statewide reference range. Those data can be downloaded and sites can be visited to explore what constitutes reference conditons for project design and planning purposes. For information about developing project reference sites, please refer to the CWMW (2019) CRAM Technical Bulletin.

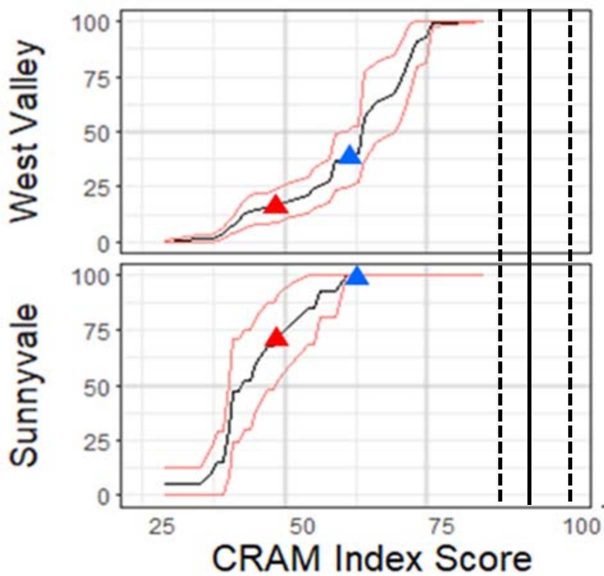

Figure 21. Pre-project (red triangle) and 5-year post-project (blue triangle) CRAM Index Scores for hypothetical Project A plotted on the CDFs for the West Valley watershed and Sunnyvale subwatershed with a statewide reference envelope based on scores from reference sites representing the desired final endpoint conditions for restoration/mitigation projects (black vertical lines). Dashed vertical lines represent the standard deviation in condition of the statewide reference sites and solid black vertical line represents their average condition.

6. Minimize and Mitigate Risks to Stream Condition

The D5 Project provided a baseline assessment of the amount, distribution, and diversity of streams and wetlands in five major watersheds in Santa Clara County, along with a probability based ambient assessment of the overall condition of stream resources (from 2010 to 2018) against which future changes in the condition of their streams can be compared. The most likely major sources of change in ambient condition for the next few decades are land use, climate, and direct human alteration. These three factors represent risks that stream condition might decline. Despite decades of environmental protection, pressures remain to alter streams and their habitats by draining, channelizing, excavating, vegetation clearing, filling, damming, hardscape, culverts and piping, etc. The principles of flood control, storm damage prevention, and to some extent, vector control are based on removing water from the landscape as quickly as possible, rather than retaining it. Advances in green infrastructure, best management practices, and Leadership in Energy and Environmental Design (LEED) are fairly recent, and implemented on limited scales. Most land development continues to add impervious hardscape, altering stream flows and water quality. In addition, alteration of stream channels, wetlands, and riparian habitat might have impacts that are not adequately mitigated. Studies show that most mitigation is not successful (Ambrose *et al.* 2007, Mathews and Endress 2008, Mathews 2015). Climate change may chronically disturb and destabilize stream systems, and poorly designed stewardship actions, such stream restoration and enhancement, may fail to achieve their target conditions. Projects, mitigation, and stewardship actions may also fail to adequately plan for land use and climate change. These impacts are interrelated and together give rise to significant secondary risks, such as biological invasion, water contamination, increased flooding, erosion and sedimentation.

Stewardship actions, restoration and mitigation need to adequately plan for/address these impacts and risks. The D5 Project could be used to help resource managers evaluate risks, avoid and minimize them. Specific goals being to understand baseline conditions within a watershed context to help prioritize mitigation and stewardship actions, and apply CRAM and ecological designs to projects to improve coordinated monitoring and watershed health over time.

6.1. Biological invasion

The invasion of stream riparian zones by nonnative, invasive vegetation is already a ubiquitous problem. Its impacts are likely to continue unless a concerted effort among land owners to effectively treat the invasion is conducted. Valley Water implements the Invasive Plant Management Program (IPMP) as mitigation for SMP to control listed invasive plant species on its fee title properties and easements. Project D2: Revitalize Stream, Upland and Wetland Habitat, other Safe, Clean Water and Natural Flood Protection Program projects and grants are attempting to reverse the trend. The first technical step in treatment of invasive species would be the production of a comprehensive map of the invasions, which Valley Water has under its IPMP, and early detection and rapid response (EDRR) networks. There are statewide attempts to do this (e.g., see the California Invasive Plant Council (Cal-IPC) and Calflora). H.T. Harvey and Associates (2018) recently completed a survey that was funded by Valley Water of key nonnative vegetation along Coyote Creek on City of San Jose property. In addition, results of the D5 Project stream condition surveys using CRAM identified the dominant invasive species within Santa Clara County watersheds (those data are available for download on EcoAtlas).

6.2. Land development

The negative impacts of roads, parking lots, buildings, and other land development are likely to continue unless economically and politically difficult mitigating measures are taken. The main measure might be to increase the width, continuity, and spatial complexity of the riparian zones along streams that border roads, suburban and urban areas. Ordinances related to stream setbacks, when established and enforced can accomplish this. The buffer and landscape context metric in CRAM shows land uses causing poor, fair, and good environmental conditions.

Installing best management practices, including Low Impact Development (LID) and LEED measures, should be used to retain and treat runoff from roads, parking lots, and rooftops, before it reaches the streams and their associated riparian areas. This can also assist with minimizing flood risks by reducing peak storm flows. Given that modern paved roads are a major source of microplastics in developed landscapes (Sutton *et al.* 2019), LID can also help reduce microplastic loading into streams. GreenPlan-IT can be very helpful in siting cost-effective LID installations.

Other human uses of the County's streams and riparian habitats, particularly camping, causes different types of land development impacts. The occurrence of homeless encampments adjacent to water bodies has been linked to their contamination (Devuona-Powell 2013, White 2013). These are socio-economic and public health problems, where affordable housing and improved medical care provide substantial solutions. Valley Water has spent considerable resources to clean creekside camps, in cooperation with municipalities, including providing social services. Also in partnership with cities, Valley Water monitors water quality, and removes trash and debris under the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). How the homeless encampments along streams will change in the future is uncertain, but the crisis has lasted decades, and is getting worse.

6.3. Climate change impacts

Climate change is likely to exacerbate all other threats to stream condition through economic as well as ecological and hydrogeomorphic relationships. With regard to the distribution, abundance, diversity, and conditions of aquatic resources in the San Francisco Bay Area, the most important climatic parameters are precipitation and evaporation (water loss with higher temperatures and wind). For the south Bay Area watersheds, the most important physical processes affected by changes in these parameters are evapotranspiration and runoff, or stream flow. Changes in these processes can have major effects on the hydrologic cycle and therefore, influence all ecosystem goods and services, including water supplies. Valley Water should and is considering the likely consequences of climate change on its mission to meet the demands of its service area for water supplies, flood management, and healthy watersheds[5].

Forecasts of future climatic conditions based on the best available science suggest precipitation amounts and patterns will change (e.g., rainstorm intensity and frequency), temperatures will rise resulting in increased evaporation, and previously normal seasonal variations will change. These will affect flows and hydrology that drive stream ecosystem condition and flood risk. Demand for water resources and flood protection will most likely increase, or remain constant with continued conservation efforts and managed urban growth.

Efforts to forecast local changes in temperature and precipitation are ongoing (Association of Bay Area Governments 2012), based on the various scenarios for greenhouse gas emissions and resultant temperature changes provided by the International Panel on Climate Change (IPCC 2013). It is important to note that during the last decade, greenhouse gas emissions have exceeded the highest levels considered, such that the forecasts of "worst case" scenarios are increasingly likely (Ackerly et al. 2012, 2018).

