Ecological Monitoring & Assessment Framework

Stream Ecosystem Condition Profile: Coyote Creek Watershed

Including the Upper Penitencia Creek Subwatershed

Final Technical Report #2

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March 31, 2011

Acknowledgements

The Consultant Team acknowledges and thanks the following District staff who participated on the Ecological Monitoring and Assessment Program's Core Technical Team throughout the duration of the Ecological Monitoring and Assessment Framework Contract (#4213) and contributed to this document: Louisa Squires (Project Manager), Ed Drury, Janell Hillman, Nina Merrill, Melissa Moore, Terry Neudorf, Kristen O'Kane, Doug Padley, Lisa Porcella, Doug Titus, and David Salsbery.

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EXECUTIVE SUMMARY

The Santa Clara Valley Water District's (District's) Ecological Monitoring and Assessment Program (EMAP) Framework is a multi-year effort to monitor and assess streams within the District's primary areas of interest in Santa Clara County. This Stream Ecosystem Condition Profile is the first implementation of the EMAP Framework. The assessment was conducted for the Coyote Creek watershed (including Upper Penitencia Creek subwatershed). It is anticipated that other major watersheds will also be assessed in coming years. The EMAP Framework is fully described in the Ecological Monitoring and Assessment Framework Technical Plan (SCVWD 2010a). The objectives of the EMAP Framework are to:

1) Integrate state of the science methods and understanding of ecological conditions with District management actions;
2) Integrate ecological monitoring activities within the District and with external efforts;
3) Identify and prioritize gaps in existing ecological monitoring data necessary to answer important District management questions;
4) Identify cost-effective approaches to address prioritized data gaps; and
5) Ensure ongoing integrative and interpretive assessments and reporting of ecological data.

The EMAP Framework represents a paradigm shift in the District's management of ecological resources that has been steadily evolving over the past 10 years. Monitoring requirements, which are often mandated on a project by project basis, have lead to a piecemeal understanding of the stream ecosystem conditions. Achieving the District's Water Resources Stewardship goal of healthy creek and bay ecosystems, however, requires a strategic approach to ecological data collection activities to evaluate whether District actions are contributing to improvements in the health of stream ecosystems. The District's current approach to evaluating effectiveness in meeting District policies focuses on indicators such as volume of sediment removed from streams and acreages of mitigation implemented. While such indicators may effectively convey achievement of specific District actions, they do not convey their influence comprehensively vis-a-vis their effects on stream ecosystem conditions and functions.

This Profile has been developed to inform decisions on the management of District facilities in the context of the watershed as a whole in order to maintain and improve stream ecosystem conditions. The District has relatively little ownership and control over streams relative to the vast drainage network in each watershed. Therefore, it is important for the District to clearly and transparently identify sources of risk to its core business that originate from areas within its control and from areas outside of District ownership. In doing so, the District can identify planning level recommendations that help inform decisions on District investments in cost-effective monitoring and management actions designed to improve stream ecosystem conditions. The synthesized and improved knowledge of ecological resources gained from the EMAP Framework should make environmental permit negotiations, mitigation, and environmental stewardship actions more efficient and cost-effective.

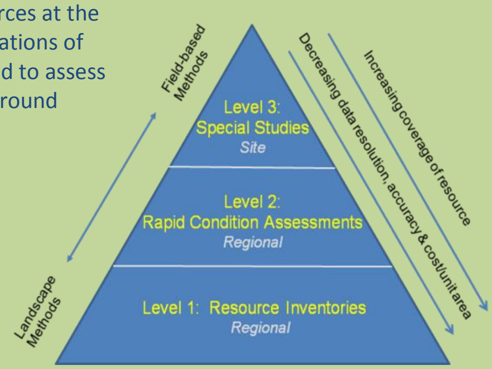
This Profile describes the condition of stream ecosystem resources by synthesizing new and existing information on the health of stream ecosystems within a watershed. Using the Framework's condition and risk assessment methods, ecological data were analyzed to provide watershed-specific guidance on the future design of monitoring efforts, flood control projects, water utility projects and maintenance/operations. Consistent with the District's Governance Policies, such guidance is presented in terms of monitoring and management actions that may be considered for adoption. For owned assets, the District could directly initiate actions and modifications. For assets that the District does not own, it may work cooperatively with partners to protect and improve stream ecosystem resources or take a role of providing technical information and/or advocating for actions by others to improve stream ecosystem conditions.

The EMAP Framework includes recommendations for how to establish Levels of Service (LOS) (numeric performance targets – see p. 7) for stream ecosystems to help the District periodically assess progress towards meeting stewardship objectives and the appropriateness of associated strategies and measurable objectives. These LOS can be established in each watershed by analyzing results of ambient surveys of stream ecosystem conditions. It is anticipated that the District will establish LOS and narrative goals for stream ecosystem condition for each watershed as one means of evaluating performance in meeting its Stewardship Policy (Ann Draper, District, personal communication 2/2/11).

The 1-2-3 Framework was selected as a model for developing the EMAP Framework. The 1-2-3 Framework is a toolkit designed to help resource managers identify and cost-effectively answer key questions about the performance of projects, programs, and policies intended to protect and manage

EMAP Assessment Framework (1-2-3)

Level 1 - Resource Inventories
Level 1 data are maps illustrating the distribution and abundance of resources at the scale of landscapes, watersheds, regions, and the state based on interpretations of other maps, aerial photography, and satellite imagery. These data are used to assess the distribution and abundance of aquatic resources and to track on-the-ground management actions and changes in resource condition.



Level 2 - Rapid Condition Assessments
Level 2 data measure overall stream ecosystem condition and functional capacity based on site-specific assessment using relatively rapid, semi-quantitative data collection methods. These data answer questions about the overall condition or health of resources relative to their expected or achievable levels of function and service and can include assessments of likely stressors that limit resource condition.

Level 3 - Special Studies/Investigations
Level 3 data quantify one aspect of site-specific resource conditions, stresses, processes, or functions relative to another based on intensive field observations and measurements. Common examples include counts of wildlife per unit time or space, percent cover of vegetation, recreational use intensity, and flood frequency. Level 3 data can be used to assess the performance of mitigation efforts and to otherwise meet the monitoring requirements of environmental regulatory permits.

aquatic resources. The State Water Resources Control Board is planning to integrate it into under the new Wetlands and Riparian Areas Protection Policy (State Water Resources Control Board 2009), and their efforts are supported by Federal Agencies that implement the Clean Water Act. The 1-2-3 Framework is based on a 3-level system of classifying questions and data (see below).

The EMAP Framework embodies the structure of the 1-2-3 Framework and directly reflects the District Act and Mission and Ends Policies (Figure ES-1). The Framework is implemented through a series of steps, beginning with establishing a set of core management questions that support District watershed and asset management decision-making. The six core management questions are presented below:

1) What is the extent and distribution of stream ecosystem resources?
2) What are the conditions of stream ecosystem resources relative to their levels of services (i.e., how are they performing)?
3) What are the likely sources of risk to stream ecosystem resources?
4) What is the likelihood that sources of risk may negatively impact stream ecosystem conditions?
5) What are the likely consequences of risk realization to stream ecosystem conditions?
6) What are the monitoring and management actions that could improve or provide a better understanding of stream ecosystem conditions and reduce risk?

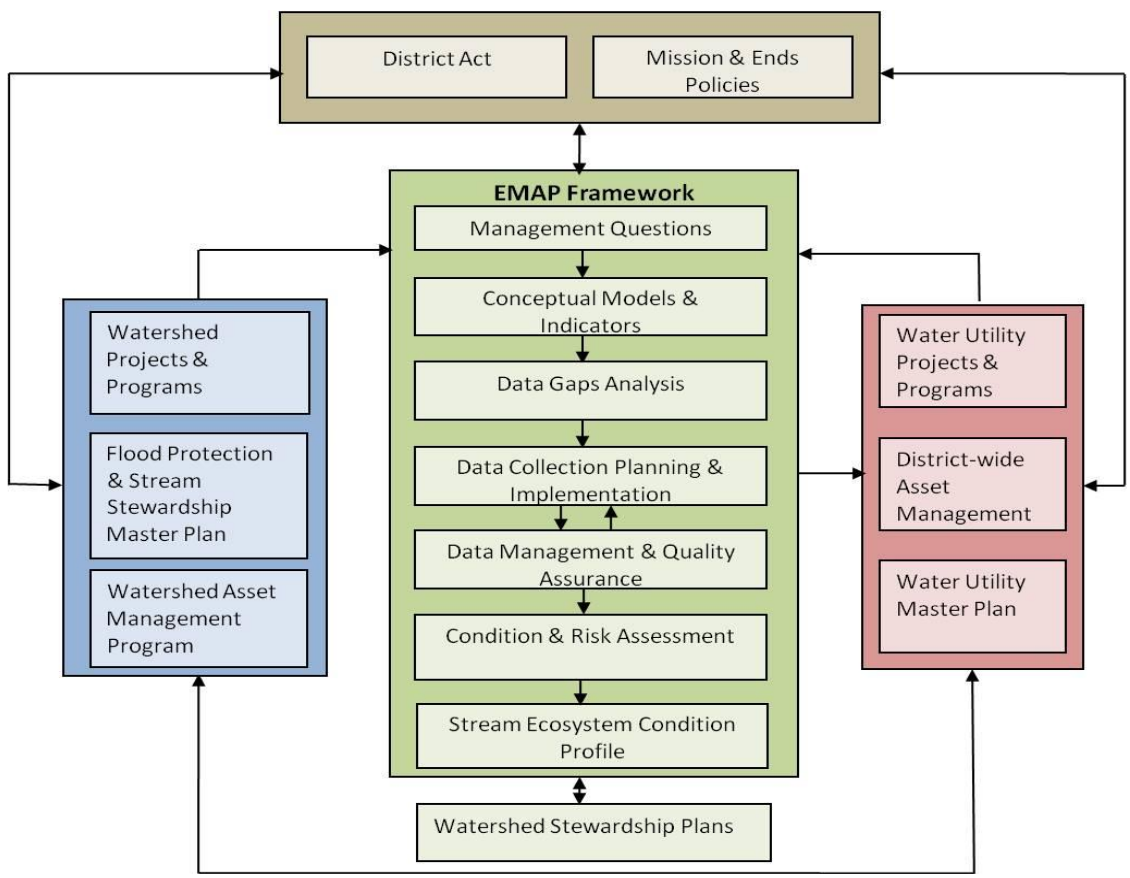


Figure ES-1. The Ecological Monitoring and Assessment Program Framework and its relationship to the District Act, Missions, Ends Policies, Programs, and Master Planning.

Summaries of answers to each core management question are presented below for the streams in the Coyote Creek Watershed. Each question was answered in such a way that they build on each other. A full discussion of each topic along with more detailed action recommendations are provided in the subsequent chapters of this report.

1) What is the extent and distribution of stream ecosystem resources?

To answer this question a base map (i.e., Level 1 data) was developed that depicts the extent and distribution of stream ecosystem resources, including riparian areas, wetlands, surface water hydrology (including engineered drainages), and areas of District fee title and easements. These Level 1 data were summarized statistically and compared to historical (c. 1850) data, developed by Grossinger et al. (2006), to quantify the change in spatial extent and distribution of selected stream ecosystem resources over time. These analyses resulted in the following:

- The modern day drainage network for the entire Coyote Creek watershed includes 2,830 stream miles in eight different stream orders[1]. Ninety percent of the natural stream network is composed of first-, second- and third-order streams, most of which are in the upper non-urbanized portion of the watershed.
- The Coyote Creek Valley now contains a dense network of over 900 miles of unnatural channels that include subsurface storm drains, engineered channels, and ditches. This represents an approximate-eight-fold increase in stream miles from the historical hydrologic network.
- Riparian width ranges from 0 meters to greater than 100 meters, with a greater range and higher levels of riparian functions corresponding to wider areas. The modern day riparian areas tend to have medium to narrow widths. About 73 percent (%) of the total stream miles in the Coyote Creek watershed have narrow riparian areas less than 30 meters wide on either side. The trend in historical changes in riparian width since about 1800 has been to shift from medium width areas (30 – 50m) to narrow areas (<30m). There has been almost a complete loss of very wide riparian areas (> 100m).

2) What are the conditions of stream ecosystem resources relative to their Levels of Service (i.e., how are they performing)?

This core management question was addressed through three subordinate questions, all of which were answered using Level 2 and Level 3 data. Rapid Level 2 data help identify watershed patterns and provide the basis for developing hypotheses about why such patterns exist. Intensive Level 3 data can be designed to test such hypotheses to help understand why the patterns exist and suggest what management or monitoring actions may support or improve stream ecosystem asset conditions. The

[1] Stream order is a measure of the position of a stream in the hierarchy of tributaries in a drainage network; with lower-order streams occurring higher in the network, and higher-order streams occurring lower in the network.

following paragraphs provide brief summaries of answers to the three subordinate questions related to current conditions of stream ecosystem resources and Levels of Service that the District may choose to adopt.

2-a) What are the conditions of stream ecosystem resources?

The CRAM provides a hierarchy of scores. For each area assessed, a CRAM Index score of overall stream ecosystem conditions is calculated (see sidebar). As measured by CRAM, the Coyote Creek watershed exhibited a broader range of stream ecosystem asset conditions than the Upper Penitencia Creek subwatershed and higher condition scores (Figure ES-2). Additionally, Figure ES-2 illustrates the distribution of stream miles among condition categories based on ambient CRAM index scores. The Coyote Creek watershed, as compared to the Upper Penitencia Creek subwatershed, had a higher proportion of stream miles in the high condition category, and fewer stream miles in the medium-high and medium-low categories. Neither watershed had any stream miles in the lowest condition category. In general, the lowest condition scores were concentrated in the lower parts of the watersheds and in the transition zone between the lower and upper watersheds. The highest condition scores were concentrated in the upper watersheds with a few in the transition zone. The lowest scores reflected channels with poor landscape and buffer condition due to proximity of adjacent development, poor hydrology condition due to associated storm drain networks and surface water management infrastructure, and in some cases poor biotic structure condition due to the prevalence of invasive species. The highest scores reflected the adjacency of undeveloped open-space lands, relatively unaltered hydrology, and typically good biotic structure.

California Rapid Assessment Method (CRAM)

CRAM is a standardized cost-effective Level 2 method that is used to rapidly assess the overall condition of wetlands and riparian sites using visual indicators in the field. Overall site condition can be assessed in 1-3 hours by two more trained practitioners. For each site, CRAM assessments produce an **Attribute Score** for each of four attributes: 1) landscape context and buffer, 2) hydrology, 3) physical structure, and 4) biotic structure; and a single **Index Score**. An Attribute Score is calculated as the sum of its **Metrics**, converted into a percentage of the maximum possible score for the attribute. The site Index score is calculated by first summing attribute scores and then converting this sum into the maximum possible score for all attributes combined. Site Index Scores range from 25 to 100 points, with the maximum possible score (100) representing the best possible condition that is likely to be achieved for the type of wetland being assessed. Therefore, a site's Index score indicates how its condition compares to the best achievable condition for that wetland type in the State of California.

Interpretation of CRAM Index scores requires examination of their component attribute scores, which are illustrated in Figure ES-3. Of the four CRAM Attributes, Physical Structure had the greatest impact on CRAM Index scores, followed by Biotic Structure for creeks in both Coyote Creek watershed and the Upper Penitencia subwatershed. For the San Francisco Bay Region as a whole, low-order streams (uppermost tributaries in a watershed) tend to have high buffer and landscape context scores and relatively low physical structure scores.

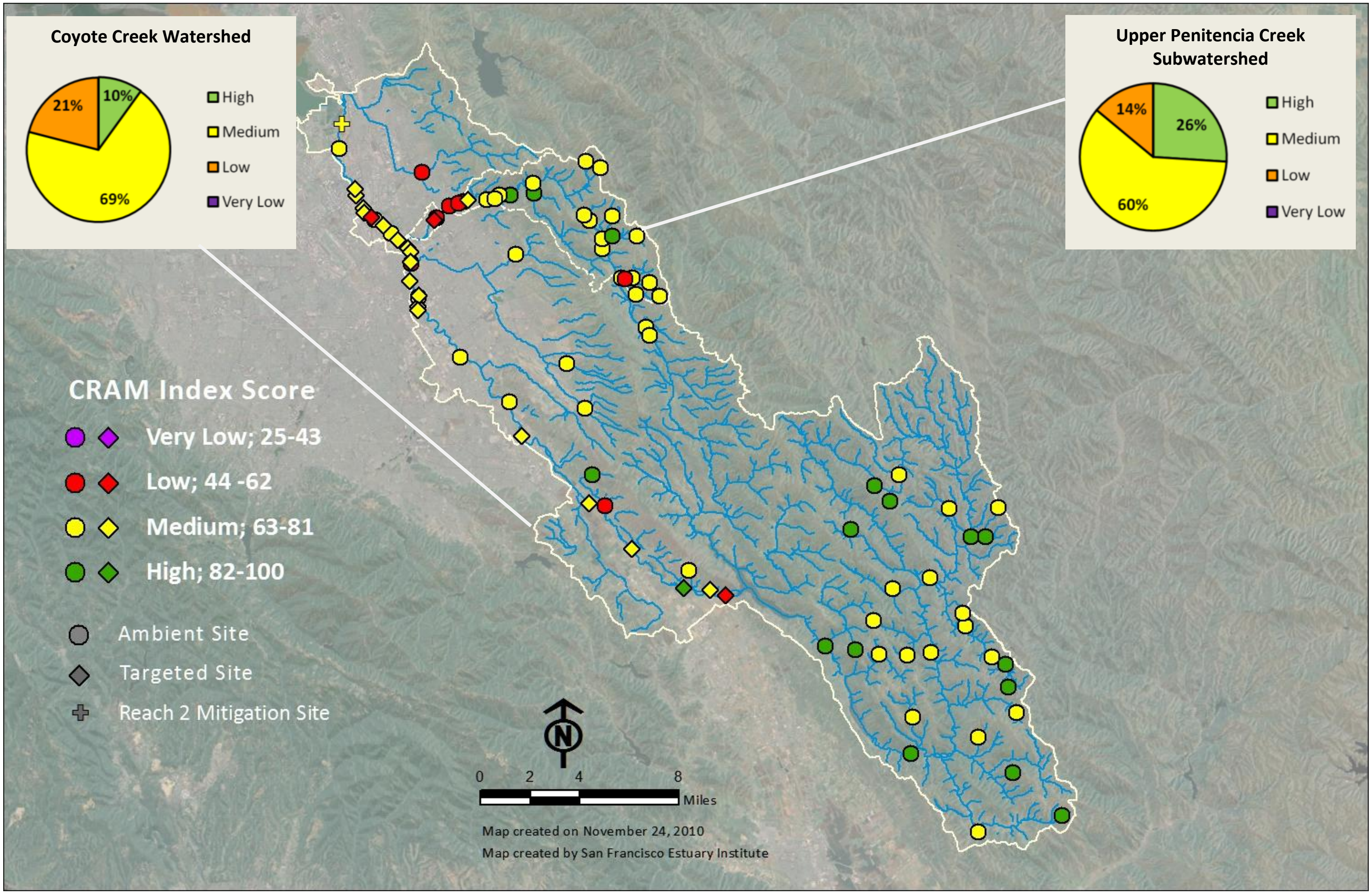


Figure ES-2. CRAM Index scores for ambient and targeted sites. Score categories were determined by dividing the total possible range of CRAM Index scores into four equal intervals of 19 points each. Four ambient sites in Upper Penitencia were removed from the map, but not the analyses due to land-owner sensitivity. Stream network data were acquired from the Bay Area Aquatic Resources Inventory (BAARI) - see www.californiawetlands.net. The Coyote Creek boundary is part of the CalWater 2.2.1 dataset; the Upper Penitencia Creek subwatershed boundary is from the District.

Similar patterns were observed for Coyote Creek watershed and the Upper Penitencia Creek subwatershed. In general, stream ecosystem conditions measured at targeted fisheries and mitigation sites along the Coyote Creek mainstem reflected the range of conditions observed throughout the watershed. A selection of Level 3 data related to fish and wildlife communities, hydrogeomorphology, vegetation characteristics, physical habitat, water quality, soil conditions, and toxicity were also assessed where they were available. These data exhibited a similar spatial pattern in which conditions were lowest in the mid-section of the Coyote Creek mainstem, approximately from upstream of Berryessa Road to Metcalf Pond. Conditions upstream of Metcalf Pond were generally highest, while conditions downstream of Berryessa Road were generally moderate, though exceptions existed for some indicators.

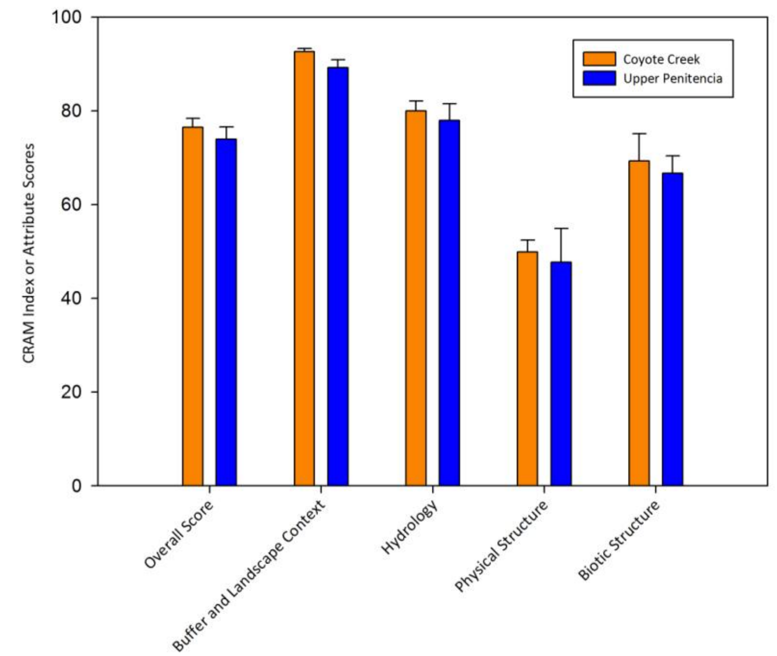


Figure ES-3. CRAM Index and Attribute scores for the ambient survey of streams in the Coyote Creek watershed (orange bars) and Upper Penitencia subwatershed (blue bars). Bars are scores represented by the 50th percentile (median) of stream miles, based on the corresponding cumulative distribution function. Error bars are the upper 95% confidence intervals at the 50th percentile.

2-b) What are the Levels of Service for stream ecosystem resources?

A Level of Service (LOS) is a benchmark of performance that can be applied to a system, service, asset or resource (see sidebar). The asset management paradigm that the District is adopting incorporates the concept of LOS for constructed assets (SCVWD 2009). LOS can be defined for non-constructed stream ecosystem resources at different spatial scales, from individual project sites to large watersheds. The District has not adopted LOS for watersheds or subwatersheds to date, but it is anticipated that LOS for stream ecosystem condition will be developed in each watershed in the near future as one means of evaluating performance in meeting the District's Water Resources Stewardship Policy. The CRAM data collected through the probabilistic (ambient) sampling design present an opportunity to establish a Level 2 LOS for the entire Coyote Creek Watershed and the Upper Penitencia Creek subwatershed. CRAM data collected using a probabilistic sampling design can be used to generate a cumulative distribution function (CDF) depicting results for

Level of Service (LOS)

A LOS is a benchmark of performance that can be applied to a system, service or asset. A LOS is usually established for constructed assets (e.g., engineered channel), but can also be defined for non-constructed stream ecosystem resources, such as riparian forests and wetlands. An LOS can be established for different spatial scales, from individual project sites to large watersheds.

each watershed. From the CDF, a simple statistic can be generated that represents the area weighted average of all CRAM scores. We refer to this simple statistic as the Ecological Services Index (ESI). The ESI is used to track stream ecosystem condition over time. The ESI can serve as the basis for establishing a quantitative LOS, and therefore the benchmark for performance. When the ESI indicates that the LOS is not achieved or emerging issues or risks are identified that threaten a LOS, priority management actions can be identified to raise the ESI by improving condition or managing associated stressors. In this Profile, baseline data from Level 2 ambient CRAM surveys were translated into an ESI statistic that represents watershed-scale stream ecosystem condition (see sidebar). Figure ES-4 illustrates that the ESIs for the Coyote Creek watershed and the Upper Penitencia Creek subwatershed are 75 and 73, respectively.

> **Ecosystem Services Index (ESI)**
>
> An ESI is a watershed-based landscape-level statistic that can be used to describe the overall condition of stream ecosystem resources that have been assessed using the California Rapid Assessment Method (CRAM). An ESI can serve as a quantitative LOS for stream ecosystem condition.

Level 2 CRAM data from ambient surveys conducted in future years can be compared to a watershed LOS to track trends in condition. The District could also potentially adopt site-specific LOS based on Level 2 CRAM data for mitigation and project sites in addition to, or in place of Level 3 performance targets that are traditionally required by permits. The latter would need to be negotiated with the permitting agencies and would only be suitable for certain projects for which measuring overall condition is an important part of performance standards.

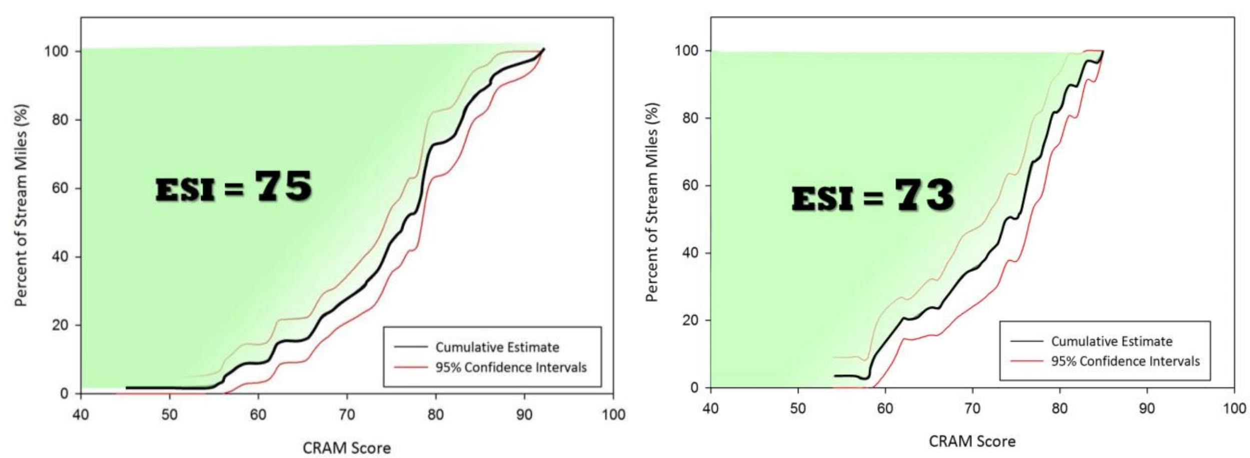


Figure ES-4. Ecological Services Index (ESI) statistics for the (A) Coyote Creek watershed, 95% Confidence interval = 72 – 78 (n=77); and, (B) Upper Penitencia Creek subwatershed, 95% Confidence interval = 70 - 75 (n=30).

2-c) How do the existing ecological conditions compare to ecological Levels of Service (LOS)?

Comparisons between existing ecological conditions, as measured by Level 2 CRAM surveys or Level 3 data, and established LOS could provide the District with an understanding of how well ecological resources are functioning in comparison to established benchmarks. Watershed-scale ecological LOS have not been established yet by the District. If the District chooses an ESI as its Level 2 LOS, then the watershed-scale ESIs for Coyote Creek and Upper Penitencia established during 2010 via CRAM, can be used to represent a benchmark for stream ecosystem conditions. Once another ambient assessment has been completed in the future, a new ESI value can be calculated to compare to the 2010 ESI. This new ESI value will enable an assessment of time trends in stream ecosystem conditions that can be used to inform monitoring and management actions.

An immediate and practical application of the ESI and associated CDF is to compare them with site-specific CRAM scores from District mitigation sites. These comparisons will demonstrate how mitigation sites are performing in the context of overall watershed condition. Additionally conducting CRAM surveys over time at District mitigation sites will allow the District to detect site-specific trends.

3) What are the likely sources of risk to stream ecosystem conditions, 4) what is the likelihood that sources of risk may negatively impact stream ecosystem conditions, and 5) what are the likely consequences of risk realization to stream ecosystem conditions?

Risk is the probability of a stressor negatively affecting stream ecosystem conditions and thus preventing the District from achieving an established LOS. A stressor is a chemical or biological agent, environmental condition, an external stimulus or event that causes stress to a stream ecosystem. Risk is assessed (see sidebar) at each of the three EMAP Framework levels in order to leverage the different scale and resolution of Level 1-3 data, and maximize the cost-effectiveness inherent in the higher Levels of data.

Ecological Risk Assessment

An ecological risk assessment is an application of a formal framework, analytical process, or model to estimate the effects of stressors on a stream ecosystem and to interpret the significance of those effects given associated uncertainties. Ecological risk assessments can be made using Level 1, 2, and 3 data.

The pilot risk assessment conducted at Level 1 focused on mapping the geographic extent of areas beyond direct District management control relative to the locations of stream ecosystem resources in the District's Area of Interest and Primary Area of Interest. The District has fee title or easement for approximately three percent of the stream miles in the Coyote Watershed. The Level 1 base map (Chapter 2) illustrates that District land ownership/easement is limited to relatively small areas of the lower part of the Coyote Creek watershed drainage network that are greatly influenced by natural and human-induced physical processes deriving from relatively large areas of the upper watershed. The success of District management actions, therefore, is influenced by upstream and downstream processes and events over which the District has little or no control. As a result, the very limited geographic extent of the District's authority within the greater stream ecosystem translates into the following considerable risks: 1) District watershed stewardship goals will not be met, unless they are carefully and explicitly limited to what the District can control and 2) the District will not be able to control the condition of the stream ecosystem resources owned and/or managed by the District. Effectively managing this risk requires knowledge of the specific stressors that are outside District control so that the District can partner or advocate for measures that can mitigate the risk.

The Level 2 risk assessment identified the stressors that have historically and/or are currently, impacting stream ecosystem resources at the watershed-scale. Stressors include those that were observed through the CRAM ambient surveys and previous studies. Per the EMAP Framework, stressors are discussed in the context of the Level 2 stream ecosystem condition conceptual model (Figure ES-5). As illustrated in Figure ES-5, the stream ecosystem condition model classifies stressors in terms of those that are naturally occurring (brown and blue boxes) and those that are related to anthropogenic activities (orange boxes). Ecological risk is characterized by whether stressors originate within or outside the District's Area or Interest or control. Stressors that occur within direct District control inform priorities for future monitoring and management actions that may maintain and/or improve stream ecosystem conditions and inform funding mechanisms to invest in stream ecosystem health. Stressors that are beyond direct District control may provide potential opportunities for cooperative stewardship and/or advocacy with external agencies, organizations, and landowners.

Spatial patterns of "high-risk" sites (see section 3.1.2) and associated stressors in the Coyote Creek watershed and Upper Penitencia Creek subwatershed were identified via Level 2 CRAM surveys. Risk associated with each CRAM attribute are summarized in Table ES-1. Though it is difficult to accurately predict whether or not the consequences of future risks to stream ecosystem asset conditions will be realized, it is possible to indicate their likelihood and probable ecological consequences, in terms of the CRAM attributes and metrics.

Risk was also assessed using selected existing Level 3 data, to identify stressors at a finer scale than Level 1 or 2 data allow, and to help interpret risk indicated by Level 2 data. The context for this exploration was the Level 3 management question identified by District staff: *"How does physical habitat affect native fish populations?"* Combining Level 2 data (CRAM scores) and multiple types of Level 3 data, ranging from biological, physical habitat, fundamental geomorphic structure, and water and sediment quality provided insight into the potential causes of low fish population metrics observed in the Coyote Creek watershed. For example, native fish diversity and abundance were lowest in the middle Coyote Creek mainstem reaches, where physical and chemical conditions were also generally poor. Such insights are discussed at greater length in Chapter 3.

6) What actions can be taken to improve or better understand stream ecosystem conditions and reduce associated risk?

This core management question is addressed in two sections. The first addresses potential monitoring actions, and the second addresses potential management actions. Since the District has relatively little ownership and control over streams relative to the vast drainage network in each watershed, it is important for the District to identify risks to core District business that originate from areas within its control and from areas outside of District ownership, and to identify planning level recommendations that help the District make informed decisions on investments in cost-effective monitoring and management actions. Both sections addressing this management question distinguish between actions that are implemented through the three fundamental action strategies used in the District Ends Policies:

independent District actions, cooperative stewardship, and advocacy/technical support. Management actions recommended for District consideration are summarized in Table ES-2.

Table ES-1. Level 2 watershed-scale risk assessment conclusions based on CRAM surveys and qualitative assessment of risk realization consequences.

CRAM Attributes	Level 2 Risk Summary	Consequence of Risk Realization
Buffer and Landscape Connectivity	The extent and severity of future impacts to riparian areas ultimately depends on the relative strength of: 1) the protection of riparian buffers via policies and ordinances and 2) the extent to which existing urban growth boundaries are maintained. Relative to the legacy impacts from rapid urban expansion since 1950, impacts to buffers and landscape connectivity from future infill and redevelopment is expected to be less overall due to the limited area available for new development within the urban growth boundary, and current redevelopment policies that require greater setbacks, improved stream bank stability, and more robust planting designs than were implemented during original construction.	If riparian areas continue to be further encroached upon and interrupted by structures and transportation corridors, it is likely that impacts will occur to riparian functions and key stream ecosystem resources such as fisheries, channel capacity for flood and storm flows, wildlife habitat, riparian forests, wetlands, and green spaces.
Hydrology	If unmitigated infill development and expansion occurs within or outside urban growth boundaries, runoff into the stream ecosystem will likely increase, and more streams in the watershed may experience impacts due to hydromodification. The magnitude and extent of such impacts largely depends on the effectiveness of hydromodification controls implemented in compliance with the Municipal Regional Stormwater Permit (MRP).[2] Additionally, the District's operation and maintenance of flood control and water supply facilities could also continue to contribute to hydromodification in the Coyote Creek watershed without adjusting existing maintenance and operation activities to focus more on improving the hydrograph to support key aquatic, riparian, and upland habitats.	If hydromodification controls included in the MRP do not successfully maintain the existing hydrograph or improve it, then urban development, associated infrastructure, and impervious surfaces will continue to increase runoff to storm drain networks, and cause a suite of related impacts, including reduced floodplain and in-stream ecological and hydrological functions. The extent to which operation and maintenance practices for flood control and water supply can successfully contribute to improved hydrology will determine the relative impacts of District management to stream ecosystem asset conditions.
Physical Structure	The relative success of hydromodification controls, flood control designs, and riparian policy and ordinance enforcement will largely determine the degree to which physical structure is impacted in the future (beyond ongoing adjustment due to legacy impacts). Physical structure may be impacted by future channel stabilization projects, including the Mid-Coyote, Upper Penitencia, Lower Silver and Lake Cunningham Flood Control Projects unless designs and implementation successfully address both flood control and ecological objectives. Additionally, some degradation of stream ecosystem conditions due to livestock grazing will likely continue in areas where cattle have access to streams or their riparian areas.	The consequences of continued impacts to physical structure would include loss of channel topographic complexity, which leads to degraded habitat quality for fisheries, aquatic organisms, and riparian wildlife.
Biotic Structure	Potential impacts to biotic structure are associated with urbanization, livestock grazing and recreation. Many of these stressors are beyond District control. The magnitude and extent of these impacts depends on 1) the distribution of development that is not subject to regulation under the MRP or other state and federal policies affecting development; 2) the relative effectiveness of hydromodification controls that are implemented (including Low Impact Development provisions in the MRP, and in flood control and mitigation project designs); 3) the extent to which adequate riparian protection policies and ordinances are established and enforced; 4) whether the municipal urban growth boundaries expand; and 5) whether Best Management Practices for livestock uses are incentivized and implemented.	The consequences of continued degradation of biotic structure would include degradation and loss of aquatic and riparian habitat, which would impact the distribution, diversity, and abundance of native fisheries, aquatic organisms, and riparian wildlife. Key stream ecosystem resources that would be impacted include short or long-term surface water storage, energy dissipation, nutrient cycling, pollutant filtration and removal, retention of particulates, export of organic carbon, and maintenance of plant and animal communities.

[2] Effective December 1, 2011.

Table ES-2. Monitoring and management actions recommended for District consideration to better understand stream ecosystem conditions and reduce associated risk. Monitoring recommendations are identified as either generally applying to all watersheds (General) or Coyote-watershed specific (Coyote-specific). All management recommendations are Coyote-specific.

Monitoring and Management Actions Recommended for District Consideration	District Role		
	Primary Responsibility	Cooperative Stewardship	Advocacy; Technical Information
Monitoring Actions			
Include all areas of potential urban development in District Primary Areas of Interest for each watershed to define the geographic scope of ambient condition monitoring efforts. (General)	X		
Conduct ambient[3] and targeted CRAM surveys[4] for each watershed in the District's Primary Area of Interest in coordination with other District programs and projects. (General)	X		
Explore options to augment ambient Level 2 surveys designed for the District's Primary Area of Interest with nested surveys at a finer geographic resolution to improve the ability of the Framework to inform site-specific recommendations. (General)	X		
Explore the project-based application of CRAM as a cost-effective method to assess project sites before and after implementation. (General)	X		
Consider options for using CRAM as a tool to help evaluate the need for more intensive and costly Level 3 data. (General)	X		
Further examine relationships between native fish diversity and abundance, physical habitat, and selected water quality parameters to more robustly test the extent to which the spatial patterns in native fish diversity are driven by physical habitat versus water quality. (General)	X		
Address a high priority question identified through the EMAF Concept Pilot: "do current water supply operations (specifically imported water and associated groundwater operations) in Upper Penitencia Creek positively or negatively impact targeted species, steelhead and Pacific lamprey, and habitat conditions that are considered to be necessary and/or critical to support them?" by sampling the Upper Penitencia Creek fishery to estimate the size and structure of the steelhead population, identify the areas of habitat they use, their seasonal movement, and the size of the run/cohorts. (Coyote-specific)	X		
Consider long-term Level 3 data needs to support District programs and projects. (General)	X		
Explore opportunities to coordinate with partners to augment ambient Level 2 surveys designed for the District's Primary Area of Interest to include the remainder of the watershed areas. (General)		X	
Participate in regional monitoring networks that are designed to 1) detect trends in regional risk and 2) evaluate regulatory policies. (General)		X	
Participate in and/or track efforts to conduct CRAM surveys in the Halls Valley area that could not be included in the EMAF 2010 survey. (Coyote-specific)		X	
Management Actions			
Adopt Stewardship Levels of Service for watersheds and subwatersheds where appropriate.	X		
Alter management of impoundments (e.g., recharge facilities) to support multi-objectives including support of stream ecosystem conditions. For instance, as feasible, incorporate actions that encourage flushing of aggraded sediment through the Coyote Creek mainstem by implementing alternative management of recharge facilities. Such measures would improve habitat for anadromous fish and increase CRAM attribute scores.	X		
Design[5] the Mid-Coyote Flood Control Project to meet flood control objectives and objectives to enhance stream ecosystem conditions by increasing gradient and floodplain connectivity.	X		
Design[3] the Upper Penitencia Creek Flood Control Project to meet flood control objectives and objectives to enhance stream ecosystem conditions, particularly physical structure, by reducing bank slopes to establish new floodplains and allow for channel lateral migration as feasible.	X		
Consider in the design for the Lower silver Creek Flood Control Project opportunities to address the issue of high turbidity, coordinate with AMP continuous creek surveys to identify areas contributing fine sediment, and	X		

[3] Ambient surveys can provide a baseline ecological LOS to: 1) evaluate trends in watershed health (stream ecosystem conditions); 2) evaluate mitigation site condition (pre-and post-implementation) relative to watershed health, and 3) prioritize mitigation site acquisition and/or mitigation implementation.
[4] Both ambient and targeted CRAM surveys can serve as cost-effective screening tools to help evaluate the need for more intensive and costly Level 3 data.
[5] Consult the SCVURPPP (2003a) report for reach-specific planning level recommendations and Grossinger et al. (2006) historical ecology palette to assist with the project design.

Monitoring and Management Actions Recommended for District Consideration	District Role		
	Primary Responsibility	Cooperative Stewardship	Advocacy; Technical Information
conduct CRAM surveys to establish pre-and post project conditions.			
Design the Lake Cunningham flood control project to restore some of the riparian and wetland resources as part of the detention basin plan. Consult Grossinger et al. (2006) to assist with the restoration design.	X		
Continue to participate in the Santa Clara Valley Habitat Conservation Plan that provides a mechanism for the District to partner with others in watershed stewardship and as a forum for advocating for stream stewardship.		X	X
Through collaborations, review and prioritize reach-scale management actions recommended by previous Level 3 watershed studies such as Biotic Resources Group (2001), SCVURPPP (2003a) and Stillwater Sciences (2006), and consider strategies to implement high priority actions.		X	
Remain engaged in forums where land use policies are discussed to advocate for: 1) retention of current urban growth boundaries; 2) implementation of riparian and wetland protection policies; 3) urban development plans and land management actions that provide opportunities to enhance wetland and riparian areas and achieve flood control and water supply objectives; and 4) development and implementation of measures by private landowners who are actively grazing and mowing in the upper watershed to implement ranchland best management practices.			X
Share information from CRAM surveys about observed stressors and sites that could be improved or protected with agencies working in those areas.			X

Chapter 1.0 Introduction

This chapter introduces the District's Ecological Monitoring and Assessment Program Framework and provides an overview of its pilot implementation in the Coyote Creek watershed.

1.1 Overview and Purpose of Framework

The Santa Clara Valley Water District's (District) Ecological Monitoring and Assessment Program (EMAP) Framework is a multi-year effort to monitor and assess streams within the District's primary areas of interest in Santa Clara County. The overall goal of the EMAP Framework is to provide cost-effective, scientifically based and integrated information on stream ecosystem conditions to answer key questions about the performance of projects, programs, and policies intended to protect and manage water resources. It represents a paradigm shift in the District's management of ecological resources that has been steadily evolving over the past 10 years. Monitoring requirements, which are often mandated on a project-by-project basis, have lead to a piecemeal understanding of stream ecosystem conditions. Achieving the goal of healthy creek and bay ecosystems, however, requires a strategic approach to ecological data collection activities in order to evaluate whether stewardship actions are contributing to improvements in the health of stream ecosystems. The District's current approach to evaluating effectiveness in meeting District policies focuses on individual indicators such as volume of sediment removed from streams. While such indicators may effectively convey achievement of specific District actions, they do not convey their influence comprehensively vis-a-vis their effects on stream ecosystem conditions and functions.

