

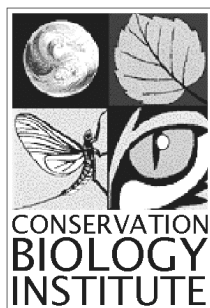
MONITORING PLAN FOR THE SANTA MARGARITA RIVER

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1.0 INTRODUCTION

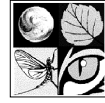
1.1 PURPOSE OF THE MONITORING PROGRAM

The purpose of the Santa Margarita River monitoring program is to (1) provide a quantitative assessment of the key ecological processes and ecological integrity of the Santa Margarita river system below the Temecula-Murrieta Creek confluence, (2) determine the potential effects of stressors on the system, and (3) evaluate the success of stressor abatement strategies and allow adaptive management to modify and refine strategies. The development of the monitoring program was initiated in response to the upcoming discharges of water to the river as part of the water rights settlement between USMC Base Camp Pendleton and the Rancho California Water District. The Nature Conservancy, which has an interest in maintaining and enhancing the resource values of the Santa Margarita River system, participated in development of a settlement agreement that provided for the maintenance of base flows in the river. Maintaining base flows and other physical, hydrological, and biological processes and conditions is critical to maintaining the high resource values of the system. The monitoring program is designed to measure a number of metrics relating to these processes and conditions so that resource values can be assessed and managed at the watershed scale to ensure their long-term conservation. Decision-makers within the watershed can use the results of the monitoring program to determine the current status of resources, measure changes over time, and assess the potential effects of proposed activities, such as development and water supply management, on the critical processes and conditions of the river system.

This monitoring plan summarizes the conservation targets and associated key ecological factors identified for the Santa Margarita River system (Section 2.0), discusses stresses and sources of these stresses and their potential effects (Section 3.0), and describes physical, hydrological, and biological elements for monitoring potential changes in the system associated with the array of stressors (Section 4.0) and the rationale for their inclusion. The monitoring plan also recommends a sampling design for the field monitoring program, suggested field monitoring methods, and a monitoring schedule.

1.2 PROGRAM OBJECTIVES

The ecological integrity or condition of the river is a function of an array of interrelated physical, hydrological, and biological factors. In many instances, our understanding of these interrelationships in the Santa Margarita River system is poor. In addition, a number of these factors may be influenced by stresses present in the Santa Margarita watershed, the prescribed settlement flows, or other strategies to abate threats to the Santa Margarita River system and, therefore, are subject to change even as we attempt to monitor their baseline patterns. The monitoring program has been developed to address the following general objectives:



1. Identify and monitor key ecological factors of the Santa Margarita River system to gain a better understanding of the baseline patterns of key riverine processes operating in the watershed, their range of variation, and their interrelationships.
2. Assess ecological integrity of the Santa Margarita River system, evaluate effects of stressors, and monitor future changes from stressor abatement strategies.
3. Document changes in the quality of habitats for target species to inform management decisions and evaluate management actions.
4. Communicate information on the condition of the Santa Margarita River system to the general public, resource users, resource managers, regulators, and researchers.

2.0 CONSERVATION TARGETS AND KEY ECOLOGICAL FACTORS

2.1 CONSERVATION TARGETS

Identifying conservation targets is a tool for conserving native biodiversity in complex systems that support many different systems, communities, and species. An approach used by The Nature Conservancy is to identify a few ecological systems, communities, and species spanning a variety of spatial scales that represent a broader array of biodiversity (Braun et al. 2000). Conservation targets for the Santa Margarita River system include elements that capture the ecological patterns and processes that shape biodiversity in the system, at-risk elements, and other individually interesting elements of biodiversity.

Conservation targets include: (1) coastal stream and riparian communities, (2) upper terrace woodland communities, (3) freshwater marsh communities, (4) coast range newt, (5) coastal sage scrub communities, (6) large area-dependent species (i.e., mountain lion, neotropical migratory birds, and steelhead trout), and (7) coastal dune and estuary communities (Table 1). This monitoring plan focuses only on the first four targets. The remaining targets merit specific treatment that is beyond the scope of this riverine-focused plan.



Table 1
Conservation Targets for the Santa Margarita River Watershed

Scale	-Communities and Ecological Systems-			
	Species	Aquatic	Riparian	Upland
Regional	Mountain lion			
	Neotropical migratory birds			
Coarse	Steelhead trout			
		Coastal stream and riparian communities		
		Coastal dune and estuary communities		
Intermediate	Coast range newt		Upper terrace woodland communities	Coastal sage scrub communities
			Freshwater marsh communities	
Local				



2.2 KEY ECOLOGICAL FACTORS

Key ecological factors are processes and resource characteristics that are essential for maintaining the ecological integrity of the conservation targets (The Nature Conservancy 2001). Key ecological factors are grouped into three categories: landscape context, condition, and size. For targets in the Santa Margarita River system, landscape context refers to hydrologic and geomorphologic processes that create and maintain conditions suitable for target resources and connectivity within the landscape. Factors in the condition category include community age and structure patterns, species richness and population stability characteristics, reproductive output and dispersal, and the distribution and abundance of native flora and fauna. Key ecological factors in the category of size include sufficient floodplain area to allow natural geomorphic processes to occur, adequate habitat areas to sustain stable populations of target species, and adequate buffer areas to mitigate influences of adjacent land use practices. Key ecological factors for each of the Santa Margarita River system targets are shown in Appendix A.

The coastal stream and riparian communities are further subdivided into four major functional units that differ in physical and biological characteristics, processes, and species composition (Stetson 2001, Holland and Haas 1996). These functional units are the basis of the recommended field sampling design.

1. The gorge reach, from approximately river mile (RM) 24 to 29, is characterized by high gradients (1.5-2.8%) in a narrow canyon. Bedrock and boulders dominate the channel, and cobbles form the substrate of the narrow floodplain. The gorge reach has a step-pool geomorphology, with the pools often enhanced by beaver dams. Little sediment is stored in this reach, so there are few sand bars suitable for arroyo toad rearing. Riparian vegetation is less dense than in downstream reaches and is dominated by oaks. In areas where cottonwood-willow riparian habitat can establish, these tree species are limited by beaver herbivory. Arroyo chubs, pond turtles, and other herpetofauna occur in pools in this reach. Oaks are used by a variety of resident and migratory bird species, including raptors such as Cooper's hawk. Pool habitat quality in the gorge reach depends on summer base flows and is sensitive to water quality changes that may result in reduced dissolved oxygen concentrations or sedimentation.
2. The middle reach of the river, from approximately RM 10 to 24, is characterized by moderate stream gradients (0.4-1.0%). Within this reach, the canyon through which the river flows has wide, sinuous sections that alternate with narrow, straight sections. The channel in this reach migrates only during very large floods. The middle reach is a zone of temporary sediment storage and active transport. Sediment is stored temporarily in alternate and point floodplain bars in sinuous sections and transported through straighter sections. The point and floodplain bars provide locations for recruitment and germination of cottonwood and willow-dominated riparian communities.



High groundwater levels allow survival and growth of these species. Higher elevation terraces in this reach are dominated by oak riparian communities.

