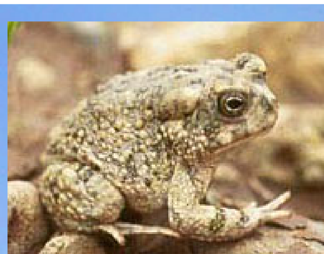
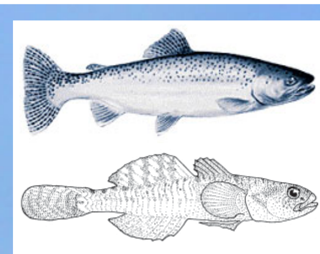
Agency Review Draft

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species



San Juan/Western San Mateo Watersheds

Orange County, California

PCR

DUDEK & ASSOCIATES, INC.

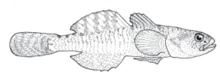
August 2002

AGENCY REVIEW DRAFT

GEOMORPHIC AND HYDROLOGIC NEEDS OF AQUATIC AND RIPARIAN ENDANGERED SPECIES







San Juan/Western San Mateo Watershed

Orange County, California

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GEOMORPHIC AND HYDROLOGIC NEEDS OF AQUATIC AND RIPARIAN ENDANGERED SPECIES

1.0 INTRODUCTION

1.1 GOALS, ORGANIZATION, AND INTENDED USE OF REPORT

This report presents an analysis and characterization of the geomorphic and hydrologic processes that determine or significantly influence key habitat features for five Federal and State-endangered species known to occur in the San Juan Creek and/or the San Mateo Creek watersheds, in southern Orange County, California. The species addressed in this report are dependent upon aquatic or riparian resources found within the Natural Communities Conservation Plan/Habitat Conservation Plan (NCCP/HCP) Southern Subregion and the San Juan/San Mateo Special Area Management Plan/Master Streambed Alteration Agreement (SAMP/MSAA) study area, as well as downstream of the study area. Three of the species addressed by this report, arroyo toad (*Bufo californicus*), least Bell's vireo (*Vireo bellii pusillus*), and southwestern willow flycatcher (*Empidonax traillii extimus*), are found both within the study area and in portions of the San Mateo watershed that are adjacent to or downstream of the study area. The other two species addressed by this report, tidewater goby (*Eucyclogobius newberryi*) and southern steelhead (*Oncorhynchus mykiss*), are only found in portions of the San Mateo watershed that are outside the study area. The California least tern (*Sterna antillarum browni*), western snowy plover (*Charadrius alexandrinus nivosus*), and brown pelican (*Pelecanus occidentalis*) use habitat around the mouth of San Mateo Creek, but do not actually reside in the watershed, and are therefore not addressed in this report. Upland species also are affected by geomorphic and hydrologic processes that are addressed in the Watershed Planning Principles. However, in order to provide an understanding of planning considerations for listed species that are uniquely influenced by aquatics systems, this report focuses solely on listed species dependent upon aquatic and riparian resources. This analysis was conducted by **PCR Services Corporation (PCR)** and Dudek & Associates (Dudek) with assistance from Philip Williams and Associates (PWA) and Balance Hydrologics (Balance).

This report is intended to be used as a planning tool during the NCCP/HCP and SAMP/MSAA processes by providing information on the physical processes that significantly affect structural habitat and life history requirements of the species addressed in the report. The report is intended to help support various aspects of the NCCP/HCP and SAMP/MSAA planning programs including the following:

- Reserve Design – The report may help identify areas where existing physical processes, such as coarse sediment generation, need to be maintained in order to protect habitat function.

- Restoration Planning – The report may help identify areas where restoration actions, such as correcting eroding areas generating fine sediments, may benefit species habitat.

- Long-Term Management – The report may help identify important hydrologic processes, such as the role of episodic storm events in shaping habitat systems, which must be maintained under future land use scenarios.

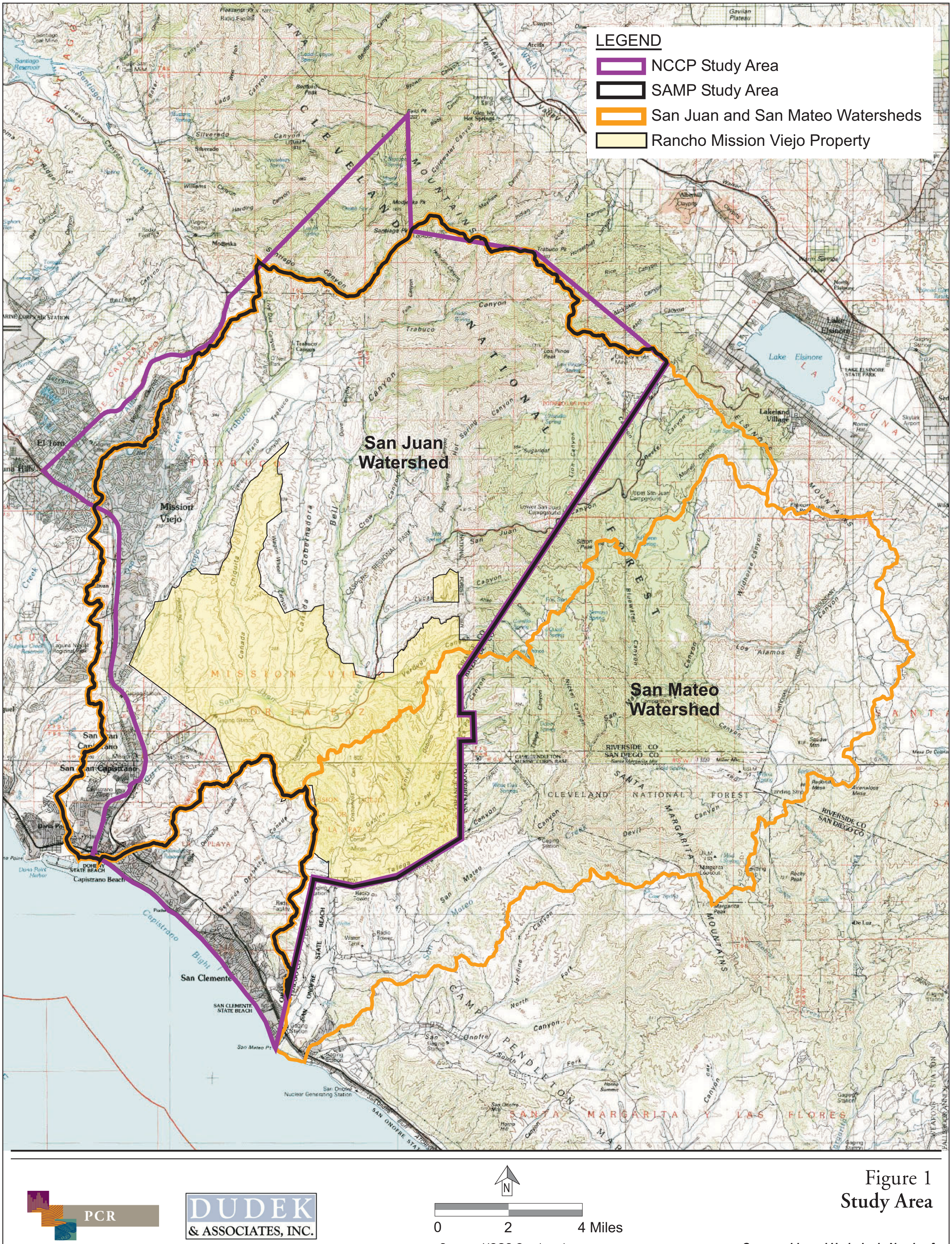
- Species Introduction or Re-Introduction – The report may help in addressing the feasibility of introducing the southern steelhead to that portion of the San Mateo Creek watershed within the study area, or re-introducing either southern steelhead or tidewater goby into the San Juan Creek watershed.

Thus, this report is intended to support the comprehensive planning efforts by providing species specific geomorphic and hydrologic information that complements the numerous biologic, geologic, hydrologic, and geomorphic technical studies and surveys that have been conducted during the past several years.

The boundaries of the study area generally coincide with those of the San Juan/San Mateo SAMP/MSAA and Southern Subregion NCCP/HCP as shown in Figure 1, *Study Area*, on page 3. Studies conducted for the NCCP/HCP and the SAMP/MSAA programs have mapped the general vegetation communities in the study area and have identified areas occupied by sensitive species. Baseline geomorphic and hydrologic conditions have been analyzed by PCR, PWA, and Balance.

The approach, methodology, and inter-relationships among the baseline studies that support this analysis have been described in detail in the Work Plan for Hydrology and Geomorphology Studies (PCR 2000b) (Work Plan). In addition to the numerous sources of information listed in the References section of this report, the following documents were instrumental during the development of this report:

- Lang, J., B. Oppenheim, and R. Knight. 1998. *Southern Steelhead (Oncorhynchus mykiss) Habitat Suitability Survey of the Santa Margarita River, San Mateo, and San Onofre Creeks on Marine Base Camp Pendleton, California*. Prepared by the U.S. Fish and Wildlife Service Coastal California Fish and Wildlife Office, Arcata, California for the Assistant Chief of Staff, Environmental Security, Environmental and Natural Resource Office, Marine Corps Base Camp Pendleton.



Source: USGS Quadrangles
Santa Ana 1983 and Oceanside, CA, 1982

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Figure 1
Study Area

- California Department of Fish & Game. February 2000. *Steelhead Rainbow Trout in San Mateo Creek, San Diego County, California*. (prepared in response to a request by the National Marine Fisheries Service). Transmittal signed by Robert C. Hight, Director CDFG.

- Lichvar, R., G. Gustina, D. MacDonald, and M. Ericsson. 2000. *Planning Level Delineation and Geospatial Characterization of Riparian Ecosystems of San Juan Creek and Portions of San Mateo Watersheds, Orange County, California*. U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.

- PCR, PWA, Balance. 2002. *Baseline Geomorphic and Hydrologic Conditions Report, Rancho Mission Viejo: Portions of the San Juan and Western San Mateo Watershed*. Prepared for Rancho Mission Viejo. February.

- PWA. 2001. *Baseline Hydrologic Conditions, San Juan & Upper San Mateo Watersheds*. Prepared for Rancho Mission Viejo. May.

- Balance Hydrologics (BH). 2002. *Groundwater Sustaining Landscape-Scale Wetland Functions*. Prepared for Rancho Mission Viejo. January

- Smith, R. D. 2000. *Assessment of Riparian Ecosystem Integrity in the San Juan and San Mateo Creek Watersheds, Orange County, California*. U.S. Army Corps of Engineers Engineering Research and Development Center, Waterways Experiment Station, Vicksburg, Mississippi 39180.

Information presented in the endangered species' profiles was primarily summarized from the federal listings and critical habitat designations for each species published in the Federal Register. Additional information utilized for developing this report included scientific status surveys and studies, biological assessments, unpublished materials, and expert opinions or personal knowledge.

1.1.1 Goals of the Report

The specific goals of this report are to address the following for the three aquatic/riparian endangered species found within the study area (arroyo toad, least Bell's vireo, and southwestern willow flycatcher) and the two aquatic/riparian endangered species found in the San Mateo watershed downstream of the study area (tidewater goby and southern steelhead).

1. Summarize the regulatory status.

2. Identify key physical habitat attributes.

3. Characterize the hydrologic and geomorphic conditions and processes that shape/determine the presence and long-term viability of habitat for all life-stages.

4. Relate key physical habitat attributes to underlying physical processes.

5. Assess the relationship between land uses and aquatic resources for species found both within and downstream and outside the planning area.

The report is intended to provide a summary of generalized habitat, geomorphic and hydrologic considerations, and a review of those considerations in the context of conditions within and downstream of the planning area.

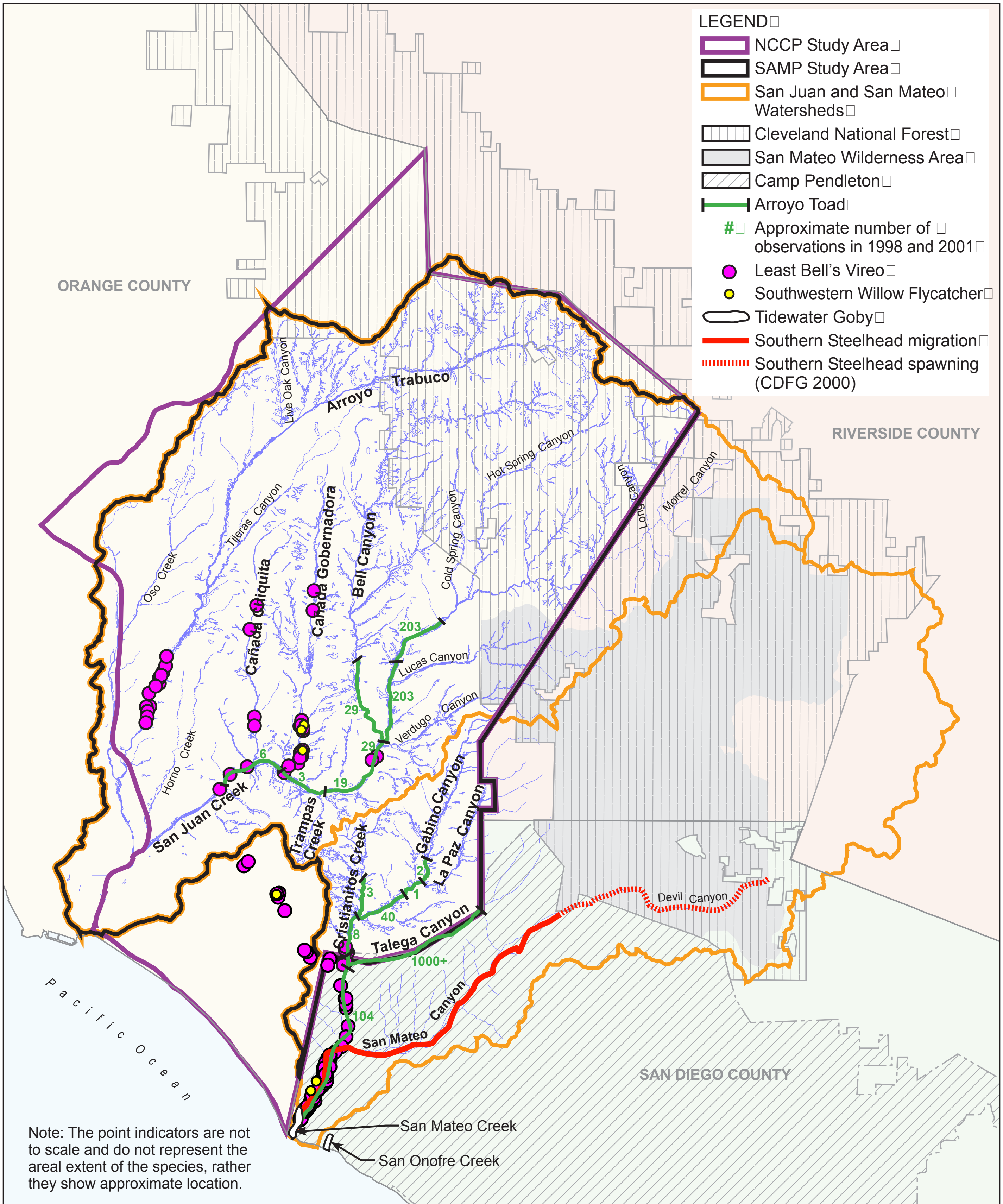
1.1.2 Organization of Report

The five endangered species addressed in this report are presented in two separate chapters. Chapter 2 addresses listed aquatic species found both within and downstream of the study area. Chapter 3 addresses species found only outside the study area in downstream and/or adjacent portions of the San Mateo watershed. Figure 2, *Major Streams and Endangered Species Locations Within the San Juan/Western San Mateo Watersheds*, on page 6, displays each species known distribution within, downstream, and adjacent to the study area. For each species, the report outlines the regulatory status, natural history, and key physical habitat components important for each life stage. Following these detailed accounts, the key geomorphic and hydrologic processes responsible for creating and maintaining the physical habitat components are discussed. The "key physical processes" chapter is organized into two categories: geomorphic and hydrologic. For each process, the report reviews the relationship between physical processes and structural habitat components for each species. The final chapter provides an overall summary of the key geomorphic and hydrologic processes for each species that should be considered in the context of future planning efforts.

1.1.3 Intended Use of Report

This report is intended to be used as a planning tool to support the reserve design process, the alternatives analysis, impact analysis, and development of the aquatic resources adaptive management program under the Southern Subregion NCCP/HCP and San Juan/San Mateo SAMP/MSAA, associated water quality planning, and Rancho Mission Viejo's request for a General Plan amendment and zone change.

By providing information that links the physical processes previously investigated in the Baseline Conditions Report (PCR 2002) with endangered and/or threatened species distribution data collected for the NCCP/HCP, this report attempts to take the next step in providing an understanding of species-specific geomorphic processes for use during aquatic resources



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Source: Lichvar et al. and ACOE 2000, Dudek 2001, Dudek and PCR 2002

Figure 2
Major Streams and Endangered Species Locations Within the San Juan and Western San Mateo Watersheds

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

planning and management within the SAMP/MSAA and NCCP/HCP study area boundaries. This report is intended to be used in two important respects. First, comprehensive management of aquatic and riparian dependent species must account for both direct effects on habitat where the species reside, as well as potential indirect effects associated with land use practices, such as changes in runoff, infiltration, or sediment generation. The results summarized in this report may help determine the location and configuration of future land uses and to help develop management measures that will ensure that future land use practices do not result in direct or indirect adverse effects to habitat that supports aquatic or riparian endangered species. In particular, this report may be used to help evaluate proposed habitat reserve designs relative to NCCP Reserve Design Principle #7 – "Maintain ecosystem processes and structures" and alternative aquatic resource management programs relative to SAMP/MSAA Tenet #8 – "Protect riparian areas and associated habitats supporting state/federally endangered species and associated critical habitat".

Second, both the NCCP/HCP and SAMP/MSAA place considerable emphasis on restoration planning and long-term adaptive management programs. An understanding of species-specific geomorphic and hydrologic processes should help identify priorities for restoration planning and provide input into the formulation of adaptive management programs.

The intended use of this report differs for the three species that occur within the study area (arroyo toad, least Bell's vireo, and southwestern willow flycatcher) versus the two species that only occur downstream of the study area (tidewater goby and southern steelhead). Actions within the study area have the potential to directly affect the three species that occur within the study area by altering physical components of their habitat. These species can be considered during formulation of the reserve design and adaptive management programs under the NCCP/HCP and SAMP/MSAA. In contrast, potential impacts associated with actions within the study area to the two species that occur solely downstream of the study area would be limited to indirect effects on downstream hydrology, water quality, and sediment delivery. Furthermore, it would not be possible to develop a reserve design or an adaptive management program for the tidewater goby and the southern steelhead because there is no ability to:

- designate and assemble habitat for species outside the study area for inclusion in a NCCP/HCP reserve;
- formulate an aquatic resource management program under the NCCP/HCP or SAMP/MSAA; or
- enforce an implementation or an adaptive management program for the area outside the study area.

Due to the lack of hydrologic connection between the portions of the San Mateo watershed within the study area and areas known to support steelhead spawning, actions proposed under the NCCP/HCP or SAMP/MSAA will not affect historic or existing steelhead spawning habitat. Accordingly, the analysis of potential impacts to the southern steelhead is limited to potential effects on migration routes[1] and lagoon habitats in the portion of San Mateo Creek that is downstream of the study area. The review of steelhead spawning habitat is included in this report to help facilitate an assessment of the potential for introducing the species into the planning area. Potential impacts on the tidewater goby are focused on those portions of San Mateo Creek and the lagoon identified in the critical habitat designation for the goby.

Every effort has been made to collect the best, most recent scientific information available. However, in preparing this document, it was discovered that several information gaps exist in the available literature regarding the specific needs of the tidewater goby, southern steelhead, arroyo toad, least Bell's vireo, and southwestern willow flycatcher. Specifically, there is generally a lack of published studies that address the relationships among geomorphic, hydrologic, and biologic disciplines that are the focus of this analysis. Following the consolidation of species profile information, conclusions were drawn regarding the interrelationships among the physical processes and biological conditions. Where information was lacking, definitive assessments and conclusions were not made. It is anticipated that this report will be the first iteration of a document that will evolve as successive studies are conducted and new information and research becomes available. Therefore, this report attempts to portray an understanding of the complex relationships that govern habitat for the subject endangered species in order to provide a foundation for further investigation, ongoing study, and refinement during the preparation and implementation of the adaptive management program for the planning area.

1.2 STUDY AREA

1.2.1 San Juan Creek Watershed

The San Juan Creek watershed is located in southern Orange County, California. The watershed encompasses a drainage area of approximately 45,584 hectares (176 square miles) and extends from the Cleveland National Forest in the Santa Ana Mountains to the Pacific Ocean at Doheny State Beach near Dana Point Harbor. The upstream tributaries of the watershed flow out of steep canyons and widen into several alluvial floodplains. The major streams in the watershed include San Juan, Bell Canyon, Cañada Chiquita, Cañada Gobernadora, Verdugo Canyon, Oso,

[1] *All potential spawning habitat for the steelhead is in catchements that are adjacent to, and not downstream of the study area.*

Trabuco, Cold Spring Canyon and Lucas Canyon creeks (Figure 2, *Major Streams and Endangered Species Locations Within the San Juan/Western San Mateo Watersheds*, on page 6). Elevations range from over 1,768 meters (m) (5,800 feet (ft)) above sea level at Santiago Peak to sea level at the mouth of San Juan Creek (Corps 1999).

The San Juan Creek watershed is bounded on the north by the San Diego, Aliso Creek, and Salt Creek watersheds, and on the south by the San Mateo Creek watershed. The Lake Elsinore watershed, which is a tributary of the Santa Ana River watershed, is adjacent to the eastern edge of the San Juan Creek watershed.

The San Juan Creek watershed supports populations of least Bell's vireos in San Juan Creek, in Chiquita and Gobernadora Canyons, and in the lower portion of Arroyo Trabuco, with populations in the watershed increasing over the last decade. A small population of southwestern willow flycatchers has been recently documented in lower Gobernadora Canyon. The arroyo toad population is relatively small in the middle to lower portions of San Juan Creek below Bell Canyon, but larger populations occur in Bell Canyon and upper San Juan Creek (see Table 1 on page 10).

1.2.2 San Clemente Hydrologic Area

The NCCP/HCP study area includes a 5,106 hectare (20 square mile) area between the lower portions of the San Juan and San Mateo watersheds, that is outside both of these drainage areas. This area is outside the SAMP/MSAA study area, is drained primarily by Segunda Deschecha and Prima Deschecha, and for the most part fully developed and/or entitled. The San Clemente Hydrologic Area supports four least Bell's vireo and supported a single southwestern willow flycatcher in 2000. Because this area is hydrologically separate from both the San Juan and San Mateo watersheds, actions within the study area will not affect the birds that reside in it. Consequently, this area is not discussed in the remainder of this report.

1.2.3 Western San Mateo Creek Watershed

The study area includes only the western portion of the San Mateo Creek watershed within Orange County and accounts for approximately 17 percent of the total watershed area (i.e., 6,120 hectares, 24 square miles). The total watershed is approximately 36,000 hectares (139 square miles) and lies mostly in currently undeveloped areas of the Cleveland National Forest, the San Mateo Wilderness Area, the northern portion of Marine Corps Base Camp Pendleton (MCBCP), and ranch lands in southern Orange County (Lang et al. 1998). The overall San Mateo Creek watershed is located in the southern portion of Orange County, the northern portion of San Diego County, and the western portion of Riverside County. The watershed is

Table 1

SUMMARY OF CURRENT DISTRIBUTION OF ENDANGERED SPECIES WITHIN AND DOWNSTREAM OF THE STUDY AREA

	Species solely outside the study area		Species within and outside the study area		
	Tidewater Goby	**Southern Steelhead**	**Arroyo Toad**	**Least Bell's Vireo**	**Southwestern Willow Flycatcher**
Occurrences within Study Area					
San Juan Creek (lower)			x	x	
Arroyo Trabuco				x	
Cañada Gobernadora				x	x
Cañada Chiquita				x	
Bell Canyon Creek			x		
Cristianitos Creek (upper)			x	x	
Gabino Creek			x		
Talega Creek			x		
Occurrences outside Study Area					
Cristianitos Creek (lower)			x	x	
San Juan Creek (upper)					
San Mateo Creek	x	x	x	x	x

bounded on the north and west by the San Juan Creek watershed, to the south by the San Onofre Creek watershed, and to the northeast by the Lake Elsinore watershed. Elevations range from approximately 1,018 m (3,340 ft) above sea level in the mountains of the Cleveland National Forest to sea level at the mouth of San Mateo Creek.

Major (named) streams in the watershed that occur within the study area boundary include upper Cristianitos, Gabino, La Paz, and Talega creeks. Lower Cristianitos, San Mateo, and Devil Canyon creeks occur within the San Mateo watershed but outside (downstream) of the study area boundary. Figure 2, *Major Streams and Endangered Species Locations Within the San Juan/Western San Mateo Watersheds*, on page 6, displays the major streams of San Juan and western San Mateo watersheds.

Located downstream of the study area boundary, the mainstem of San Mateo Creek is one of the few streams in southern California that is not hydrologically controlled by dams or reservoirs (Lang et al. 1998). San Mateo Creek flows 35.4 kilometers (km) (22 miles (mi)) from its headwaters in the Cleveland National Forest to the ocean outside the study area just south of the City of San Clemente. Flows within the headwater system may be as low as 0.5 cubic feet per second (cfs) during the summer and can average over 500 cfs during wet months. The lower reach of the creek flows along a 17 km (10.5 mi) alluvial valley to the coast, where average rainfall is 34 centimeters (cm) (13 inches (in)) per year.

The San Mateo watershed supports a large population of arroyo toad within Talega Creek and smaller populations in lower Gabino and Cristianitos creeks. Least Bell's vireo utilizes Cristianitos Creek (both within and outside the study area) and San Mateo Creek downstream of the study area boundary. The lower portions of the San Mateo Creek watershed (outside the study area) also contains aquatic resources that support the tidewater goby, southwestern willow flycatcher, and the southern steelhead within Devil Canyon (Lang et al. 1996, CDFG 2000). The geology of the steep and rocky upper San Mateo Creek and its tributaries is characterized by granitic bedrock that produces substantial baseflow, a high density of springs and bedrock pools that provide over-summering habitat for juvenile steelhead, while the runs, riffles, and depositional areas in the canyon serve as the spawning areas (CDFG 2000, Balance and PWA 2000). However, the portions of the watershed within the study area are characterized by geologic formations that produce little to no baseflow, drier streams, and the absence of pools that hold water late into the season. Therefore, steelhead have not been documented, nor are they expected to occur in these areas.

1.2.4 Geologic Setting

The study area occurs on the western slopes of the Santa Ana Mountains, which are part of the Peninsular Ranges that extend from the tip of Baja California northward to the Palos Verdes Peninsula and Santa Catalina Island. The geology of the region is complex and has been dominated by alternating periods of depression and uplift, mass wasting, and sediment deposition. Within the San Juan and western San Mateo watersheds, the Santa Ana Mountains are composed of igneous, metavolcanic, and metasedimentary rocks of Jurassic age and younger. The exposed rocks in the mountainous areas are slightly metamorphosed volcanics, which have been intruded by granitic rocks of Cretaceous age, principally granites, gabbros, and tonalites. Overlying these rocks are several thousand stratigraphic feet of younger sandstones, siltstones, and conglomerates of upper Cretaceous age, composed largely of material eroded from the older igneous and metavolcanic rocks now underlying the Santa Ana Mountains.

Younger sedimentary rocks comprise the bedrock between the Santa Ana Mountains, their foothills, and the Pacific Ocean. Most of the study area is underlain by these marine and non-marine sandstones, limestones, siltstones, mudstones, shales, and conglomerates, many of which weather, erode, and/or hold groundwater in characteristic ways. Overlying them are Quaternary stream terrace deposits and Holocene stream channel deposits.

The central portion of the study area (i.e., Chiquita, Gobernadora, Wagon Wheel, and Trampas canyons) are underlain by semi-consolidated sandstones such as the Sespe and Santiago formations that yield substantial baseflow. These areas are overlain by sandy substrates that are associated with high infiltration rates and subsequent return flow. Consequently this portion of the study area has intermittent to perennial streams that support dense stands of southern willow riparian habitat.

The eastern portion of the study area (i.e., upper San Juan Creek, Gabino, and La Paz canyons) are underlain by fine-grained consolidated sediments, such as the lower Williams formation, and metasediments of the Trabuco and Ladd formations that yield little to no baseflow. These areas are overlain by clayey and crystalline terrains that are associated with high runoff rates. Consequently, this portion of the study area has drier meandering or braided alluvial streams, with coarse substrate that supports oak and sycamore riparian habitat.

1.3 STUDY SPECIES

Planning for the protection and management of aquatic and riparian dependent species under the NCCP/HCP and SAMP/MSAA must include not only protection of habitats where species reside, but the physical processes that account for specific habitats. This understanding will allow for development of appropriate management measures related to dry and wet season runoff; sediment yield, storage, and deposition; subsurface water delivery to riparian zones; and protection of water quality. Consideration of the effect of long and short term physical processes on habitat structure and distribution is also important in designing a reserve system with adequate resiliency to accommodate natural perturbations and species population dynamics.

The key physical habitat components for each of the study species were determined based on the primary constituent elements identified in the U.S. Fish and Wildlife Service' (USFWS) current critical habitat designations[2] and listings for each species as well as other relevant technical reports and scientific studies on the species. Primary constituent elements are those habitat components that are essential for foraging, sheltering, reproduction, migration, and dispersal. The key physical habitat components and primary constituent elements for each species are summarized below and discussed in greater detail in the appropriate subsequent sections of this report. Specific buffer recommendations and requirements are not included in the species profiles. Requirements, guidelines or recommendations for buffers of specific widths for some species have been incorporated into Biological Opinions or appear in the scientific

[2] *The following critical habitat designations were reviewed: tidewater goby (USFWS 2000), southern steelhead (NMFS 2000), arroyo toad (USFWS 2001), least Bell's vireo (USFWS 1994), and southwestern willow flycatcher (USFWS 1997). Note that the critical habitat for the southwestern willow flycatcher has since been vacated by New Mexico Cattle Growers Ass'n v. USFWS, 248 F. 3d 1277 (10th Cir. 2001).*

literature. However, these suggested buffer widths are variable because appropriate buffer widths depend on a variety of factors, including: adjacent habitat, adjacent existing and future land uses, topography, and potential or existing threats. Such variable factors are better addressed on a site-specific rather than a generic basis (i.e., one size does not fit all). The species profiles do, however, contain information about suitable adjacent habitats, where relevant, to help guide planning for appropriate buffers.

1.3.1 Species That Occur Both Within And Outside The Study Area

Three aquatic/riparian dependent endangered species occur both within and outside the study area: arroyo toad, least Bell's vireo, and southwestern willow flycatcher.

For the arroyo toad, gravel or sandy-gravel substrate streams and adjacent uplands are essential for foraging, breeding, growth of larvae (tadpoles) and juveniles, intra-specific communication, migration, genetic exchange, and sheltering. Key physical processes and biological features that provide suitable habitat for the arroyo toad habitat include regular flooding cycles, the presence and replenishment of proper substrates, connectivity to upland habitats sufficient to support foraging and non-breeding activities, lack of non-native species (plants and animals), barrier-free migration[3] and dispersal[4] corridors, and undisturbed habitats (USFWS 2001).

For the least Bell's vireo, willow riparian habitat is essential for foraging, breeding, nesting, roosting, intra-specific communication, migration, dispersal, genetic exchange, and sheltering. Key physical processes and biological features that provide suitable habitat for the least Bell's vireo include: 1) a regular flooding and scour cycle that supports early and mid-successional riparian woodland containing both canopy and shrub layers; and 2) proximity to associated upland habitats.

For the southwestern willow flycatcher, willow riparian habitat is essential for foraging, breeding, nesting, roosting, intra-specific communication, migration, dispersal, genetic exchange, and sheltering. The southwestern willow flycatcher generally requires more mature habitat and closer proximity to open water than the vireo. Consequently, the flycatcher relies upon physical processes that provide for a mosaic of open water and multiple benches and terraces that include space for individual and population growth, cover or shelter, sites for breeding, reproduction, rearing of offspring, and habitats that are protected from disturbance.

[3] *Migration refers to periodic or season movements of an individual or group of organisms from one stratum, habitat, climate, or region to another.*

[4] *Dispersal refers to a less systematic movement of individuals from one area to another that may be temporary or permanent.*

1.3.2 Species That Occur Solely Outside/Downstream of the Study Area

Two aquatic/riparian dependent endangered species occur outside the study area, but within the San Mateo watershed: tidewater goby and southern steelhead.

For the tidewater goby, relatively shallow open water lagoons with backwater areas are essential for spawning, foraging, growth of juveniles, migration, dispersal, genetic exchange, and sheltering. Key physical processes and biological features that provide suitable habitat for the tidewater goby include a natural flooding cycle, the presence and replenishment of proper substrates, and a lack of non-native species (primarily exotic fish) (USFWS 2000). For the southern steelhead, gravel substrate streams that convey flow late in the season are essential for spawning, foraging, growth of juveniles, migration, genetic exchange, and sheltering. Key physical processes and biological features that provide suitable habitat for the southern steelhead include baseflow, perennial pools shaded by adjacent riparian vegetation, connection to downstream systems with minimal stream obstructions, gravel substrates, available spawning and over-summering sites, food resources, water quality and quantity, and riparian vegetation (NMFS 2000).

2.0 SPECIES THAT OCCUR WITHIN THE STUDY AREA

Three aquatic/riparian dependent endangered species occur both within and outside the study area: arroyo toad, least Bell's vireo, and southwestern willow flycatcher.

2.1 ARROYO TOAD

2.1.1 Regulatory Status

Petitioned for federal listing in August 1991, the arroyo toad was listed as an endangered species under the federal Endangered Species Act (ESA) by the USFWS on December 16, 1994, and as a "Species of Special Concern" by the State of California under the state Endangered Species Act (Steinhart 1990). On February 7, 2001, the USFWS designated a total of 73,799 hectares (182,360 acres) in Monterey, Santa Barbara, Ventura, Los Angeles, San Bernardino, Riverside, Orange, and San Diego counties, California, as critical habitat for the arroyo toad. Approximately half of the land designated occurs on federal, state or local agency land with the remainder being in private ownership. According to the USFWS, this designation identifies specific geographic areas that are essential for the conservation of the arroyo toad and require special management considerations. Designated critical habitat includes areas in the San Juan Creek watershed in and along San Juan Creek, Bell Canyon, and Trabuco Creek, and in the San Mateo Creek watershed in and along San Mateo, Cristianitos, Talega, Gabino, and La Paz creeks.

The Recovery Plan for the arroyo toad was published on July 24, 1999 and included portions of the San Juan and San Mateo watersheds within the Southern Recovery Unit. Management recommendations from the Recovery Plan include: limiting alterations in water use, release, control, diversion, and extraction; controlling mining activities and livestock grazing; limiting recreational use near specific breeding areas; and reducing or eliminating introduced plant and animal populations (i.e., exotic predators).

2.1.2 Species Profile

2.1.2.1 Description

The arroyo toad is a small, dark-spotted toad of the family Bufonidae. Adults range in size between 5.6 and 8.5 cm (2.2 and 3.3 in) in snout-vent length (SVL). The skin on its back is light-olive green or gray to tan in color with dark spots and warty. A characteristic light colored, V-shaped stripe crosses the head and eyelids. The underside is a homogeneous white or buff color.

2.1.2.2 Species Distribution

The current range of the arroyo toad includes coastal and desert drainages extending from the San Antonio River (Ft. Hunter-Liggett), in Monterey County (USFWS 1994), and near Santa Margarita, San Luis Obispo County, south to northwestern Baja California, Mexico as shown in Figure 3, *Arroyo Toad Historical and Current Distribution*, on page 17. The elevational range extends from near sea level to 2,438 m (8,000 ft) above mean sea level (MSL) in Baja California (Welsh 1988; Beaman et al. 1995). Currently, most arroyo toad populations are restricted to elevations of 305 to 1,402 m (1,000 to 4,600 ft) (USFWS 1999). Formerly widespread in southern and central California, the arroyo toad is now found in only 22 river systems (Campbell et al. 1996). The areas designated as critical habitat for the species are shown in Figure 4, *Arroyo Toad Critical Habitat*, on page 18.

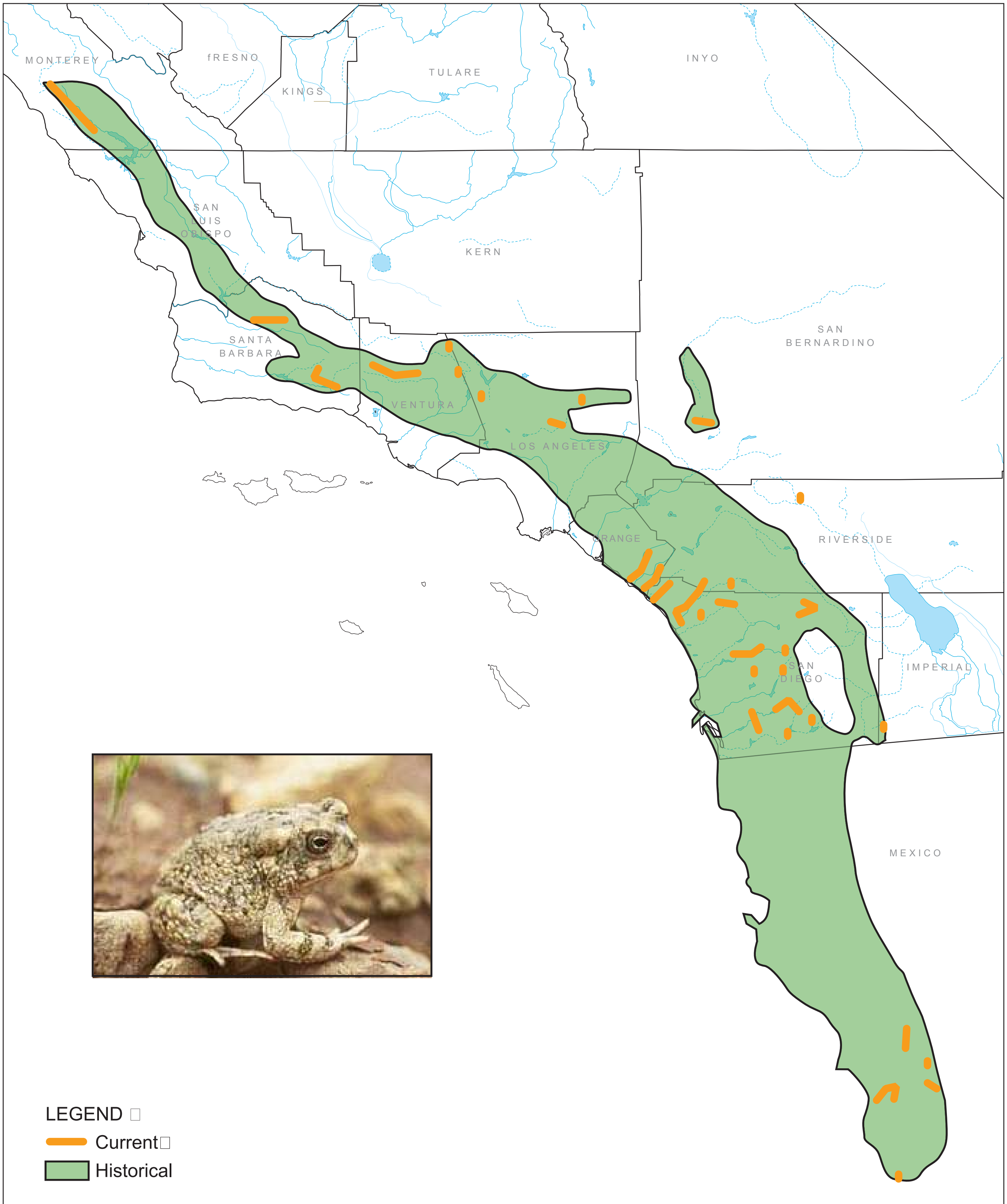
2.1.2.3 Occurrences Within the Study Area

Arroyo toads have consistently been found in San Juan Creek at and between the mouths of Chiquita Canyon and Cañada Gobernadora, at the confluence of San Juan Creek and Bell Canyon (Caspers Park), within Bell Canyon, in San Juan Creek above Bell Canyon to Hot Springs Canyon Creek, and in Hot Springs Canyon Creek approximately 2.4 km (1.5 mi) upstream of the confluence with San Juan Creek. In the San Mateo watershed arroyo toads have been documented along Cristianitos Creek, Talega Canyon, and lower Gabino Canyon. A subregion-wide survey to assess the present status of the toad was conducted in 1998 (Bloom, in litt.). He concluded that the toad occurs in four populations as shown in Figure 5, *Arroyo Toad Distribution Within the Study Area*, on page 19. Surveys for the arroyo toad in several other drainages in neighboring watersheds by Bloom in 1998 resulted in negative findings. No toads were found in Aliso Creek, Verdugo Canyon, Lucas Canyon, or Trabuco Creek below O'Neill Regional Park down to Interstate 5. However, Bloom concluded that these areas did contain suitable arroyo toad habitat.