The EMAP Framework includes recommendations for how to establish Levels of Service (numeric performance targets) for stream ecosystems to help the District periodically assess progress towards meeting stewardship objectives and the appropriateness of associated strategies and measurable objectives. These Levels of Service (LOS) can be established in each watershed by analyzing results of ambient surveys of stream ecosystem conditions. It is anticipated that the District will establish LOS for stream ecosystem condition for each watershed as one means of evaluating performance in meeting its Stewardship Policy (Ann Draper, SCVWD, personal communication 2/2/11).

Periodic assessments can be done to determine if the LOS is being achieved, to identify risks to the LOS and to identify actions needed to maintain or improve the conditions. The results of these assessments are summarized into a simple statistic referred to as the Ecological Services Index (ESI) of stream ecosystem condition. The ESI is a tool that may be used to track stream ecosystem conditions over time relative to established LOS. An analogy is to think of the ESI as a dial that reflects condition over time. The ESI may stay the same (indicating that overall condition hasn't changed), increase (indicating that overall condition has improved), or decrease (indicating that overall condition has decreased) as a result of different management actions or natural events. When the ESI indicates that a LOS is not achieved or emerging issues or risks are identified that threaten a LOS, then priority management actions can be identified to raise the ESI by improving conditions and/or managing associated stressors. This tool will enable the District to establish expectations about what conditions can be reasonably achieved and to identify associated investment costs. For example, it may make more sense to target improvements in an un-engineered reach with degraded stream ecosystem conditions than to invest capital to improve the condition of a storm drain that has little potential for providing ecological functions. Such actions and their Incremental costs can be determined and translated into District project plans and annual budgets.

The results of assessments are summarized in Stream Ecosystem Condition Profiles (Profile) that synthesizing information on the health of stream ecosystems within a watershed. Using the Framework's condition and risk assessment methods, ecological data are analyzed to provide watershed specific guidance on the future design of monitoring efforts, flood control projects, water utility projects and maintenance/operations. Stressors that potentially threaten stream ecosystem resources and pose risks to them are first discussed in terms of whether they are within or beyond District control. The District has relatively little ownership and control over streams relative to the vast drainage network in each watershed. Therefore, it is important for the District to clearly and transparently identify sources of risk to its core business that originate from areas within its control and from areas outside of District ownership. In doing so, the District can identify recommendations that help make informed decisions on District investments in cost-effective monitoring and management actions designed to improve stream ecosystem conditions. The District has three basic strategies it can take to influence such improvements. For assets that it owns, the District can directly initiate actions and modifications. For assets that the District does not own, it may work cooperatively with partners to achieve a desired LOS. Finally, the District may take a role of providing technical information or being an advocate for actions by others. Monitoring and management actions are identified and recommendations made to improve stream ecosystem conditions and classified and presented according to the three strategies discussed above. Results may also be used to reassess past monitoring requirements, set priorities for cost-effective monitoring, and inform negotiations with regulatory agencies.

This Profile describes the condition of stream ecosystem resources in the Coyote Watershed, and provides detailed attention to the Coyote Creek mainstem and the Upper Penitencia subwatershed. The Coyote Creek watershed was chosen as the focal area for this pilot implementation of the Framework in order to leverage the opportunity to use regional grant-funded data development for this watershed (www.wrmp.org/prop50). In addition, the Upper Penitencia Creek subwatershed was chosen, because the District's Asset Management Program (AMP) was a critical driver of the EMAP Project, and the AMP assessment work in the Upper Penitencia Creek Watershed provided an opportunity for EMAF to understand the AMP approach and create a Framework to support their ecological data needs and assessment of ecological risk. Both the Coyote Creek watershed and the Upper Penitencia Creek subwatershed are home to Multiple District programs such as the Three Creeks Habitat Conservation Plan, the Stream Maintenance Program, multiple flood control projects, as well as partner programs such as the Valley Habitat Conservation Plan. Collectively these efforts and associated data provided an opportunity to demonstrate how associated management issues could be addressed in the Framework.

This Profile for the Coyote Creek Watershed is the first implementation of the District's EMAP Framework. Because the EMAP Framework represents a novel approach in water resources management, this Profile was designed as a pilot effort to demonstrate how the Framework can be applied at the District and to identify needed improvements in the technical approach and reporting format. It is anticipated that other major watersheds will also be assessed in coming years. Because this is the first time that the District has undertaken an integrated monitoring and assessment approach of this magnitude and purpose, this pilot emphasized addressing major data gaps associated with stream ecosystem conditions The Framework will continue to evolve through adaptive implementation.

The remainder of this Profile is organized as follows:

- Introductory Chapter: from this point forward, this chapter presents key concepts of the EMAP Framework and its relationship to existing regulatory policy and to the District. It then describes how the Framework was implemented, including discussion of the management questions and the associated scope of monitoring conducted to address them, as well as an overview of the data collection methods used.

- Chapter Two: focuses on describing the results of implementing the Framework's Condition Assessment. It first describes the extent and distribution of stream ecosystem resources in the Coyote Creek watershed, and then discusses the conditions of stream ecosystem resources relative to their Levels of Service. Lastly, this chapter discusses results of an analysis that explored how physical habitat measured in the assessment affects native fish populations.

- Chapter Three: identifies the likely sources of risk to stream ecosystem resources and discusses the likelihood that sources of risk (i.e., stressors) may negatively influence stream ecosystem resources.

- Chapter Four: discusses the likely consequences of risk realization and presents recommended actions that may be considered to address risk and maintain and/or improve stream ecosystem conditions.

- References and Glossary of Terms: citations of reference documents used throughout the report and common terms are presented at the end of the main body of the report.

- Appendix A: presents the technical details of the Profile, including 1) methods for sampling design, site access, fieldwork, data quality assurance and management, data analysis, and map products; and 2) conceptual models.

1.2 Ecological Monitoring and Assessment Program Framework

The District selected the 1-2-3 Framework (Sutula et al. 2008) as a model for developing the EMAP Framework (SCVWD 2010a). The 1-2-3 Framework is a toolkit designed to help resource managers identify and cost-effectively answer their key questions about the performance of projects, programs, and policies intended to protect and manage aquatic resources. Cost-effectiveness is achieved by maximizing the use of less-expensive, coarser scale Level 1 and 2 data to answer management questions, and strategically guide the collection of more expensive and intensive Level 3 data collection. More detailed descriptions of each Level follow below.

Level 1. Landscape Resource Maps and Inventories.
Most Level 1 data are maps of the distribution and abundance of resources at the scale of landscapes, watersheds, regions, and the state. Level 1 data are used to assess the distribution and abundance of aquatic resources, guide on-the-ground management actions and track gross changes in resource condition. Level 1 data also include estimates of change in the distribution and abundance of resources based on comprehensive map updates (i.e., all the resources are re-mapped) or re-mapping a sample of the resources. Comprehensive Level 1 maps define the full extent of the resources and can serve as sample frames for surveying their condition using Level 2 and Level 3 tools. SFEI is developing several Level 1 base map layers (hydrology, wetlands, and riparian areas) for the San Francisco Bay Area the base maps throughout the Bay Area, referred to as the Bay Area Aquatic Resource Inventory (BAARI). The BAARI data are part of a statewide effort endorsed by the California Water Quality Monitoring Council (2010) to implement the California Aquatic Resource Inventory (CARI) as the standard Level 1 dataset for supporting water quality protection and management.

Level 2. Rapid Assessment of Overall Stream Ecosystem Condition.
Level 2 data measure overall stream ecosystem condition and functional capacity based on site-specific assessment using relatively rapid, semi-quantitative data collection methods. Level 2 data answer questions about the overall condition or health of resources relative to their expected or achievable kinds and levels of function and service, and can include assessments of likely stressors that limit resource condition. The California Water Quality Monitoring Council (2010) is encouraging the use of the California Rapid Assessment Method (CRAM) (Collins et al. 2008) as the primary Level 2 tool for assessing wetlands, wadeable streams, and associated riparian areas in California. CRAM can be used to assess the overall condition and performance of projects as well as ambient or background condition. Level 2 surveys of ambient condition can also serve to prioritize Level 3 data collection.

Level 3. Intensive Investigations of Targeted Resources.
Level 3 data quantify targeted aspects of site-specific resource functions, processes, and stresses based on intensive field observations and measurements. Common examples include counts of wildlife per unit time or space, percent cover of vegetation, recreational use intensity, and flood frequency. One use of Level 3 data by the District is to assess mitigation efforts and meet the monitoring requirements of environmental regulatory permits. Level 3 data are also necessary to validate and strengthen the

interpretation of Level 2 data and to diagnose the causes of aquatic resource condition as assessed using Levels 1 and 2 tools.

1.2.1 Framework Relationship to Wetland Protection Policy

The 1-2-3 Framework was developed by a consortium of federal and state agencies to increase the capacity of California to assess the status and trends of wetlands, streams, and riparian areas, and to assess the performance of related state policies, programs, and projects. Implementation of the 1-2-3 Framework has been recommended by the California Water Quality Monitoring Council (2010) and is the identified approach to evaluate the condition of streams across the state in the draft California Wetland and Riparian Area Protection Policy (WRAPP), which is currently under development by the State Water Resources Control Board (SWRCB). It is also being considered for incorporation into the Stream and Wetland Systems Protection Policy currently under development by the San Francisco Bay and North Coast Regional Water Quality Control Boards.

1.2.2 Framework Relationship to the District

The EMAP Framework (Framework) (Figure 1-1) embodies the structure of the 1-2-3 Framework and directly reflects District Directives, including the District Act, Mission and Ends Policies, and Strategic Plans (SCVWD 2010a). The District's Water Resources Stewardship policy states that "*There is water resources stewardship to protect and enhance watersheds and natural resources and to improve the quality of life in Santa Clara County.*" In support of that policy, the District's Board of Directors has adopted the goal of healthy creek and bay ecosystems by 1) balancing water supply, natural flood protection and water resources stewardship functions; 2) improving watersheds, streams and natural resources, and 3) promoting awareness of creek and bay ecosystem functions.

The objectives of the EMAP Framework are to:

(1) Integrate state of the science scientific methods and understanding of ecological conditions with District management actions;
(2) Integrate ecological monitoring activities within the District and with external efforts;
(3) Identify and prioritize gaps in existing ecological monitoring data necessary to answer important District management questions;
(4) Identify cost-effective approaches to address prioritized data gaps;
(5) Ensure ongoing integrative and interpretive assessments and reporting of ecological data.

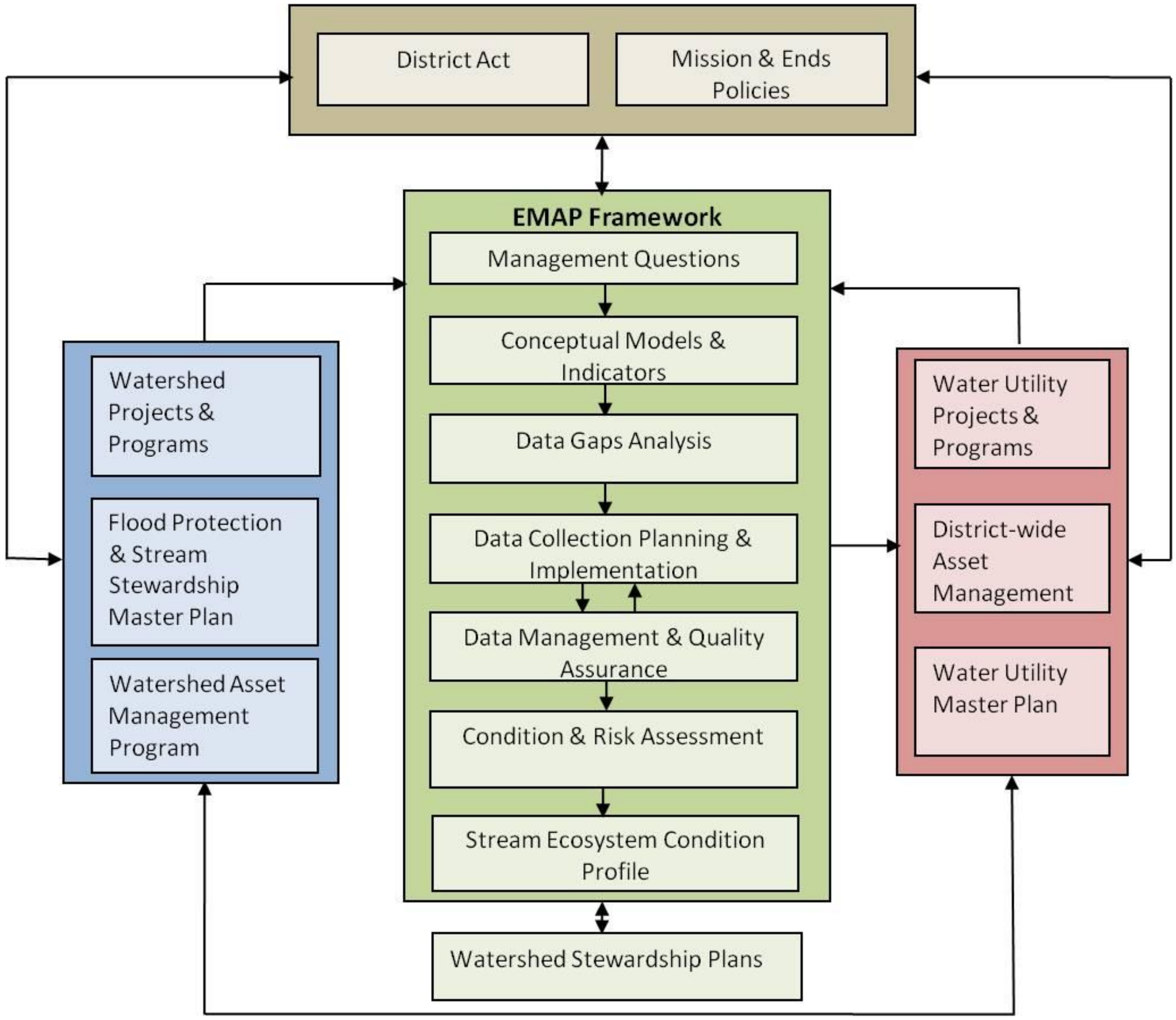


Figure 1-1. The Ecological Monitoring and Assessment Program Framework and its relationship to the District Act, Missions, Ends Policies, Programs, and Master Planning.

The Framework and the process of implementing it are described in detail in the Ecological Monitoring and Assessment Framework Technical Plan (SCVWD 2010a). In short, ecological data collection is driven by clearly articulated management questions that are translated into monitoring questions. Key steps in the Framework include:

- developing conceptual models and selecting indicators to characterize stream ecosystem components and relationships, identify important components and processes and related scientific assumptions;
- evaluating existing data in the context of these conceptual models to identify data gaps that need to be filled by ecological data collection;
- developing and implementing a data collection plan using accepted standard data collection and data management methods and adopted ISO data quality assurance procedures;

- analyzing and interpreting ecological data to evaluate the condition of stream ecosystem resources and associated risks, and develop a prioritized list of planning-level management and monitoring actions; and
- reporting results and recommended actions in a comprehensive and standard format that clearly communicates information to District staff to provide an adaptive management feedback loop, and to the public to convey progress towards meeting stewardship goals and objectives.

The planning-level management and monitoring recommendations identified in Stream Ecosystem Profiles are prioritized actions for maintaining and improving stream ecosystem condition to achieve performance targets. They serve as strategies and implementing measures to support the Board's Ends Policies to protect creek and bay ecosystems. They also inform Asset Management, Water Utility and Flood Protection efforts to balance environmental interests and promote the integration of environmental stewardship. The financial implications of implementing the recommended measures will need to be further evaluated and vetted with the public and incorporated into long-term funding strategies. Because there is currently no initiative to accomplish this, consideration may be given to establishing a watershed stewardship effort, such as the former Watershed Stewardship Plans, for this purpose. Implementing prioritized actions can then be aligned with the annual budget process and incorporated into work plans.

1.3 Framework Implementation in the Coyote Creek and Upper Penitencia Creek Watersheds

This Profile presents the pilot demonstration of the Framework. The scope of the pilot was designed to implement all aspects of the Framework, while emphasizing selected elements. Emphasis was given to filling key data gaps associated with Level 1 and 2 data and addressing fisheries concerns at Level 3, because fisheries are a key resource of interest. The approach synthesized in this pilot Profile provides the foundation for future profiles to build upon as the EMAP Framework is implemented in other watersheds.

The District established a series of six core management questions to drive Level 1 and 2 ecological data collection through the Framework. The term "core" is used because they are fundamental questions that will be addressed in every watershed. These questions can be answered using cost-effective Level 2 data derived from probabilistic surveys[6] of stream ecosystem resources. Level 3 management questions investigated through the Framework typically relate to understanding specific functions, aspects of condition, data collection methods, or may be exploratory in nature. This pilot demonstration of the Framework addresses one such question listed below.

[6] Probabilistic surveys are designed to sample a subset of watershed sites at random. These measurements can be used to describe conditions for the entire watershed.

The core management questions presented below form the organizational structure of Chapter 2, each serving as a subheading under which data have been interpreted to answer the respective questions.

Core Management Questions and Prioritized Level 3 Management Question:

1) **What is the extent and distribution of stream ecosystem resources?**

2) **What are the conditions of stream ecosystem resources relative to their levels of service (i.e., how are they performing)?**
    a. What are the conditions of stream ecosystem resources?
    b. What are the Levels of Service for stream ecosystem resources?
    c. How do the existing ecological conditions compare to ecological Levels of Service (LOS)?

    Prioritized Level 3 Management Question: How does physical habitat affect native fish populations?

3) **What are the likely sources of risk to stream ecosystem resources?**

4) **What is the likelihood that sources of risk may negatively impact stream ecosystem conditions?**

5) **What are the likely consequences of risk realization to stream ecosystem conditions?**

6) **What are the monitoring and management actions that could improve or provide a better understanding of stream ecosystem conditions and reduce risk?**
    a. What monitoring actions can be taken to better understand stream ecosystem conditions?
    b. What management actions could be taken to potentially improve existing stream ecosystem conditions?

The ecological data collected through this pilot focused on identifying the extent and distribution of stream ecosystem resources (Level 1) and assessing the overall condition of such resources (Level 2 data), which represented significant data gaps. It also focused on a high priority Level 3 management question about the relationship between the Level 2 assessment of stream condition based on the CRAM and selected Level 3 data (i.e., native fish species diversity). Coordination with the Wetland Regional Monitoring Program (WRMP) Bay Area Aquatic Resources Inventory resulted in the Coyote Creek Watershed being the first Bay Area watershed to be completely mapped for Level 1 base map data (www.wrmp.org/prop50).

1.3.1 Geographic Scope of Monitoring

The pilot data collection plan (SCVWD 2010b) was designed to measure the overall (ambient) condition of stream ecosystem resources for the Coyote Creek Watershed in its entirety, as well as an intensification of sampling within the Upper Penitencia Creek Watershed. This geographic scope of monitoring was established based on the District's Area of Interest, which is defined as the area within the Santa Clara County exterior boundaries as defined through Measuring ambient condition of stream ecosystems within entire watersheds serves multiple purposes that are presented in Chapter 2.

Through this pilot, a definition of the District's Primary Area of Interest was developed (see below) to focus assessments on those parts of the County that are considered to be most important for the District to monitor, after establishing a baseline watershed measure of stream ecosystem ambient condition. This initial monitoring and assessment effort established the overall watershed baseline, which is critical for interpreting future data from the Primary Area of Interest and for tracking change over time. The Primary Area of Interest is a useful geographic scale for which stream ecosystem monitoring can be designed in the future, as will be further explained in the Framework Implementation Plan (SCVWD 2011).

The Primary Area of Interest is defined for watersheds by identifying the areas that pertain to each of the following criteria:

1. District fee title;
2. All facilities that are managed/maintained by the District to provide flood protection and water supply and downstream areas that are influenced by such facilities;
3. District easements, cooperative agreements, and other legal agreements where the District conducts work.
4. Areas of potential risk to District assets[7] that are identified by ambient stream ecosystem surveys and other sources, including:
    A. Local, regional or global threats such as upstream source inputs, invasive species, or climate change, respectively.
    B. Existing or planned regulations (e.g., survey areas for existing or potentially listed species).
5. Areas identified through Stewardship Planning.

1.3.2 Data Collection Method Overview

This section briefly describes the monitoring designs and data collection methods associated with information assessed to develop this Profile. Technical details for all such methods are described in Appendix A.

Ambient stream ecosystem conditions (SCVWD 2010b) were measured using standard probabilistic monitoring designs and data collection methods (Stevens and Olsen 2004, Collins et al. 2008). The probabilistic monitoring design method is called the Generalized Random Tesselation Stratified design (GRTS) and was developed by USEPA (Stevens and Olsen, 2004). The ambient probabilistic surveys are

[7] The intent is to identify risks that potentially threaten the condition and performance of District assets and operations.

designed to sample a subset of watershed sites at random. Such measurements provide a statistically sound basis for using a sample of watershed sites to describe conditions for the entire watershed. A total of 77 sites were probabilistically selected for the ambient assessment of the entire Coyote Creek watershed. Thirty of these sites occurred within the Upper Penitencia Creek subwatershed, enabling the results to describe overall stream ecosystem conditions for both the entire Coyote Creek watershed and the Upper Penitencia Creek subwatershed.

Probabilistic designs can be a cost-effective approach to answering broad questions of watershed health, however, such designs are of limited use in answering questions related to targeted sites that are not included in the probabilistic design. Non-probabilistic targeted monitoring designs select sample locations non-randomly, and measure conditions at these sites. Unlike probabilistic monitoring designs, their results may not be extrapolated to measure overall watershed conditions. Targeted assessments were performed at a total of 23 sites on the Coyote Creek mainstem. Twenty-two of these sites corresponded with locations where baseline fisheries monitoring was conducted as part of the Mid-Coyote Creek Flood Protection Program (SCVWD 2008). This targeted monitoring design was implemented to 1) help validate CRAM with respect to fisheries health (not to replace fish data collection but to explore the possibility of using CRAM as an inexpensive screening tool for evaluating fisheries health and designing subsequent fisheries sampling), and 2) to use the validation regressions between CRAM and fisheries data to test the efficacy of a conceptual model of fish habitat. Similar validation studies have been conducted for benthic macroinvertebrates and riparian birds (Stein et al. 2009), but not for fish. In these previous CRAM validations, the strongest correlations were between CRAM scores and benthic macroinvertebrate IBI scores. One mitigation site on the Coyote Creek mainstem was also sampled to establish a baseline measure for a District mitigation site.

The results of the EMAP Framework validation study were also integrated with selected data summarized as part of the level 3 Condition Assessment (see Chapter 2) to demonstrate on a limited basis how the Framework integrates the three levels of information. Since many different types of Level 3 data exist, a subset was selected to be included in this Profile. The number and type of level 3 data that are included in future Condition Assessments should be tailored to each watershed. The Level 3 data included in this Profile have been collected through multiple agency efforts using various Level 3 data collection tools. The associated Level 3 data collection methods are referenced by their source documents in Chapter 2.

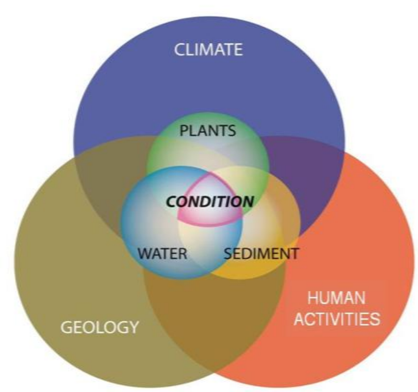


Figure 1-2: Spatial hierarchy of factors that control wetland and stream conditions, as ultimately controlled by climate, geology, and human

CRAM (Collins et al. 2008) was used to collect Level 2 data and measure stream ecosystem conditions. CRAM is a standardized cost-effective method that is used to rapidly assess the overall condition of wetlands[8] and riparian sites using visual indicators in the field. Overall site condition can be assessed in 1-3 hours by two more trained practitioners. CRAM assessments produce a single Index score for each site that ranges from 25 to 100 points. Field practitioners score 14 Metrics by selecting from four alternative descriptions of condition that are associated with fixed numerical value. Each of the 14 metrics is organized into one of four Attributes: Landscape Context and Buffer, Hydrology, Physical Structure, and Biotic Structure. The CRAM Index score is based on the component scores for the Attributes and their Metrics. An Attribute score is calculated as the sum of its Metrics, converted into a percentage of the maximum possible score for the Attribute. The site Index score is calculated by first summing the Attribute scores and then converting this sum into the maximum possible score for all Attributes combined. The maximum possible score represents the best possible condition that is likely to be achieved for the type of wetland being assessed. Therefore, a site's Index score indicates how its condition compares to the best achievable condition for that wetland type in the State of California.

CRAM is based on a conceptual model that internal and external interactions among hydrologic, biologic (biotic) and physical (abiotic) processes determine the condition of wetlands. CRAM reflects a series of assumptions about how these processes interact through space and over time (Figure 1-2). First, CRAM assumes that the condition of a wetland is mainly determined by the quantities and qualities of water and sediment (both mineral and organic) that are either processed on-site or that are exchanged between the site and its immediate surroundings. Second, the supplies of water and sediment are ultimately controlled by climate, geology, and land use. Third, geology and climate govern natural disturbance, whereas land use accounts for disturbances from human activities. Fourth, biota (especially vegetation) tend to mediate the effects of climate, geology, and land use on the quantity and quality of water and sediment and support other life. For example, vegetation stabilizes stream banks and hillsides, traps sediment, filter pollutants, provide shade that lowers temperatures, reduce winds, etc. Fifth, stress usually originates outside a wetland in the surrounding landscape or the encompassing watershed. Sixth, buffers around the wetland can intercept and otherwise mediate stress. There are additional assumptions relating wetland form and structure to wetland function. In general, CRAM assumes that, for any particular kind of wetland in any region, larger and more complex wetlands subject to less stress tend to provide higher levels of more kinds of functions.

[8] CRAM identifies six types of wetlands, however, only the riverine wetlands were assessed for this Profile. A riverine wetland consists of the riverine channel and its active floodplain, plus any portions of the adjacent riparian areas that are likely to be strongly linked to the channel or floodplain through bank stabilization and allochthanous inputs (Collins et al. 2008).

Chapter 2.0: Assessment of Stream Ecosystem Conditions

This chapter describes the results of the condition assessment for the Coyote Creek Watershed. It addresses the following core management questions and a management question prioritized for this study:

1) **What is the extent and distribution of stream ecosystem resources?**
2) **What are the conditions of these stream ecosystem resources relative to their levels of service?**

The first question focuses on describing the distribution and abundance of riparian and wetland resources throughout the pilot demonstration area and is therefore addressed using Level 1 data. The second question focuses on overall condition of the resources and therefore is addressed using Level 2 data. The prioritized management question, *"How does physical habitat affect native fish populations?",* focuses on a specific aspect of stream ecosystem condition, native fish diversity that is addressed using Level 2 and 3 data.

2.1 Extent and Distribution of Stream Ecosystem Resources

The Coyote Creek watershed base map (Figure 2-1) depicts the distribution and abundance of selected stream ecosystem resources, including riparian areas, wetlands, channels (including storm drains and other engineered drainages), and areas of District fee title and easements. The base map is shown here in a small format, but accompanies this report in electronic format and also will be available for exploration online at various scales on the California Wetlands Portal (see details at http://www.sfei.org/BAARI). The data shown on the base map are derived from various sources (see Appendix A for discussion of map production), including the BAARI and the District and provide a spatially explicit means for tracking and visualizing changes in the extent and condition of stream ecosystem assets. The BAARI data are also part of a state-wide effort of Level 1 inventories that support an interactive, web-based tool for uploading and downloading Level 2 and level 3 data based on when and where they were collected. The Coyote Creek watershed covers approximately[9] 353 square miles within its 147.3 mile perimeter and drains a portion of the west-facing slope of the Diablo or Hamilton Range. The sections below characterize the drainage network, wetlands, and riparian areas in the Coyote Creek watershed. Historical comparisons are made where data are available in the Coyote Creek Valley (Grossinger et al. 2006).

[9] The CalWater data set was used to delineate the Coyote Creek watershed in order to coordinate with the Wetlands Regional Monitoring Program which funded the Coyote Creek watershed ambient stream ecosystem condition survey. The District watershed data set estimates the watershed to be approximately 320 square miles (SCVURPPP 2003a).

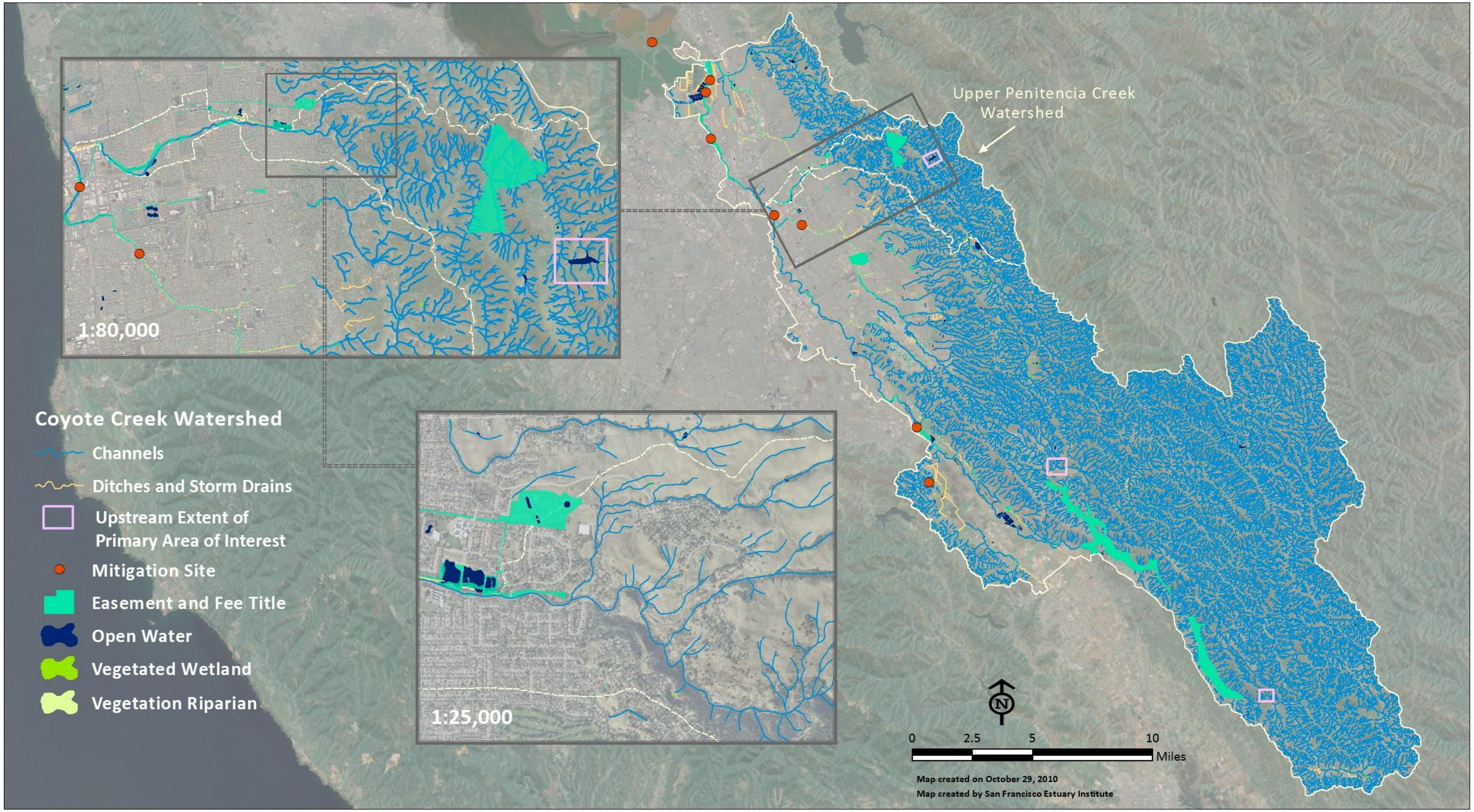


Figure 2-1. The extent and distribution of aquatic resources (streams, wetlands, riparian areas, and impoundments), District fee title easement properties, and the District's Primary Area of Interest in Coyote Creek watershed and the Upper Penitencia Creek subwatersheds. A leased property is shown as the upper half of the hourglass-shaped polygon in the Upper Penitencia Creek subwatershed), The streams, wetlands, and riparian areas were acquired from the Bay Area Aquatic Resources Inventory (BAARI) and can be found at www.californiawetlands.net. The Coyote Creek watershed boundary is part of the CalWater 2.2.1 dataset. All other data were acquired from the Santa Clara Valley Water District. The Island Ponds are located outside the Coyote Creek Watershed, but are a component of the District's Primary Area of Interest. Corresponding insets show a subset of the map at larger scales to view higher level of detail.

2.1.1 Drainage Network

The Coyote Creek upper watershed (upstream of the urbanized valley area characterized by ditches, storm drains, and reservoirs) is largely undeveloped and represents about three quarters of the entire watershed. Henry Coe State Park comprises a significant portion of the upper watershed. The steep and hilly topographic relief, distance to urban centers, and to a certain extent land use planning, have helped stave off development in this region of the watershed. These factors are the primary reasons that the upper watershed's hydrology is still relatively natural, with minimal human alteration. Constructed stock watering ponds within several natural channels and swales are exceptions. The Coyote Creek watershed has a total of 2,830 miles in eight different stream orders (Table 2-1). The District has fee title or easement on only three percent of the total stream miles in the Coyote Watershed. Almost ninety percent of the natural stream network is in the lower three stream orders, most of which are in the upper watershed.

Table 2-1. Stream miles by stream order in the Coyote Creek Watershed and District easement and fee title properties.

Stream Order	Channel Length (miles)	
	Coyote Creek Watershed	District Property
1	1,613	10
2	588	8
3	301	9
4	134	13
5	99	22
6	38	0
7	23	0
8	35	13
Total	2,830	76

Channel length (natural and ditches but not storm drains) derived from the BAARI.

Historically, the Coyote Creek Valley had 114 miles of stream network comprised of the Coyote Creek main stem and numerous distributaries[10] that drained the hillsides (Figure 2-2). The alluvial fans and permeable valley soils allowed storm water runoff and floodwaters in the valley to recharge the local underground aquifers (Grossinger, *et al*, 2006). Many of the historical tributaries did not have well-defined channels connecting to the mainstem. Instead, they distributed their flows and sediment loads across broad

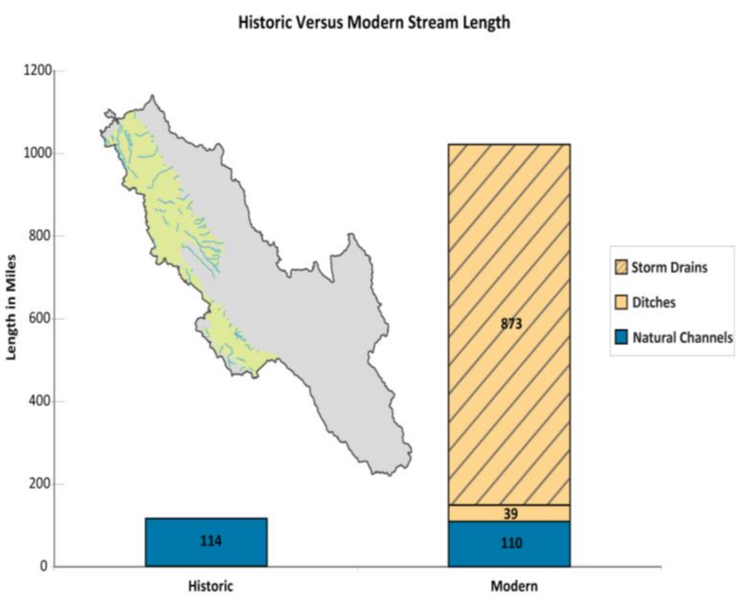


Figure 2-2. Stream network comparison of historical (c. 1850) and modern (c. 2005) in the Coyote Creek Watershed Valley floor where the greatest changes have occurred. Map depicts the valley extent (yellow area) within the larger watershed. Blue lines are the historical stream network. The valley extent and historical stream network were created as part of the Coyote Creek Watershed Historical Ecology Study. The Coyote Creek watershed boundary is part of the CalWater 2.2.1 dataset.

[10] A stream that branches off and flows away from a main stream channel and never rejoins it. The opposite of a distributary is a tributary (a stream that flows into a main stem river and does not flow directly into a sea, ocean, or lake).

alluvial fans. These distributaries were probably connected to the mainstem during major floods.

Today, all of the major tributaries connect to the mainstem of Coyote Creek through engineered channels and subsurface storm drains (Figures 2-1 and 2-2). The Coyote Creek Valley, including the alluvial fans, is highly urbanized. As in many other watersheds, the majority of the hydrological modification has occurred here, rather than on the steeper hillsides along the ridgelines. The Coyote Creek Valley now contains a dense network of over 900 miles of unnatural channels including subsurface storm drains, engineered channels, and simple ditches (Figure 2-2). There are about the same amount of natural channels now as existed historically, but there has been an almost ten-fold increase in total drainage network miles including storm drain pipes, constructed channels, and ditches. The largest factor in this increase is the subsurface storm drain network designed to convey runoff from the hillsides through the valley to the Bay; a much smaller contributor is artificial surface channels, including engineered channels and roadside ditches (Figure 2-2). Such changes to the drainage network have resulted in a reduction of groundwater recharge; hydrologic changes, notably increased runoff peak flows; total annual flows; timing and duration of high flows; and a loss of associated floodplains, riparian woodlands, wetlands, and natural buffers.

2.1.2 Non-Riverine Wetlands

The Coyote Creek watershed has approximately 100 acres of natural wetlands and 3,062 acres of unnatural wetlands (Table 2-2). Sixty percent of the wetlands in this watershed fall into the unnatural lacustrine type, e.g., bodies of water (typically reservoirs or other impoundments) greater than 20 acres with an average depth greater than 6 feet (Table 2-2) There are almost 1,200 acres of depressional wetlands (contained with topographic lows that lack surface drainage), approximately 40 of which are natural or occur without human modification of the landscape. The amount of vegetated wetland is not explicit in this table, but can be seen as very small polygons adjacent to open water and parts of the stream network in Figure 2-1 (1:80,000 inset). Sixty four acres of slope wetlands (i.e., seeps, springs, and other wetlands depending on groundwater), the majority of which are natural, still occur in the Coyote Creek contemporary landscape. It was not feasible for this study to conduct a detailed comparison between the existing and historical abundance of each kind of wetland. A simple visual comparison of the historical and modern maps of aquatic resources indicates that there was historically much more acreage of natural slope wetlands and depressional wetlands than exists now. A more quantitative comparison could be made in the future based on the completed Level 1 maps of past and present landscapes.

Table 2-2. Coyote Creek watershed non-riverine wetland acreage by type.

Non-riverine Wetland Type	Natural	Unnatural
Depressional	42	1,164
Lacustrine	0	1,891
Slope	57	7

Data for this table was generated from the BAARI dataset. Definitions of wetland types are based on the BAARI mapping standards and methodology (http://www.wrmp.org/docs/SFEI%20MAPPING%20STANDARDS_01062011_v3.pdf).

2.1.3 Riverine Wetlands and Riparian Areas

The Coyote Creek watershed contains 2,830 stream miles of riverine wetlands (Table 2-1). Riverine wetlands consist of the riverine channel and its active floodplain, plus any portions of the adjacent riparian areas that are likely to be strongly linked to the channel or floodplain through bank stabilization and allochthanous inputs.

Riparian areas attend all of the riverine wetlands and streams as part of the transition zone between them and the adjoining uplands (Figure 2-1 second inset box). The riparian areas vary in width, which affects their functions. The wider areas tend to provide higher levels of more kinds of functions (Table 2-3), which can include wildlife support, runoff filtration, allochthanous input of leaf litter and large woody debris (providing food and cover), temperature control from shading, flood hazard reduction, groundwater recharge and bank stabilization.

Table 2-3. Riparian area by width class in the Coyote Creek watershed and corresponding levels of typical riparian functions based (Collins et al. 2006). Miles of riparian are calculated as the average of right and left streamside riparian widths.

Width Class (meters)	Miles	Acres	Percent of Watershed Stream Miles	Shading	Bank Stabilization	Flood-water Dissipation	Recharge	Wildlife Support	Allochthonous Input	Runoff Filtration
0 - 10	334	1,488	30%	Very Low	Very Low	Very Low	Very Low	None[1]	Low	Low
10 - 30	484	19,292	43%	Medium	Very High	High: SC Low: LC	High: SC Low: LC	Low	Medium	Low to Medium
30- 50	272	27,874	24%	Medium to High	Very High	Medium to High	Medium to High	Medium to High	Medium to High	Very High
50 - 100	29	5,285	2.6%	Very High	Very High	Very High	Very High	High[2]	Very High	Very High
>100	4	3,003	0.4%	Very High	Very High	Very High	Very High	Very High	Very High	Very High

[1] May provide refugia but not usually viable habitat for wildlife such as amphibians, aquatic reptiles, migratory passerine birds, etc.

2 May not provide viable habitat for some large species of wildlife that are highly mobile and especially sensitive to people, including mountain lions, bears, and some raptors.

SC: small channels; LC: large channels

Seventy-three percent of the total stream miles have a narrow riparian width less than 30 meters on either side (Figure 2-3). Thirty percent of those stream miles have riparian areas less than 10 meters wide. These are streams, ditches and engineered channels in urban settings that are not steep and that have little or no streamside trees. Forty-three percent of those stream miles have riparian areas between 10 and 30 meters wide. Of the remaining twenty-seven percent of stream miles, twenty four percent are in the medium with class (30-50 meters) and only three percent of stream miles have riparian areas that are wide (50 - 100 meters) or very wide (> 100 meters). The stream miles having wide and very wide riparian areas are located in the upper portion of the watershed that supports very tall trees, including ponderosa pine.