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[5] http://www.valleywater.org/Services/ClimateChange.aspx

Many independent models suggest that mean annual temperature in the Bay Area will increase between 2 ^{o}C and 6 ^{o}C (3.6 ^{o}F and 10.8 ^{o}F) by the final decades of this century (Cayan et al. 2011), based on climate change scenario B1 (IPCC AR4 SYR 2007), which assumes major reductions in greenhouse gasses during this century (IPCC AR4 WG1 2007). Recent reports suggest that by 2080, the climate in San Francisco Bay Area would be 40 percent drier, about 7 degrees hotter in the winter (Fitzpatrick and Dunn 2019), and the number of extreme hot days will increase (Dahl et al. 2019). Future increases in temperature, regardless of whether total precipitation goes up or down, will likely cause longer and deeper California droughts, posing major problems for water supplies, natural ecosystems (Ackerly et al. 2018). Future regional changes in precipitation are more difficult to predict. Precipitation in the Bay Area will continue to exhibit high year-to-year variability, with very wet and very dry years. The region's largest winter storms will likely become more intense, and potentially more damaging, in the coming decades (Ackery et al. 2018). For the Santa Cruz Mountains in the south Bay Area, a recent modeling effort has predicted reduced early and late wet season runoff, and possibly a longer dry season, with greater inter-annual variability, and potentially increased rainfall intensity (Flint and Flint 2012). Forecasts of increased precipitation show it concentrated in mid-winter months, such that peak flows in streams are increased. As indicated above, these forecasts might be conservative, given that gas emissions have not been curtailed to date.

With regard to climate change, it is likely that the forecasted increases in storm intensity will cause an increase in peak flows, while increased temperature will generally cause an increase in total annual evaporative losses. Unless these losses are offset by increased groundwater storage, the total annual amount of water in the watershed will probably decrease, becoming drier with less acreage of wetlands, lower aquifers, and greater total lengths of ephemeral or episodic streams. The increased erosive power of higher peak flows would probably initiate a new period of channel incision and head-cutting, especially where flows are contained by entrenched channels. The resulting increase in sediment yield would increase the rate at which flood control channels aggrade, thus losing conveyance capacity. Dredging flood control channels to regain or maintain their capacity would likely impact in-stream resources, especially through downstream decreases in coarse sediment and increases in siltation. There would also be significant costs and risks associated with disposing dredged materials. Even with dredging, the aggradation of channels in valleys would likely increase the risk of flooding. More intense or frequent storms may also directly result in increased flooding, regardless of channel aggradation.

The CRAM monitoring conducted by the D5 Project supports change detection using secondary or responsive, rather than predictive indicators. The value of the monitoring results could be greatly increased by using them to develop and calibrate numerical models designed to forecast future conditions, based on alternative scenarios for land use and climate change, and stewardship actions. In this regard, Valley Water might consider intensifying its efforts to monitor stream flow, and water temperature in streams. The Riparian Zone Estimator Tool

(RipZET) could be further developed to assess the effects of riparian forest restoration on stream temperature. These kinds of efforts to build predictive models would enable Valley Water to proactively adjust its stewardship for the future.

Any efforts to improve stream conditions through purposeful changes in the form or structure of channels or their riparian areas should reflect the best available information on likely future changes in rainfall and temperature regimes. Scientific frameworks and guiding principles are available to help assure the success of large-scale ecological restoration (e.g., Beller et al. 2015).

Table 11 lists possible major effects of climate change on the distribution and abundance of aquatic resources in the five major watersheds. Valley Water should consider the effects of these changes on its ability to continue providing reliable water supplies, flood protection, meet stewardship goals and objectives, and how the effects might be ameliorated by management actions. It must be recognized that much more science is needed to understand the likelihood of these effects. How the hydrologic changes will affect riparian habitats are less known, especially regarding drought and wildfires. Will southern riparian species migrate north, tree health and cover decline, forests be replaced by chaparral, etc.?

Table 11. List of possible landscape responses to climate change

Climate Change	*Potential Major Landscape Effects*
Increased temperature translates into increased evaporation, which has similar landscape-scale effects as decreased precipitation	Decreased dry season surface water storage
	Depressed aquifers
	Decreased acreage of perennial wetlands
	Increased acreage of seasonal wetlands
	Reduced perennial stream base flow
	Reduced total length of perennial streams
	Increased total length of episodic streams
	Increased risk of wildfires
Increased precipitation, or decreased duration of the wet season with no increase in precipitation, translates into increased peak flows	Increased channel incision and bank erosion in upper watershed
	Increased channel head-cutting
	Increased hillslope gullying
	Increased landslides
	Increased sediment yields
	Decreased reservoir capacity
	Reduced flexibility to manage reservoir levels and stream flows
	Increased threat of flooding and storm damage

A growing number of Bay Area local governments, regional agencies, nonprofits, and private sector organizations have initiatives to advance climate planning and adaptation. Examples include Resilient by Design: Bay Area Challenge, Sonoma County Regional Climate Authority, Adapting to Rising Tides, Bay Area Regional Reliability Project, RISeR SF Bay, Marin County C-

SMART, Sea Change San Mateo County, Climate Ready North Bay, San Francisco Bay Restoration Authority, Bay Regional Regulatory Integration Team, Bay Conservation and Development Commission Bay Plan Amendment, San Francisco Bay Shoreline Adaptation Atlas, and the forthcoming Amendment of Bay Area Regional Water Quality Control Basin Plan. Valley Water should become familiar with these initiatives and collaborate with them as appropriate. A regional approach to climate change adaptation at the landscape or watershed scale is warranted (Beagle *et al.* 2019).

7. General Recommendations for Stream Stewardship

Valley Water owns a significant portion of the stream networks in the developed Lowland Valley region of Santa Clara County's five major watersheds (see Figure 11 and Table 6 in section 3.5 on page 18). This means that streams managed directly by Valley Water are largely subject to upstream land management practices and policies of other entities. This puts a premium on partnerships between these entities and Valley Water to manage threats to stream condition. The partnerships might consider using common or shared performance targets (see section 5 above) to coordinate and monitor progress of their various stream stewardship efforts. The partners might also use Project Tracker[6] in EcoAtlas to inventory and visualize their projects together in a watershed (or landscape) context. This will encourage coordination of the siting, planning, and design of projects across programs to maximize their positive synergies, which in turn will help avoid, or mitigate the impacts of changes in land use, accommodate climate change, improve the individual and collective performance of projects.

In addition, Valley Water is a partner in the Santa Clara Valley Habitat Plan, which is both a habitat conservation plan (HCP) and natural community conservation plan (NCCP, see https://scv-habitatagency.org/). The Valley Habitat Plan covers the Coyote Creek, upper Pajaro River, and most of the Guadalupe River watersheds. It provides environmental permitting with in lieu fee mitigation. The plan changed about two-thirds of Santa Clara County's environmental regulatory landscape in 2013 by replacing permittee-responsible onsite and in-kind mitigation with a reserve system of land in conservation, primarily in the Foothills and Headwaters. The plan also requires stream and wetland restoration in the developed Lowland Valley.

The analyses reported above suggest a broad approach to stream restoration within the five major watersheds in Santa Clara County: preserve the Headwaters, restore the Foothills to

[6] The San Francisco Bay Regional Water Quality Control Board requires permittees to upload project information to Project Tracker, with will support coordinated planning in a watershed context.

extend good conditions from the Headwaters to the margins of the Lowland Valley, and target poor condition streams of the Foothills and Lowland Valley for restoration. Stream reaches with good CRAM Index Scores should be conserved throughout all regions of the five watersheds. Continued assessment of stream and watershed ecological condition is critical to understanding environmental stewardship, reevaluating management decisions, and demonstrating success, especially given land use and climate change.

Opportunities for stream preservation or restoration within the Lowland Valley should be identified by examining the existing CRAM assessments (section 4 and available on EcoAtlas), the Landscape Profile tool on EcoAtlas (described in Appendix B, Data Management and Access), and using the new Coyote Creek Native Ecosystem Enhancement Tool (CCNEET). A similar tool or tools should be created for other streams and watersheds.

Opportunities for improving the condition, buffer width, and connectivity of riparian habitats within the Lowland Valley should be identified. RipZET could be used to identify and prioritize riparian forest restoration opportunities, especially after the tool is augmented to forecast the effect of riparian shading on stream temperature. In addition, Valley Water's (2010) SMP riparian vegetation GIS data, Valley Habitat Plan geobrowser land use, and any future map efforts could be used to help identify opportunity areas to improve riparian connectivity along stream channels.