San Juan Creek Watershed

1. <u>San Juan Creek</u>: Arroyo toads were found in San Juan Creek from approximately 300 m (1,000 ft) east (upstream) of the Antonio Parkway bridge[5] to about 0.5 mi

[5] *This location is approximately 600 meters west of the confluence between Chiquita and San Juan Creeks.*



N

No scale

Source: USFWS, 1999

Figure 3
Arroyo Toad Historical and Current Distribution

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

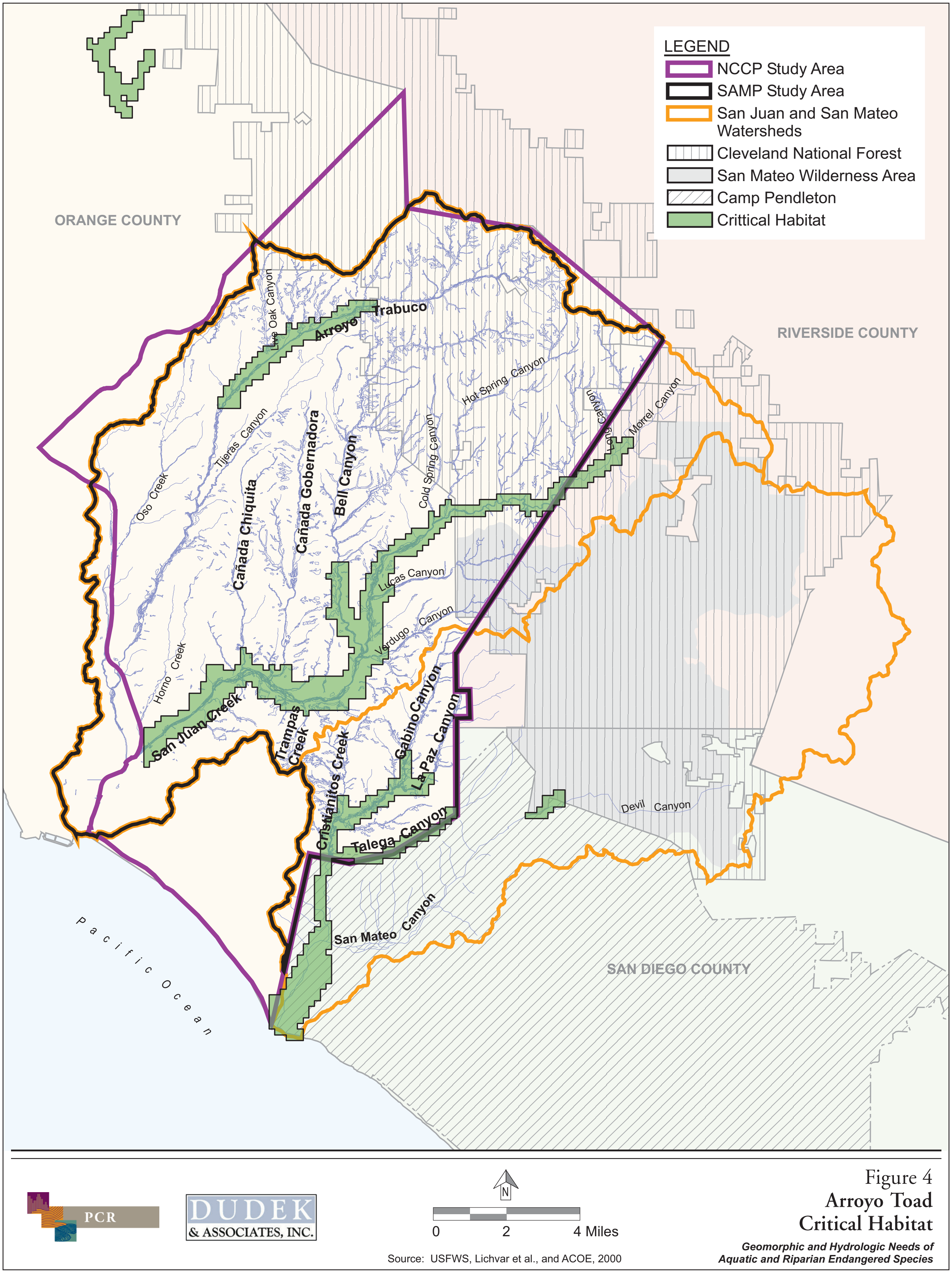
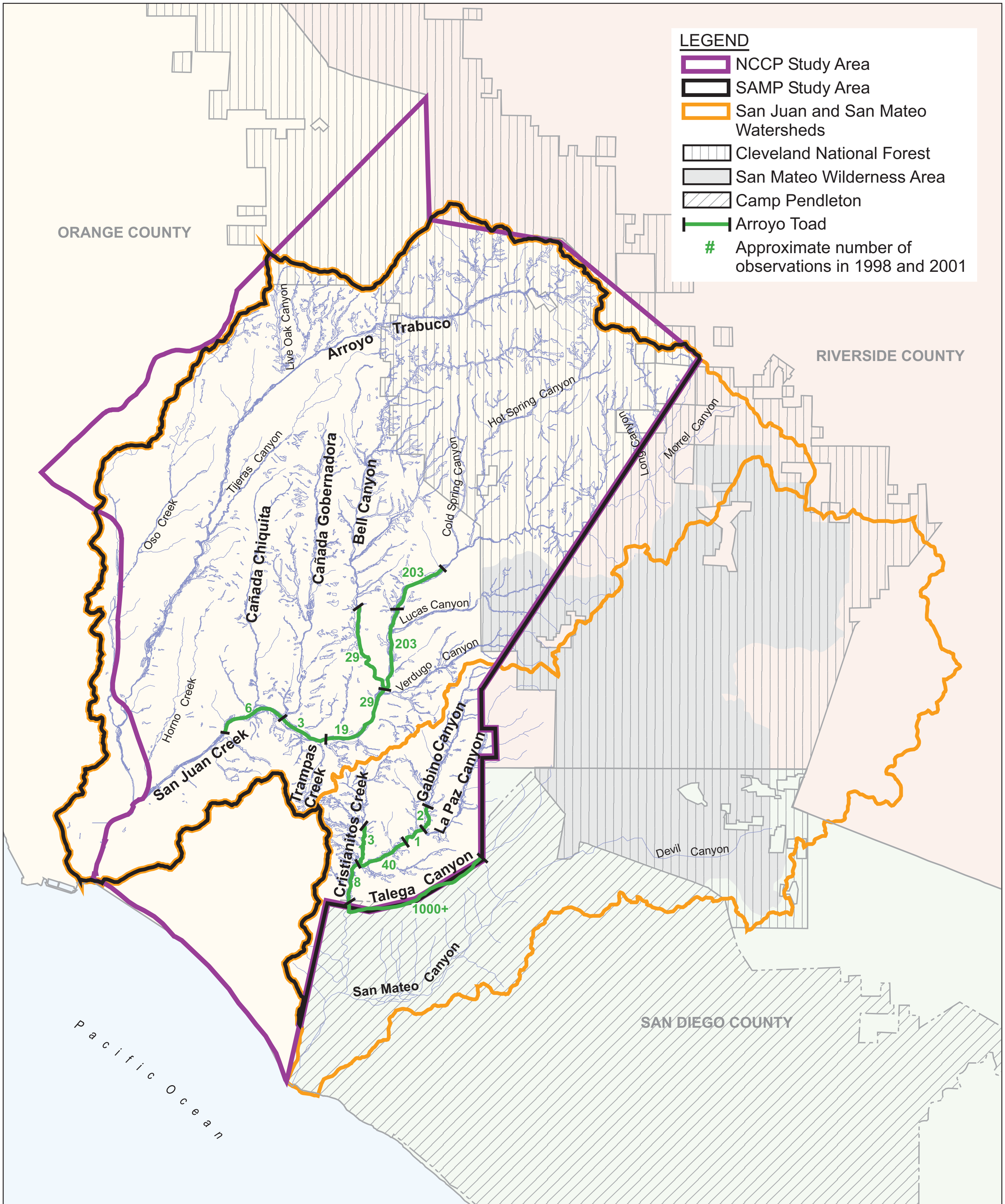


Figure 4
Arroyo Toad Critical Habitat

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species



Source: Lichvar et al. and ACOE 2000, Dudek 2001, Dudek and PCR 2002

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Figure 5

Arroyo Toad Distribution Within the Study Area

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

downstream of the confluence of Hot Springs Canyon Creek within Caspers Wilderness Park. This portion of the creek is a relatively wide braided stream system with a channel bed dominated by coarse sands and gravels. The channel form is characterized by mid-channel bars and floodplain benches that support patchy riparian habitat. Toads were also found 2.4 km (1.5 mi) upstream from the confluence of San Juan Creek and Hot Springs Canyon. No toads were found between Interstate 5 and the Antonio Parkway Bridge. A small, localized population exists on Rancho Mission Viejo between Cañada Chiquita Creek and the Caspers Wilderness Park boundary, which may be part of the upper San Juan Creek/Bell Creek metapopulation. This middle portion of San Juan Creek is affected by groundwater withdrawals, truck traffic, human activity, and contains a large abandoned mining pit that supports a population of bullfrogs. In addition, an inferred groundwater barrier between Chiquita and Gobernadora canyons and San Juan Creek may limit inter-aquifer exchange with San Juan Creek, contributing to the drier conditions in this portion of the creek (Balance 2001). In fact, the only successful breeding in this reach during 2001 was at the confluence with Trampas Canyon, where tributary outflow supported natal pools later into the breeding season. The largest, most robust arroyo toad population in Orange County exists in San Juan Creek within Caspers Wilderness Park where the stream is slightly wetter[6] for a greater portion of the season and is subject to fewer impacts from anthropogenic uses.

2. Bell Canyon Creek: Approximately 30 arroyo toads have been observed in Bell Canyon Creek from the confluence of San Juan Creek upstream to a point 3.2 km (2 mi) north of the confluence. This portion of Bell Creek contains similar substrate and habitat as San Juan Creek, but is slightly narrower and lacks the distinct vertical sideslopes present in San Juan Creek. No toads were found as far upstream as the Starr Ranch Audubon Sanctuary in either Bell Canyon or Crow Canyon.

Western San Mateo Creek Watershed (within the study area)

1. Cristianitos Creek: Arroyo toads were found in Cristianitos Creek from the MCB Camp Pendleton boundary to approximately 700 m upstream of the confluence of Gabino Creek. Approximately 11 toad locations have been documented along Cristianitos Creek within the study area, three of which are upstream and eight of which are downstream of the confluence with Gabino Creek. Cristianitos Creek, downstream of the confluence with Gabino Creek contains coarse substrate,

[6] *Hard, cemented sandstone outcrops occur beneath and within the channel at a number of locations upstream and downstream from the confluence with Bell Creek. The sandstone likely promotes arroyo toad habitat in two ways. First, the hard rock brings groundwater to the surface, if only in discontinuous pools. Second, deep pools are regularly sustained at and immediately downstream of the outcrops, providing reliable habitat for the larval (tadpole) life stage, even during drier years.*

dominated by gravels and supports patches of open canopy riparian habitat. Toad occurrences are substantially lower in the upper portion of Cristianitos Creek, most likely because the creek transitions to a more clay-dominated substrate upstream of the confluence with Gabino Creek.

2. Gabino Creek: Approximately 40 adult arroyo toads[7] were found in Gabino Creek from its confluence with Cristianitos Creek upstream to the confluence of La Paz Creek. This area is geomorphically similar to lower Cristianitos Creek and is characterized by a relatively broad, geomorphically complex meandering stream supporting patchy sycamore riparian woodland.

3. Talega Canyon: An abundant population (i.e., approximately 1,000 individuals) of arroyo toads was found along the Orange/San Diego County border in Talega Canyon on both sides of the ownership boundary between Rancho Mission Viejo and MCB Camp Pendleton. The population is located from Camp Talega upstream 3.2 km (2 mi). The floodplain of Talega Creek is narrow and geologically confined. Talega Creek, and its adjacent uplands, contains habitat supporting the largest population of arroyo toads in the study area.

San Mateo Creek Watershed (outside of study area)

Approximate point locations of arroyo toad outside the study area are shown in Figure 6, *Arroyo Toad Distribution Downstream of the Study Area*, on page 22, and discussed below.

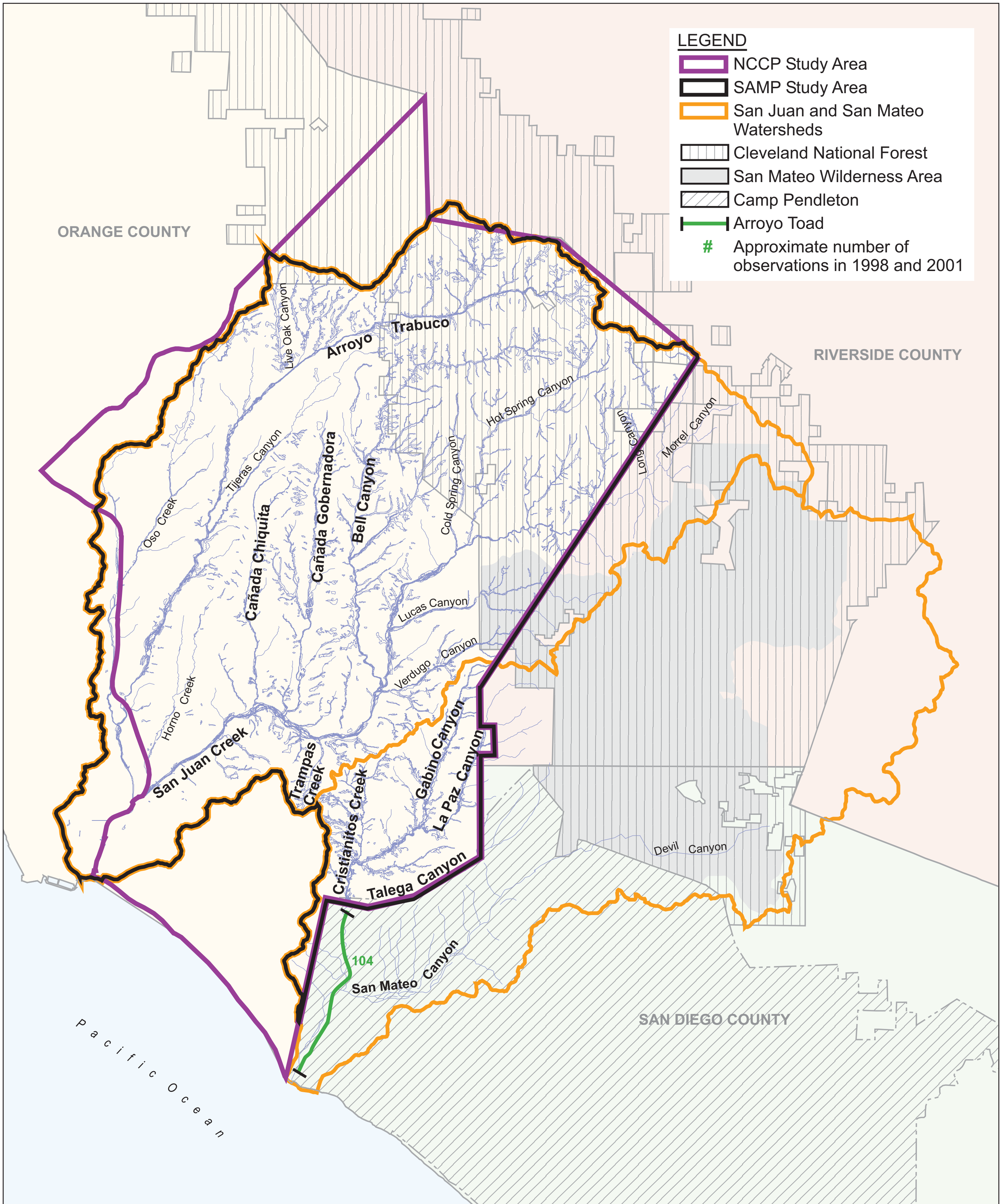
1. Lower San Mateo Creek: Arroyo toads have been found in the lower portion of San Mateo Creek from approximately 1.29 km (0.8 mi) north of Interstate 5 downstream to San Clemente Ranch Road.

2. Upper San Mateo Creek: Arroyo toads have been found in a 1.6-km (1-mi) reach of San Mateo Creek approximately 1.6 km east of the confluence of San Mateo Creek with Cristianitos Creek.

2.1.2.4 Habitat

Arroyo toads occur in a variety of habitats during their life cycle and occupy both aquatic, riparian, and upland habitats. Arroyo toads are found in foothill canyons and inter-mountain valleys where streams are bordered by low-gradient hills (Miller and Miller 1936; Sweet 1992). Arroyo toad habitat is typically shallow, slow-moving stream habitats, and riparian

[7] *Approximately 200 metamorphs were also observed in this location in 2001 by P. Bloom.*



Source: Lichvar et al. and ACOE 2000, Dudek 2001, Dudek and PCR 2002

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Figure 6
Arroyo Toad Distribution Downstream of the Study Area

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

habitats that are subject to episodic disturbances by extreme natural flows. Some of the geomorphic and landform features that characterize arroyo toad habitat include friable[8], well-sorted fine gravel and sand substrate, open streambeds that are not impounded or have little or no flow regulation, and adjacent, stable sandy floodplain benches or terraces. Arroyo toad habitat is dynamic with specific breeding and burrowing sites potentially changing from year to year.

Figure 7, *Arroyo Toad Conceptual Habitat Pro*file, on page 24, and Figure 8, *Arroyo Toad Conceptual Habitat Cross-Section*, on page 25, display a conceptual profile and cross-section of arroyo toad habitat respectively. The conceptual habitat cross-section (Figure 7) illustrates the relationship between geomorphic surfaces and aquatic/riparian habitat that typically support the various life stages of the arroyo toad.

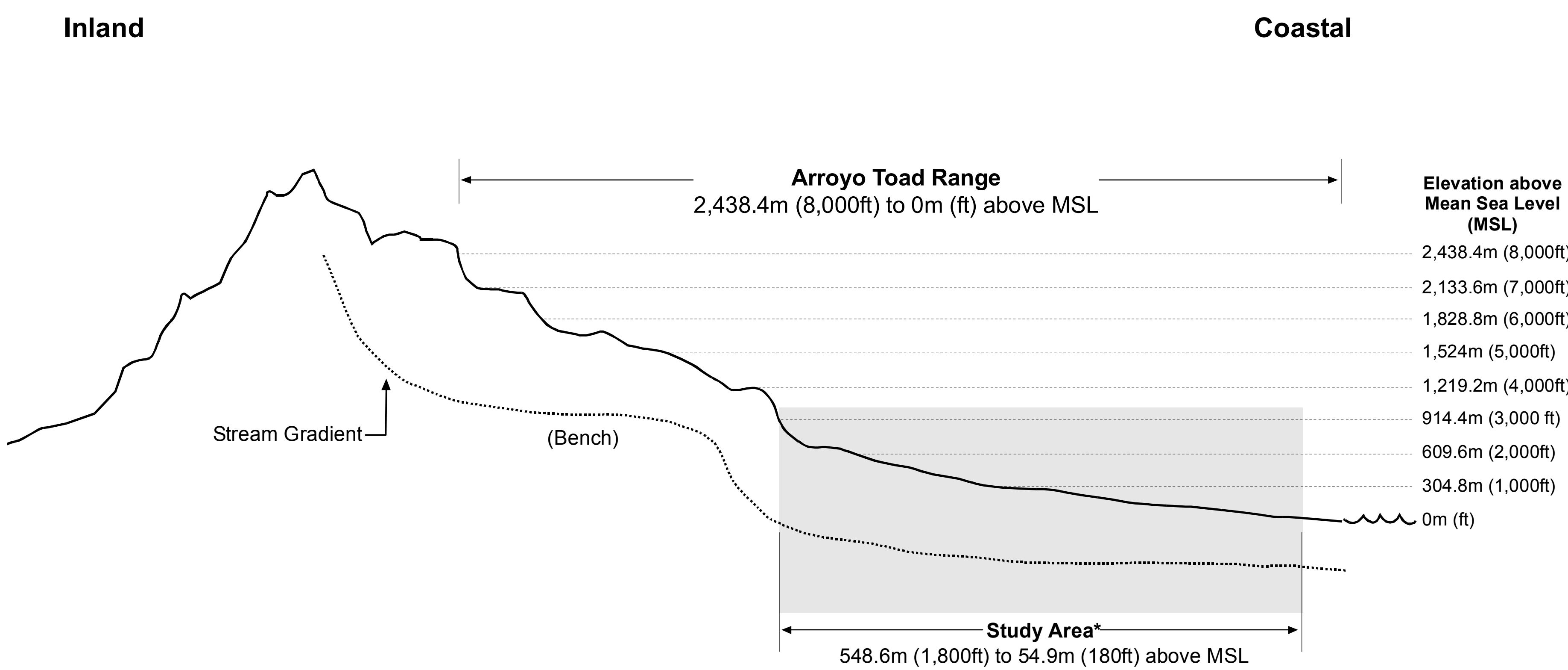
2.1.2.4.1 Breeding Areas

Breeding habitat is typically shallow, slow moving creeks and streams with persistent water from March to mid-June that have shallow, gravely pools less than 0.5 m (18 in) deep, and adjacent sandy terraces (Dudek 2000). Successful recruitment within San Juan Creek is highly correlated with the duration of breeding pool inundation (Ramirez 2001). During the 2001 season (which was unusually dry), all clutches found within San Juan Creek, except one located at the confluence of Trampas Canyon, were desiccated prior to maturation. In this location, the constant low flow from a basin constructed within Trampas Canyon upstream of the confluence extended the duration of inundation at the confluence where breeding was successful (Ramirez 2001). Nocturnal surveys conducted from 1996 to 2000 during the months of February through June (Holland et al. 2001) revealed that 90 percent (n=890) of adult toads found were within the watercourse or within 1 m (39 in) of the shore. Heavily shaded pools are unsuitable for larvae and juvenile toads due to lower water and soil temperatures and poor algal mat development (Sweet 1992). Males stop calling when they are disturbed or air temperatures fall below 13 to 14 Celsius (C) (55 to 57 F) (Myers 1930). Larval growth appears to be more rapid in pools with low silt loads (Jennings and Hayes 1994).

2.1.2.4.2 Natal Habitat

Observations made along San Mateo Creek, San Onofre Creek, and the Santa Margarita River indicate that natal habitat may only comprise 1 to 5 percent of a stretch of any drainage that is a kilometer or more in length (Holland et al. 2001). Larvae within these natal areas likely occur at the margins of a pool during the day but move to interior portions of the pool at night (Sweet 1993; Campbell et al. 1996). Suitable natal pools that retain ponded water late into the

[8] *Friable soils refer to soils that are brittle and can be readily crumbled.*



* Profile for study does not include the Cleveland National Forest.

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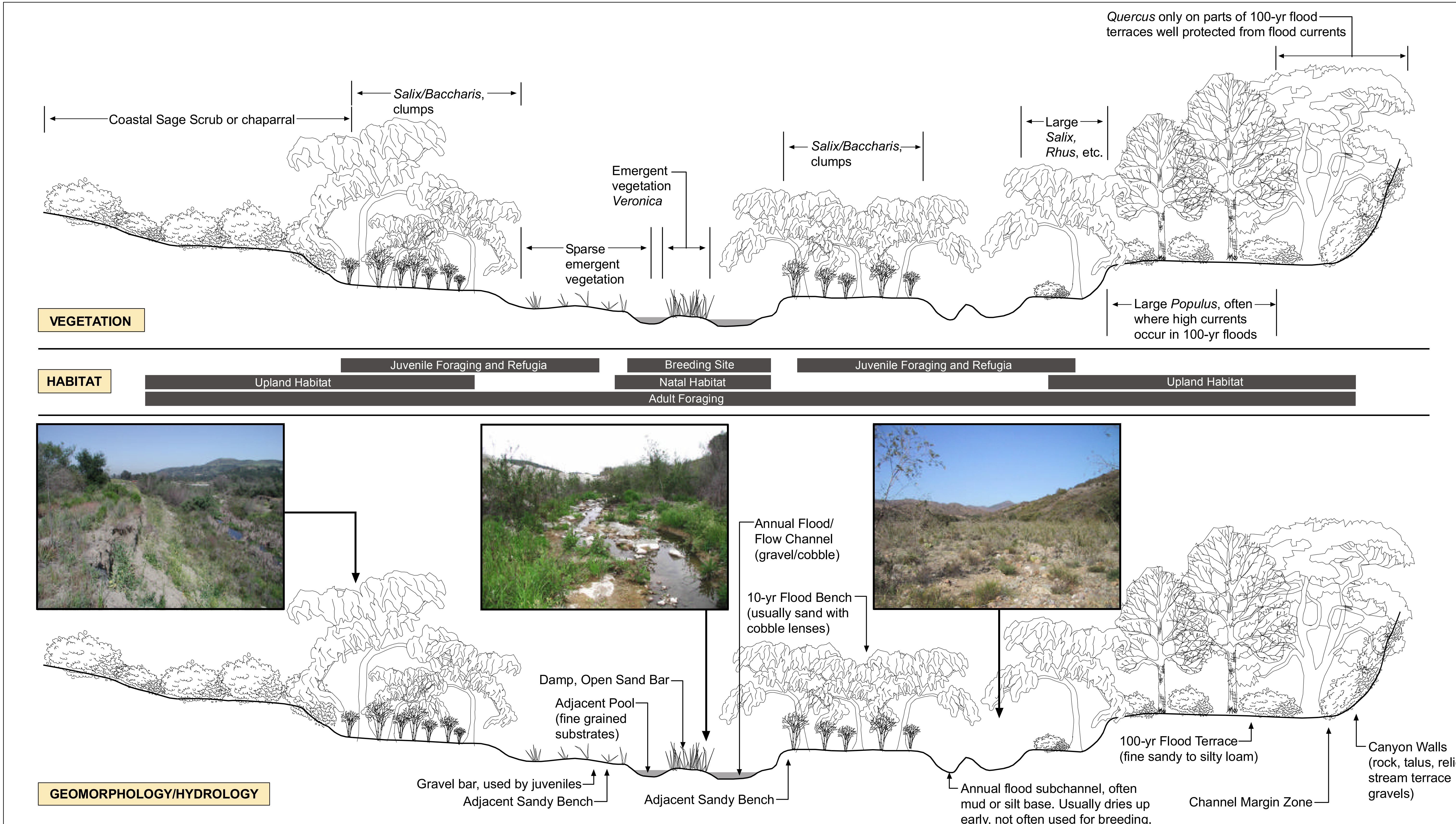
Source: Modified from Campbel et al., 1996 and Sweet, 1989

Figure 7
Arroyo Toad
Conceptual Habitat Profile



No scale

Source: PCR Services Corporation and Eric Stein, 2002

Figure 8
Arroyo Toad
Conceptual Habitat Cross-Section

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

summer are often associated with rock outcrops or other shallow impervious surfaces that bring groundwater to the surface, even during drier years. Juvenile toads require saturated, barren sand and gravel bars bordering these breeding pools (Campbell et al. 1996), where they remain primarily exposed, seeking shelter at night in shallow depressions next to stones and along dying algal mats.

2.1.2.4.3 Juvenile Refugia Areas

Areas utilized by juveniles consist primarily of sand or fine gravel bars with varying amounts of large gravel or cobble with adjacent stable sandy terraces and oak flats (USFWS 1999). Juvenile toads prefer damp areas that have some vegetative cover (less than 10 percent) such as American brooklime (*Veronica americana*). Such areas possess the refuge and thermal characteristics required for juvenile survival and rapid growth (Sweet 1992). Near the confluence at San Juan Creek and Trampas Canyon, Ramirez (2001) found that juvenile toads almost exclusively utilized non-native vegetation (greater than 50 percent sweet clover) for refugia. During diurnal surveys, they were observed between these refugia areas and the unvegetated active stream channel (Ramirez 2001). Bare sand and gravel bars may support large numbers of juvenile toads, but survivorship may be reduced due to high levels of predation (Sweet 1992).

2.1.2.4.4 Foraging Areas

Foraging habitat needs for juvenile and adult toads differ. Juvenile toad foraging habitat is characterized by low-lying, moist sandy bars located within and immediately adjacent to the streams. The streambed bars may be devoid of vegetation, but survival is higher if emergent vegetation covers approximately 10 percent of the bar (Sweet 1992). However, juvenile toads typically avoid shade. Juveniles and adults may forage on adjacent stream banks with open, sandy or gravely benches and very little herbaceous cover. These areas may contain a moderate riparian canopy of cottonwood, willow, or oak (Dudek 2000).

Adult toad foraging habitat is characterized by open streamside sand or gravel flats, margins of old flood channels, sandy terraces with a mix of dense willow clumps and open flats, canopy margins of oaks or cottonwood terraces bordering the floodplain, and edges of open sand flats bordered by cottonwood and mature willows (*Salix* spp.) where the ground is relatively bare. Female toads require an abundance of the type of foraging habitat described above, where they intensively feed for a minimum of two months prior to the breeding season.

Arroyo toads are known to forage and aestivate in riparian, coastal sage scrub, oak, chaparral, and ruderal/disturbed habitats (Dudek 2000). Foraging habitat on adjacent banks must provide open, sandy or gravelly benches with very little herbaceous cover within a moderate riparian canopy of cottonwood, willow, or oak (Dudek 2000). Holland and Sisk (2001) found that out of 280 microsites sampled within Cristianitos Creek and the Santa Margarita River from January 1998 to December 2000, the range of slopes where toads were captured was 0 to 35 degrees, with the highest proportion of captures at low slopes (less than 5 degrees). However, arroyo toads have been observed on slopes of 45 degrees or greater (Holland and Sisk 2001). Figure 9, *Variety of Arroyo Toad Burrow/Aestivation Locations*, on page 28, illustrates a range of aestivation/burrow habitats used by toads along San Juan Creek (Ramirez 2002) and illustrates that toads will use a variety of locations and habitats for aestivation.

2.1.2.5 Life Cycle/Natural History

The life span of the arroyo toad typically is five years or less (Sweet 1992, 1993). Males reach sexual maturity at two years of age and females between two to three years of age. In southern California, breeding activity usually starts in late February or early March but may occur as early as January (USFWS 1999). Male arroyo toads typically arrive at the breeding pools one to three weeks prior to the females; however, the timing of this arrival may vary with environmental conditions. In coastal San Diego County, males are usually present in numbers by the second week of February. Males call from the edge of pools and typically begin calling approximately one hour after sunset and may continue beyond sunrise (USFWS 1999; Sweet 1992). Males may continue to call until June, although the peak of activity usually occurs from March to May. Males generally form linear, loosely organized choruses along streams (Sullivan 1992) and exhibit strong site fidelity during the breeding season (Sweet 1991). Activity is thought to decline during full moon phases (Dudek 2000); however, this has not been conclusively documented. Females locate calling males, and once in amplexus, the eggs are laid (Sweet 1992). Females generally release their entire clutch, ranging from 2,000 to 10,000 eggs, as a single breeding effort on substrates of sand, gravel, cobble, or mud located away from vegetation within the shallow margins of the breeding pool. Egg-laying by the cohort of female toads may occur over a period of seven to eight weeks from the end of March through early July. Eggs typically hatch in four to six days. Tadpoles usually stay in the natal pools until metamorphosis, which peaks from late April to mid-May in southern California (USFWS 1999).

Arroyo toad larvae typically distribute themselves along the shallow margins of natal pools where they consume organic material found on the surfaces of stones and in the sandy substrate during the day, but then move to interior portions of the pool during the nighttime (Sweet 1993; Campbell et al. 1996). Following metamorphosis, juvenile toads position themselves near the natal pool on moist sand and find shelter in depressions, holes, or under leaves, rocks or debris. Once they reach 23 millimeters (mm) (0.9 in) in size, juveniles dig burrows in loose sandy ridges adjacent to the natal area and return to the moist sand bars during the nighttime to feed (Sweet 1992). After reaching 28 to 30 mm (1.1 to 1.2 in) in size, arroyo toads shift to the distant margins of the floodplain benches and into adjacent willow scrub habitat

Figure 9
Variety of Arroyo Toad Burrow/Aestivation Locations

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

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Source: Ruben Ramirez, 2001

(Dudek 2000). Most arroyo toads disperse from their natal pools a year after metamorphosis (Sweet 1993). Figure 10, *Life Stages of the Arroyo Toad*, on page 30, illustrates the various life stages of the arroyo toad.

Information on patterns of habitat use by sub-adults and non-breeding adults has slowly developed since the toad's listing in 1994. This species is primarily nocturnal, and often moves within both riparian and upland habitats during periods of high surface moisture (fog or dew) or during rain. However, large numbers of both adults and juveniles may be active at night during the spring and early summer under otherwise dry conditions. Post-metamorphic toads are diurnal for the first four to five weeks of development and switch to strictly nocturnal activity after they reach 17 to 23 mm (0.7 to 0.9 in) SVL (Cunningham 1962). During the winter, toads burrow 5 to 10 cm (2 to 4 in) deep in dry sand or at the dry/damp sand interface at the canopy edge of riparian or chaparral vegetation (Sweet 1992). Adults excavate shallow burrows on the terraces (during the breeding season) where they shelter during the day when the surface is damp or during longer intervals in the dry season (Dudek 2000). Arroyo toads within San Juan Creek were documented to burrow from 0 cm (where they utilize rocks) to 102 cm (3.3 ft) in friable soils (Ramirez 2001). The species utilizes sandy burrows or adjacent debris, with the larger juveniles and adults spending more time away from the waters edge (Cunningham 1962; Sweet 1992). Except during the breeding season, adult arroyo toads are essentially terrestrial, foraging at night in upland terrace habitats. Male toads have been observed dispersing upland as far as 1 km (0.6 mi) from the stream during their nighttime activities (Griffin et al. 1999). Sweet (1993) found that many sub-adults and some males moved along streams in a linear fashion for several kilometers. Holland (2001) found that arroyo toads are capable of moving up to 1.2 km (0.7 mi) from the upland/riparian ecotone. However, the experimental design used by Holland and Sisk (2001) measured how far toads are capable of moving before being captured in a pitfall trap, not what their distribution of habitat use is away from the riparian area.[9] The distance-frequency distribution of captures reported by Holland and Sisk indicates that the vast majority of individuals were captured at less than 500 m (1,640 ft) from the upland-riparian ecotone. The females become more sedentary as they mature, while many, but not all males maintain a tendency to move up or down the drainage during the breeding season (Dudek 2000). Sweet (1993) noticed an absence of toad movement between August and late March.

2.1.2.5.1 Migration to Upland Habitat and Dispersal Movements

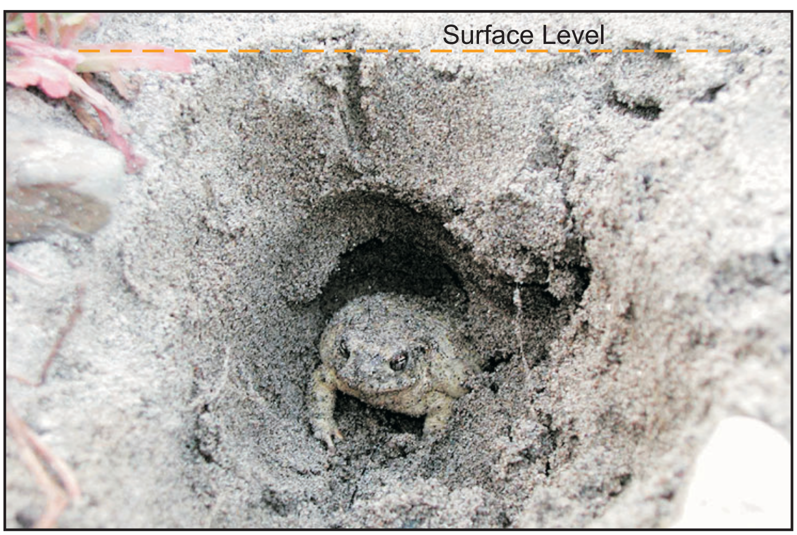
In their determination of critical habitat for the toad, the USFWS (2001) included sub-watershed areas that provide migration routes as a critical component of its habitat in order to assure uncertain breeding and burrowing habitats in the future. Recent data suggest that arroyo

[9] *PCR interpretation of data in Holland and Sisk (2001) report.*

Larvae

Metamorph

Adult



Source: Ruben Ramirez, 2002

Figure 10
Life Stages of the Arroyo Toad

toad adults may move between 1 and 2 km (0.6 and 1.2 mi) into adjacent upland habitats to aestivate (Dudek 2000). However, there is no thorough understanding of the distribution of typical upland movement distances (i.e., what percent of toads move specific distances) nor the environmental factors that dictate distance or direction of movement.

Adult and juvenile toads also disperse up and down streams during and between breeding seasons. Extended dispersal movements of approximately 6 to 8 km (4 to 5 mi) along a stream corridor have been documented; however, sufficient data do not exist to estimate with any statistical reliability the proportions of toads that may make long distance movements. Furthermore, data on the range and average distance toads will travel in different environments have not been well established (USFWS 2001).

2.1.3 Key Physical Habitat Components

2.1.3.1 Geomorphic Factors

2.1.3.1.1 Stream Order

Arroyo toads live in riparian environments located within the middle reaches of coastal streams. The majority of arroyo toad populations studied occur within 3^{rd}- and 4^{th}-order drainages that are characterized by decomposed granite bedrock. However, toad populations have been found in a wide range of stream orders, including lower, 2^{nd}-order, and higher, 5^{th}- and 6^{th}-order coastal streams characterized by sedimentary rock. As an example, San Juan Creek is a 5^{th}-order stream that supports arroyo toad (USFWS 2001), while in the San Mateo watershed the largest arroyo toad populations are in 2^{nd}- and 3^{rd}-order streams.

Table 2 on page 32 presents the bank-full and floodprone channel widths associated with areas within the San Juan and San Mateo watersheds that support arroyo toads.

2.1.3.1.2 Low-gradient Stream Segments

Stream reaches that support arroyo toads have fairly low gradients, typically less than 2 percent, and are bordered by ridges of moderate relief. In order to provide arroyo toad habitat, the drainage must be large enough for channel scouring and filling processes to operate regularly and to allow recolonization by aquatic and riparian plants between successive channel forming flows (i.e., normally those exceeding a 2- to 3-year event). Stream sections of this type are characterized by features such as late season or near perennial flow, shallow pools persisting until at least midsummer, open streamside sand/gravel flats, and sparsely vegetated low sandy benches within the channel.

Table 2

STREAM ORDER CHARACTERISTICS OF KNOWN ARROYO TOAD POPULATIONS

Population (drainage)	Watershed	Stream Order	Length (m)	Elevation Upstream (m)	Elevation Downstream (m)	Bank full Width (m)	Floodprone Width (m)
San Juan Creek	San Juan	5	32,194.8	109.7	54.9	118.3-187.8	n.d.a
Bell Canyon Creek	San Juan	4	4,8521.0	158.5	109.7	47.9-57.0	13.1-42.7
Cristianitos Creek	San Mateo	3	2,366.8	73.2	54.9	11.6-21.3	20.7
Gabino Creek	San Mateo	2	3,562.2	121.9	73.2	12.5-19.2	19.2-19.8
Talega Creek	San Mateo	2	6,992.7	195.1	54.9	n.d.a	n.d.a

n.d.a: no data available

Source: PCR 2001; PWA 2001; WES 1999.

2.1.3.1.3 Substrate Characteristics

Arroyo toads typically prefer sandy and loamy sand soils. Toads primarily burrow in loose sandy or loamy sand soils important in both the riparian and upland zones. Other soil types are crossed during migration to aestivation areas and may be utilized for temporary shelter (USFWS 2001).

Juveniles less than 22 mm (0.8 in) in SVL length are diurnal and prefer mixed rocky-sandy substrate, and actively select damp substrates with temperatures of 32 to 35 C (89 to 95 F). Because these young toads are not yet capable of long distance movements or burrowing, they avoid shade, dry substrates, and temperatures over 42 C (107 F) (Jennings and Haynes 1994). Juvenile and adult habitat consists of shoreline or central bars with stable, sandy substrates that are dampened through capillarity and possess some emergent vegetation (e.g., *Veronica americana*) (Jennings and Haynes 1994). Pool substrates preferred by arroyo toads for breeding sites generally have bottoms composed of sand or well-sorted fine gravel, although a significant component of large gravel or cobble may be present (USFWS 1999).

Observations of microhabitat characteristics utilized by adult toads active at night from linear transect surveys performed by Holland et al. (2001) revealed that a vast majority of toad microsites are on sandy substrates. However, in this case, this may have been a result of the available substrate at each of the selected microsites (i.e., the pitfall trap locations) and not a result of species preference (Holland et al. 2001). However, in cases where the habitat was more heterogeneous, Holland et al. (2001) did find a disproportionate use of areas dominated by sand.

Observations of microhabitat characteristics made by Griffin (1999) using a different methodology that surveyed quiescent toads in daytime retreats/refugia concluded that sands were the preferred substrate for adult arroyo toad burrowing. This pattern is illustrated by the fact that toad populations are considerably larger in the sandy/cobble soils of lower Gabino Creek than they are in the compacted clay soils of upper Cristianitos Creek. Similarly, areas that lack a mix of sand and gravel substrates, such as Chiquita and Gobernadora creeks, do not appear to support arroyo toad.

During the winter, toads burrow 5 to 10 cm (2 to 4 in) deep in dry sand or at the dry/damp sand interface along the canopy edge of riparian or chaparral vegetation (Sweet 1992). Toads have been documented to burrow 102 cm (3.3 ft) during summer, non-breeding months in mule fat scrub adjacent to San Juan Creek (Ramirez 2001). Griffin (1999) established a substrate preference ranking based on his results: (medium sand + coarse sand + fine sand)>>>(clay/silt + cobble + gravel) (Holland et al. 2001). Although sands (i.e., coarse sediments) were the preferred microhabitat, there was not a statistically significant relative preference between medium, coarse, and fine sands. Likewise there was not a significant relative preference between clay/silt, gravel, and cobble substrates.

2.1.3.1.4 Open Sand Bars

Shoreline and central sand bars dampened through capillarity and possessing some emergent vegetation are preferred by juvenile toads for the optimal thermal and refugia conditions (Jennings and Haynes 1994). Adults and juveniles utilize sandy terraces or benches within the 100-year flood zone. These areas lack dense vegetation, yet have appropriate levels of prey for sub-adult and adult toads (Sweet 1992). Newly metamorphosed toads remain on the saturated margins of sand or gravel bars for about a week, then move to drier areas of the bars for up to eight weeks, depending on the variation in the physical environment of the bars (Sweet 1991, 1993).

2.1.3.1.5 Adjacent Pools

Adults require overflow pools, old flood channels, and pools with shallow margins adjacent to the inflow channel for breeding. Generally 3rd and higher order streams that are free of predatory fishes are most conducive for breeding (Jennings and Haynes 1994). However, in the San Mateo Creek, large populations of arroyo toad are found in Talega Creek, which is a 3rd-order stream.[10] Breeding pools must occur within the vicinity of juvenile and adult burrowing and foraging habitat. The pools must be shallow, open bodies of water with minimal current,

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[10] *Talega Creek also receives persistent summer flows from the small (approximately 20 percent) portion of its watershed that is in the granitic rocks, likely providing more persistent pools, with more sandy substrate.*

and with a sand or pea gravel substrate overlain with sand or flocculent silt (Sweet 1989). Excessive loads of fine-grained sediment are likely detrimental to toad breeding because they could cause the eggs to be buried or asphyxiated with silt. The shallow pools should be sparsely vegetated sand and gravel bars for breeding and rearing of tadpoles and juveniles. The breeding pools must persist until at least the end of the larval period, which lasts 65 to 85 days after hatching (Campbell et al. 1996).

Adjacent pool habitats rarely have closed canopies over the lower banks of the stream channel due to regular flood events (USFWS 1999). Heavily shaded pools are generally unsuitable for larval and juvenile arroyo toads because of lower water and soil temperatures and poor algal mat development (Sweet 1992). Shallow pools with little woody vegetation and low current velocity are strongly favored. Limited amounts of overhead vegetation, often a result of episodic flooding, allow heat from the sun to keep the pools from becoming cooler than the required hatching temperature of 12 to 16 C (54 to 61 F) (Campbell et al. 1996).

2.1.3.1.6 Adjacent Habitat/Riparian Corridor

Adjacent habitats typically occur within the 100-year flood zone and may extend up to 100 m from the stream (Campbell et al. 1996). These sandy benches have a well-developed overstory of western sycamore (*Platanus racemosa*), cottonwoods (*Populus* spp.), coast live oak (*Quercus agrifolia*), and willow (Campbell et al. 1996). The understory may consist of scattered mule fat (*Baccharis* s*alicifolia*), short grasses, herbs, and leaf litter, with patches of bare or disturbed soil, or have no vegetation at all (USFWS 1999).

Most benches or bars are not immediately adjacent to the stream, but are separated by a dynamic, channel margin zone of mixed sediments that is reworked as storm waters flood the primary channel (Campbell et al. 1996). Drainages with straighter courses generally have broader marginal zones and fewer bars and benches but may have associated oak flats that provide suitable adult habitat (Campbell et al. 1996).

An important characteristic in defining suitable arroyo toad breeding pool is the proximity to a sandy floodplain bench or terrace habitat. Although no direct measurements have been made, Sweet (1992) found that generally the distance between a breeding pool and the nearest broad sandy bench ranged from less than 10 m (33 ft) to approximately 80 m (262 ft) (Sweet 1992).

2.1.3.1.7 Floodplain Connectivity

Adult arroyo toads require access to permanent water during the breeding season and unobstructed habitat for movement from water sources to adjacent upland stream habitat where much of the remaining active season is spent, and aestivation areas (Dudek 2000). Suitable dispersal routes must occur in both up and down stream directions.

2.1.3.1.8 Adjacent Upland Habitat

Adults utilize adjacent upland areas that may occur outside the 100-year floodplain. These areas typically become covered with brush and trees that stabilize the surface. Extended movements into upland habitat and away from streams are most likely the result of microclimates (dispersal). Upland dispersal has been observed all age classes of post-metamorphic toads on rainy nights and during very high relative humidity (USFWS 1999). Furthermore, it has been observed that narrow, ephemeral tributaries may serve as dispersal routes to upland areas (Ramirez 2000; Holland et al. 2001). The USFWS determined that areas up to 24 m (79 ft) in elevation above stream channels were most likely to contain the primary constituent elements for arroyo toad habitat (USFWS 2000). Sub-adult and adult arroyo toads often are found foraging in upland habitats around the drip lines of oak trees.

2.1.3.2 Hydrologic Factors

2.1.3.2.1 Flow Regime

Toads require rivers or streams with a hydrologic regime that supplies sufficient flowing water of suitable quality and quantity needed to sustain eggs, tadpoles, metamorphosing juveniles, and adult breeding toads. The flow regime should provide space, food and cover at appropriate times of the year and stage of toad development. Breeding sites generally have flow rates less than 5 cm per second (cm/sec) (USFWS 1999). Currents greater that 5 cm/sec are sufficient to displace eggs and embryos/larvae up to 82 hours post hatching (Sweet 1992).

2.1.3.2.2 Periodic Flooding

Arroyo toads have specialized habitat requirements for each stage of their life cycle. The creation and maintenance of these appropriate habitats are dependent on several factors, but largely are due to fluctuating hydrology. A natural flooding regime, or one sufficiently corresponding to natural conditions, is required to periodically scour riparian vegetation, rework stream channels and floodplains, and redistribute sands and sediments. The flooding regime is directly responsible for the development of the appropriate number and size of breeding pools, friable soils for juvenile and adult toads to create burrows, and unvegetated lower stream terraces (Jennings and Hayes 1994; USFWS 1999).

2.1.3.2.3 Shallow Pools

Adults typically breed in shallow pools that are less than 30 cm (12 in) deep and characterized by low turbidity (Sweet 1992, 1993). These pools typically occur within slow moving creeks and streams with persistent water from March to mid-June and adjacent to sandy terraces (Dudek 2000). Eggs are laid over a period of 7 to 8 weeks beginning in late March and are deposited in sand or well-sorted gravel substrates along the margins of pools in water less than 10 cm (4 in) deep. Holland (2001) found that 95 percent of toads (n=830) located in aquatic habitats were in water less than 10 cm (4 in) deep with approximately 36 percent in water 50 cm (19 in) deep or deeper. Table 3 on page 37, provides a summary of the water chemistry observed by Ramirez (2002) within San Juan Creek where arroyo toad breeding has been documented. However, this data should not be interpreted as encompassing the complete range of conditions under which toads can successfully breed.

2.1.3.2.4 Water Temperature

Water temperatures affect several life stages of the arroyo toad including breeding and larval development. Males usually begin calling when water temperatures reach 14 C (57 F) (Sweet 1992; M. Jennings, unpublished data). Larvae typically hatch within 4 to 6 days at water temperatures of 12 to 16 C (54 to 61 F) (USFWS 2001). The larval period for arroyo toads generally ranges from 65 to 85 days depending on the water temperature (USFWS 2001).

2.1.3.2.5 Soil Moisture and Late Season Inundation

Habitat suitability for arroyo toads is partially determined by soil moisture and duration of substrate inundation and/or saturation in relation to the seasonal life cycle of the arroyo toad. Shoreline or central bars and stable, sandy benches that are dampened through capillarity and possess some emergent vegetation are ideal juvenile and adult habitat. Adjacent riparian areas and upland habitats generally rely on seasonal precipitation.