Historically, riparian areas in the Coyote Creek watershed were quite heterogeneous, including densely vegetated forest, more open savanna/woodland, riparian scrub, and large, un-vegetated gravel bars (Grossinger et al. 2006). Dominant riparian vegetation varied predictably with the size of the channel, its morphology, and degree of dry season flow. Perennial creeks like those in the lower portion of the watershed and the middle and upper reaches of the mainstem were lined with cottonwoods and willows. Small intermittent creeks had fewer trees (largely oaks), while large braided intermittent reaches of the main stem supported sycamore alluvial woodland, riparian scrub, and un-vegetated gravel bars. In the historical landscape, more than seventy percent of the total creek length in the valley had a riparian width of 30-50 meters on each side, and about fifteen percent had riparian areas of more than 100 meters[11] on each side. Historically there was little functional riparian area less than 30 meters wide.

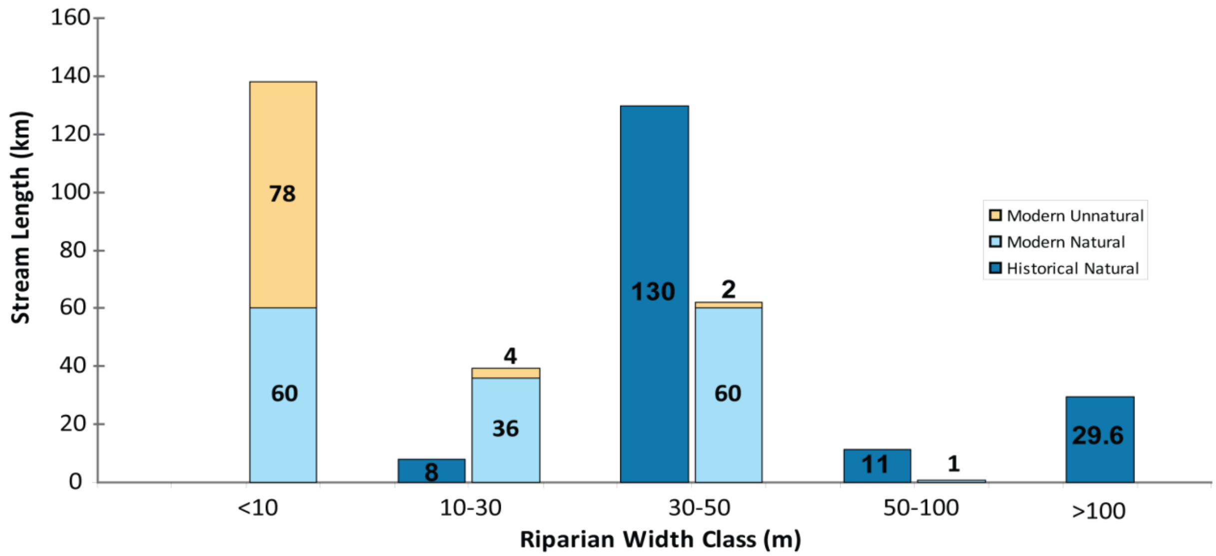


Figure 2-3. Comparison of historical and modern stream length by riparian width class in the Coyote Creek Valley calculated using the Bay Area Aquatic Resource Inventory (BAARI) riparian model and the Coyote Creek Historical Ecology Study (Grossinger et al. 2006).

The existing landscape is very different from the historical landscape. The historical landscape had much greater capacity to retain rainfall in wetlands and near-surface aquifers, and it drained much more slowly. The valley was characterized by mosaics of aquatic and wetland habitats associated with perennial and seasonal streams, their flood plains and terraces, alluvial fans, and emergent groundwater. These historical maps show how habitat mosaics naturally varied within the watershed in relation to climate and geology, especially rainfall, topography, and soils. The historical maps can therefore be used to help prioritize and design restoration and mitigation projects, and to align land management practices with natural processes.

Since the time of European settlement, the Coyote Creek Valley has lost most of its wide riparian areas (Figure 2-3). In the current landscape of the full watershed (Figure 2-4), seventy-three percent of both natural and unnatural channels have adjoining riparian areas less than 30 meters wide. Only short stretches of streams in the valley (Figure 2-3) have riparian areas wider than 50 meters, and there are no

[11] All 28 stream miles in this bin are from the Coyote Creek main stem and include both the forested riparian areas and components of the active channel created by its temporal meander.

remaining riparian areas wider than 100 meters in the Coyote Creek Valley. The decreases in riparian width are mainly due to encroachment of urban development in the lower portion of the watershed and grazing in the upper watershed. Not surprisingly, almost all of the ditches and other unnatural channels have very narrow riparian areas.

2.2 Stream Ecosystem Condition Assessment

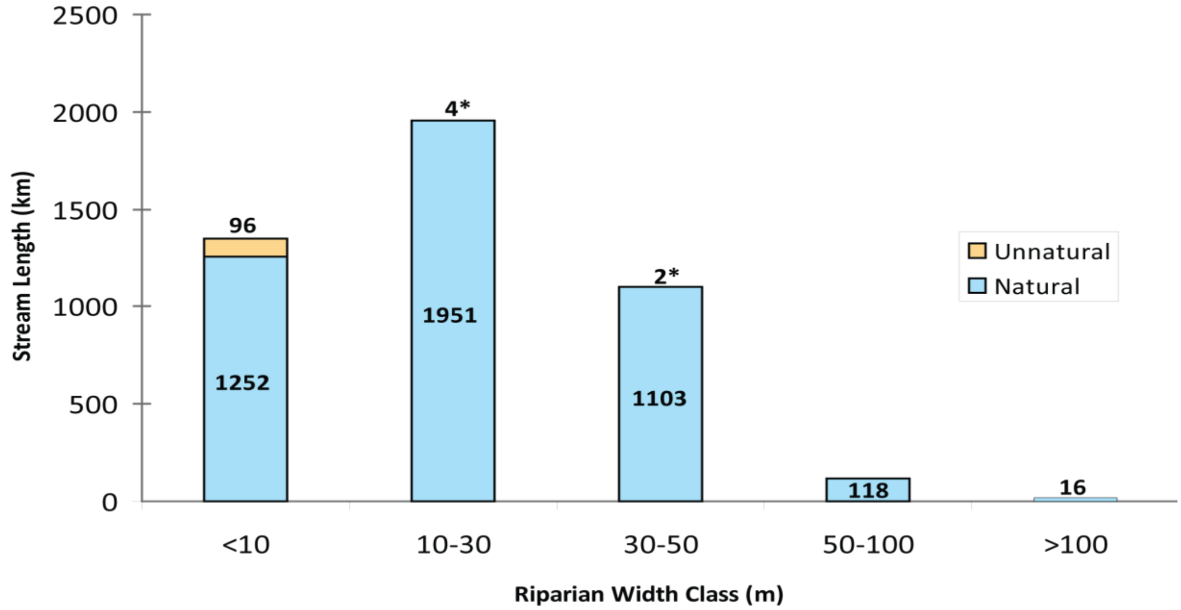


Figure 2-4. Modern stream length by riparian width class calculated for the entire Coyote Creek watershed using the Bay Area Aquatic Resource Inventory (BAARI) riparian model. Width classes 10-30 and 30-50 are labeled to illustrate the 4 and 2 kilometers of unnatural streams, respectively (because a bar representing these values cannot be seen at this scale).

This section answers the core management question: "what are the conditions of stream ecosystem resources relative to their levels of service?" the answer is separated into the following three components, each of which is separately addressed:

- What are the conditions of stream ecosystem resources?
- What are the Levels of Service for stream ecosystem resources?
- How do the existing ecological conditions compare to ecological Levels of Service (LOS)?

2.2.1 What are the conditions of stream ecosystem resources?

This section describes the existing condition of stream ecosystem resources based on Level 2 and Level 3 data. As discussed above, Level 1 data describe the distribution and extent of stream ecosystem resources. Level 2 data are used to assess the overall condition or health of such resources and to develop hypotheses regarding the causes of their observed conditions. Intensive Level 3 data can be used to test such hypotheses and to help identify management or monitoring actions to improve the condition of stream ecosystem resources.

2.2.1.1 Level 2 Data

The Level 2 data are summarized by cumulative distribution functions (CDFs) that estimate the proportion of stream miles with CRAM scores less than or equal to a given score. For example, Figures 2-5 and 2-6 show that in both watersheds, about 10% of stream miles had CRAM scores of 60 or lower. The better the condition of streams in a watershed, the more the CDF will shift to the right.

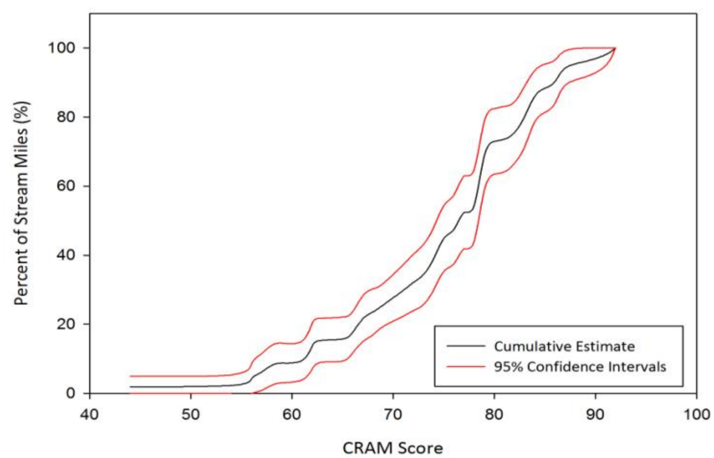


Figure 2-5. Cumulative distribution function (CDF) of CRAM Index scores relative to percent of stream miles in <u>Coyote Creek</u> watershed.

Probabilistic Survey Data

The Coyote Creek watershed[12] exhibited a broader range of stream ecosystem conditions than the Upper Penitencia Creek subwatershed and higher condition scores for each percentile of stream miles in the respective watersheds. This is clearly illustrated in the CDFs that were calculated from the ambient CRAM survey data (Figures 2-5 and 2-6) and in the summary statistics presented in Table 2-4. Figures 2-7 and 2-8 illustrate the spatial distribution of the stream ecosystem condition scores across the watersheds.

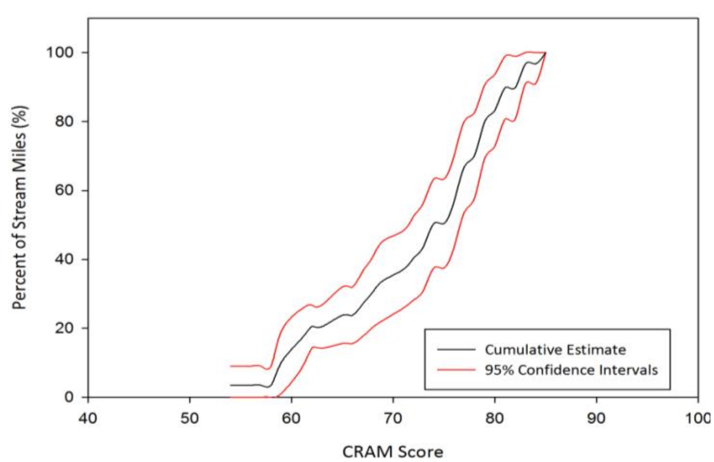


Figure 2-6. Cumulative distribution function (CDF) of CRAM Index scores relative to percent of stream miles in the <u>Upper Penitencia Creek subwatershed.</u>

The Level 2 sample was designed to represent stream ecosystem conditions throughout the entire watershed. However, a large part of the central portion of the upper Coyote Creek watershed could not be sampled due to access issues (Appendix A), and therefore is not represented in this assessment.
Access issues are common in large-scale surveys that involve private lands. To some extent, the bias of a survey due to access issues can be qualitatively estimated using the Level 1 data. Based upon visual

[12] The Coyote Creek CDF represents stream ecosystem conditions cumulatively for both the Coyote Creek watershed and the Upper Penitencia Creek subwatershed whereas the Upper Penitencia Creek CDF represents only stream ecosystem conditions in that subwatershed.

comparison of the Level 1 data and aerial imagery the streams in the inaccessible portion of the Coyote Creek watershed do not appear to be systematically different than the surveyed streams of like order. However, whether or not the lack of access to part of the watershed introduced bias into the survey cannot be determined without fully assessing the sites that were not accessed.

Table 2-4. Summary statistics for the Coyote Creek (CC) watershed (N = 77) and the Upper Penitencia Creek (UPC) subwatershed (N = 30) cumulative distribution functions.

Water-shed	Percent Stream Miles by Condition Categories				Range	Median	Mode
	Low	Medium-Low	Medium-High	High			
CC	0	14	60	26	44 - 92	77	79
UPC	0	21	69	10	54 - 85	74	77, 79

CRAM Index scores have a precision of 10 points[13], meaning that differences in CRAM Index scores of 10 points or less are within the error of the method and should not be considered to represent differences in overall condition (CWMW 2009). The average upper confidence limit for CRAM Index scores was 7 points in the Coyote Creek watershed (Figure 2-5), and 5 points in the Upper Penitencia Creek subwatershed (Figure 2-6), which was generally narrower than for the entire Coyote Creek watershed. These levels of certainty for both watersheds are well within the error bounds of the CRAM method, and therefore lend confidence to inferences made from these data pertaining to stream ecosystem conditions across all the stream miles in these watersheds.

CRAM Index scores have been classified in two ways in this Profile: 1) based on four equal interval classes of about 19 CRAM points that represent the full range of possible CRAM scores (e.g., 25-100) (Figure 2-7); and 2) based on quartiles of the observed range of CRAM Index scores as displayed in the CDFs (e.g., 44 – 92) (Figure 2-8). The equal-interval classification method is useful because it provides a standard scale that enables local watershed CRAM Index scores to be compared to other CRAM surveys conducted statewide. The watershed-specific quartile classification method is useful because it provides a perspective of condition categories relative to a specific watershed, e.g., the quartiles each represent the conditions for 25% of stream miles in a given watershed. This information may be more useful for targeting management actions than the standard scale results. Higher Index scores represented by either classification method represent better overall stream ecosystem conditions.

Figure 2-7 shows the distribution of CRAM Index scores for the Coyote Creek watershed among the four equal interval classes (<44, 44-62, 63-81, >81). Notably, no sites scored in the lowest condition category. Based on the limited pool of CRAM data available statewide at this point in time, it is relatively rare for sites to score so low. Nonetheless, this comparison of the Coyote Creek watershed CRAM Index scores to the possible range of CRAM Index scores indicates that stream ecosystem conditions in the Coyote Creek watershed are within the upper three condition categories (e.g., upper 75% of the possible range). As more CRAM data become available statewide, it will be possible to conduct more comparisons between watersheds and to the statewide CDF.

[13] Based on the results of inter-team calibration exercises (Collins et al. 2008).

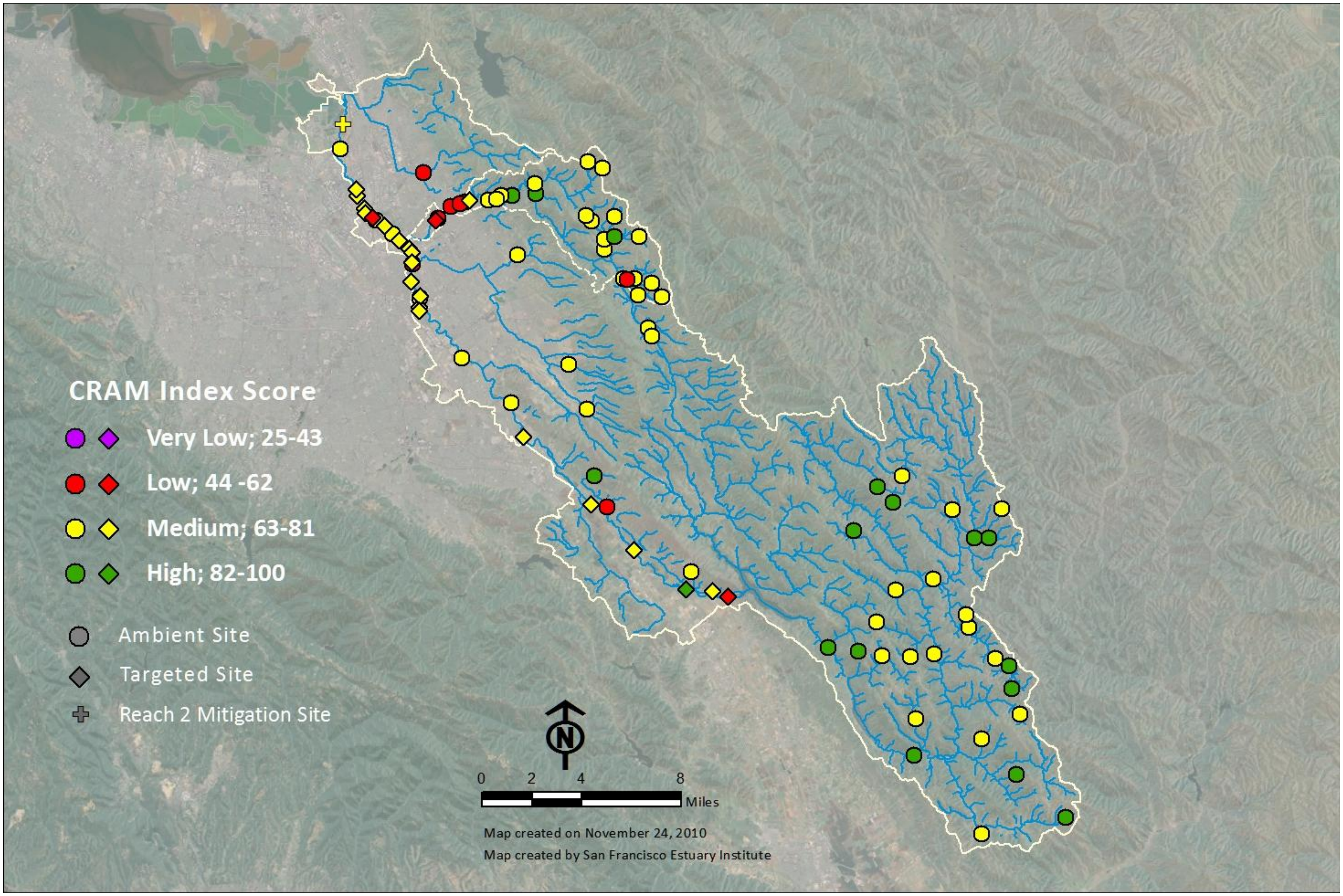


Figure 2-7. CRAM Index scores for ambient and targeted sites. Score categories were determined by dividing the total possible range of CRAM Index scores into four equal intervals of 19 points each. Four ambient sites in Upper Penitencia have been removed from the map, but not the analyses, due to land-owner sensitivity. Stream network data were acquired from the Bay Area Aquatic Resources Inventory (BAARI) and can be found at www.californiawetlands.net. The Coyote Creek boundary is part of the CalWater 2.2.1 dataset; the Upper Penitencia Creek subwatershed boundary is from the District.

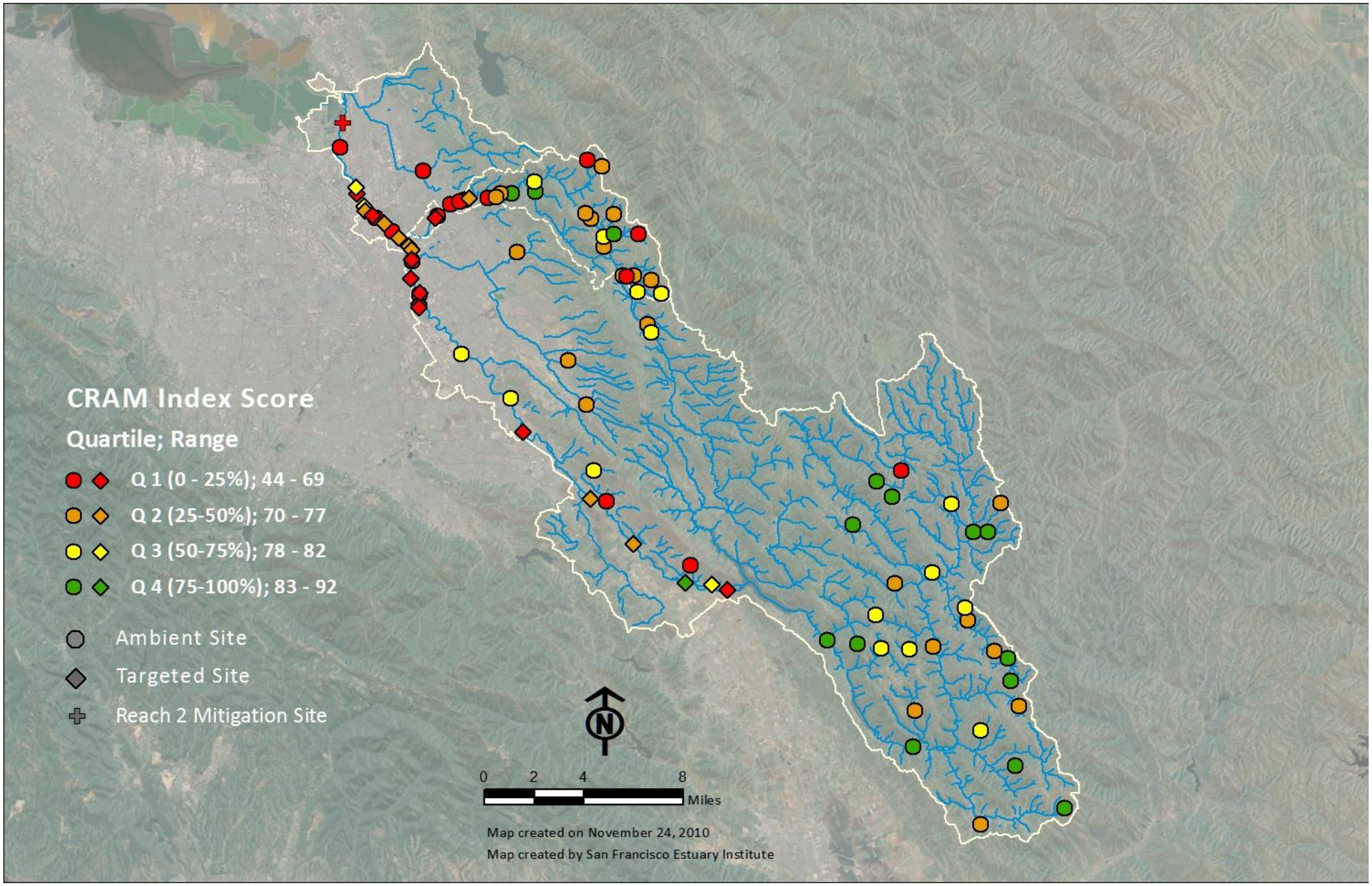


Figure 2-8. CRAM Index scores by quartiles for both ambient and targeted sites. Four ambient sites in the Upper Penitencia Creek subwatershed have been removed from the map, but not the analyses, due to land-owner sensitivity. Quartiles of the CRAM Index scores were determined from a cumulative distribution function of ambient sites in the Coyote Creek watershed. Stream network data were acquired from the Bay Area Aquatic Resources Inventory (BAARI) and can be found at www.californiawetlands.net. The Coyote Creek boundary is part of the CalWater 2.2.1 dataset, and the Upper Penitencia Creek subwatershed boundary is from the District.

Figure 2-8 shows the distribution of CRAM Index scores based on the observed ranges in the Coyote Creek watershed CDF (44-69, 70-77, 78-82, 83-92), and therefore illustrates the variability in overall stream ecosystem conditions observed in this watershed. In general, the lowest condition scores were concentrated in the urbanized transition zone between the lower and the upper portions of each watersheds. The highest condition scores were concentrated in the upper portions of the watersheds.

The highest scores pertain to sites mostly located in natural open-space lands or lands managed to have relatively unaltered hydrology and few dominant invasive species. The lowest CRAM Index scores pertain to sites with poor landscape and buffer condition due to their close proximity to intensive land uses resulting in unnatural hydrology (mainly resulting from storm drain input and other runoff from impervious surfaces) and the prevalence of invasive plant species.

Scores for some of the upper watershed sites were lowered by their relatively simple physical structure. This is a common characteristic for very small seasonal streams, such as first-order channels in arid areas. CRAM tends to be biased against such streams because it emphasizes the greater overall value of complex systems. To minimize this bias, the surveys of the Coyote Creek watershed and the Upper Penitencia Creek subwatershed excluded first-order channels. Some scores were lowered by their simplified biotic structure, which in some cases was correlated to simple physical structure, and in other cases was due to recent wildfire.

The variety of Index scores associated with the transitional zones between urban land uses and open space probably reflects the dynamic nature of natural stream processes and concomitant diversity of management practices in these areas. These zones of land use transition tend to correspond to transitions in important stream characteristics. For example, these are the zones of transition between the steeper headward portions of the watersheds and their valleys, and they therefore correspond to changes in channel slope, which translate into changes in channel form and behavior. Early impoundments and diversions for agriculture are often located in these zones. Rates of incision, aggradation (the build-up of sediment on the channel bed), and bank erosion can be highly

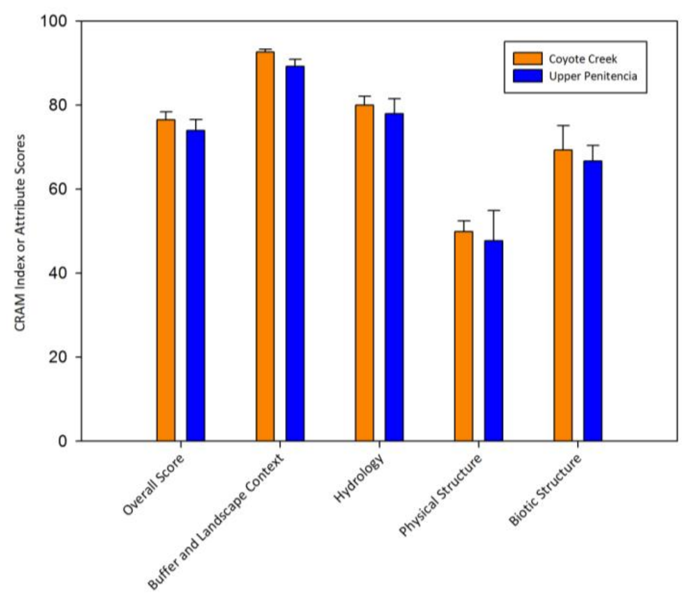


Figure 2-9. CRAM Index and Attribute scores for the ambient survey of riverine wetlands in the Coyote Creek watershed (orange bars) and Upper Penitencia subwatershed (blue bars). Bars are scores represented by the 50th percentile (median) of stream miles, based on the corresponding cumulative distribution function. Error bars are the upper 95% confidence intervals at the 50th percentile.

variable in these zones, which translates into a broad range of stream management practices.

CRAM Index scores are best understood by examining their component Attribute scores. Very high scores have high component scores, and very low scores have low component scores, but many combinations of different Attribute scores can yield the same mid-range Index score. Explanations of mid-range scores therefore require examination of their component Attribute scores. Likewise, Attribute scores are best understood by examining their component Metric scores.

Figure 2-9 illustrates that Attribute scores tended to be lower in the Upper Penitencia Creek subwatershed than in the Coyote Creek watershed by a relatively consistent amount. Figure 2-9 also illustrates that sites tended to score moderately high for all Attributes except Physical Structure; the median score for Physical Structure was approximately 50 for both watersheds, and was greater than 70 for the other Attributes. The Physical Structure Attribute had the greatest impact on lowering the overall Index scores. The score for the Biotic Structure Attribute was the next lowest, having a median score of about 70 for both watersheds. It therefore also had a relatively large influence on lowering the Index scores. CRAM assessments are becoming common in the Bay Region and elsewhere. This will increase the opportunity to compare patterns in CRAM scores between watersheds. The limited pool of CRAM data for stream ecosystems in the San Francisco Bay Area suggests that the pattern of relatively high scores for Buffer and Landscape Context and relatively low scores for Physical Structure, as observed for the Coyote Creek watershed, may be common in this region.

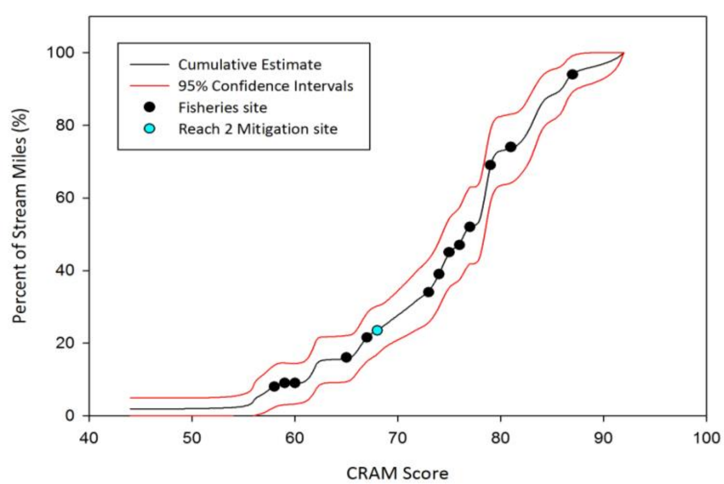


Figure 2-10. Stream ecosystem asset condition of targeted sites in the Coyote Creek watershed, as assessed using CRAM, in relation to the cumulative distribution function (CDF) of CRAM Index scores for the watershed. Black circles represent the index scores from 22 District fisheries monitoring sites and the blue circle represents the score from a mitigation site located on Reach 2 of Coyote Creek. Nine fisheries sites received the same CRAM Index score, thus reducing the number of black circles relative to the actual number of projects assessed.

Targeted Data

The targeted sites (fisheries study sites and mitigation project site) along the Coyote Creek mainstem exhibited the same range in CRAM Index scores as the entire watershed indicating that even on the Valley floor a wide range of conditions exist. The majority of the targeted sites CRAM Index scores fell within the range of 65 – 79 (Figure 2-10). Three sites scored lower, between 58 and 60, and 3 sites scored higher, between 81 and 87. The mitigation site had a score of 68, which is higher than what would be expected for approximately 25% of the total stream miles in the watershed. It is important to note that the scores for targeted sites cannot be substituted for ambient scores because the targeted sites do not represent an unbiased sample of the ambient condition

2.2.1.2 Level 3 Data:

The following discussion presents the results of assessing the Level 3 fisheries data with the targeted Level 2 CRAM data. This targeted monitoring design was implemented to 1) help explore correlations between CRAM and fisheries health (not to replace fish data collection but to explore the possibility of using CRAM as an inexpensive screening tool for evaluating fisheries health and designing subsequent fisheries sampling), and 2) to demonstrate the use of a conceptual model to link Level 2 and Level 3 data. Additional Level 3 data that were selected (see Section 1.2.2) to describe existing conditions in the Coyote Creek watershed are also discussed in the context of interpreting the condition of the existing fishery.

Assessment of Targeted Fish and CRAM data

Statistical analysis of District fisheries data and CRAM Metric data from the targeted design (Appendix A) found a significant relationship between native fish diversity and two CRAM Metrics: Topographic Complexity[14] and Hydrologic Connectivity[15]. These results somewhat agreed with the Physical Habitat/Fisheries Health (PHFH) conceptual model of the expected relationships between Level 2 CRAM Metrics and the selected Level 3 Metrics (Appendix A). The basic tenet of the model is that many CRAM Metrics reflect stream physical habitat, and that the physical condition of the habitat affects fish populations. Each aspect of physical habitat that affects native fish populations was hypothesized to have a particular relationship to CRAM Metric scores.

The significant positive correlation between high topographic complexity and high native fish diversity was expected, based on the PHFH. The significant negative correlation between hydrologic connectivity (e.g., degree of channel entrenchment) and native fish diversity, however, was the opposite of what was expected. The PHFH predicted that high hydrologic connectivity (e.g., low degree of channel entrenchment) would support high native fish diversity. This is because channels that are not entrenched tend to have larger amounts of woody debris, active floodplains, more robust riparian vegetation, and other characteristics that represent good fish habitat. Entrenched channels typically offer less quality and quantity of habitat for fish because they have steeply sloped banks and lack broad floodplains. Less entrenched channels are also better able to accommodate rising flood waters without major changes in channel structure or form.

This unpredicted negative correlation between hydrological connectivity and native fish diversity could indicate one or more of the following three things. First, the PHFH model may need adjustment,

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[14] Refers to the micro- and macro-topographic relief within a wetland due to physical, abiotic features, and elevation gradients (Collins et al. 2008).

[15] Refers to the ability of water to flow into or out of a wetland or to accommodate rising flood waters without persistent changes in water level that can result in stress to wetland plants and animals. For riverine wetlands it is assessed based on the degree of channel entrenchment (Collins et al. 2008).

particularly with respect to the meaning of entrenchment relative to fish habitat. For example, perhaps entrenchment brings the channel floor into the ground-water zone and provides better habitat conditions for fish. Second, this result may indicate the need for additional data. The targeted study was designed to evaluate whether there were correlations between CRAM Metrics and Native Fish Diversity metrics where fish data had been collected previously for the Mid-Coyote Creek Flood Control Project. However, the sample size was relatively small, spanned several years (notably consecutive dry water-years) and focused on one segment of the Coyote Creek mainstem. The Level 3 dataset therefore under-represents other segments of the Coyote Creek and Upper Penitencia Creek mainstems. Potential follow-up to this study is discussed in Chapter 4. Third, CRAM may not be able to track all aspects of fisheries health in this highly altered system, including influences of upstream reservoirs, water quality, and non-native species introductions.

It is important to remember that CRAM is not meant to substitute for intensive Level 3 data, such as measurements of fish populations; it is intended to provide data on overall stream ecosystem condition, and not any one particular function such as fish support. In the case of the Coyote Creek watershed, the history of land-use change, water management, and non-native fish introductions have created a complex physical, chemical and biological system. Some of the factors that control fisheries health probably cannot be detected by CRAM Metrics. The results of this investigation, therefore, were encouraging in that a correlation was found between two CRAM metrics and native fish diversity. As discussed above, these correlations may give some insight into the conceptual model relating CRAM to fisheries health. As well, a larger, more randomly collected Level 3 data set covering a greater variety of streams would be more likely to elucidate more numerous or stronger relationships between CRAM Metrics and native fish diversity.

Summary of selected existing Level 3 data for the Coyote Creek and Upper Penitencia Creek mainstems

The Coyote Creek and Upper Penitencia Creek urbanized mainstems are relatively rich in Level 3 data due to the number of intensive local studies that have been conducted on them. Selected studies[16] have been reviewed and summarized in Table 2-5, and are discussed below. The reaches referenced in Table 2-5 are based on patterns exhibited in the native fish diversity Metric and the relative abundance of native and non-native fish from the Mid-Coyote Creek Flood Control Project. These data exhibit a spatial pattern along the Coyote Creek mainstem, with native diversity moderate and native abundance high in the lower reaches, native diversity low and native abundance low in the middle reaches, and native diversity moderate to high and native abundance high to very high in the upper reaches. The middle reaches stand out as having relatively few native species and fewer native than non-native individuals (particularly at sites in downtown San Jose). The Upper Penitencia Creek mainstem is treated as one reach since it was only sampled in two places by the Mid-Coyote Flood Control Project baseline

[16] Due to the large number of Level 3 studies that have been conducted in these watersheds, the scope of this effort was defined to include a subset. The District Mitigation Monitoring Activities Database may be used to identify additional Level 3 data and associated metadata.

fisheries survey. Native fish diversity was high at both sites and native relative abundances were also high, particularly at the lower site (site A).

A fundamental influence on these reaches has been the historical subsidence of the valley floor due to groundwater extraction. The Coyote Creek Valley has been under developmental pressure since the early 1800s, beginning with agriculture and leading to intensive urbanization (Grossinger et al. 2006). Both development phases increased water supply demand, which drew down the groundwater aquifer and caused the valley floor to subside between 1939 and 1969. Land subsidence ranged from approximately 3.5 feet at the downstream-most fisheries/CRAM site to a maximum of 8 ft in the downtown San Jose area, and ended around Story Road. On Upper Penitencia Creek, the maximum subsidence of 3.6 feet occurred at the confluence with Coyote Creek and mostly ended around the I-680 crossing, just downstream of Upper Penitencia Creek site A.

Several other factors represented in Table 2-5 correspond spatially with the relatively low native fish species diversity and relative abundances observed in the middle reaches. For example, physical habitat metrics exhibit similar patterns as the native fish diversity metric, e.g., of lower conditions in the reaches most impacted by subsidence. The Topographic Complexity Metric (micro- and macro-topographic relief) scored low to moderate, particularly for micro-topographic complexity. The Hydrologic Connectivity Metric (entrenchment also scored very low to low in the middle reaches. Table 2-5 also illustrates that fisheries physical habitat data (SCVWD 2006, SCVURPPP 2001, 2003a) indicate that habitat in these reaches is simplified, mainly consisting of highly embedded mid-channel pools with limited instream cover. Benthic macroinvertebrate physical habitat corroborate this spatial pattern, with conditions measured as marginal to fair (SCVURPPP 2008). The targeted CRAM Index scores, which reflect instream and riparian physical habitat, also exhibited a similar spatial pattern of lower conditions in the middle reaches. As well, available water quality metrics including dissolved oxygen, sediment chemistry, sediment toxicity, and temperature (SCVURPPP 2008 and Hopkins et al. 2002) indicate relatively poor water quality the middle reaches (Table 2-5).

2.2.2 What are the Levels of Service for stream ecosystem resources?

Levels of Service (LOS) are benchmarks of performance that can be applied to systems, services, and assets. The asset management paradigm that the District is adopting incorporates the concept of LOS. A LOS is usually established for individual constructed assets (SCVWD 2009). A LOS can also be defined for non-constructed stream ecosystem resources at different spatial scales, from individual project sites to large watersheds. The District could adopt watershed-scale LOS for each major watershed in its Area of Interest, and for subwatersheds within its Primary Area of Interest. The District could also potentially adopt site-based LOS based on Level 2 CRAM data for mitigation and project sites in addition to, or in place of Level 3 performance targets that are traditionally implemented through permits. The latter would require the permitting agency approval and would only be suitable for certain projects for which measuring overall condition is an important part of performance standards.

Table 2-5. Selected existing Level 3 data for the Coyote Creek (CC) and Upper Penitencia Creek (UPC) mainstems summarized by District Mitigation Monitoring Activities Database Ecological Attribute categories across coarse-scale stream reaches defined based on spatial patterns observed in the native fish diversity metric. Data analyzed by other sources are presented using their categorical descriptions. Categorical descriptions for source data analyzed for this Profile (SCVWD 2007 and "Current Study") are listed as footnotes to this table.

	Metric	Lower Reaches CC Fish sites 1a – 7 (N = 8)	Middle Reaches CC Fish sites 8 through 3CS1 (N = 10)	Upper Reaches CC Fish sites 3CS2 through UCD (N = 4)	UPC sites A and B (N = 2)	Data Source	Notes
MMAD Ecological Attribute	**Road Crossings/ Landmarks**	**Montague to Berryessa Rd**	**U/S Berryessa Rd to Metcalf Pond**	**Metcalf Road to Anderson Dam**	**Coyote Creek to Dorel Drive**	NA	
Fish and Wildlife Communities	**Native Fish Diversity**[1]	Range: Low to Moderate Average: Moderate	Range: Low Average: Low	Range: Low to High Average: Moderate	Range: Moderate to High Average: High	SCVWD 2007 - 2009	SCVURPPP 2001 found similar pattern with % native fish significantly increasing at 3CS1.
	Fish Relative Abundance[2]	Native: Moderate Nonnative: Low	Native: Low, esp. sites 9 - 12: Nonnative: Moderate	Native: Moderate Nonnative: Low (none)	Native: V High Nonnative: Low	SCVWD 2007 - 2009	Relative abundance for all species lowest at 13 through 3CS2.
	BMI (B-IBI)	Poor	Poor	Poor	No Data	SCVURPPP 2008	4 stations[3]
Hydro-geomorphology	**Land Subsidence (ft)**	4	6....8...6...4..2.........0		3.6....0	Grossinger et al. 2006, Jordan et al. 2009	
	Topographic Complexity[4]	Moderate to High	Low to Moderate	Mostly Moderate; Low at 3CS1, High at UCC - C & D	Low at B Moderate at A	Current Study	
	Hydrologic Connectivity[4]	Mixed: mostly high; Low at site 2	Mixed: very low to high	High	Low	Current Study	
Vegetation Characteristics & Physical Habitat	**Targeted CRAM Quartile Scores**	Low to Medium	Low	Low to High	Low	Current Study	

	Metric	Lower Reaches CC Fish sites 1a – 7 (N = 8)	Middle Reaches CC Fish sites 8 through 3CS1 (N = 10)	Upper Reaches CC Fish sites 3CS2 through UCD (N = 4)	UPC sites A and B (N = 2)	Data Source	Notes
MMAD Ecological Attribute	**Road Crossings/ Landmarks**	**Montague to Berryessa Rd**	**U/S Berryessa Rd to Metcalf Pond**	**Metcalf Road to Anderson Dam**	**Coyote Creek to Dorel Drive**	NA	
Physical Habitat	**Coldwater Fish Habitat Units**	55 - 90% Pool (mostly mid-channel pool)	95 - 100% Pool (mostly mid-channel pool)	ND	No Data	SCVWD 2006	
	SEIDP CW fish Habitat Units	50% Pool	40% - 100% Pool	15 - 78% Pool		SCVURPPP 2001	
	BMI Physical Habitat Quality	Marginal	Marginal to Fair	Good	No Data	SCVURPPP 2008	4 stations[3]
Water Quality	**Temperature**	High (21-22C) at Flea Market (just u/s site 7)	V High (23C) at Silver Creek Rd.	no sample	no sample	SCVURPPP 2010	9 stations[5]
	Dissolved Oxygen	Moderate (7 - 9 mg/L)	Very low (3 mg/L) to Moderate (4 - 8 mg/L)	no sample	no sample	SCVURPPP 2010	Similar low to moderate values in the middle reaches reported by SCVURPPP (2003a) and Hopkins et al. (2002).
Soil Condition	**Sediment Chemistry**	Good	Fair	Marginal	No Data	SCVURPPP 2008	4 stations[3]
Toxicity	**Sediment Toxicity (% survival)**	Marginal	Poor to Optimal	Optimal	No Data	SCVURPPP 2008	4 stations[3]

[1] Average number of native fish species sampled from 2007 – 2009: Low = 1-3 species; Moderate = 4-5 species; High = 6-7 species. These categories are relative to number of species observed from these samples and are not intended to reflect regional relative abundances.
[2] Average number of individuals sampled from 2007 – 2009: Low = 0 – 20; Moderate = 20 – 40; High = 40 – 60; Very High = 60 – 80. These categories are relative to abundances observed from these samples and are not intended to reflect regional relative abundances.
[3] From I-880 to Fisher Creek confluence.
[4] CRAM metric scores presented here as: Low = 3; Moderate = 6, High = 9; Very High = 12
[5] From Montague to Fisher Creek confluence.