The CRAM metric scores should be used to guide project-specific design details by revealing the local changes in stream setting, physical and biotic structure needed to significantly improve overall ecological condition. In general, early experience with CCNEET plus existing CRAM scores (section 4.1.1) indicate that stream stewardship in the Foothills and Lowland Valley should focus on the restoration of multi-bench channels with active floodplains, and adjoining riparian forest at least 100 feet wide, including the replacement of invasive vegetation with native riparian trees, in combination with naturalistic flow regimes that will sustain the restored conditions. The California Environmental Flows Workgroup (see weblink in Appendix A) seeks to advance the science of ecological flow assessment, supporting management decisions by balancing natural resources with consumptive water uses.

To improve and support cross Valley Water programs and inter-agency coordination related to stream management actions, restoration and mitigation planning, all projects and recurring stream maintenance activities should be uploaded into Project Tracker of EcoAtlas. This will help plan projects together in a watershed context because it shows project footprints, provides basic project information, has a file archive, allows coordination between and among projects to establish ecological linkages, continuity, corridors, and prevent impacts or overlap.

A stream Habitat Development Curve (HDC) could be developed for the Bay Area Ecoregion or for Santa Clara County specifically. CRAM–based CDFs and a local, stream HDC could be used to set project performance targets track performance over time. Every project should at least score above the 50th percentile of the CDF for its watershed or the five watersheds in Santa Clara County as whole, assuming the CDF covers the full range in condition from poor to good based on the standard CRAM condition classes. Projects should also score on or above the HDC, or be on a developmental trajectory to intercept the HDC within 5 to 10 years of project completion.

CRAM–based CDFs should also be used to help set performance targets for stream stewardship overall. The target for each major watershed could be based on increasing the amount of streams that are in good ecological condition based on the D5 Project's baseline ambient surveys, or based on a statistically significant increase in the CRAM Index Score corresponding to the 50th percentile of the stream CDF. Progress toward the target would be tracked through decadal reassessments of ambient stream condition employing the GRTS survey design and analysis methods, as currently done by the D5 Project.

The CRAM Index and Attribute CDFs for each major watershed and its subregions (Lowland Valley, Foothills, and Headwaters) should be recalculated for each decadal assessment to assess changes in ambient condition. The interim changes in total impervious surface area, miles of restored streams, ambient stream temperature, air temperature, precipitation, and in-stream flow regime should be monitored to help explain the relative influences of stewardship, land use and climate change on ambient stream condition. Valley Water's network of stream, reservoir, and precipitation gauges, which is expanding, could be applied to the analyses, climate trend studies, and selected water quality measurements made at the stations (see http://alert.valleywater.org/).

The inventory of wetlands (BAARI) and riparian areas (RipZET or the SMP GIS dataset) should be updated for the County every decade or two to serve as the sample frame for the CRAM-based probabilistic ambient surveys of condition, and asses changes in the distribution, abundance, and diversity of wetlands and riparian areas.

Valley Water should consider adding depressional wetlands (ponds), lacustrine wetlands (vegetated margins of lakes and reservoirs), and tidal Baylands to the D5 Project's ambient condition surveys based on CRAM.

Valley Water should produce a public summary report on the health of streams and other surface waters following each decadal assessment. The next report should be based on the results and recommendations of findings herein, and additional information decided by Valley Water.

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Appendix A. Glossary of Key Terms and Web Links

California Environmental Flows Workgroup	California Environmental Flows Workgroup is a workgroup of the State Water Quality Control Board's California Water Quality Monitoring Council. Its mission is to advance the science of ecological flows assessment and its application for supporting management decisions aimed at balancing natural resource needs with consumptive water uses to establish environmental flows. Website: https://mywaterquality.ca.gov/monitoring_council/environmental_flows_workgroup/index.html
D5 Project	Valley Water's Safe, Clean Water and Natural Flood Protection Program, Priority D, Project D5: Ecological Data Collection and Analysis https://www.valleywater.org/project-updates/d5-ecological-data-collection-and-analysis
Five major watersheds	The five major watersheds of Santa Clara County assessed by the D5 Project include the Coyote Creek, Guadalupe River, Lower Peninsula (within the Santa Clara County), upper Pajaro River (including Uvas and Llagas Creeks Pacheco Creek watersheds within the County) and West Valley watersheds (see https://www.valleywater.org/learning-center/watersheds-of-santa-clara-valley). It does not include the Alameda Creek watershed in northeast Santa Clara County. The D5 Project's individual watershed assessment reports are available on the D5 Project and SFEI's websites: https://www.valleywater.org/project-updates/d5-ecological-data-collection-and-analysis, https://www.sfei.org/node/6075#sthash.2JTccY7s.dpbs
Stream Maintenance Program (SMP)	Valley Water's Stream Maintenance Program. The SMP works to improve the environment, reduce the risk of flooding and keep communities safe. The SMP actively manages streams below the 1,000 foot elevation contour, including partly within the Baylands of Santa Clara County. https://www.valleywater.org/flooding-safety/stream-maintenance-program
Stream	The Technical Advisory Team established by the State Water Resources Control Board (SWRCB) to support development of the Stream and Riparian Area Protection Policy on specific topics recommended the following definitions for a stream in its Technical Memorandum No 2: Wetland Definition (SWRCB TAT 2012). A stream is a wetland having a physically defined course of perennial, seasonal, or episodic surface water flow inclusive of visibly evident physical, chemical, and biological processes and conditions resulting from recurrent interactions among the surface flow, subsurface water if it exists, and the adjacent landscape. Simply stated, a stream is a channel plus its riparian area. The stream definition is consistent with the California Department of Fish and Wildlife (CDFW) definition, and is the same as the Regional Water Quality Control Board definition. Other regulatory agencies do not have a stream definition. A stream can include a number of different kinds of wetlands (including riverine, palustrine, depressional, or slope/seep wetlands) as well as its riparian area.
Wetland	The SWRCB adopted the *State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State* (Procedures, SWRCB 2019) for inclusion in the forthcoming Water Quality Control Plan for Inland Surface Waters and Enclosed Bays and Estuaries and Ocean Waters of California, effective May 28, 2020. The wetland definition is basically consistent with the USACE, CDFW, and BCDC. The Procedures define a wetland as: An area is wetland if, under normal circumstances, (1) the area has continuous or recurrent saturation of the upper substrate caused by groundwater or shallow surface water or both; (2) the duration of such saturation is sufficient to cause anaerobic conditions in the upper substrate and; (3) the area either lacks vegetation or the vegetation is dominated by hydrophytes.
Riparian Areas	The Technical Advisory Team established by the SWRCB to support the development of the Stream and Riparian Area Protection Policy on specific policy topics recommended the

	following definition for riparian areas in its Technical Memorandum No 2: Wetland Definition (SWRCB TAT 2012). Riparian Areas are areas through which surface and subsurface hydrology connect water bodies including wetlands, lakes, estuarine and marine waters with their adjacent uplands. The riparian areas include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems. The riparian definition is consistent with recommendations by the National Research Council and is broader, and more inclusive of other definitions.
CRAM	California Rapid Assessment Method for wetlands (CRAM, www.cramwetlands.org) is a science based, standard field method to assess the overall ecological condition of streams, and other wetland types within California by assessing and scoring observable measures of condition.
Subregions defined in this report	The three subregions defined in this synthesis report include the: 1) Lowland Valley that generally identifies the edge of urban and agricultural development in the valley floor and adjacent lands; 2) undeveloped Foothills - between the Lowland Valley and SMP's 1,000 ft. elevation boundary; and 3) Headwaters – undeveloped areas in the upper watersheds above the SMP boundary.
Lowland Valley	The developed Lowland Valley extent was created by SFEI for this memorandum. The boundary generally identifies the extent of urban, residential, and agricultural land uses within the five D5 Project watersheds. The area covers the Santa Clara / Almaden / Silicon Valley floor and can include portions of the foothills with dense residential, quarries, golf-courses or similar land uses.
Foothills	The undeveloped Foothills is the region between the Lowland Valley and SMP's 1,000 ft. elevation boundary. The SMP actively manages streams below that elevation contour, thus the D5 Project characterized the condition of streams within this managed region separately from the Headwaters, which are outside Valley Water's area of management.
Headwaters	The undeveloped Headwaters include the upper regions of the five major watersheds in the County above the SMP's 1,000 ft. elevation boundary. First order streams at the top or uppermost elevations (as mapped by BAARI) were not included in the CRAM stream assessment and not summarized in the Level 1 summaries in this report (with the exception of Table 2).
GRTS survey design and analysis methodology	Generalized Random Tessellation Stratified (GRTS) survey design and analysis methodology developed by the United States Environmental Protection Agency (USEPA) for monitoring and assessing streams and wetlands. The GRTS survey design for the D5 Project is a spatially balanced random sample of candidate CRAM assessment sites. The GRTS survey analysis outputs are cumulative distribution function estimates of the condition of stream resources within a specific surveyed area. https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NHEERL&dirEntryId=234794
CDFs	Cumulative Distribution Function estimates the condition of stream resources within a specific surveyed area. CDFs presented in this synthesis report are the analysis output of a GRTS survey (ambient survey) and field assessment employing CRAM for streams.
EcoAtlas, Landscape Profile tool, and Project Tracker	EcoAtlas (www.ecoatlas.org) is a public website of environmental data that supports mitigation planning, monitoring, and assessment. The website hosts CARI, CALVEG, USGS hydric soils, CRAM, Project Tracker, and many other spatial and site-specific datasets that support resource management planning and tracking within a landscape context. The Landscape Profile tool (https://www.ecoatlas.org/about/#landscape-profile) summarizes ecological information serviced by EcoAtlas at various user-defined spatial scales for assessment, planning, and reporting. The summarized information can be downloaded as Adobe .pdf documents. Ambient stream and wetland condition survey CDFs, based on CRAM, are available on the site within the Landscape Profile tool. Currently, EcoAtlas includes the following CDFs based on past GRTS surveys: statewide streams, tidal and