Juvenile toads exhibit a strong tendency to remain in the saturated substrate along the margins of breeding pools for up to four months following metamorphosis (Campbell et al. 1996). Although research efforts on the arroyo toad have not identified a range of soil moistures, damp substrates (low-lying bars and gravel beds) with midday surface temperatures of 34 to 37 C (93 to 99 F) are preferentially selected by newly metamorphoses juveniles (less than 22 mm (0.8 in) in length) (Sweet 1992).

Table 3

SUMMARY OF WATER CHEMISTRY WITHIN A PORTION OF SAN JUAN CREEK THAT SUPPORTS BREEDING ARROYO TOAD

Heading	Range	Mean ± 1 Standard Deviation (SD)	95% Confidence Limit
Specific Conductance (uS)	267 – 412	319 ± 41.5	337
PH	7.4 – 8.4	7.9 ± 0.3	7.8
Total Dissolved Solids (mg/L)	133 – 203	160 ± 22	170
Turbidity (Nephelmetric Turbidity Units (NTU))	2.5 – 8.9	4.2 ± 1.4	4.8

* *These data should not be interpreted as encompassing the complete range of conditions under which toads can successfully breed.*
Source: Ramirez 2002

Adults are primarily nocturnal and often move throughout both riparian and upland habitats during periods of high surface moisture (fog or dew) or during rain. Over wintering habitat utilized by adults include vegetated areas adjacent to the stream with toads having a critical dependence on terrace habitat in late fall and winter (Campbell et al. 1996). Toads burrow 5 to 10 cm (2 to 4 in) to reach the dry-damp sand interface (Sweet 1992).

2.1.4 Summary

Species Profile

- *Study Area Distribution* — Occurs within study area
- *San Juan Creek Watershed Distribution* — San Juan Creek (between Chiquita and Cañada Gobernadora Canyons and upstream into Capsers Park), confluence of San Juan Creek and Bell Canyon, and Bell Canyon
- *Western San Mateo Creek Watershed Distribution* — Lower and upper San Mateo Creek, middle Cristianitos, lower Gabino, and Talega creeks
- *General Habitat:* — Riparian, water courses with sandy benches along streams
- *Breeding and Migration Seasons:* — Breeding-Jan-early July; males call when water temp 14 C (57 F) from water less than 5 cm (2 in) deep (or sandbar); may be active all year, which depends on rainfall and moderate temperatures (7 C) (45 F); dispersing juveniles (8 to 9 weeks from October to November) to nearby willows

- *Habitat Requirements/Range:* Immediately upstream of river mouths up to 2,440 m above MSL; juveniles: damp; less than 10 percent vegetative cover, preferably *Veronica americana* for juveniles, foraging juveniles feed on loose organic material within substrate, cover includes cobbles, algal mats, pieces of debris; adults: dripline of oaks for foraging; egg laying shallow margin of pools away from vegetation on sand, gravel, cobble, or mud; metamorphosis occurs in shallow water along edges of gravel/sand bars and often under/along stranded algal mats
- *Known Natural and Exotic Predators:* Pools (mallards, giant water bugs, garter snakes, green sunfish, largemouth bass, fathead minnows, bullfrogs, prickly sculpins, African clawed frogs, western pond turtles); upland habitats (killdeer, garter snakes, bullfrog, green-backed and great blue herons, raccoons, opossum, crows, ravens)

Key Physical Habitat Components

Geomorphic

- *Substrate Type/Coarseness:* Friable sands and gravels (breeding pools, foraging habitat)
- *Underlying Geology/Terrain:* Crystalline or other terrains which erode to a wide range of sands and gravels, with some cobble; streams draining formations which tend not to produce gravels (e.g., Santiago and Sespe formations) or sands (e.g., lower Williams formation) do not seems to support arroyo toad
- *Channel Form/Geometry:* Sand; well-sorted fine gravel (significant portion may be large gravel or cobble); adjacent stable sandy benches, terraces and oak flats; open/undammed streambeds
- *Deposition or Erosion Areas:* Scour needed to create pools and open bars and benches; pools formed by outcrops or shallow restrictive layers

Hydrologic

- *Frequency of Scour/Habitat Age-Stand Distribution:* Periodic/unpredictable; reworked channels; altered pool locations; sediment deposition and vegetation needed to stabilize upper floodplain benches or terraces

- *Abundance/Distribution of Ponded Areas:* Surface stream flows that frequently pool or are intermittent for at least a few months a year; low surface area to depth ratio to prevent premature pond evaporation
- *Magnitude of Baseflow:* <5 cm/s (breeding)
- *Duration of Baseflow/Length Of Year With Surface Flow:* Intermittent
- *Magnitude of 5-, 10-, or 25-Year Event:* Enough to keep low stream bars and bench surfaces vegetation free and the soils friable
- *Temperature (Celsius):* >14C (57 F) (calling); 12 to 16C (54 to 61 F) (hatching); 32 to 37C (90 to 99 F) (preferred for aestivation)
- *Adjacent Habitat Utilization:* Coastal sage scrub, chaparral, grassland, oak woodland; willows (dispersing juveniles)
- *Home Range and Movement:* Up to 6 or 8 km (4 to 5 mi) longitudinally along the streambed under favorable conditions
- *Frequency of Episodic Events:* Sufficient to maintain open channel areas and loose sand and/or gravel substrate; probably less than 10 years' typical 're-set' of riparian vegetation, but unpredictable and probably consistent with episodic disturbance under natural conditions

2.2 LEAST BELL'S VIREO

2.2.1 Regulatory Status

In response to the dramatic reduction in numbers and range of the least Bell's vireo in California, the California Fish and Game Commission listed the species as endangered on June 27, 1980 under the California ESA of 1970. The least Bell's vireo was petitioned for listing by the USFWS on November 8, 1979 along with the Arizona Bell's vireo (*V. b. arizonae*). On May 2, 1986, the vireo was Federally listed as endangered. On February 2, 1994, the USFWS designated critical habitat for the least Bell's vireo at ten areas encompassing approximately 15,378 hectares (38,000 acres) in Santa Barbara, Ventura, Los Angeles, San Bernardino, Riverside, and San Diego Counties (USFWS 1994c). Critical habitat for the vireo encompasses 49 percent of its population and includes the Santa Ynez River, Santa Clara River, Santa Ana River, Santa Margarita River, San Luis Rey River, Sweetwater River, San Diego River, Tijuana River, Coyote Creek, and Jamul-Dulzura Creeks. Federal land within the critical habitat consists of approximately 4,433 hectares (10,979 acres). There is no designated critical habitat for the least Bell's vireo within the study area.

The draft Recovery Plan for the least Bell's vireo was published in 1998 (USFWS 1998), but has not been finalized. The Recovery Plan lists habitat in Arroyo Trabuco, Cañada Gobernadora, and San Mateo Creek as important for the long-term recovery of the species. In addition to habitat protection and elimination of predation by brown-headed cowbirds, recovery objectives for the Orange County population include reduction in the amount of stream impoundments, channelization, and removal of stream bank vegetation. The ultimate goal is to restore habitat patches to provide a series of "stepping stones" for the continued (northward) expansion of the species (USFWS 1998).

2.2.2 Species Profile

2.2.2.1 Description

The least Bell's vireo is one of four subspecies of the Bell's vireo, a small migratory songbird, of which two subspecies occur in California. This subspecies is generally gray above and whitish below with indistinct white spectacles, two faint white or whitish wing bars with the lower bar appearing more prominent. The least Bell's vireo is a member of the avian family Vireonidae and is taxonomically similar to crows and jays (Corvidae), and woodwarblers, tanagers, buntings, and blackbirds (Emberizidae) (Brown 1993). Genetic research has shown that there are large interspecific differences within the genus vireo and suggests that the taxon is polyphyletic[11] (Johnson et al. 1988). A more recent study has shown that despite the presence of several distinct groupings in the vireo, the evolutionary histories provided by gene sequencing were unable to determine whether the group was monophyletic or polyphyletic (Murray et al. 1994). Four different subspecies of Bell's vireo have been recognized based on taxonomy (American Ornithologists' Union 1957) and geographic separation (Hamilton 1962).

Banding records have documented Bell's vireo that have lived approximately seven years (Klimkiewicz et al. 1983); however, their maximum life-span is probably longer (Brown 1993). Nevertheless, Greaves and Gray (1991) found that only a small percentage of least Bell's vireo studied over two distinct time periods were older than 3 to 4 years.

2.2.2.2 Species Distribution

The *V. b. pusillus* subspecies was once common, and was the major breeding subspecies throughout the Central Valley and other low elevation riverine areas in California. This subspecies historically bred in valley bottom riparian woodlands from the interior of northern California (Tehama County) southward to northwestern Baja California, Mexico, and as far east

[11] *The term polyphyletic refers to a group of organisms that does not include their most recent common ancestor (i.e., the groups have different recent ancestors).*

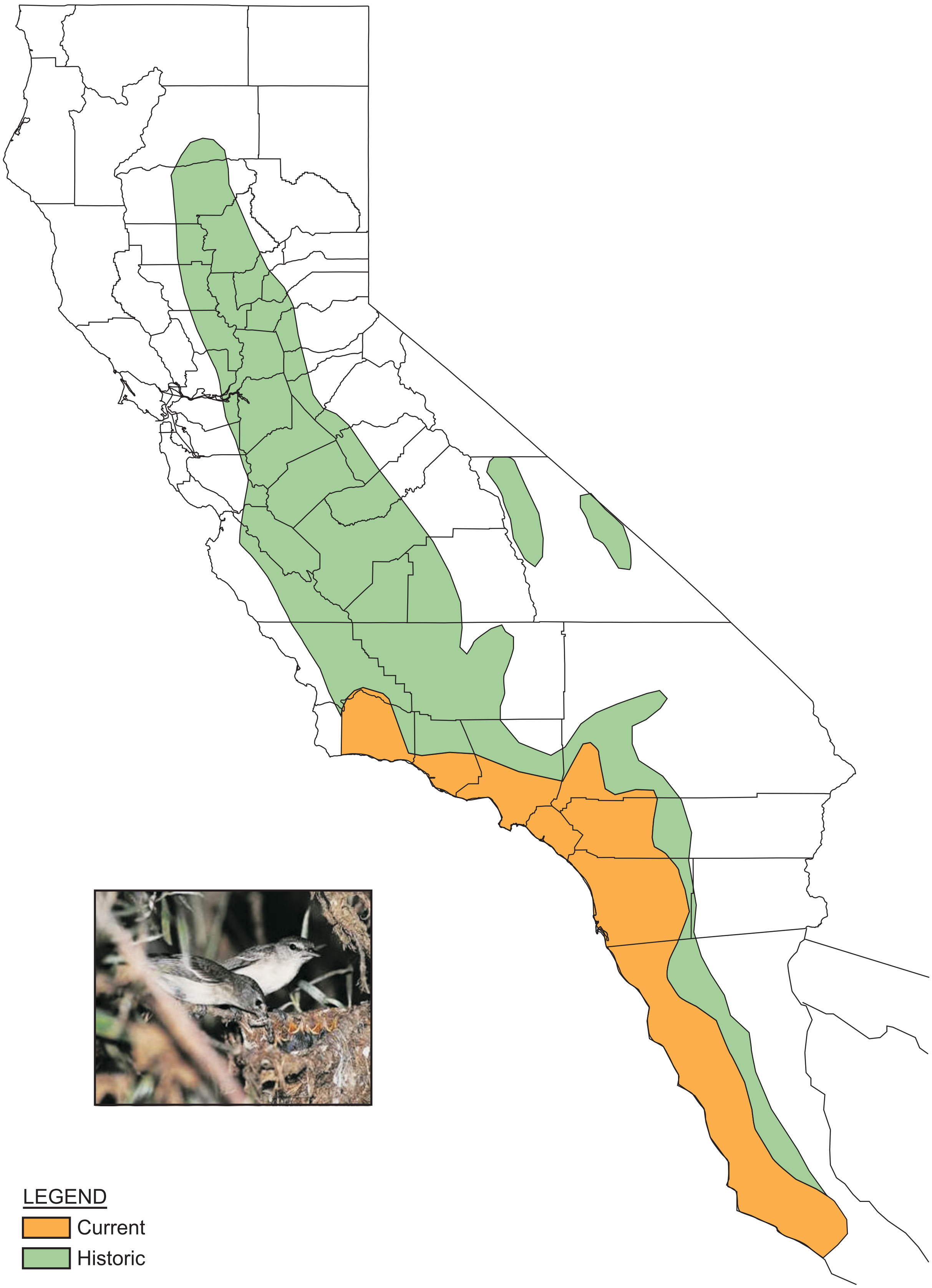
as the Owens Valley, Death Valley, and along the Mojave River (Grinnell and Miller 1944). Its current breeding distribution is restricted to a few localities in southern California and northwestern Baja California, Mexico (Franzreb 1989) as shown in Figure 11*, Least Bell's Vireo Historical and Current Distribution*, on page 42. It is endemic to California and northern Baja California and is now a rare, local, summer resident below about 600 m (2,000 ft) in coastal southern California and along the western edge of the deserts. Areas currently designated as critical habitat for the species are shown in Figure 12, *Least Bell's Vireo Critical Habitat*, page 43. Between 1977 and 1985, intensive surveys of virtually all potential breeding habitat were conducted (Gaines 1977; Goldwasser 1978; Goldwasser et al. 1980), resulting in occurrences at only 46 of over 150 former localities. Once common, the vireo populations had decreased substantially by the late 1980's due to loss and degradation of habitat as well as from cowbird parasitism (Goldwasser et al. 1980).

From 1977 to 1978, 67 males or paired individuals were counted at 23 of 65 sites surveyed on the coastal slope of southern California, and 23 at 9 of 18 sites on the desert slope (Goldwasser et al. 1980; Garrett and Dunn 1981). Except for a few outlying pairs, the subspecies is currently restricted to southern California south of the Tehachapi Mountains and northwestern Baja California (Garrett and Dunn 1981). Breeding pairs have been observed in the counties of Monterey, San Benito, Inyo, Santa Barbara, San Bernardino, Ventura, Los Angeles, Orange, Riverside, and San Diego, with the highest concentrations along the Santa Ana River behind Prado Dam and in San Diego County along the Santa Margarita River (Small 1994).

Most of the populations of least Bell's vireo have undergone tremendous growth over the last decade. Currently available census data indicate that the population in southern California has increased from an estimated 300 pairs in 1986 to an estimate 1,346 pairs in 1996, primarily as a result of an effective cowbird trapping program (USFWS 1998).

2.2.2.3 Occurrences Within the Study Area

Within the study area, least Bell's vireos have consistently been found in Cañada Gobernadora, Arroyo Trabuco, and in low numbers along San Juan Creek and Cristianitos Creek. Recently, vireo have been documented in Cañada Chiquita. As of winter 2002, the NCCP/HCP database includes 54 records for vireos. Least Bell's vireos occur within five drainages of the study area as shown in Figure 13, *Least Bell's Vireo Distribution Within the Study Area*, on page 44. Significant numbers of vireo also occur within lower San Mateo Creek, outside the study area.

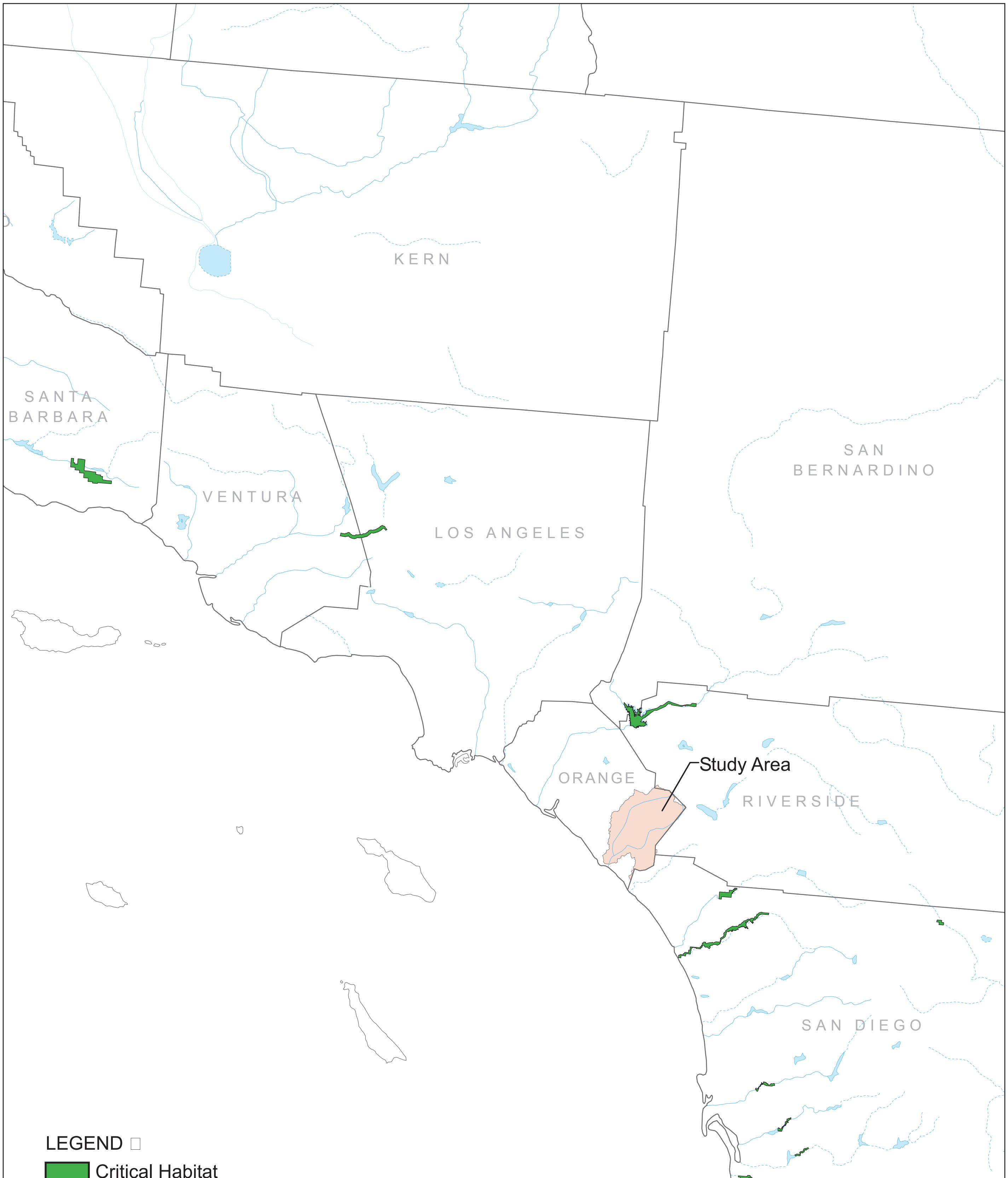


No scale

Source: USFWS, 1998

Figure 11
Least Bell's Vireo Historical and Current Distribution

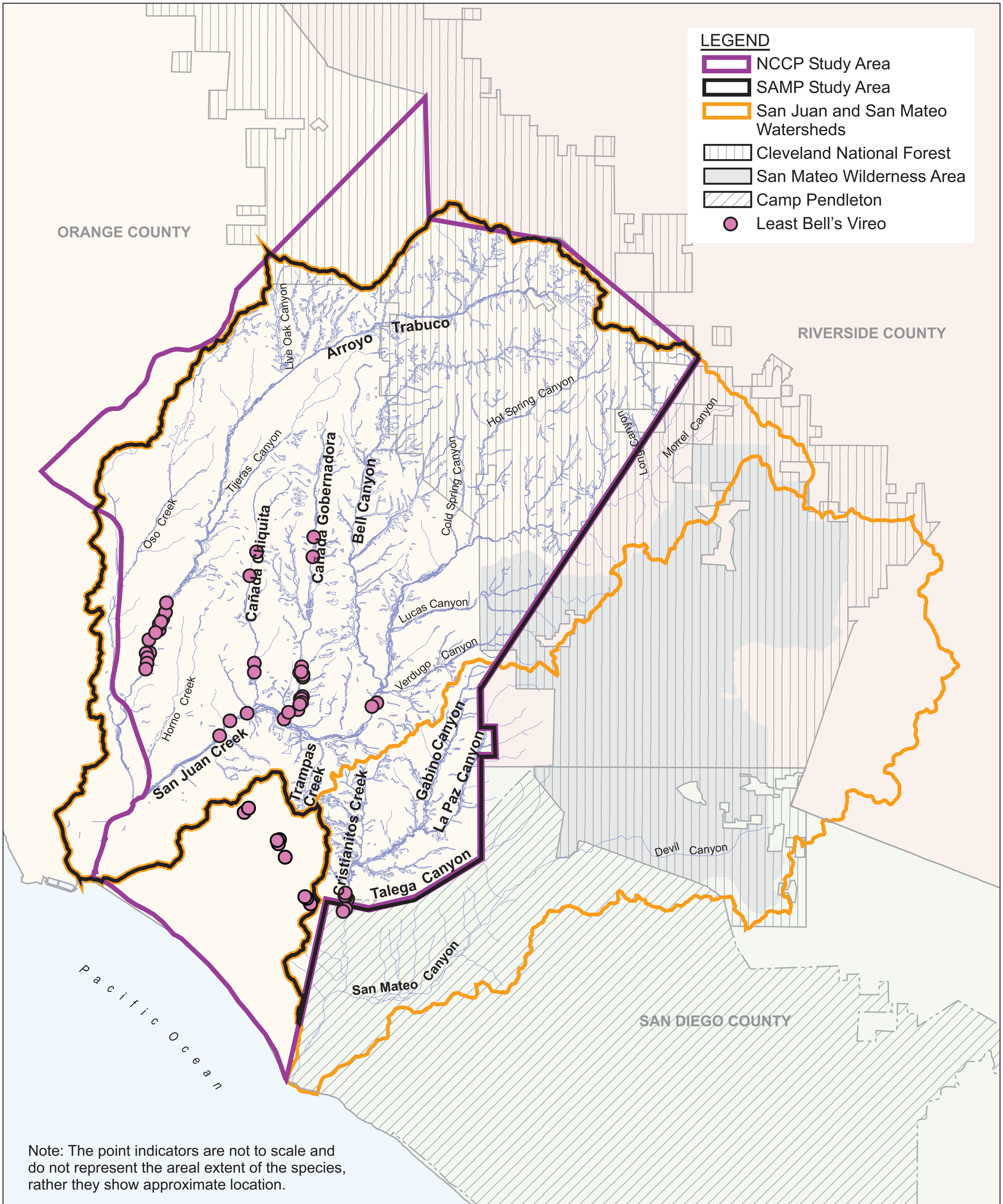
Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species



Source: USFWS, 1994

Figure 12
Least Bell's Vireo Critical Habitat

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species



Source: Lichvar et al. and ACOE 2000, Dudek 2001, Dudek and PCR 2002

Figure 13
Least Bell's Vireo Distribution Within the Study Area

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

San Juan Creek Watershed

1. San Juan Creek: Least Bell's vireos are sparsely distributed within San Juan Creek from downstream of the confluence with Cañada Chiquita Creek upstream to Bell Canyon Creek. This portion of San Juan Creek contains patchy riparian habitat dominated by willow, mule fat, and sycamore in relatively wide meandering stream.

2. Arroyo Trabuco: No vireos were detected in 1991 surveys but recent surveys indicate that least Bell's vireos occur in a breeding population of 9 to 11 pairs within the Arroyo Trabuco between Crown Valley Parkway and Avery Parkway. This area supports relatively dense willow riparian habitat along a well defined, somewhat entrenched streamcourse.

3. Cañada Gobernadora: Least Bell's vireos occur within Cañada Gobernadora north of Ortega Highway within the Gobernadora Ecological Restoration Area (GERA) and at a few locations within Coto de Caza.

4. Cañada Chiquita: Least Bell's vireo occur in the lower portion of Cañada Chiquita in areas of relatively dense willow riparian habitat within a narrow confined streamcourse.

San Clemente Hydrologic Area

1. The USFWS NCCP database includes four observations for least Bell's vireo within the San Clemente Hydrologic Area. One pair was observed south of Avenida Pico and east of Avenida Vista Hermosa in a small isolated patch of arroyo willow riparian forest. The second pair was observed in a small drainage northwest of the Talega development and west of the planned Talega Valley Drive in willow riparian scrub/herbaceous riparian habitat. The third pair was observed east of La Pata Avenue and north of Camino del Rio in a isolated patch of herbaceous riparian habitat. The fourth pair was observed west of La Pata Avenue and just east of the Prima Deshecha Landfill in a small drainage supporting willow riparian scrub and mule fat scrub.

San Mateo Creek Watershed

1. Cristianitos Creek: Approximately eight least Bell's vireo sites are located within Cristianitos Creek just north of the MCB Camp Pendleton boundary. This area supports patchy riparian habitat in coarse substrate stream. However, areas adjacent to the creek support mature oak woodland habitat.

2.2.2.4 Occurrences Outside the Study Area

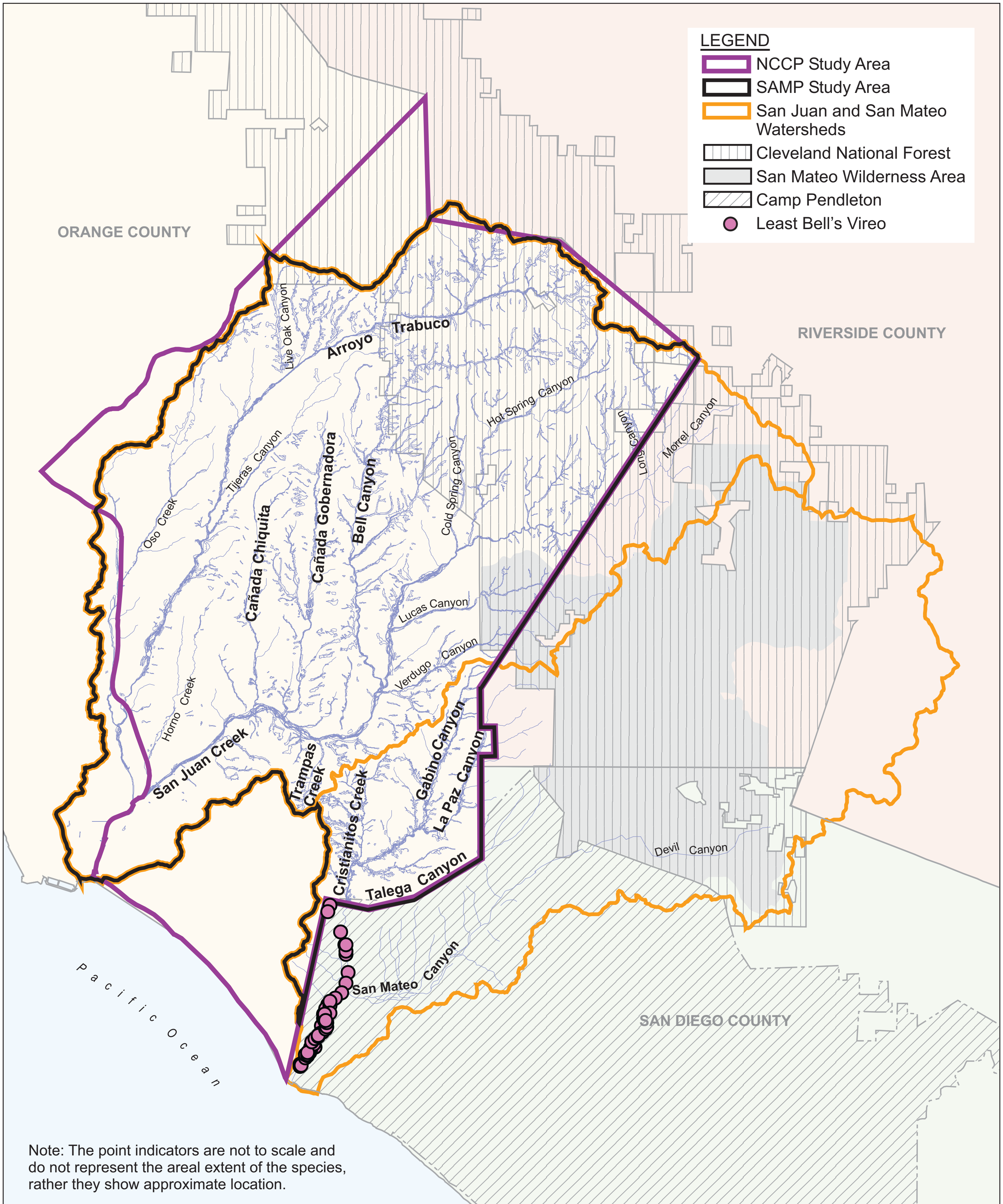
Least Bell's vireo have been found in substantial numbers within the lower San Mateo Creek watershed on the MCB Camp Pendleton property, as shown on Figure 14, *Least Bell's Vireo Distribution Downstream of the Study Area*, on page 47.

2.2.2.5 Habitat

Least Bell's vireos nest primarily in willows, but also use a variety of other shrub and tree species for nest placement. Least Bell's vireos forage in riparian and adjoining upland habitats, particularly late in the breeding season (Salata 1983; Kus and Miner 1987). Although the vireo may use other habitats and plant species, it is considered an obligate riparian breeder, typically inhabiting structurally diverse woodland along watercourses. Vireos occur in a number of riparian habitat types, including cottonwood-willow woodlands and forests, oak woodlands, and mule fat scrub (USFWS 1998). Two features that appear to be essential to occupation of a riparian area by the least Bell's vireo include the presence of dense cover within one to two meters (3.3 to 6.6 ft) of the ground where nests are typically placed, and a dense, stratified canopy for foraging (Goldwasser 1981; Gray and Greaves 1981; Salata 1981; RECON 1989). Nesting areas commonly consist of impenetrable thickets with nearly 100 percent ground cover, with areas of herbaceous cover and open ground interspersed through the site (Brown 1993). Although least Bell's vireos typically nest in willow-dominated areas, plant species composition does not appear to be as important a determinant of nesting site selection as habitat structure.

The selection of breeding sites does not appear to be limited to riparian stands of a specific age, although least Bell's vireos are characterized as preferring early successional habitat. Early successional riparian habitat typically supports the dense shrub cover required for nesting and also a structurally diverse canopy for foraging. Unless disturbed, willows and other species form dense thickets in approximately 5 to 10 years and become suitable least Bell's vireo habitat (Goldwasser 1981).

Although least Bell's vireos are tied to riparian habitat for nesting, they have been observed foraging in adjacent upland habitats. In the arid southern California landscape, riparian habitats typically occur in close proximity to non-riparian habitats, such as coastal sage scrub, and vireo have been observed to maintain territories that incorporate both habitat types (USFWS 1998).



Note: The point indicators are not to scale and do not represent the areal extent of the species, rather they show approximate location.

PCR

DUDEK & ASSOCIATES, INC.

Source: Lichvar et al. and ACOE 2000, Dudek 2001, Dudek and PCR 2002

Figure 14

Least Bell's Vireo Distribution Downstream of the Study Area

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

Little is known about the wintering habitat requirements of the vireo. Several individuals banded in Southern California have been located in Baja California, Mexico during the winter. Although specific locations and habitats used by wintering birds remain obscure, it is known that the vireo is not exclusively dependent on riparian habitat on the wintering grounds (USFWS 1998; Greensfelder 2000).

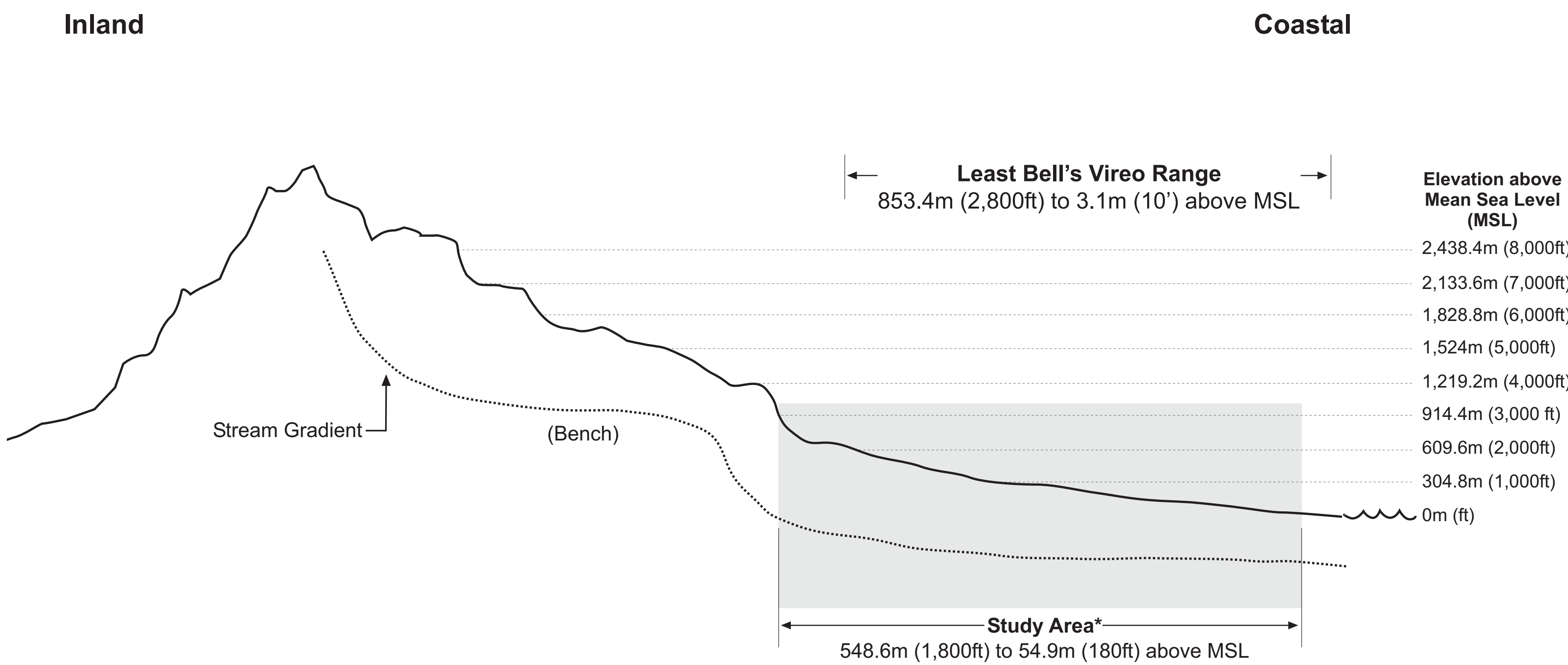
Figure 15, *Least Bell's Vireo Conceptual Habitat Profile*, on page 49, and Figure 16, *Least Bell's Vireo Conceptual Habitat Cross-Section*, on page 50, display a conceptual profile and cross-section of least Bell's vireo habitat, respectively. Figure 16 illustrates the relationship between geomorphic surfaces and aquatic/riparian habitat that typically support the various life stages of the least Bell's vireo.

2.2.2.5.1 Breeding Areas

Least Bell's vireo nests are usually placed between 0.9 and 1.5 m (3 and 5 ft) from the ground with a range between 0.2 and 3.6 m (2.9 and 4.9 ft) (Goldwasser 1981; Salata 1984; RECON 1989). Females probably select the nesting sites but both genders participate in nest construction (Barlow 1962). Cover surrounding nests is moderately open midstory with an overstory of willow, cottonwood, sycamore, or oak. Crown cover is usually more than 50 percent and contains occasional small openings (Hendricks and Rieger 1989). The most critical structural component to least Bell's vireo breeding habitat is a dense shrub layer at 0.6 to 3.0 m (2 to 10 ft) above the ground (Goldwasser 1981; Franzreb 1989).

2.2.2.5.2 Foraging Areas

Least Bell's vireos forage primarily within willow stands or associated riparian vegetation with forays into non-riparian vegetation, including chaparral, and oak woodlands later in the breeding season (Gray and Greaves 1984; Salata 1983; Kus and Miner 1987). Least Bell's vireo are known to forage upon a variety of tree and shrub species, preferring black willow (*Salix gooddingii*), arroyo willow (*Salix lasiolepis*), and mule fat (Miner 1989). Individuals are known to travel between 3 and 61 m (9.8 and 200 ft) (mean = 15.5 m (50.8 ft)) between habitat patches while foraging, with the majority of these destinations occurring within 30 m (98 ft) of the edge of riparian vegetation (Kus and Miner 1987). Least Bell's vireo are known to forage in all vertical vegetation layers from 0 to 20 m (65.6 ft) but most feeding is concentrated above the ground surface in the lower vegetation layers between 0 to 6 m (19.6 ft) (Miner 1989; Kus and Miner 1987; Salata 1983).



* Profile for study does not include the Cleveland National Forest.

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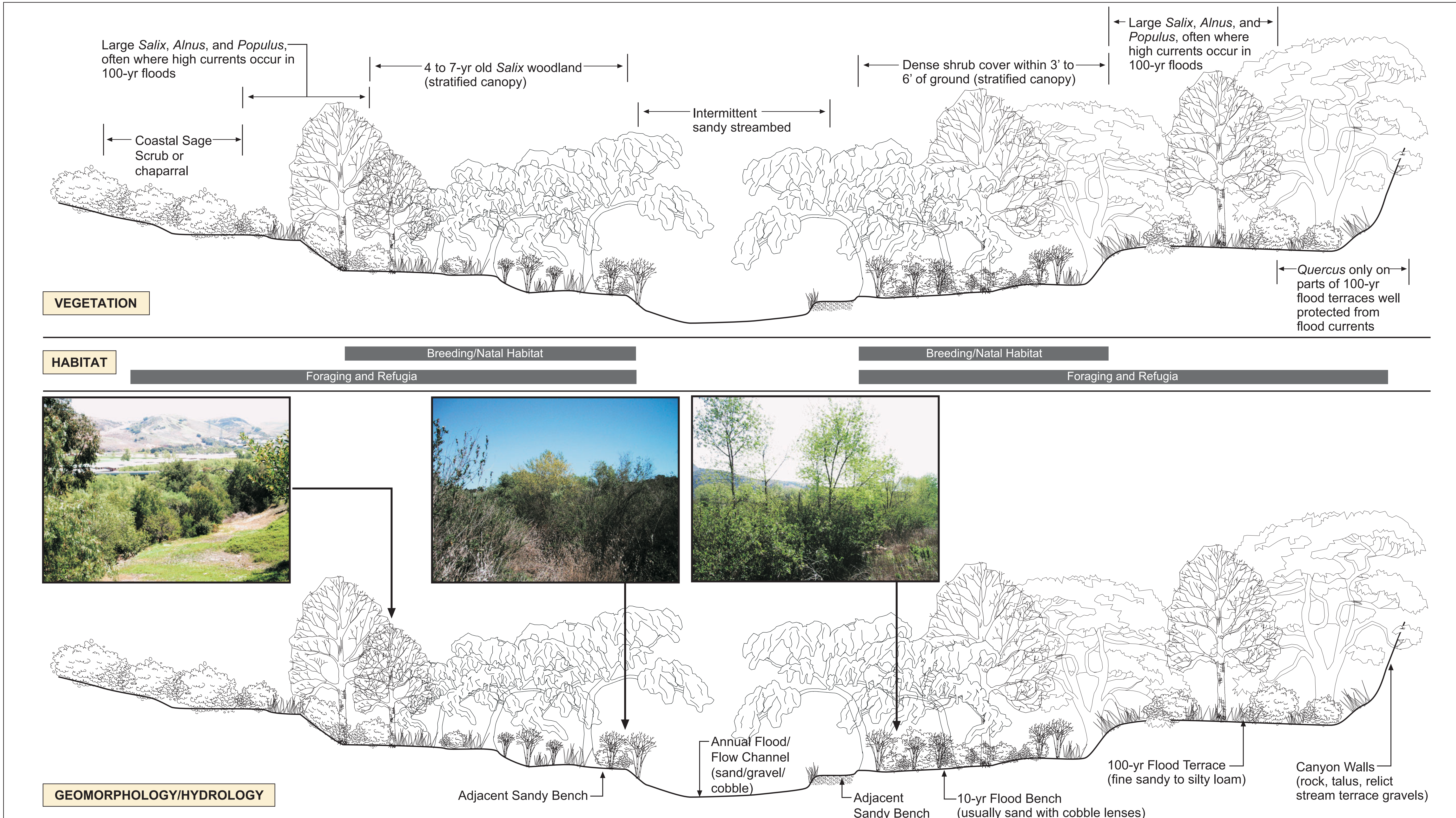
Source: Modified from Campbel et al., 1996 and Sweet, 1989

Figure 15
Least Bell's Vireo Conceptual Habitat Profile



No scale

Source: PCR Services Corporation and Eric Stein, 2002

Figure 16
Least Bell's Vireo
Conceptual Habitat Cross-Section

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

2.2.2.5.3 Upland Habitat

Native upland buffers are particularly important in narrow drainages. Franzreb (1987) observed that pairs that selected areas bordered by coastal sage scrub and grasslands tended to be more successful than those bordered by agricultural and urban areas. Based on a single site with a relatively low sample size, Franzreb (1987) concluded that vireo territories adjoining golf courses, campgrounds, and sand mines had significantly fewer successful pairs than those next to chaparral, coastal scrub oak or grasslands. More recently, the USFWS has concluded in several biological opinions[12] that with the inclusion of appropriate buffers (and other control measures) to deter access, runoff control and water quality treatment measures, and the provision of transitional habitat, vireo are likely to persist adjacent to golf courses.

2.2.2.6 Life Cycle/Natural History

The least Bell's vireo exhibits year-round diurnal activity; and is known to be a nocturnal migrant (Brown 1993). Feeding behavior largely consists of collecting prey from leaves or in bark crevices while perched or hovering, and less frequently by capturing prey by aerial pursuit (Salata 1983; Miner 1989). Species of Bell's vireo are known to feed primarily on insects and spiders, and rarely on fruit (Chapin 1925). Insects consumed include flying and crawling species including bugs, beetles, bees, wasps, ants, snails, grasshoppers, moths and butterflies (Chapin 1925; Bent 1950; Terres 1980).

The breeding season for least Bell's vireo is typically mid-March to September (USFWS 1986). During this period least Bell's vireos are known to breed almost exclusively within riparian habitats (USFWS 1998). Nests are typically suspended in forked branches of many different riparian species with no clear preference for any particular species (Nolan 1960; Barlow 1962; Goldwasser 1981). Because willow and mule fat are typically the most abundant species in vireo habitat these species also are the most commonly selected for nesting (Goldwasser 1981; Franzreb 1989).

Least Bell's vireos typically arrive from the Mexican wintering areas by the end of March to early April, and depart by the end of September (Zeiner et al. 1990). The males precede the females in arrival by a few days and stragglers have been noted post-breeding as late as November (USFWS 1998). Nests appear to only be used once, with new ones constructed following failed or successive broods (Greaves 1987). Between two to five (typically three or four) eggs are laid shortly after nest construction (Salata 1984; Kus 1998; USFWS 1998). A typical clutch is incubated by both parents for about 14 days, with the young remaining in the

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[12] *Biological Opinion 1-6-01-F-119, Morro Hills Golf Course, San Diego County, California; and Biological Opinion for the Arroyo Trabuco Golf Course, Orange County, California.*

nest for another 10 to 12 days (Pitelka and Koestner 1942; Nolan 1960; Barlow 1962). Fledglings range from established breeding territories, remaining under parental care for several more weeks (USFWS 1998). Least Bell's vireos typically produce only one brood per season, but on occasion additional broods of between two and five eggs have been reported (Franzreb 1989; USFWS 1998).

Survival rates measured as average nesting success have been recorded for several large drainages in southern California (USFWS 1998). The average percentage of nests to successfully produce fledglings ranges over several study areas from 46 percent (on the Santa Ana River) to a high of 74 percent (on the west San Luis Rey River) (USFWS 1998). Another measure of reproductive success is the number of fledglings produced per each pair. This measure for sites in southern California over multiple years of study averages between 1.8 and 2.5 fledglings per pair (USFWS 1998). Predation by coyotes, raccoons, domestic cats, and gopher snakes is common in least Bell's vireo due in part to the close proximity between nest and ground (Franzreb 1989; Kus 1994). Nest predation by brown-headed cowbirds has been reported as high as 45 percent in the San Luis Rey River to as low as 8 percent on the San Diego River (Salata 1983; Jones 1985), and is one of the primary threats to successful reproduction in least Bell's vireo (USFWS 1998; Powell and Steidl 2000).

Although least Bell's vireo produce a relatively high number of fledglings, it is estimated that less than 29 percent of these individuals survive to return to breeding habitat (USFWS 1998). The causes of mortality are unknown. Beyond one year, survivorship increases, averaging approximately 47 percent (Salata 1983; Kus, unpublished data as described in USFWS 1998). Preliminary data have shown 76 percent mortality for least Bell's vireo in the first year after hatching, and approximately 53 percent mortality per year thereafter (Salata 1983, as cited in Brown 1993).

2.2.2.6.1 Dispersal Movements in Upland Habitat

Fledgling least Bell's vireos expand their dispersal distances from about 10 m (33 ft) the first day to approximately 60 m (197 ft) several weeks after fledging (Hensley 1950; Nolan 1960, as cited in Brown 1993). This distance has been shown to increase to approximately 1.6 km (1 mi) during the same breeding season (Gray and Greaves 1984).