Hydrogeomorphic processes maintain habitat quality for target species in this reach by creating open sand bars and floodplain areas, which are sites for riparian vegetation recruitment and arroyo toad rearing. These processes also maintain channel and floodplain pool habitats for aquatic species such as arroyo chub and breeding arroyo toad. The least Bell's vireo and southwestern willow flycatcher have been detected in cottonwood-willow riparian habitats in the middle reach, which are present in patches of varying age/size structure characteristics. Low flow discharges of sufficient water quality and relatively high groundwater elevations are important to maintain productive riparian habitats and high quality aquatic habitats.

3. The lower reach of the river, from approximately RM 1 to 10, is characterized by low stream gradients (<0.4%). The river channel meanders through a broad, sandy, vegetated floodplain. This reach of the river is a zone of sediment storage and active transport. Below the lowest end of this reach, below the Ysidora Narrows, the river becomes tidally influenced. Habitat quality in the lower reach of the river is maintained by overbank flow that inundates floodplain areas, active channel meandering, and sediment deposition. These characteristics maintain a varied age structure of riparian vegetation and open sandy habitats. Floodplains are wider in the lower reach of the river than in the middle reach, and the majority of cottonwood-willow dominated riparian habitat is in this reach. Pool habitat is generally lacking in the lower reach, but vegetated channel areas and backwater habitats in the floodplain (e.g., relict channel features) provide habitat for native aquatic species such as the pond turtle and are a source of invertebrate production. The open sandy areas provide habitat for arroyo toad rearing.
4. Several tributaries to the mainstem, particularly those that drain the north slope of the watershed, support conservation targets. These include Sandia Creek, De Luz Creek, and Roblar Creek (a tributary of De Luz Creek). Sandia, De Luz, and Roblar creeks drain south from the Santa Rosa Plateau. The upper reaches of these tributaries have high stream gradients, while the lower reaches have moderate gradients. These tributary streams are characterized by oak and willow riparian communities and support habitat for coast range newt, arroyo chub, arroyo toad, and, formerly, southern steelhead trout. In addition to the tributaries described above, we include Stone Creek, which drains north to the mainstem Santa Margarita River, as part of this functional unit. Stone Creek is one of the few tributaries in the watershed whose subbasin has not been modified by land use changes and, therefore, provides a good "control" site for monitoring purposes. While we do not have a good understanding of the processes that maintain key ecological factors in these drainages, because of the similarity of their physical characteristics to



the middle mainstem reach, they are likely maintained by the same processes discussed above for the middle reach. The processes include high flows to drive sediment and channel dynamics, good water quality in both surface and ground water-supported pool habitats, and groundwater elevations that support riparian vegetation communities and maintain pool habitats.

Within the three mainstem reaches, Stetson (2001) has identified a total of 20 subreaches. These subreaches are geomorphically distinct and tend to be relatively uniform with respect to canyon width and form, channel bed substrate, floodplain bar width, floodplain substrate, and in-channel and off-channel pool characteristics. Little physical analysis has been conducted of the tributaries of the system; therefore, we have a poorer understanding of the targets and key ecological processes in the tributaries than for the mainstem river. For the purposes of the monitoring program, we have divided two tributary systems (DeLuz and Sandia creeks) into subreaches based on slope, topography, and locations of tributary confluences.

3.0 STRESSES AND SOURCES OF STRESS

Stresses in the Santa Margarita River watershed can adversely affect conservation targets by altering key ecological factors. Gaining a greater understanding of the potential influences of the stressors on ecological factors is a fundamental goal of a monitoring program. Stressors and their potential effects on the Santa Margarita River system are discussed below.

3.1 STRESSES

3.1.1 Alteration of Base Flows

Late season, base flow discharges in the mainstem have been steadily decreasing due to upstream reservoir operation, increased groundwater pumping, and declining rates of groundwater recharge (associated with decreased infiltration in urbanizing areas). In tributary drainages, base flows have been increasing due to irrigation in agricultural and urban areas. Decreasing base flows in the mainstem can reduce groundwater elevations and reduce the abundance of pool habitats. Increasing base flows in these tributary drainages are modifying their hydrology from historically intermittent flows to perennial base flows. This situation facilitates establishment of nonnative species such as bullfrogs.

3.1.2 Alteration of Flood Regime

Urbanization and channelization projects can increase the magnitude of peak flood events, with corresponding negative impacts on riparian habitat and sediment dynamics. Urbanization and channelization also alter the flood flow regime by making flows flashier, increasing the number of flood events, and altering the timing of peak flood



events. At the same time, some of the impacts may be offset by the effect of the Vail reservoir. In fact, for some hydrologic parameters such as flood peaks, urbanizing influences may counterbalance the effects of the reservoirs by restoring peak floods to the river. However, it is unknown how such a modified hydrograph compares to the historic hydrographs of the Santa Margarita River system. Alteration of the river's hydrograph can alter geomorphic processes, the frequency and extent of floodplain inundation, and sediment dynamics. These alterations can reduce the establishment of new cohorts of riparian vegetation, reduce formation of new pool habitat, and change the composition of channel and sand bar substrates.

3.1.3 Exotic Species

Nonnative plants and animals are an increasing concern for native species and their habitats and the hydrology of the Santa Margarita River system. Nonnative species include the invasive giant reed (*Arundo donax*), nonnative fish (e.g., red-eyed bass), bullfrogs, and beavers. Nonnative species can reduce habitat quality by displacing native plants or invading aquatic habitats, affect channel dynamics by stabilizing banks and obstructing river flow, and prey on or compete with native species.

3.1.4 Alteration of Water Chemistry and Temperature

Point and non-point discharges in the watershed contribute suspended and dissolved solids, nutrients, metals, petroleum compounds, pathogens, and human pharmaceuticals to surface waters. Point and non-point source pollutants can alter the productivity, species composition, and habitat quality of aquatic habitats. Elevated nutrient concentrations are of particular concern in that they can cause algal blooms and depressed dissolved oxygen concentrations in aquatic habitats. These effects are particularly important during summer base flow periods.

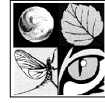
3.1.5 Alteration of Natural Sediment Regime

Land uses in the Santa Margarita River watershed have likely altered the river's sediment transport regime. Excessive amounts of fine sediment transported from areas graded during development can fill pools and interstitial spaces in sand and gravel-dominated channel substrates. Reduced transport of coarse sediment resulting from sand mining activities and water storage structures reduces the amount of suitable sand bar habitat for use by arroyo toads.

3.2 SOURCES OF STRESSES

3.2.1 Water Management for Water Supply

The management and use of surface water and groundwater for domestic and agricultural supplies affect the hydrology of the basin. Water supplies are obtained via extraction of groundwater and storage of surface water at Vail and Skinner reservoirs. While the



reservoirs are designed to allow elevated river flows to pass downstream, they affect the low flow hydrograph. Water management in the watershed has resulted in lowered groundwater levels and an associated reduction in the quantity of groundwater that resurfaces at the gorge. With the exception of the record flood in 1993, downstream releases from Vail Reservoir are promptly removed by groundwater pumps below the dam (Groeneveld, personal communication). These hydrologic modifications have diminished river base flows and groundwater levels that support aquatic and riparian species.

3.2.2 Urban Development

Development within the watershed may affect various key ecological factors. Development-related stressors generally include: (1) changes in hydrologic patterns from runoff of impervious surfaces, (2) contribution of chemical constituents to the river and tributaries, and (3) direct or indirect effects on habitat quality (e.g., habitat loss, noise and light pollution, increased abundance of nonnative species).