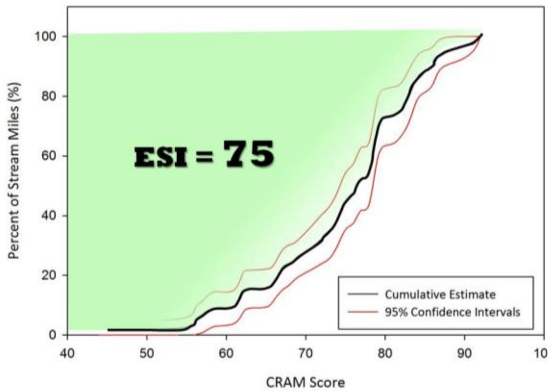

Figure 2-11. Ecosystem Services Index (ESI) for the Coyote Creek watershed. ESI 95% Confidence interval = 72 – 78 (n=77).

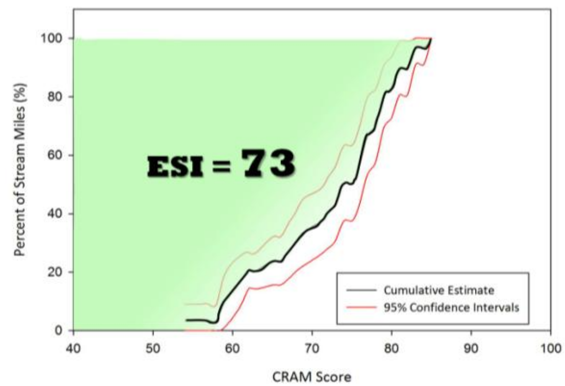

Figure 2-12. Ecological Services Index (ESI). for the Upper Penitencia Creek subwatershed. ESI 95% Confidence interval = 70 - 75 (n=30).

Site-specific LOS based on Level 3 data already exist for many District mitigation areas as performance targets that have been established through regulatory permits or other legal requirements (see Table 2-6 *that follows the Reference section*). LOS based on Level 3 data must be assessed using Level 3 tools in order to demonstrate compliance; however, Level 2 CRAM data could also be used to monitor the LOS for these same and/or other mitigation project sites. In the future, permitting agencies may allow CRAM assessments to be part of a mitigation project monitoring strategy that also involves Level 3 monitoring. CRAM is most effectively used as a mitigation monitoring tool when sites are assessed pre-construction in order to establish a baseline condition that can be compared to with post-construction monitoring.

LOS for watersheds and subwatersheds have not been adopted to date. The CRAM data collected through the probabilistic sampling design present an opportunity to establish Level 2 LOS for the entire Coyote Creek Watershed and the Upper Penitencia Creek subwatershed. CRAM data collected using a probabilistic sampling design was used to generate a cumulative distribution function (CDF) to present the results. From the CDF, a simple statistic called the Ecological Services Index (ESI) was derived that represents the area weighted average of all CRAM scores in the CDF. As illustrated in Figures 2-11 and 2-12, the ESI represents the areas above the CDFs, and is calculated as the percent of stream miles multiplied by the stream ecosystem condition (CRAM Index scores). The first ESI that is derived for a watershed represents a baseline conditions and can be adopted as the LOS. The ESIs for the Coyote Creek watershed and the Upper Penitencia Creek subwatershed are 75 and 73, respectively, and have similar 95% confidence intervals (72 -78 and 70 – 75, respectively) (Figures 2-11 and 2-12).

The ESI is a tool that may be used to track stream ecosystem condition over time. The 2010 ambient surveys established the ESIs listed above. When ambient surveys are conducted in the future, the ESIs can be recalculated and compared to the 2010 baseline to understand how condition may have changed over time. The ESI may stay the same (indicating that overall condition hasn't changed), increase (indicating that overall condition has improved), or decrease (indicating that overall condition has worsened) as a result of different management actions or natural events. When the ESI indicates that a LOS is not achieved or emerging issues or risks are identified that threaten a LOS, priority management actions can be identified to raise the ESI by improving conditions and/or managing associated stressors. This tool will enable the District to establish expectations about what conditions can be reasonably achieved and to identify associated investment costs to maintain or improve conditions. For example, it may make more sense to target improvements in an un-engineered reach with degraded stream ecosystem conditions than to invest capital to improve the condition of a storm drain that has little potential for providing substantial ecological functions. Such actions and their incremental costs can be determined and translated into District project plans and annual budgets.

The Ecosystem Services Index (ESI) has received draft endorsement from the CRAM steering committee as a watershed-based or landscape level summary statistic for overall condition of aquatic resources assessed using CRAM. The methods by which an ESI statistic is calculated from an ambient survey CDF are described in Appendix A. Other potential approaches to deriving LOS for stream ecosystem resources are also presented in Appendix A. It is important to keep in mind that the development of ecological LOS is an emerging interest for the District based on its need to assess and monitor the performance of its stewardship program. No standard approach exists at this time. LOS development may need to be iterative in order to respond to changes in related science and management needs.

Several companion figures are useful to explain what the ESI represents in terms of stream ecosystem conditions. One such figure (2-7) presented in section 2.2.1.1 is the map of all the ambient CRAM scores by stream ecosystem condition category. Figures 2-13 and 2-14 presented here illustrate the percentage of stream miles characterized by the four stream ecosystem condition categories in both the Coyote Creek watershed and the Upper Penitencia Creek subwatershed. Notably, no sites in either watershed fell within the Low condition category. In comparison to the Upper Penitencia Creek subwatershed, the Coyote Creek watershed had a higher proportion of stream miles within the High condition category and lower proportions of stream miles in the Medium-High and Medium-Low condition categories.

2.2.3 How do the existing stream ecosystem conditions compare to ecological

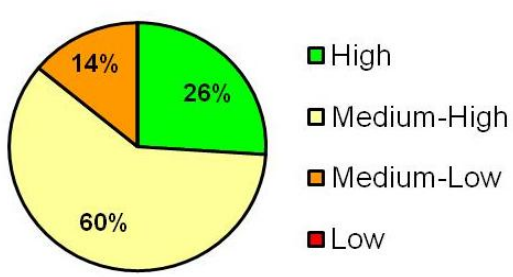

Figure 2-13. Percent of stream miles in the Coyote Creek watershed by stream ecosystem condition category (High 82 – 100, Medium High 63 – 81, Medium-Low 44 – 62, and Low (<44).

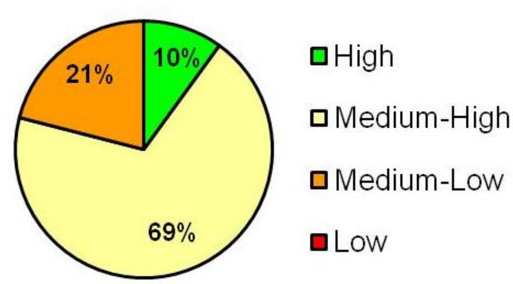

Figure 2-14. Percent of stream miles in the Upper Penitencia Creek subwatershed by stream ecosystem condition category (High 82 – 100, Medium-High 63 – 81, Medium-Low 44 – 62, and Low (<44).

Levels of Service?

This section of the Profile is largely a placeholder because the watershed ESI values have only been derived this year using the first-ever Level 2 ambient survey data, and no other ambient survey data exist to compare to these baseline assessments of stream ecosystem conditions. Once other ambient assessments have been completed, new ESI values can be calculated and compare to the 2010 ESI values in order to track how stream ecosystem condition has changed over time (e.g., increased, decreased, or stayed the same) and inform monitoring and management actions. If the District adopts the watershed ESI values as watershed LOS, then watershed ESI values derived from future ambient assessments would be compared to the adopted watershed LOS.

As discussed in Section 2.2.1.2 for the Targeted Survey, site-specific CRAM Index scores for riverine wetlands can be compared to the respective watershed ESI and watershed CDF in order to understand overall site stream ecosystem condition relative to overall watershed stream ecosystem condition. Such comparisons can be used to inform strategies for investing in riverine wetland mitigation or site maintenance, or for riverine wetland mitigation site acquisition. These topics are further discussed In Chapter 4. Currently the District evaluates the performance of District mitigation projects relative to their existing Level 3 ecological LOS. The existing Level 3 ecological LOS and the performance evaluations conducted by lead project District staff for mitigation projects that have been in place for several years are presented in Table 2-6.

Chapter 3.0 Assessment of Stream Ecosystem Condition Risk

This chapter address the following two EMAP core management questions using Level 1 – 3 data:

1) **What are the likely sources of risk to stream ecosystem resources?**
2) **What is the likelihood that sources of risk may negatively impact stream ecosystem conditions?**

Risk is defined here as the probability of stressors negatively affecting stream ecosystem conditions and thus preventing the District from achieving established Levels of Service or goals. Therefore, risk assessment sets the stage for identifying and prioritizing management actions that the District may consider implementing in order to maintain and/or improve stream ecosystem conditions. Such actions and their Incremental costs can be determined and translated into District project plans and annual budgets in order to establish expectations about what can be reasonably achieved and at what cost. In the following sections risk is assessed for each of the three Framework levels in order to leverage the scale and resolution of data included in each of the Levels, particularly the cost-effectiveness inherent in the higher Levels of data.

The first section of this chapter describes the likely sources of risk that threaten to degrade stream ecosystem resources in terms of those within and beyond District control. The second section in this chapter discusses the likelihood that such sources of risk may negatively impact stream ecosystem conditions.

3.1 Risk Identification

This section addresses the question: what are the likely sources of risk to stream ecosystem conditions?

3.1.1 Level 1

The Level 1 risk assessment focuses on mapping the geographic extent of areas beyond direct District management control relative to the locations of stream ecosystem resources in District ownership (District feet title easement), the District Area of Interest, and the Primary Area of Interest. The District has fee title/easement for only 3% of the total stream length in the County (Table 2-1) which is limited to relatively small areas of the lower part of the Coyote Creek watershed drainage network (Figure 2-1) that are greatly influenced by natural and anthropogenically-induced physical processes deriving from relatively large areas of the upper watershed. Therefore, the success of District management actions is influenced by upstream processes and events over which the District has little or no control. As a result, the very limited geographic extent of the District's authority within the greater stream ecosystem translates into considerable risks that 1) District watershed stewardship goals will not be met, unless they are carefully and explicitly limited to what the District can control, and that 2) the District will not be able to control the condition of the stream ecosystem resources owned and/or managed by the District.

3.1.2 Level 2

The Level 2 risk assessment identifies the stressors that have impacted the stream ecosystem resources historically and that were observed through the CRAM ambient surveys. Stressors can be characterized as either originating outside of or within direct District control (i.e., on lands held by the District in either fee title or easement). Stressors originating outside of direct District control represent opportunities for cooperative stewardship with other organizations and land owners or advocacy. Stressors that originate in areas within direct District control inform priorities for future monitoring and management actions by the District that may maintain and/or improve stream ecosystem conditions and inform investments in stream ecosystem health. The management implications of different types of risk are discussed in Chapter 4.

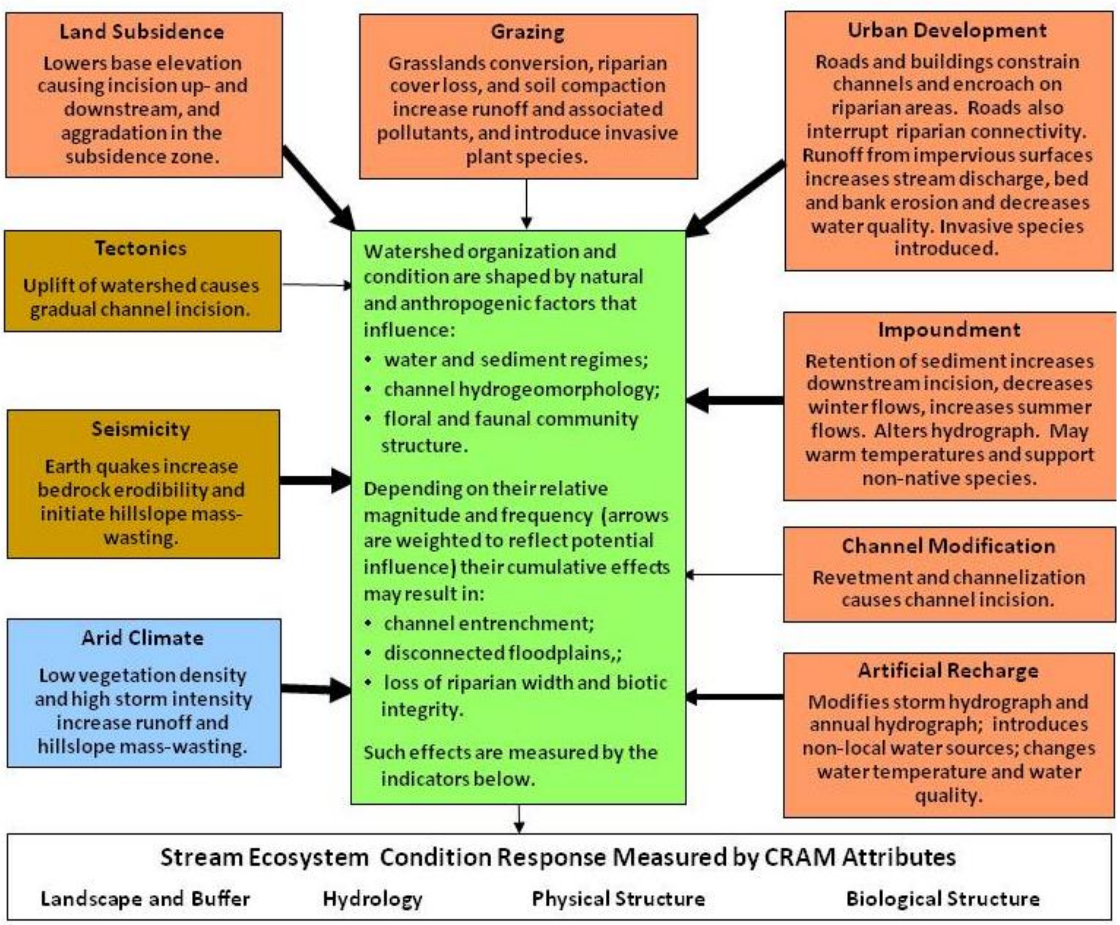

Figure 3-1. Level 2 conceptual model of natural and anthropogenic stressors influencing the condition of stream ecosystems (green box), measurable by the CRAM Attributes (white box). Brown and blue boxes indicate naturally occurring stressors that are beyond District control. Orange boxes indicate stressors that are related to anthropogenic activities, some of which may be within District control.

Stressors are discussed in the context of the Level 2 stream ecosystem condition conceptual model (SEC model) (Figure 3-1). The SEC model classifies stressors in terms of those that are naturally occurring and those that are related to anthropogenic activities. In the following subsections, stressors that are present in the Coyote Creek watershed are introduced generally in terms of those that are beyond District control (3.1.2.1) and within District control (3.1.2.2).

The last subsection (3.1.2.3) discusses a two-pronged approach to describing the spatial distribution of "high-risk" sites and associated stressors in order to identify targets for making investments to improve or protect stream ecosystem conditions. The first approach begins by identifying the sites from the ambient CRAM surveys with the lowest Attribute scores that may warrant investment to maintain or improve stream ecosystem conditions (e.g., sites with scores in the lowest 10% based on the CDF for each CRAM attribute - see Appendix A for explanation of this threshold). Then, the associated metrics are examined to understand which of them most influenced the Attribute scores. Finally, the stressors most associated with the low metric scores are identified. The second prong of the Level 2 risk assessment approach is to identify sites in the watersheds with the highest Attribute scores (e.g., highest 10% based on the CDF for each attribute) that warrant protection to maintain their condition. Figure 3-2 illustrates the location of the highest and lowest ambient survey CRAM Attribute scores. Figure 3-3 illustrates the locations of the lowest ambient survey CRAM attribute scores and the stressors that are most likely to have significant negative effects on these sites.

Investments in improving conditions should not be considered automatically for all low-scoring sites. It is necessary to evaluate the consequences of not taking action and the likelihood that the actions taken can have the desired benefits at acceptable cost. The example presented in Chapter 2 of a highly engineered channel with little ecological functional value might receive a CRAM Index score in the lowest 10% of a watershed CDF, but investing in improving its ecological value might not provide as much return as investing in another low scoring site with more natural channel features and vestiges of ecological functional value. For some low-scoring sites, a strategy of protecting them from further degradation may be the best investment strategy. Such investment decisions will be greatly influenced by whether areas are directly under District control or not, as well as what the sources of stress are and the extent to which they can be addressed. For example stream ecosystem conditions at sites that are beyond District control may necessarily further degrade unless a cooperative stewardship mechanism can be implemented to improve them. In other cases this same ecological outcome could result because the source(s) of stress that are degrading stream ecosystem conditions are so strong that they overwhelm the ability to improve conditions requiring considerable investments in order to improve conditions. Thus, considerable investment would be required to improve conditions, but this intervention might not provide much, if any, return in terms of ecological value.

3.1.2.1 Sources of Risks beyond District Control

Natural Factors:

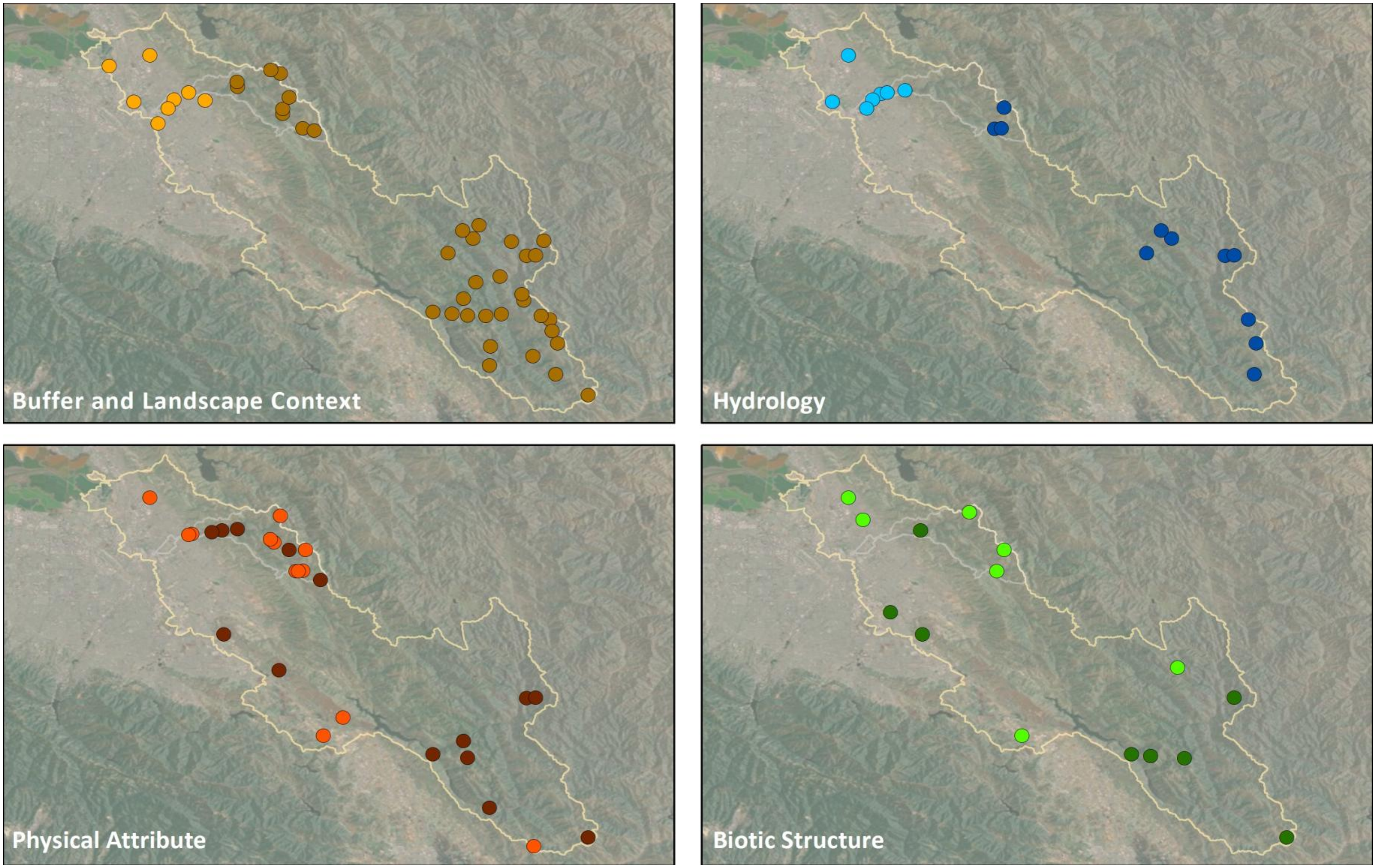

Figure 3-2. Highest and Lowest Scores for CRAM Sites by Attribute. Ambient sites in lighter colors had scores in the lowest 10% based on the CDF for each CRAM Attribute, with the exception of Physical Structure for which the lowest 25% are shown (see Appendix A for explanation). Ambient sites in darker colors had scores in the highest 10% for each CRAM Attribute, with the exception of Buffer and Landscape Context for which the highest 25% are shown.

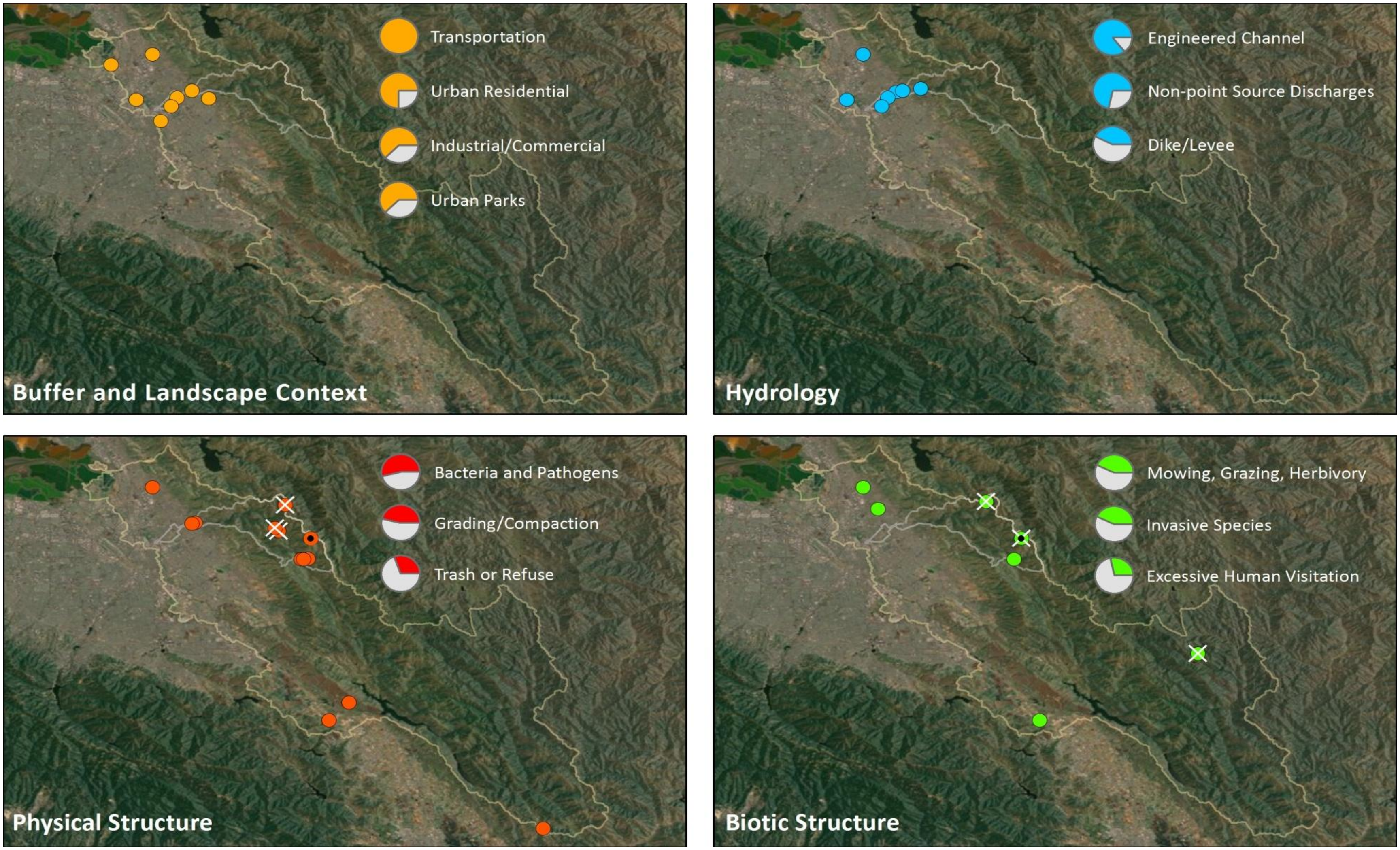

Figure 3-3. Lowest Scores and Associated Stressors for CRAM Sites by Attribute. Ambient sites with scores in the lowest 10% based on the CDF for each CRAM Attribute, with the exception of Physical Structure for which the lowest 25% are shown (see Appendix A for explanation). The pie charts identify the top stressors in Coyote Creek watershed for each attribute. Pie charts indicate the proportion of lowest scoring sites for which field teams observed potential stressors (e.g., Transportation). Points overlain with white X's refer to sites for which none of the listed stressors were identified as negatively affecting the site. Points with black dots in the center were identified as recently disturbed by fire.

Climate

The Bay Area climate is characterized by high inter-annual and intra-regional variation in precipitation that results in a large degree of natural variability in stream form and condition. Many drainage networks are naturally subject to occasional droughts and deluges that can cause substantial changes in the plan form, cross-sectional form, and even the location of streams, especially in valleys. In addition to this natural variability, many streams are still adjusting in form to historical changes in land use that influence runoff regimes and supplies of sediment. For example, the extraction of groundwater in Santa Clara Valley to irrigate farmlands caused the valley to subside, which in turn lowered the base elevation of Upper Penitencia Creek, which promoted its incision (Poland and Ireland 1988). The effects of any effort to manage the conditions may be masked or overwhelmed by this large amount of ongoing variability. In other words, the management actions may need to be large and/or persistent to achieve their goals.

One aspect of climate change may be a persistent and systematic shift in temperature and the usual timing and/or amount of rainfall occurring annually. Climate change appears to be accelerating worldwide largely due to anthropogenic factors (U.S. Global Change Research Program 2009). The near-term and long-term consequences for the Bay Area are not certain. It is expected that temperatures will rise, that there will be greater fluctuation in seasonal rainfall amounts with drier dry seasons and more intense rainstorms during wet season (U.S. Global Change Research Program 2009). These increased intensity of rainstorms may increase peak flows in local streams, which could in turn increase flooding and channel instability. Chanel incision may increase in the middle and upper watersheds. In the lower watersheds, however, sea level rise could raise the base elevation of drainage networks connected to the Bay, which could exacerbate flood risks but have a mitigating effect on channel incision.

The combination of natural spatial and temporal variability in stream form and condition, the amount of change in the climate (temperature and rainfall patterns) contribute to a large degree of uncertainty about the efficacy of local efforts to manage stream ecosystem conditions. This uncertainty represents some amount of risk that the actions may not succeed, or that the successes may be temporary.

Seismic Activity

The Coyote Creek watershed, like all watersheds within the District's Area of Interest, is located in a seismically active area. Several active faults (e.g., San Andreas, Calaveras, Shannon-Monte Vista, and Silver Creek) exist in or near the Coyote Creek watershed and have the potential to greatly influence sudden changes in channel geomorphology and stability. The TC-HCP (SCVWD 2009) discusses the probability of such faults resulting in a magnitude 6.7 earthquake before 2030 in the context of planning for seismic safety dam retrofits. Ongoing land movements along active fault traces can contribute to the form and condition of streams. Active fault traces that cross streams can cause sudden changes in stream grade, excessive bank instability, offsets in stream direction, and increases in sediment pulses to downstream reaches. Whether the seismic influence is due to horizontal or vertical movements of the earth surface largely controls stream response. Uplift can flatten the stream gradient and thereby increase its capacity to store sediment and decrease its capacity to transport sediment downstream. Down drops can increase stream gradient and initiate channel incision with increased conveyance of sediment downstream. As Grossinger et al. (2006) noted, following the correction for land subsidence due to replenishment of the groundwater aquifer, the Silver Creek fault may have contributed to the low gradient area in the middle reaches of the Coyote Creek mainstem.

Plate Tectonic Movement

The incremental and continuing shifts in the Earth's tectonic plates explains the overall topography of the Santa Clara Valley and its adjacent ranges of hills. Tectonic uplift of the hills is a major cause of their dissection by streams, and stream gradient. In general, for any given climatic regime, and in the absence of anthropogenic factors, tectonic uplift is countered by stream erosion. Efforts to manage sediment supplies in local streams should consider the natural or background erosion rates that result from tectonics and therefore cannot be prevented on a watershed-scale.

Anthropogenic Factors:

Subsidence

As noted above, land subsidence can lower the base elevations of local streams, thus changing their slopes which may result in incision in some places and ponding or more gentle slopes in other places. Historically the Coyote Creek Valley experienced considerable land subsidence between 1939 and 1969 due to groundwater extraction to meet water demands, first for agriculture and then for urbanization. Land subsidence of up to 8 feet occurred between the tidally influenced reaches of the Coyote Creek mainstem upstream to approximately the Tully Road crossing. Maximum subsidence occurred in the area corresponding to downtown San Jose. The Level 3 risk assessment section (3.1.5) discusses these patterns in greater detail. Land subsidence is no longer occurring in the Coyote Creek watershed as the District manages groundwater recharge to maintain the groundwater aquifers and prevent further land subsidence. The risk of future subsidence depends on the availability of adequate quantities of water sources to maintain groundwater aquifers to meet water demands, e.g., there is a risk that groundwater levels may decrease and result in subsidence depending on the relative balance of the following factors: water import allocations, precipitation, temperature, and water demand.

Grazing

Grazing by livestock and wildlife in the upper watershed (SCVURPPP 2009) can result in soil compaction, loss of vegetative cover, alteration of plant species composition (including introduction of invasive non-native species), and destabilization of hillslopes and stream banks (Mount 1995). Grazing can also increase the amount of runoff, fine sediment, and nutrients contributed to the stream network (Stillwater Sciences 2008). Grazing is one of the land uses that likely has destabilized local streams and caused a change in their flow regimes and in the amounts and kinds (size) of sediment they convey (Stillwater Sciences 2008). In time, as physical systems, streams can adjust to grazing and stabilize especially if the grazing is not intense and grazing practices remain the same for decades. Flow and sediment regimes, however, are sensitive to grazing practices, and changes in the practices tend to cause changes in stream form and condition. For example, soil compaction reduces infiltration capacity and increases runoff that can contribute to gully formation. Loss of vegetative cover reduces rainfall interception, further increasing runoff and erosion, and may increase stream temperatures if riparian canopy cover is reduced. Reductions of native grassland species increases runoff and erosion as native species bind soil more cohesively than non-native annual grasses.

Urban Development

Urban Growth Boundaries:

Municipalities establish urban growth boundaries to define the maximum extent of urban development and create economic incentives to focus infill and redevelopment within an urban growth boundary. The intent of an urban growth boundary is to discourage/prevent urban sprawl, encroachment of urban development into steeply sloped hillsides, and protect the public from natural hazards such as wild fires and landslides. Urban growth boundaries are typically established in association with a municipal general plan for a twenty to thirty year timeframe. Urban growth boundaries often extend beyond a city's urban service area as part of a long-term planning strategy; before urban-scale development can occur on land within the urban growth boundary, the land must first be annexed to a city's urban services area. An urban service area is city land (developed, undeveloped or agricultural), either incorporated or unincorporated, that is served by urban services (police, fire, water and sanitation) or that is proposed to be served by urban services in the near future. Land must be annexed to a city's urban service area before urban-scale development is allowed. The three municipalities (City of Milpitas, City of San Jose, and the City of Morgan Hill) in the Coyote Creek watershed have established urban growth boundaries. The City of San Jose covers the largest portion of the watershed.

Urban growth boundaries, even when associated with general plans, however, are not guarantees that future development will not extend beyond the respective demarcation. General Plans can be amended prior to the planning timeframe, and minor adjustments may be allowed through a General Plan Amendment process.

Municipal Sphere of Influence:

A Municipality's Sphere of Influence may also play a role in the potential for an urban growth boundary demarcation to be surpassed. A Sphere of Influence refers to the ability of a municipality to extend its boundaries through annexation and incorporation. Major urban growth boundary expansions may be allowed but often require consultation with multiple agencies and development-related code/plans. Expansions for any of the three municipalities in the Coyote Creek watershed would have to be consistent with not only the respective Cities' fiscal goals (e.g., provision of urban services to such areas) but also applicable LAFCO[17] policies, and provision of both the Cities' and County's General Plans and the Cities' municipal codes.

[17] Spheres of influence are regulated by Local Agency Formation Commissions (LAFCO). Each county in California has a LAFCO.

Riparian Encroachment:

As discussed in Chapter 2, urban development has greatly encroached upon riparian areas in the Coyote Creek watershed, reducing their width, and associated stream ecosystem functions. Roads and buildings constrain channels and encroach upon riparian areas. Roads also interrupt the connectivity of riparian corridors and provide points of introduction for invasive species (in addition to intentional cultivation of non-native species for landscaping purposes).

The status of riparian protection has been summarized for municipalities in the Santa Clara Basin (SCVURPPP 2003b). The degree to which riparian areas are protected by policies or ordinances varies across the Basin. In 2002 as an effort to clarify and streamline local permitting for streamside activities, representatives from the District, the 15 cities in Santa Clara County, the County, and business, agriculture, streamside property owner and environmental interests established the Water Resources Protection Collaborative (Collaborative). The Collaborative (2006) developed a document that established guidelines and standards for land use near streams in order to provide tools, standards, and procedures to protect stream ecosystem conditions in Santa Clara County. The Collaborative agreed to set of guidelines and standards (G&S) with the understanding that municipalities would undertake a process to determine how they would adopt and implement these G&S and related implementing tools and confirm these decisions with the District. While the Collaborative has dissolved as a forum since publishing these guidelines and standards, they still provide information that could be used by municipalities to guide riparian development.

Prior to the formation of the Collaborative the City San Jose adopted a riparian policy for 100-foot development setbacks (1999). Through the Santa Clara Valley Habitat Conservation Plan (Valley HP) (ICF International 2010) there is a commitment to apply a more rigorous version of the City of San Jose's Riparian Policy to new developments or redevelopments. Details of this approach are discussed in chapter 4. In general, policies are weaker land use management tools than ordinances because the latter are enforceable by law whereas policies are not.

As illustrated in Chapter 2, different riparian functions are associated with different riparian widths. Most riparian functions have minimum riparian width requirements. In general, the overall number and levels of riparian functions increase with riparian width, with most physical functions being supported in the first 30 – 50 meters (100 – 167 feet) of width, and intrinsic ecological functions, such as wildlife support, requiring riparian areas that are from 50 – 100 meters (167 – 333 feet) or even wider, depending on the wildlife species. The width required to support a full suite of riparian functions does not necessarily decrease with channel order (e.g., smaller order streams that occur in the upper portions of a watershed). In general, however, the width required to support a full suite of riparian functions is greatest for high-order streams in valleys, narrows somewhat for mid-order streams in the moderately steep middle reaches of drainage networks, and increases somewhat in low-order channels in steep headwater areas to account for riparian hillslope processes, such as landsliding that contributes sediment to the drainage network. Therefore, in many cases, the existing 100-foot riparian setback policy will not adequately protect the full suite of riparian functions. Thus, further loss of riparian function is likely due to infill and redevelopment, unless setback requirements reflect site-specific riparian functions widths. The Riparian Area Mapping Tool (RAMPT) of the Bay Area Aquatic Resources Inventory (BAARI) (see Appendix A) can be used to identify local setback needs and options.

Urban Runoff Quality:

Pollutants in urban runoff (i.e., stormwater and non-stormwater discharges) can cause toxicity and other adverse impacts to aquatic ecological resources. Since the early 1990's, urban runoff transported via municipal separate storm sewer systems to Santa Clara Valley water bodies has been regulated through a National Pollutant Discharge Elimination System (NPDES) Permit. Currently, all municipalities in the Santa Clara Valley and the District are subject to requirements in the San Francisco Bay Area Municipal Regional Stormwater Permit (commonly referred to as the MRP). In compliance with the MRP, municipalities and the District implement a range of pollution prevention, source control and treatment control best management practices (BMPs). Additionally, creek and pollutant loads monitoring are required by the MRP and coordinated at the countywide level.

Hydromodification:

Runoff from impervious surfaces increases stream discharge, bed and bank erosion and decreases water quality. Over the last century the Coyote Creek watershed has experienced significant hydromodification due to urban expansion of transportation corridors, businesses, institutions, and residences (SCVURPPP 2001, Grossinger et al. 2006). The MRP, which went into effect in December 2010, includes significant requirements to reduce hydromodification in Santa Clara Basin streams. The implications of such controls for future risk realization are discussed in section 3.2.

Invasive Species

Introductions of non-native invasive plants, invertebrates, amphibians, fish, and other wildlife often negatively impact the biotic integrity of native flora and fauna of local stream ecosystems. The San Francisco Bay is one of the most invaded aquatic regions on Earth, with more than half its fish and most of its bottom-dwelling organisms representing non-native species (The Nature Conservancy 2008). Non-native species may be introduced to watersheds via several vectors, including ballast water exchange in the Bay, intentional stocking or discarding of pets, ornamental landscaping or re-vegetation to prevent soil erosion, via humans and other animals traveling along roads and trails, and via wind. The following are examples[18] of non-native species that have invaded the Coyote Creek watershed and are considered to pose considerable risk to stream ecosystem conditions:

- Ballast water exchange[19]: Asian clam (*Potamocorbula amurensis*), Chinese mitten crab (*Eriocheir sinesis*);

[18] The species listed here include several of the thirty five plant species are considered to be problems for District resource management (Lisa Porcella, District Biologist, personal communication 2/18/11).

[19] Recent legislation may help decrease the rate of invasions from this vector, for example, the 2009 Marine Invasive Species Act, AB 248.

- Intentional stocking or discarding of pets: largemouth bass (*Micropterus salmoides*) and common carp, (*Carassius auratus),* red-eared slider (*Trachemys scripta elegans*), bull frog (*Rana catesbeiana*);
- Ornamental landscaping or erosion prevention: pampas grass, (*Cortaderia selloana)*, giant cane reed, (*Arundo donax), and* Atlantic smooth cordgrass (*Spartina alterniflora* and other hybrids);
- Roads and trails: stinkwort (*Dittrichia graveolus*) and yellow star thistle (*Centaurea solstitialis)*.

Invasions are difficult to prevent or even reverse once they reach a critical extent. Early detection, control, and eradication has been shown to yield a cost-to-benefit of $17 - $34 for every $1 invested (California Invasive Pest Council 2010). Therefore establishing a monitoring network to detect invasions in their early stages can be a useful approach to prevent costly large invasions. The District is a partner in the Santa Clara County Weed Management Area, which is party to the Bay Area Early Detection Network (BAEDN). This type of monitoring network is best implemented through cooperative stewardship and is discussed in Chapter 4.

3.1.2.2 Risks within District control

The District can influence the condition of stream ecosystem resources in some subwatersheds of the Coyote Creek watershed through the operation and maintenance of water supply and flood control infrastructure, management of District fee title and easement lands, and through cooperative stewardship with other agencies. The District can increase its influence on stream ecosystem conditions by taking a watershed approach to these design, operational, and management actions that recognizes their inter-relations and by focusing on minimizing negative impacts associated with hydromodification to achieve specific ecological as well as flood control and water supply goals.

Impoundment

Impoundments can have a variety of negative impacts on stream ecosystem conditions. The kind and severity of the impacts depends on the design of the impoundments and how they are managed. One of the most significant and common impacts is downstream incision, sometimes termed the hungry water effect (Kondolf 1997), caused by the impoundment of sediment. Impoundments can also alter seasonal and annual hydrographs and warm or cool downstream water temperatures. The physical impacts of impoundments can also create conditions that are favorable to non-native species.

The District manages several impoundments, Coyote and Anderson Reservoirs, and Metcalf Pond that have significant effects on stream ecology in the Coyote Creek watershed. Historically the District also operated the Ford Road Percolation Ponds and Standish Dam. The City of San Jose manages the Cherry Flat Reservoir in the Upper Penitencia Creek headwaters. The TC-HCP provides an opportunity to consider management of impoundments in the context of multiple objectives, including support of stream ecosystem conditions. Such potential is discussed in Chapter 4.

Artificial Recharge

The operation of artificial recharge facilities diverts seasonal and storm-related stream flows and therefore affects downstream sediment transport and channel form. It can also influence water temperature, and water quality. The magnitude and timing of these effects depends on the configuration of the facilities and their water sources (i.e., whether they are within or outside the watershed). The TC-HCP provides an opportunity to consider management of artificial recharge facilities in the context of multiple objectives, including support of stream ecosystem conditions. Such potential is discussed in Chapter 4.

Channel Modification

Channel modification refers to such actions as bank revetment, bridge construction, culvert installation and replacement, construction of check dams, channel alignment or channelization, etc. With the exception of check dams and channelization, these actions generally[20] harden channel beds and banks, reducing natural roughness and increasing flow velocities and stream power. This increased energy can result in local bed and bank erosion, and downstream channel aggradation. Channelization typically straightens channels and reduces their overall length, thus effectively shortening their length and increasing their slope, which in turn can increase flow velocities, resulting in the same kinds of hydromodification caused by channel hardening.

District flood control projects including the Mid-Coyote Creek (MCFCP), Upper Penitencia Creek, Silver Creek, and Lake Cunningham provide opportunities to consider channel modification in the context of addressing flood control and stream ecosystem condition objectives. The relatively large scale of the MCFCP means it has the potential to improve conditions throughout the middle portion of the Coyote Creek mainstem. Such potential is discussed in Chapter 4.