The literature on the dispersal and status remains unclear. Early data suggested that least Bell's vireo are strongly site tenacious and return to the same site in close proximity to previously occupied territories (Salata 1983; Greaves 1987, 1989). More recent studies by Kus and Greaves have estimated that in the years following fledging, approximately 20 percent of least Bell's vireo disperse outside their natal drainages and attempt to establish territories over distances of up to 209 km (130 mi) from their natal area (from unpublished data cited in

USFWS 1998). Data collected by Kus also suggest that males are more likely to disperse from their natal sites than females (from unpublished data cited in USFWS 1998). Additional study is necessary to determine patterns of site tenacity in first year adults vs. returning breeders.

2.2.3 Key Physical Habitat Components

2.2.3.1 Geomorphic Factors

2.2.3.1.1 Adjacent Benches and Terraces

Least Bell's vireos are nearly obligate riparian breeders. They appear to be especially dependent on the presence of willows and tend to prefer early successional habitat (USFWS 1998). Preferred territories occur in sites that include small amounts of aquatic and herbaceous cover, large amounts of shrub and tree cover, and a large proportion of tree cover with shrub understory. Essential features of a vireo territory include the presence of dense cover within 1 to 2 m (3.3 to 6.6 ft) of the ground and a dense, stratified canopy for foraging.

Vireo nest sites are most frequently located in stands between 5 and 10 years of age (RECON 1988). Nesting sites are typically selected within structurally heterogenous woodlands, forests and scrubs that support dense vegetation near the ground, and dense horizontally separated vegetation higher up in the canopy (Goldwasser 1981; Gray and Greaves 1981; Salata 1983; RECON 1989). Even though mature trees are present at many of the sites, the average age of willow vegetation in the immediate vicinity of most nests is between four and seven years. When mature riparian woodland is selected, vireos nest in areas with a substantial robust understory of willows and other species.

The habitat selected by least Bell's vireo typically results from periodic floods that scour mature vegetation communities along rivers and creeks (Robinson et al. 1995). The early- to mid-successional riparian habitat selected by the vireo typically occurs on benches within the 10-year floodplain. Maintenance of this habitat depends on the presence of an unobstructed floodprone area where peak flows can scour vegetation without causing channel incision. Constriction or confinement of the floodprone area and associated channel entrenchment can lead to desiccation or senescence of floodplain riparian habitat and increase the frequency and intensity of scour within the channel. The result is a perpetually scoured channel that does not develop the requisite habitat for the vireo over a 5 to 10 year period.

2.2.3.1.2 Upland Habitat

The zone where least Bell's vireo forage and nest is often comprised of a combination of aquatic and upland areas. Transitional riparian habitat adjacent to the stream channel not only provides a wider zone of potential habitat, but can also provide a buffer between upland land uses and active territories. This area can be important in filtering runoff from upland areas before it enters the stream and can discourage direct encroachment by people and animals into the active stream course.

Intact upland areas adjacent to the stream also provide critical areas for potential stream dispersion. Because long-term viability of vireo habitat depends on regular scour, there must be sufficient area adjacent to the stream channel to allow overbank flow and channel braiding or meandering. Excessive confinement or constriction of the riparian zone may inhibit these processes and ultimately contribute to entrenchment of the channel.

2.2.3.2 Hydrologic Factors

2.2.3.2.1 Flow Regime

Least Bell's vireos primarily occupy floodplain riparian habitats along flowing water or along dry parts of intermittent streams. It uses habitat which is limited to the immediate vicinity of water courses below 457 m (1,500 ft) in elevation above MSL in the interior (USFWS 1986; Small 1994).

Least Bell's vireo habitat requires both sufficient dry season flow or shallow subsurface water to sustain riparian habitat, and appropriate frequency and magnitude of storm flows to regularly rejuvenate breeding habitat. The willow, mule fat, and cottonwood habitat necessary to support vireo relies on an aquic or peraquic moisture regime.[13] This moisture regime requires a combination of baseflow conditions and substrate type that promotes saturated soils within the 2 to 3 meter (6.6 to 9.9 ft) root zone of the dominant riparian species. Changes in flow regime that reduce moisture levels can result in desiccation of riparian habitat. Conversely, increases in the duration and magnitude of baseflow may result in a conversion or shift of plant community composition to more herbaceous marsh-like habitat, which is not suitable for the vireo.

As noted in Section 2.2.3.1.1, long-term maintenance of vireo habitat relies on an appropriate frequency of scour of mature vegetation. However, immediately following a major storm or fire/flood event, the early-successional habitat available for least Bell's Vireo may be temporarily constrained, as willow thickets tend to be washed away by such events. Following major flow events, vireo may rely on remnant riparian habitat, commonly found on terraces just

[13] *Aquic moisture regime refers to a condition where the soil is saturated and chemically reduced such that it is virtually free of dissolved oxygen. A peraquic moisture results from seasonal saturation that results in temporarily reduced, anoxic conditions. Both aquic and peraquic moisture regimes are associated with wetland and riparian habitat.*

above the high-water mark or on bars formed behind debris jams or rock outcrops. Decreases in the magnitude or frequency of storm flows (as may result from upstream impoundment or diversion) may result in senescence of plant communities to a habitat that is not suitable for vireo. Conversely, increases in the magnitude or frequency of storm flows (as may result from floodplain constriction or encroachment) can result in excessive scour that precludes establishment of the necessary early -to mid-successional riparian habitat.

2.2.4 Summary

Species Profile

• *Study Area Distribution*	Occurs within the study area
• *San Juan Creek Watershed Distribution*	San Juan Creek, lower Cañada Gobernadora, and lower Arroyo Trabuco (between Avery Parkway and Crown Valley Parkway)
• *Western San Mateo Creek Watershed Distribution*	San Mateo Creek (MCB Camp Pendleton) and upper Cristianitos Creek
• *General Habitat:*	Southern willow scrub riparian
• *Breeding and Migration Seasons:*	Mid-March to September; territorial sites range from 0.2 to 3 hectares (0.5 to 7.4 acres); winter in Mexico
• *Habitat Requirements/Range:*	Riparian habitats between 3 and 853 m (10 and 2,800 ft) above MSL; dense riparian cover within 1 to 2 m (3 to 6 ft) of the ground (nest placement typically within 1 meter of ground); dense, stratified canopy for foraging developed over 5 to 10 years; willow, mule fat, California wild rose, poison oak, grape, elderberry, cottonwood, sycamore, oak. Site tenacious - return year after year; size of habitat patch very important
• *Known Natural and Exotic Predators:*	Nest parasitism by brown-headed cowbirds; other predators include scrubjays, rats, domestic cats; distance to livestock/grazing/ agricultural areas most important variable particularly for cowbirds (6.4 km (4 mi))

Key Physical Habitat Components

Geomorphic

• *Underlying Geology/Terrain:*	Stream segments with gradient of 2 percent or less

- *Channel Form/Geometry:* Early successional riparian habitat to include nearly vertical banks (if vegetated); width of vegetation belt important
- *Deposition or Erosion Areas:* Erosion may reduce riparian habitat; deposition may bury/kill riparian vegetation

Hydrologic

- *Frequency of Scour/Habitat Age-Stand Distribution:* Scouring of vegetation by flooding and river meandering rejuvenates the sparse overstory and dense understory (preferably 4 to 7 year old willow community)
- *Magnitude of 5-, 10-, or 25-Year Event:* Need to maintain riparian community in 4 to 7 year growth; sufficient buffer to retain some willow habitat after major flood events
- *Groundwater fluctuations* No deeper than needed to sustain solid patches of willow habitat --within 1.5 to 5 m (5 to 17 ft) of the streambed
- *Adjacent Land Use:* Chaparral, coastal sage scrub, native grasslands
- *Home Range and Movement:* 2.7 to 55.8 (9 to 183 ft) from riparian edge to upland areas; forages in all canopy layers but concentrates in lower layer to 5.5 m (18 ft) height; exhibits year-round diurnal activity a nocturnal migrant; may disperse from natal site up to 209 km (130 mi)

2.3 SOUTHWESTERN WILLOW FLYCATCHER

2.3.1 Regulatory Status

The southwestern willow flycatcher was petitioned for listing on January 25, 1992. On July 23, 1993, the USFWS published a proposal to list the southwestern willow flycatcher as endangered with critical habitat (USFWS 1993). The USFWS published a final rule to list the species as endangered on February 27, 1995 (USFWS 1995). On July 22, 1997 the USFWS designated a total of approximately 964 km (599 mi) of stream and river as critical habitat for the southwestern willow flycatcher (USFWS 1997). The areas described were chosen for critical habitat because they contain the remaining known southwestern willow flycatcher nesting sites and/or formerly supported nesting southwestern willow flycatchers, and/or have the potential to support nesting southwestern willow flycatchers. No areas of critical habitat were designated within the study area. However, the 10th Circuit Court recently vacated the critical habitat designation[14]; at this time no critical habitat is designated for this species.

2.3.2 Species Profile

2.3.2.1 Description

The southwestern willow flycatcher is a small migratory songbird, approximately 15 cm (5.9 in) long. It has a grayish-green back and wings, often with two thin wing bars on each wing, whitish throat, light grey-olive breast, and pale yellowish belly. The eye ring is faint or absent. The upper mandible is dark, the lower mandible is light. Both males and females have similar plumage. The song is a sneezy "fitz-bew" and the call is a repeated "whitt" (Braden and McKernan 1998).

The southwestern willow flycatcher is one of four subspecies of willow flycatcher which are distinguished primarily by subtle differences in color and morphology (Unitt 1987). The four subspecies of the willow flycatcher are segregated by their breeding ranges (five subspecies are described by one investigator). Two subspecies can occur within southern California, *E. t. brewsteri* and *E. t. extimus.* The breeding range of *E. t. brewsteri* extends from the central California coast north, through western Oregon and Washington to Vancouver Island (USFWS 1995). The listed subspecies *E. t. extimus*, is described in detail below. Observations of migrating flycatchers within the area often may be of the subspecies *E. t. brewsteri*. In southern California, breeding activity must be determined in order to confirm that the observation of a willow flycatcher is *E. t. extimus* (San Diego Natural History Museum 1995).

2.3.2.2 Species Distribution

The southwestern willow flycatcher is known to breed in less than 80 riparian sites scattered through southern California, Arizona, New Mexico, southwestern Colorado, Texas, and the extreme southern portions of Nevada and Utah (Sogge et al. 1997; Marshall 2000). In Southern California, the breeding range for this species includes: Owens Valley, south fork of the Kern River, the Los Angeles Basin, the Santa Ynez River near Buellton, the Santa Ana River at Prado Basin in Riverside County, the Santa Margarita and San Luis Rey rivers in San Diego County, Middle Peak in the Cuyamaca Mountains, and near Imperial Beach (Unitt 1987; Zeiner et al. 1990; Small 1994). Breeding areas are shown in Figure 17, *Southwestern Willow Flycatcher Historical and Current Distribution*, on page 58. Breeding populations also exist in southern Nevada, Arizona, and New Mexico (Garrett and Dunn 1981). Additionally, this taxon

[14] *New Mexico Cattle Growers Ass'n v. USFWS, 248 F. 3d 1277 (10th Cir. 2001)*

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N
No scale

Source: USFWS, 1995

Figure 17
Southwestern Willow Flycatcher Historical and Current Distribution

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

overwinters in Mexico (USFWS 1995). Riparian habitats along the Rio Grande provide important stopover sites for flycatchers as they migrate between their breeding and wintering grounds (Yong and Finch 1997).

Based on survey data collected between 1993 and 1996, the total known population of southwestern willow flycatchers throughout the breeding range is estimated to be 549 territories. At least 386 of these territories have been documented as probable breeding pairs (Finch and Stoleson 2000). Within California, there are an estimated probable 121 territories (Finch and Stoleson 2000).

2.3.2.2.1 Occurrences Within the Study Area

Southwestern willow flycatchers have only been observed in a few locations of southern California. The only documented breeding sites for southwestern willow flycatchers within the study area are in Cañada Gobernadora, as shown in Figure 18, *Southwestern Willow Flycatcher Distribution Within the Study Area*, on page 60.

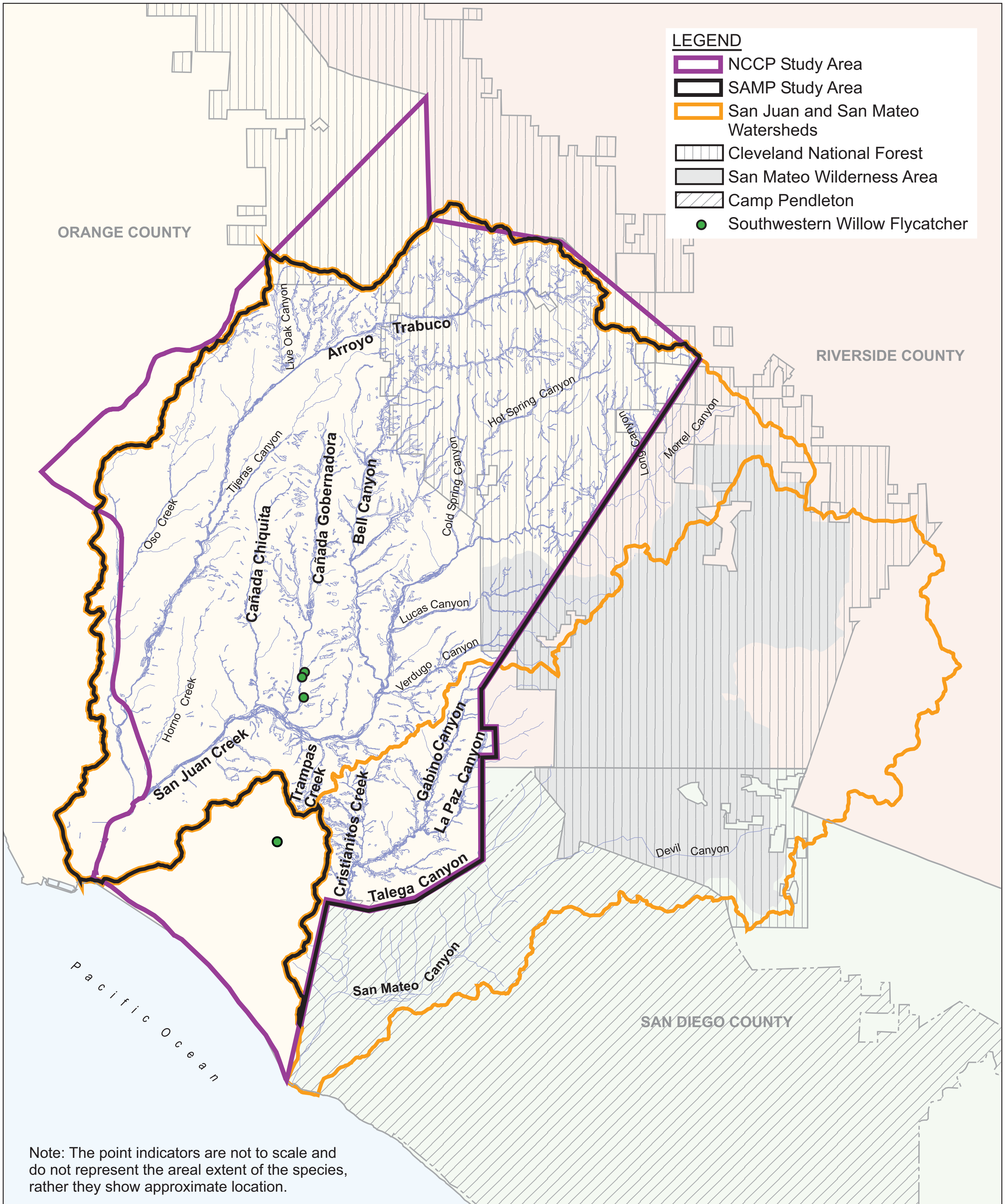
San Juan Creek Watershed

1. Cañada Gobernadora: Approximately six southwestern willow flycatcher have been documented in Cañada Gobernadora within the GERA. This area is characterized by a relatively wide riparian zone that contains patches of mature riparian forest. The geologic setting, sandy terrains, and historic lakebed deposits[15] result in the stream having water at or near the surface for the most of the year, which likely contributes to the suitability of this area for the flycatcher.

San Clemente Hydrologic Area

1. The USFWS NCCP database includes a single record for southwestern willow flycatcher within the San Clemente Hydrologic Area. The record is from an isolated patch of herbaceous riparian habitat east of La Pata Avenue and north of Camino del Rio.

[15] *Inferred historic lakebed deposits form a layer of lower permeability beneath the streambed that allow surface flows to persist late into the season (PCR et al. 2002).*



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Source: Lichvar et al. and ACOE 2000, Dudek 2001, Dudek and PCR 2002

Figure 18
Southwestern Willow Flycatcher Distribution Within the Study Area

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

2.3.2.2.2 Occurrences Outside the Study Area

Southwestern willow flycatcher occur in lower San Mateo Creek south of the study area boundary, as shown in Figure 19, *Southwestern Willow Flycatcher Distribution Downstream of the Study Area*, on page 62.

San Mateo Creek Watershed

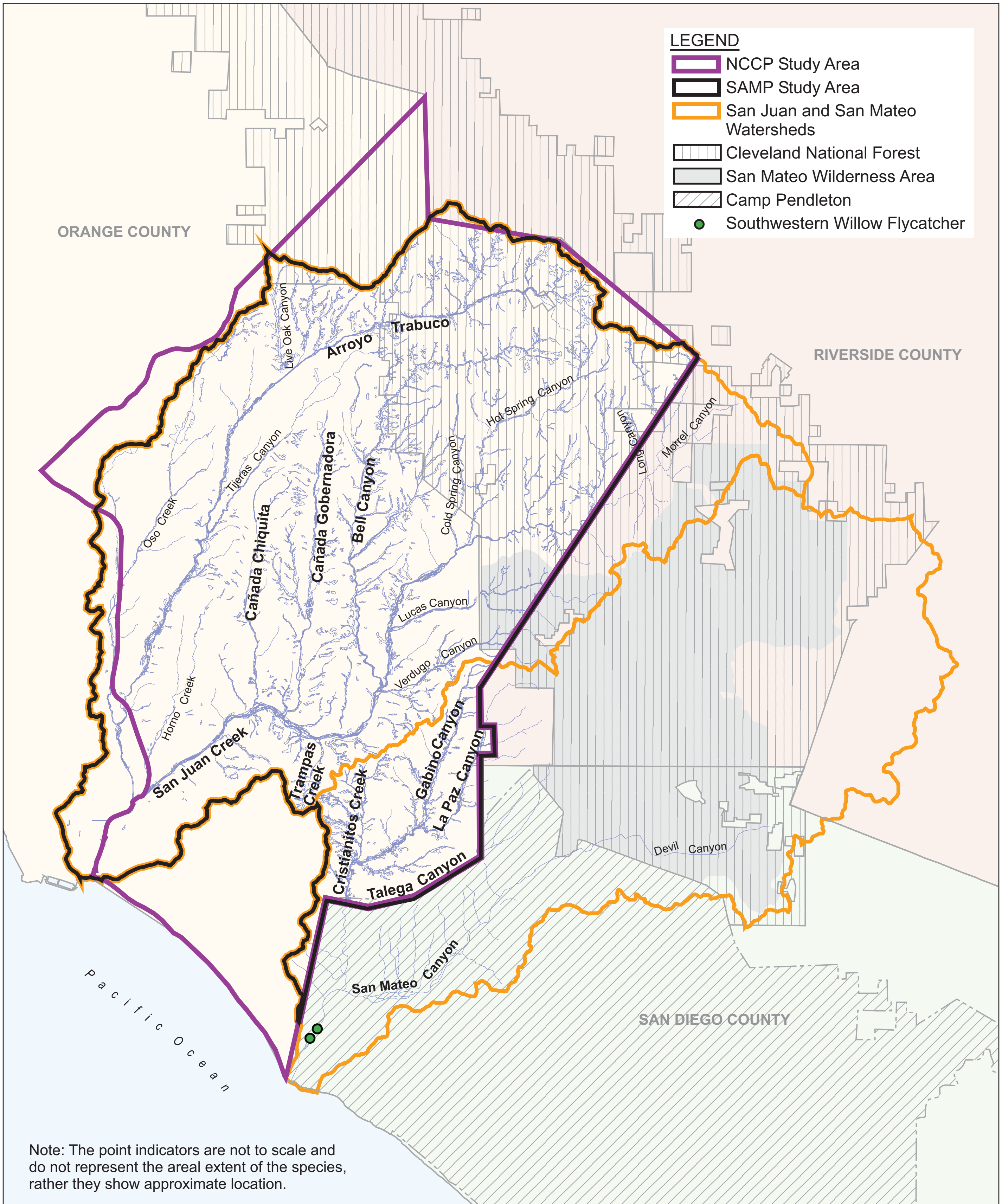
1. San Mateo Creek: Several breeding southwestern willow flycatcher locations have been documented south of the study area in lower San Mateo Creek just west of the MCB Camp Pendleton boundary.

2.3.2.3 Habitat

The southwestern willow flycatcher is restricted to riparian woodlands along streams and rivers with mature, dense stands of willows, cottonwoods or smaller spring fed or boggy areas with willows or alders (*Alnus* spp.). Riparian habitat provides both breeding and foraging habitat for the species.

The willow flycatcher nests in 0 to 4 m (0 to 13 ft) high thickets of trees and shrubs that are approximately 4 to 7 m (13 to 23 ft) tall with a high percentage of canopy cover and dense foliage. The nest site plant community is typically even-aged, structurally homogeneous and dense (Brown 1988; Whitfield 1990; Sedgewick and Knopf 1992). In contrast to the least Bell's vireo, which nests in younger (i.e., 4 to 7 year old) stands of riparian habitat, the willow flycatcher prefers more mature stands that are in closer proximity to ponded areas or open, flowing water. Historically, the willow flycatcher nested primarily in willows and mule fat with a scattered overstory of cottonwoods (Grinnell and Miller 1944). With recent changes in the composition of riparian plant communities in the region, the species still nests in willows where available, but is also known to nest in thickets dominated by tamarisk and Russian olive (Hubbard 1987; Brown 1988) when native riparian habitat is absent.

Figure 20, *Southwestern Willow Flycatcher Conceptual Habitat Profile*, on page 63, and Figure 21, *Southwestern Willow Flycatcher Conceptual Habitat Cross-Section*, on page 64, display a conceptual profile and cross-section of southwestern willow flycatcher habitat respectively. Figure 21 illustrates the relationship between geomorphic surfaces and aquatic/riparian habitat that typically support the various life stages of the southwestern willow flycatcher.



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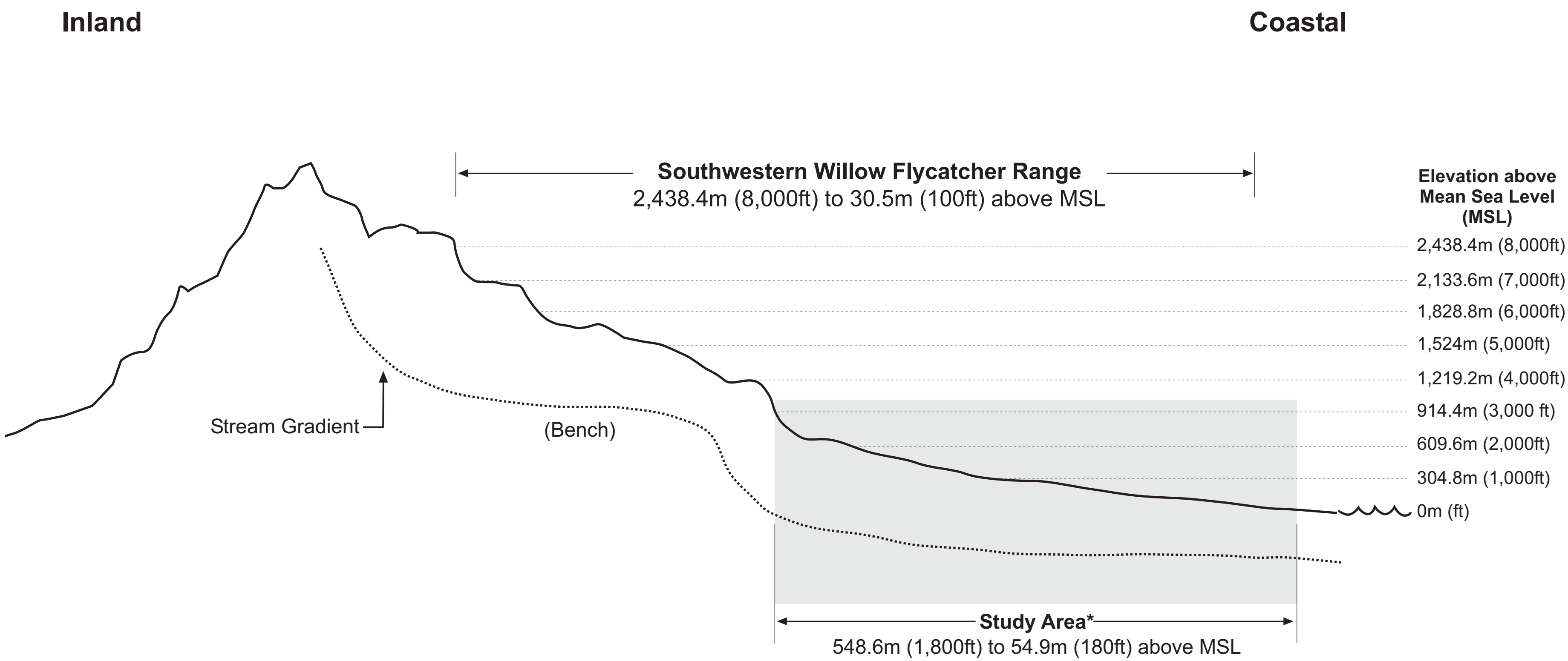
Source: Lichvar et al. and ACOE 2000, Dudek 2001, Dudek and PCR 2002

Figure 19
Southwestern Willow Flycatcher Distribution Downstream of the Study Area

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species



* Profile for study does not include the Cleveland National Forest.

Source: Modified from Campbel et al., 1996 and Sweet, 1989

Figure 20
Southwestern Willow Flycatcher
Conceptual Habitat Profile

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

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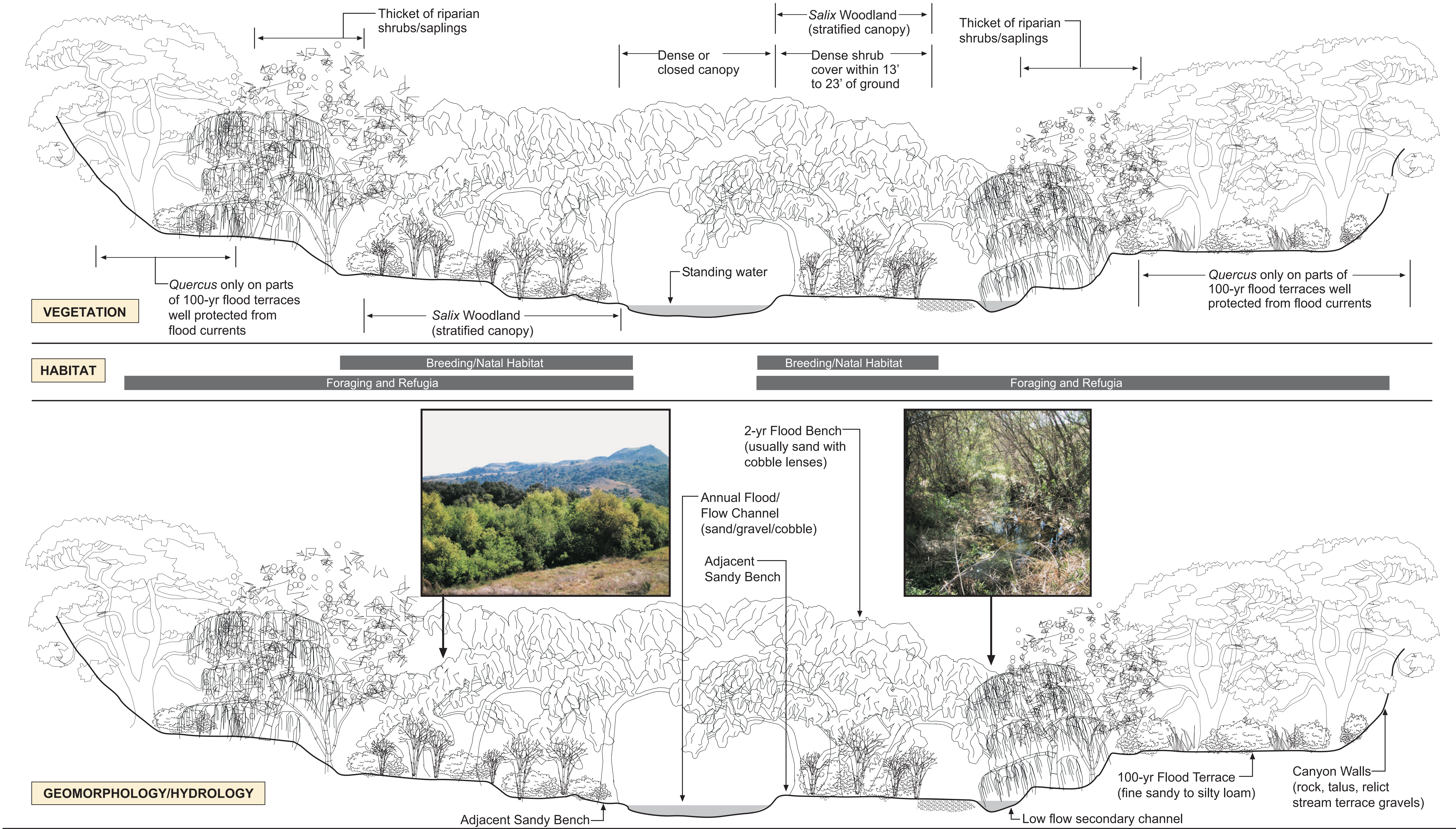


PCR

DUDEK & ASSOCIATES, INC.

No scale

Source: PCR Services Corporation and Eric Stein, 2002

Figure 21
Southwestern Willow Flycatcher Conceptual Habitat Cross-Section

2.3.2.4 Breeding areas

The willow flycatcher is more abundant in the continuous mesic shrub association than in other streamside vegetation structures supporting herbaceous xeric shrub or discontinuous mesic shrub (Sanders and Edge 1998). This species almost exclusively depends on hydrophytic shrub thickets for nesting in the semiarid western United States and is especially threatened by the elimination or loss of structural diversity of continuous associations of mesic shrub vegetation.

In their study of southwestern willow flycatcher habitat, Sedgwick and Knopf (1992) determined that flycatchers exhibit vegetation preferences at three scales of vegetation measurement: microplot (central willow and four adjacent shrubs); mesoplot (0.07 hectare, 0.2 acre); and macroplot (flycatcher territory size). Nest sites are distinguished by high willow density and low variability in willow patch size and bush height. Song perch sites are characterized by large central shrubs, low central shrub vigor, and high variability in shrub size. Unused sites are characterized by greater distances between willows and willow patches, less willow coverage, and a smaller riparian zone width than either nest or song perch sites.

2.3.2.5 Adjacent Land Use

Southwestern willow flycatchers are known to nest and forage in dense riparian vegetation in proximity to open water or saturated soils (Sogge et al. 1997). Flycatcher are more likely to utilize riparian habitats that are adjacent to habitats/land uses that possess infiltration and subsurface water flow patterns that promote open water or saturated conditions in the riparian zone. For example, in Cañada Gobernadora high infiltration rates associated with sandy soils combined with a shallow subsurface layer that restricts deep percolation of groundwater results in areas of open water in the adjacent creek, which support willow flycatcher. In addition, Sedgewick and Knopf (1992) found that habitats not selected by southwestern willow flycatchers for either nesting or singing are riparian zones with greater distances between willow patches and individual willow plants.

2.3.2.6 Life Cycle/Natural History

The southwestern willow flycatcher is a small, diurnally active bird species. It prefers healthy riparian forests with structural diversity that provide nest cover and diverse insect populations (USFWS 1995).

The species forages within and above dense riparian vegetation and takes insects on the wing or gleans them from foliage (USFWS 1993). This species also forages in areas adjacent to nest sites, but still within or immediately adjacent to the riparian zone (USFWS 1995).

The southwestern willow flycatcher has a home range that is larger than the defended territory. The territory size varies from 0.24 (0.6 acre) to 0.45 hectares (1.1 acres), but may be smaller where suitable habitat is limited. The maximum documented densities are six females and five males in 4.4 hectares (11 acres), or about 0.7 hectares (1.8 acres) per pair (San Diego Natural History Museum 1995). Sogge et al. (1997), as reported in USFWS (1995), found territorial flycatchers in habitat patches ranging from 0.5 to 1.2 hectares (1.2 to 3.0 acres), with two habitat patches of 0.5 and 0.9 hectares (1.2 and 2.2 acres) each supported two territories.

Males typically arrive in southern California at the end of April, and females arrive approximately one week later. The species initiates territorial defense in late May. Nest construction is initiated about a week after pair bond formation, and egg laying commences as early as late May to mid-June and lasts until August. Adults typically depart from the breeding territory in mid-August to early September (San Diego Natural History Museum 1995).

The female southwestern willow flycatcher performs nest construction lasting approximately three to eight days (San Diego Natural History Museum 1995). Southwestern willow flycatchers typically raise one brood per year, but may attempt double-brooding following initial nest failure (USFWS 1993). The clutch size ranges from two to five with the average clutch size being 3.4 eggs in coastal southern California. The species usually has a monogamous mating system within a given nesting season, when all territorial males are mated (San Diego Natural History Museum 1995).

2.3.2.6.1 Migration Patterns

The southwestern willow flycatcher fledglings leave the nest at age 12 to 15 days in early July (USFWS 1993) and migrate from the natal territory at age 26 to 30 days minimum. Approximately 25 percent of adults return to their territory from the previous year and at least 20 percent of juveniles return to the natal area, which is usually two to four km (1.2 to 2.5 mi) from the natal territory. Adults usually depart from their breeding territory between 12 August and 4 September (San Diego Natural History Museum 1995).

The migration routes and winter destination of the southwestern willow flycatcher are not well understood. The species has been reported to sing and defend winter territories in Mexico and Central America. The southwestern willow flycatcher most likely winters in the neotropics of southwestern Mexico, Central America, and perhaps northern South America, but the habitats it uses on the wintering grounds are unknown (USFWS 1993).

2.3.3 Key Physical Habitat Components

2.3.3.1 Geomorphic Factors

2.3.3.1.1 Adjacent Benches and Terraces

Southwestern willow flycatchers are restricted during all life stages to mature riparian woodlands along streams or smaller spring fed areas that support riparian species. Constituent elements of suitable habitat include the riparian ecosystem within the 100-year floodplain, including areas where dense riparian vegetation is not present, but may become established in the future. The species composition of vegetation ranges from nearly monotypic stands to stands with multiple species. Vegetation structure ranges from simple, single stratum patches as low as 3 m (10 ft) in height and lacking a distinct overstory to complex patches with multiple strata and canopies nearing 18 m (59 ft) in height. Vegetation patches may be uniformly dense throughout, or occur as a mosaic of dense thickets interspersed with small openings, bare soil, open water, or shorter/sparser vegetation. Riparian patches used by breeding flycatchers vary in size and shape, and may be relatively dense, linear contiguous stands or irregularly-shaped mosaics of dense vegetation with open areas. The size of vegetation patches or habitat mosaics used by southwestern willow flycatchers varies considerably and ranges from as small as 0.8 hectares (2.0 acres) to several hundred hectares. However, narrow linear riparian patches only one to two trees in width that have no potential to increase in depth are not considered suitable breeding habitat, although they may be used by southwestern willow flycatchers for dispersal routes.

The riparian zone where southwestern willow flycatchers forage and nest is often comprised of a combination of aquatic and upland areas. Riparian habitat adjacent to the stream channel not only provides a wider zone of potential habitat, but can also provide a buffer between incompatible upland land uses and active territories. This buffer area can also be important in filtering runoff from upland areas before it enters the stream, acting as a noise and visual barrier, and can discourage direct encroachment by people and animals into the active stream course.

Presence of open areas adjacent to the stream also provides important areas for overbank flow and for potential stream migration. Because long-term viability of flycatcher habitat depends on periodic scour, there must be sufficient area adjacent to the stream channel to allow overbank flow and channel braiding or meandering. Furthermore, southwestern willow flycatcher rely on habitat in proximity to areas that are inundated or saturated late into the breeding season. The aquic moisture regime of such areas may rely on geologic conditions (e.g., shallow layers with low permeability), phreatic flow from the uplands, or groundwater discharge. Upland land uses that disrupt these processes may result in decrease or degradation of suitable habitat.

In contrast with least Bell's vireo, southwestern willow flycatchers typically utilize denser more mature habitat and the species appears to require habitat in closer proximity to saturated or ponded portions of the streamcourse. Therefore, southwestern willow flycatchers may require streams and rivers with broader, more geomorphically stable terraces that can support their preferred habitat. This translates to portions of the floodplain that are scoured less frequently than typical vireo habitat, but still have sufficient moisture to support a dense understory. For example, lower Cañada Gobernadora supports willow flycatcher in areas with stable terraces and mature riparian habitat. In contrast, flycatchers are absent, but vireo are present in Cañada Chiquita, which contains riparian habitat that is scrubbier than that found in Gobernadora. Constriction or confinement of the riparian floodplain, changes in the magnitude or frequency of high flows, or changes in the channel geometry that inhibit overbank or phreatic (i.e., shallow sub-surface) flow may cause decreases in the extent of suitable habitat.

2.3.3.2 Hydrologic Factors

2.3.3.2.1 Flow Regime

Although nesting willow flycatchers of all subspecies prefer areas with surface water nearby (Harris et al. 1986), the southwestern willow flycatcher virtually always nests near surface water or saturated soil (TNC 1994). At some nest sites, surface water may be present early in the breeding season but only damp soil is present by late June or early July. Ultimately, a water table close enough to the surface to support riparian vegetation is necessary.

Similar to the least Bell's vireo, suitable habitat for the southwestern willow flycatcher depends on periodic scouring stormflows and somewhat persistent dry season flow hydrology. However, dry season hydrology is likely more critical for flycatcher habitat than it is for the vireo. Maintenance of suitable flycatcher habitat depends on geomorphic terrains and watershed land uses that facilitate late season saturation in the riparian zone, through either surface or subsurface (groundwater) flows or a combination of the two. Habitat conditions rely on prolonged dry season surface discharge, dry season subsurface discharge, or a combination of the two that produce the required moisture conditions necessary to sustain dense riparian vegetation. Changes in flow regime that reduce moisture levels can result in desiccation of riparian habitat. However, increases in the duration and magnitude of baseflow may result in a conversion or shift of plant community composition to more herbaceous marsh-like habitat, which is not suitable for the vireo or the flycatcher. In contrast, increased groundwater recharge in adjacent floodplains and sandy tributary valleys may increase the area of the stream with sufficient persistent moisture to support riparian habitat and open water areas.

In addition to dry season flow, long-term maintenance of flycatcher habitat relies on periodic storm flows of appropriate frequency and magnitude to regularly rejuvenate breeding habitat. Decreases in the magnitude or frequency of storm flows (as may result from upstream impoundment or diversion) may result in senescence of plant communities to a habitat that is not suitable for flycatcher. Conversely, increases in the magnitude or frequency of storm flows (as may result from floodplain constriction or encroachment) can result in excessive scour that precludes establishment of the necessary mature dense riparian habitat.

2.3.4 Summary

Species Profile

• *Study Area Distribution*	Occurs within study area
• *San Juan Creek Watershed Distribution*	Cañada Gobernadora
• *Western San Mateo Creek Watershed Distribution*	Lower San Mateo Creek (outside the study area on MCB Camp Pendleton)
• *General Habitat:*	Southern willow scrub riparian
• *Breeding and Migration Seasons:*	Breeding - late-April to late-August; territorial habitat patches range from 0.5 to 1.2 hectares (1.2 to 3.0 ac); winter migration in Mexico, Central America
• *Habitat Requirements/Range:*	Southern CA, AZ, NM, southern NV, UT, western TX, southwestern CO, northwestern Mexico. Woody riparian habitats between 30 and 2,438 m (100 and 8,000 ft) above MSL; nests are constructed 0 to 4 m (0 to 13 ft) above ground in shrub thickets with a high percent of canopy cover and dense foliage; high willow density and low variability in patch size and bush height; song perch sites were characterized by large central shrubs, low central shrub vigor, and high variability in shrub size
• *Known Natural and Exotic Predators:*	Nest parasitism by brown-headed cowbirds; other predators include scrub jays, rats, domestic cats

Key Physical Habitat Components

Geomorphic

• *Substrate Type/Coarseness:*	Saturated soils
• *Underlying Geology/Terrain:*	Stream segments with gradient of 4 percent or less
• *Channel Form/Geometry:*	Channel form needs to maintain native riparian habitat

• *Deposition or Erosion Areas:*	Erosion may reduce riparian habitat; deposition may bury/kill riparian vegetation

Hydrologic

• *Abundance/Distribution of Ponded Areas (included seasonal ponds):*	Surface water should be present at least through May; may be supported by smaller spring fed or boggy areas with willows or alders; nesting birds prefer to have surface water nearby
• *Magnitude of 5-, 10-, or 25-Year Event:*	Should not be so high as to rip out riparian vegetation
• *Frequency of Channel-forming Events (i.e., 10 year flow or greater):*	Need to maintain open water channel under closed canopy
• *Salinity/Alkalinity:*	High salinities may reduce riparian vegetation
• *Groundwater fluctuations*	Groundwater levels which do not fall below levels necessary to sustain mature willows and sycamores, probably 6 to 8 m (20 to 26 ft) below the bed during droughts
• *Adjacent Land Use:*	Minimal grazing
• *Home Range and Movement:*	Diurnally active, singing pre-dawn; approximately 25 percent show site fidelity, returning to within 2 to 4 km (1.2 to 2.4 mi) of the nest

3.0 SPECIES THAT OCCUR OUTSIDE/DOWNSTREAM OF THE STUDY AREA

Two aquatic/riparian dependent endangered species occur within the San Mateo watershed, but completely outside the SAMP/MSAA and NCCP/HCP study area: tidewater goby and southern steelhead. Both these species occur downstream of the study area in the San Mateo Creek lagoon.

Spawning areas for the steelhead occur to the east of the study area in tributary sub-basins to San Mateo Creek that are geographically distinct and separated (i.e., not hydrologically connected) from those being analyzed by the SAMP/MSAA or NCCP/HCP processes. In order to provide an understanding of steelhead habitat considerations, all life cycles of the steelhead are discussed in the following sections. As noted in Section 1.0, discussion of all life cycles will be helpful in the event that introduction of southern steelhead is considered for that portion of the San Mateo Creek watershed located within the study area or, if consideration is given to re-introducing the southern steelhead run to San Juan Creek. However, due to the absence of hydrologic connectivity between the planning area and documented steelhead spawning habitat, the assessment of potential impacts related to actions within the study area are focused on hydrology and sediment delivery within the migration corridor and lagoon in lower San Mateo Creek. Potential downstream impacts on the tidewater goby focus on those areas identified in the critical habitat designation (i.e., San Mateo lagoon and the main creek 0.9 mi upstream). Consequently, for the tidewater goby and southern steelhead, the focus of the analysis is on the effect of physical processes on downstream habitat structure and/or suitability.

3.1 TIDEWATER GOBY

3.1.1 Regulatory Status

Petitioned for federal listing in October 24, 1990, the tidewater goby (*Eucylogobius newberryi*) was listed as an endangered species under the Federal ESA on March 7, 1994. The goby is also designated as a "Species of Special Concern" by the California Department of Fish and Game (CDFG). On August 3, 1999, the USFWS proposed to designate the lower portion of 10 coastal streams within Orange and San Diego counties, totaling approximately 14.5 km (9 mi), as critical habitat for the endangered tidewater goby. These drainages were designated as critical habitat on November 20, 2000 (USFWS 2000). This designation identifies specific geographic areas that are essential for the conservation of the tidewater goby and require special management considerations, including "San Mateo Creek and its associated lagoon and marsh, from the Pacific Ocean to approximately 1.3 km (0.9 mi) upstream."

The draft recovery plan for the tidewater goby includes the San Mateo Creek lagoon within Recovery Unit 13. The recovery plan recommends the following measures to ensure habitat suitability within the 13 recovery units: management of water quality, maintenance of sufficient freshwater inflow, control of exotic predatory species, preventing excessive sedimentation, and minimizing anthropogenic breaching of lagoon mouths.