Urban development generally increases the area of impervious surfaces in the watershed, resulting in decreased infiltration rates and increases in peak storm runoff. Runoff from urban areas typically has elevated concentrations of nutrients and metals (e.g., lead). Runoff from development and the associated hydrologic modifications that are expressed in the lower basin can result in alterations to geomorphic processes and water quality. These alterations can, in turn, greatly affect suitable germination areas, breeding sites, and habitat for riparian plants and animals. Development also results in a direct loss of habitat area and reduced habitat quality as a result of increased light and noise pollution and nonnative species. The cumulative effects of development can reduce the abundance of target species in the system and reduce habitat connectivity between areas of viable open space.

3.2.3 Agricultural Land Uses

Agricultural land uses in the Santa Margarita River watershed consist largely of citrus and avocado orchards, vineyards, and nurseries. Runoff from agricultural lands typically contains elevated concentrations of nutrients and other chemical constituents (e.g., herbicides and pesticides). Irrigation of agricultural areas often alters the hydrology of adjacent streams, resulting in modifications to surface and groundwater hydrology and water quality. However, use of imported water of higher quality than native groundwater for irrigation may actually improve groundwater quality for certain constituents (e.g., total dissolved solids) over time (Groeneveld, personal communication). Conversion of natural habitat to agricultural land potentially facilitates the invasion of nonnative plant and animal species, reduces the abundance of habitat and target species in the system, and fragments natural habitats.



3.2.4 Effluent Discharges

Point source discharges of treated sewage effluent can alter river water quality and discharge patterns. Elevated constituents in effluent include nutrients and, potentially, pharmaceutical compounds from human waste. As urban growth occurs, sewage effluent comprises a larger percentage of the total annual discharge in the river. The Regional Water Quality Control Board has identified point source discharges in conjunction with urban and agricultural runoff as the sources of nutrients causing impairment of beneficial uses in Rainbow Creek and the Santa Margarita River estuary. These elevated chemical constituents can also affect the river system by altering productivity, decreasing dissolved oxygen concentrations, and altering the species composition of stream invertebrates.

3.3 MONITORING HYPOTHESES

The monitoring program is structured primarily to develop an understanding of baseline spatial and temporal patterns and variability of key ecological factors. The monitoring program also is structured to address hypotheses relating to how stresses may affect the Santa Margarita River system. However, system responses to potential stresses are expected to be multifaceted, and the responses of individual variables are interrelated. Therefore, attributing responses of individual variables to specific stresses is problematic. Hypotheses that may potentially be addressed via the monitoring program are presented below.

3.3.1 Alteration of Base Flows

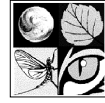
Changes in base flows in the river and tributaries will result in changes in:

- Shallow groundwater elevations
- Distribution, abundance, and patch characteristics of riparian vegetation communities
- In-channel and off-channel pool hydrology
- Distribution and abundance of pool-dependent aquatic species or life stages
- Distribution and abundance of nonnative plant and animal species

3.3.2 Alteration of Flood Regime

Changes in the flood regime of the river and tributaries will result in changes in:

- Channel and floodplain geomorphology
- Frequency and extent of overbank flooding
- Channel, floodplain, and pool substrate composition
- Distribution, abundance, and patch characteristics of riparian vegetation communities
- Distribution and physical characteristics (area, depth) of pools



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- Distribution and abundance of aquatic species

3.3.3 Exotic Species

Changes in the abundance and distribution of exotic species will result in changes in:

- Abundance and distribution of native riparian plant species
- Abundance and distribution of native riparian wildlife species
- Abundance and distribution of native aquatic species
- Geomorphic and sediment transport processes

3.3.4 Alteration of Water Chemistry and Temperature

Changes in concentrations of water quality constituents will result in changes in:

- Distribution and species composition of aquatic invertebrates
- Distribution and abundance of native aquatic vertebrate species
- Dissolved oxygen concentration of aquatic habitats

3.3.5 Alteration of Natural Sediment Regime

Changes in the sediment transport regime will result in changes in:

- Channel and floodplain geomorphology
- Channel, floodplain, and pool substrate composition
- Distribution and physical characteristics (area, depth) of pools
- Distribution, abundance, and patch characteristics of riparian vegetation communities

4.0 PROGRAM DESIGN AND DATA MANAGEMENT

4.1 PROGRAM DESIGN

In the preceding sections, we have identified conservation targets, associated key ecological factors, stressors that could potentially change the key ecological factors, and potential sources of these stressors in the Santa Margarita River system. The Santa Margarita River monitoring program is designed to collect information on the key ecological factors that we believe maintain the identified conservation targets in the system and that may change in response to stresses in the watershed. The program is also designed to integrate with existing biological and water quality monitoring programs in the watershed (e.g., Zedler et al. 2001, Santa Margarita River Water Quality Monitoring Group efforts).



The Nature Conservancy intends that this monitoring program serve as a model to be adapted and used by stakeholders in the watershed. The Nature Conservancy also recognizes that this program is ambitious and that cooperation among stakeholders in the watershed is crucial to adequately funding and implementing the program. Implementing the monitoring program likely will occur in phases and potentially may require funding sources from outside the watershed (e.g., federal, state, or foundational grants).

The monitoring program is designed to allow both the assessment of trends along the entire river system and the evaluation of patterns and processes at finer spatial scales (e.g., within specific reaches and subreaches). The monitoring information collected in this program will allow:

1. Increased understanding of the interrelationships of the hydrological, physical, and biological variables of the system.
2. Trends in these variables to be followed over time.
3. Land use managers to assess the overall condition of the system to prioritize management activities and evaluate responses to management actions.
4. Regulatory authorities, public decision-makers, and the public to have a comprehensive view of the state of the system and degree of past change prior to making land use decisions.

Field monitoring will be conducted in selected subreaches within each of the four major functional units described in Section 2.0. Nine subreaches from the total of 20 mainstem reaches were recommended for monitoring activities by Stetson (2001). These nine subreaches (Table 2) were selected to capture a range of geomorphological characteristics within each of the three mainstem reaches, while also considering vehicle accessibility. We have identified six additional subreaches in De Luz, Roblar, and Sandia creeks and an unnamed tributary (Table 2), which support conservation targets. These fifteen subreaches can be used to provide an estimate of average conditions for conservation targets along the mainstem river and selected tributaries as a whole.

Monitoring within reaches will be tailored to address the specific key ecological factors relevant to the particular reach. Field sampling will occur at multiple locations within subreaches so that variation within subreaches, as well between subreaches, can be estimated. In this way, analyses of monitoring data can be spatially or geomorphologically hierarchical, depending on the nature of the questions being addressed.

The sampling locations within each subreach, referred to as plots, are 300-foot wide swaths oriented perpendicularly to the river and extending to the outer edges of the floodplain on both sides of the river. The locations of the monitoring plots will be randomly located within each subreach. Within each plot, monitoring data will be



collected in a variety of standardized ways appropriate to the particular metric (e.g., using cross-river transects for channel geomorphology or riparian vegetation communities, visual surveys or point-counts of wildlife species within the plot, aquatic invertebrate samples). The number of plots within each subreach and locations for data collection within a plot are variable for different monitoring elements and are discussed further in Section 5. Table 2 summarizes the subreaches proposed to be monitored for different elements, the proposed number of plots per subreach, and the proposed method for each monitoring element (refer to Section 5 for details).