3.1.2.3 Assessment of High-Risk Sites from Ambient CRAM Surveys

This section identifies low-scoring sites where stressors have clearly impacted stream ecosystem conditions, and high-scoring sites that have been less impacted by stressors. Site condition is considered for each of the four CRAM Attributes.

Low-Scoring Sites

Buffer and Landscape Context Attribute

Sites with low Buffer and Landscape Context Attribute scores are all located in the lower portion of Coyote Creek watershed. The low Buffer and Landscape Context Attribute LC scores are due to the urban landscape context of these sites. The stressors that have been identified as likely causes for low Buffer and Landscape Context scores are transportation corridors, residential, industrial, and commercial development (e.g., buildings and parking lots), and heavily used recreational parks. The

[20] These actions generally harden channel beds, but some ban repair projects incorporate natural materials and geomorphic strategies that do not involve such hardening.

Buffer and Landscape Context Metrics most directly affected by these stressors are Buffer Width and Buffer Condition, particularly on the valley floor. While riparian corridors are interrupted by some road crossings, scores were consistently high for the Landscape Connectivity Metric. This indicates that even in dense urban areas, riparian corridors are relatively continuous. It should be noted, however, that the stream ecosystem assessments revealed that the riparian areas, though continuous, were narrow due to the developments that have encroached upon them. Thus, roads running parallel to creeks are having a greater negative impact on stream ecosystem conditions than roads crossing the creeks.

Hydrology

Sites with low Hydrology Attribute scores were restricted to the lower portion of the Coyote Creek watershed, and mainly to the Upper Penitencia Creek subwatershed. These sites were negatively influenced by dikes and levees, non-point source discharges, and actively managed hydrology (i.e., diversions and water imports associated with active management of hydrology for percolation ponds). Observed impacts include incision due to upstream runoff, revetment and other channel modifications. The Metrics accounting for the low Hydrology Attribute scores differed between the upper and lower portions of the Coyote Creek watershed. In the lower portion of the watershed, non-point source discharges lowered the Water Source Metric score, whereas channel incision (i.e., low score for the Hydrological Connectivity Metric) were more prevalent in the upper portion of the watershed.

The Channel Stability metric generally scored very high throughout most of the watershed, illustrating that many of the assessed reaches are not currently experiencing severe degradation (incision) or aggradation. This result was unexpected in parts of the mainstem and lower watershed tributaries, because many portions of similar Bay Area streams are experiencing degradation. A recent study of Upper Penitencia Creek (Jordan et al. 2009), however, found that the Upper Penitencia Creek mainstem has been able to adjust to the historical reduction in effective drainage area, increased runoff, and reduction in base elevation (valley subsidence). The high scores for the Channel Stability Metric for segments of the Coyote Creek mainstem that have levees suggest that 1) the channel in these segments has adjusted to the artificially confined flows, and 2) the lower portions of the mainstem are far enough downstream of Anderson Dam to avoid its hydromodification effects.

Physical Structure

Sites with low Physical Structure Attribute scores occurred in both the upper and lower portions of the Coyote Creek watershed and most were associated with stressors relating to intensive urban and agricultural land uses. The stressors commonly identified that would affect Physical Structure scores included revetment and grading/compaction of adjacent buffer areas. The three sites illustrated in Figure 2-14 that lacked these stressors but exhibited low Physical Structure Attribute scores were all headwater reaches which naturally have simplified physical structure and thus tend to score lower for this Attribute. Although not noted as an immediate (adjacent) stressor relating to low Physical Structure Attribute scores, urbanization upstream of these sites is likely to have a negative effect on physical structure by requiring hardening of the channels (levees or engineered revetments) to prevent flooding and bank erosion).

Many of the sites on the valley floor in the lower portion of the Coyote Creek watershed scored moderately for the Topographic Complexity Metric due to the positive influence of multiple topographic benches (as viewed in cross section) and the negative influence of streambank modification, hydrologic management, and woody debris removal that has apparently reduced channel bed complexity and overall micro-topographic relief (SCVURPPP 2009). Notably, almost all sites lacked debris jams, which are accumulations of large woody debris that are vitally important for providing channel complexity and habitat for fish and other aquatic wildlife.

Biotic Structure

Site with low Biotic Structure Attribute scores occurred in both the upper and lower portions of the Coyote Creek watershed and most were associated with stressors indicative of intense urban and agricultural land uses, including intensive grazing or mowing, excessive human visitation, invasive species, channel modification for flood control, and managed burning. The Biotic Structure Attribute also scored low for some low-order sites in the upper watershed that are naturally not biologically complex due to the arid setting and because their substrate is mainly bedrock.

Most of the low Biotic Structure Attribute scores can be attributed to low scores for the Percent Invasion Metric. Invasive plant species were dominant at these sites. Some of these sites also scored low or moderately low for the Number of Plant Layers and Vertical Biotic Structure Metrics, usually due to the absence of one or more plant layers and the presence of only a few distinct plant patches.

High-Scoring Sites

Buffer and Landscape Context and Hydrology

Sites with high Buffer and Landscape Context and H Attribute scores are restricted to the upper portion of the watershed, in areas open space or protected land that provide wide, high-quality stream buffers. Protecting these areas will involve eliminating grazing or maintaining good grazing practices, and preventing urban encroachment and the associated hydromodification.

Physical Structure

Sites with high Physical Structure Attribute scores were located in both the upper and lower portions of the Coyote Creek watershed, where the stream has either been protected from land use stressors or the streams have adjusted to them. In the lower portion of the watershed, some of the sites with high Physical Structure scores are located in either City or County Parks. Protection of these less impacted sites and their adjoining stream reaches in the urban/rural transition zone (e.g., the three sites in the transition zone of Upper Penitencia Creek and the other Coyote Creek sites upstream of downtown SJ in the City and County Parks) might be especially important because they appear to be buffering downstream areas from upstream stressors.

Biotic Structure

Sites with high Biotic Structure Attribute scores occurred in relatively complex reaches sporadically throughout the upper watershed, and in the transition zone of the Upper Penitencia Creek mainstem, and on the Coyote Creek mainstem in some City and County Parks. Protection of these sites and their adjoining reaches will involve management of their riparian areas to further promote complexity.

Level 2 Risk Assessment Synthesis

Sites with low scores for the Buffer and Landscape Context and Hydrology Attributes were concentrated in the lower portion of the watershed, probably due to stressors associated with urban land uses. Urbanization stresses stream ecosystems by narrowing riparian areas, altering plant community structure and composition, altering flow and sediment regimes leading to hydromodification that in turn leads to channel instability and a lack of hydrological connectivity. These effects are clearly evident for the Upper Penitencia Creek and Coyote Creek mainstems and associated tributaries. Whether or not the same effects are evident in the Lower Silver Creek subwatershed and the Berryessa Creek subwatershed is not known because these subwatersheds were not well represented in the Level 2 survey of ambient condition. By inference, however, the existing survey results strongly suggest that similar conditions currently exist in these subwatersheds. Despite the fact that historically Lower Silver and Berryessa Creeks had narrower riparian corridors and less complex riparian community structure than Upper Penitencia and Coyote Creeks, it is likely that outside of areas where District mitigation efforts have restored floodplains and native vegetation, urbanization has modified corridors as described above, resulting in the loss of multiple functions that were once supported. The few sites that were assessed in the Berryessa Creek subwatershed had low CRAM Index scores, which means they also had low Attribute and Metric scores, suggesting that stream ecosystem conditions in the Berryessa Creek subwatershed may be at greater risk of decline than those in the Upper Penitencia Creek subwatershed, where some sites received high Index scores. The Jordan et al (2009) Level 3 comparison of geomorphic conditions in the Upper Penitencia Creek and Berryessa Creek subwatersheds is consistent with this scenario.

Sites with low scores for the Physical Structure and Biological Structure Attributes occurred in both the upper and lower portions of the watershed. Some of the low scores in the upper watershed are probably attributable to the naturally simple physical and biological structure of headwater streams in arid settings. All the Low Physical Structure and Biological Structure scores in the lower portion of the watershed can probably be attributed to anthropogenic stressors.

Sites with the high scores for the Buffer and Landscape Context and Hydrology Attributes were concentrated in the upper portion of the watershed, as were sites with high score for the Physical and Biological Structure Attributes. This indicates that 1) headwater landscape position does not always result in simplified physical structure and biological structure; and 2) lower watershed position does not always result in degraded physical structure and associated biological structure. Both the upper and lower portions of the Coyote Creek watersheds support high quality stream ecosystem resources that may be protected through District stewardship, including cooperative efforts with other agencies and land owners. This topic will be discussed in Chapter 4.

3.1.3 Level 3 Risk Assessment

As indicated by the 1-2-3 Framework, Level 3 data can be used to identify stressors that neither Level 1 nor Level 2 data can, and to validate and interpret risk indicated by Level 2 data. Combining Level 2 and Level 3 data in this way provides an opportunity to use a "weight of evidence approach" to assess stream ecosystem conditions and may provide insight into potential causes of low Level 2 scores. By characterizing a suite of metrics ranging from biological, physical habitat, fundamental geomorphic structure, and water and sediment quality, it is possible to identify spatial patterns in certain aspects of condition that can help interpret risks to stream ecosystem conditions. This section summarizes information from selected reports that present and analyze data associated with urbanization of the Coyote Creek Valley.

As mentioned in the Level 3 assessment of stream ecosystem conditions (and see Table 2-5), land subsidence and factors related to urbanization have had considerable influence on stream ecosystem conditions. Jordan et al. (2009) discuss the relative effects of three major influences on channel stability for the Upper Penitencia Creek and Berryessa subwatersheds: 1) land subsidence, 2) hydrologic alteration to historic flow regime due to increased impervious land cover, drainage-area manipulation, and water diversion, and 3) urbanization infrastructure elements including grade control structures, sedimentation basins, and in-stream culverts. They conclude that land subsidence has been the major factor contributing to channel instability (degradation, aggradation; erosion and deposition) for the Upper Penitencia Creek mainstem. The modified urban flow regime (increased impervious area and intensified drainage network, balanced by decreased drainage area) and flow management - construction of the relatively small Cherry Flat Reservoir in the headwaters, and extraction into off-channel percolation ponds - has not adversely affected channel stability. Furthermore, such water management appears to have successfully mitigated valley subsidence on the Upper Penitencia Creek mainstem resulting in a channel that is largely stable with only a few localized areas of instability upstream of the I-680 crossing. Jordan et al. (2009) further conclude that the geomorphic condition of Upper Penitencia Creek is much more stable than its neighbor, Berryessa Creek, largely as a result of differences in their experiences with hydrologic alteration and in-stream infrastructure.

While a similar analysis is not available for the Coyote Creek mainstem, the prevalence of subsurface storm drains, engineered channels, and ditches have greatly expanded the size of the drainage network directly connected to the Coyote Creek mainstem without a counterbalancing effect of a decrease in drainage area, as occurred in the Upper Penitencia Creek subwatershed. Thus channel stability in Coyote Creek has likely been more impacted by hydrologic alteration and urbanization infrastructure than Upper Penitencia Creek. Grossinger et al. (2006) discuss the impact that historical subsidence has had on Coyote Creek geomorphology. They studied historical data for the Coyote Creek mainstem and noted that between the Upper Penitencia Creek confluence and Highway 280 (corresponding to the "middle reaches" designated in Table 2-5, and including most of the extent of the Mid-Coyote Flood Control Project) the Coyote Creek mainstem is "notably flat". The modern (2003) longitudinal profile featured in that report indicates that approximately 15 feet of vertical relief exist for the approximately six stream miles between Montague Expressway and Highway 280. Grossinger et al. also note that the Coyote Creek mainstem was historically incised. Available historical cross-sections measured prior to land subsidence at sites 11 and 12 in the middle reaches show that thalweg elevations are not significantly different from those measured in 2003. One possible explanation for such similarity is that after these historic measurements were made, the channel incised further due to subsidence and has now aggraded to a similar level as observed pre-subsidence. Grossinger et al. also note that the incision rate since land subsidence ceased is consistent with the hypothesized long-term rate and trends observed since the early 1980s. SCVURPPP (2003) found that the Coyote Creek mainstem in the middle reaches, as referenced above, was incised most dramatically between the confluence with Upper Penitencia Creek and Lower Silver Creek eliminating most floodplain access.

Construction of Anderson Dam was associated with the accelerated urbanization boom of the 1950s and is another factor that has fundamentally influenced the watershed hydrogeomorphology, resulting in a multitude of typically associated impacts, e.g:

- Trapping of sediments 1) reduced the amount of coarse substrate available for habitat downstream, 2) created “hungry” sediment-starved water that “ate away” downstream beds and banks, causing channel incision downstream of the reservoir release locations and contributing to the significant channel entrenchment observed today;
- Reduction of peak flows and managed baseline flows have dampened and homogenized the hydrologic patterns so that the fines created by hungry water (and urban hydromodification) have not been flushed out of the system and instead have been deposited in the lower gradient reaches, including the middle reaches that were flattened by land subsidence;
- Riparian complexity has been reduced as entrenchment and management of flows have prevented frequent floods from occurring. The historic frequent flood flows delivered nutrients from floodplains to plants and scoured floodplain surfaces allowing the germination of adapted native plant species, such as those associated with sycamore alluvial woodland communities and riparian scrub (these communities were historically present in the reaches downstream of Anderson Dam, downstream of Burnett Road to Tully Road, Grossinger et al. 2006). Channel modifications and managed flows associated with the urbanization boom have created perennial reaches on Coyote and Upper Penitencia Creeks that were otherwise dry for part of the year, thus contributing to shifts in aquatic and riparian communities that included species that were adapted (behaviorally or physiologically) to these drier conditions.

The combination of a) low stream gradient due to land subsidence, and b) aggradation of fines contributed by hydrologic alteration due to dam infrastructure and expansion of the urban drainage network appear to have allowed a considerable buildup of deposited fines and accumulated organic matter which has reduced the complexity and quality of physical habitat. Due to the relatively large size of Anderson Dam, such effects have been more noticeable on Coyote Creek than on Upper Penitencia Creek. Moreover, they are most pronounced in the middle reaches of the Coyote Creek mainstem. The Level 2 CRAM metrics that strongly correlated with native fish diversity reflect this (Table 2-5). The

Topographic Complexity Metric (micro- and macro-topographic relief) scored low to moderate, particularly for micro-topographic complexity. (The fisheries physical habitat data collected by the District (2006) for the Mid-Coyote Creek Flood Control Project and by SCVURPPP (2001, 2003a) also indicate that habitat in these reaches is simplified and mainly consists of mid-channel pools which are relatively embedded.) The middle reaches also scored very low to low for the Hydrologic Connectivity Metric (entrenchment). The fact that the statistical analysis indicated that native fish diversity would likely be high when entrenchment is high[21] indicates that native fish are present in these middle reaches. Their relative abundance and species diversity, however, are lower than in other mainstem reaches (Table 3-1). This may indicate that enough habitat complexity is present for a limited number of native fish species to survive at very low abundances but not necessarily enough to thrive, as do non-native fish in these reaches. Another CRAM metric, Structural Patch Richness, while not significantly correlated with the native fish diversity metric, exhibited a similar spatial pattern as the native fish diversity and abundance, e.g., Structural Patch Richness scored very low to low in the middle reaches, also indicating that the available habitat is simplified.

Available water quality parameters for the middle reaches ([Dissolved oxygen, sediment chemistry, and sediment toxicity, and temperature] SCVURPPP 2008 and Hopkins et al. 2002), indicate relatively poor water quality, particularly in the middle reaches of Coyote Creek (Table 2-5). These parameters likely reflect the fact that the accumulation of sediment and organic matter in this low-flow, low-gradient stream segment, creates a relatively stagnant environment that approaches anoxic and/or toxic conditions at some sites. Therefore, it is likely that water quality, in addition to simplified physical habitat, is negatively impacting the biological communities, as measured by both fisheries and macroinvertebrate indicators (SCVURPPP 2008) particularly in the middle reaches of the Coyote Creek mainstem. Similar water quality data were not available for Upper Penitencia Creek, but its flow and gradient conditions are not likely to cause such a stagnant environment.

In summary, the Level 3 data presented here indicate that where native fish diversity and abundance are lowest, physical and chemical conditions are also generally degraded. This pattern is most pronounced in the middle reaches of the Coyote Creek mainstem. Two stressors, land subsidence and hydrologic modification, have exerted large-scale impacts that have fundamentally changed the hydrogeomorphology of the drainage network. The Level 3 metrics discussed above demonstrate that particularly in the middle reaches of the Coyote Creek mainstem, entrenched channels with simplified physical habitat and lower water quality reflect degraded stream ecosystem conditions that do not support as high native biotic diversity as in adjacent reaches, as measured by fish and macroinvertebrate indicators. Section 3.2 discusses the likelihood that stressors to stream ecosystem resources may cause further degradation in the future. Chapter 4 discusses the likely consequences of risk being realized and actions that may be taken to address it.

[21] Native fish diversity correlated negatively with the Hydrologic Connectivity Metric. Since this Metric is indicative of an inverse degree of entrenchment, a negative correlation with the Hydrologic Connectivity Metric indicates that when connectivity is low, entrenchment is high.

3.2 Likelihood of Future Risk Realization Impacting Stream Ecosystem Conditions

This section addresses the question: what is the likelihood (i.e., risk) that stressors may negatively impact stream ecosystem conditions? As discussed in Chapter 2, ambient CRAM surveys established baseline stream ecosystem conditions that the District may adopt as ecological LOS. In section 3.1 risk to stream ecosystems was discussed both in terms of stressors that have historically impacted stream ecosystem conditions and that are currently observed. This section discusses the likelihood of these stressors continuing to threaten and possibly degrade stream ecosystem conditions in the future. The potential consequences of these risks being realized are discussed in Chapter 4.

3.2.1 Likelihood of Stressors further degrading Buffer and Landscape Context

As infill development and expansion within urban growth boundaries occur, the proportion of the watershed's streams experiencing degradation of riparian buffer size and condition will likely increase unless 1) adequate riparian protection policies are strictly adhered to and/or riparian protection ordinances are established and implemented, and 2) urban growth boundaries are contained (e.g., do not continue to expand from current delineation). There is no guarantee that urban growth boundaries will be strictly enforced, and they could be amended to extend beyond their current configuration. The likelihood of significant expansion beyond the urban growth boundary is largely dependent upon factors beyond the District's control, namely population growth, economic performance, and political will. That said, relative to the legacy impact from the rapid urban expansion that has occurred throughout most of the Valley since 1950, the impact to the Buffer and Landscape Context Attribute score for the entire Coyote Creek watershed from infill and redevelopment should be small because the area available for development within the urban growth boundary, and even beyond, is small relative to the existing developed area. The impact to this same Attribute within the locally affected reaches could, however, be relatively large.

The impacts to the riparian areas ultimately depend on the relative strength of riparian policies and ordinances and the effectiveness of their implementation. The public review draft of the Valley HP (ICF International 2010) includes requirements for riparian setbacks. Such provisions should be carried through to the final plan. The setbacks would apply to new development or redevelopment. During the course of the 50-year permit term, a substantial length of stream would be subject to these setbacks. The setback requirements are described in Condition 11 of Chapter 6. Setbacks for fish bearing streams (Category 1 streams), are greater than for non-fish bearing streams (Category 2 streams). Inside of the urban service areas, setbacks of 100 feet are required for fish-bearing streams. Outside of the urban service areas, setbacks of 150 feet are required for fish-bearing streams. In areas where the slope is greater than 30%, an additional 50 feet is added to the setback requirement. The setback requirements for non-fish bearing streams is 35 feet.

3.2.2 Likelihood of Stressors further degrading stream Hydrology

As infill development and expansion occur within urban growth boundaries, runoff into the stream ecosystem is likely to also increase, and more streams in the watershed may experience degradation from hydromodification. The magnitude and extent of such impacts depends on 1) the distribution of development that does not have to be addressed by hydromodification controls through the MRP; 2) the relative effectiveness of hydromodification controls where they are applied; and 3) whether the municipal urban growth boundaries expand. The MRP requires that new development and redevelopment projects include appropriate source control, site design, and treatment measures to manage stormwater runoff pollutants and prevent increases in runoff flows from project sites (SFRWQCB 2010). However, not all development is subject to these requirements, and the efficacy of preventative measures is not certain at this time.

The "preferred" stormwater management approach stated in the MRP is Low Impact Development (LID). LID practices strive to treat stormwater as a resource rather than as a waste product, keeping rain water on site rather than filtering and discharging it to the storm drain system. LID prioritizes minimizing hardscape and using permeable surfaces, and preserving open spaces and natural or engineered site features to filter, evaporate, or infiltrate runoff.

3.2.2.1 Hydromodification beyond District Control

Several key requirements in the MRP will address (beginning December 1, 2011) future hydromodification from certain categories of development. These include:

- Runoff from new public and private development projects that create or replace 10,000 square feet or more of impervious surface must be managed though LID practices.
- Projects involving auto service facilities, retail gasoline outlets, restaurants, and uncovered parking that create or replace 5,000 square feet or more of impervious surface must treat the sites' runoff with LID.
- Construction of new roads and widening of existing roads involving 10,000 square feet or more of newly constructed contiguous impervious surface are now required to treat the road's runoff.
- Hydromodification Management requires projects that create or replace one acre or more of impervious surface and are located in a subwatershed that is comprised of 65% or greater impervious surfaces to manage stormwater runoff so that post-project runoff does not exceed pre-project runoff rates and durations.
- New requirements on small and single-family home development projects that create or replace ≥ 2,500 to < 10,000 square feet of impervious surface entail selection and implementation of one or more stormwater design measures from a list of six (ref this list).

This list of requirements, however, does not cover all development categories. Thus, the relative impact of these requirements will depend on 1) their effectiveness in preventing hydromodification and 2) the distribution and frequency of developments occurring in categories that are not covered by the MRP. The San Jose General Plan 2040 (draft pending public review in early 2011), however, will include these

MRP stormwater goals and policies that encourage a LID-based approach to stormwater management. The City of San Jose will also coordinate with the District to identify opportunities to construct regional hydromodification management facilities to manage runoff from multiple projects, and potentially enhance riparian habitat. The City of San Jose may also develop an Alternative Compliance program to allow qualified projects to meet stormwater treatment requirements through the construction of stormwater facilities off-site or by payment of in-lieu fees, consistent the MRP's recognition that certain site conditions may preclude or impede the construction of on-site stormwater treatment.

Although the plan to develop the Coyote Valley (CVP), within the City of San Jose's urban growth boundary, was put on hold in 2008 (http://www.sanjoseca.gov/coyotevalley/), it is possible that as South Bay population and business development pressures increase, this planning effort will be revived and implemented as a Specific Plan within the City of San Jose's General Plan. The volume of work that was completed for that planning effort now represents a vision document that does not meet the statutory requirements of a Specific Plan but does contain a compendium of information that the City would consider in any future comprehensive planning effort in Coyote Valley. The CVP divided the Coyote Valley into three sub-areas, each with a different land use designation in the San José 2020 General Plan: the North Coyote Valley Campus Industrial Area (1,400 acres), the Mid-Coyote Urban Reserve Area (2,000 acres), and the South Coyote Valley Greenbelt Area to the south (3,600 acres). The Greenbelt Alliance (2003) also developed an award-winning alternative plan to the CVP called Getting it Right: Preventing Sprawl in Coyote Valley. This Plan describes a multi-objective comprehensive stormwater management open-space greenway design to contain the flows associated with a 100-year storm events at watershed build-out and ensure that creek system hydrology and habitat values remain intact and are improved beyond their existing conditions.

Water releases from Cherry Flat Reservoir are managed by the City of San Jose and regulated under a permit (section 1600) from the California Department of Fish and Game to maintain a "wet/active" channel below the dam (SCVURPPP 2003). The City does not maintain a schedule of flow releases. Most years the flows from the natural springs on which the dam is built supply adequate flows to maintain a wet streambed. Flows are typically not released from the dam unless early or high rains are predicted and storage capacity needs to be increased.

3.2.2.2 Hydromodification within District Control

The Three Creeks Habitat Conservation Plan (TC-HCP) (SCVWD 2009a) provides an opportunity for the District to consider future flow management within the context of multiple needs, including those listed below.

- Groundwater recharge
- Habitat needs for native species
- Flushing flows to move aggraded sediment downstream

The TC-HCP Conservation Program includes 28 measures that are intended to improve ecological conditions related to:

- Habitat access;
- Habitat quantity and quality;
- Invasive species management;
- Channel dewatering management.

The TC-HCP is likely to be implemented within the next few years (Beth Dyer, District, personal communication March 2011), meaning that the District will likely address aspects of hydromodification associated with its maintenance and operations of flood control and water supply facilities. The extent to which such management changes improve stream ecosystem conditions could be ascertained by implementing a monitoring design that would include collecting Level 1, 2, and 3 data. This is further discussed in Chapter 4.

3.2.3 Likelihood of Stressors further degrading Physical Structure

As discussed above, degradation from future hydromodification is feasible, and largely depends on the pattern of urban development and expansion and the relative success of hydromodification controls. Future degradation from flood control channel stabilization practices implemented to manage hydromodification impacts largely depends on how flood control projects are implemented. Designs that support or re-establish functional floodplains have the potential to improve physical structure. Designs that simplify physical structure and constrain channels, particularly using non-natural hardened materials, have the potential to degrade physical structure. Both the Mid-Coyote Creek Flood Control Project, the Upper Penitencia Creek Flood Control Project, the Lower Silver Creek Flood Control Project, and the Lake Cunningham Flood Control Project provide opportunities to design projects that address both flood control and ecological objectives. As discussed in Chapter 3, the stream ecosystem conditions in the middle reaches of the Coyote Creek mainstem are in relatively poor condition due to a legacy of urban impacts. The potential for such flood control projects to improve stream ecosystem conditions will be discussed in Chapter 4.

Some degradation of stream ecosystem conditions due to livestock grazing will likely continue in areas where management practices continue to allow cattle to access streams or their riparian areas. Impacts to physical structure could increase depending on the intensity of grazing (animal unit months) and the frequency of grazing rotations. On the other hand, the implementation of best management practices for grazing (grazing BMPs), such as creating off-creek water and shade resources, reducing grazing intensity, and/or altering rotation schedules, can improve the physical structure of stream ecosystems. Some ranches and public lands in the upper watershed are managed to reduce the likelihood that livestock spend too much time in riparian areas, but no comprehensive program exists in Santa Clara County to conduct outreach to ranchers and encourage and support implementation of grazing BMPs (Sasha Gennett, Stewardship Biologist, TNC, personal communication, 12/15/10).

3.2.4 Likelihood of Stressors further degrading Biotic Structure

As discussed previously, most of the stressors to biotic structure are associated with urbanization. As infill development and expansion occur within urban growth boundaries, more of the streams are likely to experience degradation of biotic structure due to loss of riparian width and disturbance of physical and biological processes and structure, leading to increased biological invasion. The magnitude and extent of such impacts depends on 1) the distribution of development that is not subject to regulation under the MRP or other state and federal policies affecting development; 2) the relative effectiveness of hydromodification controls that are implemented (including LID provisions included in the MRP and design of flood control and mitigation projects); 3) the extent to which adequate riparian protection policies are strictly adhered to and/or riparian protection ordinances are established and enforced; and 4) whether the municipal urban growth boundaries expand. Livestock and recreation in the upper watershed also impact biotic structure and such impacts are likely to continue unless land managers are made aware of BMPs, and have incentives to implement them.

Chapter 4.0 Likely Consequences of Risk Realization and Recommended Monitoring and Management Actions to Maintain and/or Improve Stream Ecosystem Conditions

This chapter addresses the last two core EMAF management questions:

1) **What are the likely consequences of risk realization to stream ecosystem conditions?**
2) **What are the monitoring and management actions that can be improve or provide a better understand stream ecosystem conditions and reduce risk?**

It discusses the likely consequences of the sources of risk in the Coyote Creek watershed (discussed in Chapter 3) being realized and identifies potential monitoring and management actions that if implemented, might reduce the likelihood and consequences of such risks. Though it is difficult to accurately predict whether or not the consequences of future risk to stream ecosystem conditions will be realized, it is possible to indicate their likelihood and probably ecological consequences in terms of CRAM attributes and metrics. Since the District has relatively little ownership and control over streams relative to the vast drainage network in each watershed, it is important for the District to identify risks to core District business that originate from areas within its control and from areas outside of District ownership, and to identify planning level recommendations that help District managers make informed decisions on investments in cost-effective monitoring and management actions designed to improve stream ecosystem conditions. The District's Governance Policies identify three roles that the District can take to influence such improvements. For assets that it owns, the District can directly initiate actions and modifications. For assets that the District does not own, it may work cooperatively with partners to achieve a desired LOS. Finally, the District may take a role of providing technical information or be an advocate for actions by others. The monitoring and management actions presented for District consideration in this chapter are organized according to these three potential roles.

4.1 Likely Consequences of Risk Realization

This section discusses the ecological consequences likely associated with the potential risks discussed in Chapter 3. Table 4-1 describes the key stream ecosystem services that could be impacted in association with degradation of each of the four CRAM Attributes. Table 4-2 briefly summarizes the Level 2 watershed-scale risk assessment conclusions based on CRAM surveys and the following discussion of the likely consequences of risk realization.

4.1.1 Buffer and Landscape Context

Likely Consequence of Risk Realization: If riparian buffers continue to be encroached upon and interrupted by structures and transportation corridors, it is likely that impacts will occur to the key stream ecosystem services described in Table 4-1 and the riparian functions presented in Table 2-3, e.g., bank stabilization, floodwater dissipation and runoff filtration, groundwater recharge, wildlife support, and nutrient cycling. More specifically, reductions in riparian width and continuity will further reduce and fragment wildlife populations, decrease pollution filtration, and contribute to flashier, more flood-prone hydrographs. The areas most likely to be impacted will be where undeveloped land is available for infill development, mainly near the edges of the urban growth boundaries in Milpitas and south San Jose. Redevelopment is less likely to impact Buffer and Landscape Context, as City planners could require greater setbacks, improved streambank stability, and more robust planting designs than were implemented during the original construction.

Table 4-1. Expected relationships among CRAM attributes, metrics, and key stream ecosystem services (source: Collins et al. 2008).

Key Stream Ecosystem Services	Buffer & Landscape Context	Hydrology			Physical Structure		Biotic Structure				
	Buffer & Landscape Connectivity Metrics	Water Source	Hydroperiod or Channel Stability	Hydrologic Connectivity	Structural Patch Richness	Topographic Complexity	Number of Plant Layers	Number of Co-dominant Species & Native Species Richness	Percent Invasion	Horizontal Interspersion and Zonation	Vertical Biotic Structure
Short-or long-term surface water storage	X		X	X	X	X				X	X
Subsurface water storage		X	X	X		X					
Moderation of ground-water flow or discharge	X	X									
Energy dissipation					X	X	X			X	X
Nutrient Cycling	X		X	X	X	X	X	X	X		X
Element & compound removal	X		X	X		X	X			X	
Particulate retention			X	X	X	X	X	X		X	
Organic carbon export			X	X			X		X	X	X
Plant and animal community maintenance	X		X	X	X	X	X	X	X	X	X

4.1.2 Hydrology

Likely Consequence of Risk Realization: If the hydromodification controls included in the MRP do not successfully maintain the existing hydrograph, then urban development and associated impervious surfaces will continue to increase runoff to storm drain networks, and cause a suite of related impacts such as chronic channel incision and simplification of stream physical structure. This degradation of

Table 4-2. A summary of Level 2 watershed-scale risk assessment conclusions based on CRAM surveys and a qualitative assessment of the consequences of risk realization.

CRAM Attribute	Level 2 Risk Summary	Consequence of Risk Realization
Buffer and Landscape Connectivity	The extent and severity of future impacts to riparian areas ultimately depends on the relative strength of: 1) the protection of riparian buffers via policies and ordinances and 2) the extent to which existing urban growth boundaries are maintained. Relative to the legacy impacts from rapid urban expansion since 1950, impacts to buffers and landscape connectivity from future infill and redevelopment is expected to be less overall due to the limited area available for new development within the urban growth boundary and current redevelopment policies that require greater setbacks, improved stream bank stability, and more robust planting designs than were implemented during original construction.	If riparian areas continue to be further encroached upon and interrupted by structures and transportation corridors, it is likely that impacts will occur to riparian functions and key stream ecosystem resources such as fisheries, channel capacity for flood and storm flows, wildlife habitat, riparian forests, wetlands, and green spaces.
Hydrology	If unmitigated infill development and expansion occurs within or outside urban growth boundaries, runoff into the stream ecosystem will likely increase, and more streams in the watershed may experience impacts due to hydromodification. The magnitude and extent of such impacts largely depends on the effectiveness of hydromodification controls implemented in compliance with the Municipal Regional Stormwater Permit (MRP).[22] Additionally, the District's operation and maintenance of flood control and water supply facilities could also continue to contribute to hydromodification in the Coyote Creek watershed without adjusting existing maintenance and operation activities to focus more on improving the hydrograph to support key aquatic, riparian, and upland habitats.	If hydromodification controls included in the MRP do not successfully maintain the existing hydrograph or improve it, then urban development, associated infrastructure, and impervious surfaces will continue to increase runoff to storm drain networks, and cause a suite of related impacts, including reduced floodplain and in-stream ecological and hydrological functions. The extent to which operation and maintenance practices for flood control and water supply can successfully contribute to improved hydrology will determine the relative impacts of District management to stream ecosystem asset conditions.
Physical Structure	The relative success of hydromodification controls, flood control designs, and riparian policy and ordinance enforcement will largely determine the degree to which physical structure is impacted in the future (beyond ongoing adjustment due to legacy impacts). Physical structure may be impacted by future channel stabilization projects, including the Mid-Coyote, Upper Penitencia, Lower Silver and Lake Cunningham Flood Control Projects unless designs and implementation successfully address both flood control and ecological objectives. Additionally, some degradation of stream ecosystem conditions due to livestock grazing will likely continue in areas where cattle have access to streams or their riparian areas.	The consequences of continued impacts to physical structure would include loss of channel topographic complexity, which leads to degraded habitat quality for fisheries, aquatic organisms, and riparian wildlife.
Biotic Structure	Potential impacts to biotic structure are associated with urbanization, livestock grazing and recreation. Many of these stressors are beyond District control. The magnitude and extent of these impacts depends on 1) the distribution of development that is not subject to regulation under the MRP or other state and federal policies affecting development; 2) the relative effectiveness of hydromodification controls that are implemented (including Low Impact Development provisions included in the MRP, and design of flood control and mitigation projects); 3) the extent to which adequate riparian protection policies and ordinances are established and enforced; 4) whether the municipal urban growth boundaries expand; and 5) whether Best Management Practices for livestock uses are incentivized and implemented.	The consequences of continued degradation of biotic structure would include degradation and loss of aquatic and riparian habitat, which would impact the distribution, diversity, and abundance of native fisheries, aquatic organisms, and riparian wildlife. Key stream ecosystem resources that would be impacted include short or long-term surface water storage, energy dissipation, nutrient cycling, pollutant filtration and removal, retention of particulates, export of organic carbon, and maintenance of plant and animal communities.

[22] Effective December 1, 2011.

stream ecosystem condition would lead in turn to reduced floodplain and in-stream ecological and hydrological functions, including short or long-term surface water storage, subsurface water storage, nutrient cycling, pollutant filtration and removal, retention of particulates, organic carbon export, and maintenance of plant an animal communities (Table 4-1). As discussed in Chapter 3, the MRP will not prevent all increases in impervious watershed area, as small projects (less than 2,500 square feet) will not be covered under this permit. The cumulative consequence of continued increases in peak flow and total annual stream flow due to a multitude of small impervious developments could be noticeable. Such impacts, however, may also be countered by cumulative decreases in impervious area that may result from redevelopment projects. The net effect of land use change and water quality control policies on stream ecosystem conditions can be assessed through routine ambient monitoring using Level 1 and Level 2 tools.

The relative consequence of developing the Coyote Valley (if and when it occurs) will greatly depend on the design that is implemented. Designs that accommodate large riparian setbacks that allow streams to meander, accommodate runoff onsite and provide runoff filtration, and support in-stream and riparian habitat could result in improvement in stream ecosystem conditions compared to existing conditions. Designs that do not include appropriate setbacks, constrain channels, and contribute additional runoff, particularly without adequate vegetative filtration, will likely degrade stream ecosystem conditions.

The District’s operation and maintenance of flood control and water supply facilities contribute to hydromodification in the Coyote Creek watershed. The Draft TC-HCP (SCVWD 2009a) includes a suite of changes to existing maintenance and operation activities that are focused on improving support for key aquatic, riparian, and upland habitats. It is possible that the Draft TC-HCP will not be adopted, however in that event, the District could address the management included therein through another effort. The extent to which such management actions successfully meet their objectives will determine the relative consequences of District management to stream ecosystem conditions.

4.1.3 Physical Structure

Likely Consequence of Risk Realization: Similar to the discussion for hydromodification, the relative success of hydromodification controls, flood control designs, and municipal riparian policy and ordinance implementation will largely determine the degree to which physical structure is impacted in the future (beyond ongoing adjustment to legacy impacts). The consequences of continued impacts to physical structure would include loss of channel topographic complexity that leads to degraded habitat quality for aquatic and riparian wildlife. Key ecosystem services that would be impacted include short or long-term surface water storage, subsurface water storage, energy dissipation, nutrient cycling, pollutant filtration and removal, retention of particulates, and maintenance of plant an animal communities (Table 4-1).

4.1.4 Biotic Structure

Likely Consequence of Risk Realization: The consequences of continued degradation of biotic structure would include degradation and loss of aquatic and riparian habitat, which would impact the distribution, diversity, and abundance of native aquatic and riparian wildlife. Key stream ecosystem services that would be impacted include short or long-term surface water storage, energy dissipation, nutrient cycling, pollutant filtration and removal, retention of particulates, export of organic carbon, and maintenance of plant an animal communities (Table 4-1).

4.2 Recommended Monitoring Actions

This section presents recommended monitoring actions, which include data collection to fill priority data gaps, changes to the monitoring design to improve the utility of the Framework for the District, and programmatic monitoring actions that promote integration of the District Framework with regional monitoring. Monitoring actions for District consideration are presented in terms of the potential roles the District can take as represented in the District Board Governance Policies, e.g., independent District actions for owned assets, cooperative stewardship with partners to achieve a desired LOS, and advocacy for action by others and/or technical support. Since no monitoring actions identified here fall under the District's third potential strategy for action through advocacy and/or technical information sharing, it is not included as a subheading in this Profile. The monitoring actions recommended for consideration in the Coyote Creek watershed are briefly summarized in Table 4-3 and are discussed in greater detail in the following sections.

4.2.1 Independent District Monitoring

The following preliminary monitoring recommendations are intended to assist the District by providing direction on future monitoring efforts as related to implementation of the Framework. Monitoring recommendations for the collection of Level 1, 2 and 3 data are described. It is important to note that these recommendations are preliminary and should be considered in the context of available resources and management priorities established by the District. Additionally, as enhanced and/or new information on ecological resources becomes available over time or management priorities are revised, these recommendations will likely need to be revisited and adjusted.

4.2.1.1 Level 1 Independent District Monitoring

District Primary Area of Interest

One finding from the risk assessment is that the District may want to consider including all areas of potential urban development, e.g., the Urban Growth Boundaries, in the Primary Area of Interest. As discussed in the Introduction, the Primary Area of Interest identifies the geographic scope of stream ecosystem monitoring for those parts of the County that are considered to be most important to monitor, apart from establishing overall stream ecosystem ambient condition.

Table 4-3. Monitoring Actions Recommended for District Consideration to better understand stream ecosystem conditions and reduce associated risk. Monitoring recommendations are identified as either generally applying to all watersheds (General) or Coyote-watershed specific (Coyote-specific).

Monitoring Actions Recommended for District Consideration	District Role		
	Primary Responsibility	Cooperative Stewardship	Advocacy; Technical Information
Include all areas of potential urban development in District Primary Areas of Interest for each watershed to define the geographic scope of ambient condition monitoring efforts. (General)	X		
Conduct ambient[23] and targeted CRAM surveys[24] for each watershed in the District's Primary Area of Interest in coordination with other District programs and projects. (General)	X		
Explore options to augment ambient Level 2 surveys designed for the District's Primary Area of Interest with nested surveys at a finer geographic resolution to improve the ability of the Framework to inform site-specific recommendations. (General)	X		
Explore the project-based application of CRAM as a cost-effective method to assess project sites before and after implementation. (General)	X		
Consider options for using CRAM as a tool to help evaluate the need for more intensive and costly Level 3 data. (General)	X		
Further examine relationships between native fish diversity and abundance, physical habitat, and selected water quality parameters to more robustly test the extent to which the spatial patterns in native fish diversity are driven by physical habitat versus water quality. (General)	X		
Address a high priority question identified through the EMAF Concept Pilot: "do current water supply operations (specifically imported water and associated groundwater operations) in Upper Penitencia Creek positively or negatively impact targeted species, steelhead and Pacific lamprey, and habitat conditions that are considered to be necessary and/or critical to support them?" by sampling the Upper Penitencia Creek fishery to estimate the size and structure of the steelhead population, identify the areas of habitat they use, their seasonal movement, and the size of the run/cohorts. (Coyote-specific)	X		
Consider long-term Level 3 data needs to support District programs and projects. (General)	X		
Explore opportunities to coordinate with partners to augment ambient Level 2 surveys designed for the District's Primary Area of Interest to include the remainder of the watershed areas. (General)		X	
Participate in regional monitoring networks that are designed to 1) detect trends in regional risk and 2) evaluate regulatory policies. (General)		X	
Participate in and/or track efforts to conduct CRAM surveys in the Halls Valley area that could not be included in the EMAF 2010 survey. (Coyote-specific)		X	

Most of the low scores that are related to anthropogenic influences occur in the lower watershed, particularly in the portion of the lower watershed that is most heavily urbanized. Some of the highest scores still exist in the transition zone between urbanized and non-urbanized areas. These areas are potentially at risk of being developed, due to their proximity to urbanized areas, and thus present potential risks to stream ecosystem conditions both in that area as well as downstream. The potential for development to occur is dependent upon municipal master plans and associated development policies and ordinances. The urban growth boundaries established by the Cities of San Jose, Milpitas, and Morgan Hill can be used to demarcate this zone of potential urban development and reflect the

[23] Ambient surveys can provide a baseline ecological LOS to: 1) evaluate trends in watershed health (stream ecosystem conditions); 2) evaluate mitigation site condition (pre-and post-implementation) relative to watershed health, and 3) prioritize mitigation site acquisition and/or mitigation implementation.