3.1.2 Species Profile

3.1.2.1 Description

The tidewater goby is a small, elongate fish of the family Gobiidae. Body coloration ranges from dark olive to transparent, with a mottled brownish upper surface and commonly displaying spots or bars on dusky dorsal and anal fins (USFWS 2001; Moyle et al. 1995). Adults rarely exceed 50 mm (2 in) in standard length, or 1 gram in weight (Swift et al. 1989). The head is blunt and the mouth is large, terminal, oblique, with the maxillary extending to the posterior margin of the eye (Moyle et al. 1995). However, the distinctive anatomical characteristic of the tidewater goby is their pelvic (or ventral) fins. The yellow or dusky-colored pelvic fins are completely fused, forming a ventral, cone-shaped sucker cup that allows the fish to cling to the base of the lagoon or estuary. The pelvic fins are joined below the chest and belly from the gill cover to just before the anus (USFWS 1996). Tidewater gobies have two, dusky-colored dorsal fins set very closely together. Fish of all sizes have the first dorsal fin distinctively colored a prominent cream or orange color, with the distal one-third to one-half transparent (Moyle et al. 1995). The first dorsal fin has five to seven slender spines and the second dorsal fin has 11 to 13 soft, branched rays (USFWS 1996). Another characteristic feature of the tidewater goby are the large, transparent pectoral fins (USFWS 1994a). Pectoral fins are large and the caudal fin elongate and rounded. The dusky-colored anal fin usually has 10 to 11 elements. Scales are small and cycloid, and often lacking on the anterior 20 to 25 percent of the body (head, chest, belly, and nape) (Moyle et al. 1995).

3.1.2.2 Species Distribution

The tidewater goby is endemic to California and uniquely adapted to coastal lagoons and to the uppermost brackish zones of larger estuaries and are entirely dependent upon these habitats for their survival. Historically, tidewater gobies were found from Del Norte County (Smith River) in northern California near the Oregon border south to San Diego County (but have been absent from three sections of the California coast: 1) Humboldt Bay and Ten Mile River, 2) Point Arena and Salmon Creek, and 3) Monterey Bay and Arroyo del Oso (USFWS 1994). The USFWS (2000) asserts that the populations of tidewater gobies in Orange and San Diego Counties are genetically distinct from the populations north of Orange County.

Populations of tidewater gobies have experienced a severe decline that is directly attributable to the degradation of California's coastal wetlands (Finney and Edmondson 2000). Of the 110 sites from which tidewater gobies have historically been reported, many no longer support tidewater goby populations (Finney and Edmondson 2000). The current range of the tidewater goby is confined to shallow, brackish portions of coastal streams, marshes, lagoons, and estuaries located discontinuously within the original known range of the species (Smith River to Agua Hedionda Lagoon) (Swift et al. 1989, Brown and Swenson 1994) as shown in Figure 22, *Tidewater Goby Historical and Current Distribution*, on page 74. Restricted to low-salinity waters in coastal wetlands, the fish occurs in the following drainages from north to south:

San Luis Obispo County
- Tortuga Canyon
- Arroyo del Puero
- Little Pico
- Pico
- San Simeon
- Santa Rosa
- Villa
- San Geronimo
- Cayucos
- Piso creeks
- Santa Maria River

Santa Barbara County
- Shuman Canyon
- San Antonio Creek
- Santa Ynez River
- Jalama Creek
- Canadas de Cojo
- Las Agujas
- Santa Anita
- Alegria
- Gaviota Creek
- Refugio Canyon
- Bell Canyon

Ventura County
- Ventura River
- Santa Clara River

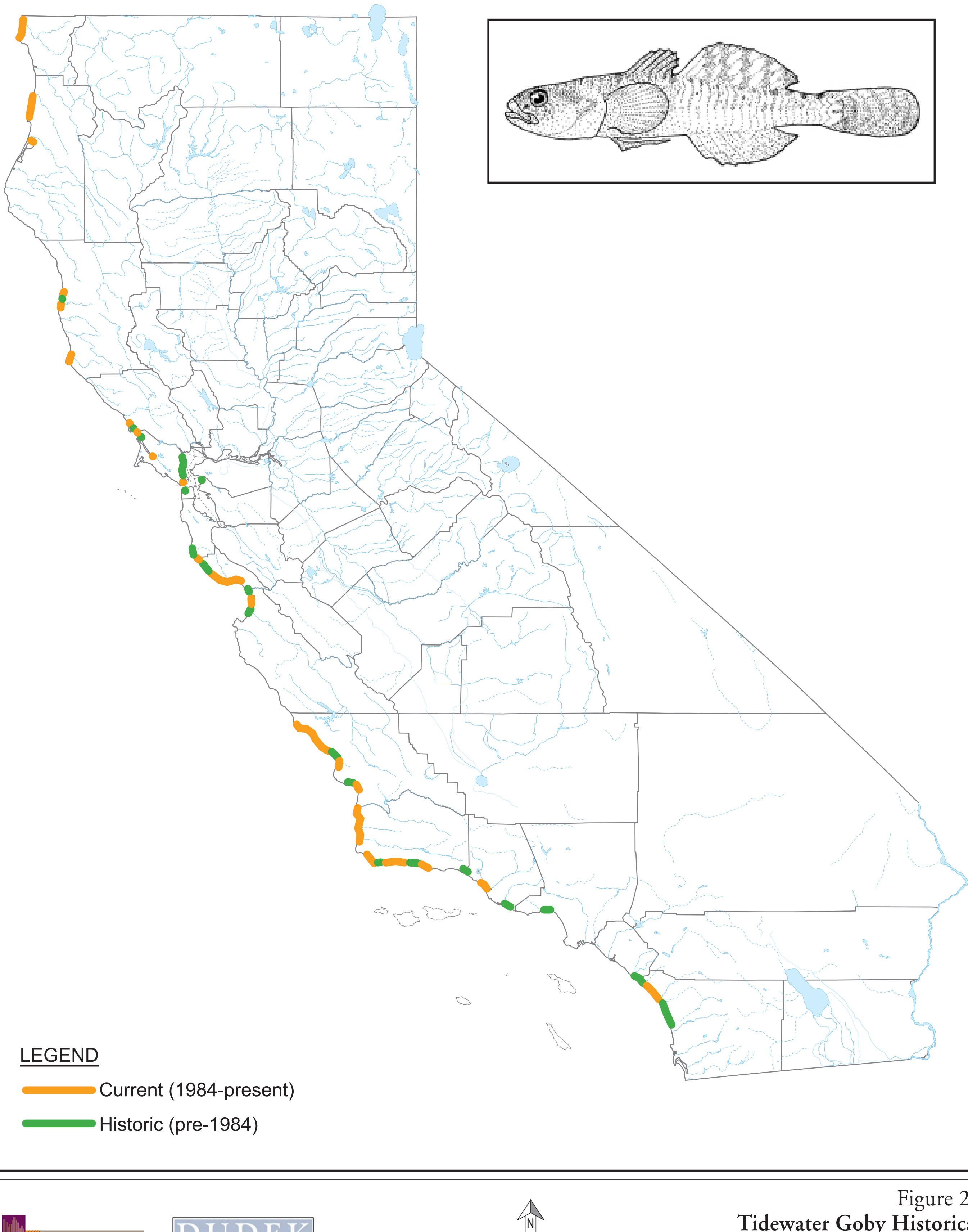
Los Angeles County
- Malibu Creek

San Diego County
- San Onofre Creek
- Las Pulgas Creek
- Cocklebur Canyon
- Santa Margarita River
- Agua Hedionda Lagoon
- San Mateo Creek

(Swift et al. 1993)

Tidewater gobies have a relatively high rate of extirpation and recolonization, especially following wet years (USFWS 1996). However, they have disappeared from some formerly occupied localities, such as San Juan Creek, and not recolonized. The species was last collected from San Juan Creek within an approximately 4 to 10 hectare (10 to 25-acre) lagoon in late 1968 (USFWS 1996). This area is now channelized and the historic lagoon has been filled. Consequently, the tidewater goby population from the mouth of San Juan Creek is considered extirpated and likely cannot naturally re-establish (USFWS 1996). Currently, 10 coastal stream segments in Orange and San Diego counties have been designated as critical habitat as shown in Figure 23, *Tidewater Goby Critical Habitat*, on page 75. The following creeks and their associated lagoon and marsh areas in Orange and San Diego counties have been designated as critical habitat:

Unit 1: Aliso Creek from the Pacific Ocean to approximately1 km (0.6 mi) upstream
Unit 2: San Mateo Creek from the Pacific Ocean to approximately 1.5 km (0.9 mi) upstream
Unit 3: San Onofre Creek from the Pacific Ocean to approximately 0.6 km (0.4 mi) upstream
Unit 4: Las Flores Creek from the Pacific Ocean to approximately 1 km (0.6 mi) upstream
Unit 5: Hidden Creek from the Pacific Ocean to approximately 0.8 km (0.5 mi) upstream
Unit 6: Aliso Creek from the Pacific Ocean to approximately 0.6 km (0.4 mi) upstream
Unit 7: French Creek from the Pacific Ocean to approximately 0.6 km (0.4 mi) upstream
Unit 8: Cockleburr Creek from the Pacific Ocean to approximately 1 km (0.6 mi) upstream
Unit 9: Santa Margarita River from the Pacific Ocean to approximately 5 km (3.1 mi) upstream
Unit 10: Agua Hedionda Lagoon from the Pacific Ocean to approximately 3.7 km (2.3 mi) upstream



Source: Swift et al., 1989

Figure 22
Tidewater Goby Historical and Current Distribution

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

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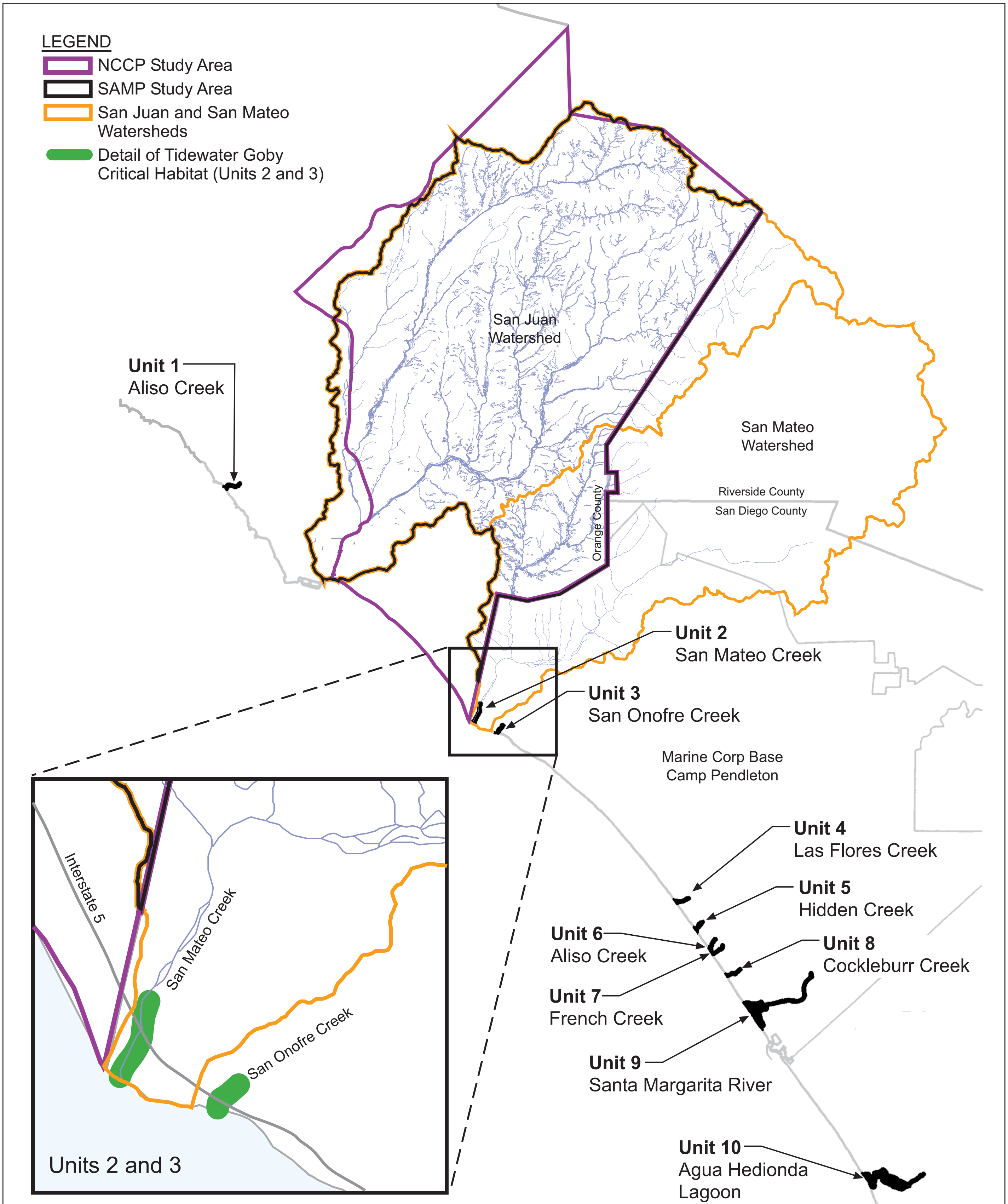

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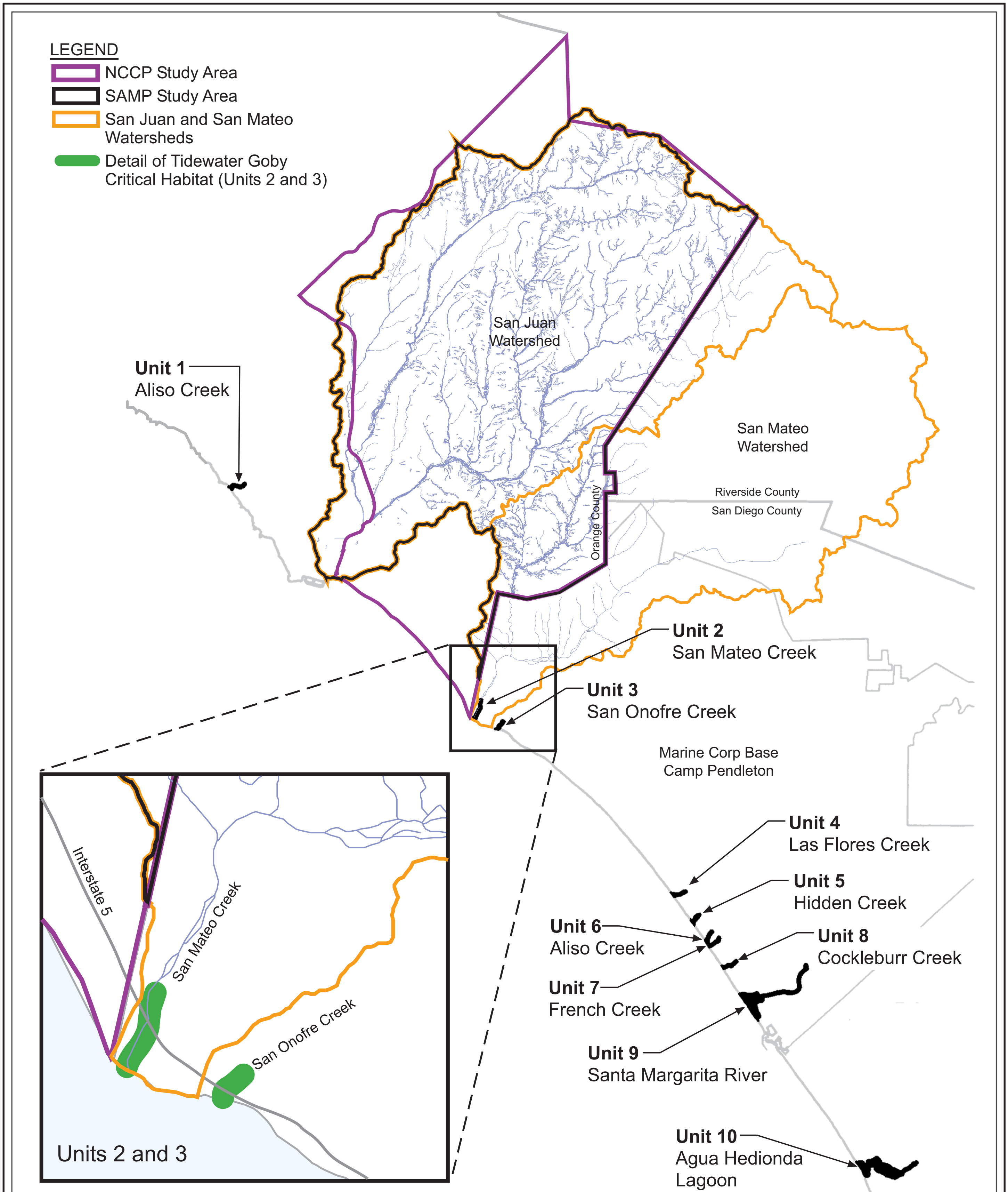
Source: USFWS, 2000

Figure 23
Tidewater Goby Critical Habitat

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species



Source: USFWS, 2000

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Figure 23
Tidewater Goby Critical Habitat

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

3.1.2.3 Occurrences Outside the Study Area

The only occurrence of tidewater gobies is outside the study area, within eastern and lower San Mateo Creek as shown in Figure 24, *Tidewater Goby Distribution Downstream of the Study Area*, on page 77.

San Mateo Creek Watershed

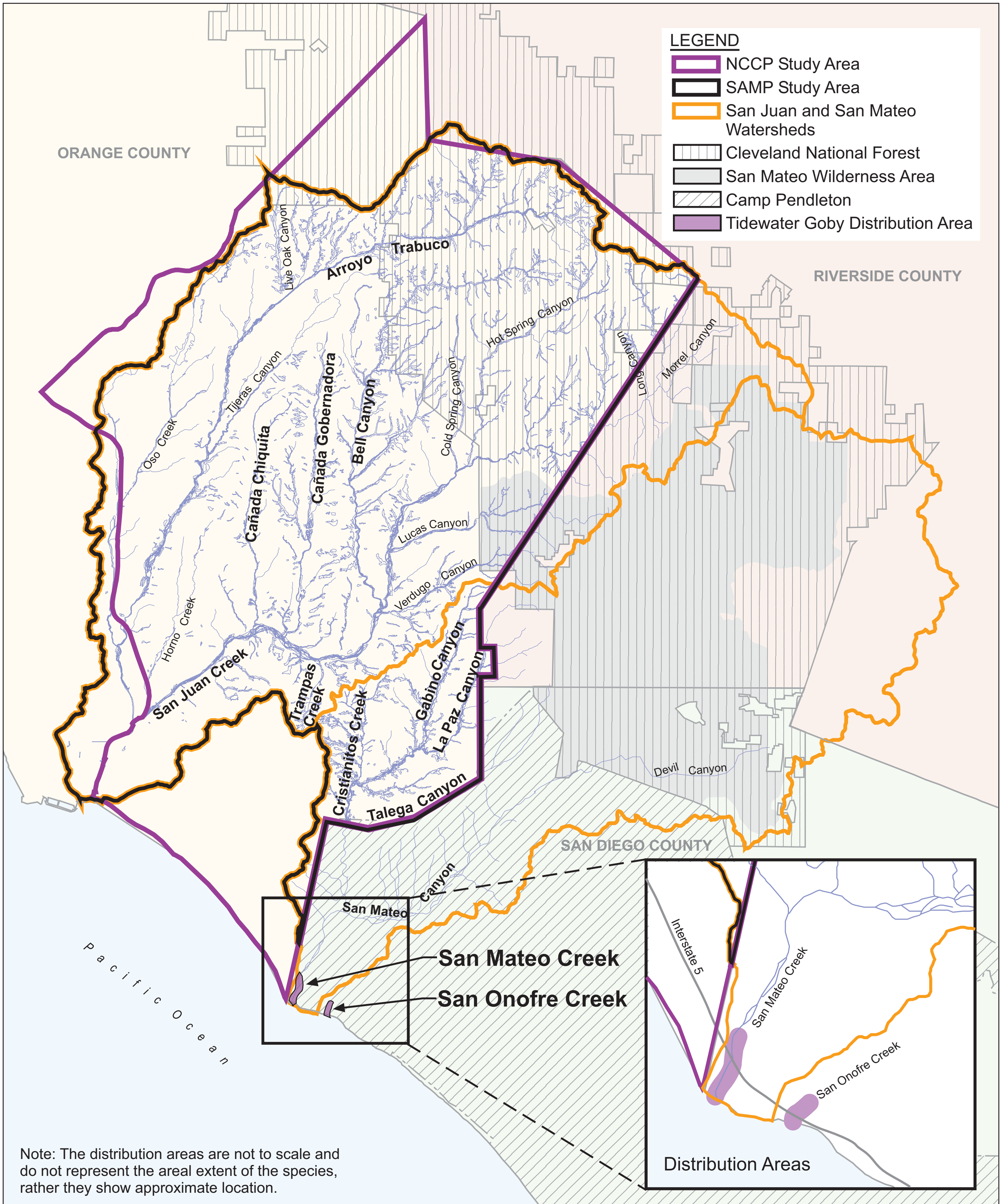
1. San Mateo Creek: The mouth of San Mateo Creek supports a lagoon that ranges from approximately 4 to 10 hectares (10 to 25 acres). Tidewater gobies were considered extirpated in 1989 (Swift et al. 1989); however, the fish was collected in the fall of 1993 (Swift et al. 1994) and again in 1995 and 1996 (USFWS 1996). In 1995, a large population of tidewater gobies was found in San Mateo Lagoon and a single individual was caught upstream in San Mateo Creek (USFWS 2000).

   The San Mateo lagoon is relatively shallow, with the deepest areas being between 0.6 and 1.2 m (2 to 4 ft) deep. Inflow to the lagoon consists of natural baseflow, treated effluent, and agricultural runoff. Inflow during the driest portion of the year is primarily groundwater upwelling, and the surface is often covered with algal mats. When the mouth of the estuary is closed the upstream inputs result in a nearly freshwater lagoon. The lagoon has been subject to varying degrees of degradation, including construction of railroad and highway bridges, military training, construction of roads and dikes, and water diversion, which have collectively led to a reduction in the historical size of the lagoon (USFWS 1998).

3.1.2.4 Habitat

Tidewater gobies are found in brackish to fresh water within shallow lagoons and lower stream reaches of California. Known localities directly correspond to coastal regions with littoral cells of sediment movement that facilitate lagoon formation (Swift et al. 1989). These fish are commonly found in the brackish waters at the upper end of lagoons and estuaries where salinities are less than 10 parts per thousand (ppt) throughout all life stages (USFWS 1994). However, adult tidewater gobies often migrate upstream into tributaries up to 2 km (1.2 mi) and downstream to the ocean tolerating salinities that range from 3 to 42 ppt and temperatures of 8 to 23 C (46 to 73 F) (USFWS 2000). Breeding adults utilize a more narrow range of water parameters preferring salinities that range from 5 to 10 ppt and temperatures of 18 to 22 C (64 to 72 F) (Moyle et al. 1995).

Tidewater gobies feed along the bottom of coastal lagoons, marshes, creeks, and estuaries, preferring clean, shallow, slow-moving waters. The presence of backwater, marshy habitats within the lagoons is important for their survival where they can find refuge during



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Source: Lichvar et al. and ACOE 2000

Figure 24
Tidewater Goby Distribution Downstream of the Study Area

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

winter flood flows (Moyle et al. 1995). Typical water depth in areas that support tidewater gobies ranges from 25 to 100 cm (10 to 39 in) and dissolved oxygen is fairly high (Irwin and Soltz 1984). However, tidewater gobies sometimes can persist under anoxic conditions that eliminate other fish species and have been observed to come up and gulp air at the water surface (C. Swift, pers. comm.). The substrate utilized by gobies is characterized by relatively unconsolidated, clean, coarse sand averaging 0.5 millimeters (0.02 in) in diameter (USFWS 2000) with abundant emergent and submerged vegetation (Moyle 1976). These aquatic habitats are typically disturbed by annual natural flows of flood magnitude. Tidewater gobies avoid open areas where there is strong wave action or currents (Moyle et al. 1995).

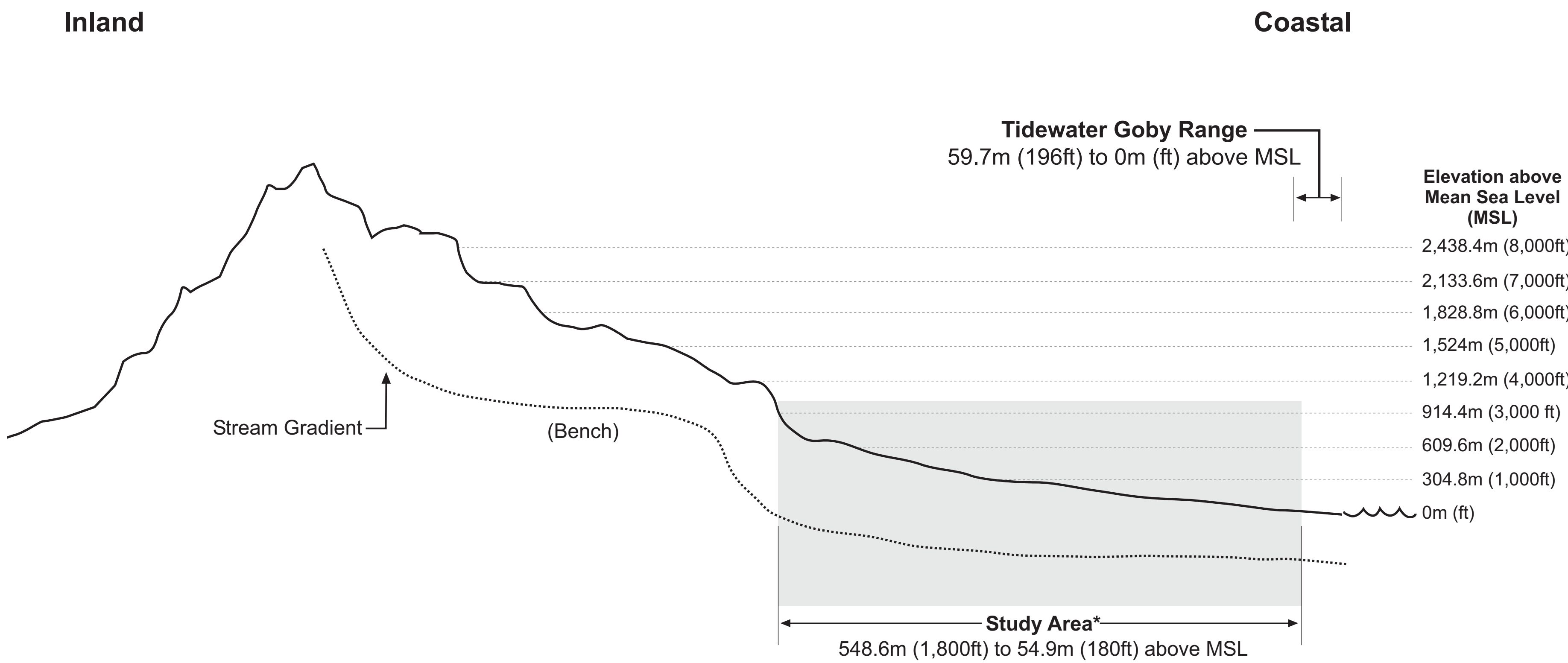
Figure 25, *Tidewater Goby Conceptual Habitat Profile*, on page 79, displays a conceptual profile of tidewater goby habitat.

3.1.2.4.1 Spawning Areas

Spawning sites throughout the species range are generally concentrated near the ocean from spring to summer and transition further upstream from summer to fall (Wang 1982). Spawning fish are often found in the shallow tidal channels, sloughs, and inshore areas of lower lagoons during the breeding season. Tidewater gobies in southern and central California breed primarily in sand and mud substrates, and apparently avoid areas that contain large amounts of decaying vegetation (USFWS 1994a). Ideally, the first winter rains, which occur from November to January, fill coastal lagoons until they overflow and break through the sandbar, thus emptying the lagoon and leaving a sandy-bottom stream (Swift et al. 1989). Breached sandbars located at the mouths of coastal drainages allow tidal inflows to mix with lagoon waters. Outgoing tides remove the warm, saline, and oxygen and nutrient deficient water that contain concentrations of suspended silt, organic material, and chemical pollutants. A sandbar quickly builds again within a few days at the mouth and the lagoon begins to fill again. Several partial breaches may occur from December to March, and by April the lagoon is again completely closed to the ocean (Swift et al. 1989). Formation of this sandbar slows base flows resulting in the deposition of sand throughout the lagoon ecosystem. Following lagoon closure, in April or May males dig breeding burrows to depths of 75 to 100 mm (3 to 4 in), usually in relatively unconsolidated, clean, coarse sand averaging 0.5 mm (0.02 in) in diameter (USFWS 2000).

3.1.2.4.2 Natal and Juvenile Refugia Areas

Juvenile tidewater gobies are typically found near breeding areas in inland areas, or the upper portion of estuarine environments. Larval tidewater gobies are found mid-way within the water column generally around submerged vegetation until they mature to become strictly benthic dwelling organisms (Swift et al. 1989).



* Profile for study does not include the Cleveland National Forest.

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Source: Modified from Campbel et al., 1996 and Sweet, 1989

Figure 25
Tidewater Goby
Conceptual Habitat Profile

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

Suitable water conditions for nesting are characterized as oligohaline[16] to freshwater in the inland areas. They have been reported in water at 5 to 10 ppt salinities with temperatures ranging from 18 to 22 C (64 to 72 F) (Moyle et al. 1995). Note that these parameters are more narrow than described above for the general habitat.

3.1.2.4.3 Foraging Areas

Juvenile and adult tidewater gobies are benthic inhabitants, typically foraging in shallow water less than 1 meter (3.3 ft) deep Swift (1980). Although gobies have occasionally been observed at depths of 1.5 to 2.3 m (4.9 to 7.6 ft) (USFWS 1994).

3.1.2.5 Life Cycle/Natural History

Tidewater gobies have a short lifespan, with the majority of individuals completing their life cycle within one year (Irwin and Soltz 1984; Swift et al. 1990). The tidewater goby occurs in loose aggregations of a few to several hundred individuals (USFWS 1994). This benthic forager's diet consists mostly of small crustaceans, aquatic insects, and mollusks (Moyle et al. 1995). This bottom-dwelling, carnivorous fish does not have a marine life cycle phase, which severely restricts the frequency of genetic exchange between coastal lagoon populations (USFWS 1994). The short life span and absence of a marine life stage also severely restricts the potential for gobies to recolonize habitats from which they have been extirpated (USFWS 1994).

The life history of the tidewater goby is tied to the annual hydrologic cycles of the coastal lagoons and estuaries. Tidewater gobies have developed a special adaptation to the annual natural process of building and breaching lagoon sandbars (USFWS 2000). Suitable water conditions for nesting have been reported as 5 to 10 ppt salinities and 18 to 22 C (64 to 72 F) temperatures (Moyle et al. 1995). Tidewater gobies spend the majority of their life-cycle within the estuary, but adults and sub-adults may migrate several kilometers upstream during the summer and fall in some low gradient streams (USFWS 2000).[17] However, there is little evidence of reproduction in these upper stream areas (Swift et al. 1997).

Successful breeding and recruitment depends on the adequacy of spawning habitat and suitable salinity and temperature regimes during the reproductive and rearing period. Factors that contribute to suitable breeding habitat include maintaining the quality of freshwater flows and allowing the natural development of barrier sand berms at the mouth of coastal drainages to

[16] *oligohaline refers to a moderately saline condition*

[17] *Tidewater gobies in southern California have been found as far as 5 km (3 mi) upstream of the estuary in the Santa Margarita River (USFWS 2000) and have been documented in ponded freshwater habitats as far as 8 km (5 mi) upstream from San Antonio lagoon in Santa Barbara County (Irwin and Soltz 1984).*

enhance lagoon formation and protect habitats (Lafferty et al. 1996). During the summer months of wetter years, San Mateo lagoon often possesses these characteristics. However, input of agricultural runoff may degrade water quality and diminish habitat suitability.

Female gobies in southern California have been documented at various stages of ovarian development throughout the year (Moyle et al. 1995). However, spawning is most common from spring to mid-summer, peaking in late April through early May. This period of time corresponds with the natural hydrologic cycle of lagoon isolation from the ocean and low-salinity brackish water conditions. Males dig a vertical nesting burrow 10 to 20 cm (4 to 8 in) deep into the sandy substrate, usually in water 25 to 50 cm (10 to 20 in), in which the female deposits her eggs (Moyle et al. 1995). Females aggressively spar with each other for access to burrows for laying their eggs (USFWS 1996). Females typically produce 640 to 800 eggs and may lay more than one clutch in a season dependent on optimal environmental conditions (USFWS 1996). Males often have more than one clutch from different females within their burrow. Male gobies guard the elongate, pear-shaped eggs that are hung from the ceiling and walls of the burrow until hatching occurs 9 to 10 days after oviposition. Although the potential for year-round spawning exists, seasonal low temperatures and disruptions of lagoons during winter storms often prevent this from occurring (Swift et al. 1993; USFWS 1994).

3.1.3 Key Physical Habitat Components

3.1.3.1 Geomorphic Factors

3.1.3.1.1 Lagoon and estuarine systems

Tidewater gobies are found in shallow lagoons and estuaries within the lower reaches of coastal streams. These dynamic, aquatic ecosystems are usually semi-enclosed by land and characterized by sporadic access to the open ocean. Estuarine habitats encompass subtidal areas, which includes deepwater habitats, and intertidal areas, which includes wetlands (Ferren et al. 1995). Ferren et al. (1995) identified seven major types of estuaries in California (river mouth, canyon mouth, lagoonal, coastal dune-creek, bay, structural basin, and artificial drain), each of which contain several classes and subclasses that differ in their physical and biological attributes. The river mouth, canyon mouth, lagoonal, coastal dune-creek, and artificial dam subsystems support the appropriate combination of features suitable for tidewater goby breeding, foraging, and refuge areas: a contributing coastal terrace or foothill watershed, medium to small-sized coastal brackish water lagoon, temporary sand bar barrier, and inland, freshwater habitats that extend from 1.6 to 8 km (1 to 5 mi) upstream. The largest tidewater goby populations are at the mouths of streams where lagoons and estuaries are of intermediate size from 2 to 50 hectares (5 to 125 acres) (USFWS 2000).

Geomorphic features important to the properly functioning intertidal and subtidal lagoon system include the presence of a seasonally breached sand barrier, adjacent wetlands, and backwater creeks, and marshy pools. Tidewater gobies depend on a variety of structurally complex habitats that support aquatic and emergent vegetation, thereby providing areas where they can avoid winter flood flows for their survival (USFWS 2000; Moyle et al. 1995).

3.1.3.1.2 Coarse-Grained Substrate

It has long been assumed that male tidewater gobies prefer relatively unconsolidated, clean, coarse sand that averages 0.5 mm (0.02 in) in diameter. This substrate is particularly important for digging deep breeding burrows (USFWS 2000). However, studies have not conclusively determined the importance of substrate in determining the presence of tidewater gobies, and they apparently can complete their life cycle in a variety of habitats, including sandy lagoons, mud or gravel-bottom reaches of creeks, and muddy, marsh pools (USFWS 2000). Little is known about the geomorphology of spawning areas with the exception of known goby occurrences within shallow ditches and inshore areas of lower lagoons. However, spawning tidewater gobies occur within the muddy, marshy conditions of San Mateo Lagoon.

3.1.3.1.3 Sand Barriers

Sand barriers are usually breached during heavy precipitation between December and April. However, in some years, breaching may not occur due to insufficient runoff. Once a sand barrier is breached, tidal flushing may occur for several weeks before the sand bar again blocks a surface connection between the marine and estuarine environments (Ferren et al. 1995). Although tidewater gobies can tolerate high salinity waters, they remain within the brackish waters of estuaries and depend on the seasonal flooding that breaches sand barriers to expose coarse-grained substrate (important for spawning), flush stagnant water, and to moderate salinity levels and water temperatures.

3.1.3.1.4 Low-gradient Stream Segments

In southern California, low-gradient, inter-tidal creeks located near mean sea level are dominated by resident gobies (Zedler 2001). Tidal creeks and channels connect salt marshes with sub- and inter-tidal basins and the ocean, and function as conduits of energy (Zedler 2001). Although usually associated with lagoons and low gradient streams, tidewater gobies have been documented in ponded freshwater habitats as far as 8 km (5 mi) upstream in Santa Barbara County (USFS 2001; Irwin and Soltz 1984). These aquatic areas provide several pockets of slow-moving water that the goby utilize during the winter to avoid flood flows.

3.1.3.2 Hydrologic Factors

3.1.3.2.1 Flow Regime

Hydrologic regime[18] drives the geomorphic development and functioning of lagoons and estuaries (Zedler 2001). Only lagoons and estuaries that retain a hydrologic cycle that emulates historic patterns of seasonal building and breaching of river mouth sand barriers provide the requisite habitat elements listed above. Activities such as water diversion or impoundment, groundwater pumping, artificial lagoon breaching, or any other activity that alters water quality or quantity may affect the suitability of a lagoon for breeding (USFWS 2000). Equally important is the dynamic physical environment, which determines the distribution and composition of the biotic communities (vegetation and food sources) that characterize estuaries that support tidewater goby (Ferren et al. 1995).

The pattern of water occurrence within lagoon and estuary systems varies in frequency, duration, depth, scouring action, and seasonal timing of water occurrence. These factors are important determinants affecting lagoon systems (Cylinder et al. 1995). Only lagoons and estuaries that retain a hydrologic cycle that emulates historic patterns of seasonal buildup and breaching of river mouth sand barriers provide the requisite elements for goby habitat. Suitable breeding, foraging, and refuge areas for the tidewater goby are confined to subtidal and some intertidal regions of these coastal systems.

Considerable daily and seasonal fluctuations in the hydrologic regime occur within tidewater goby habitat. Winter rains and the subsequent increase in stream flows often result in transient conversion of estuaries into freshwater systems (USFWS 1996). Flooding plays an important role in maintaining the brackish to fresh waters characteristic of shallow lagoons and lower streams. Salinity levels found in the upper reaches of suitable tidewater goby habitat are controlled by freshwater runoff from the watershed. Likewise, the lower reaches of suitable goby habitat are occasionally diluted by freshwater runoff from the watershed. Salinity within estuarine habitat may be periodically increased above that of the open ocean by evaporation (Ferren et al. 1995).

Flow rates responsible for the distributions of fish and invertebrates are typically slow-moving or fairly still, but not stagnant (Zedler 2001; Irwin and Soltz 1984). Tidewater gobies avoid strong currents, preferring subtidal, backwater areas that provide refugia.

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[18] *The pattern of occurrence of water in a wetland that varies in its frequency, duration, depth, scouring action, and seasonal timing (Cylinder et al. 1995).*

3.1.3.2.2 Periodic Flooding

Winter rains and subsequent flooding wash out lagoon waters. Optimally, winter flows that breach sand barriers need to occur annually between December and April. This annual flooding promotes several weeks of tidal flushing before the sandbar again blocks the marine and estuarine connection. Initial high flows scour the lagoon bottom to levels below the accumulated fine silt material, thereby exposing suitable breeding substrate. Gradually declining flows allow considerable amounts of coarse sand and sediment to be evenly distributed on the lagoon bottom.

3.1.3.2.3 Shallow Pools

Shallow, backwater pools associated with marsh habitats offer juvenile and adult refuge. These areas are associated with intertidal brackish lagoons and coastal saltmarsh habitats that are hydrologically affected on a seasonal basis. Shallow pools that retain water are particularly important during drought years to sustain goby populations that become isolated as a result of evaporation.

3.1.3.3 Water Temperature

Suitable water temperatures for the tidewater goby ranges from 18 to 22 C (64 to 72 F) (Moyle et al. 1995). These temperatures are influenced by the proximity to the equator, solar radiation, coastal fog, and salinity. Lagoon waters are often several degrees cooler than stream waters further upstream as a result of coastal fog. Temperature differences often create stratified water columns with the more saline waters occurring along the bottom of the lagoon. These lower-lying saline waters absorb heat during the summer and result in warmer bottom waters. This effect is particularly important during the summer when water temperatures may remain depressed from a few weeks to months, thus minimizing water column stratification and prolonging increases in salinity (USFWS 1996).

3.1.3.4 Water Quality Parameters

Tidewater gobies are restricted to low-salinity waters and within the Gobiidae family represent the species with the highest tolerance for brackish/freshwater systems. (Swift et al. 1989). Tidewater gobies are found at the upper end of lagoons in salinities less than 10 ppt during all life stages. Populations are usually centered on the fresh-saltwater interface. A balance of freshwater runoff, tidal flushing, and evaporation combine to create the proper salinity for these fish.

Salinity in lagoon systems depends on the amount of freshwater inflow that occurs during sandbar formation, which typically occurs from spring to late summer (USFWS 2000).

3.1.4 Summary

Species Profile

- *Study Area Distribution* — Does not occur within study area
- *San Juan Creek Watershed Distribution* — None
- *Western San Mateo Creek Watershed Distribution* — San Mateo Lagoon, San Mateo Creek
- *General Habitat:* — Estuary/Lagoon Systems
- *Breeding and Migration Seasons:* — Breeding in estuary only: late April-May to July (possibly Nov-Dec); males dig burrows (75 to 100 mm (3 to 4 in) deep) in clean coarse sand; migration - subadult/adult fish move upstream in summer
- *Habitat Requirements/Range:* — Range - estuary up to 2 km (1.2 mi) upstream (5 to 8 km (3 to 5 mi) documented)
- *Known Natural and Exotic Predators:* — Prickly sculpin, staghorn sculpin, starry flounder, steelhead, largemouth bass, yellowfin goby, sunfish, black bass, channel catfish
- *Substrate Type/Coarseness:* — Clean, coarse sand .5 mm (0.02 in) diameter; mud

Key Physical Habitat Components

Geomorphic

- *Underlying Geology/Terrain:* — Alluvial deposits
- *Channel Form/Geometry:* — Freshwater creek, brackish lagoon, coastal saltmarsh which support aquatic emergent vegetation; abandoned flood channels
- *Deposition or Erosion Areas:* — Winter flows needed to breech lagoon mouth
- *Frequency of Scour/Habitat Age-Stand Distribution:* — Annual

Hydrologic

- *Magnitude of Baseflow:* — 25 to 200 cm (10 to 78 in) depth (typically less than 1 m (3 ft)
- *Magnitude of 5-, 10-, or 25-Year Event:* — 50-year floodplain designated critical habitat
- *Salinity/Alkalinity:* — 0-42 ppt (typically 10 ppt; preferred range is 5 to 10 ppt); Reproduction 0 to 25 ppt

- *Temperature (Celsius):* 8 to 25 C (46 to 77 F); Reproduction 18 to 22 C (60 to 68 F)
- *Nutrients:* Dissolved oxygen – less than or equal to 1mg/L
- *Home Range and Movement:* Coastal brackish water/lagoon to 2 to 8 km (1.2 to 5 mi) upstream
- *Frequency of Episodic Events:* Annual breeching of lagoon mouths

3.2 SOUTHERN STEELHEAD

3.2.1 Regulatory Status

Petitioned for federal listing on February 9, 1994, the southern California steelhead Evolutionary Significant Unit (ESU) was listed as an endangered species under the Federal ESA by the National Marine Fisheries Service (NMFS) on August 18, 1997. Both geographic and genetic evidence led the NMFS to consider that southern California steelhead constituted a distinct ESU. This ESU occurs from Santa Barbara County south and is genetically and behaviorally distinct from the remaining steelhead stocks of the Pacific Northwest. The State of California does not have a listing for this species under the State Endangered Species Act, but it is designated as a California Species of Special Concern.

On March 17, 2000, the NMFS designated as critical habitat all river reaches and estuarine areas accessible to listed steelhead in coastal river basins from the Santa Maria River, San Luis Obispo County (inclusive) to the southern extent of the species range. Excluded from the proposed range were areas above man-made and longstanding natural barriers, which included Vaquero Dam, Bradbury Dam, Casitas Dam, Robles Dam, Santa Felicia Dam, Rindge Dam, as well as natural waterfalls in existence for at least several hundred years. On December 19, 2000, the NMFS proposed to extend the southern portion of the range of critical habitat to San Mateo Creek in San Diego County. On April 30, 2002, the U.S. District Court for the District of Columbia approved a NMFS consent decree withdrawing critical habitat designations for 19 salmon and steelhead populations on the West Coast, in response to litigation challenging the process by which this agency established critical habitat. Therefore, at this time there is no designated critical habitat for the southern steelhead.