4.2 DATA MANAGEMENT

The effectiveness of the monitoring program will depend largely on having a data management system that will allow storage of raw data, analysis of results, and interpretation and dissemination of monitoring information. The data management system must have the capability of managing and integrating both spatial Geographic Information System (GIS) data and numerical relational data (e.g., water quality, discharge, species counts). The data management system should have a dedicated staff for the Santa Margarita River program that will be responsible for timely analysis and dissemination of results. The development of the monitoring database structure and organizational responsibilities should be initiated as soon as possible.

4.3 DATA ANALYSIS

Analysis of monitoring data should inform resource managers and decision-makers about the conditions of the Santa Margarita River system and whether human-induced changes in the watershed threaten conservation targets. To accomplish this, we ideally should have a good understanding of the baseline conditions, dynamics, and interrelationships of components of the river system prior to initiating the monitoring program so that conditions outside of the normal range can be identified. However, as is the case with many river systems, there are no comprehensive baseline data for the Santa Margarita River system prior to human alteration. As a result, for most monitoring elements the monitoring program will be unable to identify threshold conditions that are likely to trigger significant changes to the targets identified for the system. Therefore, the focus of the analyses will be to identify patterns and relationships among monitoring elements.

These analyses will examine both spatial and temporal variation in key ecological factors that correlate with high levels of integrity and resource values of conservation targets. The analysis of the patterns and relationships of monitoring elements will increase our understanding of key ecological factors and allow us to identify conditions that are favorable to conservation targets. The monitoring data also will provide a current, comprehensive assessment of the condition of the river for resource managers and decision-makers.

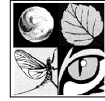


Table 2
Summary of Monitoring Program

MONITORING ELEMENT	SUBREACHES	PLOTS PER SUBREACH	DATA COLLECTION METHOD	MONITORING FREQUENCY
1.0 Hydrological and Water Quality Elements				
1.1 Hydrograph	All ¹	NA	Gaging stations	Continuous
1.2 Floodplain inundation	16, 15, 10, 9, 8, 4, 2, Tributaries	1	Staff gages	Every other month
1.3 Groundwater elevations	16, 15, 10, 9, 8, 4, 2, Tributaries	1	Piezometers, monitoring wells at 1 location in plot	Continuous
1.4 Pool distribution and hydroperiod	21, 19, 16, 15, 10, 9, 8, 4, 2, Tributaries	3	Measurements along each of 3 transects per plot	Quarterly
1.5 Surface water quality	21, 19, 16, 15, 10, 9, 8, 6, 4, 2, Tributaries	Pools = 3 Mainstem =NA	Water samples, hand-held and <i>in situ</i> meters	Mainstem - Table 3 Pools - quarterly
2.0 Physical and Geomorphic Elements				
2.1 Channel-floodplain elevations	16, 15, 10, 9, 8, 4, 2, Tributaries	3	Cross-sections measured along each of 3 transects per plot	Annually
2.2 Channel-floodplain substrate comp.	16, 15, 10, 9, 8, 4, 2, Tributaries	3	Measurements along each of 3 transects per plot	Annually
2.3 Sand bar distribution	16, 15, 10, 9, 8, 4, 2, Tributaries	3	Measurements along each of 3 transects per plot	Annually
3.0 Biological Elements				
3.1 Riparian & aquatic community dist.	All	NA	Remote sensing	Every 5 years
3.2 Riparian veg. com. patch structure	16, 15, 10, 9, 8, 4, 2, Tributaries	3	Measurements along each of 3 transects per plot	Annually
3.3 Aquatic invertebrate diversity	19, 15, 10, 6, Tributaries	1	3 point samples per plot	Twice per year
3.4 Wildlife species rich. & abund. a. Target species b. Community level	21, 19, 16, 15, 10, 9, 8, 4, 2, Tributaries	1-3	Various	Various
4.0 Land Use Elements	All	NA	Remote sensing	Annual updates



Table 2
Summary of Monitoring Program
(continued)

¹Hydrographs are considered to be adequately measured by existing gaging stations.
NA = Not applicable

Mainstem subreaches (from Stetson 2001)

21	RM 28.42 – 29.22
19	RM 25.65 – 26.49
16	RM 23.27 – 23.95
15	RM 21.78 – 23.27
10	RM 17.31 – 18.50
9	RM 15.78 – 17.31
8	RM 13.05 – 15.78
4	RM 5.34 – 8.37
2	RM 1.32 – 2.83

Tributaries

Roblar Creek
De Luz Creek, below De Luz
De Luz Creek, above De Luz
Lower Sandia Creek, in San Diego County
Upper Sandia Creek, in Riverside County
Stone Creek

5.0 MONITORING ELEMENTS

This section outlines the various elements recommended for monitoring, the rationale for including them in the monitoring program, the suggested methods for measuring each element, and a proposed schedule for monitoring. The elements are grouped into four interrelated categories: (1) hydrological and water quality, (2) physical and geomorphic, (3) biological, and (4) land use. Changes in one category are likely to be associated with changes in another. Table 2 summarizes monitoring elements by subreach.

5.1 HYDROLOGICAL AND WATER QUALITY ELEMENTS

The hydrologic and water quality regime of the Santa Margarita River is a product of runoff from the watershed and point source and non-point source discharges to the river. Various stressors can affect hydrology and water quality by changing land cover characteristics, impounding or diverting surface water, pumping groundwater, and discharging chemical constituents to surface and groundwater. Hydrological and water quality changes can affect aquatic habitats in all reaches of the river and riparian and floodplain habitats in the middle and lower reaches of the river.



5.1.1 Hydrograph

The hydrograph of the river describes its pattern of discharge over time and is a function of upstream runoff, gains or losses of groundwater, and channel geomorphology. The hydrograph ultimately determines river elevation (stage) and, therefore, the area and timing of floodplain inundation and distribution of pool habitats. The hydrograph of the river can be affected by upstream development, water diversion and groundwater extraction, and effluent discharges.

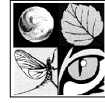
With the exception of the Roblar Creek tributary, existing gaging stations on the lower Santa Margarita River and its tributaries are likely adequate for monitoring hydrographs within the four functional units of the system for the purposes of this monitoring program. However, the existing gages would be inadequate to monitor finer scale changes in discharge due to gains and losses from groundwater in individual subreaches, which are not specifically addressed in this program. Existing gaging stations (USGS station number) include:

- Santa Margarita River near Temecula, CA (11044000)
- Rainbow Creek near Fallbrook, CA (11044250)
- Santa Margarita River at FPUD sump near Fallbrook, CA (11044300)
- Sandia Creek near Fallbrook, CA (11044350)
- De Luz Creek near De Luz, CA (11044800)
- Santa Margarita River at USMC Diversion Dam near Ysidora, CA (11045050)
- Fallbrook Creek near Fallbrook, CA (11045300)
- O'Neill Lake Channel near Fallbrook, CA (11045700)
- O'Neill Lake Spill Channel near Fallbrook, CA (11045700)
- Santa Margarita River at Ysidora, CA (11046000)

5.1.2 Floodplain Inundation

The area and frequency of floodplain inundation are a function of the river hydrograph, channel geomorphology, and floodplain elevations. Inundation frequency is an important determinant of riparian vegetation community composition and structure. Inundation of the floodplain can also fill and maintain off-channel pools that serve as breeding habitat for various amphibian and invertebrate species. Floodplain inundation can be affected by stresses that reduce peak flows or modify sediment dynamics (e.g., water management, urban and agricultural development). Establishing relationships between seasonal patterns of discharge, river stage, floodplain elevation, and groundwater elevation in specific subreaches of the river will provide information on the interrelationships of these various hydrologic and physical elements.