	depressional wetlands; Ecoregional and local watershed streams including Valley Water's D5 Project's Stream Condition Surveys. Project Tracker (https://www.ecoatlas.org/about/#project-info) is a data entry tool for uploading and editing information on wetland restoration, mitigation, and habitat conservation projects. Project information can be viewed and downloaded along with other projects and data layers on EcoAtlas. Improved tracking and mapping of project activities will allow for better analyses of changes in habitat extent, landscape-scale conservation planning, evaluation of progress towards meeting resource management objectives, and leveraging of restoration resources.
RipZET	The Riparian Zone Estimation Tool (RipZET) is an Excel and GIS-based modeling tool developed by the SFEI for the California Riparian Habitat Joint Venture and the SWRCB to assist in the visualization and characterization of riparian habitats adjacent to streams and wetlands. RipZET estimates the likely extent of riparian areas based on the concept of "functional riparian width." According to this concept, various riparian functions can extend different distances from their adjacent surface waters, depending on topographic slope, vegetation, and position along a drainage network. https://www.sfei.org/projects/ripzet, https://www.sfei.org/content/ripzet-and-users-manual
SFEI's Data Center	SFEI is the regional data center for the San Francisco Bay-Delta and northern montane regions. The Institute manages water quality, tissue, aquatic resources (streams and wetlands), historical, and geospatial data, and develops tools for uploading, accessing, and visualizing environmental data. https://www.sfei.org/sfeidata.htm
Wetlands and Riparian Area Monitoring Plan (WRAMP)	The Wetlands and Riparian Area Monitoring Plan (WRAMP) of the California Water Quality Monitoring Council (see https://mywaterquality.ca.gov/eco_health/index.html) is a plan for comprehensive monitoring and assessment of aquatic resources using a watershed or landscape context. WRAMP, like USEPA's three-tier monitoring and assessment framework (https://www.epa.gov/wetlands/wetlands-monitoring-and-assessment), includes three levels of assessment and analysis, and provides the framework for making these three levels of assessment work together in the analysis of the overall condition, and viability of aquatic resources within a watershed. For WRAMP see https://mywaterquality.ca.gov/monitoring_council/wetland_workgroup/index.html#frame).

Appendix B: D5 Project's Watershed Survey Methods

Overview

In order to explain the D5 Project's monitoring and assessment methodology, it is necessary to provide some regulatory context for monitoring streams and wetlands. In 2003, a consortium of federal, state, and local scientists and managers began working to develop a science and technology based framework to support wetland and riparian monitoring, and assessment across a variety of California agency programs at various landscape scales. The purpose was to develop tools to assist in making informed decisions regarding wetland, stream, and riparian resource protection and management, and improve coordination and efficiency of regional, state, and federal wetland programs.

In 2010, the CWMW of the California Water Quality Monitoring Council, endorsed a watershed approach to environmental monitoring and assessment described in the State's *"Tenets of a State Wetland and Riparian Area Monitoring Program"* (April 2010). The watershed approach recommends standardized data collection, online access to data, and the use of the 3-level wetland monitoring and assessment framework recommended by the United States Environmental Protection Agency (USEPA). The watershed approach to restoration, resource management and planning has since been adopted into State's 401 certification regulation with the *State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State* (Procedures) effective May 28, 2020.

The 3-level framework includes collection of geospatial mapping of aquatic resources (Level 1) usually managed within a GIS, rapid field assessments of mapped resources using a probability-based or targeted sampling design (Level 2), and additional water quality or ecological field sampling (Level 3) to address specific physical, biological, or chemical questions related to regulatory requirements for the protection of aquatic resources and wildlife.

Level 1: GIS-based landscape level data

For each watershed, an initial assessment of the amount, distribution, and diversity of streams, and other wetland types was done using the best available geospatial data. Secondary datasets were used to identify or summarize stream ownership, protected areas, extent of development, watershed extents, and for the Riparian Zone Estimation Tool (RipZET).

The D5 Project is using the best available geospatial data of streams and wetlands to characterize the amount, distribution, and diversity of aquatic resources within the five major watersheds in Santa Clara County. In the Coyote Creek, Guadalupe River, Lower Peninsula, and West Valley watersheds, BAARI was used for assessing both streams and wetlands. Valley Water's "Creeks" GIS-layer was employed for assessing streams in the upper Pajaro River watershed within Santa Clara County. Both of these datasets have been incorporated into

CARI v0.3 (SFEI 2017), the statewide GIS layer of stream and wetland resources that is standardized to a common classification system and is available to download on SFEI's Data Center web-page (www.sfei.org/sfeidata.htm) and visible on EcoAtlas (www.ecoatlas.org).

The following GIS datasets were used in the Level 1 assessments. They were developed by SFEI, provided by Valley Water, or publically available online as referenced below:

- Bay Area Aquatic Resources Inventory (BAARI *streams* & *wetlands* layers v.2.1) for four of the five major watersheds within Santa Clara County
- BAARI Mapping Methods
- California Aquatic Resources Inventory (CARI v0.3) wetland polygon layer for the upper Pajaro River Watershed[7]. San Francisco Estuary Institute (SFEI 2017)
- Valley Water's "Creeks" GIS layer (2004), based on 2001 countywide orthophotos for the upper Pajaro Watershed within Santa Clara County. SFEI added Strahler stream order, flow direction, and an estimate of natural and unnatural channel planforms (based on Santa Clara County Historical Ecology GIS data - SFEI 2008-2015).
- Santa Clara County line GIS layer (Valley Water 2007)
- Valley Water's Stream Maintenance Program (SMP) 1,000-foot elevation boundary. The SMP boundary is based on 2006 LiDAR contour datasets (Valley Water 2006)
- Valley Water-owned lands from Valley Water's fee title GIS layer (2009 [Unpublished]). Data layer was provided in August 2019
- California Protected Areas Database (CPAD, GreenInfo Network 2018)
- National Land Cover Database "Developed Layer" (NLCD 2016) used to help define the developed Lowland Valley extent
- Association of Bay Area Governments' 2005 land use layer. Urban/Non-Urban attributes were added to the stream and wetland GIS layers by intersecting them with a modified version of the 2005 land use layer. Employing this layer, 'Agriculture', 'Forest Land', and 'Rangeland' were classified as 'Non-Urban' and the rest of the classes were classified as 'Urban'.
- Santa Clara County Historical GIS Data. SFEI, 2008-2015. "Santa Clara Valley Historical Ecology GIS Data version 2". Data are available to download at: http://www.sfei.org/content/santa-clara-valley-historical-ecology-gis-data.
- The USDA Forest Service CALVEG (Zone 6 - Central Coast) data were used by RipZET to assign tree heights to estimate stream riparian extents using the Vegetation Processes module.
- Landcover GIS layer for the Santa Clara County Habitat Conservation Plan or Valley Habitat Plan (Jones and Stokes 2006). These data were used by RipZET to assign

[7] The CARI wetland GIS data for the upper Pajaro River watershed within Santa Clara County was sourced from the National Wetlands Inventory (NWI, USFWS 2008-2011)

tree heights to estimate forested stream riparian extents for the upper Pajaro Watershed.