3.2.2 Species Profile

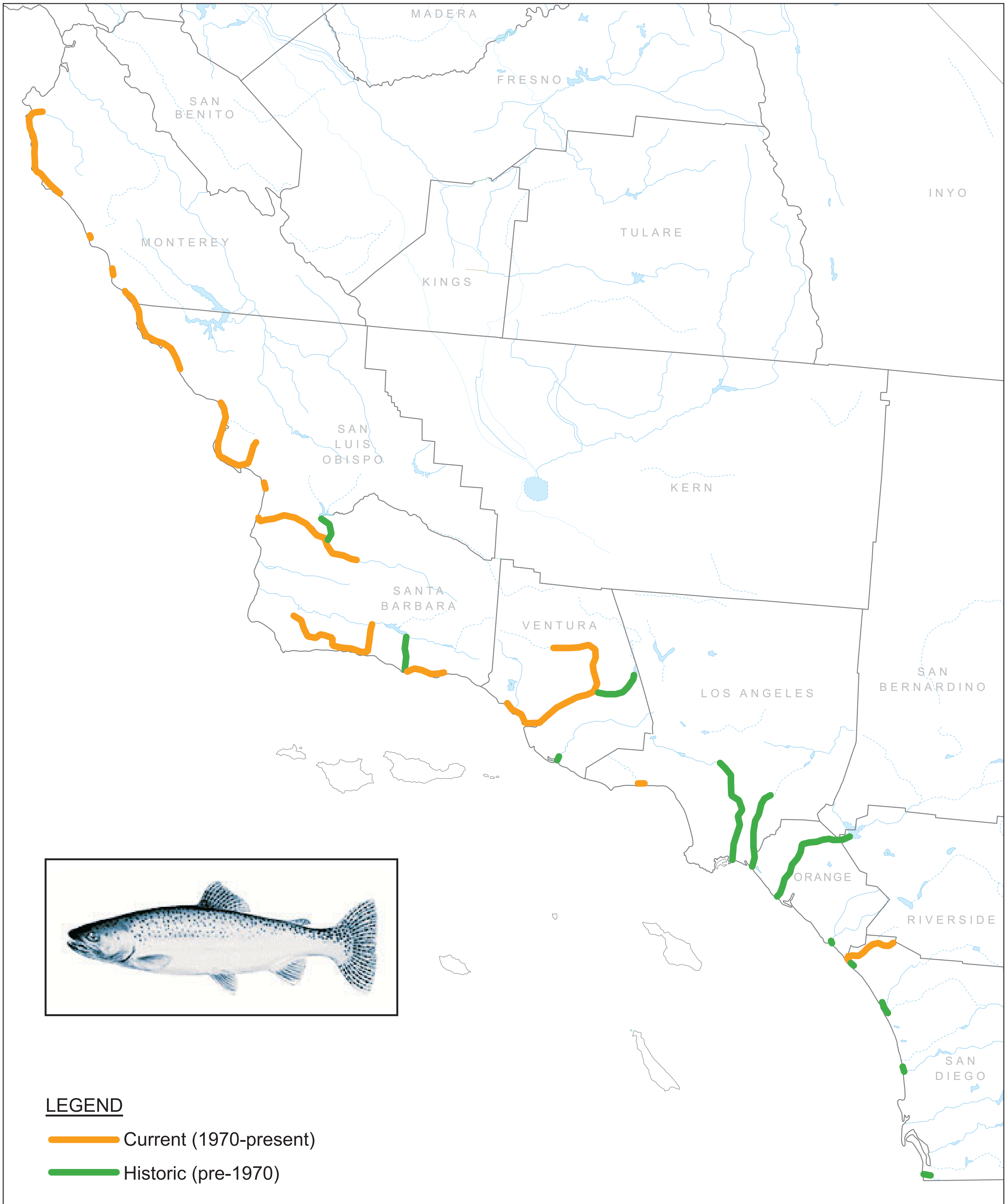
3.2.2.1 Description

The southern steelhead is a member of the Salmonidae family. This fish is named for their steel-blue coloring and are actually rainbow trout with a life cycle similar to that of a salmon. Southern steelhead are sea-run rainbow trout that have large mouths with well-developed teeth on both upper and lower jaws, the head and shaft of the vomer, the palatines and on the tongue. There are 10 to 12 dorsal fin rays, 8 to 12 anal fin rays, 9 to 10 pelvic fin rays, and 11 to 17 pectoral fin rays. The caudal fin is forked. Scales are small, with 18 to 35 rows above the lateral line and 14 to 29 below. In California the average length of steelhead after two years in the ocean is 59 cm (23 in) (Withler 1966, cited in Barnhart 1990). This species is an anadromous form of the rainbow trout, meaning that it is born and reared in freshwater streams; juveniles migrate to estuaries, where they adapt to saltwater and then migrate to the ocean where they mature into adults. Estuaries generally are rich in food sources which promote faster growth rates then freshwater environments. Southern steelhead feed on aquatic and terrestrial insects such as caddisflies, mayflies, stoneflies, and snails, in addition to other fish (Shapovalov and Taft 1954). In the ocean, steelhead feed on a variety of organisms, specifically juvenile greenling, squids, and amphipods.

3.2.2.2 Species Distribution

Historically, steelhead ranged from northern Baja California to the Bering Sea and Japan. Steelhead evidently once utilized most of the major coastal streams in southern California, but have been extirpated from at least 10 southern California streams. The current range of the southern steelhead includes coastal drainages extending from Santa Ynez River south to the Santa Margarita River as shown in Figure 26, *Southern Steelhead Historical and Current Distribution*, on page 88. The elevational range extends from sea level to 1,372 m (4,500 ft) above mean sea level. Formerly widespread in southern and central California, the self-sustaining populations of the southern steelhead are limited to Malibu Creek, Ventura River, Sespe and Santa Clara creeks in the Santa Clara drainage, and the Santa Ynez River.

The combined, total population of steelhead within Malibu Creek, Ventura River, Sespe and Santa Clara creeks in the Santa Clara drainage, and the Santa Ynez River.was estimated to be less than 500 adult fish (Titus 1994). These populations of steelhead, that reside below long-term, natural and man-made impassable barriers, were listed in all five steelhead ESUs as either threatened or endangered (NMFS 1997). When the NMFS designated critical habitat for the southern steelhead ESU, only its current distribution was included as essential for recovery of the ESU. Areas excluded from the designation were historically-occupied areas above impassable dams and headwater areas above natural barriers (i.e., waterfalls). However, the vast majority of ancestral spawning and rearing habitat for the southern steelhead currently exists above these barriers. San Mateo Creek watershed historically supported steelhead runs from the creek mouth up to 13 km (8 mi) upstream. At one time, San Mateo Creek was an important steelhead producing stream to the extent that it supported significant local fisheries of both juveniles and adults (Hubbs 1946). Through the late 1940s, steelhead populations likely exceeded 10,000 individuals and adults as large as 9 kg (20 lbs) were observed. A February 2000 report prepared



Source: Southern California Academy of Sciences, 1993 and CDFG, 2000

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Figure 26
Southern Steelhead Historical and Current Distribution

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

by CDFG for NMFS entitled *Steelhead Rainbow Trout in San Mateo Creek, Can Diego County*, describes changes in habitat conditions since the 1940s as follows:

> There were fewer observations of juvenile steelhead/rainbow trout in San Mateo Creek after 1950. Trout sere found from the lagoon to the headwaters at Los Alamos Canyon during a Department survey on September 1,1979. Woelfel (1991) reported anecdotes of juvenile steelhead/rainbow trout presence in pools in the upper drainage during the early 1980's, and of a few steelhead adults . . . captured by a local resident in the lower creek in 1986. However, no juvenile steelhead/rainbow trout were found in San Mateo Creek by Woelfel during surveys in 1987 and 1988.
>
> The San Mateo Creek steelhead population was probably reduced periodically by natural episodes of sediment input from within the watershed. However, increased groundwater extraction in the lower creek area since themed-1940s is responsible, both directly and indirectly, for the inability of steelhead to use the system as they have historically (Lang et al. 1998). Riparian vegetation has been lost, stream channel width has increased, and surficial flow has been eliminated during most years. Thus, the migration corridor for immigrating adult steelhead and emigrating smolts has become very unreliable. Recent human-caused fires farther upstream resulted in large sediment inputs which filled in pools and the lagoon, both of which are important rearing habitats for juvenile steelhead. Fish faunal surveys in San Mateo Creek in 1995, 1996, and 1997 failed to find steelhead (Lang et al. 1998).
>
> Nehlsen et al. (1991) classified the San Mateo Creek steelhead population as extinct. Although we agree that conditions in the lower creek system, as described above, renders the stream conducive to anadromy on a less frequent basis than it was prior to extensive groundwater pumping and development, the Department recognizes the upstream spawning and rearing areas as functional for steelhead production, and that they are still used when sufficient flow allows passage of immigrating adults.

Cristianitos, Gabino, La Paz, and Talega creeks are the main tributaries within the western portion of the watershed that are within in the SAMP/MSAA and NCCP/HCP study areas. None of these creeks has historically or currently supports steelhead runs (Lang et al. 1998). Furthermore, sub-basins in the upper, western portion of San Mateo Creek, such as Gabino and La Paz, are underlain by bedrock formations that yield low amounts of baseflow. The dry nature of these sub-basins, combined with their steep slope (which promotes rapid runoff), makes it unlikely that they can retain flow late enough into the summer to support steelhead spawning.

The CDFG has performed some field work focused on the presence of native fish (including arroyo chub and three-spine stickleback) in the San Juan Creek watershed over the past two years. However, no southern steelhead individuals were found during these surveys.

The river mouth and lagoon are now channelized and the historic lagoon has been filled. Therefore, it is unlikely that southern steelhead populations could naturally establish themselves within the San Juan Creek watershed.

3.2.2.3 Occurrences Outside the Study Area

Southern steelhead occur within one drainage of the San Mateo Creek watershed located outside the study area as shown, Devil Canyon Creek, in Figure 27, *Southern Steelhead Distribution Outside the Study Area*, on page 91.

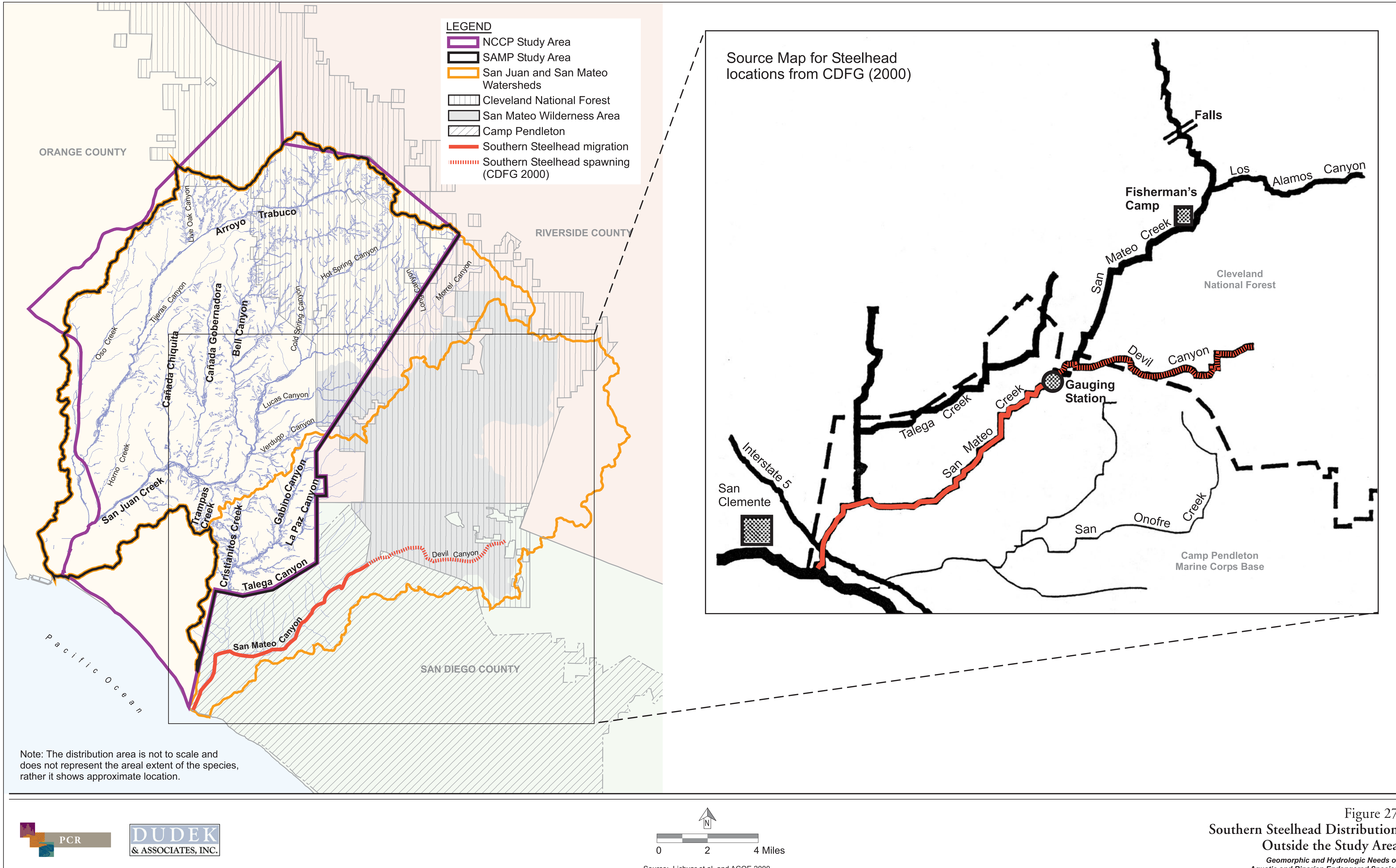
San Mateo Creek Watershed

San Mateo Creek: Lower San Mateo Creek (within MCB Camp Pendleton) contains runs, low gradient riffles, mid-channel pools, and lateral scour pools associated with bedrock throughout the drainage network (Lang et al. 1998). Suitable spawning and rearing habitat occurs on San Mateo Creek and in Devil Canyon located within the Cleveland National Forest (Lang et al. 1998), in an area with granitic bedrock that sustains springs and baseflows more effectively than other terrains in the San Mateo Creek watershed. Between March 3 and September 3, 1999, CDFG biologists observed 78 steelhead in San Mateo Creek. The majority of these observations occurred in the reach between the upper gauging station and the confluence with Devil Canyon Creek. Four steelhead were observed in San Mateo Creek above the confluence with Devil Canyon Creek, one of which was observed 4 km (2.5 mi) above the confluence. Four steelhead were observed in Devil Canyon Creek (CDFG 2000). CDFG did not conduct mark-and-recapture studies, so the precise population size cannot be estimated; however, it is believed to be quite low (CDFG 2000). The best habitat for steelhead is considered to be from the upper gauging station to a point approximately 4 km (2.5 mi) upstream, as this area typically contains numerous perennial pools connected by surficial flow (CDFG 2000).

3.2.2.4 Habitat

The habitat requirements of southern steelhead are similar to those of more northern steelhead stock. However, Higgins (1991) suspected that southern steelhead have greater physiological tolerances of warmer and more variable conditions commonly encountered in southern California streams.

1. Major streams in southern California originate in the coastal mountains and often cross broad alluvial areas before flowing into the sea. Low-elevation alluvial flats are characterized by intermittent, warm surface waters with fluctuating temperatures,



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Source: Lichvar et al. and ACOE 2000

Figure 27
Southern Steelhead Distribution Outside the Study Area

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

making them inhospitable as spawning areas for southern steelhead. Historically, these areas may have been important to steelhead for spawning and rearing in wet years when temperatures remained low late into the year. Today, only the higher-elevation headwaters that are characterized by perennial flow are the primary spawning and rearing areas for steelhead (Moyle et al. 1995). CDFG (2000) reported that the best habitat for steelhead is considered to be within the Cleveland National Forest from the upper San Mateo Creek gauging station to a point approximately 4 km (2.5 mi) upstream (there is no hydrologic connection between this area and the sub-basins within the study area).

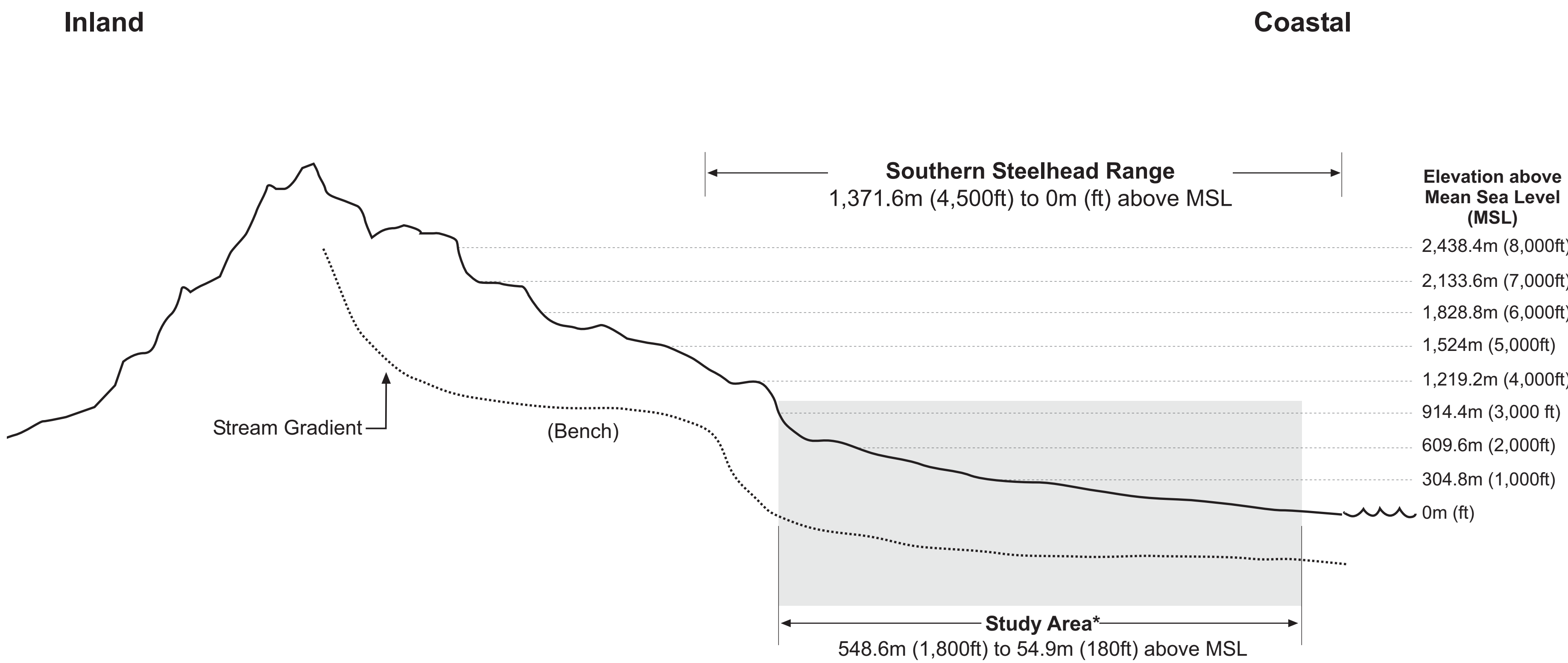
Many historic steelhead spawning areas have been degraded by excessive sedimentation from upstream agricultural runoff, surface water impoundments or diversions, or groundwater pumping that consequently increases infiltration and storage and leaves reaches of the streambed dry (Moyle et al. 1995). Individually, the production capability of small coastal streams such as San Mateo Creek may be relatively small compared to large, perennial river systems, but collectively they provide a means to ensure a greater diversity of subpopulations, and for range expansion and recovery after drought or other perturbations have reduced population numbers. Thus, utilization of these habitats increases the likelihood of the long-term persistence of the metapopulation and is even more critical now that habitat of many southern California streams has become severely impacted or eliminated due to water development and adverse land-use practices.

Southern steelhead typically migrate as two-year-old juveniles from freshwater to the ocean and then reside in marine waters from two to three years before returning to their natal, freshwater stream to spawn as four- to five-year-olds (NMFS 1997). This behavior of anadromy separates this species from the commonly occurring freshwater rainbow trout.

Figure 28, *Southern Steelhead Conceptual Habitat Profile*, on page 93, displays a conceptual profile of southern steelhead habitat.

3.2.2.4.1 Spawning Areas

Adult southern steelhead fish enter freshwater after winter storms breach sand bars allowing open access to coastal drainages. Migrating fish move up into perennial or seasonal stream reaches and seek out spawning areas in riffles or pool tails of higher-elevation headwaters (Carroll 1985; Moyle et al. 1985). Stream flow must be adequate to maintain oxygen levels of at least 5 parts per million (Bjornn and Reiser 1991) and temperatures between 3 and 20 C (37 and 68 F) (Bell 1986). Channel depths of no less than 25 cm (10 in) are necessary and channel dimensions where the ratio of width to depth is around 10 to 15:1 is thought to contribute to the best spawning conditions.



* Profile for study does not include the Cleveland National Forest.

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Source: Modified from Campbel et al., 1996 and Sweet, 1989

Figure 28
Southern Steelhead Conceptual Habitat Profile

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

Southern steelhead need cool, clean, well-oxygenated water flowing over poorly-sorted gravel filled pools to breed. Spawning habitat is found in stream segments with a low (0 to 1 percent) gradient. Breeding areas commonly occur in deep holding pools typically greater than 30 cm (11.7 in) at the top of a riffle or downstream edge of a pool where velocity is high. These pools often have some form of cover (rock ledge or bubble curtains) and contain 0.64 to 13.0 mm (0.02 to 0.5 in) sized gravel particles that comprise greater than 30 percent of the substrate (Phillips et al. 1975). Riffle and pool complexes such as these are present in Devils Canyon Creek, but not within Gabino, La Paz, upper Cristianitos or Talega Creeks. Fine sediments should make up less than 10 percent of the substrate (Olsson and Persson 1988). Female steelhead locate appropriate nest egg sites and uses their tail to clear out a depression in the gravel, called a redd.

3.2.2.4.2 Natal and Juvenile Refugia Areas

Juvenile steelhead require gravel-bottomed pools during their initial development for up to six weeks before emerging. Alevin/fry move into shallow, protected stream margins and begin to establish and defend feeding locations. Fry live in segregated schools primarily limited to the slow moving water typically less than 10 cm/s (Sheppard and Johnson 1985) along stream margins or side channels (FISRWG 1998). Juveniles move progressively further into riffles, then into runs and pools as their size increases.

Juvenile steelhead rely on estuaries during the latter portion of the rearing period. Estuaries are necessary to allow juvenile fish to acclimate to salinity changes before entering the ocean. In addition, during drought years many lowland stream areas that are perennial during typical rainfall years may completely dry out during the crucial developmental stage (Moyle et al. 1995). These brackish habitats provide a more permanent source of surface water for juveniles to emigrate to during seasonally low flows. Historically, large numbers of juvenile southern steelhead were often caught in coastal lagoons throughout the year (Swift et al. 1993).

Following the two to four years of juvenile development in freshwater, southern steelhead migrate to the ocean. Mature adults are known to stray from their natal streams and may opportunistically utilize more favorable streams when their natal streams have dried up or are blocked by sand berms (Higgins 1991). This behavioral adaptation promotes the success of the species, particularly in times of drought.

3.2.2.4.3 Foraging Areas

Foraging areas occur throughout occupied southern steelhead stream reaches and are characterized by low gradient stream reaches that range from 0 to 4 percent. Newly hatched fish (alevin and fry) utilize and defend shallow, protected stream margins for feeding (Shapolav and

Taft 1954). Adult southern steelhead spend one to three years foraging in the nutrient-rich ocean waters where numerous food sources are available to them. Generally, adults reach up to 9 kg (20 lbs) before returning to their natal streams.

3.2.2.5 Life Cycle/Natural History

Rainfall in southern California is substantially lower and more variable than the northern portion of the State. As a result, migration and life history patterns of southern California steelhead ESU probably are more closely tied to climatic fluctuations and resultant stream flow than northern populations (NMFS 1997).

Ocean, estuarine, and riverine ecosystems are all important during different stages of the southern steelhead's life. Steelhead eggs incubate in redds, or nesting gravels, for 1.5 to 4 months depending on the water temperature. The larval fish hatch as alevins and depend on food stored in a yolk sac. Following yolk sac absorption, young juveniles, or fry emerge from gravel beds and begin actively feeding (NMFS 1997). Juveniles usually rear in freshwater from one to four years, but have been found rearing in freshwater for up to seven years, and then emigrate to the ocean as smolts (NMFS 1997). The smolts emigrate to estuaries in spring, adjust to saltwater, and then move on to the ocean. They then reside in marine waters typically from two to three years while they mature prior to returning to their natal stream to spawn as four- and five-year-olds (NMFS 1997).

Adults immigrate to natal streams for spawning, which typically begins in January and continues through early June, with peak spawning occurring from February through March. Unlike salmon, southern steelhead are capable of spawning more than once and may make the spawning journey several times during their life. However, it is rare for steelhead to spawn more than twice before dying (NMFS 1997). Two classes of southern steelhead are often used to describe their reproductive state based on their sexual maturity at the time of river entry and the duration of their spawning migration: stream maturing and ocean maturing (NMFS 1997). Stream maturing steelhead are sexually immature when they enter freshwater and require several months to mature before spawning while ocean maturing steelhead contain well-developed gonads and spawn shortly after river entry (NMFS 1997). These two reproductive ecotypes are more commonly referred to by their season of freshwater entry (e.g., summer and winter steelhead) (NMFS 1997). Southern steelhead are winter-run ecotypes that persist in streams that have warm, dry lower reaches on the coastal plain (Moyle et al. 1995). River entry ranges from early November through June, with peaks in January and February.

The life cycle of southern steelhead continues in the upstream, freshwater rearing habitat where spawning adults deposit and fertilize their eggs within the gravel-bottomed streambeds during the winter months. Female steelhead dig nests within the streambed and then deposit from 500 to 3,100 eggs (USFWS 1984). Following fertilization by the male, the female covers the nest with a layer of gravel. Embryos incubate within the nests and hatching time varies from three weeks to two months depending on water temperature. The young alevin emerge from the gravel pocket approximately two to six weeks after hatching. Spawning cannot occur in the absence of cool, clear, gravel-bottomed streams, that retain water late into the season; conditions that do not occur in Gabino, LaPaz, upper Cristianitos, and Talega creeks. Following freshwater rearing in the headwaters, southern steelhead emigrate downstream from December through May to estuaries where they acclimate to salinity changes prior to entering the ocean (Moyle et al. 1995).

3.2.3 Key Physical Habitat Components

3.2.3.1 Geomorphic Factors

3.2.3.1.1 Lagoon System

Southern steelhead exhibit a diverse life history that encompasses several different aquatic habitats. Southern steelhead spend a majority of their adult lives in the ocean and can be found throughout the drainage network of coastal watersheds, from lagoons and estuaries within the lower reaches to the headwater systems within the higher-elevation reaches.

Key to steelhead occurrence within a watershed is a seasonally open estuary and a freshwater stream system with reaches that maintain perennial flow. As mentioned above, estuarine habitats support migrating steelhead, sometimes for extended periods of time. However, unlike the tidewater goby, steelhead are less dependent on the subtidal, backwater areas and more dependent on the lagoon or estuary mainstem, where they may reside for several years as they mature. The hydrologic regime is an important factor affecting the geomorphology of these systems, as only lagoons and estuaries that retain a hydrologic cycle that provide the requisite habitat elements listed above can support steelhead. In the case of lower San Mateo Creek, this hydrologic cycle has been adversely affected by groundwater extraction and diversion (CDFG 2000). Equally important is the dynamic physical environment, which determines the distribution and composition of the biotic communities that characterize estuaries that support southern steelhead (Ferren et al. 1995).

3.2.3.1.2 Riffle-pool Complexes

Steelhead spawning typically occurs in meandering channels with varying water depths, widths, and geomorphic features such as pools, riffles, and runs, as opposed to straight channels with consistent depth and width and no variation in habitat types. Riffle-pool complexes only occur along upper San Mateo Creek and Devils Canyon Creek and do not occur in the sub-basins within the study area. Furthermore, the sub-basins within the study do not drain to the portions of the watershed that contain riffle-pool complexes.

The vast majority of ancestral spawning and rearing habitat for the southern steelhead currently exists above natural and man-made impassable barriers. Inaccessibility to these areas due to impassable barriers is the primary reason for the decline of southern steelhead (Titus 1994). Furthermore, these barriers are the single greatest limiting factor for the natural recovery of southern steelhead (Finney and Edmondson 2001). Passage impediments and permanent barrier structures prohibit upstream fish passage and cut off the headwater system of coastal drainages where steelhead spawn and rear their young. In addition, water management activities often restrict steelhead spawning and rearing to lower elevation stream reaches where summer water temperature is often too high for juvenile rearing (Finney and Edmondson 2001).

The mainstems of major streams, such as San Mateo Creek, serve primarily as dispersal (i.e., immigration and emigration) corridors for steelhead during sufficient surface water flows. Portions of mainstem drainages that contain coarse, gravely substrates, low water temperature, riffle-pool complexes, and retain flows during the summer may also serve as suitable spawning and rearing habitat for juveniles. However, the middle and lower reaches of San Mateo Creek currently are dominated by finer-grained substrates. Consequently, these areas act primarily as migration routes and have not been documented to support spawning habitat. Figure 28 illustrates the portions of San Mateo watershed utilized for a spawning vs. those used solely for migration.

3.2.3.1.3 Gravel Substrate

The quality of steelhead habitat, particularly spawning habitat, is largely determined by the stream substrates. Southern steelhead construct redds in riffle areas where gravel (from 0.64 to 13.0 mm (0.02 to 0.5 in)), and sometimes small cobble, are the primary substrate type (Lang et al. 1998). Females select redd locations at specific geomorphic features, which often occurs at the top of a riffle or downstream edge of a pool. In addition to having the appropriate size, granitic gravels must be relatively “clean”, or free of sedimentation (i.e., low embeddedness, with adequate interstitial space for egg incubation). Finer sediment and smaller sized materials generally clog redds and reduce water and oxygen permeability in the streambed. Streambed material larger than small cobbles (20 mm (0.8 in)) are too heavy to allow female steelhead to construct egg nests in the stream bottom.

3.2.3.1.4 Sand Barriers

Similar to the tidewater gobies, southern steelhead depend on seasonal breaching of river mouth sand barriers from December through April for adult migration to breeding areas and juvenile emigration. Breached sand barriers allow tidal flushing to occur that effectively results in the exchange of energy, sediments, nutrients, and populations of fish from freshwater to marine habitats. Closed lagoons are important to juvenile steelhead prior to emigration to the ocean and for foraging habitats because they provide calm, protected areas for development and foraging.

3.2.3.1.5 Adjacent Habitat/Riparian Corridor

Aquatic habitats that support southern steelhead are characterized by a diverse, riparian community that supports both instream and lower bank vegetation. Habitat features associated with these closed canopy communities include coarse woody debris, aquatic and emergent vegetation, root wads, undercut banks, boulders, and a dense riparian canopy that are crucial to juvenile and adult foraging. Such features protect fish from winter scouring, thermal extremes (sun exposure), and predation. Streamside riparian habitat is important in keeping water temperatures below the chronic lethal level of 23 C (73 F). The roots system of adjacent riparian zones stabilize the stream banks and fix nitrogen that support stream and terrestrial ecosystems. Riparian zones along lower and upper creek reaches support prey species that migrating and emigrating steelhead depend on, provides shade to the stream, stabilize banks, and provides organic litter and nutrients. Based on the health of these systems, they also function to store sediment, recycle nutrients and chemicals, mediate stream hydraulics, and control microclimates (USFWS 2000).

3.2.3.2 Hydrologic Factors

3.2.3.2.1 Flow Regime

Critical components of the flow regime that regulate steelhead habitat include the magnitude, frequency, duration, timing, and rate of change of hydrogeologic conditions (Poff et al. 1997). Stream flow quantity and timing are greatly influenced by region-wide climatic conditions. The variable climate of southern California imposes several selective pressures on steelhead populations because of their dependence on flow regime. The region's Mediterranean-type climate is influenced by distance from the coast, topography, and elevation. Most of the precipitation falls from November through March and is concentrated in a half dozen storms that may occur within a few months (Mooney and Parsons 1973; Goldman et al. 1986).

Particularly important for steelhead, this seasonal pattern of precipitation determines the quantity and quality of stream flows throughout the watershed, timing and duration of floods and low flows, presence of river mouth sand barriers, and flood water storage within lagoon and estuary systems. Because steelhead are anadromous, they utilize different portions of the watershed during specific times of the year.

Following juvenile development, steelhead require adequate flows during the winter to emigrate to the ocean. The timing and duration of surface water flows during this critical period must ensure that river mouth sand barriers are open and that proper mixing of estuary waters allows steelhead to acclimate to salinity changes. However, it is not uncommon for the lower reaches of southern California streams to be dry during portions of the year. Under such circumstances, steelhead may be restricted to perennial pools in the upper reaches of the watershed for several years until there is sufficient flow to allow passage to the lower reaches and the lagoon.[19] Excessive groundwater pumping in the lower stream reaches increases the duration that juvenile steelhead are precluded from emigrating due to lack of streamflow (CDFG 2000). CDFG (2000) recommended, as part of their assessment of steelhead habitat in San Mateo Creek, that a process be established to identify and implement habitat restoration for steelhead in San Mateo Creek. According to CDFG:

> *"For example, alternatives may include development of a base-wide water conservation program for Camp Pendleton to reduce or eliminate their groundwater pumping of the San Mateo Creek aquifer, and control of exotic fish populations throughout the watershed, including stock ponds located on private, in-holdings within the Cleveland National Forest."*

Surface flows responsible for stream and river mouth openings must occur for emigrating juveniles to the ocean during late spring and summer and immigrating adults from January through June. If winter flows are not powerful enough, sand berms may restrict movement of steelhead. In addition, low winter flows that extend the duration of sand berms across the river mouth, may prevent steelhead from accessing spawning areas.

When steelhead return to the mouth of their chosen spawning stream, they often utilize estuaries or brackish mixing zones to acclimate to the freshwater. When adequate flow conditions exist, often after a big rain, steelhead migrate upstream to suitable spawning grounds. The quantity and quality of surface water flows affects important water column parameters (dissolved oxygen, pH, temperature, and suspended solids) that determine juvenile and embryo survival. Water flows through the gravel-bottomed redds are needed to prevent fine sediment and sand from filling interstitial spaces between substrate particles and decreasing dissolved oxygen levels.

3.2.3.2.2 Shallow Pools

Young and maturing juvenile steelhead rely on pool habitats and often seek cover and cooler temperatures during the summer (Nielsen et al. 1994). Perennial groundwater-fed pools

[19] *Perennial pools do not exist within the sub-basins that are within the study area.*

may also provide over-summering habitat during dry years (CDFG 2000). Such pools do not occur in Gabino, La Paz, upper Cristianitos, or Talega creeks due to the steep slope and lack of groundwater-bearing bedrock in these sub-basins. Pools with abundant escape cover in the form of large woody debris, undercut banks, root masses, and large boulders are ideal. Water depths in these pools range from 0.3 to 1.8 m (1 to 6 ft).

3.2.3.2.3 Water Temperature

Streams that have fast flowing waters with an adjacent riparian canopy generally have lower water temperatures. High water temperature can delay upstream migration of adults and timing of spawning, and downstream emigration of juveniles to the ocean. However, southern steelhead are able to utilize coastal rivers that have relative higher temperatures than those to the north. Water temperatures utilized by southern steelhead range from 16 to 23 C (61 to 73 F) (Lang et al. 1998).

3.2.3.2.4 Water Quality Parameters

Low dissolved oxygen and high turbidity can delay or halt upstream migration of adults and timing of spawning, and downstream emigration of juveniles to the ocean. Dissolved oxygen concentration, turbidity, and pH are the key water column parameters affecting survival of incubating embryos. Steelhead prefer vegetation cover and have been observed in areas of dense overhanging willows or dense algal mats (Lang et al. 1998).

3.2.4 Summary

Species Profile

• *Study Area Distribution*	Does not occur within study area
• *San Juan Creek Watershed Distribution*	None
• *Western San Mateo Creek Watershed Distribution*	San Mateo Creek, Devil Canyon Creek
• *General Habitat:*	Estuary/freshwater streams
• *Breeding and Migration Seasons:*	Peak spawning from mid-February to mid-March. Smolts emigrate during higher flows (December to May)

Key Physical Habitat Components

Geomorphic

• *Substrate Type/Coarseness:*	0.64 to 13.0 mm (0.02 to 0.5 in) gravel

Hydrologic

- *Channel Form/Geometry:* Juveniles need shallow protected stream margins
- *Magnitude of Baseflow:* Need winter rains to flush juveniles out to sea and sustained baseflow to support bedrock pools
- *Frequency of Channel-Forming Events:* Adults need channels free of barriers for migration
- *Suspended Sediment Load:* Adults need access to gravel areas free of heavy sedimentation with adequate flow and cool, clear water

4.0 KEY PHYSICAL PROCESSES

Each of the species addressed in this report requires a specific suite of physical habitat components that may vary spatially and temporally both within and outside the study area. Habitat components important for each species found within the study area and outside the study area are summarized in Chapters 2 and 3, respectively. Key physical processes must all occur and interact to provide requisite habitat for the target endangered species. However, to help provide an understanding of each process and its effect on physical habitat structure we have summarized the processes independently.

The structure of all streams is fundamentally shaped by the nature of flow and the amount and composition of sediment being delivered, conveyed and stored in the stream. Consequently, the key physical processes responsible for the creation, development, and maintenance of the crucial habitat components for riparian and aquatic-dependent endangered species can be categorized into geomorphic and hydrologic processes. Table 4 on page 103 provides a summary of these major physical habitat components organized into geomorphic and hydrologic categories and relates each feature to the life stage-specific environs for each species. Table 5 on page 105 illustrates the relationships between major habitat components the key physical process responsible for their development and persistence. The balance of this chapter provides additional discussion of the relationship between each major process and the physical habitat for each species addressed by this report.

Understanding the link between physical processes and habitat components is critical to realizing the intended applications of this report, which were discussed in Section 1. In the context of reserve design and adaptive management, understanding processes such as sediment yield and transport and infiltration/runoff is essential to the ability to ensure long-term integrity of riparian habitats. For example, ensuring appropriate delivery of coarse sediment (as opposed to fine sediment) through the stream systems will minimize potential direct habitat loss associated with channel incision, and indirect degradation of downstream resources associated with increased turbidity. From a restoration planning perspective, processes such as runoff patterns and groundwater recharge/discharge will dictate the viability of proposed stream restoration. For example, the ability to manage infiltration and runoff patterns will partially determine the level of surface and subsurface hydrology that can be used to support expanded riparian zones. Similarly, runoff and groundwater discharge patterns will influence the extent of downstream habitat by affecting the magnitude and duration of flow, ponding, and lagoon breaching. Accordingly, this chapter will focus on processes within the planning study area that could potentially affect the habitat of species addressed in this report.

Table 4

RELATIONSHIP BETWEEN PHYSICAL HABITAT COMPONENTS AND VARIOUS LIFE STAGES OF ENDANGERED SPECIES

	HABITAT FOR VARIOUS LIFE STAGES															
	Tidewater Goby				**S. Steelhead**				**Arroyo Toad**				**LBV/SWWF**			
PHYSICAL HABITAT COMPONENTS	**Spawning Areas**	**Natal Areas**	**Juvenile Refugia**	**Foraging Areas**	**Spawning Areas**	**Natal Areas**	**Juvenile Refugia**	**Foraging Areas**	**Breeding Areas**	**Natal Areas**	**Juvenile Refugia**	**Foraging Areas**	**Breeding Areas**	**Natal Areas**	**Juvenile Refugia**	**Foraging Areas**
Geomorphic																
Stream Network (down-valley contiguity, integration of hillslope flow, tributary connections)					X	X	X	X			X	X				
Valley Features (floodplain & terrace depositional environments)												X				X
Channel Geometry (width/depth related to discharge, benches)					X	X				X	X		X	X	X	
Channel Sediment Properties (substrate size and composition, sand bed, gravel bed, cobble)	X	X			X	X			X	X	X					
Macrotopographic Complexity & Discrete Roughness (large wood, rocks, scour holes)		X	X			X	X	X		X	X					
Hydrologic																
Sub-basin physiography (shape, size, slope, soil type)					X	X	X	X	X	X			X	X	X	X
Major Structural Changes in Response to episodic events & Wet-dry cycles (including post-fire scenarios)	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X

Table 4 (Continued)

RELATIONSHIP BETWEEN PHYSICAL HABITAT COMPONENTS AND VARIOUS LIFE STAGES OF ENDANGERED SPECIES

	HABITAT FOR VARIOUS LIFE STAGES															
	Tidewater Goby				**S. Steelhead**				**Arroyo Toad**				**LBV/SWWF**			
PHYSICAL HABITAT COMPONENTS	**Spawning Areas**	**Natal Areas**	**Juvenile Refugia**	**Foraging Areas**	**Spawning Areas**	**Natal Areas**	**Juvenile Refugia**	**Foraging Areas**	**Breeding Areas**	**Natal Areas**	**Juvenile Refugia**	**Foraging Areas**	**Breeding Areas**	**Natal Areas**	**Juvenile Refugia**	**Foraging Areas**
Moderate Structural Changes in Response to low-moderate Flow Events (annual peak flows, channel forming flows)	X	X	X	X	X	X			X	X	X		X	X	X	
Dry-season flow (baseflow, mid-watershed springs, released imported flows)	X	X	X	X	X	X	X	X	X	X	X		X	X		
Sub-surface water/moisture (hyporheic zones, groundwater)				X				X	X	X			X	X		
Water Chemistry (salinity, pollutants, turbidity, temperature, suspended sediments)	X	X	X	X	X	X	X	X	X	X	X					

Table 5

RELATIONSHIP BETWEEN PHYSICAL HABITAT COMPONENTS AND KEY PHYSICAL PROCESSES

	KEY PHYSICAL PROCESSES						
	Geomorphic				Hydrologic		
PHYSICAL HABITAT COMPONENTS	**Hillslope Sediment Yield (erosion, rilling, sheetwash)**	**Mass Movement and Debris Flow**	**In-Channel Sediment Transport (bedload, suspended load, scour, bank erosion)**	**Sediment Storage (short-term, in-channel, long-term, floodplain)**	**Infiltration (including interflow)**	**Runoff (sheetflow, tributary flow, channel flow)**	**Discharge from springs, seeps, or shallow aquifers**
Geomorphic							
Stream Network (down-valley contiguity, integration of hillslope flow, tributary connections)		X		X	X	X	
Valley Features (floodplain & terrace depositional environments)		X		X		X	
Channel Geometry (width/depth related to discharge, benches)	X		X	X		X	
Channel Sediment Properties (substrate size and composition, sand bed, gravel bed, cobble)	X	X	X	X			
Macrotopographic Complexity & Discrete Roughness (large wood, rocks, scour holes)		X				X	
Hydrologic							
Sub-basin physiography (shape, size, slope, soil type)	X	X		X	X	X	
Major Structural Changes in Response to episodic events & Wet-dry cycles (including post-fire scenarios)		X		X		X	
Moderate Structural Changes in Response to low-moderate Flow Events (annual peak flows, channel forming flows)	X		X	X	X	X	X
Dry-season flow (baseflow, mid-watershed springs, released imported flows)					X	X	X
Sub-surface water/moisture (hyporheic zones, groundwater)					X		X
Water Chemistry (salinity, pollutants, turbidity, temperature, suspended sediments)	X		X			X	X

4.1 GEOMORPHIC PROCESSES

The geomorphic processes that shape creek channels, floodplains, and terraces can be roughly divided into processes that yield sediment (i.e., hillslope processes and mass movements), transport sediment within channels (i.e., bed load, suspended load, short-term scour and fill), and store sediment (i.e., long and short term storage on bars, floodplains, and terraces). (FISRWG 1998). In this section, the terms floodplain and terrace are used in their geomorphic context as defined below (Leopold et al. 1964).

> floodplain = strip of relatively smooth land bordering a stream that is overflowed at times of high water. Floodplains may include benches at different elevations that roughly correspond to various magnitude of discharges.
>
> terrace = remnants former valley floors, that now stand above (in elevation) active stream channels and their floodplains (i.e., abandoned floodplains).

Each geomorphic process is described below and related to the relevant physical habitat components for each species.

4.1.1 Hillslope Sediment Yield

Hillslope sediment yield consists of the processes of sheetwash, rilling, and gullying, which are responsible for producing much of sediment that is delivered to a stream on an average annual basis (i.e., excluding large episodic events). Once the infiltration capacity in a contributing catchment is exceeded,[20] water flows downhill, typically eroding and transporting sediment with it. Minor irregularities in the surface of hillslopes (either natural or human induced) can cause flow to coalesce. This localized concentration of flow increases shear stress and can result in rilling (i.e., tiny incisions or channels in the hillslope). As rills deepen and coalesce, they form gullies, which over time can supply significant amounts of sediment to the receiving watercourses.

Hillslope sediment yield contributes sediment supply to streams, which in turn affects the geometry of the channel and the substrate properties in the stream. The nature and volume of the sediment generated from the contributing watershed as well as the ability for this sediment to be transported to the stream, influences whether streams have a sand bed, gravel bed, or cobble bed. This in turn influences the suitability of streams for particular aquatic species. The geology, soils, vegetation, and land use in the upland watershed also affects the chemical, nutrient, or

[20] *Infiltration capacity is a product of the soil type, slope, vegetative cover, and antecedent moisture.*

pollutant loads that are delivered to streams along with hillslope sediment yield. Figure 29, *Sediment Sources and Key Transport Areas*, on page 108, illustrates the major sources of coarse and fine sediment in the study area, as well as streams that provide major sediment transport functions.

Sediment contributions from the hillslopes vary strongly throughout coastal drainages in central and southern California with the time since the last fire, flood, or other episodic events (Wells 1982). The same storm may yield 20 times as much sediment from the slopes after a fire preceded by many decades without one (Hecht 1984). Re-burns of areas recently burnt may be expected to produce intermediate yields. Storms of different intensities and durations – even if assigned the same 'recurrence' – may yield sharply different volumes of sediment from the slopes.[21] Debris flows and landslides are examples of variable sediment yields that can occur during a given event or period within a single watershed.