Floodplain inundation will be measured in the middle and lower reaches of the river. A permanent staff gage will be installed within a single monitoring plot in each subreach. Preferably, a continuously recording water level meter will be installed in each location.



Alternatively, stage can be recorded once every other month starting in October (6 times per year). If the latter method is used, stage should not be monitored during or immediately after a storm, which can cause a short-term rise in surface water elevation. Obtaining channel and floodplain elevations (see Section 5.2.1) will allow river stage to be related to floodplain elevations measured in specific subreaches, thus allowing inundation area to be monitored.

5.1.3 Groundwater Elevations

Groundwater elevations along the river are a function of recharge and withdrawal rates, substrate composition, underlying geologic features, and abundance and productivity of phreatophyte vegetation. Groundwater elevations can be affected by groundwater withdrawals, modifications of river flow by water management, and alterations of runoff characteristics by upstream land use changes. Shallow groundwater elevations can affect recruitment, survival, and productivity of species populations in riparian communities and the hydroperiod of channel and floodplain aquatic habitats. Therefore, spatial and temporal patterns of shallow groundwater elevation can determine habitat distribution and quality for specific species.

Groundwater elevations will be measured in the middle and lower reaches of the river. Shallow groundwater monitoring wells will be established within a single monitoring plot in river subreaches where floodplain and channel elevation (Section 5.2.1), substrate composition (Section 5.2.2), and floodplain inundation (Section 5.1.2) data are being collected. This will allow characterization of the relationships among these monitoring elements and the effects on elements such as pool distribution, pool hydroperiod, and biological characteristics. Each monitoring well will be placed on the widest side of the floodplain, halfway between the channel edge and the edge of the floodplain. Groundwater elevations will be collected with a data logger.

5.1.4 Pool Distribution and Hydroperiod

The hydroperiod of in-channel and floodplain pools is determined largely by shallow groundwater elevations and substrate composition, which is closely tied to geomorphic processes and surface water dynamics. Pool hydroperiod can be altered by stresses that lower groundwater elevations (e.g., groundwater withdrawals) or that result in elevated deposition of sediments (e.g., land use changes in the upstream watershed). Pool hydroperiod affects habitat suitability for aquatic species. For example, fish species such as the arroyo chub require annually permanent aquatic habitat, although pools may be spatially dynamic from year to year. Species such as the arroyo toad require pools that remain at least until larvae metamorphose. Shorter-lived pools that do not support vertebrate species can contribute significantly to invertebrate production. Standing water also has been correlated with the quality of southwestern willow flycatcher habitat.

Pool distribution and hydroperiod will be measured in all three mainstem reaches and the tributaries. Pool hydroperiod will be monitored in conjunction with pool distribution



(Section 5.2.4) and channel and floodplain elevations (Section 5.2.1). Within each of the three plots to be monitored per subreach, three transects will be randomly located perpendicular to the river. At each pool intercepting a transect line, the pool's position along the transect and its maximum depth and dimensions (length x width) will be recorded. These are the same transect lines used for the channel and floodplain elevations (Section 5.2.1) monitoring elements. Pool distribution and hydroperiod will be monitored at least quarterly starting in September (4 times per year).

5.1.5 Surface and Groundwater Quality

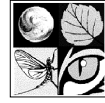
Surface and groundwater quality in the lower Santa Margarita River basin is a function of watershed soils, quality of point and non-point source discharges, aerial deposition of constituents, and chemical cycling processes in soils, surface water, and groundwater. Stresses that contribute to reduced water quality are point and non-point sources of discharge associated with urban and agricultural development. Water quality may affect recruitment and productivity of riparian vegetation communities. Temperature, dissolved oxygen, nutrients (nitrogen and phosphorus compounds), salinity and conductivity, suspended solids, and urban constituents (e.g., metals, pesticides, and herbicides) affect habitat quality for biological resources. Additional constituents that may affect habitat quality but whose influences are less understood include pharmaceutical compounds found in human wastewaters.

A number of different agencies currently are monitoring water quality at several locations on the river. In addition, the Santa Margarita River Water Quality Monitoring Group is developing a comprehensive water quality monitoring program that would serve the compliance monitoring needs of all the stakeholders in the watershed. As part of this collaborative effort, a Framework Monitoring Plan was developed (CDM 2001) that proposes a number of water quality sampling locations on the mainstem Santa Margarita River and several tributaries. Monitoring objectives described in this plan should be coordinated with the monitoring objectives of the Water Quality Monitoring Group, so that the ultimate monitoring plan meets the needs of all interested parties in the watershed.

For the purposes of this plan, we have modified the proposed water quality sampling locations suggested by CDM (2001). Table 3 shows the locations of water quality monitoring locations on the Santa Margarita River proposed in this study, along with recommended sampling frequency and monitoring parameters. In addition, we propose to monitor temperature and dissolved oxygen concentration quarterly in the floodplain pool habitats discussed in Section 5.1.4 to characterize seasonal water quality dynamics in pools of varying hydroperiods.

5.2 PHYSICAL AND GEOMORPHIC ELEMENTS

The physical and geomorphic characteristics of the Santa Margarita system are shaped by the hydrologic regime operating within the physical landscape of the watershed. Stresses



that modify the hydrologic regime or the physical landscape (e.g., water management activities, urban and agricultural development) of the system have the potential to alter its physical and geomorphic characteristics. This is particularly true in the middle and lower reaches of the river, where geomorphic processes and channel form are dynamic. This dynamism maintains habitat quality for a variety of target species. In the gorge reach of the system, geomorphic processes are constrained by the bedrock-dominated canyon, and the key ecological factors have little relationship to channel and floodplain dynamism.

5.2.1 Channel-Floodplain Elevations

The relative elevations of river channel and floodplain, and the manner in which these elevations change, determine channel migration, periodicity of overbank flow, and depth to groundwater, which strongly influence the type and quality of habitats in any particular reach of the river. In particular, dynamic geomorphological processes are crucial to removing stands of mature riparian vegetation and creating new germination areas for cottonwood and willow trees. Geomorphic processes that create sandbars and off-channel pools in the system are critical for maintaining breeding and rearing habitat for arroyo toads. Stresses that can change channel and floodplain cross-sections are those that affect river flow and sediment dynamics, such as water diversions, groundwater withdrawals, and upstream development.

Monitoring river channel shape and location and floodplain elevation will allow measurement of lateral channel migration, channel aggradation or degradation, and sediment deposition and scour of floodplain areas. Channel-floodplain cross-sections will be measured in subreaches in the middle and lower reaches of the river. In each subreach to be monitored, three monitoring plots will be randomly located. Within each monitoring plot, three transects will be permanently established at random locations within the plot (these are the same transects used for pool monitoring and riparian community patch monitoring elements - Sections 5.1.4, 5.2.4, 5.3.2). Transects will extend perpendicular to the river channel, across the entire floodplain. Within each subreach, one (or more as necessary) permanent elevational benchmark(s) will be established in sight of all transects within the subreach, and its elevation will be determined from known benchmarks.

The elevations of the floodplain and channel cross-section will be measured along each transect within each monitoring plot. The measurement interval will be determined by the width of the channel along the particular transect, but at least ten intervals in the channel will be measured. Surface water elevations in the channel will be measured as well. Channel and floodplain cross-sections will be measured once each year, during the summer baseflow period.