- The USGS National Elevation Dataset (10-meter digital elevation model or DEM). Available at: https://lta.cr.usgs.gov/products_overview/
- U. S. and Canada Major Roads dataset, Tele Atlas North America (ESRI 2010)

D5 PROJECT WATERSHED AREAS

The five D5 Project's watershed extents were modified from Valley Water's "Santa Clara County Watershed" dataset for each individual survey. In general, the D5 Project team modified the boundaries to 1) clip to the Santa Clara County boundary, 2) remove tidal baylands and tidal streams (although with a few exceptions), 3) include portions of the Pacheco Creek and upper Pajaro River watersheds along the Santa Clara County boarder, and 4) ensure stream channels that followed the County boundary (e.g., San Francisquito Creek and Pajaro River) were included within the watershed extents. For more information about other specific modifications to the watershed extents, please refer to the individual ambient survey reports available on the D5 Project's website (here).

STREAMS AND WETLANDS DATA

The D5 Project selected the best geospatial datasets available at the time to characterize the amount, distribution, and diversity of aquatic resources within each of the five major watersheds in Santa Clara County, develop the survey design and sample draw for the watershed-based ambient stream condition surveys. As mentioned above, the Coyote Creek, Guadalupe River, Lower Peninsula, and West Valley watersheds, used BAARI for assessing both streams and wetlands. Valley Water's "Creeks" GIS-layer was employed for upper Pajaro River watershed assessment within Santa Clara County and CARI (sourced from the NWI) was used to characterize the amount and distribution of other wetland types in the upper Pajaro River watershed.

Valley Water's "Creeks" GIS-layer required minimal modifications, which included adding Strahler stream orders (Strahler 1952, 1957), flow direction, natural and unnatural reach designations to make it comparable to the BAARI streams dataset employed in the other four watershed surveys. Stream orders were required for the ambient survey sample draws for each D5 watershed. Stream order and flow directions are required for running RipZET, described below.

A comparison of the "Creeks" and BAARI datasets indicated that mapping methodologies and level of detail was different between the upper Pajaro River watershed ("Creeks") and the other four watersheds (BAARI). Headwater streams mapped in the upper Pajaro River watershed were more similar to 2^{nd} order streams mapped in the other watersheds. Therefore, the lowest order headwater streams mapped in the upper Pajaro River were designated 2^{nd} order streams to standardize the datasets across all five watersheds. As a result, summaries of the amount and distribution of stream resources across the D5 watersheds reported here do not include 1st order headwater streams mapped in BAARI. This was different from the original individual watershed assessment reports for the four major watersheds for which BAARI data was used to assess the amount and distribution of stream resources. Those reports included BAARI's 1st order stream reaches in their Level 1 analyses.

The GIS data for nonriverine wetland types in the upper Pajaro River watershed within Santa Clara County was sourced from CARI with the underlying data source being NWI, which employed different mapping standards than BAARI. Those data were standardized to a common classification system in CARI. The upper Pajaro River wetlands data were further reviewed and 'cleaned-up' to remove *riparian areas* adjacent to streams, which were not mapped in other watersheds. The following wetland types were mapped and classified within the D5 Project's five major watersheds: Slope and Seep Wetlands, Pond and Associated Vegetation, and Lakes, Reservoirs and Associated Vegetation. The open water portions of lakes and reservoirs were separated from wetland areas adjacent to them based on the CARI 'clicklabel' (grouping lacustrine nonvegetated vs. lacustrine emergent and vegetated, respectively).

It should be noted that, because of possible differences in the level of detail mapped between BAARI and NWI, the datasets may not be completely comparable, and summaries of the amount and distribution of nonriverine wetlands in the upper Pajaro River compared to the other four watersheds may not be as accurate as comparing between watersheds that were consistently mapped with BAARI. One would need to map portions of the upper Pajaro River watershed using BAARI mapping methods, then compare the two methods to understand the level of discrepancy, which was beyond the scope of the D5 synthesis effort.

SUBREGIONS (LOWLAND VALLEY, FOOTHILLS, AND HEADWATERS)

Assessment of the amount, distribution, diversity, and ecological condition of streams across the five D5 watersheds was done for three subregions to further characterize differences between the developed Lowland Valley and undeveloped upper watershed, while still characterizing the condition of streams within Valley Water's SMP boundary.

The three subregions (Figure B.1) include: 1) developed Lowland Valley that generally identifies the edge of urban and agriculture; 2) less developed Foothills - between the Lowland Valley and SMP boundary; and 3) Headwaters - above the SMP boundary.

SMP Boundary: Valley Water's SMP works to improve the environment, reduce the risk of flooding and keep communities safe. The SMP actively manages streams below the 1,000-foot elevation contour and within the Baylands throughout the County.

Developed Lowland Valley Boundary: The developed Lowland Valley extent was created by SFEI for this report. The boundary generally identifies the extent of urban, residential, and agricultural land uses, and was created from the existing Santa Clara County Historical Ecology GIS dataset (SFEI 2015) that identified the historical extent of the Valley Floor from geologic alluvial soils data. Edits were made to include developed areas that extend up into the watershed. Those edits used the NLCD 2016 'developed' land use classes and 2018 NAIP imagery to visually identify and include residential subdivisions, quarries, golf courses, and landfills.

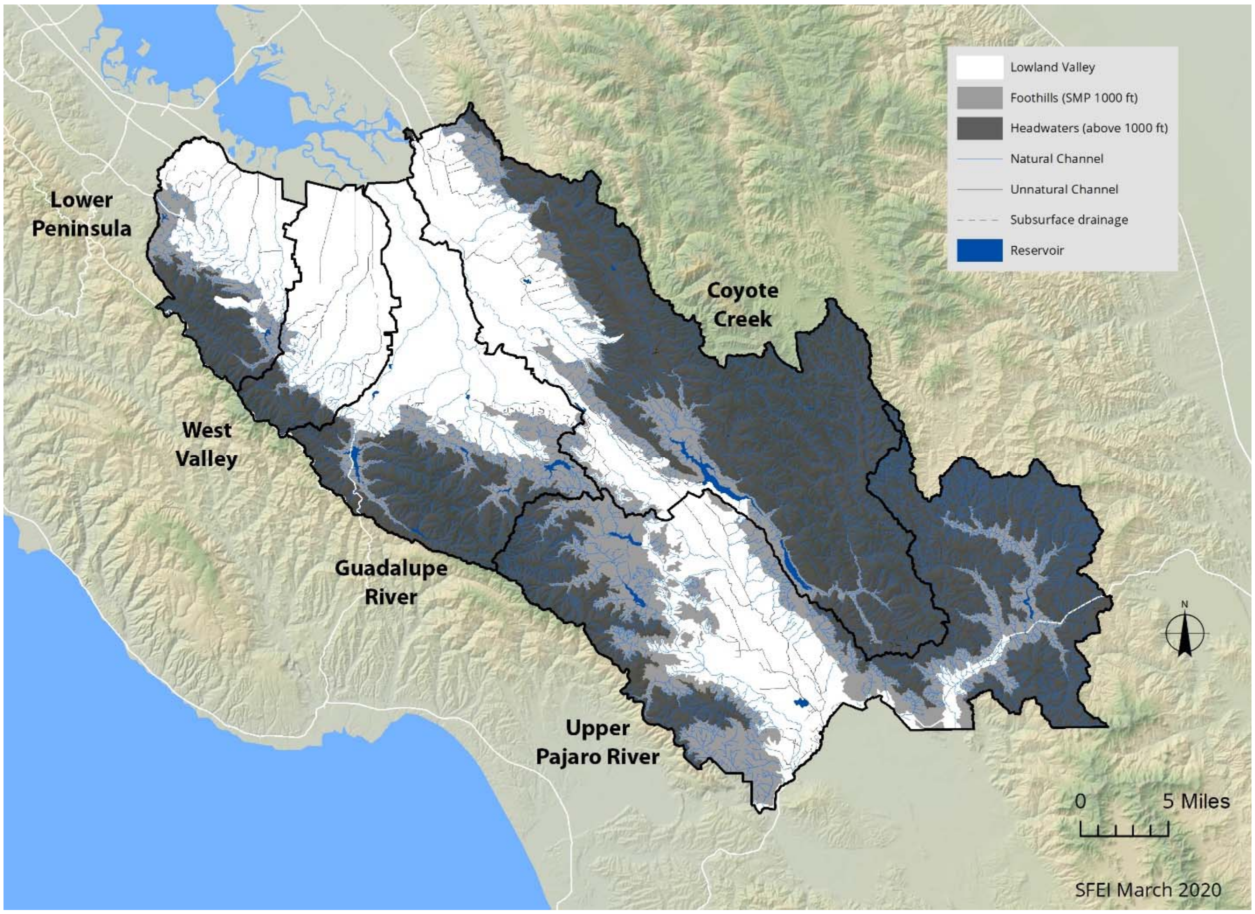

Figure B.1. Map of the three regions across the five major watersheds within Santa Clara County