[24] Both ambient and targeted CRAM surveys can serve as cost-effective screening tools to help evaluate the need for more intensive and costly Level 3 data.

area of greatest potential risk to stream ecosystem resources. The areas with highest scores that occur in the lower watershed are also included in this delineation, and thus through this definition of the Primary Area of Interest, would also be monitored to provide information to continue to at least support such conditions.

4.2.1.2 Level 2 Independent District Monitoring

Primary Area of Interest Ambient CRAM Surveys

It is recommended that the District conduct surveys of ambient stream ecosystem condition within their Primary Area of Interest in coordination with District programs such as Asset Management and Stream Maintenance. This topic is addressed in the EMAF Implementation Plan (SCVWD 2011). Other District programs such as the Stream Maintenance and capital improvement projects (e.g., flood control projects such as the Mid Coyote) should also find ambient surveys of stream ecosystem conditions useful as a baseline to measure against. District programs and planning processes, such as the TC-HCP and the Valley HP, may also find it useful to design nested surveys at finer geographic resolutions to improve the ability of the Framework to inform site-specific management recommendations.

Targeted Reach-scale CRAM Surveys

While probabilistic watershed-wide ambient surveys are useful to inform strategic program level planning they do not lend themselves to detailed reach-level recommendations for capital improvement projects that comprise much of the District's management focus (see below). CRAM surveys may need to be designed to develop reach-specific scores in order to meet Stewardship interests of identifying priorities for investing in management actions to improve stream ecosystem conditions, and determining the cost of implementing those actions. Therefore, it is recommended that the District pilot reach-level CRAM assessments in the near future through the EMAP Implementation Plan.

In this pilot, the targeted Level 2 assessment of sites sampled to establish a baseline fisheries condition provided some finer resolution data that enabled more detailed discussion for projects on the Coyote Creek mainstem. However, a continuous survey of stream reaches for prioritized watershed areas could provide the spatial resolution of information that would best-serve project planning needs.

Prioritize Potential Mitigation Sites

Using CRAM to conduct targeted surveys at potential mitigation sites can be an effective strategy to evaluate their condition and understand the relative potential to improve stream ecosystem conditions at each site. Such information could be used to prioritize mitigation site acquisition and/or mitigation implementation. For example, evaluation of CRAM Attribute and Metric scores could indicate which sites have the greatest potential for improving their scores (e.g. site-specific Level 3 LOS), and such information could factor into a broader strategy of maintaining or improving a watershed-scale LOS.

Pre & Post Project-Implementation Monitoring

CRAM may also be used as a cost-effective method to assess sites before and after project implementation and measure the difference in stream ecosystem condition. Site monitoring can be continued over a period of time to measure the trajectory in stream ecosystem conditions and determine how a project is performing relative to its Level 3 LOS. Establishing a full suite of wetland functions for wetland mitigation projects often takes several years (Ambrose and Lee 2004), therefore, monitoring site condition over time is useful to not only determine performance relative to a LOS, but also to gather information about how long it may take to mitigate different sites and different types of wetlands.

Identify Level 3 Data Needs
CRAM can serve as a cost-effective screening tool to help evaluate the need for more intensive and costly Level 3 data. CRAM Attributes and Metrics can be analyzed to identify factors that may be impacting overall stream ecosystem conditions. Based on such analysis, hypotheses can be developed that can then be tested by targeted Level 3 data, which are appropriate to diagnose the causes of observed conditions.

4.2.1.3 Level 3 Independent District Monitoring

Follow up on Fisheries Habitat Physical Habitat Conceptual Model Testing
Several potential monitoring ideas (1-3) are presented here as follow-up to the special study conducted in conjunction with the ambient surveys for the EMAF pilot project.

1. Examine correlations of fisheries metrics to water quality parameters such as dissolved oxygen, temperature, average rainfall, stream flow to more robustly test the extent to which the spatial patterns in native fish diversity on the Coyote Creek and Upper Penitencia Creek mainstems are driven by physical habitat versus water quality factors. Such study would benefit from a greater sampling density for fish and water quality upstream of the Mid Coyote Flood Control Project area and on Upper Penitencia Creek.

2. Test the hypothesis that the Physical Structure CRAM Metrics of Topographic Complexity and Hydrologic Connectivity (entrenchment) have a positive influence on native fish diversity by stratifying future synoptic monitoring of CRAM and fisheries data by these Metrics. This should be done where the District has fisheries data available (e.g., Guadalupe) to determine if the CRAM Metrics are indeed indicative of what is influencing native fish or if it is an anomaly.

3. Using existing stream temperature data to the extent feasible, conduct an analysis to test the hypothesis that groundwater (level and temperature) may contribute to native fish diversity in entrenched reaches, e.g., are native fish surviving in highly entrenched reaches because cooler groundwater is available in these reaches, so although physical habitat is not optimal for their survival, groundwater provides enough deep water for native species to survive?

Follow up on Management Questions Identified through the EMAF Project

Through the EMAF Project Concept Pilot[25], a high priority Level 3 management question was identified, and conceptual models were developed (Appendix A) to address it. During the timeframe of scoping the second Field-based Pilot, however, District management decisions were made that precluded the need to address this management questions. The high priority question was: "*Do current water supply operations (specifically imported water and associated groundwater operations) in Upper Penitencia Creek positively or negatively impact targeted species, steelhead (Oncorhynchus mykiss) and Pacific lamprey (Entospheunus tridentata), and habitat conditions that are considered to be necessary and/or critical to support them?"* During the scoping phase for the second EMAF Pilot, the District was in the process of negotiating with the National Marine Fisheries Service (NMFS) and made a decision to stop importing water into Upper Penitencia Creek. This decision has since then been changed, thus making this management question a priority again. To address this question the following monitoring is suggested: sample the Upper Penitencia Creek fishery to estimate the size and structure of the steelhead population; identify the areas of habitat they use and their seasonal movement, including any impediments to passage as part of those studies; and identify the size of the run/cohorts in order to evaluate the potential impacts of imported water on this target species. While steelhead is a listed species, Pacific lamprey may also become a listed species in the future, so sampling for this species would also provide information that could help prepare for the anticipated listing.

Potential Long-Term Monitoring

District EMAP staff should meet to consider what Level 3 data may be useful to consider for incorporating into a long-term monitoring plan. To maximize cost-effectiveness, such monitoring should be considered in the context of information needs for District Stewardship and Asset Management Monitoring as well as monitoring needs of capital improvement projects. Several ideas are listed below in the form of questions for EMAP staff to consider.

- Are some species of fish so indicative of stewardship performance that they should figure into a long-term monitoring plan?

- How do monitoring recommendations that have been made from earlier Level 3 studies in the Upper Penitencia Creek and Coyote Creek watersheds (e.g., Jordan et al. 2009, Stillwater Sciences 2006, SCVURPPP 2003a, Biotic Resources Group 2001) fit into District information needs?

1) What are other specific aspects of condition, function or stress that the District might want to consider routinely measuring?
    A. Would more stream-flow gauges be helpful?
    B. What are information needs of TMDLs; are there mercury or sediment problems that need to be tracked?

[25] The EMAF Project was designed to have two pilot assessments. The first pilot assessment was a "concept" pilot that was conducted to ground-truth the development of the Framework using only existing data; no fieldwork was conducted. The second pilot was a larger scope, and involved fieldwork to ground-truth the framework.

4.2.2 Cooperative Stewardship Monitoring

Watershed Ambient CRAM surveys

Conducting ambient CRAM surveys for each watershed in the District's Area of Interest provides a baseline ecological condition that can be useful for 1) evaluating trends in watershed health (stream ecosystem conditions), and 2) evaluating mitigation site condition relative to watershed health. The District may want to explore the idea of coordinating with partners that have vested interest in understanding watershed-scale stream ecosystem conditions to augment Level 2 surveys for the Primary Area of Interest to include the remainder of the watershed. Entities that may have an interest in such partnership include the Santa Clara County Open Space Authority, the Santa Clara County Urban Runoff Pollution Prevention Program, The Nature Conservancy, the University of California Cooperative Extension, State and County Parks, the County, and other municipalities.

Halls Valley CRAM Survey

Due to the fact that field crews were not granted access to a large section of the Coyote Creek watershed in time for the 2010 second pilot field season, it could be useful to plan to sample this section of the watershed in 2011 in the same timeframe as sampled in 2010, e.g., August/September. This would provide an understanding of relative condition and stressors in this part of the watershed, although the one-year offset in data collection would mean that these data could not be included in the calculation of the 2010 Coyote Creek LOS (e.g., the ESI statistic).

Regional Monitoring Networks

Through partnerships, the District could participate in regional monitoring networks that are designed to detect trends in regional risk and can function as early warning systems that identify the extent and magnitude of stressors that may affect Santa Clara County stream ecosystem conditions. Such information would provide data to inform District management decisions, for example:

- detect trends in water level changes to assess climate change and its potential impacts;

- detect early small invasions to prevent large invasions of invasive non-native species from taking hold. Note: the District participates in this kind of monitoring for plant species through the Santa Clara County Weed Management Area, which is partner to the Bay Area Early Detection Network (BAEDN), but no similar network exists for fauna; and

- assess the risk of urban runoff to stream ecosystem resources through continued participation and coordination with in the Santa Clara Valley Urban Runoff Pollution Prevention Program's (SCVURPPP) receiving water monitoring and assessment program.

Participation in regional monitoring networks may also be useful to evaluate regulatory policies. For example, as discussed in Chapter 3, the relative effect of hydromodification controls implemented via the MRP is currently unknown. Thus establishing a network of reference sites to monitor streambed and bank responses to changes in hydromodification control implementation could be useful to evaluate the efficacy of this policy. Sites located downstream of relatively large planned developments (e.g., such as the North Coyote Valley) would likely have a greater likelihood of detecting effects of hydromodification controls due to the size of their footprint relative to the watershed area.

4.3 Recommended Management Actions

Ambient surveys of stream ecosystem conditions at a watershed scale, such as those conducted to develop this Profile also provide an opportunity to identify management actions suitable for the District to consider. Similar to how potential monitoring actions were presented in section 4.2, potential management actions are presented in this section in terms of the fundamental implementation strategies, as represented in the District Board Governance Policies, e.g., independent District actions for owned assets, cooperative stewardship with partners to achieve a desired LOS, and advocacy for action by others and/or technical support. Use of this organization is intended to facilitate the process of adopting any of these management actions into the District Governance Policies as stewardship strategies and implementing measures, should the District so choose to do this. The management actions recommended for consideration in the Coyote Creek watershed are summarized in Table 4-4 and are discussed in greater detail in the following sections.

4.3.1 Independent District Management Actions

This section focuses on how information from the condition and risk assessments presented in this Profile can be used to inform the ecological objectives for District programs and projects from a planning level perspective. Management actions recommended for District consideration are presented in order, with those pertaining to higher level planning first, followed by project and/or area-specific last.

Consider Adopting Watershed-Scale LOS:

Implement an outreach strategy with District managers and the Board to advance the concept of adopting Stewardship Levels of Service for watersheds and subwatersheds where appropriate. The ESIs calculated from ambient surveys of stream ecosystem conditions in the Coyote Creek watershed and the Upper Penitencia Creek subwatershed could serve as pilots for LOS adoption.

Design large scale capital improvement projects to improve stream ecosystem conditions while addressing flood control and/or water supply objectives:

In Chapter 3, risks to stream ecosystem conditions within District control that were discussed included operation and maintenance of impoundments, artificial recharge facilities, and channel modifications. The Level 1 data analyzed in this Profile indicate that the Coyote Creek watershed has lost a considerable amount of riparian areas and riverine wetlands. The Level 2 and 3 data analyzed in this

Profile indicate that stream ecosystem conditions in the middle reaches of the Coyote Creek mainstem are relatively poor and potentially could be improved through actions that would:

1) Increase gradient and improve flow velocity in order to remove aggraded sediment and organic matter that impact physical habitat and water quality;

2) Lay back incised channels to re-establish active floodplains and promote improved physical and biotic structure.

Table 4-4. Management Actions Recommended for District Consideration in the Coyote Creek watershed to better understand stream ecosystem conditions and reduce associated risk.

Management Actions Recommended for District Consideration in the Coyote Creek watershed	District Role		
	Primary Responsibility	Cooperative Stewardship	Advocacy; Technical Information
Adopt Stewardship Levels of Service for watersheds and subwatersheds where appropriate.	X		
Alter management of impoundments (e.g., recharge facilities) to support multi-objectives including support of stream ecosystem conditions. For instance, as feasible, incorporate actions that encourage flushing of aggraded sediment through the Coyote Creek mainstem by implementing alternative management of recharge facilities. Such measures would improve habitat for anadromous fish and increase CRAM attribute scores.	X		
Design[26] the Mid-Coyote Flood Control Project to meet flood control objectives and objectives to enhance stream ecosystem conditions by increasing gradient and floodplain connectivity.	X		
Design[3] the Upper Penitencia Creek Flood Control Project to meet flood control objectives and objectives to enhance stream ecosystem conditions, particularly physical structure, by reducing bank slopes to establish new floodplains and allow for channel lateral migration as feasible.	X		
Consider in the design for the Lower silver Creek Flood Control Project opportunities to address the issue of high turbidity, coordinate with AMP continuous creek surveys to identify areas contributing fine sediment, and conduct CRAM surveys to establish pre-and post project conditions.	X		
Design the Lake Cunningham flood control project to restore some of the riparian and wetland resources as part of the detention basin plan. Consult Grossinger et al. (2006) to assist with the restoration design.	X		
Continue to participate in the Santa Clara Valley Habitat Conservation Plan that provides a mechanism for the District to partner with others in watershed stewardship and as a forum for advocating for stream stewardship.		X	X
Through collaborations, review and prioritize reach-scale management actions recommended by previous Level 3 watershed studies such as Biotic Resources Group (2001), SCVURPPP (2003a) and Stillwater Sciences (2006), and consider strategies to implement high priority actions.		X	
Remain engaged in forums where land use policies are discussed to advocate for: 1) retention of current urban growth boundaries; 2) implementation of riparian and wetland protection policies; 3) urban development plans and land management actions that provide opportunities to enhance wetland and riparian areas and achieve flood control and water supply objectives; and 4) development and implementation of measures by private landowners who are actively grazing and mowing in the upper watershed to implement ranchland best management practices.			X
Share information from CRAM surveys about observed stressors and sites that could be improved or protected with agencies working in those areas.			X

[26] Consult the SCVURPPP (2003a) report for reach-specific planning level recommendations and Grossinger et al. (2006) historical ecology palette to assist with the project design.

The District is already engaged in planning several large scale projects that are intended to improve stream ecosystem conditions while addressing flood control and/or water supply objectives (SCVWD 2009a, 2010c). As discussed in section 4.2.1.2, the District may choose to implement future CRAM surveys within specified areas in their Primary Area of Interest. This topic will be addressed in the EMAF Implementation Plan. Such information could be used in combination with Level 3 data to guide project planning and design. Other Level 3 studies, such as SCVURPPP (2003a) and Jordan et al. (2010) also provide reach-scale analyses that inform potential management actions, and examples are referenced below for consideration.

Three Creeks Habitat Conservation Plan (SCVWD 2009):

The District is developing a habitat conservation plan called the Three Creeks Habitat Conservation Plan (TC-HCP) for the water supply activities of the Coyote, Guadalupe and Stevens Creek watersheds for a 50-year permit term. Water supply activities include the on-going operation of the reservoirs, maintenance and repair of those reservoirs including seismic safety retrofits; on-going operation, maintenance and repair of the recharge system including recharge ponds, diversions, and augmentation as well as on-going operation, maintenance and repair of the stream gauge network.

The spatial extent of the TC-HCP includes the Coyote watershed from just upstream of Coyote Reservoir to the last stream gage near the Bay. The Draft TC-HCP describes a series of measures to manage the District's water supply facilities in Coyote Creek differently in order to address habitat needs (flow regimes and temperatures) for native coldwater fish species. In addition, a series of conservation measures are proposed to mitigate for all of the District's water supply impacts and provide substantial conservation to justify the issuance of a 50-year permit.

The TC-HCP focuses on improving the habitat for anadromous fisheries which includes actions that could improve CRAM attributes by:

1. Improving Andromous Fish Passage: two major types of passage problems have been identified; instream facilities that fish cannot jump over easily and may lengthen their migration, and in-stream ponds that provide warm water habitat and harbor predators that reduce the likelihood of successful anadromous migration and emigration. Since improvements to passage impediments will be implemented with the best practicable methods, habitat values at these project sites should improve. Over the 50-year permit term, all the priority 1 barriers identified in the FAHCE Settlement Agreement (Anonymous 2003) will be improved and over two miles of on-stream ponds will be separated from the Coyote mainstem.

2. Augmenting Gravels: reservoirs hold back the transport of sediment. Gravel augmentation will be carried out to improve spawning gravels.

3. Managing Flow: manage reservoir releases from Anderson Reservoir to create a more naturalistic flow regime on the mainstem of Coyote Creek; manage recharge releases on Upper Penitencia Creek to create a more naturalistic flow regime during the winter.

Additional actions that could further benefit stream ecosystem conditions and may be incorporated into the TC-HCP as described above include:

1) Action: manage releases from Anderson Dam to allow for flushing flows that periodically flush aggraded sediment through the stream network system.

   Associated Considerations: flows capable of this effect may cause downstream flooding and the current outlet size limits the amount that can be released; however, if this potential action was evaluated in coordination with the flood control projects planned downstream to protect the 1% floodplains (e.g., Mid-Coyote, Silver Creek, Cunningham Lake), it might be feasible to release flows designed to achieve this end.

2) Action: restore free-flowing hydrologic regime on the Coyote Creek mainstem by implementing alternative management of recharge facilities. Options could include:

   A. moving Metcalf recharge ponds off-stream;
   B. operating Metcalf dam seasonally as bladder dam;
   C. re-engineering the Ford Road Percolation Ponds to establish greater macro- and micro-topographic complexity.
   D. Using the Coyote Canal to convey water to the recharge facilities.

   Associated Considerations: Such actions likely involve tradeoffs for groundwater recharge capacity.

Mid-Coyote Flood Control Project (SCVWD 2010c):

The spatial extent of the Mid-Coyote Flood Control Project (MCFCP) (Montague upstream to I-280) entirely overlaps with the middle reaches of the Coyote Creek mainstem where stream ecosystem conditions are the lowest. Therefore, this project presents great potential to improve stream ecosystem conditions in this section of the Creek. Due to the large spatial extent of this project, and the relatively poor existing stream ecosystem conditions within, it is noteworthy to point out that implementation of a flood control design that incorporates restoration of stream ecosystem conditions could result in a measurable increase in the Watershed Ecological LOS. This potential outcome depends on the extent to which the MCFCP can be designed to increase the reach gradient and floodplain connectivity to enhance stream ecosystem conditions while still meeting flood control objectives. Outstanding questions that need to be addressed in order to evaluate this potential include the following.

1) How could the minimal vertical relief (~15 feet) between the top and bottom of the 6.1 mile MCFCP project reach be modified to enhance flow and sediment transport and floodplain connectivity?

2) To what extent could streambed grading be achieved without greatly harming the existing conditions, particularly in the other mainstem reaches, and how much degradation would be acceptable possibly in some parts of the mainstem either in the short- and/or the long-term in order to improve stream ecosystem functions?

Upper Penitencia Creek Flood Control Project (SCVWD 2010c):
The spatial extent of the Upper Penitencia Creek Flood Control Project (Coyote Creek confluence upstream to Noble Avenue) entirely overlaps with the urbanized extent of the Upper Penitencia Creek mainstem where stream ecosystem conditions, particularly the Buffer and Landscape Context, Hydrology, and Physical Structure Attributes were low. Therefore this project also presents potential to improve stream ecosystem conditions. CRAM survey results indicated low Hydrology Attribute scores, in large part due to the presence of modified water sources. As previously discussed, however, Jordan et al. (2010) concluded that changes to the hydrologic regime have not caused the locally observed channel instability because the combination of historic drainage-area reduction and flow augmentation for groundwater recharge effectively offset the effects of urban land use change on flow regime. While this aspect of the low CRAM score does not appear to be causing channel instability nor impacting physical structure, the imported qualities of the water likely influence the qualities of the water native to the watershed, however, this potential effect has not been measured. As cessation of this diversion operation is being considered by District management as part of the TC-HCP, it may cease to be a factor influencing stream ecosystem conditions. The Hydrologic Connectivity (entrenchment) Metric, however, scored very low, particularly upstream of I-680, corresponding to the conclusions of Jordan et al. (2010), that Upper Penitencia Creek is a relatively stable stream system with areas of localized channel instability (erosion or deposition) upstream of the I-680 crossing caused by historic subsidence and channel re-alignment. The reach-scale integrated assessment of stream ecosystem functions conducted by SCVURPPP (2003a) provides planning-level recommendations for how the Upper Penitencia Creek Flood Control Project could improve stream ecosystem conditions in this area and along the entire Upper Penitencia Creek mainstem. Selected examples from SCVURPPP (2003a) that pertain to improving channel physical structure that could be addressed through the Upper Penitencia Creek Flood Control Project include:

SCVURPPP Reach 1: Coyote Creek confluence to North King Road

1) Action: widen channel and reduce bank slope to the extent possible, to create floodprone areas, increase lateral migration of channel, and create low flow channel.

   Associated Considerations: restoration may require purchase or easements of land along the Flea Market; coordinate with existing projects identified in the Coyote Watershed Stream Stewardship Plan (CCWSSP) (SCVWD 2002). Protecting and enhancing riparian vegetation could also stabilize banks, as well as increase canopy cover and decrease water temperatures. Enhancing channel features by adding large woody debris and other structures could increase micro- and macro-topographic complexity, enhancing habitat for aquatic fauna.

SCVURPPP Reaches 2 through 4: (Reach 2: North King Road to Mabury Road; Reach 3: Mabury to Capital Avenue; Reach 4: Capital to Noble Avenue)

2) Action: restore the stream channel using a geomorphic design that includes removing the earthen levee to widen channel and allow the Creek to migrate laterally and access the floodplain by reducing bank slopes, or allowing them to gradually relax (i.e., become less steep) to establish new floodplains. Such measures would increase channel capacity and maintain the hydrological and sediment transport processes. Floodplain restoration would allow channel migration, development of gravel bars, and formation of a low flow channel. Large woody debris and other structures can be installed in the channel[27] to create scour pools and trap sediment. Riparian vegetation could be planted in some areas to increase bank stability and stream shading. Such actions could improve habitat for aquatic species and other wildlife.

   Associated Considerations:

   A) Reach 2: Floodplain restoration potential is greater in Reach 2 than in Reach 1 due to the increased availability of open space in the riparian corridor and less channel incision; floodplain restoration potential is greatest between King Road and Mabury Road crossings and below the Mabury Diversion Dam.
   B) Reach 3: Floodplain restoration potential is greatest between Penitencia Creek Park and I-680 due to the presence of adjacent open space. Floodplain restoration could provide similar associated benefits as stated above.
   C) Reach 4: Restoration potential in this reach may be greater than in downstream reaches due to the following reasons. CRAM Structural Patch Richness Metric was lowest in this Reach. Urban land uses and flooding potential impose fewer constraints in this Reach than in downstream reaches. The area downstream of the Penitencia Road crossing is the most incised and open space is available to augment floodprone area. Where road proximity constrains channel migration, the existing channel could be widened. Managing stream flows and enhancing riparian vegetation could also positively influence habitat for aquatic species and other wildlife.

Lower Silver Creek (SCVWD 2010c):

Since the Coyote Creek watershed ambient CRAM survey only included one site in the Lower Silver Creek drainage, little information is available to discuss reach-specific conditions in the area where the Lower Silver Creek Flood Control Project is located. SCVURPPP (2003a) recommended several management actions for this drainage that included identifying sources of high turbidity and nutrients that were measured in Lower Silver Creek and implementing associated control measures. Depending on the source locations of fine sediments, the Lower Silver Creek Flood Control Project design may partly address the issue of high turbidity, though to date, the project has reported no evidence of scour or erosion in the project area (Table 2-6). It may also be useful to coordinate with AMP continuous

[27] The District has been implementing some bioengineered drop structure on the Upper Penitencia Creek mainstem (Melissa Moore, SCVWD fisheries biologist, personal communication, 2010).

creek surveys to identify areas contributing fine sediment and follow up with a CRAM survey to establish pre and post-project condition.

Lake Cunningham (SCVWD 2010c):
The Lake Cunningham Project plans to construct improvements so that Lake Cunningham functions as a detention basin. As discussed in Chapter 2, urbanization has increased the Coyote Creek Valley drainage almost ten-fold from historic conditions, and has greatly decreased the acreage of wetlands and riparian areas. Similar to previous discussion of the Laguna Seca area, this project provides a stewardship opportunity to restore some of the riparian and wetland resources (originally associated with Laguna Socayre, an array of freshwater wetlands (Grossinger et al. 2006)) that have been lost from the Coyote Creek valley while addressing flood control and water supply objectives. The historical ecology palette developed by Grossinger et al. (2006) provides information that can be helpful in the design of this project.

4.3.2 Cooperative Stewardship Management Actions

Cooperative Stewardship can take many forms that involve a broad range of effort. As discussed, multiple stressors associated with urbanization influence stream ecosystem conditions but many are beyond District control. Despite this, the District can potentially decrease the likelihood that stressors beyond their direct control negatively influence stream ecosystem conditions in the Coyote Creek watershed by remaining engaged in decision-making processes to ensure that the following management actions are realized.

The Santa Clara Valley Habitat Conservation Plan
The District has partnered with five local agencies to develop the Valley HP (ICF International 2010). This plan provides comprehensive conservation to protect 24 species under the Federal Endangered Species Act and the California Natural Communities Conservation Planning Act. Over the 50-year permit term, it will amass approximately 48,000 acres of reserves for wildlife protection. In addition to the reserve system, the conservation program includes extensive best management practices that all local partner agencies are agreeing to follow as well as conditions that must be followed for development. This partnership will provide a mechanism for the District to engage in watershed stewardship as well as a forum for advocating for stream stewardship.

Review reach-scale management actions recommended by previous Level 3 watershed studies
Several studies in Upper Penitencia Creek and Coyote Creek (Biotic Resources Group 2001, SCVURPPP 2003a, Stillwater Sciences 2006, SCVURPPP 2009) have reported reach-specific management recommendations to improve stream ecosystem functions that are appropriate for cooperative stewardship.

4.3.3 District Advocacy Role

Many of the risks to stream ecosystem resources may be addressed through District advocacy. Thus it is recommended that the District remain engaged in forums where land use policies are discussed, including the planning process for the Valley HP, SCVURPPPP, and the Santa Clara Basin Watershed Management Initiative (WMI) in order to advocate the following.

1) Urban Growth Boundaries are maintained and not exceeded.

Urban Growth Boundaries are an important tool to protect stream ecosystems conditions from further degradation due to stressors associated with urbanization. The Valley HP recognizes the significance of Urban Service Areas and used them as an important boundary condition in developing the plan. The Valley HP assumes full build-out of the general plans of San Jose, Gilroy and Morgan Hill and the preservation of the existing Urban Service Areas and Urban Growth Boundaries at the time of permit issuance. The Valley HP might have to be amended if the Urban Growth Boundaries were to change during the 50-year permit term and result in additional ecological impacts.

2) Large developments are designed and constructed to protect and enhance wetland and riparian resources.

The District should support growth plans that provide stewardship opportunities to enhance wetland and riparian areas and achieve flood control and water supply objectives. The Valley HP is an important vehicle for the District to promote the stewardship of all the Local Partner Agencies. The Laguna Seca area in the north end of the Coyote Valley provides the greatest potential acreage (~1,000 acres) and unique multi-objective wetland restoration potential, e.g., re-establish natural hydrogeomorphic process, increase floodwater attenuation and storage, and support a range of native species (Grossinger et al. 2006). In the Valley HP, Laguna Seca is identified as a conservation zone for protection. Upland areas adjacent to Laguna Seca may be purchased as part of a reserve system to provide habitat for the red-legged frog and the California Tiger Salamander. As discussed in Chapter 3, competing plans exist to develop this area.

3) Riparian areas are protected to the maximum extent possible in municipal ordinances and policies.

As discussed previously, the Valley HP currently includes requirements for riparian setbacks. Such provisions should be carried through to the final plan. The setbacks would apply to new development or redevelopment. During the course of the 50-year permit term, a significant length of stream would be subject to these setbacks. The setback requirements are described in Condition 11 of Chapter 6 of the public review draft (ICF International 2010). Setbacks for fish bearing streams (Category 1 streams), are greater than for non-fish bearing streams (Category 2 streams). Inside of the urban service areas, setbacks of 100 feet are required for fish-bearing streams. Outside of the urban service areas, setbacks of 150 feet are required for fish-bearing streams. In areas where the slope is greater than 30%, an additional 50 feet is added to the setback requirement. The setback requirements for non-fish bearing streams is 35 feet.

In addition to the setback requirements, the Valley HP protects riparian areas by charging a substantial fee for encroachment into riparian areas that will help support the stream restoration and preservation efforts of the plan. The Valley HP will fully mitigate for encroachment into riparian areas inside the study area. (For details about riparian protection see Table 5-13 in the Valley HP).

4) **Land management agencies acquire lands or conservation easements in wetland and riparian areas in less developed areas of urban growth boundaries where development may soon occur and where land may be cheaper.**

The District should remain deeply engaged in advocating for strong policy implementation and adoption of riparian ordinances with suitable setbacks to ensure that riparian areas are at least maintained or improved. This will help maintain and/or improve ecological LOS. The Framework should be implemented as part of these discussions. Per the Framework, those involved should: (1) decide what riparian functions matter, (2) determine the width needed to provide those functions, (3) equate the set-back distance to the required functional riparian width. The Bay Area Aquatic Riparian Inventory Riparian Mapping Tool (see Appendix A) enables planners to determine what riparian widths (and functions) are possible given existing conditions (vegetation height and side slope steepness, mostly), and to identify what land use change may be needed (e.g., how much streamside land needs to be converted from one land cover type to another) to achieve new or additional riparian functions.

5) **A comprehensive strategy is implemented to conduct outreach to private landowners who are actively grazing and/or mowing their lands in the upper watershed areas and evaluate and encourage the use of best management practices that apply to ranchlands.**

Such a strategy may either be implemented by a single agency, or a workgroup comprised of representatives from different agencies. In other parts of the Bay Area Resource Conservation Districts[28] (RCDs) fulfill this role. For example, in Alameda County, the RCD conducts outreach to local landowners to inform them of USDA-NRCS programs such as the Environmental Quality Incentives Program (EQIP) the Wildlife Habitat Incentives Program (WHIP), the Grassland Reserve Program (GRP), and the Ranch Water Quality Planning Program (FWQPP). Each of these programs helps protect and support ecological conditions in upland and/or riparian areas and most include incentives such as permit streamlining and financial and technical assistance. RCDs often conduct workshops to explain such programs and support landowners in the development of plans to implement best management practices on their properties. The funding plan for the Valley Plan includes a staff member whose job is public outreach. Although the specifics of this job have yet to be defined, it is expected that this person

[28] RCDs are local entities that are funded by the United States Department of Agriculture's Natural Resource Conservation Service (NRCS). The purpose of the RC&D program is to accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in designated RC&D areas.

would work with local landowners to educate them about land management practices that are protective of the covered species, the Conditions of the Valley Plan, and its Best Management Practices. An important management strategy for serpentine soils that are prevalent in the Coyote watershed, is to implement controlled grazing that manages invasive plant species. Outreach will be conducted with landowners that graze their livestock in the Serpentine soil zone as a way to protect the habitat of the Bay Checkerspot Butterfly.

6) **Information from CRAM surveys about observed stressors, low-scoring sites that could be improved, and high-scoring sites that should be protected, is shared with agencies working in those areas.**

The results of the Risk Assessment conducted to develop this Profile identified high-scoring sites that should be protected in order to at least maintain their conditions and low-scoring sites that could be rehabilitated to improve their site conditions. The majority of the high-scoring sites (for all CRAM Attributes) are located in the upper watershed. Several of the sites that scored high for the Physical Structure and Biotic Structure Attributes, however, were located on the urbanized valley floor in City and County Parks. Information about all of these sites should be addressed through cooperative stewardship in the form of sharing information with agencies that have jurisdiction in these areas. The majority of low-scoring sites in the upper watershed that were associated with human-related stressors could be addressed through the mechanism discussed in #6 above.

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Table 2-6. Level 3 Ecological Levels of Service (LOS) and associated performance status for District mitigation projects in the Coyote Creek watershed. LOS performance status evaluated by District staff.

MMAD Project Id	Project Name	MMAD Project Goal Description	MMAD Project Objective Description	**Required Ecological Monitoring with LOS**	**Discretionary Ecological Monitoring with LOS**	**LOS Performance Status**
40262033	Lower Silver Creek Mitigation & Monitoring	To monitor and maintain all re-vegetation sites as required in the Project permitting to fulfill mitigation requirements.	Determine if re-vegetation is successful.	70% survival by year 5 (2008/09); by year 10 absolute woody (tree & shrub) canopy cover must show a steady trend toward 70% or more and no less than 50% at any one re-vegetation site; 6 acres of upland vegetation reaches 1a, 1d, 3a, 3e, 3f, and 6b and 5 acres of SRA/riparian.	None	Exceeded the year 5 survival LOS; acreage LOS met.
40262033		To monitor all geomorphic aspects required in the Project permitting to fulfill mitigation requirements.	Determine if geomorphic aspects of project function as planned.	None	None	No erosion or scour issues detected.
40262033		To monitor wetlands to mitigate for construction impacts.	Monitor wetlands.	Create 12.7 acres of jurisdictional wetlands and open water habitat (4.7 acres specifically needs to be wetland)	None	Trending toward meeting LOS by year 5 (2008/09). A formal delineation will be done in year to verify.
62181005	Coyote Parkway Wetlands Mitigation & Monitoring	Create 7 acres of seasonal and near-perennial wetland to fulfill SMP mitigation requirements.	To monitor and maintain 7 ac constructed wetland basin as required to fulfill SMP mitigation requirements.	By Year 5: 35% of vegetation FACW-OBL in seasonal area; > 50% FACW-OBL in near-perennial area; jurisdictional wetland criteria met by Year 5.	After Year 5: Qualitative vegetation and hydrology monitoring per the project Long Term Management Plan; LOS consistent with Year 5 LOS.	Year 5 Wetlands success criterion met in year 3 (2009)

62181005		Revegetate 1080 sq. feet of willow riparian forest to mitigate wetland project impacts.	To monitor and maintain willow forest revegetation to mitigate for wetland construction impacts.	80% cover by year 5.	After Year 5: Qualitative monitoring; LOS consistent with Year 5 LOS.	Year 5 willow forest success criteria is in progress and on track to meet 5 year criterion
62042032	Island Ponds	Inundation regime	Monitor tidal cycles to ensure full tidal exchange is occuring within the island ponds	Ensure full tidal exchange, if not achieved, modify breaches per adaptive management of the site	None	Full tidal exchange has been achieved without modifications.
62042032		Substrate development	Monitor sedimentation rates to track progress prior to vegetation growth	None	None	A portion of the sites are meeting the sediment rate targets.
62042032		Levee breach and outboard marsh geometry	Monitor breach width and outboard scour	None	None	Breaches eroding without concern.
62042032		Channel network evolution	Monitor channel progression and development	None	None	Channel development occurring.
62042032		Vegetation mapping	Monitor the establishment of vegetation at the ponds beginning when 30-acres of vegetation established.	Need 75 acres of vegetation at 75% cover	None	Trending toward 30-acre trigger to initiate vegetation monitoring.
T		Spartina monitoring and control	Monitor for invasive spartina and perform control if identified	Manage site to achieve zero acres of establishment of invasive spartina	None	Target being met on annual basis.
62042032		Wildlife Use -CLRA	Monitor for CA clapper rail	Detect 1 Clapper Rail by year 15	None	Monitoring triggered upon establishment of

						30-acres of vegetation.
62042032		Wildlife Use -SMHM	Monitor for salt marsh harvest mouse	None	Detection of SMHM at site	*NA; no required LOS*
62042032		Wildlife Use -shorebirds	Monitor shorebird useage at ponds	None	None	Target met
62042032		Rail bridge scour	monitor bridge piers for signs of scour	None	None	No deficiencies detected
62042032		Fringe Marsh Scour	monitor both banks of coyote creek near and around the ponds for signs of scour	None	None	No deficiencies detected
62042032		Scour of levees opposite the breach	monitor the levees opposite the breaches for signs of scour	None	None	No deficiencies detected
62042032		Rail line erosion	monitor the rail line for signs of erosion	None	None	No deficiencies detected
62042032		Deterioration of the Town of Drawbridge	monitor the for scour at the town of drawbridge	None	None	No deficiencies detected
40212032	Coyote Creek Mitigation & Monitoring	Establish and document a general trend towards reaching self-sustaining riparian habitat in Reach 3 (Monitoring done by Corps of Engineers)	Monitor cover of Riparian Forest Revegetation sites (Corps responsible for riparian habitat monitoring).	Complete Cover by year 10 and 15 and at 10 year intervals thereafter	None	LOS met in year 10

40212032		Establish and document trends in wildlife populations (amphibians, reptiles, small mammals and birds) in Reach 3 in comparison to an adjacent reference condition.	Monitor use of the revegetation site by amphibians, reptiles, small mammals and birds.	Presence of amphibians, reptiles, small mammals and birds	None	LOS met in year 10
40212032		Evaluate the success of the pickleweed marsh creation in optimizing salt marsh harvest mouse habitat and providing suitable escape areas and cover during flood events	Monitor the extent, distribution and quality of the habitat for the salt marsh harvest mouse.	Plant cover greater than 85 percent; Pickleweed height greater than 1 foot; Pickleweed greater than 60 percent relative cover; No greater than 10 percent reduction of plant cover in any 1 year.	None	LOS not met as of 2010. Under agency negotiation.
40212032		Evaluate the success of the pickleweed marsh creation in optimizing salt marsh harvest mouse habitat and providing suitable escape areas and cover during flood events	Visual observation and photo documentation of the planted marsh and levee slopes to determine the success of the revegetatation.	85% cover on levee slopes	None	LOS achieved.
40212032		Evaluate the success of the pickleweed marsh creation in optimizing salt marsh harvest mouse habitat and providing suitable escape areas and cover during flood events	Monitor soil conditions (texture, pH, electrical conductivity, sodium, calcium, magnesium and chloride) to indicate conditions that might influence pickleweed establishment and growth.	Salinity 30-60 ppt; pH 6.5 - 8.0	None	LOS achieved.

40212032		Evaluate the success of the mitigation site in protecting the salt marsh harvest mouse population in the SMHM management area	Monitor the occurrence of salt marsh harvest mouse through biannual trapping	One salt marsh harvest mouse per 200 trap nights.	None	LOS achieved.
40212032		Evaluate the feeding habitat provided by the waterbird pond and the use of the pond by waterfowl and shorebirds (Discretionary)	Monitor waterbird pond and salinity level to determine when adjustments to water control structures should be made to provide suitable conditions for shorebird and waterfowl feeding in the point and to avoid flooding of shorebird nesting on the island (Discretionary).	Maintain 0.5 to 1.5 feet of water.	None	LOS achieved.
40212032		Evaluate the feeding habitat provided by the waterbird pond and the use of the pond by waterfowl and shorebirds (Discretionary)	Monitor the use of the waterbird pond by waterfowl and shorebirds through weekly surveys	Presence of waterfowl and shorebirds	None	LOS achieved.
40212032		Evaluate fish habitat in the vicinity of Standish Dam	Evaluate effectiveness of enhanced gravels by monitoring amount of spawning habitat lost and replace at a 2:1 ratio	Less than 15% embeddedness of placed gravel.	None	*NA; fisheries monitoring suspended pending agency negotiations*

40212032		Evaluate impacts of tidal encroachment on riparian vegetation in the Standish Dam area	Monitor cover of riparian vegetation at the downstream end of the pilot revegtation once per year to evaluate vegetation damage from salinity encroachment.	80 % cover	None	LOS achieved.
40212032		Complete mitigation for Coyote Creek Reach 2.	Revegetate 32 acres with riparian plants on 6 sites, 2 in Reach 2	Revegetate 32 acres of riparian habitat	None	LOS achieved.
40212032		Establish and document a general trend towards reaching self-sustaing riparian habitat in Reach 2	Monitor riparian cover at revegetation sites	80% Cover	None	LOS achieved.
40212032		Establish and document a general trend towards reaching self-sustaing riparian habitat in Reach 2	Monitor riparian cover at revegetation sites	Presence of amphibians, reptiles, small mammals and birds	None	LOS achieved.

Glossary of Terms

Aggradation: the increase in land elevation due to the deposition of sediment. Aggradation occurs in areas in which the supply of sediment is greater than the amount of material that the system is able to transport.

Allochthonous: The organic matter synthesized within the drainage basin and brought to the lakes or streams in various forms.

Asset: any intangible resource (intellectual property, goodwill), financial resource (cash, stocks, debt instruments), natural physical resource (land, air, water, wildlife species, or habitat), or unnatural physical resource (building, equipment, or infrastructure) that has economic or social value to the District exceeding $1,000 over a period longer than one year.

Base Map: in the EMAF context, a base map consists of the spatial data in a geographic information system (GIS) that are commonly needed to address all or most of the management questions.

Cumulative Distribution Function (CDF): the CDF estimates the proportion of stream miles with CRAM scores less than or equal to a given score. For example, Figures 2-5 and 2-6 show that in both watersheds, about 10% of stream miles had CRAM scores of 60 or lower. The CDF is plotted on a Cumulative Frequency Diagram (CFD) graph, which can cause some confusion, since the acronyms are so similar.

Cumulative Frequency Diagram (CFD): the CFD represents a graph of the running total of all CRAM scores from a given survey of ambient stream ecosystem conditions.

CRAM: The California Rapid Assessment Method is a cost-effective and scientifically defensible Level 2 method for monitoring the conditions of wetlands throughout California. See www.cramwetlands.org for more information.

Degradation: the lowering of a fluvial surface, such as a stream bed or floodplain, through erosional processes. It is the opposite of aggradation.