Species Found Both Within and Outside the Study Area

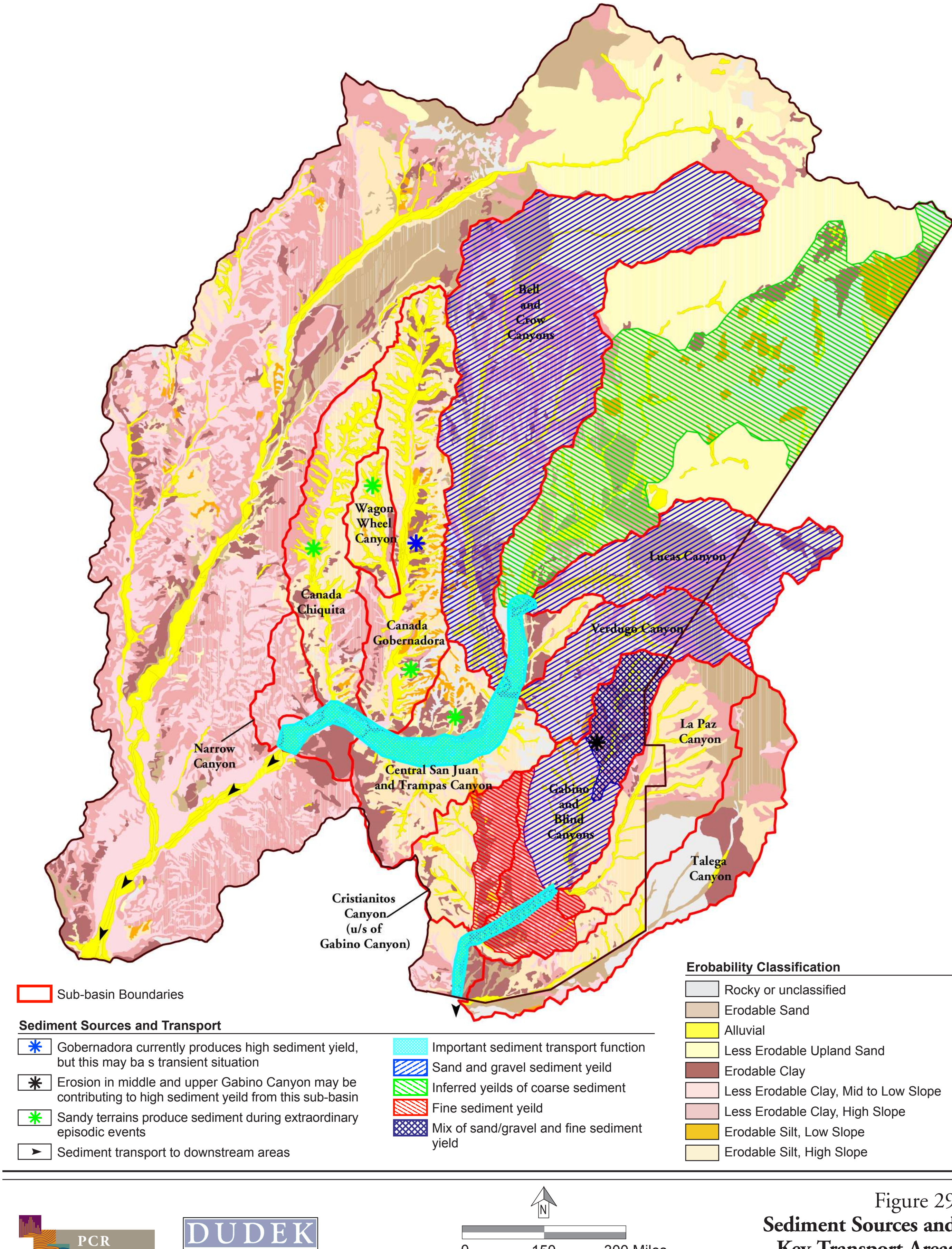
4.1.1.1 Arroyo Toad Implications

Stream and terrace habitats where arroyo toads breed, forage, and burrow are predominately sandy or loamy sand. Consequently catchments with sandy terrains are more likely to yield material of appropriate texture to support arroyo toad. In contrast catchments that yield silts and clays are less likely to support arroyo toad populations, because eggs are sensitive to being buried or asphyxiated with silt (Balance and PWA 2000) and larvae are sensitive to increased siltation from fine sediments that can bury their food supply (Jennings and Haynes 1994).

4.1.1.2 Least Bell's Vireo and Southwestern Willow Flycatcher Implications

This process does not play a direct role in formation of habitat for these species as long as suitable riparian habitat in the channel is maintained. However, hillslope sediment yield may affect habitat for vireo and flycatcher by contributing to channel incision or avulsion. These processes are discussed in more detail in Section 4.1.3.2.

[21] *The SAMP area provides graphic examples of these differences. The 1938 storm caused massive gullying and low-order channel incision throughout the areas with sandy soils, while other areas were not seriously affected by this intense, brief event (c.f., PCR et al. 2002). In contrast, the California Division of Mines and Geology's basic geologic maps (Morton 1970; 1974), prepared shortly after the 1969 storms, show widespread slope and colluvial slope failures and gully formation following these long-duration storms with protracted wet conditions, while the sandy soils were essentially unaffected.*



Source: PCR Services Corporation 2002 and Balance Hydrologics, Inc., 2000

PCR

DUDEK & ASSOCIATES, INC.

Figure 29
Sediment Sources and Key Transport Areas

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

Species Found Only Outside the Study Area

4.1.1.3 Tidewater Goby Implications

The habitats utilized by tidewater gobies include shallow, sand-bottomed lagoons; mud and gravel-bottomed brackish creeks; and muddy, backwater pools. Consequently, tidewater goby rely on delivery of both coarse (sands, gravels) and fine-grained substrates to the coast. Watersheds that support tidewater goby contain sufficient sources of both coarse and fine sediments and an intact stream network that allows coarser materials to be deposited in lagoons and a relatively unobstructed ability for excessive fine sediments to be transported to the coast.

4.1.1.4 Southern Steelhead Implications

Streambed habitats utilized by southern steelhead ideally have a mixture of coarse-grained substrates including sand, gravel, cobble, boulders, and bedrock. Generally, gravel in pool tail-outs surrounded or buried by fine sediments is a preferred spawning location for salmonids (Lang et al. 1998). The mix of sediments required by southern steelhead for spawning and migration results from a combination of topography and underlying geology. For example, the geologic source material in the San Mateo Creek watershed, such as the Schultz Ranch Member of the Williams formation, produces poorly sorted sediments, that are rich in clay, silt, and boulders, as it erodes. Steep gradient watersheds are able to convey flows of sufficient velocity to wash away the fine-grained sediment and transport the coarser substrate to lower gradient portions of the creek where riffle and pool sequences that define steelhead habitat can form. As this material continues to be transported downstream it forms substrates that are conducive to steelhead migration. In contrast, excessive generation of fine-grained material may bury coarser sediments and decrease the suitability of downstream migration habitat.

Similar to the tidewater goby, southern steelhead rely on delivery of both coarse (sands, gravels) and limited fine-grained substrates being delivered to the coast to support lagoon habitats. Lagoons that support steelhead receive both coarse and fine sediments from their contributing watershed through an intact stream network that allows sediment to be delivered and deposited in the lagoons.

4.1.2 Mass Movement and Debris Flow

In many geologic settings in southern Orange County, the majority of total sediment delivered to a stream corridor over an extended period of time can enter as mass movements, such as slides, flows, heaves, dry ravel, or creep, often associated with episodic events such as large wildfires or major floods (Hecht 1993). In particular, floods that follow shortly after fires often result in substantial mass movement and debris flow (Hecht 1984). In central and southern

California, up to 98 percent of the amount of sediment moved in any single decade is often mobilized during one or two intense flow events (Knudsen et al. 1992).

Mass movements have the capacity to dramatically alter the form of channels, floodplains, and terraces. Debris flows often contain large rocks or trees that form jams, scour holes, pools, and bars that can divert flow and entrain sediment, thereby providing habitat for species such as southern steelhead and arroyo toad. Large volumes of sediment and debris produced during mass movements can dam rivers and facilitate channel migration and sediment deposition, resulting in abandoned floodplains and formation of new terraces. More typically, mass movements may impinge streamflow, resulting in localized erosion or downcutting. In many cases, it may take decades (or longer) for streams to cut through sediments deposited during mass movement, during which time the deposited mass of sediment and debris acts as a source of sediment to downstream areas. In this manner, these events may affect the geomorphology of the aquatic ecosystem for extended periods of time.

Species Found Both Within and Outside the Study Area

4.1.2.1 Arroyo Toad Implications

Mass movements and debris flows deliver large wood, boulders and other coarse material to the stream, that may form log-jams, backwater pools, scour holes, and other macrotopographic features that may provide breeding areas for the arroyo toad. Mass movements can also result in the formation of new floodplain and terrace features that serve as foraging and aestivation habitat. For example, Ramirez (2002) observed arroyo toads utilizing sandy substrates in association with large debris piles (e.g., 0.3 to 0.6 m (1 to 2 ft) thick) within the floodplain of San Juan Creek for aestivation. In contrast, decreases in the interval between successive mass movement events may result in perpetual scour of open bars that are important for juvenile foraging and refugia, thereby reducing habitat suitability for arroyo toad.

4.1.2.2 Least Bell's Vireo and Southwestern Willow Flycatcher Implications

Long-term sustainability of riparian habitats suitable for least Bell's vireos and southwestern willow flycatcher depends on episodic geomorphic disturbance and subsequent recovery (Balance and PWA 2000). Episodic disturbances capable of this type of landscape-scale disturbance include regionally significant storms (generally of the 10-year flood magnitude), upland fires, large landslides, and other natural causes. Curtailment of episodic floods or disturbances may result in the senescence of riparian communities or encourage invasion by non-native plant species. Furthermore, alteration in volumes and rates of flow and sediment transport have been shown to result in a decrease in the total area of riparian vegetation due to either increased scour, exposure of depositional bars, or excessive deposition (Dominick and O'Neill 1998).

For the least Bell's vireo, scouring flows should be sufficient enough to inhibit development of dense riparian growth, and promote early successional riparian habitats. Habitat requirements for the southwestern willow flycatcher are generally the same as those for the least Bell's vireo, but the southwestern willow flycatcher tends to breed in more mature riparian communities that are closer to open water. Therefore, channel forming factors that scour to a lesser degree and frequency actually increase habitat suitability for the flycatcher.

Debris flows and mass movements often result in debris jams, terrace deposits, or other obstructions, which trap sediment and form areas that are somewhat sheltered from the effects of storm flows. Riparian vegetation that grows in these areas can provide habitat for vireo and flycatcher in the decade(s) following large scouring flows. This habitat may be particularly important because large flows often remove most of the riparian vegetation on mid-channel bars and overbank benches typically used by the vireo and flycatcher.

Species Found Only Outside the Study Area

4.1.2.3 Tidewater Goby Implications

Large episodic events may result in delivery of sands, gravels, and debris to lagoon areas, which can alter refugia habitat for the gobies and, under extreme circumstances, may wash gobies out to sea. Following large storms in 1998, tidewater goby were extirpated from the San Mateo lagoon. However, by 2000, tidewater goby were again present in San Mateo lagoon. According to a 2000 Coastal Commission report, a "goby reintroduction plan was developed that includes nonnative predatory species removal, relocation of approximately 500 gobies from San Onofre Lagoon to San Mateo Creek lagoon, success criteria, remedial measures and a 5-year monitoring program" (North Coast Transit District Application No. 6-98-69). We have been unable to verify whether the reappearance of goby in San Mateo lagoon resulted from reintroduction by North Coast Transit District (as was recommended by the CCC) or by natural recolonization from adjoining areas. The implications of changes in episodic flows to lagoon habitats are discussed in more detail in Section 4.2.2.3.

4.1.2.4 Southern Steelhead Implications

Mass movements play a critical role in developing physical features that provide shelter for southern steelhead, including deep pools, boulders, and surfaces for growth of streamside vegetation. However, the frequency of mass movements should be such that succession of riparian communities along channels can maintain bank stability, recruitment of large woody debris, and canopy that ensures stream temperatures suitable for proper functioning of all life stages of steelhead (NMFS 1997). Natural episodes of debris flow and mass sediment input historically reduced the viability of steelhead migration habitat in certain years. However, increases in the magnitude and frequency of large sediment inputs due to human-caused fires in the upper watershed have filled pools and the lagoon. As a result, in combination with other factors previously noted, the steelhead migration corridor has become very unreliable (CDFG 2000).

4.1.3 In-Channel Sediment Transport

Once sediment is delivered to a channel via hillslope yield or mass movement, it may move downstream as bed load or suspended load. Bed load transport is the movement of coarser sediments along the channel substrate under shear force, most of which typically occurs in pulses during large storm events (Patten 2000). Suspended load is the movement of particles (which may be finer grained) within the water column, typically during higher flow events. In addition to bed load and suspended load (or "wash load") generated from slope areas, a substantial amount of the total sediment load in a system may be generated from within the channel due to either channel incision or lateral channel migration. Mobilization of sediments stored in-channel or within the floodplain can be caused by increases in stream discharge, decreases in sediment supply, or a combination of the two. Circumstances that mobilize stored sediment may be caused by land use practices that alter flow or sediment delivery to streams by natural responses to episodic events (i.e., erosion of material deposited during an episodic event or debris flow), or by ongoing adjustment to geologic changes in the valley planform.

In-channel sediment transport processes affect channel geometry and bedform. The erosion and movement of sediment within a channel can result in changes in the channel width and depth, and affect the structure of floodplain benches (Leopold et al. 1992). In turn, the size and elevation of the channel bed and the adjacent benches can affect the type of habitat that persists. For example, the height of a sand bar may dictate whether it supports herbaceous marsh habitats that provide habitat for juvenile arroyo toad versus mid-succesional riparian scrub that supports habitat for least Bell's vireo. In addition, sediment transport can influence the texture of the streambed (i.e., whether sands, gravels, or cobbles predominate), and bedform features such as ripples, scours, or hummocks.

Species Found Both Within and Outside the Study Area

4.1.3.1 Arroyo Toad Implications

In-channel scouring and sediment transport is important for creation of bars and benches that provide key components of arroyo toad habitat. A stream must be large enough for channel scouring to create pools, open bars required by juvenile toads, and benches, but small enough to prevent loss of habitat structure following flood events (Sweet 1992). In contrast, excessive scour may deepen pools making them unsuitable for arroyo toad breeding and may facilitate invasion by non-native predators, such as bullfrogs. Alternatively, the lack of scouring action on riparian vegetation can also be detrimental by creating dense plant communities. Dense, heavily shaded pools are unsuitable for larvae and juvenile toads because of lower water and soil temperatures and poor algal mat development (Sweet 1992).[22] Therefore, there must be an appropriate balance of the frequency and intensity of scour events, in the context of natural climatic variations.

Bank erosion from slopes at the riparian/upland ecotone also plays a role in creation of suitable natal and juvenile habitat. However, erosion from adjacent sandy terraces and flats must not be so severe as to compromise the stability of adjacent upland areas and thereby degrade suitable adult foraging habitat. Likewise, sediment yields as a result of bank incision should not be so excessive that breeding and larval pools are buried, especially from February through August when toads are breeding.

4.1.3.2 Least Bell's Vireo and Southwestern Willow Flycatcher Implications

Sediment transport processes are important for maintenance of floodplain benches that support habitat for vireo and flycatcher (as discussed in Section 4.1.2.2). Severe decreases in sediment yield or transport may result in scouring of riparian vegetation and channel entrenchment. Increases in channel width to depth ratios (resulting from channel entrenchment) can decrease the frequency of overbank flooding, resulting in less seed dispersal; thereby precluding the establishment or maintenance of riparian habitat (DeBano and Schmidt 1990). Finally, scour induced channel entrenchment may result in phreatic[23] draining and desiccation of streamside riparian habitat, thereby reducing the extent of foraging and refuge habitat.

Species Found Only Outside the Study Area

4.1.3.3 Tidewater Goby Implications

Sediment delivery to the lower reaches of coastal drainages and estuarine habitats is an important process for breeding gobies. Tidewater gobies in southern and central California breed primarily in sand and mud substrates and avoid areas that contain large amounts of decaying

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[22] *Although dense plant communities immediately adjacent to the active channel are detrimental to larval development, thick vegetation types including arroyo willow and mule fat scrub are consistently utilized for aestivation.*

[23] *Phreatic movement of water refers to the shallow subsurface movement of water along a hydrologic gradient.*

vegetation (USFWS 1994). Successful breeding appears to require transport of sufficient amounts of both coarse and fine sediment to the coast in advance of the breeding period (April to May). However, excessively high levels of delivery of fine sediments could substantially alter reproductive behavior and result in mortality of eggs and/or juveniles by burying spawning areas or facilitating conversion of refugia to herbaceous marshes.

4.1.3.4 Southern Steelhead Implications

Steelhead migration corridors and lagoon habitats require a somewhat continuous supply of sediments transported from the upper watershed. Disruption of sediment transport processes may result in scour that increases turbidity and destabilizes streamside vegetation. Loss of streamside riparian vegetation results in increased water temperature (due to lack of shading) and channel widening (associated decrease in depth and velocity of flow), which may reduce the ability of a stream to support steelhead migration. Finally, excessive sediment delivery to lagoons may bury rearing habitat. In the case of San Mateo lagoon, increased sediment delivery (mainly associated with upstream human-caused fires) has resulted in excessive sedimentation that has made the migration corridor unreliable (CDFG 2000).

4.1.4 Sediment Storage

Sediment storage is one of the fundamental processes that affects the structure of stream channels and adjacent terraces. Sediment storage occurs following large flow events that mobilize sediment from either upland catchments or upstream valley storage. Storage occurs in areas where stream competence decreases and sediment can be deposited as either long-term or short-term storage. Short-term storage typically occurs either within the channel in the form of bars, hummocks, or levees, or on floodplains. Longer-term storage occurs on the upper margins of the floodplain and on stream terraces. Sediment storage processes influence the complexity of a stream channel and the valley morphology over time. Geomorphic surfaces on the floodplain and terraces that form as a result of sediment deposition and storage, often support various seral stages of riparian habitat. Following subsequent high flows, this habitat is scoured, and redistributed as sediment storage patterns change; thereby contributing to the overall habitat complexity of a stream reach.

Species Found Both Within and Outside the Study Area

4.1.4.1 Arroyo Toad Implications

Both short- and long-term sediment storage areas provide habitat for various life stages of arroyo toads. Accumulated bed load storage reduces the channel gradient and leads to a meandering stream channel that encourages lateral erosion and redistribution of its alluvium into well-sorted pools, channel bars and floodplain deposits (Sweet 1992). Sandy pools provide ideal substrates for depositing clutches and contribute to survivorship of larvae due to their cryptic coloration, while bars provide important foraging habitat for newly metamorphosed toads and refugia for juveniles (Campbell et al. 1996). Sand bars are also extensively utilized for adult male toads (within or adjacent to suitable breeding pools or side channels) to elicit advertisement calls. Sandy sediments that are ultimately deposited and stored on benches, on the margin of floodplains, and on terraces provide aestivation and foraging areas for adult toads.

4.1.4.2 Least Bell's Vireo and Southwestern Willow Flycatcher Implications

Long-term sediment storage forms floodplain benches and valley terraces that provide surfaces for the recruitment and survival of riparian plant species that are an important part of suitable vireo and flycatcher habitat. These channel benches and flood terraces must be high enough to be protected from frequent scour by high flows, yet low enough to avoid desiccation during low rainfall years (Shafroth et al. 1998).[24] In addition, germination of many riparian species relies upon deposition of "clean sediments" at an elevation on the floodplain terrace where the rate of decline of shallow alluvial groundwater (following annual storm flows) is conducive to riparian seedling establishment (Segelquist et al. 1993). Therefore, sediment storage areas provide important surfaces for propagation of least Bell's vireo and southwestern willow flycatcher habitat.

Species Found Only Outside the Study Area

4.1.4.3 Tidewater Goby Implications

This process does not play a major role in formation of habitat for this species. Sediment stored within channels, floodplains, and terraces may ultimately be delivered to lagoons over the course of years (or decades). However, habitat for the tidewater goby depends more on annual or episodic delivery of sediment to the lagoon in association with hydrologic processes than on sediment storage.

4.1.4.4 Southern Steelhead Implications

Sediment storage on lower stream terraces provides areas for energy dissipation of flood flows, which facilitates channel migration and maintenance of riffle pool sequences. In addition, sediment stored in floodplain benches often supports riparian habitat that provides canopy cover,

[24] *The preferred elevation of bars and benches (relative to the stream) may vary between vireo and flycatcher.*

source materials, nutrient input (e.g., carbon) to the streambed community within the channel, and provide hyporheic zones[25] that help maintain late season flow.

Sediment storage within in-channel and adjacent riparian zones is important for sustaining appropriate surface water levels for adult and juvenile migrations. Reductions in upstream storage capacity may produce accelerated water flow downstream during winter storms that may damage or destroy riffle-pool complexes, wash egg nests to undesirable locations, and degrade stream reaches used for migration.

4.2 HYDROLOGIC PROCESSES

The magnitudes, frequencies, and patterns of surface flow through uplands and within stream channels are among of the deterministic factors of the integrity and distribution of riparian habitat (PCR et al. 2002). The hydrologic processes that shape the physical habitat structure of the target endangered species can be summarized as infiltration processes (including interflow), runoff processes (i.e., sheetflow, tributary flow, and channel flow), and subsurface discharge from aquifers, springs, and seeps. Each of these hydrologic processes is described below and related to the relevant physical habitat components for each species.

4.2.1 Infiltration

The infiltration rate, or the amount of water that enters the soil pores over a given length of time, is largely determined by rainfall intensity, substrate type, land cover, timing of inter-storm events and the antecedent moisture conditions (FISRWG 1998). As the soil's storage capacity fills, the infiltration rate decreases. If the rate of rainfall exceeds the infiltration capacity of the soil, the excess water either ponds on the surface or travels downslope as surface runoff. A portion of the water that infiltrates may reach a restrictive layer and move as interflow (or lateral subsurface flow), eventually discharging to the adjacent stream.

The USDA soil hydrologic soil group classification system can be used to represent the inherent infiltration rates and capacities of soils. In general, Type A soils are coarser textured sand and gravels and have high infiltration (and low runoff) rates. In contrast, Type D soils consist of finer grained, less permeable clays. Type B and C soils have infiltration rates between the extremes of Type A and D soils. Much of the SAMP/MSAA – NCCP/HCP study area is

[25] *Hyporheic zones can be broadly defined as connections between surface water and soil water that influence the biogeochemistry of riparian ecosystems by increasing solute contact with substrates; thereby affecting dissolved oxygen and pH (Bencala 2000).*

underlain by Type C and D soils, with higher infiltrating A and B soils found along alluvial corridors.

Infiltration rates are related to sub-basin physiography, such as slope and soil type, and in turn influence sub-surface moisture conditions, and dry-season flow in the riparian zones. Soil moisture that is partially dictated by infiltration rate is a deterministic factor in the ability of a stream reach to support wetland or riparian habitat that may be important for least Bell's vireo and southwestern willow flycatcher.

Species Found Both Within and Outside the Study Area

4.2.1.1 Arroyo Toad Implications

Infiltration and resultant soil moisture in floodplains and terraces may partially determine habitat suitability for various life stages of arroyo toad and may also serve as an environmental cue for movement or breeding. Juvenile toads require saturated substrates along the margins of breeding pools and central bars from June through November (USFWS 1994). Furthermore, refugia along bars, and sandy benches for dispersing metamorphs need to be moist enough to support emergent vegetation. Juveniles favor areas that remain damp and contain less than 10 percent cover, as these sites possess the thermal and refuge characteristics required for juvenile survival and rapid growth (Sweet 1992). Adults require less saturated conditions than juveniles; however, they excavate shallow burrows on terraces where they shelter during the day (USFWS 1994). During the non-breeding season, the location/distance where toads burrow relative to the stream may be dictated by soil moisture; and adults have been recorded burrowing to a depth of more than 100 cm (39 in) where soils are damp, friable, and suitable for aestivation (Ramirez 2002).

4.2.1.2 Least Bell's Vireo and Southwestern Willow Flycatcher Implications

Infiltration rates in floodplains and terraces contribute to the amount and duration of soil moisture that helps support riparian habitat which vireo and flycatcher rely on. Higher infiltration rates, and associated interflow, extend the duration of near stream soil moisture and reduce the likelihood of bank erosion (associated with high surface runoff); thereby increasing suitability for riparian habitat. Furthermore, riparian saplings are particularly influenced by subsurface water fluctuations near the active channel, with root extension being maximized where seasonal infiltration is followed by water table decline (as opposed to a static water table) (Segelquist et al. 1993). Seasonal infiltration can also facilitate development of understory species which provide an important component of vireo and flycatcher habitat.

Infiltrating water may also convey minerals, salts, or other compounds to the riparian or stream habitat. These minerals or salts, which can originate from either inherent soil properties or from land uses, can affect the plant community composition of the riparian zone. In cases where salts or pH are high, the growth and development of cottonwoods and some willow species may be limited.

Species Found Only Outside the Study Area

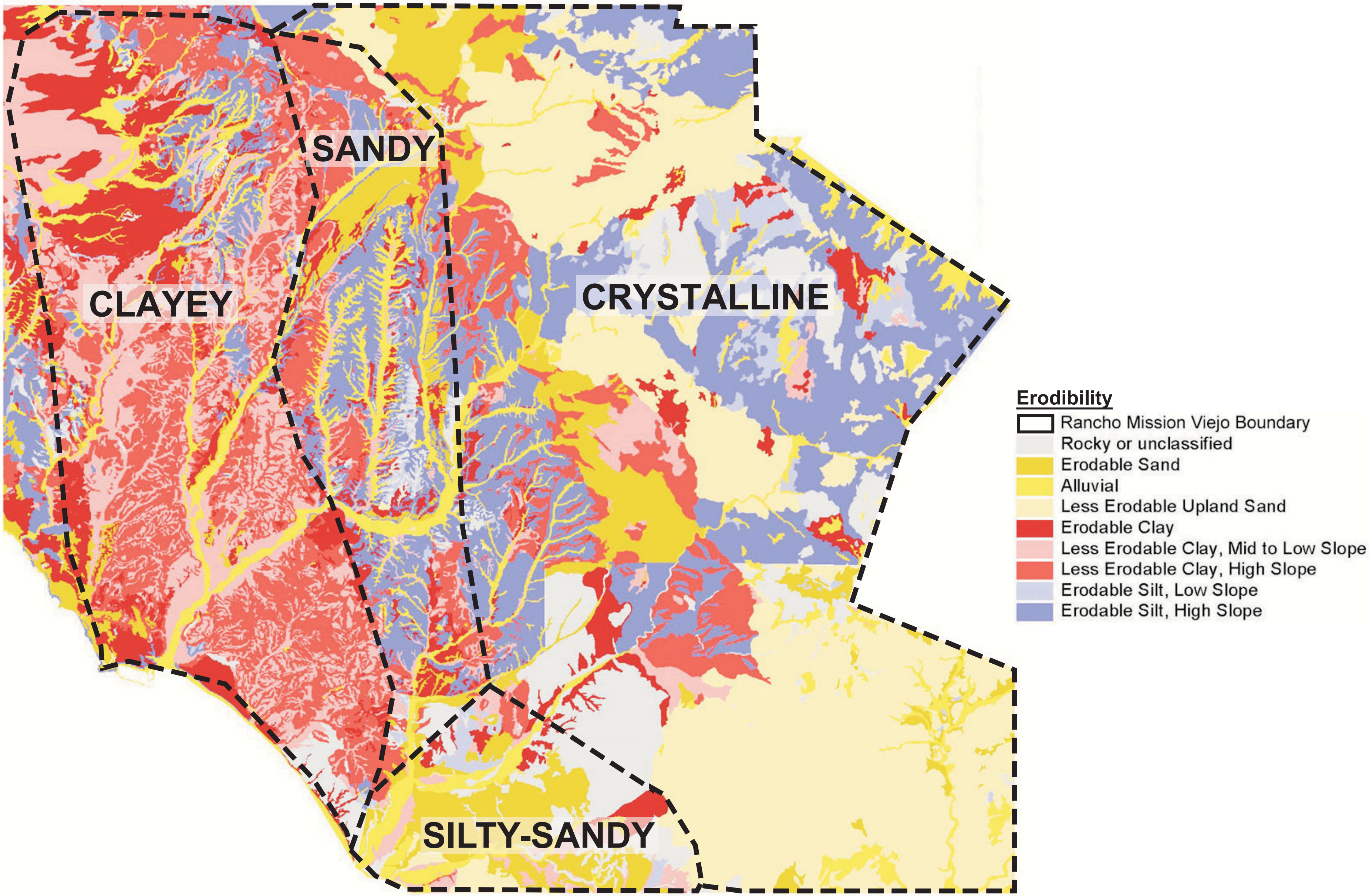
4.2.1.3 Tidewater Goby and Southern Steelhead Implications

Infiltration and runoff patterns occurring within and adjacent to riparian habitats directly affect the downstream hydrologic patterns of streams and coastal estuaries inhabited by southern steelhead and/or tidewater goby. Low-gradient slopes characterized by deep alluvial deposits and wide floodplains function as storage units for subsurface water. These areas have high infiltration rates and support flows longer after storm events. The prolonged flow is especially important to late season flow that may be important for steelhead smolt dispersal and for shallow backwater pools necessary for tidewater goby refuge that often dry up during the summer. Increased groundwater extraction from the lower portion of San Mateo Creek since the 1940s has resulted in decreased surficial flow, which has made the migration corridor for immigrating adult steelhead and emigrating smolts very unreliable (CDFG 2000). Groundwater extraction also alters the ability of lagoon systems to provide habitat for tidewater goby by decreasing dry season freshwater input (USFWS 1996).

4.2.2 Runoff

Once the infiltration capacity of soil is exceeded, additional water flows as runoff. Runoff can occur as overland sheetflow, tributary flow, or channelized flow. Similar to infiltration, runoff patterns are affected by basin size and slope, configuration of the drainage network, land cover, and the underlying terrain type. Within the SAMP/MSAA – NCCP/HCP study area, there are four general terrains; sandy and sandy-silty terrains that favor the infiltration of stormwater and produce proportionately less surface runoff; clayey terrains that are characterized by very high surface runoff rates, with little contribution to groundwater; and crystalline terrains that have high runoff rates during large storms and are typified by rock outcrops and other impervious surfaces, see Figure 30, *Geomorphic Terrains*, on page 119 (PCR et al. 2002).

Surface and channel runoff affects nearly all aspects of the physical habitat structure for the target endangered species. The size and shape of the stormflow hydrograph affects the channel geometry, bedload characteristics, sediment transport and storage properties, and water chemistry. Flood events (along with basin physiography) influence the channel form (e.g., well-



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Source: Balance Hydrologics, Inc., 2000

Figure 30
Geomorphic Terrains

defined single channel, meandering channel, braided system), which largely determines which species can persist in a specific stream reach or sub-basin.

Species Found Both Within and Outside the Study Area

4.2.2.1 Arroyo Toad Implications

Arroyo toads require persistent flow during the breeding season (March to July) and periodic scouring flows that maintain open sandy bars and benches. Base flow through the summer results from a combination of surface runoff and bedrock or spring derived groundwater discharge. Because runoff in the San Juan and San Mateo watersheds is typically short-lived and "flashy", the latter is likely the dominant source of late season flow (see Section 4.2.3).

Seasonal runoff to streams that support arroyo toad should be sufficient to support emergent marsh or sparse scrub vegetation along open stream bars. Changes in episodic flow conditions that encourage growth of dense in-stream riparian habitat may decrease suitability for arroyo toad. Increases in the magnitude or frequency of peak storm flow events, associated with runoff from urban sources may disrupt fluvial processes that create terrace pool habitats required by arroyo toads (Dudek 2000, Sweet 1992). High winter flows can affect arroyo toad habitat by causing potentially significant changes in depth, bank slope, pool bottom deposition, and can create or destroy central and marginal bars.

Episodic flooding is critical to maintenance of arroyo toad habitat by keeping the low bars and benches relatively vegetation free. This type of flooding functions to limit the amount of overhead vegetation, while allowing heat from the sun to keep pools from becoming cooler than the required hatching temperature of 12 to 16 C (54 to 61 F) (Balance and PWA 2000). Also, it has been hypothesized that some random downstream dispersal is caused by flood or large storm events (Dudek 2000).

Amphibians are generally sensitive to water chemistry and turbidity, especially during their natal and juvenile stages of development. However, little empirical data are available on the effect of water quality on arroyo toads. It is known that settling of excessive fine sediment from the water column can adversely affect suitable arroyo toad breeding habitat. During the winter, stream velocities through pools are needed to flush accumulated silt. During the summer, development of algal mats in quiet shallows appears to be important in reducing late larval and metamorphic mortality by providing areas of concealment from predators (Sweet 1992). By early to mid-May a film of algal and bacterial mats begins to form on the surface followed by strands of filamentous green algae (*Cladophora* sp.) that detach from the substrate (Sweet 1992). Extensive mats form by early to mid-July, dependent on water velocity, depth, and shading of water. Delayed development occurs when the water is over 0.3 m (1 ft) deep, or is shaded for more than a third of the day (Sweet 1992).

4.2.2.2 Least Bell's Vireo and Southwestern Willow Flycatcher Implications

The long-term sustainability of riparian habitats suitable for least Bell's vireo and southwestern willow flycatcher depends on both frequent runoff events and episodic geomorphic disturbance (Balance and PWA 2000). Early successional habitats, important for breeding, are created by small, frequent flooding within adjacent terraces and ideally contain a dense shrub layer at 0.6 to 3 m (2 to 10 ft) above the ground. Periodic overbank flooding facilitates development of riparian habitat by depositing sediments, dispersing seeds, re-hydrating floodplain soils, and flushing accumulations of salts.

Riparian vegetation within and along stream channels (willow woodlands and mule fat scrub stands) should experience the disturbance and subsequent recovery cycles typical of southern California streams. Scouring flows should be sufficient to inhibit development of dense riparian growth, and promote early successional riparian habitats. Without scouring flows, flooding and meandering, canopy forests would continue to mature and ultimately shade and reduce understory vegetation, which is important nesting habitat for the vireo and flycatcher. Droughts and overpumping of alluvial aquifers can create many of the same effects, without the benefits of re-sorting the gravels and removing fine sediments which may have entered the substrate over time.

Species Found Only Outside the Study Area

4.2.2.3 Tidewater Goby Implications

Tidewater gobies depend on cool, calm lagoons that undergo regular flushing and periods where the mouth is both open and closed. Winter runoff is necessary to breach lagoon mouths and scour the lagoon bottom of accumulated fine sediments and expose the coarse-grained sediments (0.5 mm, (0.02 in)) required for burrows. Runoff that is insufficient during the winter to scour bottom sediments and breach lagoon barriers adversely affects tidewater gobies by trapping the fish in the lagoons that eventually become stagnant, stratified, low in oxygen, and lack a clean source of sediments.

Infrequent extreme runoff events and associated river flooding have been reported to destroy tidewater goby burrows and physically wash the small fish out to sea (USFWS 1994). High flood events, such as those that occurred in 1995, flush gobies out to the ocean's littoral zone where they are dispersed by longshore currents to other estuaries generally to the south. Although devastating to local populations, these extreme wet years may contribute to recolonization of sites where goby have temporarily disappeared (USFWS 2000). However, increases in the magnitude and frequency of peak flow events due to reduced infiltration upstream, development influenced flow modifications, or stream channelization, as well as non-seasonal lagoon entrance openings, can result in frequent flushing of goby from the lagoon or subject the goby to osmotic shock. This could result in scouring of juvenile and adult refugia within lateral marshes to areas where they are not protected from high flows (USFWS 1994; Moyle et al. 1995). In contrast, reduction in the frequency of river mouth breaching due to upstream impoundments and/or flow attenuation may reduce the frequency or magnitude of flushing of fine sediments from lagoons. This may result in suitable breeding substrate being buried under excessive silt.

Freshwater runoff and stream flow is important to maintaining goby habitat because of its effect on lagoon salinity. Salinity conditions within lagoons used by goby are particularly important during the spring breeding season when the goby has a preferred salinity range of 5 to 10 ppt. Increased freshwater flows during the summer dry season may create a persistent condition of lower salinity in the lagoon which could negatively impact the tidewater goby. Excessive erosion in clayey terrains during the storm season could generate fine, silty sediments which effectively overlay the coarser sandy sediments and reduce available goby spawning habitat (Balance 2000). Alternatively, decreased flows due to upstream impoundments may affect the extent of downstream habitat and frequency of river mouth breaching, which is necessary to maintain structure of tidal channels and brackish conditions in the lagoon.

Although year-round tidal flow encourages uniformly saline water (unstratified) with high dissolved oxygen content and an abundance of nutrients typical of healthy coastal wetlands, continual flow during the summer may detrimentally affect tidewater gobies. Typically high runoff experienced only during the winter and early spring causes the sandbars at the mouths of lagoons to breach. Prolonged dry season flows that become powerful enough may prevent the formation of sandbars at the mouths of coastal drainages, thereby eliminating the sand deposits within the estuary channels necessary for breeding fish.

4.2.2.4 Southern Steelhead Implications

Runoff patterns influence the ability of a watershed to support steelhead by its effect on both stream and lagoon habitat. Runoff to streams can affect the physical structure of the stream (as discussed in Section 4.1.2.4 and 4.1.4.4), the nature of streamside habitat (which can influence water temperature and dissolved oxygen), and may convey sediments that may be beneficial or detrimental to spawning steelhead (see sections 4.1.1.4 and 4.1.3.4). The frequency and magnitude of peak flows should be such that streamside vegetation can persist, but does not get frequently scoured or eroded due to channel incision. This vegetation provides carbon to the stream and shades and cools the water. Although steelhead can withstand high water temperatures of 29 C (84 F) for a short time and 25 C (77 F) for longer periods, they have a progressively harder time extracting dissolved oxygen from water at temperatures above 21 C (70 F)[26] (Lang et al. 1998). Changes in baseflow may also affect concentrations of dissolved oxygen. Dissolved oxygen commonly decreases when flows decline below levels needed to sustain surface flows between pools. Decreases commonly occur during late summer and early fall days when decaying organic matter such as leaves or algal mats (important to arroyo toads) have accumulated in the slow-flowing water (Balance and PWA 2000). The combination of low surface flow and high oxygen demand (associated with decaying organic matter), can reduce dissolved oxygen levels below 4.2 mg/L, which is generally considered harmful to steelhead (Lang et al. 1998). Finally, runoff derived from upstream surface flow, water bearing geologic formations, and from coastal alluvial aquifers must persist late enough into the season to allow migration of smolt from the streams to the lagoon system. Upstream impoundments or groundwater pumping (as has occurred along lower San Mateo Creek since the 1940s) significantly impacts stream migration corridors for steelhead in lower San Mateo Creek. Like the tidewater goby, southern steelhead depend on winter flood flows to fill coastal lagoons until they breach the river mouth sandbars. These flows function to remove stagnant, oxygen- and nutrient-deficient water that contains concentrations of suspended silt, organic material, and chemical pollutants. The magnitude of flood flows sufficient to breach lagoon barriers required for adult migration to spawning runs and/or to flush juveniles to the ocean is estimated to occur at the 5-year recurrence interval for the San Mateo Creek watershed. However, unlike the tidewater goby, for steelhead the frequency of high flows sufficient to breach lagoons does not necessarily need to occur on an annual basis. Southern steelhead have developed an adaptive strategy for survival during drought years when access to spawning areas is prohibited. They will remain in the ocean and feed in the nutrient-rich waters. However, prolonged periods of insufficient flows capable of breaching lagoon mouths may prevent some adults from ever finding suitable spawning habitats and trap emigrating juveniles in the lagoons that eventually become stagnant, stratified, and low in dissolved oxygen.

4.2.3 Discharge from Springs, Seeps, and/or Aquifers.

In the semi-arid landscape of southern California, aquifers, springs and seeps play a substantial role in the persistence of dry season flows that are important for the support of riparian plant communities and geomorphic features such as shallow pools within and along drainages. Groundwater recharge to alluvial aquifers beneath the channels, floodplains, and valleys provides seasonal storage, which can be discharged to the riparian zones as baseflow or dry-season flow. Subsurface flow patterns are controlled by several factors, including the elevation and location of recharge and discharge areas, the nature of the underlying geologic materials, the thickness of the materials, and the configuration of the aquifer. As groundwater

[26] *Recent observations on Quiota and Hilton creeks, in the Santa Ynez watershed, indicate that steelhead can persist and grow in significantly warmer water, even in the absence of stratified pools. Revision of thermal criteria for southern steelhead is likely in the near future, based on these observations by NMFS staff.*

passes through the bedrock aquifers, it acquires chemical characteristics that are reflective of the geologic composition of the aquifer.

Resilient sources of groundwater include baseflow from the Santiago and Sespe formations, seeps and springs originating from the volcanic, metavolcanic, and granitic geologic formations found in the eastern (crystalline) portions of the San Mateo Creek watershed outside the study area, localized seeps and springs from large landslides, sandy swales, and areas where clay-rich marsh or lake deposits help bring shallow groundwater to the surface (Balance 2001). The distribution of seeps, springs, and geologic formations that yield substantial baseflow is shown in Figure 31, *Bedrock Derived Baseflow*, on page 125. Discharge of subsurface water may become more critical to the persistence of aquatic or riparian habitat that supports endangered species during extended dry periods.

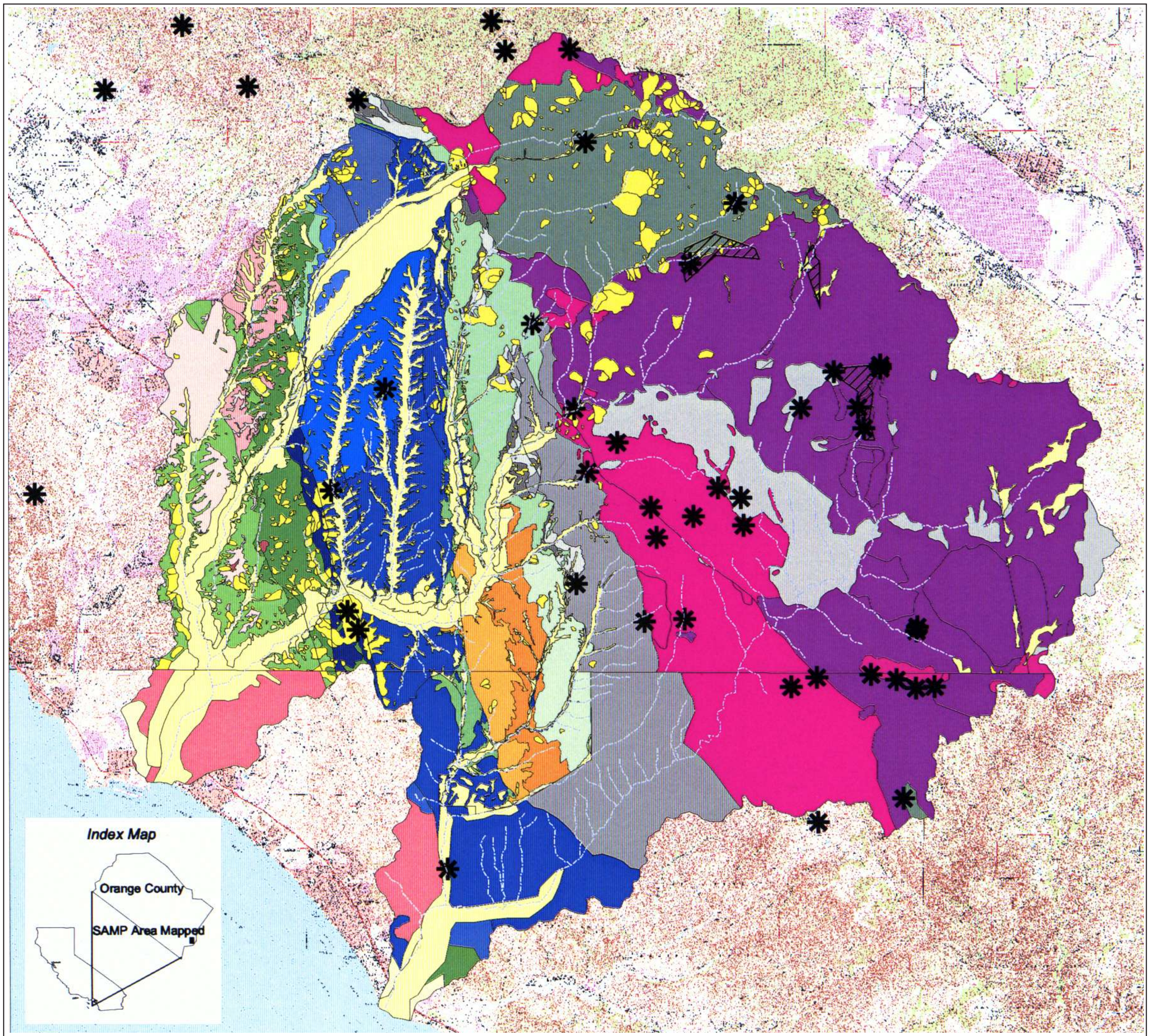
Species Found Both Within and Outside the Study Area

4.2.3.1 Arroyo Toad Implications

Groundwater discharge is an important factor in maintaining persistent summer flows that help support shallow pools within and along stream reaches. These pools are critical for arroyo toad breeding and early development. Discharge (i.e., combined surface and subsurface) should be sufficient to provide a base flow with a relative low velocity (e.g., less than 5 cm/s) through July, with surface stream flows that frequently pool or pond for at least a few months a year (Sweet 1992). Juvenile toads must shelter in holes in drying algal mats or available small damp refuges and depressions following cessation of summer flows (Jennings and Hayes 1994). However, substantial increases in discharge may result in drowning of emergent marsh vegetation used by juvenile as refugia or deepening of pools. Pool deepening has been associated with decreases in temperature or invasion by exotic predators, which interferes with successful toad breeding.