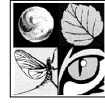


Table 3
Summary of the Water Quality Monitoring Elements
for the Santa Margarita River (SMR)

SUBREACH	DESCRIPTION	SAMPLING FREQUENCY: MONITORING PARAMETERS
21	SMR at Temecula	<u>Continuous</u> : temperature, pH, dissolved oxygen, total conductivity <u>Monthly</u> : nitrogen series, phosphorus, fecal coliform, THM, TDS, TSS, hardness, alkalinity, minerals <u>Storm events</u> : oil and grease, TDS, TSS, TOC, metals, herbicides and pesticides, nitrogen series, phosphorus
19	SMR at Santa Margarita Ecological Reserve	<u>Semiannually</u> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus
16	SMR at confluence with Stone Creek	<u>Quarterly</u> : temperature, dissolved oxygen in pools ¹ <u>Monthly</u> : temperature, pH, dissolved oxygen, total conductivity, nitrogen series, phosphorus, fecal coliform, THM, TDS, TSS, hardness, alkalinity, minerals
15	SMR at confluence with Rainbow Creek	<u>Semiannually</u> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <u>Quarterly</u> : temperature, dissolved oxygen in pools ¹ <u>Monthly</u> : nitrogen series, phosphorus, fecal coliform, THM, TDS, TSS, hardness, alkalinity, minerals <u>Storm events</u> : nitrogen series, phosphorus, oil and grease, TDS, TSS, TOC, metals, herbicides and pesticides
13	SMR at confluence with Sandia Creek	<u>Semiannually</u> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <u>Monthly</u> : temperature, pH, dissolved oxygen, total conductivity, nitrogen series, phosphorus, TDS, TSS, hardness, alkalinity, minerals



Table 3
Summary of the Water Quality Monitoring Elements
for the Santa Margarita River (SMR)
(continued)

SUBREACH	DESCRIPTION	SAMPLING FREQUENCY: MONITORING PARAMETERS
10	SMR at Fallbrook Public Utility District (FPUD sump)	<i>Continuous</i> : Temperature, pH, dissolved oxygen, total conductivity <i>Semiannually</i> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <i>Quarterly</i> : temperature, dissolved oxygen in pools ¹ <i>Monthly</i> : temperature, pH, dissolved oxygen, total conductivity, nitrogen series, phosphorus, TDS, TSS, hardness, alkalinity, minerals
9	SMR near Fallbrook	<i>Quarterly</i> : temperature, dissolved oxygen in pools ¹
8	SMR upstream of De Luz Creek	<i>Quarterly</i> : temperature, dissolved oxygen in pools ¹
6	SMR at confluence with De Luz Creek	<i>Semiannually</i> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <i>Monthly</i> : temperature, pH, dissolved oxygen, total conductivity, fecal coliform, nitrogen series, phosphorus, TDS, TSS, hardness, alkalinity, minerals <i>Storm events</i> : oil and grease, TDS, TSS, TOC, metals, herbicides and pesticides, nitrogen series, phosphorus
4	SMR near airfield	<i>Quarterly</i> : temperature, dissolved oxygen in pools ¹
2	SMR upstream of estuary	<i>Quarterly</i> : temperature, dissolved oxygen in pools ¹ <i>Monthly</i> : temperature, pH, dissolved oxygen, total conductivity, fecal coliform, nitrogen series, phosphorus, TDS, TSS, hardness, alkalinity, minerals <i>Storm events</i> : oil and grease, TDS, TSS, TOC, metals, herbicides and pesticides, nitrogen series, phosphorus
Roblar Creek		<i>Semiannually</i> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <i>Quarterly</i> : temperature, dissolved oxygen in pools ¹

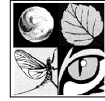


Table 3
Summary of the Water Quality Monitoring Elements
for the Santa Margarita River (SMR)
(continued)

SUBREACH	DESCRIPTION	SAMPLING FREQUENCY: MONITORING PARAMETERS
Upper De Luz		<i>Semiannually</i> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <i>Quarterly</i> : temperature, dissolved oxygen in pools ¹
Lower De Luz		<i>Semiannually</i> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <i>Quarterly</i> : temperature, dissolved oxygen in pools ¹
Upper Sandia		<i>Semiannually</i> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <i>Quarterly</i> : temperature, dissolved oxygen in pools ¹
Lower Sandia		<i>Semiannually</i> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <i>Quarterly</i> : temperature, dissolved oxygen in pools ¹
Stone Creek		<i>Continuous</i> : temperature, pH, dissolved oxygen, total conductivity <i>Semiannually</i> : benthic macroinvertebrates, temperature, pH, dissolved oxygen, total conductivity, nitrate, phosphorus <i>Quarterly</i> : temperature, dissolved oxygen in pools ¹

Mainstem subreaches (from Stetson 2001)

- 21 RM 28.42 – 29.22
- 19 RM 25.65 – 26.49
- 16 RM 23.27 – 23.95
- 15 RM 21.78 – 23.27
- 10 RM 17.31 – 18.50
- 9 RM 15.78 – 17.31
- 8 RM 13.05 – 15.78
- 4 RM 5.34 – 8.37
- 2 RM 1.32 – 2.83

Tributaries

- Roblar Creek
- Lower De Luz Creek, below De Luz
- Upper De Luz Creek, above De Luz
- Lower Sandia Creek, in San Diego County
- Upper Sandia Creek, in Riverside County
- Stone Creek

¹Water quality in a sample of pools monitored per Section 5.1.5 of Monitoring Plan.



5.2.2 Channel-Floodplain Substrate Composition

The size distribution of river channel and floodplain substrates is a function of river velocities and source materials and can affect habitat suitability for biological resources. Substrate composition can be altered by stresses that affect sediment dynamics or flow regimes, such as upstream land clearing and development and water management practices. The composition of bar and floodplain substrates can influence moisture retention and the germination success of riparian trees species. Coarser floodplain substrates allow rapid drainage and reduced retention of soil moisture, while sandy or clayey loams can increase moisture retention, germination rates, and seedling survival. Germination and seedling survival are dependent on groundwater elevations and fluctuations, which can affect soil moisture. Storage and transport of sand-sized material in the system are important for maintaining pools suitable for arroyo toad breeding and bars suitable for rearing of post-metamorphosed toads.

Substrate composition will be monitored in the middle and lower reaches of the river to track changes in the size distribution of material. This will allow characterization of the effects of river hydraulics on sediment particle size distribution. The composition of channel and floodplain substrates will be measured along transects established for monitoring channel-floodplain elevations (Section 5.2.1). At each point along a transect where an elevational measurement is taken, the size class of the floodplain or channel substrate will be estimated visually at that point. Size classes are as follows (from Lazorchak et al. 1998):

- Bedrock (>4000 mm - rocks bigger than a car)
- Boulders (>250 to 4000 mm - basketball to car-sized rocks)
- Cobbles (>64 to 250 mm - tennis ball to basketball-sized rocks)
- Coarse gravel (>16 to 64 mm - marble to tennis ball-sized rocks)
- Fine gravel (>2 to 16 mm - ladybug to marble-sized rocks)
- Sand (>0.06 to 2 mm - smaller than ladybug-sized but distinct particles)
- Fines (<0.06 mm - silts, clays, and muck, not distinct particles)

Channel and floodplain substrate composition will be measured once each year, during the summer baseflow period.