Depressional Wetlands: wetlands that exist in topographic lows that may or may not have outgoing surface drainage. Precipitation and overland flow are their main sources of water. They differ from springs and seeps that depend mainly on groundwater. They differ from lacustrine wetlands by having a perennial body of water at less than 6 feet deep and smaller than 20 acres in area during the dry season. Depressional wetlands can have prominent areas of shallow open water and can be densely vegetated.

Distributary: A stream that branches off and flows away from a main stream channel and never rejoins it. The opposite of a distributary is a tributary (a stream that flows into a main stem river and does not flow directly into a sea, ocean, or lake).

Drainage network: a system of hydrologically interconnected channels, seeps, wetlands, lakes, and other aquatic areas that account for the storage and conveyance of surface runoff, interflow, return flow, and groundwater in a watershed.

Ecosystem Services Index: a watershed-based, landscape-level statistic that can be used to describe the overall condition of aquatic resources assessed using the California Rapid Assessment Method (see definition above). The methods by which an ESI statistic is calculated from an ambient survey cumulative distribution function (see definition above) are described in Appendix A.

Entrenchment: a measure of the vertical confinement (bank height) of the stream caused by degradation (see definition above). Synonymous with incision (see definition below). The entrenchment ratio is determined by dividing the width of the flood prone area by the bankfull width. The flood prone area is defined by measuring the width of the channel at twice bankfull depth. Entrenchment determines whether the flat area next to the stream is a frequent floodplain, an ancient floodplain, or outside of the flood zone.

Incision: a process by which a stream or river erodes through (degrades – see definition of degradation above) its channel and the bed of the valley floor. When long- term erosion exceeds sedimentation, channel incision occurs.

Lacustrine Wetlands: wetlands that exceed 20 acres in total area with a minimum depth of at least 6 feet during the dry season of most years. Lacustrine wetlands are comprised of three parts; the area of open water that is apparent when the lake is full, the non-vegetated area that is exposed when the lake is not full, and the area of wetland vegetation that borders either the open water or the non-vegetated area.

Level of Service: benchmarks of performance that can be applied to systems, services, and assets.

Probabilistic Monitoring Design: a plan to sample a subset of sites (in the context of this study, within a watershed) at random. These measurements can be used to describe conditions for the entire watershed.

Riparian Area: areas through which surface and subsurface hydrology interconnect aquatic areas and connect them with their adjacent uplands. They are distinguished by gradients in biophysical conditions, ecological processes, and biota. They can include wetlands, aquatic support areas, and portions of uplands that significantly influence the conditions or processes of aquatic areas.

Riverine wetlands: the riverine channel and its active floodplain, plus any portions of the adjacent riparian areas that are likely to be strongly linked to the channel or floodplain through bank stabilization and allochthanous inputs.

Seeps and Springs form due to seasonal or perennial emergence of groundwater into the root zone or onto the ground surface. They usually form on hillsides or along the base of hills or alluvial fans, etc. They can lack well-defined channels. Seeps and springs are almost entirely dependent on groundwater (slope wetlands).

Stream ecosystem conditions: the states of physical, chemical, and biological indicators of processes and functions intrinsic to watershed health.

Stream Order: a system of hierarchically classifying streams (Strahler 1952, 1957) in which the uppermost tributaries farthest from the watershed outlet are first (low) order streams which join to produce second order streams, which join to form third (higher) order streams and so on.

Targeted Monitoring Design: a plan to sample sites non-randomly (in the context of this study, within a watershed), and measure conditions at these sites. Unlike probabilistic monitoring designs, results may not be extrapolated to measure overall watershed conditions.

Wetland: Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. There are many definitions of wetlands. Under the Clean Water Act, the term wetlands means "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

APPENDIX A. Technical Information

APPENDIX A. TECHNICAL INFORMATION

A.1 Methods:

A.1.1 Ambient and Targeted Surveys of Coyote Creek (CC) watershed and the Upper Penitencia Creek (UPC) subwatershed

A total of 100 sites were assessed in the CC watershed and the UPC subwatershed using probabilistic and targeted monitoring designs (Table A-1) (Figure A-1).

Table A-1. Sites assessed using the California Rapid Assessment Method (CRAM).

Hydrologic Unit	Number of Sites	Monitoring Design Type	Purpose
Coyote Creek Watershed	47	Probabilistic: throughout watershed	Measure ambient stream ecosystem condition for the watershed
Coyote Creek Watershed	20	Targeted: on the mainstem	Measure stream ecosystem condition at sites where District sampled fish communities
Coyote Creek Watershed	1	Targeted: on the mainstem	Measure stream ecosystem condition at a District mitigation site
Upper Penitencia subwatershed	30	Probabilistic: throughout subwatershed	Measure ambient stream ecosystem condition for the subwatershed
Upper Penitencia subwatershed	2	Targeted: on the mainstem	Measure stream ecosystem condition at sites where District sampled fish communities

A.1.1.1 Sample Design

Probabilistic Design:
To measure ambient stream ecosystem condition at the watershed scale, a probabilistic design was developed (Figure A-1) using the Generalized Random Tessellation Stratified (GRTS) approach developed for USEPA's Environmental Monitoring and Assessment Program (Stevens and Olsen, 2004). The ambient survey sample frame included all possible 2nd to 7th order streams within the CC watershed (including the UPC subwatershed) identified using the Bay Area Aquatic Resources Inventory (BAARI) stream network data set. The boundary of the CC watershed was delineated from CalWater 2.2.1, while the boundary for the UPC subwatershed was acquired from the District.

A total of 77 sites were probabilistically selected from the ambient sample frame. Sites were selected for two strata: 1) UPC subwatershed (n = 30); and 2) the CC watershed (n = 47). For each stratum, the sample size was weighted based on the relative abundance of 2nd to 7th order streams. The GRTS design can be used to balance the number of channels of each order that are included in the sample draw by accounting for their inclusion probabilities, which is a function of their relative abundances. For example, since low-order channels are more common than high-order channels, there is a greater probability of randomly selecting low-order AAs than high-order AAs. GRTS accounts for these probabilities and uses them to weight the corresponding assessment scores. To allow for situations where sites selected in the initial 80-site sample draw could not be sampled due to access issues, an oversample selection of 300% was created. The GRTS design for the ambient surveys was created using the R system with version 2.10.0 of the psurvey analysis statistical library.

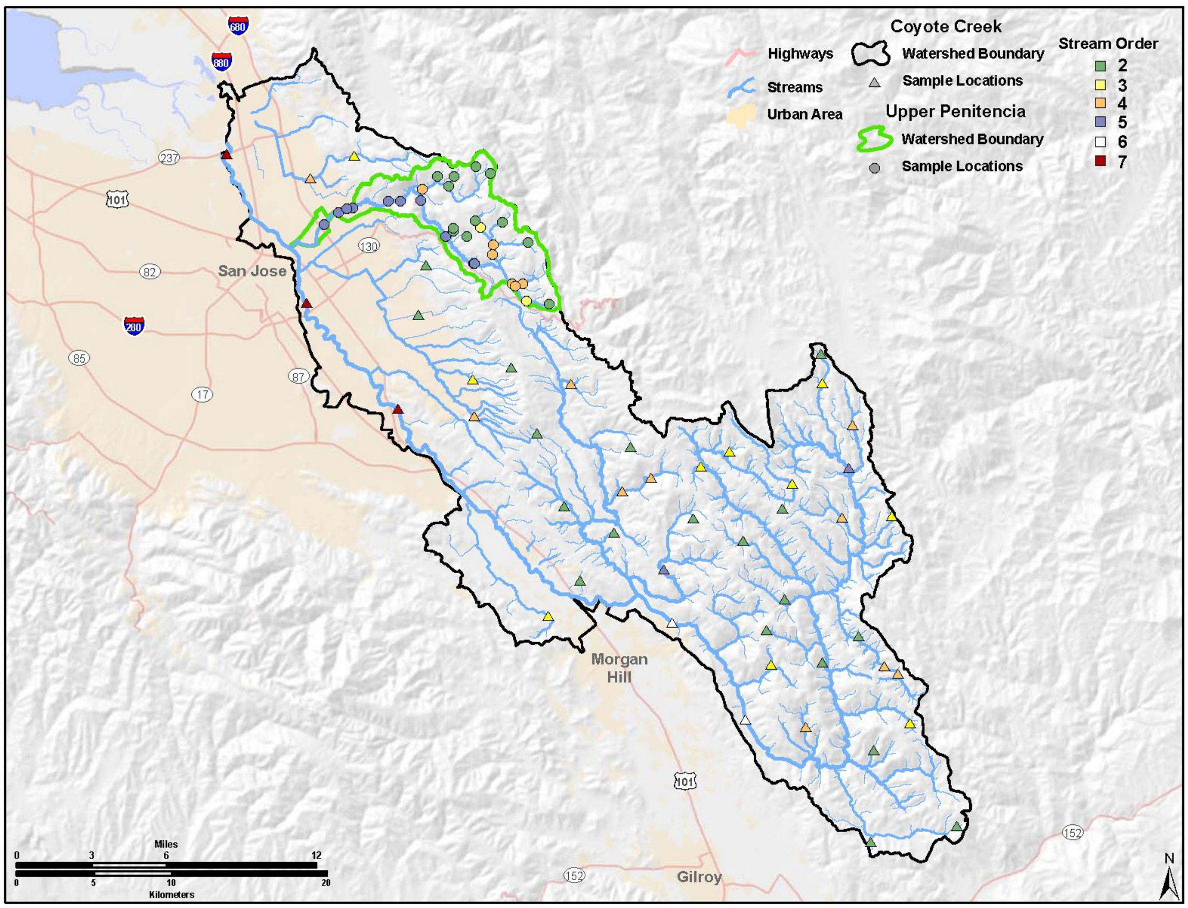

Figure A-1. CRAM ambient survey sites in the Coyote Creek watershed and the Upper Penitencia Creek subwatershed.

Targeted Design:

Targeted sites were located where either District biologists had sampled fisheries on the CC and UPC mainstems as part of the Mid-Coyote Flood Protection Project baseline fisheries survey (SCVWD 2008), and at a selected mitigation site. The twenty-three fisheries sites represented in the MCCFPP were targeted for assessment using CRAM. One of the CC sites could not be accessed due to safety issues and therefore was not sampled, reducing the total number of sites in the targeted assessment to 22. Twenty (20) of these sites were located along the main-stem of Coyote Creek (CC) and two sites were in the Upper Penitencia Creek watershed (UPC). One mitigation site was included for the purpose of being able to demonstrate how CRAM data may be used to evaluate mitigation site performance.

A.1.1.2 Site Access

For each site, the field team requested permission from the landowner to enter the property and spend time in the creek. Land ownership for each site in the sample draw was identified using existing park and open space maps and the Santa Clara County's parcel database (http://sccplanning.org/gisprofile/). Obtaining permission to access creek sites included in both the probabilistic and targeted samples was streamlined because 1) many sites were owned by the same landowners (e.g., Henry Coe State Park, Joseph Grant County Park, other various Santa Clara County Parks and Recreation District properties, City of San Jose's Alum Rock Park, University of California's Blue Oaks Ranch Reserve, and Santa Clara County Open Space Authority); and 2) many of the sites located on the Coyote Creek mainstem are held by the District in fee title or the District has access via easements. Field staff coordinated closely with landowners to inform them of field team on-site activities.

The field team relied heavily upon the parcel database to obtain assessor parcel numbers. The landowner's name or mailing address, however, was not always listed in the database, thus requiring additional internet searches to identify contact information. Once contact information was gathered, a letter was sent to landowners describing the project and requesting access to the site. Some letters resulted in successfully obtaining access permission. In the Upper Penitencia Creek watershed, one particular landowner was very cooperative and helpful, and provided names of adjacent owners, and even made phone calls to them. In other cases permission to access sites required follow-up phone calls. In some cases permission to access sites was not obtained either because the land owners were never identified or because they denied access. Unfortunately, a large track of private land in the south-central Coyote Creek watershed (Hall Valley) was not sampled because the field team was denied access. When permission to access a site was denied, a new site was selected from the oversample draw. New sites were selected in the order that they were originally drawn into the sample. All of the landowner contact information and communications to obtain site access were documented in an excel spreadsheet.

A.1.1.3 Fieldwork

California Rapid Assessment Method:

Stream ecosystem condition at all sites was assessed using the California Rapid Assessment Method (CRAM) (Collins et al. 2008) (http://www.cramwetlands.org/documents). CRAM surveys were conducted by field teams consisting of two or more CRAM technicians. The field team assessed each site based on four attributes (Table A-2): buffer and landscape context, hydrology, physical structure, and biotic structure. Each attribute was evaluated by 2-4 Metrics, which were assigned a letter grade A-

D to reflect relative condition ("A " indicating better condition). Numerical scores were generated for each of the four attributes and for the overall site score using the CRAM scoring method (Collins et al. 2008) (Figure A-2). The Metric scores for each Attribute are summed into an Attribute score, and the Attribute scores are averaged to derive a single Index score for each site.

Table A-2. Attributes and Metrics in the California Rapid Assessment Method (Collins et al. 2008).

Attributes		Metrics
Buffer and Landscape Context		Landscape Connectivity
		Buffer:
		Percent of AA with Buffer
		Average Buffer Width
		Buffer Condition
Hydrology		Water Source
		Hydroperiod or Channel Stability
		Hydrologic Connectivity
Structure	Physical	Structural Patch Richness
		Topographic Complexity
	Biotic	Plant Community:
		Number of Plant Layers Present or Native Species Richness (vernal pools only)
		Number of Co-dominant Species

The location of the CRAM assessment area (AA) for each site was determined using the GRTS-selected location to define the downstream origin of each AA. The AA extended 100-200m upstream from its downstream origin. The exact length of the AA was determined by approximating 10x the average bankfull width. Exceptions to this method were made for fish sites. For these locations, the AA was moved, whenever possible, to overlap with District fisheries project locations of the Mid-Coyote Creek Flood Protection Project (SCVWD 2008). Occasionally the location of an AA was shifted slightly upstream or downstream to prevent major changes in hydrology or geomorphology from occurring within the AA. For example, if a large tributary entered in the middle of the AA, the AA would be shifted either entirely up or downstream of that tributary junction. Sampling locations were sometimes moved up to 200m when a location could not be accessed safely. In other instances, sampling locations were moved to the closest reach. Specifically, two of the sites fell within the middle of a large reservoir; for these sites the field team assessed the closest fluvial reach upstream of the reservoir. The lateral extent of the AA was defined to include the extent of the riparian area that likely contributed allochthonous material directly to the channel.

Fisheries:

The District's baseline fisheries study focused on a 6.1 mile stretch of the Coyote Creek mainstem between Montague Expressway and Highway 280. Sites were also sampled on Upper Penitencia Creek and Lower Silver Creek, since they have confluence points within the project area. Additional sites, either upstream or downstream of the project reach, were sampled to correspond to previous or current sites of monitoring by the Santa Clara Valley Urban Runoff Pollution Prevention Plan (SCVURPPP).

Overall, District biologists sampled twenty-five fisheries monitoring stations between 2007 and 2009. Project reaches were separated into segments of 200 feet, and individual sampling locations selected by random number within each reach. All sampling sites were 200 linear feet or greater depending on sampling net placement. Detailed field methods are documented in previous District reports (SCVWD 2007, 2008).

A.1.1.4 Data Quality Assurance and Management

CRAM data collected at each site were reviewed using the standard CRAM quality assurance (QA) procedure. Before leaving the site, the field team confirmed that all necessary fields were complete on the data sheet, and all photographs had been taken. On the evening of the assessment, the field team lead technician reviewed the data sheet again to confirm that scores were written and calculated accurately. The AA polygon was drawn in eCRAM by the field team lead technician each evening. The eCRAM is the online version of CRAM used to exchange CRAM results with the statewide CRAM database. The data were subsequently entered into eCRAM. The field team lead technician compared the paper copy to the electronic copy, including each individual worksheet, plant list, and stressor list and fixed any errors. Any unidentified plant samples were added to a master plant identification list, with the sample placed in a single binder. The field team was assisted by a District botanist, Janell Hillman, to identify some plant species. After all of the sites were assessed, the field team lead technicians again reviewed the data for each site, and "finalized" site scores. The dates of each of these QA steps are listed in a spreadsheet detailing the steps implemented for each site. Once all site data were finalized, the data management team completed one final QA review, looking specifically at site codes and grouping codes, to ensure correct grouping of the entire dataset.

Quality assurance procedures implemented for the fisheries data are documented elsewhere in the source documents (SCVWD 2007, 2008).

A.1.1.5 Data Analysis

The sampling was designed to represent the entire CC watershed. Therefore, the samples should be representative of the different areas mentioned in the interpretation sections of the Profile. CRAM attribute scores have a precision of 3-5 points. CRAM index scores have a precision of 10 points. Differences in scores of 10 CRAM points or less are within the error of the method and therefore should not be considered to represent differences in overall condition (CWMW 2009). Differences in attribute scores of 3-5 points or less are within the error of the method and, therefore, should not be considered to represent differences in condition (CWMW 2009).

CRAM index scores should always be interpreted by breaking down the overall score into its component Attribute scores and Metric scores to account for the Attribute scores and the Index scores. For interpretation of individual site scores, an examination of the Metric scores and Stressors is necessary.

Cumulative Distribution Functions

Stream ecosystem conditions for the UPC subwatershed and the entire CC watershed (e.g., including all data from the UPC subwatershed) were summarized from the CRAM ambient survey data using a probabilistic statistical approach to calculate cumulative distribution functions (CDFs). Prior to estimating CDFs, the number of sites sampled in the stream network (n = 77) relative to the number of sites selected by the GRTS design (n = 80) was accounted for. The re-weighting of sites accounted for the total length of riverine habitat that the network represented, to generate length-weighted estimates of condition. These length-weighted estimates were used to calculate CDFs for both the UPC subwatershed and the entire CC watershed. The statistical analysis is based on the assumption of the GRTS monitoring design that the streams sampled by GRTS were representative of the population of streams that could be sampled in the watershed. CDFs were calculated with version 2.10.0 of the psurvey.analysis statistical library, using the R system (Stevens and Olsen 2004). CRAM scores collected at targeted sites were plotted on the respective CDFs to evaluate them in the context of ambient watershed condition.

Approaches to Inform the District Ecological Level of Service

<u>Ecosystem Services Index</u>

The method selected[1] to inform the District's Ecological Levels of Service (LOS) is called the Ecosystem Services Index (ESI). The ESI statistic was calculated to summarize the CC watershed and the UPC subwatershed CDFs as follows:

ESI = $\sum$ (CRAM score x Proportion of total stream length represented by score)

The ESI statistic can vary from 25 - 100, corresponding to the possible range in CRAM scores. An ESI of 100 indicates that the surveyed area achieved the highest possible stream ecosystem condition score, whereas an ESI of 25 indicates the lowest possible stream ecosystem score.

<u>Alternative Approaches to Establishing Ecological Levels of Service</u>

[1] The ESI was discussed and adopted at the District EMAF Core Technical Team meeting (October 5, 2010) and the District Executive Managers meeting (November 4, 2010).

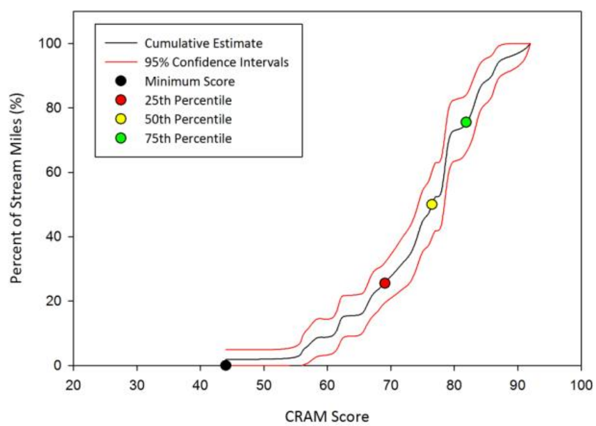

Figure A-3. Cumulative distribution function (CDF) of CRAM Index scores from ambient sites (n = 77) relative to percent of stream miles in the Coyote Creek watershed. Colored circles identify percentiles of the cumulative curve. The lowest score in this ambient survey was 44, shown by the black circle.

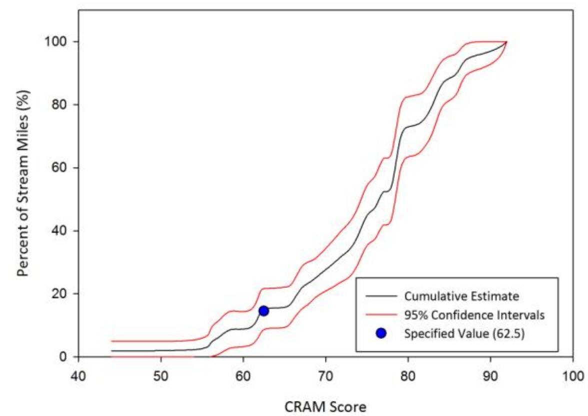

Figure A-4. Cumulative distribution function (CDF) of CRAM Index scores from ambient sites (n = 77) relative to percent of stream miles in the Coyote Creek watershed. Blue circle identifies a specified value that could be used to define an ecological LOS.

Several alternative approaches to calculate LOS were discussed with District staff, in addition to the ESI approach presented above. These other approaches that were not selected for representation in this profile report are nevertheless presented here. LOS development is an iterative process involving both scientific and management review. The District may want to refine the LOS approach presented in this Profile. Therefore, the following alternative approaches may be considered for future profiles.

1. Characterizing CDF Quartiles (Figure A-3): At least maintain existing (baseline) condition as measured by the minimum CFD value and the 25th, 50th, and 75th percentile values and their associated confidence intervals.
2. Using a median value as illustrated in Figure A-3 (50th percentile indicated by yellow circle).
3. Selecting another specified value of the CDF as the LOS. The example shown in Figure A-4 is a value of 62.5 which represents the mid-point between 50 (which equates to a CRAM Index alphabetic score of C) and 75 (which equates to a CRAM Index alphabetic score of B). The value of 62.5 represents the lower 15% of ambient condition. In other words, 85% of stream length in the watershed exhibited values greater than 62.5.

The following summarizes the pros and cons of different approaches to establishing ecological LOS.

1) **CFD shapes:**
    - Harder to track visually and quantitatively;
    - May be more difficult to explain to non-technical audience.
2) **Quartile and "Anchor" values:**
    - Provide visual and conceptual points on a CFD that
        - are easier to track quantitatively;

- may be easier to explain to non-technical staff;
- better represent range of values.

3) **Median values:**
   - Single values easy to explain and visualize;
   - Do not describe CFD shape nor the range of values
4) **Minimum values:**
   - Tend to focus subsequent management resource investment on the low tail of ecological condition distribution.
5) **Ecosystem Services Index:**
   - Single Value easy to explain and visualize;
   - Companion graphics (pie charts, bar graphs) help explain Index Value;
   - Area weighted;
   - Cumulative representation of stream ecosystem condition;
   - CRAM Steering Committee draft endorsement.

Risk Analysis

The intent of the high-risk analysis was to identify sites with low or high scores from the tails of the CDF distributions (Figure A-5). Sites with low scores would represent stream reaches with lower stream ecosystem conditions and indicate areas potentially threatening the watershed LOS. Sites with high scores would represent stream reaches that might be at-risk from stressors, and might warrant protective management actions. Low-scoring sites were those within the lowest 10% of the CDFs and the high-scoring sites were those within the highest 10% of the CDFs. These thresholds were selected because they corresponded very well to the inflection points observed in most of the CDFs. There were two exceptions for which a threshold of 25% was used: the lower tail of the Physical Structure (PS) CDF and the upper tail of the Buffer and Landscape Context (BLC) CDF. For the PS attribute, the lowest 10% of the CDF consisted of a single-value of 38, thus the 10% threshold did not represent much of the lower CDF tail. For the BLC attribute, the slope of the tail was so steep that the 10% threshold represented an extremely narrow range (99-100). Adopting the 25% threshold for this attribute expanded the range to 96 – 100. Table A-3 illustrates the relationship between the CDF inflection points and the 10% and 25% threshold values.

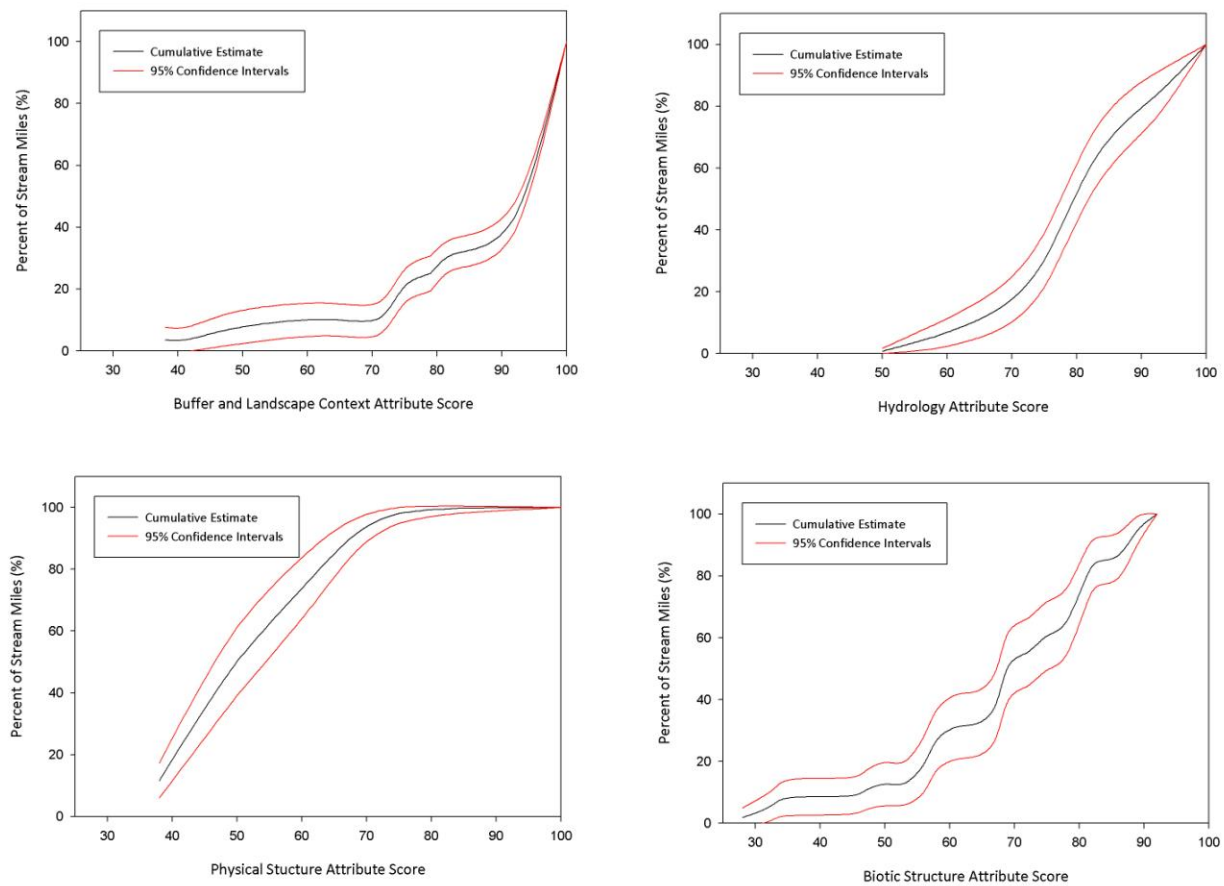

Figure A-5. Cumulative Frequency Distributions for California Rapid Assessment Method (CRAM) Attributes surveyed in the Coyote Creek Watershed using a probabilistic design.

Table A-3. CRAM attribute CDF inflection points and tails characterized by either 10% or 25% of stream miles.

Attribute	Lower 25%	Lower 10%	Lower Inflection Point (%)	Comment
Buffer and Landscape Context	38 - 79	38 - 62	38 - 71 (11%)	10% captures inflexion
Hydrology	50 - 72	50 - 63	50 - 72 (23%)	10% captures inflexion
Physical Attribute	38 - 42	38 - 38	None	10% does not capture range, use 25%
Biotic Structure	28 - 58	28 - 46	28 - 54 (12%)	10% captures inflexion
Attribute	Upper 25%	Upper 10%	Upper Inflection Point (%)	Comment
Buffer and Landscape Context	96 - 100	99 - 100	91 - 100 (60%)	Use 25%, better captures inflexion and range
Hydrology	88 - 100	95 - 100	83 - 100 (30%)	10% an 25% capture inflexion
Physical Attribute	60 - 100	69 - 100	70 - 100 (11%)	10% captures inflexion
Biotic Structure	80 - 92	87 - 92	85 - 92 (15%)	10% captures inflexion

Fisheries and Physical Habitat Conceptual Model

A conceptual model of the relationship between stream ecosystem condition, as measured by CRAM, and native fish population health was developed with District fisheries biologists (Figure A-6). This conceptual model was based on the idea that many CRAM Metrics reflect stream physical habitat, the quality of which affects fish populations. Each aspect of physical habitat that affects cold-water or warm-water fish populations and that should be reflected in a CRAM score was hypothesized to have a particular relationship with that CRAM score (Tables A-3 and A-4). Detailed hypotheses and predictions (Table A-5) were written in consultation with District fisheries biologists (Melissa Moore and Lisa Porcella) to explain the mechanistic relationships represented in the Physical Habitat/Fisheries Health (PHFH) conceptual model (see below). The PHFH conceptual model development was a way to document the *a priori* hypotheses of the District biologists about how native fish populations relate to stream condition as measurable by CRAM. The statistical analysis of CRAM and fisheries data (described below) that was done subsequent to the conceptual model development was an unbiased test of how any CRAM Metric could relate to native fish diversity. Therefore, *a priori* hypotheses were recorded but were not allowed to limit the results of the statistical analysis.

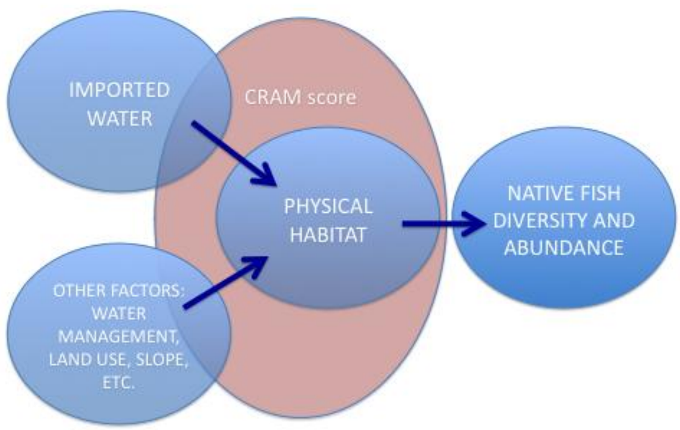

Figure A-6. Simplified graphic version of the Physical Habitat/Fisheries Health Conceptual Model, which depicts the relationship between CRAM scores, physical habitat, and the diversity and abundance of native fish.

CRAM/Fisheries Data Manipulation

Through discussions with District biologists, it was determined that the fish response variable of most interest to evaluate the conceptual model was native fish diversity. Therefore, data analysis focused on evaluating relationships between native fish diversity and CRAM Metrics. A total of 22 sites were sampled with CRAM that overlapped with the District's fisheries monitoring study. Fourteen sites had fisheries data for all three years, seven sites had data for two years, and one site (UCCB) was only sampled in 2008.

To maximize the available sample size for analysis, all sites were included, even though one site was not replicated in multiple years. To obtain a representative statistic to represent all three years of data, the fish response variable was calculated as the mean number of native species across all years. Mean number of natives reflects the overall tendency of a site to support a diverse fish population, no matter the particular conditions that year. We also investigated summing the number of unique native fish species across all three years for each site, and found the result to be very similar to the mean value. A summed value would indicate the tendency of a site to support different species over time as conditions change. In this case, the values were very similar and we chose to use the mean number of natives. The reason for the similarity may have been that all three water years when fish were collected were rather dry.

First, the number of native species was calculated by summing the number of native species per site in each year. District biologists provided the list of native species. Next, weighting was used to augment the diversity statistic when important indicator species were present. Specifically, if Pacific lamprey were present at a site, the total number of native species was increased by a weight of 1; if steelhead trout were present at a site, the total number of native species was increased by a weight of 2; and if both lamprey and trout were present at a site, the total number of native species was increased by a weight of 2. In this way, sites with either of these species present in a given year were considered more diverse (healthier) than sites without these species present but with the same number of native species total. These two indicator species were selected because they are integral to future water management activities of the District.

Statistical Analysis

Data were analyzed by Non-metric Multidimensional Scaling (NMS) with the R Statistical Software version 2.10.0, using packages "vegan" and "MASS". NMS is an ordination technique commonly used in community ecology, when multiple variables need to be examined that occur on various distribution scales. In this study, NMS was used to identify the optimum set of CRAM Metrics and direction of response, to describe spatial patterns in mean native fish diversity. The CRAM data were distributed on an ordinal scale (3, 6, 9, 12) and the fish diversity were discrete (0 – 7 species). NMS was performed using a relative Euclidean dissimilarity (standardized to the square root) and Wisconsin double standardization using the meta MDS method (Cox and Cox, 1994). NMS runs were first evaluated by performing ordination along 1 to 5 axes and examining the stress. Stress is measured on a scale of 0 – 100, where a stress value of greater than 20 is viewed as a poor ordination with limited interpretative confidence. In simple terms, lower stress equals a better fit to the ordination structure.

Preliminary runs indicated that the stress was less than 20 when employing two axes and the 2 dimension (2D) ordination produced the largest reduction in stress. Therefore, only the 2D ordination results are represented here. The meta MDS method employs a random starting configuration to avoid local optima and identifies the global best solution. A convergent solution was obtained after 15 random starts, suggesting reasonable confidence in the final results. Once a final solution was obtained, the axes scores were examined for goodness of fit against all variables included in the analysis to determine their contribution to the underlying variance structure. The goodness of fit statistic used was the square of the correlation coefficient.

Simple (Spearman's) rank correlation of the fish response variable to all CRAM variables (Index and Metrics) was also performed to substantiate the NMS-based inferences. The purpose of this analysis was purely as a secondary check to make sure that no major errors were made in the NMS analysis. The NMS approach has much more power than simple Spearmen's rank correlation. Therefore, NMS is the primary analysis used to make inference for this study.

Results (AM)

The 2D NMS ordination found a significant relationship between native fish diversity and CRAM Metrics (Figure A-7). The stress value for this global NMS solution was approximately 17 indicating a 'fair' ordination, based on Clarke's rule of thumb (Clark, 1993). Most ecological data tend to have solutions with stress between 10 and 20 (McCune and Grace, 2002). The vector arrows on Figure A-7 depict the direction of the variables with significant coefficient of determination (r^2) to the NMS axes.

Axis one described an underlying variance structure related to four biotic structure Metrics and a buffer Metric. These variables did not strongly relate to native fish diversity as they plot in different ordination spaces (horizontal) to the fish response variable (vertical). The inverse relationship between percent invasion and plant layers, species, and horizontal structure may point to a disturbance gradient being picked up by the biotic structure attributes.

Axis two is described by native fish diversity, topographic complexity, and hydrologic connectivity. Both topographic complexity and native fish diversity were positively related to each other, as indicated by vectors corresponding to the same ordination space. Hydrologic connectivity is indicative of an inverse degree of entrenchment. NMS results indicated that when connectivity is low (entrenchment is high), the native fish diversity would likely be high.

For both of the two axes, native diversity had a goodness of fit statistic of 0.58 (Table A-6). The other two variables that fit the ordination best (based on r^2) were buffer width and percent invasion. However, as shown in Figure A-7, these two Metrics were not related to fish, but described a pattern in CRAM biotic structure Metrics.

The Spearman's rank correlation analysis supported the NMS inference that topographic complexity has a significant, positive correlation (0.44) to native fish diversity (Table A-7, Figure A-8). Therefore, this rank correlation analysis confirmed that the NMS analysis appeared to be correctly implemented. Table A-7 shows the rank correlations and Figure A-8 shows the relationships of the CRAM Metrics to native fish diversity.

In summary, the NMS results suggest a pattern in fish native diversity related to physical structure and entrenchment. Specifically, more topographic complexity and greater entrenchment resulted in higher native fish diversity among the three years of fisheries study. A caveat should be acknowledged that the fisheries data were collected prior to the CRAM surveys, and thus may not entirely represent current condition.

Table A-3. Detailed conceptual model of relationship between cold-water native fish community and CRAM Metric scores.

Cold Water Fish Community					CRAM	
Life Phase	Habitat Factor	Habitat Factor Attribute	Habitat Factor Attribute Detail	Habitat Relationship to Fish Abundance/ Diversity	CRAM Metric	CRAM Metric Score Prediction
Rearing	Imported Water	Increased perennial		Positive (rearing and outmigration)	Vertical Biotic Structure	Higher
					Water Source	Lower
	Physical Habitat	Riffle, run, pool		Positive	Structural Patch Richness	Higher
		Large woody debris		Positive		Higher
		Vegetation	Steep slope	Positive	Vertical Biotic Structure	Higher
			Shallow slope	Negative		Higher
		Sediment size and quantity	More fines	Negative	Channel Stability, Buffer, and Structural Patch Richness	Lower
			More gravel	Positive		Higher
			More boulders	Positive		Higher
		Sediment quality	Armoring	Negative	Topographic Complexity	Lower
		Water quality	Chemical, Temperature[1]	Positive	Water Source, Buffer, Vertical Biotic Structure	Higher
		Water quantity (year-round)		Positive	Topographic Complexity, Structural Patch Richness, and Vertical Biotic Structure	Higher

[1] Chemical measured as fewer contaminants; Temperature below 23 C

Table A-4. Detailed conceptual model of relationship between warm-water native fish community and CRAM Metric scores.

Warm Water Fish Community					CRAM	
Life Phase	**Habitat Factor**	**Habitat Factor Attribute**	**Habitat Factor Attribute Detail**	**Habitat Relationship to Fish Abundance / Diversity**	**CRAM Metric**	**CRAM Metric Score Prediction**
Rearing and Adult Survival and Reproduction	Imported Water	Increased perennial		Positive	Vertical Biotic Structure Water Source	Higher Lower
	Physical Habitat	Riffle, run, pool		Positive	Structural Patch Richness	Higher
		Large woody debris		Positive		Higher
		Backwater pools, side channels		Positive	Structural Patch Richness, Hydrologic Connectivity	Higher
		Vegetation	Shallow slope	Negative	Vertical Biotic Structure	Higher
		Sediment size and quantity	More fines	Negative	Channel Stability, Buffer, and Structural Patch Richness	Lower
			More gravel	Positive		Higher
		Sediment quality	Armoring	Negative	Topographic Complexity	Lower
		Water quality	Chemical, Temperat ure	Positive	Water Source, Buffer, Vertical Biotic Structure	Higher
		Water quantity (year-round)		Positive	Topographic Complexity, Structural Patch Richness, and Vertical Biotic Structure	Higher

Table A-5. Hypotheses and predictions for the Physical Habitat/Fisheries Health conceptual model relating CRAM Metric scores to Coyote Creek Watershed native fish diversity and abundance.

Number	Hypotheses	Predictions
1	Riffle-run-pool sequences and large woody debris positively affect native fish rearing (both assemblages) and adult (warm-water assemblage only) life phases. These habitat features increase the CRAM Structural Patch Richness score.	Higher native fish diversity and abundance will be associated with higher CRAM scores for Structural Patch Richness.
2	Back-water pools and side channels positively affect warm-water assemblage native fish rearing and adult life phases. These habitat features increase the CRAM Structural Patch Richness and are related to higher Hydrologic Connectivity scores	Higher native fish diversity and abundance will be associated with higher CRAM scores for Structural Patch Richness and Hydrologic Connectivity.*
3	Greater amounts of vegetative cover have a positive effect on cold-water assemblage native fish rearing in steep-slope streams. This habitat feature increases the CRAM Vertical Biotic Structure score.	Higher native fish diversity and abundance will be associated with higher CRAM scores for Vertical Biotic Structure in steep-slope streams.

4	Greater amounts of vegetative cover have a negative effect on native fish rearing (both assemblages) and adult life phases (warm-water assemblage only) in shallow-slope streams. This habitat feature increases the CRAM Vertical Biotic Structure score.	Higher native fish diversity and abundance will be associated with lower CRAM scores for Vertical Biotic Structure in shallow-slope streams.
5	Greater amounts of fine sediments have a negative effect on native fish rearing (both assemblages) and adult life phases (warm-water assemblage only). This habitat feature decreases the CRAM Structural Patch Richness score and is associated with lower scores for Channel Stability and Buffer.	Higher native fish diversity and abundance will be associated with higher CRAM scores for Channel Stability, Buffer, and Structural Patch Richness.
6	Greater amounts of gravel and boulder sediments have a positive effect on native fish rearing (both assemblages) and adult life phases (warm-water assemblage only). This habitat feature increases the CRAM Structural Patch Richness score and is associated with higher scores for Channel Stability and Buffer.	Higher native fish diversity and abundance will be associated with higher CRAM scores for Channel Stability, Buffer, and Structural Patch Richness.
7	Channel armoring has a negative effect on native fish rearing (both assemblages) and adult life phases (warm-water assemblage only). This habitat feature is associated with lower scores for Topographic Complexity.	Higher native fish diversity and abundance will be associated with higher CRAM scores for Topographic Complexity.**
8	Good water quality (fewer contaminants, temperature below 23 degrees Celcius) has a positive effect on native fish rearing (both assemblages) and adult life phases (warm-water assemblage only). This habitat feature is associated with higher scores for Water Source (except in areas with imported water), Buffer, and Vertical Biotic Structure.	Higher native fish diversity and abundance will be associated with higher CRAM scores for Water Source, Buffer, and Vertical Biotic Structure.
9	Increased water quantity in each season of the year has a positive effect on native fish rearing (both assemblages) and adult life phases (warm-water assemblage only). This habitat feature is associated with higher scores for Topographic Complexity, Structural Patch Richness, and Vertical Biotic Structure.	Higher native fish diversity and abundance will be associated with higher CRAM scores for Topographic Complexity, Structural Patch Richness, and Vertical Biotic Structure.**
10	Imported water positively affects native fish rearing (both assemblages), outmigration (cold-water assemblage only), and adult survival and reproduction (warm-water assemblage only) by increasing perennial flow. Increased perennial flow supports a greater degree of vegetative cover. Artificial hydrology in the dry season is scored lower (C score) in the CRAM water source Metric.	Higher native fish diversity and abundance will be associated with higher CRAM scores for Vertical Biotic Structure and with lower CRAM scores for Water Source in areas with imported water[2].