RIPARIAN ZONE ESTIMATION TOOL (RIPZET)

RipZET (SFEI 2015) employs digital vegetation, aquatic resource, and elevation data within GIS and Excel platforms to estimate riparian habitat extents based on topographic slope, density and height of mapped vegetation. It has three main components: core code, modules, and output. The core code prepares input GIS layers used by the modules. The Hillslope and Vegetation Processes modules are run separately for a geographic area defined by the user. Each module generates a GIS dataset representing riparian habitat extent based on their respective modelled riparian functions.

The maximum riparian habitat extent from both modules is summarized according to the concept of “functional riparian width”, which are ecological functions a riparian area can provide depending on its structure, including topographic slope, density and height of vegetation, plant species composition, and soil type. Some key riparian functions include wildlife support, runoff filtration, input of leaf litter and large woody debris (allochthonous inputs), shading, flood hazard reduction, groundwater recharge, and bank stabilization (Collins *et al.* 2006). For any given structure, the levels of specific functions within a riparian area depend on its width and length. Wider and longer riparian areas tend to support higher levels, and a greater number of riparian functions than shorter and narrower areas (Wenger 1999). The concept of functional riparian width is central to the riparian definition recommended by the National Research Council (NRC 2002) and integral to many riparian design and management guidelines (e.g., Johnson and Buffler 2008).

RipZET GIS outputs are not regarded as riparian *maps* per se because they do not depict actual boundaries based on field observations. Instead, they represent modelled areas, where riparian functions are likely to be supported based on hillslope and vegetation processes. The module outputs can be overlaid to estimate the maximum riparian extent for all riparian functions represented by both modules.

RipZET was rerun for all the D5 watersheds for this report based on updated stream datasets that represent comparable levels of stream complexity. Specifically, the BAARI 1st-order streams were excluded from the Coyote Creek, Guadalupe River, Lower Peninsula, and West Valley watersheds, and stream orders for the upper Pajaro River watershed were numbered comparably to the other watersheds (i.e., 1st-order streams were designated 2nd-order streams, and 2nd-order streams were designated 3rd-order streams, etc.), as previously explained. RipZET’s Hillslope and Vegetation modules were run on the following vegetation and elevation GIS datasets:

<u>Coyote Creek, Guadalupe River, Lower Peninsula, and West Valley watersheds:</u>

> USDA Forest Service CALVEG data Zone 6 - Central Coast, published in 2014 and using imagery from 1997-2013; BAARI *streams* v.2.1 – without 1st order stream reaches; and USGS National Elevation Dataset, 10-meter node Digital Elevation Model (DEM) for topography.

<u>Upper Pajaro River watershed:</u>

> Santa Clara County Habitat Conservation Plan’s landcover layer (Jones & Stokes 2006); Valley Water’s “Creeks” data layer attributed for stream order (starting with stream order #2 to be comparable to BAARI) and flow direction; and USGS National Elevation Dataset, 10-meter node DEM for topography.

RipZET results are presented as a map of the overlaid Vegetation and Hillslope Processes GIS layers, and a table that summarizes the estimated number of stream miles, and acres of riparian habitat by functional width class (based on the output from RipZET's Vegetation module[8], Collins et al. 2006).

Similar to the Level 1 mapping and Level 2 CRAM analyses, the most complete data came from BAARI, a separate mapping project completed in 2008, which mapped streams and wetlands throughout the immediate Bay Area. The BAARI GIS map is updated periodically based on local requests to improve the dataset. The most recent updates are found in version 2.1 (BAARI 2017). The upper Pajaro River watershed streams and wetlands were mapped using different mapping methods, which required additional review and standardization to make the GIS-data more comparable to BAARI used for the Coyote Creek, Guadalupe River, Lower Peninsula, and West Valley watersheds. Please keep this in mind when reviewing the upper Pajaro River watershed summaries and comparisons in this report.

Level 2: Stream ecosystem condition based on CRAM

The D5 Project employs CRAM's statewide database service to manage and access their CRAM data. The CRAM website (www.cramwetlands.org) is a free, online data management service that serves the CRAM community. The website includes CRAM field books, technical guidance, QA/QC, and other resources, as well as information about annual field Practitioner training schedules, and a link to the CRAM Data Entry forms. Uploaded CRAM data can be accessed online[9] through EcoAtlas, the statewide comprehensive watershed database shared with land use agencies, environmental resource groups, and the public.

The D5 Project's ambient stream condition surveys using the CRAM Riverine wetland module consist of statistically based random survey designs and sample draws that characterize the overall ecological condition of streams in five watersheds of Santa Clara County with a known level of confidence. The D5 Project employs the USEPA's recommended Generalized Random Tessellation Stratified (GRTS) statistical survey design and analysis methodology for monitoring and assessing aquatic resources.

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[8] Note that riparian length and area for each width class is calculated for the left and right stream banks separately. Therefore, the estimated riparian stream miles are the sum of both banks divided by two. Total stream miles in the riparian functional width class summary table will not add up to the total stream network length (based on the linear stream GIS flow-line down the thalweg of the channels). This is because the buffered thalweg line used by RipZET is an estimate of the left and right stream banks.

[9] CRAM data is made public only when the landowners have given permission for the data to be made public (the CRAM data entry forms include public/private access options).

AMBIENT STREAM CONDITION SURVEY DESIGN AND SAMPLE DRAW

The USEPA's National Environmental Monitoring and Assessment Program (Messer *et al.* 1991; Diaz-Ramos *et al.* 1995; Stevens and Olsen 2003; Stevens and Olsen 2004, Kincaid 2016, Kincaid and Olsen 2016) developed the GRTS survey design and analysis methodology (Gitzen *et al.* 2012), which includes online documentation and the 'spsurvey' statistical package to support GRTS. *Spsurvey* is an R programing language package that includes sample design, sample draw, and analysis tools for both *linear* (e.g., streams) and *area* (e.g., wetlands, lakes) resources. The *spsurvey* analysis outputs consist of cumulative distribution function (CDF) estimates, plots, and percentile tables.

1st order headwater streams (as mapped in BAARI) tend to lack structural complexity and therefore, are not suited for CRAM[10]. As a result, 1st order streams mapped in BAARI were dropped from the D5 ambient stream condition surveys. It was intended that the ambient stream condition surveys conducted in the five watersheds in Santa Clara county employ comparable stream mapping methods (the same levels of detail) for the individual watershed survey designs and sample draws in order to compare the overall condition of streams across and between all the watersheds.

For each D5 watershed, candidate sites were selected from a GIS basemap of surficial, freshwater streams of Strahler Stream Order 2 or higher. The BAARI, and Valley Water 'Creeks' GIS datasets were used to select sites with stream orders standardized as previously described.