5.2.3 Sand Bar Distribution

Sand bars represent discrete areas that support germination of riparian tree species and rearing of metamorphosed arroyo toads. The distribution of sand bars within the system is dynamic, with redistribution of bars often resulting from high flow events and associated geomorphic dynamics. Stresses that modify sediment dynamics and peak flows (e.g., upstream developments and water management practices) can alter the distribution and maintenance of sand bars in the system. Monitoring the distribution of



sand bars in the system will allow temporal and spatial mapping of this important microhabitat.

Distribution of sand bars will be monitored in two ways: (1) using remote sensing approaches (e.g., aerial photography – refer to Section 5.3.1) and (2) recording bar elevations and dimensions as part of measurements collected along floodplain and channel transects (Section 5.2.1).

5.3 BIOLOGICAL ELEMENTS

The biological characteristics of the Santa Margarita River are largely a product of the hydrological, physical, geomorphic, and water quality elements discussed above (Sections 5.1 and 5.2). Modifications to the temporal patterns or states of these elements caused by various stresses in the watershed can affect the status of biological resources. Monitoring biological resources will provide information to identify, prioritize, and implement management actions and to assess their effectiveness.

5.3.1 Riparian and Aquatic Community Distribution

Mapping the distribution of riparian vegetation and aquatic communities along the river system over time will facilitate coarse-scale evaluation of the spatial and temporal dynamics of habitats in the system. Vegetation communities (e.g., southern cottonwood-willow riparian forest), aquatic habitat types (e.g., off-channel pools, Section 5.2.4), and sand bars (Section 5.2.3) will be mapped at periodic intervals (e.g., every 5 years), using remotely sensed information (e.g., low-altitude aerial photographs or satellite imagery) in all three mainstem reaches and tributaries. Once the initial community map is developed, subsequent mapping efforts will focus on change detection. Research efforts are underway at the San Diego State University Geography Department to refine processing techniques of remotely sensed imagery to facilitate large-scale change detection for monitoring purposes. Vegetation community maps will allow assessments of the quantity of potential riparian and aquatic habitat types, the distribution and connectedness of habitats, significant areas of disturbance, and large-scale invasions of nonnative plant species (e.g., giant reed).

5.3.2 Riparian Vegetation Community Patch Structure

In addition to the coarse-scale vegetation community information, finer scale information on riparian community patch sizes and structure is necessary to understand the interrelationship between physical, hydrological, and biological elements. For example, bird species such as the least Bell's vireo and southwestern willow flycatcher require vegetation communities of different age or size structure for breeding. The river's flood regime influences the range of age or size structures of riparian vegetation community patches and their distribution through the landscape. A number of stresses can alter the structure and dynamics of riparian vegetation patches in the system, including changes in flow regimes, groundwater withdrawals, and altered sediment dynamics associated with



upstream development and water management practices. Coarse-scale vegetation mapping does not provide adequate resolution to determine patch-scale habitat characteristics.

Riparian vegetation community patch structure will be measured in the middle and lower reaches of the river. Within identified subreaches, species composition and vertical structure of riparian vegetation communities will be measured, along three replicate transects oriented perpendicular to the river and extending laterally into the floodplain, within each of three monitoring plots. These transects will correspond to those being used to collect channel and floodplain elevations and substrate composition (Sections 5.2.1 and 5.2.2).

Methods are adapted from those used on Camp Pendleton by Zedler et al. (2001). Vegetation cover and composition will be measured at 2 meter intervals along each transect. At each interval, a telescoping pole will be extended to the top of the riparian canopy. The type of surface directly under the pole will be recorded (e.g., bare ground, grass, leaf litter). At each interval along the transect, the height distributions of all riparian species will be recorded within a series of 2 meter vertical increments from the ground to the top of the riparian canopy. For each species, each 2-meter height increment within which it touches the telescoping pole will be recorded. For each of these records, the portion of the plant touching the pole will be classified as live or dead. Within a 1 meter square area centered at each interval, the number of woody riparian species seedlings will be counted. Riparian vegetation community patch structure will be measured once per year during the summer and early fall, before trees start losing their leaves.

5.3.3 Aquatic Macroinvertebrate Community Composition

The taxonomic composition of benthic aquatic macroinvertebrate communities is a good indicator of water quality in aquatic systems. Many groups of invertebrates are found only in systems with relatively “clean” water, and others dominate in systems with elevated concentrations of nutrients and low dissolved oxygen concentrations, which can result from urban and agricultural runoff. Many benthic macroinvertebrates are the larval stages of adult terrestrial insects, and the adults that emerge from these larval stages can be important food items for a variety of insectivorous vertebrate species. The composition of benthic aquatic invertebrates will be monitored in selected subreaches within the middle and lower reaches of the mainstem and in the tributaries.

Within each of the identified subreaches, the composition of the aquatic macroinvertebrate community will be measured using the California regional adaptation of the national Rapid Bioassessment Procedure (EPA 1997), which is called the California Stream Bioassessment Procedure (California Department of Fish and Game 2002). The Rapid Stream Bioassessment procedure will be conducted within a single monitoring plot within each subreach, where three replicate samples of the macroinvertebrate community will be collected. The aquatic macroinvertebrate



community will be sampled semiannually (twice each year): once in the spring (April) and once in the fall (October).

5.3.4 Wildlife Species Richness and Abundance

Habitat quality for individual wildlife species in the Santa Margarita River system is related to a variety of physical, hydrological, and biological community characteristics, which are being monitored as part of the elements discussed above. A wide variety of wildlife species could be monitored to provide information on conditions of the system. However, for most species, we do not completely understand the temporal and spatial dynamics of the physical, hydrological, and biological elements that produce the species' required habitat conditions. Some wildlife species can be used as indicators of habitat characteristics or quality. Monitoring wildlife species also allows us to evaluate the relationship of the system's biological resources with the larger biological landscape (e.g., as a migratory corridor for terrestrial and aquatic species). Several species on the river are state or federally listed endangered or threatened species. Information on these special status species may be important for future regulatory actions (e.g., federal endangered species permit actions, California Natural Community Conservation Planning programs, identification of beneficial uses, and development of Total Maximum Daily Loads).

Wildlife surveys of riparian bird, herpetofauna, and fish communities will be conducted in selected subreaches of the river (Table 2). Community level surveys using standardized methodologies will quantify the abundance of the particular wildlife community. Wildlife community monitoring will be conducted in all three mainstem reaches and the tributaries as follows:

- Bird communities will be monitored using a point-count methodology. In each of three monitoring plots in each subreach, counts will be made within a single 50-meter (160-foot) radius, circular plot within the riparian habitat in the monitoring plot. The circular plot will be located on a randomly selected side of the river or, if necessary, the widest side of the floodplain to fit the circular plot. Within each circular plot, all individuals detected (i.e., seen or heard) within a 10-minute period are counted. Numbers of individuals are recorded after 3 minutes and at the end of the 10-minute period. The number of individuals present within a known area (1.8 acres) allows the computation of species abundance, density, and diversity metrics. Surveys will be conducted annually during the spring breeding period.
- Herpetofauna communities will be monitored by a number of methods to adequately sample a range of species habits. These methods include (1) visual and aural surveys, (2) pitfall traps, and (3) turtle traps.
 - (1) Visual and aural amphibian surveys – In each subreach, observers will walk the length of both stream banks within a single monitoring plot and

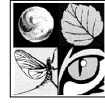


record calling males and observations of adults, larvae, or egg masses. Surveys will be conducted both during the day and at night, two times in the early and late spring (March and June). All species observed during these surveys will be recorded.