* The NMS analysis indicated the opposite of this prediction: as native fish diversity increased, Hydrologic Connectivity decreased.
**The NMS analysis supported this prediction: as native fish diversity increased, Topographic Complexity increased.
For all other predictions in this table, the NMS analysis showed no relationship.

[2] Note that Water Source Metric has opposite predictions for streams with imported water and other streams. This duality will require consideration during data analysis.

Table A-6. Goodness of fit of variables to the ordination structure shown in Figure A-7.

Variable	CRAM Attribute	r^2	Probability-value	Significance
Native Fish Diversity	--	0.578	0.001	***
Landscape Connectivity	BLC	0.108	0.333	
Percent of AA with Buffer	BLC	0.084	0.438	
Average Buffer Width	BLC	0.502	0.001	***
Buffer Condition	BLC	0.167	0.170	
Water Source	HYD	0.060	0.533	
Channel Stability	HYD	0.238	0.085	.
Hydrologic Connectivity	HYD	0.366	0.012	*
Structural Patch Richness	PHY	0.164	0.171	
Topographic Complexity	PHY	0.285	0.040	*
Horizontal Inter. and Zonation	BIO	0.168	0.189	
Vertical Biotic Structure	BIO	0.368	0.018	*
Number of Plant Layers Present	BIO	0.359	0.024	*
Number of Co-dominant Species	BIO	0.405	0.007	**
Percent Invasion	BIO	0.768	0.001	***

Significance: *** = < 0.001, ** = < 0.01, * = < 0.05, . = < 0.1
Attributes: BLC = Buffer and Landscape Context; HYD = Hydrology; PHY = Physical Structure; BIO = Biotic Structure

Table A-7. Spearman's rank correlation of CRAM Metric scores to mean native fish diversity.

CRAM Variable	CRAM Attribute	Correlation Coefficient (r)	Probability-value	Significance
Landscape Connectivity	BLC	0.298	0.178	
Percent of AA with Buffer	BLC	0.091	0.686	
Average Buffer Width	BLC	0.124	0.583	
Buffer Condition	BLC	0.053	0.815	
Water Source	HYD	0.425	0.049	N/A
Channel Stability	HYD	-0.040	0.859	N/A
Hydrologic Connectivity	HYD	-0.239	0.284	
Structural Patch Richness	PHY	0.242	0.279	
Topographic Complexity	PHY	0.441	0.040	*
Horizontal Inter. and Zonation	BIO	0.335	0.128	
Vertical Biotic Structure	BIO	-0.021	0.926	
Number of Plant Layers Present	BIO	-0.008	0.972	
Number of Co-dominant Species	BIO	-0.120	0.594	
Percent Invasion	BIO	0.118	0.601	

Significance: * = < 0.05
Attributes: BLC = Buffer and Landscape Context; HYD = Hydrology; PHY = Physical Structure; BIO = Biotic Structure
N/A: Metrics with only two levels of CRAM score (e.g., scores of 6 and 9) were not assessed, because they did not have a wide enough range of scores to support regression analysis (see Fig A-8).

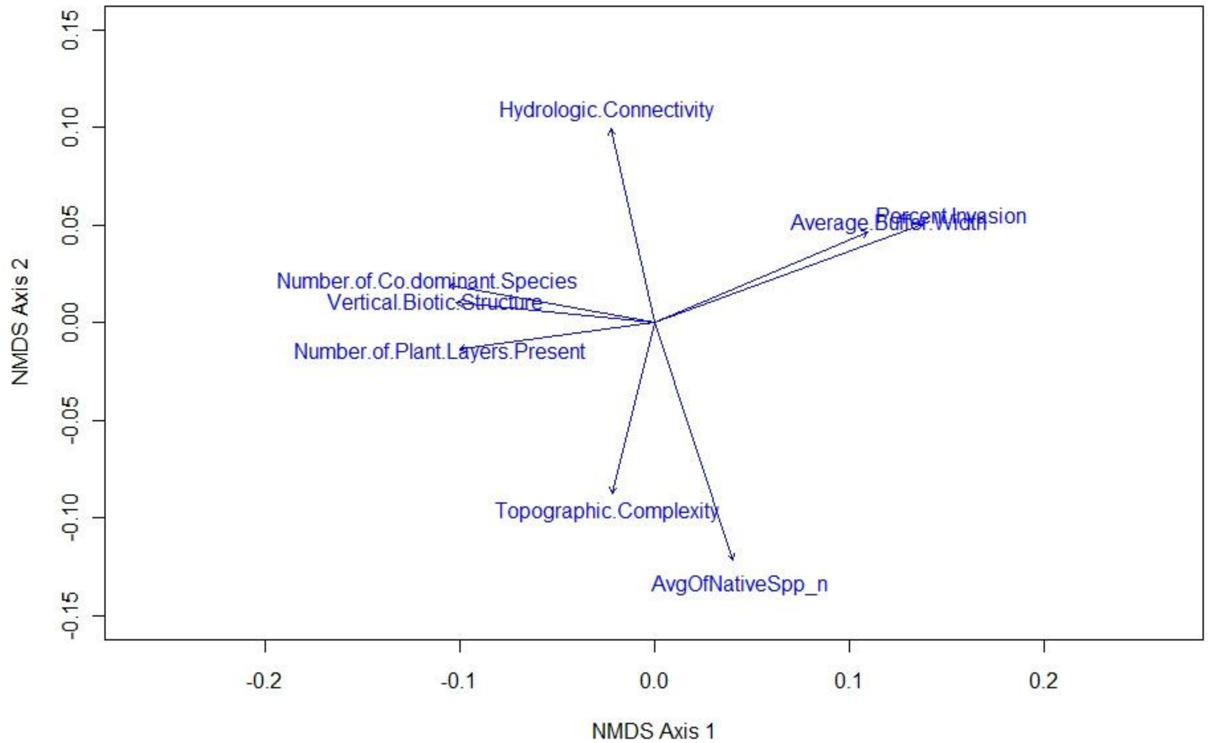

Figure A-7. Non Metric Multi-dimensional Scaling (NMS) Ordination of native fish diversity and CRAM Metrics. Vectors represent Metrics that provided a significant r2 (goodness of fit) to the two NMS axes. Table A-6 shows the contribution of each Metric to the overall ordination structure.

Stress = 17.6

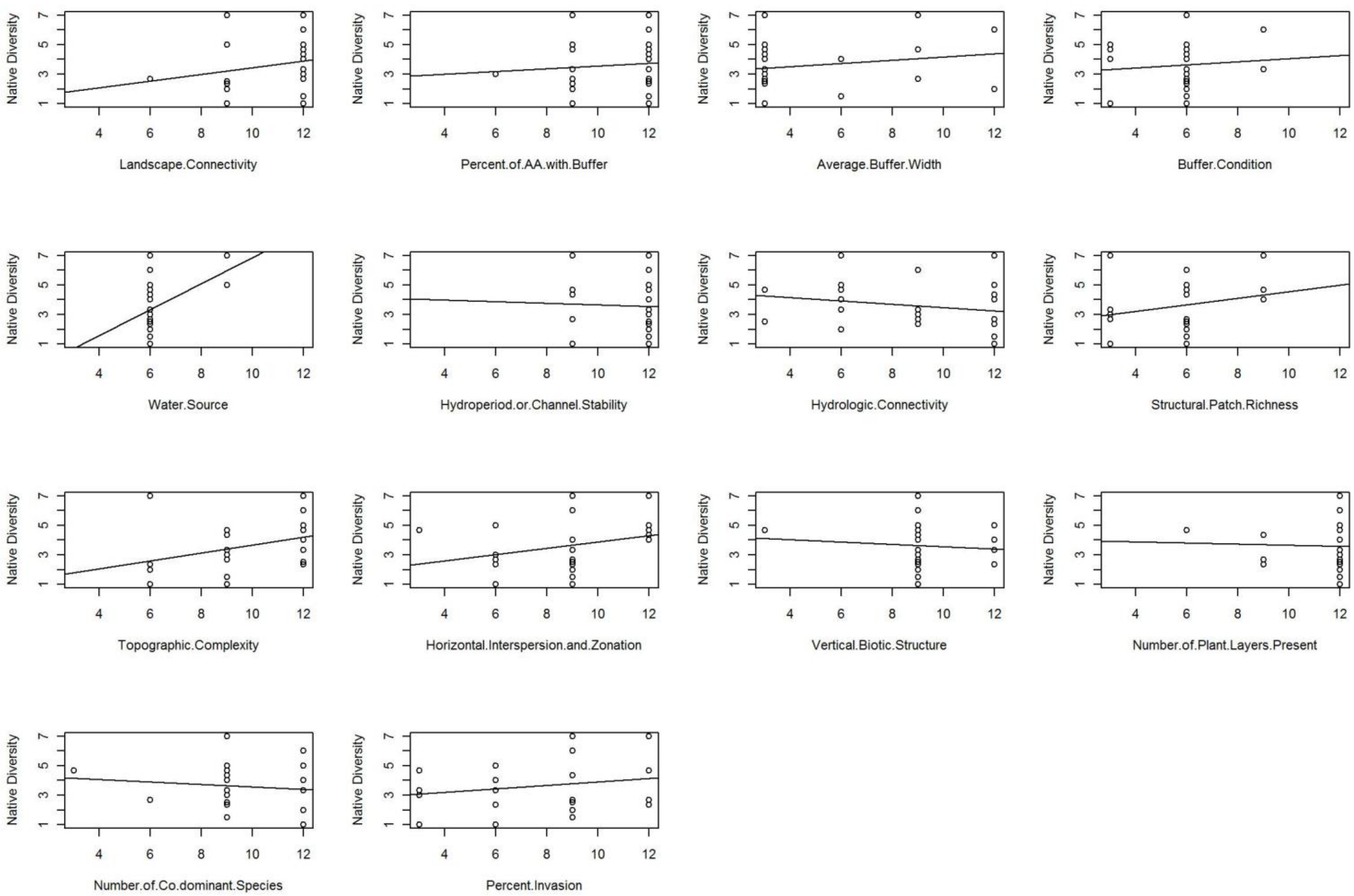

Figure A-8. Correlation of each CRAM Metric to mean native diversity. Lines represent the linear correlation in the data. Refer to Table A-7 for Spearman's rank correlation coefficients and levels of statistical significance.

Concept Pilot Level 3 Conceptual Models

This section describes Level 3 conceptual models designed during the EMAF Concept Pilot Assessment (SCVWD 2010a) to address a District-identified[3], high priority management concern: potential impacts of imported water and associated groundwater recharge operations on two target species, Steelhead (*Oncorhynchus mykiss*) and Pacific lamprey (*Entosphenus tridentata*). This conceptual model focuses on identifying factors, and associated stressors influencing different life history stages of these species. It was developed generically so that it can be applied to any watershed in which these operations and target species are present, meaning that this model was not populated to describe the relative strength of relationships[4] between stressors and life history stages specific to the Upper Penitencia Creek Watershed[5].

This section begins by describing the life history stages of both target species because the Concept Pilot Level 3 conceptual model is structured to identify how stressors may impact specific life stages of each target species. The conceptual model is then described succinctly in Table A-8, and Figure A-9, with supporting narrative text.

Life History Stages of Steelhead and Pacific Lamprey

Life history stages and habitat requirements of steelhead and pacific lamprey are described below and depicted in Figure 6-14 because they provide valuable information that can be used to understand the relative influences of various natural and anthropogenic stressors. Explicitly incorporating these life history stages into conceptual model structure facilitates identification of factors limiting the distribution and abundance of these species, and evaluation of the potential impacts as well as benefits from management operations.

<u>Steelhead Life Stages</u>

The following information was derived primarily from a single comprehensive source (Stillwater Sciences 2006). This source also provides detailed information on the linkages of physical habitat to specific life stages of steelhead.

<u>Adult</u>

Steelhead return from the ocean to spawn in the stream they were hatched, usually in their fourth or fifth year of life. Steelhead migrate to their natal stream from late-fall through spring as sexually mature adults, and spawn in late winter or spring (Meehan and Bjornn 1991, Behnke 1992). Female steelhead construct redds and lay eggs in suitable gravels, often in pool tailouts and heads of riffles, or in isolated patches in cobble-bedded streams.

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[3] This management concern was identified by the EMAF Core Technical Team.
[4] e.g., the relative size of arrows between boxes illustrated in the Level 3 conceptual model.
[5] The original Concept Project Assessment scope of work only included the development of a Level 2 conceptual model, populated to the extent feasible using existing data. This scope of work was amended in January 2010 to additionally define a generic Level 3 model and associated management questions.

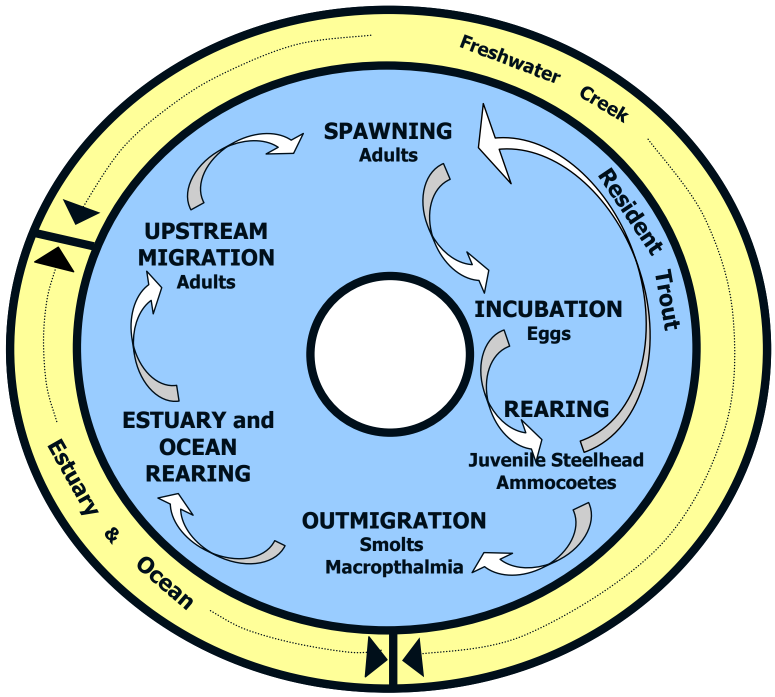

Figure A-9. Primary stages of steelhead and Pacific lamprey life histories (adapted from Stillwater Sciences 2006).

<u>Egg</u>

Eggs incubate in redds for 3–14 weeks, depending on water temperatures (Shapovalov and Taft 1954, Barnhart 1991). After hatching, alevins remain in the gravel for an additional 2–5 weeks while absorbing their yolk sacs, and then emerge in spring or early summer (Barnhart 1991).

<u>Juvenile</u>

Juvenile steelhead are characterized by two phases of growth (fry and parr) in which individuals utilize different aspects of similar rearing habitat, and one phase of outmigration (smolt), in which individuals encounter additional habitat types.

Fry

After emerging from gravels, alevins are referred to as fry (or 0+ age-class).Fry move to shallow-water, low-velocity habitats, such as stream margins and low-gradient riffles, and forage in open areas (Hartman 1965, Fontaine 1988). As fry grow and improve their swimming abilities in late summer and fall, they increasingly use areas with cover and show a preference for higher velocity, deeper mid-channel areas (Hartman 1965, Everest and Chapman 1972, Fontaine 1988).

Parr

Parr (1+ age-class) rear in freshwater habitat before outmigrating to the ocean as smolts. The duration of time parr spend in freshwater appears to be related to growth rate, with larger, faster-growing members of a cohort smolting earlier (Peven *et al.* 1994). Steelhead in warmer areas, where feeding and growth are possible throughout the winter, may require a shorter period in freshwater before smolting, while steelhead in colder, more northern, and inland streams may require three or four years before smolting (Roelofs 1985).

Juvenile (fry and parr) occupy a wide range of habitats, preferring deep pools as well as higher velocity riffle and run habitats (Bisson *et al.* 1982, Bisson *et al.* 1988). During periods of low temperatures and high flows that occur in winter months, juveniles prefer low-velocity pool habitats with large rocky substrate or woody debris for cover (Hartman 1965, Raleigh *et al.* 1984, Swales *et al.* 1986, Fontaine 1988). During high winter flows, juveniles seek refuge in interstitial spaces in cobble and boulder substrates (Bustard and Narver 1975).

Smolt

Juvenile steelhead emigration as smolts typically occurs from March through June. Emigration appears to be more closely associated with size than age, (though smolting typically manifests in the 2+ age-class), with 6 – 8 inches (15 – 20 centimeters) being most common for downstream migrants. Depending partly on growing conditions in their rearing habitat, steelhead may migrate downstream to estuaries as age 0+ juveniles or may rear in streams for up to four years before outmigrating as smolts to the estuary and ocean (Shapovalov and Taft 1954). As well, smolts may rear for one month to a year in an estuary before entering the ocean (Shapovalov and Taft 1954, Barnhart 1991).

<u>Pacific Lamprey Life Stages</u>

The following information was derived primarily from a single comprehensive source (Streif 2008). Brown et al., (2009) provides more detailed information on the linkages of physical habitat to specific life stages of Pacific lamprey.

<u>Adult</u>

After spending 1 to 3 years in the marine environment, Pacific lampreys cease feeding and migrate to freshwater between February and June. They are thought to overwinter and remain in freshwater habitat for approximately one year before spawning, where they may shrink in size up to 20 percent. Most upstream migration takes place at night. Adult size at the time of migration ranges from about 15 to 25 inches. Pacific lampreys spawn in similar habitats to salmon; in gravel bottomed streams, at the upstream end of riffle habitat, typically above suitable juvenile lamprey (ammocoete) habitat. Spawning occurs between March and July depending upon location within their range. The degree of homing is unknown, but adult lampreys cue in on ammocoete areas which release pheromones that are thought to aid adult migration and spawning location. Both sexes construct the nests, often moving stones with their mouth. After the eggs are deposited and fertilized, the adults typically die within 3 to 36 days after spawning.

<u>Egg</u>

The period of incubation is dependent on water temperature, and may range from 18 – 49 days. Egg survival is optimal in a range of 10 – 18 ° C, and sharply declines once temperatures reach 22 ° C. Within this range, at 15° C, embryos hatch in approximately 19 days (Streif 2008).

Juvenile

Juvenile Pacific lampreys are characterized by two phases of growth (ammocoete and macropthalmia) in which individuals utilize different aspects of similar rearing habitat.

Ammocoetes

After emerging from eggs, ammocoetes drift downstream to areas of low velocity and fine substrates where they burrow, grow and live as filter feeders for 3 to 7 years and feed primarily on diatoms and algae. Several generations and age classes of ammocoetes may occur in high densities. Ammocoetes move downstream as they age and during high flow events. Little is known about movement and locations of ammocoetes within the substrates. Anecdotal information suggests that they may occur within the hyporheic zone and may move laterally through stream substrates.

Macropthalmia

Metamorphosis to macropthalmia (juvenile outmigrating life stage) occurs gradually over several months as developmental changes occur, including the appearance of eyes and teeth, and they leave the substrate to enter the water column. This outmigrating life stage differs to that of steelhead smolts in two ways: it typically occurs over a longer period of time; and, during outmigration, macropthalmia utilize habitat differently than in the preceding ammocoete life stage, namely, they utilize the water column as opposed to the subsurface streambed substrate. Transformation from ammocoetes to macropthalmia typically begins in the summer and is complete by winter. Macrophthalmia slowly emigrate downstream between late fall and spring where they mature into adults and enter the ocean.

Management Operations and Potential Threats to Target Species

The District implements a variety of management operations as described in detail in Chapter 2.0. Each of these management operations can potentially threaten steelhead and/or Pacific lamprey (hereafter referred to as lamprey). This section describes how such management operations may impact the target species both in terms of the general categories of threats associated and the specific factors that impact the life stages of the target species. Management operations, threats and factors are summarized in Table 6-4, depicted in Figure 6-14, and described in further detail below.

Construction and Maintenance of Artificial Structures

The construction of physical structures in the stream channel can impede migration and movement upstream and downstream for juvenile and adult life stages of both target species to spawning and/or rearing areas. In some cases, areas that were historically accessible are no longer accessible; in other cases, areas may only be accessible seasonally or intermittently. Structures including dams, diversions, culverts, road and bridge crossings, and other grade control structures (e.g., utilities) may create physical and/or velocity barriers. Impoundments created by dams and diversions may create environmental barriers (e.g., poor water quality, predation from non-native species) that negatively impact the migration and movement of adult and juvenile stages of both target species. Impoundments may also submerge historical spawning and rearing habitat.

Upstream migration over some structures can be mitigated with fish ladders or weirs; however many designs suitable for steelhead are not suitable for Pacific lampreys. The high level of swimming energy required by adult Pacific lampreys to pass through fish ladders or culverts, combined with sharp angles and high water velocities, effectively block or restrict passage (USFWS 2008). During downstream migrations juvenile steelhead and/or lampreys may be entrained in water diversions without fish screens. Outmigrating juvenile lamprey are also susceptible to getting impinged on fish screens, potentially resulting in injury or death.

In addition to altering hydrological regime, dams and diversions may disrupt downstream transport of sediment and large woody debris, which are important components for the development of quality spawning and rearing habitat (Collins 1976) normally utilized by juvenile and adult stages of both target species. Dams can also alter nutrient cycling and food supplies to downstream fish communities.

Table A-8. Potential relationships between management operations and factors affecting life stages of two target species, *Oncorhynchus mykiss* (steelhead), and *Entosphunus tridentata* (Pacific lamprey). Bold text in the "Factors" column indicates management operations that may positively impact life stages of target species; non-bold text indicates factors that negatively impact life stages of target species.

Management Operations Potentially Threatening Target Species	Potential Threats Operations Pose to Target Species	Associated Factors Impacting Life Stages of Target Species	Steelhead				Pacific Lamprey			
			Egg	Juvenile: Parr/Fry	Juvenile: Smolt	Adult	Egg	Juvenile: Ammo-coete	Juvenile: Macro-pthalmia	Adult
Construction and maintenance of artificial structures: dams/diversions, reservoirs, instream ponds, fish ladders/screens, culverts, bridge/road crossings grade control structures	Physical and environmental barriers to migration and movement	Structures and impoundments can block migration to historically available spawning and rearing habitat; access to ocean		X	X	X		X	X	X
	Fish passage facility not maintained or properly designed	Delays in migration can cause stress, injury or mortality during passage; diversion screens can impinge movement and cause stress or injury			X	X		X	X	X
	Structures block downstream transport of sediment	Insufficient sediment quantity and/or quality for spawning and rearing habitat		X		X[1]		X		X[1]
Water Supply and/or Facility Maintenance Operations: reservoir releases, flow augmentation, diversions, dewatering for instream projects	Overall changes to natural flow regime	Altering cues that trigger upstream or downstream fish migration			X	X			X	X
	Decrease in flow	Dewatering redds, stranding juvenile fish, inadequate water depth for adult migration, reduced growth rates, poor water quality and temperature	X	X	X	X	X	X	X	X
	Increase in flow (non-imported water)	Increase sheer stress and sediment transport affecting quantity and quality of spawning and rearing habitat; flows can also displace fry and juvenile fish	X	X			X	X		
	Imported water	Introduced non-native organisms: competition (food and habit), predation, hybridization	X	X	X	X	X	X	X	X
		Disease: Reduced fitness and increased susceptibility to mortality for all life stages.	X	X	X	X	X	X	X	X
		Poor water quality (e.g., increased water temperatures, turbidity)	X	X	X	X	X	X	X	X
		Water imports can increase baseflow and lengthen downstream perennial extent resulting in increased carrying capacity	**X**	**X**			**X**	**X**		

Management Operations Potentially Threatening Target Species	Potential Threats Operations Pose to Target Species	Associated Factors Impacting Life Stages of Target Species	Steelhead				Pacific Lamprey			
			Egg	Juvenile		Adult	Egg	Juvenile		Adult
				Parr/Fry	Smolt			Ammo-coete	Macro-pthalmia	
Channel Modification and Maintenance: Channelization, levee construction, flood bypass, armored bed and banks, sediment removal, vegetation and woody debris removal, and bank protection.	Stream and floodplain degradation	Increase bed mobility/scour, lack of large woody debris and suitable substrate affecting quantity and quality of spawning, rearing and adult holding habitat, loss of side channels	X	X		X	X	X		X
	Instream erosion causing excess fine sediment deposition	Spawning gravel quality and quantity, Summer and winter rearing habitat, pool filling can reduce quality of adult holding habitat	X	X		X			X	
	Alteration to riparian vegetation, dewatering for sediment removal	Water quality and temperature	X	X	X	X	X	X	X	X
Management of Rural Areas: Road construction and maintenance; grazing, timber harvest, mining	Surface erosion and landslides causing excess fine sediment deposition	Spawning gravel quality and quantity, Summer and winter rearing habitat, pool filling can reduce quality of adult holding habitat	X	X		X			X	
Urbanization: storm water runoff, accidental spills, chemical treatment, illegal dumping, commercial shipping accidents	Chemical Contaminants	Water quality and temperature	X	X	X	X	X	X	X	X
	Poor Physical Water Quality	Water quality and temperature, environmental migration barriers	X	X	X	X	X	X	X	X
	Homelessness, trash	Poor water quality, poaching	X	X	X	X	X	X	X	X
	Increased magnitude and frequency of peak flows	Scour developing eggs, displace fry and juvenile fish, increase bed mobility affecting quantity and quality of spawning and rearing habitat	X	X			X	X		
	Estuarine Conditions	Water quality and temperature, predation, loss of estuarine habitat			X				X	
	Increased flows during dry season	**Runoff can increase baseflow and lengthen downstream perennial extent resulting in increased carrying capacity**	**X**	**X**			**X**	**X**		
Recreation: boating, fishing, swimming	Introduce non-native organisms and disease	Competition with introduced species (food and habitat competition), predation and hybridization	X	X	X	X	X	X	X	X
	Disturbance to fish	Human disturbance in adult holding habitat can stress fish				X				X
Fisheries Management	Over harvest, poaching	Removal of adult fish in ocean and freshwater holding areas				X		X		X

Management Operations Potentially Threatening Target Species	Potential Threats Operations Pose to Target Species	Associated Factors Impacting Life Stages of Target Species	Steelhead				Pacific Lamprey			
			Egg	Juvenile		Adult	Egg	Juvenile		Adult
				Parr/Fry	Smolt			Ammo-coete	Macro-pthalmia	
	Hatchery fish	Loss of genetic diversity and introduction of diseases; both can result in reduced fitness and mortality		X	X	X				
Regional Development	Ocean Conditions	Water quality and temperature				X				X
Global Development	Climate Change	Water quality and temperature	X	X	X	X	X	X	X	X

[1] Affects adult spawning life stage

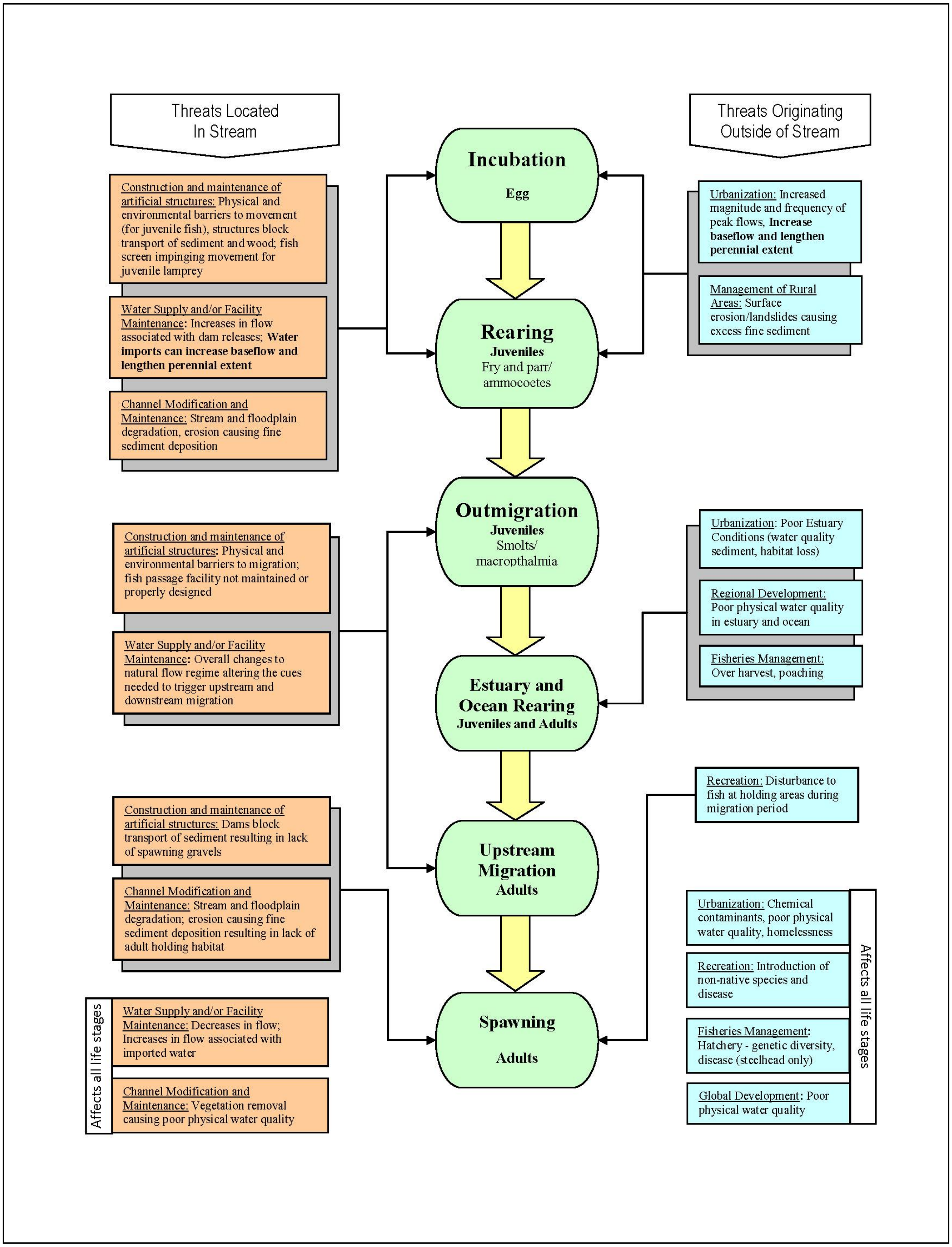

Figure 6-15. Level 3 generic conceptual model illustrating factors influencing life history stages of two target species: Oncorhynchus mykiss (steelhead), and Entosphunus tridentata (Pacific lamprey).

Water Supply and/or Facility Maintenance Operations

Operations that result in changes to hydrologic regime can affect fish migration and movement and the quality and quantity of habitat for different life stages of steelhead and lamprey. Operations discussed here that alter the natural flow regime include reservoir releases, flow augmentation, water diversions and dewatering the channel for construction projects.

Such operations may impact steelhead and lamprey populations by altering cues that trigger migration downstream (juvenile) and upstream (adults), thereby influencing when individuals attempt to migrate, and possibly where (e.g., which stream). Operations that augment springtime flows may delay juvenile outmigration by increasing the volume and velocity of base flow from the typical seasonal trend and providing a delayed flow cue. Conversely, augmented springtime flows may enhance the perennial quality of a stream, and increase the number of successful outmigrants, particularly in drought years when the stream might otherwise dry back in some reaches and prevent outmigration. The potential of imported water operations to negatively impact adult upstream migration depends on two factors: the volume of import relative to the natural hydrograph, and the chemical properties of the imported water. Imported flows that represent a relatively small proportion of the hydrograph are less likely to negatively impact the ability of adult steelhead or lampreys to cue on flow alone, however, large import volumes may alter the timing of upstream migration. Adults of both target species are known to migrate upstream in response to chemical cues (Quinn et al., 1989, Streif 2008). Though the precise mechanisms involved in this process are not well-understood, the chemical qualities of the mixed flow (imported and local) could potentially impact the ability of adults of either species to detect chemical cues that facilitate their return to their natal streams (Quinn et al., 1989, Streif 2008).

Rapid reductions in flow associated with dam operations and/or diversions can result in dewatering areas that contain redds, negatively impacting egg and alevin survival as well as stranding juvenile steelhead and lamprey (Stillwater 2006, USFWS 2008). Instream projects (e.g., sediment removal, culvert replacements) may also dry up stream reaches where juvenile steelhead and ammocoetes reside. Reduced flows can result in poor water quality and increased water temperature. Elevated water temperatures may reduce populations of all life stages of target species both directly through increased mortality and indirectly through factors such as changes to growth rates or timing of emergence and downstream migration (Stillwater 2006, Luzier 2009). Warm water may also favor non-native fish competitors or increase susceptibility to mortality from diseases (Holt *et al.* 1975). Flow reductions may also delay or stop steelhead migration if minimum water depths are not maintained (Everest *et al.* 1985), and likely lamprey as well, as they tend to travel deeper in the water column than steelhead (Streif 2008).

Sudden large increases in flow associated with dam releases can displace juvenile steelhead and lamprey, increase shear stress on channel, and can scour suitable substrate used for adult spawning and juvenile rearing (Stillwater 2006, Streif 2008). In addition to those impacts discussed above, imported water can potentially have both negative and positive impacts on target species. Imported water may negatively affect water quality, by increasing turbidity and temperatures, thereby impacting growth rates, and fitness (increasing susceptibility to disease). It may also introduce non-native fish, which can affect populations of steelhead and lamprey through competition for resources, predation and hybridization. Conversely, imported water may positively influence rearing habitat by increasing base flows and lengthening the perennial extent, thereby increasing carrying capacity of fish populations compared to historical flow conditions.

Channel Modification and Maintenance

Channel modification and stream maintenance activities that result in stream and floodplain degradation can affect the quality and quantity of spawning and rearing habitat for juvenile steelhead and lamprey. Channel modification projects include channelization, levee construction, flood bypass structures and armoring of channel bed and/or banks. Stream maintenance activities include sediment removal, vegetation and large woody debris removal and bank protection.

Channel simplification (i.e., straightening, levee construction) reduces overall roughness of channel, which can result in increased water velocities and sediment transport capacity (Stillwater Sciences 2006). Furthermore, armoring of banks combined with higher water velocities can increase sheer stress to channel bed, resulting in channel incision and bank erosion at downstream locations. Channel incision over time can lead to disconnection to flood prone areas, loss of side channels and reduction in the large woody debris in the channel. These changes in channel morphology can all greatly influence the quality of habitats that support spawning, rearing and migratory life stages for steelhead and lamprey. In addition, lack of channel-forming structure (e.g., large woody debris) combined with higher levels of fine sediment supply, can decrease the number of deep pools used by adult steelhead and lamprey for resting during migration periods.

Channel maintenance activities, such as removal of bank vegetation and large woody debris that are implemented to maintain flood design capacities, similarly affect habitat quality as described above, and impact overall water quality (e.g., lower dissolved oxygen and high water temperatures). Sediment removal activities that require dewatering the channel during dredging can also reduce water quality conditions, and lead to stress or mortality of all life stages of target species.

Urban Development

Urbanization poses several threats to both steelhead and lamprey populations. Storm water runoff can introduce chemical contamination, and degrade water quality (e.g., decrease dissolved oxygen and increase water temperature) in receiving waters. Chemical contaminants and poor water quality conditions can also result from accidental spills, chemical treatments and illegal dumping activities that occur directly in streams. Homeless encampments along streams can also contribute waste that contributes to chemical contamination and poor water quality conditions in streams. Chemical contaminants can cause acute or chronic toxicity to all life stages of both target species. Poor water quality can contribute to stress, disease, and/or mortality to all life stages of both target species.

Urban runoff can also increase channel instability due to higher and more frequent peak flows that may cause bank erosion and higher sediment supply to the channel. Such sediment loads can negatively influence the quantity and quality of habitats available to support spawning, rearing and migratory life stages for steelhead and lamprey.

Threats associated with urbanization, as described above, can also degrade estuarine habitats, which are important holding habitats for steelhead and lamprey during upstream and downstream migration. Commercial shipping accidents in the San Francisco Bay can also contribute contaminants that may impact estuarine habitats.

Land Use Disturbance in Rural Areas

Land use activities in rural areas may include construction and maintenance of rural roads, grazing, timber harvest and mining. These activities can introduce considerable volumes of excess fine sediment to streams, thereby degrading the quality of rearing habitat for juveniles, as well as spawning and holding habitat for adults of both target species.

Recreation

Human disturbance associated with recreational activities such as boating, swimming or fishing may affect adult steelhead and lamprey. These activities may especially affect fish during holding periods and can result in stress and possible mortality (Stillwater 2006, Streif 2008). Fishing activities may also result in intentional or unintentional introduction of non-native organisms. Introduction of non-native fishes (e.g., largemouth bass) can result in predation or competition for resources with target species.

Fisheries Management

Fisheries management actions can affect steelhead and lamprey populations during adult stages in the ocean and returning to natal streams. Management actions may include establishing quotas for harvest, enforcement against poaching and proper utilization of hatchery fish. Steelhead are most susceptible to poaching during holding periods when they congregate in large numbers in a small number of suitable pools (Stillwater Sciences 2006). Steelhead are typically most susceptible in streams that are more accessible to people. Introduction of hatchery steelhead can result in the loss of genetic diversity and introduction of diseases, both potentially causing reduced fitness and mortality.

Regional and Global Development

Regional and global development resulting in changes to ocean conditions can potentially impact both target species. Increases in water temperature can change the relative distribution and abundance of prey species and/or potential predators for steelhead and lamprey. Reductions in the availability of host/food species can reduce survival and growth for both target species.

A.2 Map Production

This section discusses the sources and associated accuracy of the data used to generate mapped figures as well as many of the quantitative figures in this Profile.

A.2.1 Basemap Production

The Bay Area Aquatic Resources Inventory (BAARI) comprises the main Level 1 data set used to generate the basemap. This data set consists of three component GIS layers: stream network, wetlands, and riparian functional areas. Other Level 1 data sets included in the basemap are the stormdrain network (published by the Oakland Museum – see below), the watershed boundary (CalWater 2.2.1), and several District data sets: fee title and easements, percolation ponds, and the Lower Coyote Creek Reach data set (note: the location of the District mitigation site shown as a point was estimated as the centroid of Reach 2).

All channels, ditches, stormdrains, open water features, and wetlands are derived from the BAARI (see below). All non-tidal features were mapped at a scale of 1:5,000, while tidal features were mapped at 1:2,500. The minimum mapping unit (mmu) for non-tidal and tidal wetlands was 0.1 and 0.05 hectares, respectively. The mmu for all streams was 50m. The BAARI QAQC process (see below) was applied to the entire BAARI extent.

CRAM survey points and associated data were derived from the CRAM database (California Wetlands Portal, http://www.californiawetlands.net/tracker/). All thresholds represented in the maps were derived from the data analysis section of this report.

A.2.2 Bay Area Aquatic Resources Inventory Description

BAARI is a standardized effort to map all aquatic resource features in the Bay Area, excluding groundwater, using high-resolution (1m) remotely sensed imagery from the National Agriculture Imagery Program (NAIP) and a variety of ancillary data sources, including USGS topographic maps, municipal storm drain layers, DEM-derived hillshade, Google Earth, the National Hydrography Dataset (NHD), and the National Wetlands Inventory (NWI).

The standardized BAARI mapping methodology includes quality assurance and quality control procedures (QAQC) to ensure that the map products meet minimum federal and state standards and are consistent across the region. Part of the BAARI QAQC requires that all data have an error rate less than 15% in a number of quantified parameters. QAQC scores for the Coyote Creek watershed can be found at www.californiawetlands.org. BAARI layers in this figure include the stream network, wetlands, and riparian areas. For detailed information about the BAARI mapping standards and methods visit www.wrmp.org/prop50. All other data were acquired from the Santa Clara Valley Water District and have varying mapping methods and levels of accuracy. To view BAARI data for other regions, see www.californiawetlands.net.

Surface features in the BAARI datasets were developed through interpretation of 2009 aerial imagery along with supporting ancillary datasets. QAQC of the dataset was also completed with remote sensing techniques. At the time of publication, no follow-up field work was done to ground truth the BAARI datasets. Subsurface stormdrain data incorporated into BAARI for this project are from the Creek and

Watershed Map collection published by the Oakland Museum www.oaklandmuseumofcalifornia.net/creeks. Data for this map collection were collected by William Lettis and Associates (WLA). Site-specific management questions should be supported by site verification of these data.

Figures 2-3 and 2-4 are based on the Riparian Area Mapping Tool (RAMT). RAMT is a part of the BAARI mapping methodology. It is VBA script model that calculates riparian functional width based on the BAARI data -- stream network and/or wetland boundaries plus vegetation and slope information. RAMT assigns both a left and right slope and vegetation value to each segment of the drainage network (length of channel between confluences or between them and a channel endpoint). RAMT creates a riverine polygon layer based on heads-up (on-screen) digitizing of drainage network midlines, plus polygons of channel area based heads-up digitizing of channel banks when they are visible or user-selected standard channel widths. Channel origins are modeled as variable water source areas. A similar approach is used to map wetlands riparian areas except only the upland side of a wetland is considered and wetlands lack source areas or origins.

The accuracy of RAMT outputs depend on the accuracy of the data inputs. Model inputs for modern riparian widths were from the following sources: stream network (BAARI); vegetation data (California Department of Forestry and Fire); and slope data (US Geological Survey (USGS) 10 meter National Elevation Dataset (NED)). Historical riparian widths were also calculated using the BAARI riparian model. Data inputs to the model included the historical stream network (Coyote Creek Historical Ecology Study – Grossinger et al. 2006), slope (US Geological Survey [USGS]), and vegetation (Coyote Creek Historical Ecology Study – Ibid).

Due to the automated methodology and reliance on input data from various sources, there is an expectation of some error in the riparian model output. The biggest source of error is the vegetation input data. The best available data are dated and more coarse than desired. Visual comparison between the output and aerial imagery, suggests the error is not substantial, although it has not yet been quantified. The calculated (modeled) riparian functional widths are well within the range of locally observed values.

The historical stream network was reconstructed in a GIS for the valley based on interpretation of historical records including maps, land grants, and court documents. Some validation from historical aerial photography was also conducted. The historical maps represent a time period just prior to European settlement.

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