The D5 Project's individual watershed assessment reports are available on the D5 Project and SFEI's websites for more information: https://www.valleywater.org/project-updates/d5-ecological-data-collection-and-analysis, https://www.sfei.org/node/6075#sthash.2JTccY7s.dpbs

CRAM FOR ASSESSING THE ECOLOGICAL CONDITION OF STREAMS

CRAM is a well established, standardized rapid assessment method, employed in the field for measuring the overall ecological condition of streams and wetlands. CRAM enables two or more trained practitioners, working together at a stream (or other wetland type), to assess the condition of a prescribed assessment area (AA, the GRTS selected field study site) by choosing the best-fit set of narrative descriptions of observable conditions ranging from worst to best achievable. Wetland or stream types have their own field books (see https://www.cramwetlands.org/documents#field+books+and+sops). There are four alternative

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[10] Validation efforts have indicated that CRAM is broadly applicable throughout the range of conditions commonly encountered. However, since CRAM emphasizes the functional benefits of structural complexity, it may yield artificially low scores for streams and wetlands that do not naturally appear to be structurally complex. CRAM should therefore be used with caution in such wetlands (CRAM 2013, CWMW 2013). This includes riverine stream reaches in the uppermost headwaters of Bay Area watersheds mapped in BAARI.

descriptions of condition for each metric of condition represented by a score of 3, 6, 9, or 12, poorest to best condition (respectively). Metrics are organized into four main Attributes: (Buffer and Landscape Context, Hydrology, Physical Structure, and Biotic Structure). Attribute Scores are averaged into an Index Score of overall condition.

The CRAM field assessments were conducted by trained CRAM Practitioners from Valley Water, SFEI, EOI, H. T. Harvey and Associates, and Michael Baker International, who conducted field surveys during the spring to fall sampling season between 2010 and 2018. Intercalibration exercises were conducted during the CRAM field seasons to document and compare consistency among the CRAM field Practitioners. These exercises are opportunities for additional CRAM training and help reduce Practitioner-introduced variation, which is unavoidable in large surveys where many field teams are involved in data collection. Every effort was made to get permissions to access and sample all targeted sites (AAs chosen by the GRTS sample draw). However, for various reasons (such as landowner denied access, AA too remote, AA did not to meet the criteria for Riverine CRAM (see https://www.cramwetlands.org/sites/default/files/2013.03.19_CRAM%20Field%20Book%20Riverine%206.1_0.pdf), inaccessible due to impenetrable poison oak) some sites were dropped and replaced by oversample sites (also selected in priority order by GRTS).

The probability-based CRAM stream condition surveys were completed by Valley Water's D5 Project and comparative studies done by the California Surface Water Ambient Monitoring Program's Perennial Stream Assessment Program (PSA[11], SWAMP 2016) over the past decade:

- West Valley watersheds: n=60 AAs field assessed in 2018
- Lower Peninsula watersheds: n=54 in 2016
- upper Pajaro River watershed: n=81 in 2015
- Guadalupe watershed: n=53 in 2012
- Coyote Creek watershed: n=77 in 2010
- Bay/Delta Ecoregion CDF: n=40 (subset of SWAMP-PSA 2008-2014)
- Statewide Perennial Stream Assessment: n=765 (SWAMP-PSA and Southern California Stormwater Monitoring Coalition 2008-2014[12])

CRAM DATA ANALYSES

Before compiling the CRAM assessments across all five major watersheds in Santa Clara County, the original sample weights were adjusted to account for dropped and non-target sites. The D5 Project employed a 'missing-at-random' assumption to decide that stream

[11] http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/

[12] Perennial Stream Assessment Program of the Stated Water Resources Control Board; http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/

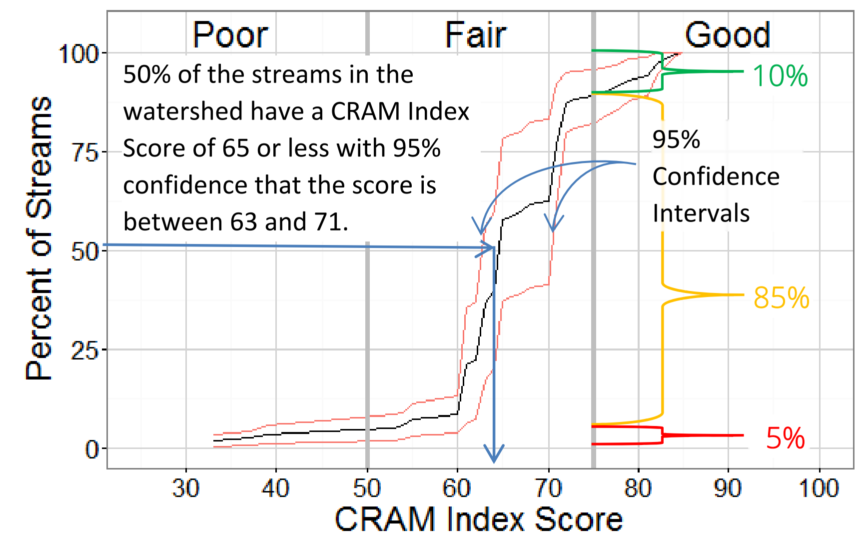
reaches not sampled were likely similar enough to reaches that were able to be sampled (i.e., similar stream orders and settings). Therefore, the final outcome of surveyed sites were assumed to be representative of the overall condition of streams in the whole watershed.

To implement the 'missing-at-random' assumption across all five ambient stream condition surveys, sample weights were adjusted to sum to the full extent of the stream resource (the full sample frame length) minus dropped sites that did not meet the criteria for Riverine CRAM. Once sample weights were adjusted, it was possible to combine the data and characterize overall ecological condition of streams across all five D5 watersheds, and compare conditions between watersheds using the *spsurvey* analysis package. The *spsurvey* analysis outputs consisted of cumulative distribution function (CDF) estimate tables, CDF plots, and CDF percentile tables of CRAM Index and Attribute scores.

INTERPRETING THE GRTS CRAM AMBIENT SURVEY RESULTS

A CDF estimate plot enables a user to visually evaluate and compare the percent of the resource (in this case – stream miles across all five watersheds in Santa Clara County and within each watershed) versus CRAM ecological condition scores. Figure B.2 presents an *example* CDF curve from an ambient stream condition survey in a watershed, based on CRAM. The black line indicates the estimated mean CRAM Index Score (x-axis) for any percentage of stream length in the watershed (y-axis). The red lines indicate the 95% confidence intervals around the mean. Confidence intervals are generally wider when there is a lot of variation in condition within a surveyed area or when only a few sites (AAs) represent a large proportion of the surveyed area.

Reading the horizontal and vertical arrows in the figure, one would say that 50% of the streams in the watershed have an Index Score of 65 or lower. Interpreting the red confidence intervals in the example CDF, one would say (with 95% confidence) that half of the streams in the watershed have a CRAM Index Score estimated to be between 63 and 71 or lower.



CRAM's standard ecological health classes (also called condition classes) represent streams that are in poor (25-50), fair (51-75) and good condition (76-100).

In this example, 10% of the streams in the watershed are in good overall ecological condition, 85% are in fair condition, and 5% are in poor condition.

Figure B.2. Example CDF plot for a watershed-based stream condition assessment employing CRAM.

Differences in the shape of the CDF curve and its position along the x-axis indicate differences in condition. A CDF curve that is shifted to the right reflects relatively better ecological conditions (higher CRAM scores) and conversely a curve that is shifted to the left reflects relatively poorer ecological conditions (lower CRAM scores). A convex curve (one that starts with a steep slope upward, then decreases or flattens) indicates a higher proportion of stream miles with low CRAM condition scores, compared to a concave upward curve (one that starts with a gradual upward slope that increases) indicates a higher proportion of stream miles in fair to good condition as seen in Figure A.2.

Three standard CRAM ecological health classes (also called condition classes) represent streams that are in poor, fair, or good condition. These classes define the maximum range of possible CRAM Index (or Attribute) Scores. That is, poor condition scores range from 25 to 50, fair condition scores range from 51 to 75, and good condition scores range from 76 to 100. These 'health classes' can be represented in bar charts or CDFs as a way to group CRAM scores to facilitate reporting, comparison, and evaluation. Stream resources in the example watershed in Figure A.2 would be generally characterized as having fair condition. Finally, stream conditions can be further compared in staked bar charts by comparing the percent of resources that are in good, fair, or poor ecological condition based on the ambient surveys (see section 4.1.2).