- (2) Pitfall traps – In each subreach, a single pitfall trap array will be established in a single monitoring plot. The pitfall trap arrays will follow the standard USGS design and include snake traps. Trap arrays will be opened for three consecutive nights during the periods March – June and August – November. Arrays will be checked daily during the sampling period, and all captured individuals will be counted, measured, and released.
 - (3) Turtle traps – In each subreach with suitable habitat, a single turtle trap will be placed in each of two monitoring plots. Turtle traps will be checked for three consecutive nights during the periods March – June and August-November. Traps will be checked twice per day, and all individuals will be counted, measured, sexed, and released.
- Fish communities will be monitored by seining within a single monitoring plot in each subreach. Within each monitoring plot, 10 seine hauls will be made, and the fishes collected will be combined into a single sample for the subreach. Fish community sampling will be conducted three times each year, during the periods of April, July, and mid-October through November. For each composite sample, numbers and lengths of individuals of each species will be summarized. Other taxa collected during seining (e.g., newts) will be counted and reported.

5.4 LAND USE ELEMENTS

As discussed in Section 3.0, adjacent land uses and water management practices produce the primary stresses in the Santa Margarita River system. Monitoring land use change is an important aspect of understanding physical, hydrological, and biological processes and conditions in the system and the effects of stresses on these processes and conditions. Land use monitoring will be conducted in all three mainstem reaches and the tributaries via remote sensing approaches and utilizing information available from local jurisdictions (e.g., Counties of San Diego and Riverside, MCB Camp Pendleton, San Diego Association of Governments). Land use changes (e.g., natural habitat to agricultural or urban development and agriculture to urban development) will be recorded in a GIS. In addition, the locations of outfalls or channelization projects will be recorded. Records of land use changes will be used in the interpretation of data collected for other monitoring elements. For example, distance from habitat edge to various land uses may be used to explain species distributions, or the dominant land use type in a watershed subbasin may be used to explain water quality characteristics.



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APPENDIX A

**SANTA MARGARITA RIVER MONITORING PROGRAM
LIST OF CONSERVATION TARGETS AND KEY ECOLOGICAL FACTORS**

TARGET	KEY ECOLOGICAL FACTORS		
	SIZE	CONDITION	LANDSCAPE CONTEXT
Regional species -Mountain lion -Neotropical migratory birds -Southern steelhead trout	-Numbers of individuals in neotropical migratory bird populations adequate to maintain stable or increasing populations sizes	-Native species composition and abundance within natural range of variation -Reproductive success adequate to maintain stable or increasing species population sizes	-Hydrologic regime that produces natural geomorphic processes in mainstem and tributary channels and floodplains -Water chemistry suitable to support sensitive aquatic species -Longitudinal connectivity to facilitate wildlife, fish, and plant dispersal up and down the river corridor -Availability of riparian vegetation patches with a range of age/size structural characteristics -Continuous habitat along river corridor, wide enough to support mountain lion movement and foraging

TARGET	KEY ECOLOGICAL FACTORS		
	SIZE	CONDITION	LANDSCAPE CONTEXT
Coastal stream and riparian communities	-Perennial stream miles to meet aquatic species needs	-Macroinvertebrate community characteristic of unimpaired system -Reproductive success of native species adequate to maintain stable or increasing population sizes -Competition and predation within natural range of variation -Sufficient emergent or floating vegetation for forage/cover for arroyo chub -Riparian vegetation community patch sizes and distributions suitable for range of riparian wildlife species (e.g., young, shrubby habitat to mature, open habitat)	-Geomorphic processes that maintain a variety of instream aquatic habitat types (e.g., pools, riffles, runs); create sand bars; and scour floodplain areas -Periodic overbank flooding to establish and maintain areas suitable for germination of riparian plant species, including deposition of alluvium with texture suitable for germination of riparian plant species and maintenance of groundwater elevations high enough to maintain survival of riparian plant species -Base flow and water quality above threshold values to maintain aquatic habitat quality and to support native aquatic species, including intermittent discharges in tributary drainages -Longitudinal connectivity of habitats to facilitate dispersal and interspecific interactions

TARGET	KEY ECOLOGICAL FACTORS		
	SIZE	CONDITION	LANDSCAPE CONTEXT
Coastal dune and estuary communities	<ul style="list-style-type: none"> -Adequate size of wetland community to provide buffers against adverse land use impacts -Adequate area of coastal wetlands to sustain native bird community -Numbers of individuals of native species adequate to maintain stable or increasing populations sizes 	<ul style="list-style-type: none"> -Known range infaunal species occur in the estuary -Maintenance of upper/lower salt marsh vegetation communities and dune habitats -Productive populations/colonies of marsh and beach nesting birds (e.g., clapper rails and least terns) -Presence of salt pan species (e.g., tiger beetles) -Native predators limited in distribution and abundance (e.g., skunks, ravens) 	<ul style="list-style-type: none"> -Sediment transport regime and tidal dynamics adequate to maintain tidal prism and dune dynamics -Flow regimes adequate to periodically open lagoon mouth -Connectivity maintained between freshwater and saltwater habitats -Periodic tidal inundation of marsh areas -Sufficient base flows to prevent salt water intrusion at the downstream end of the system -Concentrations of nutrients at levels that will not cause adverse algal blooms or otherwise depress DO concentrations to unacceptable concentrations -Maintenance of open sandy substrates and salt pannes
Coast range newt	<ul style="list-style-type: none"> -Adequate tributary miles with permanent aquatic habitat to meet needs of coast range newt -Numbers of individuals adequate to maintain stable or increasing populations sizes 	<ul style="list-style-type: none"> -Reproductive success adequate to maintain stable or increasing native species population sizes -Competition and predation within natural range of variation 	<ul style="list-style-type: none"> -Base flow and water quality above threshold values to maintain aquatic habitat quality to support newts -Sediment transport regimes in tributaries suitable to prevent excess sedimentation

TARGET	KEY ECOLOGICAL FACTORS		
	SIZE	CONDITION	LANDSCAPE CONTEXT
Upper terrace woodland communities	-Numbers of individuals of native species adequate to maintain stable or increasing populations sizes	-Mature trees and snags present for cavity nesting species	-Water table elevation and dynamics necessary to support upper terrace riparian plant species -Sufficient upland habitat (e.g., coastal sage scrub and chaparral) to separate upper terrace communities from adjacent land uses
Coastal sage scrub	-Adequate area of habitat to support breeding pairs of California gnatcatchers as part of core population	-Maintenance of California sagebrush and flat-topped buckwheat dominated sage scrub with open structure -Presence of top carnivores to prevent mesopredator release	-Distribution of coastal sage scrub community across the watershed (north-south) to provide connectivity of California gnatcatcher habitat in south San Diego County and Camp Pendleton -Fire regime suitable to maintain desired sage scrub condition
Freshwater marsh communities		-Competition and predation within natural range of variation -Sufficient cover provided for arroyo chub refuges	-High groundwater elevations and permanent surface water in localized areas maintained by recharge of alluvial aquifer and summer base flow -Nutrient concentrations low enough to prevent depression of dissolved oxygen concentrations in interior portions of flooded marsh stands -Range of deep to shallow water habitats