Data Management and Access

As mentioned above, the D5 Project employs CRAM's statewide data entry and management service to manage their CRAM data. The data can be accessed and visualized through EcoAtlas (www.EcoAtlas.org). EcoAtlas is a free, statewide data access, visualization, and summary tool that supports stream and wetland restoration and mitigation project planning, monitoring, and assessment. It is designed around the WRAMP framework of using geospatial data, field rapid assessments of condition, and more involved field samples to support resource management and regulation. EcoAtlas is the public access point for CARI, which is the interactive base map on the site that includes:

- data upload tools for adding wetland restoration and compensatory mitigation projects to the EcoAtlas map(via Project Tracker), and uploading CRAM scores (via the CRAM website),
- data visualization and access for habitat maps (including CARI, historical ecology, CALVEG, SSURGO hydric Ssoils),
- data visualization and access to CRAM and California Stream Condition Index ecological condition assessment scores and data, and other water quality monitoring data from the California Environmental Data Exchange Network database (CEDEN), and
- data summary tools that support landscape based aquatic resource management including the Landscape Profile Tool and Project Tracker.

LANDSCAPE PROFILE TOOL AND PROJECT TRACKER

EcoAtlas' Landscape Profile Tool summarizes the amount, distribution, and condition of aquatic resources, and other ecological information at various spatial scales for assessment, planning, and reporting. Based on a user-specified area of interest, or predefined areas such as the USGS Hydrologic Units (HUCs), and Valley Water's five watersheds within Santa Clara County. The tool generates graphical summaries of the following data sources:

- abundance and diversity of existing aquatic resources based on BAARI and CARI;
- abundance and diversity of historical aquatic resources, and terrestrial plant communities;
- survey and project summary statistics for eelgrass aquatic resources;
- ecological restoration or compensatory mitigation based on Wetland Habitat Projects;
- aquatic resource condition assessments based on CRAM; includes a comparison of selected CRAM scores to the local or eco-regional *CDF* curve (when available).
- Stream condition based on the California Stream Condition Index CSCI.
- human population (2010 Census) and language spoken at home (2008-2012 American Community Survey);
- species of special status (federally and California listed species) based on the California Natural Diversity Database (CNDDB); and
- developed land cover by the 2011 National Land Cover Database (NLCD).

Through EcoAtlas, wetland habitat project information, CRAM and other monitoring data are available to regulatory managers, scientists, and the public.

EcoAtlas has two interactive project evaluation tools that support wetland condition assessments for CRAM. These tools are part of the WRAMP framework for standardized monitoring and assessment tools and can be used at various landscape scales. It is intended that, over time, local and regional entities will develop watershed specific project performance curves (a.k.a., habitat development curves) and ambient condition assessments using CRAM (a.k.a., GRTS surveys and CDF estimates).

1. HDCs: Wetland Habitat Development Curves are used to evaluate project performance to the expected rate of habitat development for the same age and habitat type based on CRAM. HDCs have been developed for three BAARI wetland types (riverine, estuarine, and depressional) using existing CRAM assessments from wetlands across California. Each curve represents the average rate of development bounded by its 95% Confidence Interval (CI), average condition and 95% CI for a set of reference sites. Projects that are well designed for their location and setting, and well managed tend to be on or above the curve. In general, as projects age, their habitats should mature and their CRAM scores should increase at a similar rate as the HDC. Comparing project Index and/or Attribute scores to the expected level on HDCs can help identify general ecological functions that are performing well, or that may warrant corrective actions.

2. CDFs: Cumulative distribution functions (CDFs) are developed from probabilistic ambient surveys using CRAM. CDFs estimate the relative abundance of stream miles (or wetland areas) within a surveyed geographic extent that is likely to have conditions below (or above) any particular score. CDFs can be developed for any geographic extent, from large wetland project areas to watersheds, eco-regions, or statewide. CRAM project scores or other targeted assessments can be compared to CDF curves of wetlands of the same type in the same geographic area. These comparisons provide a watershed (or eco-regional) context to evaluate if a targeted assessment falls within the upper or lower 50th percentile of similar wetlands in the area, or if it falls within the top (or bottom) 25th percentile of similar wetlands in the surveyed area. This information helps inform management actions.

   The CDFs for the five watersheds in Santa Clara County are available through the Landscape Profile Tool on EcoAtlas (Figure B.3). A manager can view existing CRAM assessment scores plotted on a watershed CDF by:

   - Going to www.EcoAtlas.org and zooming into Santa Clara County on the map (in the lower South Bay area within the Bay/Delta Ecoregion)
   - Go to Layers and select "CRAM" to see the distribution of CRAM scores on the map. You can also turn on the "habitat Projects" layer to see restoration or mitigation project areas on the map if they have been uploaded to Project Tracker.
   - Click on the "Show Tools" button in the top right side and select "Landscape Profiles".
   - There are currently two profiles available: *Standard* (which is a summary of geospatial data), and *CRAM and CSCI* (which is the ecological condition summary). Once you define your profile region you will be able to run both profiles for your user-defined area.

- To compare the CRAM scores of a specific, user-defined area to the local watershed CDF, zoom into the target area and draw a polygon on the map using the edit tool that includes the CRAM AAs of interest. Select the “Draw a Polygon” option and use the edit tool to draw your area by clicking around the perimeter.
- Double-click inside the polygon and the *Standard* profile will be generated in a pop-up box. This profile describes the amount and kinds of aquatic resources within the user defined area, the historical resources, CalVeg, endangered species, etc. (as described above).
- Select the *CRAM and CSCI* profile mode and again double-click inside the polygon. This new pop-up profile lists the CRAM AAs located within the polygon and plots any CSCI scores within the area on a chart indicating the number of scores by condition class.
    - Click on the “View Scores on CRAM CDF” button and final pup-up allows you to select wetland type and available CDFs (from drop-down lists). The CRAM scores from the user-defined area are then plotted on the selected watershed or regional CDF (they appear as grey diamonds, Figure B.3).

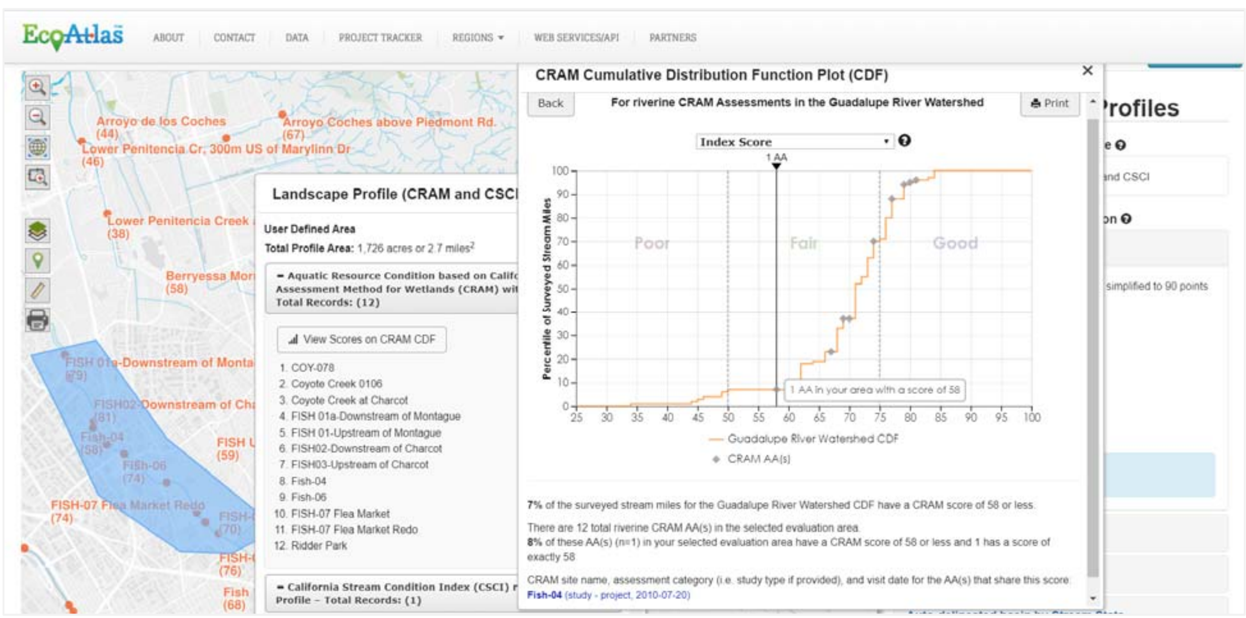


Figure B.3. Screenshot of the Guadalupe River watershed CDF accessed through EcoAtlas with overlaid CRAM scores (grey diamonds) from AAs located in the user defined area.