4.2.3.2 Least Bell's Vireo and Southwestern Willow Flycatcher Implications

Subsurface water levels in the alluvial aquifers along the individual channels are important in sustaining riparian woodland or mule fat scrub that is used as breeding habitat for vireo and flycatcher. Shallow subsurface water that supports riparian habitat may be derived from natural aquifer discharge, as occurs along Chiquita Creek and lower Gobernadora Creek. Shallow subsurface water levels that support riparian habitat may also be augmented by urban runoff that increases surface flow, infiltration, and subsequent discharge of shallow groundwater. This latter situation occurs in upper Gobernadora Creek and Arroyo Trabuco, where the riparian zone has expanded due to urban-derived flow.



Legend

Sem-consolidated sandstones yielding substantial baseflow
- San Onofre Breccia
- Santiago Formation
- Sespe Formation
- Vaqueros Formation
- Undifferentiated San Onofre Breccia, Topanga, and Monterey Formations
- Undifferentiated Sespe and Vaqueros Formations

Granitic Rocks
- Mixed granitic rocks generating substantial baseflow

Volcanic and metavolcanic rocks generating substantial baseflow
- Santiago Peak volcanics
- Elsinore Peak basalt and Santa Rosa basalt

Consolidated sandstones and other coarse-grained sediments yielding discernible baseflows
- Pleasant sandstone member of Williams Formation
- Schulz Ranch "sandstone" member of Williams Formation

Broadly-fractured sandstones and shales locally yielding baseflow
- Monterey Formation
- Siltstone facies of Capistrano Formation
- Topanga Formation

Fine grained consolidated sediments yielding little baseflow
- Bedford Canyon Formation
- Lower Schulz Ranch "siltstone" member of Williams Formation
- Silverado Formation
- Starr member of Williams Formation

Major unconsolidated deposits not likely to generate baseflows
- Niguel Formation
- Oso Sandstone member of Capistrano Formation
- Undifferentiated Capistrano Formation
- Undifferentiated Puente and Capistrano Formations

Metasediments of Trabuco and Ladd Formations
- Holtz Shale member of Ladd Formation
- Trabuco Formation
- Undifferentiated Williams, Ladd, and Trabuco Formations
- Undifferentiated metasedimentary
- Baker Canyon member of Ladd Formation

Other unconsolidated deposits locally yielding limited baseflows
- Marine Terrace Deposits
- Alluvium, colluvium, and non-marine terrace deposits
- La Vida member of Puente Formation
- Landslides

- Potreros (historic summer pasture)
- Major Watershed Creeks
- Springs

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N

0 2 4 Miles

Source: Balance Hydrologics, Inc., 2002

Figure 31
Bedrock Derived Baseflow

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

Seedling recruitment and establishment during the first year following germination also depends on the depth and drawdown rate of alluvial groundwater (Scott et al. 1993). This level, as well as fluctuations in groundwater levels is largely controlled by aquifer recharge/discharge and the contribution of springs and seeps. Excessive drawdown or dewatering may lead to mortality of riparian habitat used by vireo or flycatcher.

Subsurface water levels in alluvial aquifers also play a role in determining the overall width of the riparian zone and its ability to rejuvenate following large storm events. For example, following the 1938 storms, most of the riparian habitat on mid-channel bars and overbank terraces was completely washed away in Gabino, La Paz, Talega upper and middle Cristianitos creeks, as well in San Juan Creek from the confluences of Bell Creek to Trabuco Creek.[27] However, much of this habitat typically rejuvenates within 10 to 15 years, provided there is sufficient alluvial groundwater. Therefore, activities that alter alluvial groundwater levels, especially following large floods or fires, may affect the long-term ability of a stream to support vireo or flycatcher.

Species Found Only Outside the Study Area

4.2.3.3 Tidewater Goby Implications

Inflow to lagoon systems during the driest portion of the year is primarily groundwater upwelling. Decreases in available groundwater may result in desiccation of portions of the lagoon and a decrease in the total area available for foraging and refugia. Decreases in freshwater input may also result in the formation algal mats and associated decreases in dissolved oxygen. If coupled with artificial breaching of the mouth of the estuary, salinities may increase and result in osmotic shock to the fish. In the case of San Mateo Creek, the lagoon has been subject to varying degrees of degradation, including construction of railroad and highway bridges, military training, construction of roads and dikes, and water diversion, which have collectively led to a reduction from the historical size of the lagoon (USFWS 1998).

4.2.3.4 Southern Steelhead Implications

In southern California, extended streamflow condition depends on geologic formations that yield baseflow and/or contain a high density of springs, such as the volcanics, metavolcanics, and granitics found in the eastern portion of the San Mateo watershed (Figure 31). Extended streamflow sustains rearing habitat and pools that persist long enough for fry to

[27] *Based on Balance Hydrologics' review of aerial photographs flown shortly after the 1938 storms.*

develop, helps maintain dissolved oxygen concentrations between 5.0 and 7.7 mg/L,[28] and contributes to continuous flow that allows smolt to migrate to coastal lagoons. During dry years bedrock pools supported by seeps or springs provide over-summering habitat where juvenile steelhead can survive until winter rains create continuous flow conditions again (CDFG 2000). Reduced stream flow and lower water table may eliminate bank-stabilizing riparian vegetation that provides a stream canopy and pool-forming scour points (Lang et al. 1998). Late season discharge from aquifers, seeps, or springs is particularly important during drought years, where water tables are lowered by groundwater extraction, or where streamflow is diverted. For these reasons and, those noted previously, it does not appear that it is feasible to introduce steelhead into the creeks within the San Mateo watershed that are located within the planning study area.

[28] *Although steelhead can withstand dissolved oxygen less than 5.0 mg/L for short periods of time, optimal spawning conditions are around 7.7 mg/L. Dissolved oxygen concentrations of 4.24 mg/L and lower are generally considered harmful (Lang et al. 1998).*

5.0 SUMMARY OF KEY PHYSICAL PROCESSES IMPORTANT FOR EACH SPECIES

The life cycles of the listed riparian and aquatic species addressed in this report have adapted to accommodate the stochastic and episodic cycles of disturbance and rejuvenation that are typical of southern California. These life cycles are governed by hydrologic and geomorphic processes that create the physical habitat components for each species. The distribution of the species in the watersheds is, in turn, governed by the resultant habitat structures. Table 6 on page 129 provides a summary of the relationship between key physical processes and life stages for each species addressed in this report. Figure 32, *Sensitive Species Breeding/Spawning and Migration Periods*, on page 130, summarizes the breeding and migration periods for each species addressed by this report. Key physical processes important for each species are summarized below. In reviewing these processes, it is important to be cognizant of the distinction between how future actions may affect physical habitat components for species that occur within the study area versus those that only occur downstream of the study area. For species that occur within the study area, the NCCP/HCP and SAMP/MSAA must consider both direct and indirect effects on processes that support habitat. For the tidewater goby and southern steelhead, the NCCP/HCP and SAMP/MSAA must limit consideration of the effects of future actions within the study area to:

- Impacts of actions within the study area on downstream hydrology, water quality and sediment delivery; and

- Provision for biological connectivity for species located within both the downstream area and the southern Sub-region.

Finally, in some instances the needs of one species may not be wholly consistent with the needs of another. For example, southwestern willow flycatcher may require dense riparian habitat, while arroyo toad require open sandbars; or the persistent flow regime and perennial pools required by steelhead, may not be conducive to arroyo toad. In these instances, management priorities will need to be determined, based on a thorough understanding of the effects of land-use decisions on physical processes and habitat components.

5.1 SPECIES FOUND BOTH WITHIN AND OUTSIDE THE STUDY AREA

The arroyo toad, least Bell's vireo, and southwestern willow flycatcher occur within the SAMP/MSAA – NCCP/HCP study area. Consequently, the physical processes described below

Table 6

RELATIONSHIP BETWEEN KEY PHYSICAL PROCESSES AND HABITAT REQUIREMENTS FOR VARIOUS LIFE STAGES OF ENDANGERED SPECIES

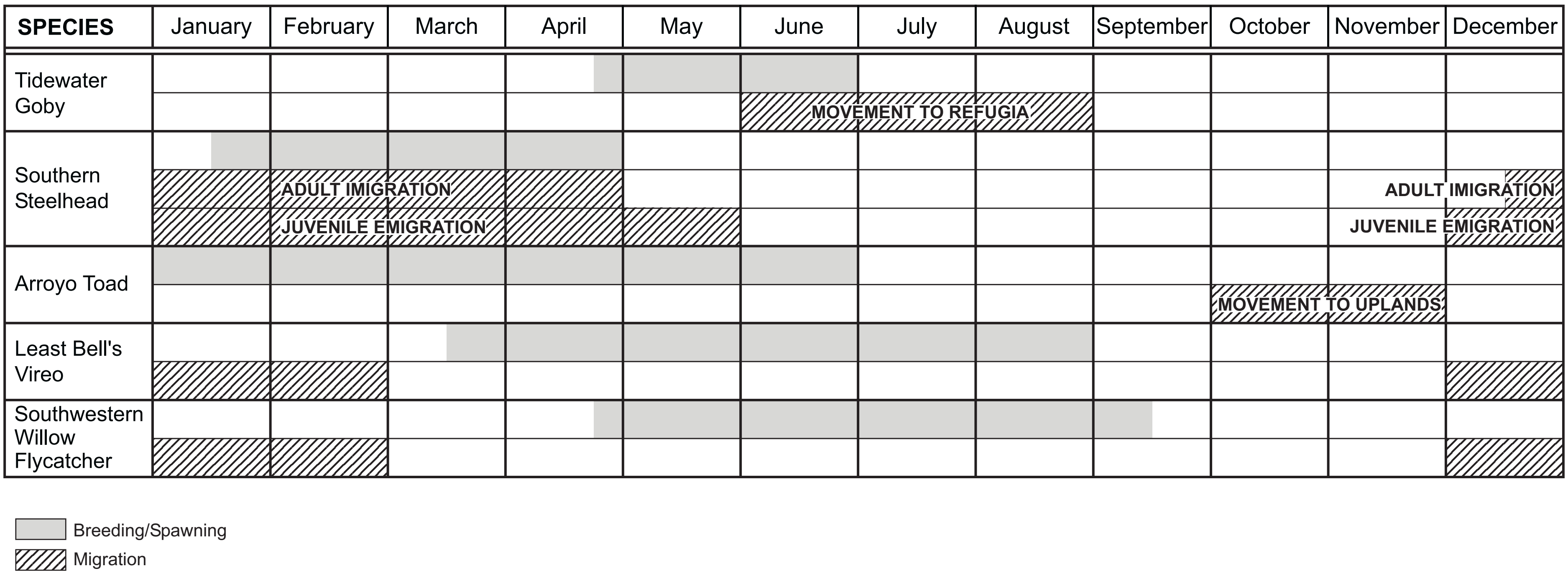
	KEY PHYSICAL PROCESSES						
	Geomorphic				*Hydrologic*		
	Hillslope Sediment Yield (erosion, rilling, sheetwash)	**Mass Movement and Debris Flow**	**In-Channel Sediment Transport** (bedload, suspended load, scour, bank erosion)	**Sediment Storage** (short-term, in-channel, long-term, floodplain)	**Infiltration** (including interflow)	**Runoff** (sheetflow, tributary flow, channel flow)	**Discharge from springs, seeps or shallow aquifers**
Arroyo Toad	all	all	b, n, j	n, j, f	j, f	b, n, j	b, n, j
LBV and SWF	----	b, n, j	b, n, j	all	all	b, n, j	all
Tidewater Goby	all	----	All	----	j, f	all	----
Steelhead	s, n	s, n	s, n, j	all	s, n, j	all	s, n, j

s spawning
b breeding
n natal
j juvenile
f adult foraging/aestivation

directly affect habitat within the study area and changes to these processes could potentially result in direct effects to the species (in either a positive or negative manner, depending on the change).

5.1.1 Arroyo Toad

- Sandy sediment produced in upland catchments and delivered to the streams provides the requisite substrate for breeding and foraging.
- Sandy sediments stored in lateral bars, benches, or terraces contribute to habitat used for foraging and aestivation.
- Aquifer recharge and associated subsurface discharge is an important factor in maintaining persistent summer flows that help support shallow pools and damp refuge areas within and along stream reaches.
- Infiltration and runoff patterns support streamside vegetation that stabilizes streambanks, shades the stream margins, and provides adult foraging and refuge areas.
- Seasonal runoff to streams that support arroyo toad often supports emergent marsh or sparse scrub vegetation along open stream bars.



Source: PCR Services Corporation, 2001

Figure 32
Sensitive Species
Breeding/Spawning and Migration Periods

Geomorphic and Hydrologic Needs of Aquatic and Riparian Endangered Species

- The infiltration capacity of floodplain soils provides soil moisture that is important for juvenile refugia and adult burrowing and aestivation.

- Periodic scouring flows and mass movements/debris flows are important for maintaining open/vegetation free sand/gravel bars and benches and providing macrotopographic features (e.g., log jams, scour holes) that serve as breeding and natal habitat.

5.1.2 Least Bell's Vireo and Southwestern Willow Flycatcher

- Long-term sediment storage areas comprise floodplain benches and valley terraces that provide surfaces for the recruitment and survival of riparian plant species that are important part of suitable vireo and flycatcher habitat.

- The infiltration capacity of floodplain soils can play an important role in providing sufficient soil moisture to support riparian vegetation that provides habitat and stabilizes stream banks.

- Infiltration during moderate rainfall events, ensures that excessive surface runoff and/or sheetflow do not result in bank erosion or channel entrenchment (which can destabilize riparian habitat).

- Subsurface water levels in the alluvial aquifers contributing to and along individual channels are important in sustaining riparian woodland or mule fat scrub that is used as breeding habitat for vireo and flycatcher.

- The salinity and pH of return flow and interflow affects the ability of a stream to support willow riparian plant communities that are used by the vireo and flycatcher.

- Periodic overbank flooding facilitates development of riparian habitat by depositing sediments, dispersing seeds, re-hydrating floodplain soils, and flushing accumulated salts.

- Long-term sustainability of early- to mid-successional riparian habitats is dependent on periodic scouring flows and associated geomorphic disturbance at a frequency that provides sufficient opportunity for habitat recovery between events.

5.2 SPECIES FOUND ONLY OUTSIDE THE STUDY AREA

The tidewater goby and southern steelhead do not occur within the SAMP/MSAA – NCCP/HCP study area. However, they do occur in other portions of the San Mateo watershed, including in habitats downstream of the study area.[29] Consequently, the processes summarized below should be considered in the context of their effect on downstream habitat and how changes to these processes could potentially result in secondary or indirect effects to the downstream species.

5.2.1 Tidewater Goby

- Tidewater goby rely on generation and transport of sufficient amounts of both coarse and fine sediment to the coast to rejuvenate sand-bottom breeding areas. However, excessively high levels of fine sediments could result in mortality of eggs and/or juveniles by burying spawning areas or facilitating conversion of refugia to herbaceous marshes.

- Beneficial sediment transport to the coast requires a stream network that allows fine sediments to be conveyed to the ocean rather than settling out within stream corridors.

- Winter peak runoff is necessary to breach lagoon mouths and scour the lagoon bottoms of accumulated fine sediments and to expose the coarse-grained sediments required for burrows. Runoff that is insufficient during the winter to scour bottom sediments and breach lagoon barriers adversely affect tidewater gobies by trapping the fish in the lagoons that eventually become stagnant, stratified, low in oxygen, and lack a clean source of sediments.

- Increases in the magnitude and frequency of peak flow events due to reduced infiltration upstream, land-use caused changes in runoff patterns, or stream channelization, as well as deliberate openings of the lagoon entrance, can result in frequent flushing of goby from the lagoon or subject the goby to osmotic shock.

- Summer runoff and stream flow is important to maintaining goby habitat because of its effect on the lagoon structure, extent, and salinity. Alluvial groundwater may provide subsurface water storage and discharge that prolongs the duration of flow after storm events. This prolonged flow is important for shallow backwater pools that provide tidewater goby refuge. During the dry season, the majority of inflow to the lagoon may result from groundwater discharge.

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[29] *Areas downstream of the study area provide breeding habitat for the goby and migration habitat for the steelhead. All known (or believed potential) steelhead spawning habitat is in tributaries that are not directly connected to the study area.*

5.2.2 Southern Steelhead

- Coarse sediment generation, and in-channel sediment transport to lower gradient portions of the creek facilitates formation of riffle and pool sequences and lateral scour pools that define steelhead spawning and migration habitat.

- Sediment storage within in-channel and adjacent riparian zones is important for sustaining appropriate surface water levels for adult and juvenile migrations.

- Steelhead are unlikely to migrate to and spawn in areas that lack late season discharge necessary to support pools. The granitic or densely-fractured crystalline rocks that are the most likely sources of late-season discharge occur upstream of Devil's Canyon Creek, outside the study area.

- Late season discharge from aquifers, seeps, or springs contributes to continuous flow to stream migration corridors and downstream lagoons, and helps support streamside riparian habitat.

- The frequency and magnitude of peak flows should be such that streamside vegetation (important for shading) can persist, but does not become frequently scoured or eroded due to channel incision or meandering.

- Stream flows must persist at a magnitude and duration into the late spring that provides sufficient dissolved oxygen and provides a continuous path for smolt migration.

- Winter flows must periodically be sufficient to breach lagoon mouths and allow steelhead passage.

6.0 REFERENCES

American Ornithologists' Union. 1957. *Checklist Of North American Birds*. 5th edition. Lord Baltimore Press, Baltimore, Maryland. 691 pp.

Balance (Balance Hydrologics) and PWA. 2000. *Inferred Hydrologic and Geomorphic Needs of Endangered Species, San Juan/San Mateo Creeks Special Area Management Plan (SAMP/MSAA), Southern Orange County, California*. Prepared for PCR Services, Inc. November.

Balance (Balance Hydrologics). 2001. *Groundwater Sustaining Landscape-Scale Wetland Functions, San Juan and San Mateo Watersheds, Southern Orange County, California*. Prepared for Rancho Mission Viejo, September

Barlow, J. C. 1962. *Natural History of Bell's Vireo, Vireo bellii* Audubon. University of Kansas Publication 12:241-296.

Barnhart, R. 1990. *In* Trout, edited by Judith Stolz and Judith Schnell. Stackpole Books (The Wildlife Series), Harrisburg, Pennsylvania.

Bell, M. C. 1986. *Fisheries Handbook of Engineering Requirements and Biological Criteria*. Fish Passage Development and Evaluation Program, Corps of Engineers, North Pacific Division, Portland, Oregon. 290 p.

Bencala, K. E. 2000. *Invited Commentary: Hyporheic zone hydrological processes: Hydrological Processes*, v. 14, p. 2797-2798.

Bent, A. C. 1950. *Life Histories of North American Wagtails, Shrikes, Vireos, and their Allies*. U.S. National History Museum Bulletin 197.

Bjornn, T. and D. Reiser. 1991. *Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats.* Special Publication 19.83-138, American Fisheries Society, Bethesda, Maryland.

Braden, G. T., and R. L. McKernan. 1998. *Nest Cycles, Vocalizations, And Survey Protocols Of The Endangered Southwestern Willow Flycatcher (Empidonax Traillii Extimus)*. Biological Sciences Section, San Bernardino County Museum. Report to U.S. Bureau of Reclamation, Lower Colorado River Office, Boulder City, Nevada. 36 pp.

Brown, B. T. 1988. *Breeding Ecology Of A Willow Flycatcher Population In Grand Canyon, Arizona*. Western Birds 19:25-33.

Brown, B. T. 1993. *Bell's Vireo. In The Birds of North America*, No. 34 (A. Poole, P. Stettenheim, and F. Gill, Eds.) Philadelphia: The Academy of Natural Sciences; Washington D.C.: The American Ornithologists' Union.

Brown, C., and R. Swenson. 1994. *Tidewater Goby.* Pp. 390-391. *In:* C. G. Thelander & M. Crabtree (ed.) Life on the Edge, a Guide to California's Endangered Natural Resources, Biosystems Books, Santa Cruz. 550 pp.

Campbell, L., T. Graham, L. Thibault, and P. Stine. 1996. *The Arroyo Toad: Ecology, Threats, And Research Needs*: United States Department of Interior, National Biological Service, California Science Center Davis, California Technical Report NBS/CSC-96-01. 46 p.

Carroll, E. W. 1985. *An Evaluation Of Steelhead Trout and Instream Structures in a California Intermittent Stream*. M.S. Thesis, Humboldt State Univ., Arcata, California. 62 pp.

CDFG (California Department of Fish and Game). 2000. *Steelhead Rainbow Trout in San Mateo Creek, San Diego County, California.* Prepared for the National Marine Fisheries Service by the California Department of Fish and Game Native Anadromous Fish and Watershed Branch, South Coast Region. 22 p.

Chapin, E. A. 1925. *Food Habits of the Vireos*. Bulletin 1355, U.S. Department of Agriculture, Washington D.C.

Cunningham, J. 1962. *Observations on the Natural History of the California Toad, Bufo californicus* Camp. Herpetologica 17 (4):255-260.

Cylinder, P., K. Bogdan, E. Davis, and A. Herson. 1995. *Wetlands Regulation: A Complete Guide to Federal and California Programs.* Solano Press Books, Point Arena, California.

DeBano, L. F., and L. J. Schmidt. 1990. *Potential for Enhancing Riparian Habitats in the Southwestern United States with Watershed Practices.* Forest Ecology and Management, Vol. 33/34 385-403.

Dominick, D. S. and M. P. O'Neill. 1998. *Effects of Flow Augmentation on Stream Channel Morphology and Riparian Vegetation: Upper Arkansas River Basin, Colorado.* Wetlands Vol. 18(4) 591-607.

Dudek (Dudek & Associates, Inc.). 2000. *Riverside County Integrated Project Species Accounts: Amphibians*. April.

Ferren, W., P. Fiedler, and R. Leidy. 1995. *Wetlands Of The Central And Southern California Coast And Coastal Watersheds: A Methodology For Their Classification And Description*. Final report prepared for the U.S. Environmental Protection Agency. Revised August 1996.

FISRWG (Federal Interagency Stream Restoration Working Group). 1998. *Stream Corridor Restoration: Principles, Processes, and Practices*. GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN3/PT.653. Revised August 2001.

Finch, D. M. and S. H. Stoleson, eds. 2000. *Status, Ecology, And Conservation Of The Southwestern Willow Flycatcher*. Gen. Tech. Rep. RMRS-GTR-60. Ogden, UT: U.S. Department of Agriculture, forest Service, Rocky Mountain Research Station. 131 pp.

Finney, K. and J. Edmondson. 2001. *Swimming Upstream: Restoring the Rivers and Streams of Coastal Southern California for Southern Steelhead and other Fishes.* Prepared for the Southern California Steelhead Recovery Coalition.

Finney, K. and J. Edmondson. 2000. *Swimming Upstream: Restoring the Rivers and Streams of Coastal Southern California for Southern Steelhead and other Fishes.* Prepared for the Southern California Steelhead Recovery Coalition.

Franzreb, K. E. 1989. *Ecology and Conservation of the Endangered Least Bell's Vireo*. Biological Report 89(1), U.S. Dept. Of the Interior, USFWS, Sacramento, California.

Franzreb, K. 1987. *Perspectives on Managing Riparian Ecosystems for Endangered Bird Species*. In Western Birds. 18, 3-9.

Gaines, D. 1977. *The Status of Selected Riparian Forest Birds in California.* Unpubl. report to Calif. Dept. Fish and Game. Sacramento, California.

Garrett, K., and J. Dunn. 1981. *The Birds of Southern California: Status and Distribution*. Los Angeles Audubon Society. 408 pp.

Goldman, S., K. Jackson, and T. Bursztynsky. 1986. *Erosion And Sediment Control Handbook*. McGraw-Hill Book Company, New York.

Goldwasser, S. 1978. *Distribution, Reproductive Success And Impact Of Nest Parasitism By Brown-Headed Cowbirds On Least Bell's Vireos*. Final Report, California Department of Fish and Game, Project W-54-R-10, Job IV 1.5.1.

Goldwasser, S. 1981. *Habitat Requirements of the Least Bell's Vireo*. Final Report, California Department of Fish and Game, Job IV-38.1. 16 pp.

Goldwasser, S., D. Gaines, and S. R. Wilbur. 1980. *The Least Bell's Vireo In California: A De Facto Endangered Race*. American birds 34:742-745.

Gray, M. and J. Greaves. 1981. *The Riparian Forest as Habitat for the Least Bell's Vireo (Vireo bellii pusillus).* Paper presented at the California Riparian Systems Conference, Univ. of Calif., Davis; September 1981.

Gray, M. V., and J. Greaves. 1984. *The Riparian Forest as Habitat for the Least Bell's Vireo*. In R. Warner and K. Hendrix, eds. California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press, Davis California.

Greaves, J. M. 1987. *Nest-site Tenacity of Least Bell's Vireos*. Western Birds 18:50-54.

Greaves, J. M. 1989. *Maintaining Site Integrity for Breeding Least Bells Vireos*. Pp. 293-298 in D. L. Abell, ed. California Riparian Systems Conference: Protection, Management, and restoration for the 1990's; 1988 September 22-24, Davis, California. Pacific Northwest Forest and Range Experiment Station, Berkeley, California; USDA Forest Service General Technical Report. PSW-110. 544 pp.

Greensfelder, L. 2000. *Wild Lives: Unvanquished Vireo.* In California Wild, Winter 2000. California Academy of Sciences, http://www. Calacademy.org/calwild/winter2000. (22 March 2000).

Griffin, P., T. Case, and R. Fisher. 1999. *Radio Telemetry Study Of Bufo californicus, Arroyo Toad Movement Patterns And Habitat Preferences*: Contract Report to California Department of Transportation Southern Biology Pool. 66 p.

Grinnell, J., and A. H. Miller. 1944. *The Distribution of the Birds of California*. Pacific Coast Avifauna Number 27. Reprinted by Artemisia Press, Lee Vining, California, 1986. 615 pp.

Hamilton, T. 1962. *Species Relationships and Adaptations for Sympatry in the Avian Genus Vireo*. Condor 64:40-48.

Harris, J. H., S. D. Sanders, and M. A. Flett. 1986. *The Status And Distribution Of The Willow Flycatcher In California, 1986*. California Department of Fish and Game, Wildlife Management Division Administrative Report.

Hecht, B. 1993. South of the spotted owl -- *Restoration strategies for episodic channels and riparian corridors in central and southern California*: Proceeding of the Society of Wetlands Scientists, Western Wetlands Conference, March 25-27, 1993. Davis, California. Pp. 104-117.

Hecht, B. 1984. *Sequential Changes in Bed Habitat Conditions in the Upper Carmel River Following the Marble-Cone Fire of August 1977.* Pp. 42-49 in Warner, R.E. and K.M. Hendrix, eds. California Riparian Systems Conference: Ecology, Conservation, and Productive Management. 1991. University of California Press, Berkeley, California. 1,044 pp.

Hendricks, B. J. and J. P. Rieger. 1989. *Description of Nesting Habitat for the Least Bell's Vireo* in San Diego County. Pp. 285-292 in D. L. Abell, ed. California Riparian Systems Conference: Protection, Management, and restoration for the 1990's; 1988 September 22-24, Davis, California. Pacific Northwest Forest and Range Experiment Station, Berkeley, California; USDA Forest Service General Technical Report. PSW-110. 544 pp.

Hensley, M. 1950. Notes on the Breeding Behavior of the Bell's Vireo. Auk 67:243-244.

Higgins, P. 1991. *Southern California steelhead recovery assessment: San Mateo Creek, Santa Margarita River. A wider role for TU in Protection and Recovery*. Report to South Coast Chapter of Trout Unlimited. 26 pp.

Holland, D. and N. Sisk. 2001. *Habitat Use and Population Demographics of the Arroyo Toad (Bufo californicus) on MCB Camp Pendleton, San Diego County, California 1998-2000.*

Holland, D., N. Sisk, R. Goodman. 2001. *Linear Transect Censusing of the Arroyo Toad (Bufo californicus) from 1996-2000 on MCB Camp Pendleton, San Diego County, California*. July.

Hubbard, J. P. 1987. *The status of the Willow flycatcher in New Mexico*. Endangered Species Program, New Mexico Dept. Of Game and Fish, Santa Fe, New Mexico. 29 pp.

Hubbs, C. L. 1946. Wandering of pink salmon and other salmonid fished into southern California. Calif. Fish Game 32:81-86

Irwin, J. F. and D. L. Soltz. 1984. *The Natural History Of The Tidewater Goby, Eucyclogobius Newberryi, In The San Antonio And Shuman Creek Systems, Santa Barbara County, California*. U.S. Fish and Wildl. Serv. Rep., Sacramento Endangered Species Off. Contract Order No. 11310-0215-2.

Jennings, M., and M. Hayes. 1994. *Amphibian And Reptile Species Of Special Concern In California*. Final report to the California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California. Contract 8023. iii + 255 pp.

Johnson, N. K., R. M. Zink, and J. A. Martin. 1988. *Genetic Evidence for Relationships in the Avian Family Vireonidae*. Condor 90:428-445.

Klimkiewicz, M. K., R. B. Clapp, and A. C. Futcher. 1983. *Longevity records of North American birds: Remizidae through Parulinae*. J. Field Ornithol. 54:287-294.

Knudsen, K., and B. Hecht. 1992. *Hydrologic and Geomorphic Factors Affecting Management of the Lower Sisquoc River Alluvial Corridor, Santa Barbara County, California.* Consulting report prepared by Balance Hydrologics, Inc. for SP Milling company. 66 p. plus five appendices.

Kus, B. E., and K. L. Miner. 1987. *The use of non-riparian habitats by least Bell's vireos (Vireo bellii pusillum)* In: D. L. Abell, ed. California Riparian Systems Conference: Protection, Management, and restoration for the 1990's; 1988 September 22-24, Davis, California. Pacific Northwest Forest and Range Experiment Station, Berkeley, California; USDA Forest Service General Technical Report. PSW-110. 544 pp.

Kus, B. E. 1994. *Breeding Status of the Least Bell's Vireo in the Tijuana River Valley, California, 1994*. Unpublished report prepared for the International Boundary and Water Commission. 22 pp.

Lafferty, K., R. Swenson, and C. Swift. 1996. *Threatened fish of the world: Eucyclogobius newberryi Girard, 1857 (Gobiidae).* In Environmental Biology of Fishes 46:254, 1996.

Lang, J., B. Oppenheim, R. Knight. 1998. *Southern Steelhead (Oncorhynchus mykiss) Habitat Suitability Survey of the Santa Margarita River, San Mateo, and San Onofre Creeks on Marine Base Camp Pendleton, California.* Prepared by the U.S. Fish and Wildlife Service Coastal California Fish and Wildlife Office, Arcata, California for the Assistant Chief of Staff, Environmental Security, Environmental and Natural Resource Office, Marine Corps Base Camp Pendleton.

Leopold, L., M. Wolman, J. Miller. 1992. *Fluvial Processes in Geomorphology*. Dover Publications, New York.

Leopold, L., M. Wolman, and J. Miller. 1964. *Fluvial Processes in Geomorphology.* San Francisco: W. H. Freeman and Co., 522 pp.

Lichvar, R., G. Gustina, D. MacDonald, and M. Ericsson. 2000. *Planning Level Delineation and Geospatial Characterization of Riparian Ecosystems of San Juan Creek and Portions of San Mateo Watersheds, Orange County, California*. U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.

Lisle, T. 1989. *Sediment Transport and Resulting Deposition in Spawning Gravels, North Coastal California.* Water Resources Research 25(6):1301-1319.

Lisle, T., and R. Eads. 1991. *Methods to Measure Sedimentation of Spawning Gravels*. Res. Note PSW-411. Berkeley, California: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. 7 p.

Marshall, R. 2000. *Population Status on Breeding Grounds*. In <u>Status, Ecology, and Conservation of the Southwestern Willow Flycatcher</u>. D. M. Finch and S. H. Stoleson, eds. General Technical Report RMRS-GTR-60, USDA, Forest Service, Rocky Mountain Research Station, Ogden, Utah, 3-11.

Miller, L. and A. Miller. 1936. *The Northward Occurrence of Bufo californicus in California.* Copeia 1936 (3):176.

Miner, K. 1989. *Foraging Ecology of the Least Bell's Vireo, Vireo bellii pusillus.* Unpublished Master's thesis, San Diego State University.

Mooney, H. and D. Parsons. 1973. *Structure and function of the California chaparral-an example from San Dimas*. Pages 83-112 *in*: F. diCastri and H. Mooney (Editors). Mediterranean-Type Ecosystems. Springer-Verlag, Berlin.

Morton, Paul K. 1974. Geology and engineering geologic aspects of the south half of the Cañada Gobernadora quadrangle, Orange County, California: California Division of Mines and Geology Special Report 111. 30 p.

Morton, Paul K. 1970. Geology of the NE 1/4 and NW 1/4 Cañada Gobernadora quadrangle, Orange County, California: California DMG Preliminary Report 10. Map at 1:12000

Moyle, P. 1976. *Inland Fishes of California*. University of California Press, Berkeley. 405 pp.

Moyle, P., R. Yoshiyama, J. Williams, and E. Wikramanayake. 1995. *Fish Species Of Special Concern In California*. Second Edition. Department of Wildlife & Fisheries Biology.

Murray, B. W., W. B. McGillivray, J. C. Barlow, R. N. Beech, and C. Strobek. 1994. *The Use of Cytochrome B Sequence Variation in Estimation of Phylogeny in the Vireonidae*. Condor 96:1037-1054.

Myers, G. 1930. *The Status of the southern California Toad, Bufo californicus* (Camp). Proceedings of the Biological Society of Washington 43(11):73-78.

Nielsen, J., T. Lisle, and V. Ozaki. 1994. *Bthermally Stratified Pools and Their Use by Steelhead in Northern California Streams*. Transactions of the American Fisheries Society 123:613-626.

NMFS (National Marine Fisheries Service). 1997. *Endangered and Threatened Species: Listing of Several Evolutionary Significant Units (ESUs) of West Coast Steelhead*. Federal Register 62 (159):43937-43954. August.

NMFS (National Marine Fisheries Service). 2000. *Designated Critical Habitat: Critical Habitat for 19 Evolutionary Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California*. Final Rule. Federal Register 65 (32):7764-7787.

Nolan V. 1960. Breeding Behavior of the Bell Vireo in southern Indiana. Condor 62:225-244.

Olsson, T. I. and Persson, B. G. 1988. *Effects of Deposited Sand on Ova Survival and Alevin Emergence in Brown Trout (Salmo trutta l.)*. In Hydrobiologia, 113(4):621-627.

Patten, D. 2000. *Riparian ecosystems of North America's intermountain west and adjacent plains*. *In*: International Conference on Riparian Ecology and Management in Multi-land Use Watersheds. American Water Resources Association.

PCR Services Corporation, Balance Hydrologics, PWA, Dudek and Associates, and EDAW. 2002. *Watershed and Sub-basin Planning Principles*. Prepared for Rancho Mission Viejo. March. Multi-paginated.

PCR Services Corporation. 2001. *Slope Wetland Functional Assessment.* Irvine, California, June.

PCR Services Corporation. 2000. *Slope Wetland Functional Assessment*. Irvine, California, June.

Phillips, R., R. Lantz, E. Claire, and J. Moring. 1975. *Some Effects of Gravel Mixtures on Emergence of Coho Salmon and Steelhead Trout Fry.* Transactions of the American Fisheries Society 104:461-466.

Pitelka, F., and Koestner. 1942. *Breeding Behavior of Bell's Vireo in Illinois*. Wilson Bulletin 54:97-106.

Poff, N., J. Allan, M. Bain, J. Karr, K. Prestegaard, B. Richter, R. Sparks, and J. Stromberg. 1997. *The Natural Flow Regime: A paradigm for river conservation and restoration*. In: Bioscience, Vol. 47, No. 11, 769-784.

Powell, B. and R. Steidl. 2000. *Nesting Habitat and Reproductive Success of Southwestern Riparian Birds*. In Condor 102, 823-831.

PWA (Phillip Williams & Associates). 2001. *Baseline Hydrologic Conditions of San Juan and Western San Mateo Creek Watersheds*. Prepared for Rancho Mission Viejo. May 30.

Ramirez, R. S., Jr. 2002. *Arroyo toad (Bufo californicus) Radio Telemetry Study, San Juan Creek, Orange County, California*. Interim Report. Prepared for Rancho Mission Viejo.

Ramirez, R. S., Jr. 2001. *Arroyo toad (Bufo californicus) Radio Telemetry Study, San Juan Creek, Orange County, California*. Interim Report. Prepared for U.S.D.A. Forest Service, Cleveland National Forest.

Ramirez, R. S., Jr. 2000. *Arroyo toad (Bufo californicus) radio telemetry study, Little Rock Creek, Los Angeles County, California*. Interim Report. Prepared for U.S.D.A. Forest Service, Angeles National Forest, Arcadia, California. 62 + v pp., plus appendix.

RECON (Regional Environmental Consultants. 1988. *Draft Least Bell's Vireo Study Program: interim report for Eastside Reservoir Siting Project*. Prepared for the Metropolitan Water District. 1989.

RECON (Regional Environmental Consultants. 1989. *Comprehensive Species Management Plan for the Least Bell's Vireo*. Prepared for the San Diego Association of Governments.

Robinson, S., S. Rothstein, M. Brittingham, L. Petit, J. Grzybowski. 1995. *Ecology and Behavior of Cowbirds and Their Impact on Host Populations*. In Ecology and Management of Neotropical Migrants. T. E. Martin and D. M. Finch, eds., Oxford University Press, New York, 428-460.

Salata, L. 1983. *Status of the least Bell's vireo on Camp Pendleton, California: report on research done in 1983*. Unpubl. Rept., U.S. USFWS, Laguna Niguel, California. 63 pp.

Salata, L. 1984. *Status of the least Bell's vireo on Camp Pendleton, California: report on research done in 1984*. Unpubl. Rept., U.S. USFWS, Laguna Niguel, California. 54 pp.

Sanders, T. A. and W. D. Edge. 1998. *Breeding bird community composition in relation to riparian vegetation structure in the western United States*. Journal of Wildlife Management 62:461-473.

San Diego Natural History Museum. 1995. *Empidonax extimus traillii in California: The Willow Flycatcher Workshop*. November 17.

Scott, M. L., M. A. Wondzell, and G. T. Auble. 1993 Hydrograph characteristics relevant to the establishment and growth of western riparian vegetation. Pp. 237-246 in H. J. Morel-Seytoux, ed. Proceedings of the Thirteenth Annual American Geophysical Union Hydrology Days. Hydrology Days Publications, Atherton, California.

Scott, M. J., R. D. Sands, L. W. Vail, J. C. Chatters, D. A. Neitzel, and S. A. Shankle. 1993. *The effects of climate change on Pacific Northwest water-related resources: summary of preliminary findings*. PNL-8987, Pacific Northwest Laboratory, Richland, WA, USA. 46 pp.

Sedgewick, J. A., and F. L. Knopf. 1992. *Describing willow flycatcher habitats: scale perspectives and gender differences*. Condor 94:720-733.

Segelquist, C. A., M. L. Scott, and G. T. Auble. 1993. *Establishment of Populus deltoides under simulated alluvial groundwater decline.* American Midland Naturalist Vol. 130(2) 274-285.

Shafroth, P. B., G. T. Auble, J. C. Stromberg, and D. T. Patten. 1998. *Establishment of Woody Riparian Vegetation in Relation to Annual Patterns of Streamflow, Bill Williams River Arizona.* Wetlands Vol. 18(4) 577-590.

Shapovalov, L. and A. Taft. 1954. *The Life Histories of the Steelhead Rainbow Trout, Salmo gairdneri and Silver Salmon, Oncorhynchus kisutch with Special Reference to Waddell Creek California, and Recommendations Regarding their Management.* California Department of Fish and Game. Fish Bulletin No. 98. 303 pp.

Sheppard, J. D., and J. H. Johnson. 1985. *Probability-of-Use for Depth, Velocity, and Substrate by Subyearling Coho Salmon and Steelhead in Lake Ontario Tributary Streams*. North American Journal of Fisheries Management 5:277-282.

Small, A. 1994. *The Birds of California*, Winchester Press, New York, New York.

Small, A. 1994. *California Birds: Their Status and Distribution*. Ibis Publishing Company: Vista, California. 342 pp.

Smith, R. D. 2000. *Assessment of Riparian Ecosystem Integrity in the San Juan and San Mateo Creek Watersheds, Orange County, California.* U.S. Army Corps of Engineers Engineering Research and Development Center, Waterways Experiment Station, Vicksburg, Mississippi 39180.

Sogge, M. K., T. J. Tibbitts, and J. R. Petterson. 1997. *Status and breeding ecology of the southwestern willow flycatcher in the Grand Canyon*. Western Birds 28:142-157.

Steinhart, P. 1990. California's wild heritage. *Threatened and endangered animals in the Golden State*. California Department of Fish and Game, California Academy of Sciences, Sierra Club Books, San Francisco.

Sullivan, B. 1992. *Calling Behavior of the Southwestern Toad (Bufo microscaphus*). Herpetologica, 48 (4):383-389.

Sweet, S. 1991. *Initial Report on the Ecology and Status of the Arroyo Toad, Bufo microscaphus californicus, on the Los Padres National Forest of Southern California, with Management Recommendations.* Prepared for the U.S. Forest Service. University of California Santa Barbara.

Sweet, S. 1989. *Observations On The Biology And Status Of The Arroyo Toad, Bufo Microscaphus Californicus, With A Proposal For Additional Research*. Unpublished report. 23 pp.

Sweet, S. 1992. *Ecology And Status Of The Arroyo Toad (Bufo Microscaphus Californicus) On The Los Padres National Forest Of Southern California With Management Recommendations*. Report to United States Department of Agriculture, Forest Service, Los Padres National Forest, Goleta, California. ii + 198 pp.

Sweet, S. 1993. *Second Report On The Biology And Status Of The Arroyo Toad (Bufo Microscaphus Californicus) On The Los Padres National Forest Of Southern California*. Report to United States Department of Agriculture, Forest Service, Los Padres National Forest, Goleta, California. ii + 73 pp.

Swift, C., J. Nelson, C. Maslow, and T. Stein. 1989. *Biology and Distribution of the Tidewater Goby, Eucyclogobius newberryi (Pisces: Gobiidae) of California.* Natural History Museum of Los Angeles County, Los Angeles. 19 pp.

Swift, C., T. Haglund and M. Ruiz. 1990. *Status Of Freshwater Fishes Of Southern California With Recommendations For Preserves To Maintain Their Existence*. Report to Calif. Dept. Fish and Game. 217 p.

Swift, C., T. Haglund, M. Ruiz, R. Fisher. 1993. *The Status and Distribution of the Freshwater Fishes of Southern California.* In the Bulletin of Southern California Academy of Sciences, 92(3), 1993. Pp. 101-167.

Terres, J. K. 1980. *The Audubon Society Encyclopedia of North American Birds*. Alfred A. Knopf, New York, New York. 1109 pp.

Titus R. G., D. C. Erman and W. M. Snider. 1994. *History and status of steelhead in California coastal drainages south of San Francisco Bay*. Dept. of Fish and Game, Environmental Services. Sacramento, California.

TNC (The Nature Conservancy). 1994. *Status and distribution of the least Bell's vireo in the Prado Basin, California, 1986-1994*. Unpublished draft report prepared for the Orange County Water District, County of Orange, California Department of Fish and Game, Corps of Engineers, and the U. S. Fish and Wildlife Service.

Unitt, P. 1987. *Empidonax traillii extimus; An endangered subspecies*. Western Birds 18:137-162.

USFWS (U.S. Fish and Wildlife Service). 1984. *Life Stage Periodicities of Anadromous Salmonids in the Klamath River Basin, Northwestern California.* Ecological Services, Sacramento, California. Contributing authors Leidy, R. A. and G. R. Leidy. 36 pp.

USFWS (U.S. Fish and Wildlife Service). 1986. *Endangered And Threatened Wildlife And Plants; Determination Of Endangered Status For The Least Bell's Vireo*. Final Rule. Federal Register 51:16474-16482.

USFWS (U.S. Fish and Wildlife Service). 1993. *Endangered and Threatened Wildlife and Plants; Proposed Rule to List the Southwestern Willow Flycatcher as Endangered with Critical Habitat*. Federal Register 58:39495-39519.

USFWS (U.S. Fish and Wildlife Service). 1994. *Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Tidewater Goby. Final Rule*. Federal Register 59:5494-5499.

USFWS (U.S. Fish and Wildlife Service). 1994. *Endangered And Threatened Wildlife And Plants; Determination Of Endangered Status For The Arroyo Southwestern Toad*. Federal Register 59 (241):64859-64866.

USFWS (U.S. Fish and Wildlife Service). 1994. *Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Least Bell's Vireo. Final Rule*. Federal Register 59:4845-4867.

USFWS (U.S. Fish and Wildlife Service). 1995. *Endangered and Threatened Wildlife and Plants; Final Rule Determining Endangered Status for the Southwestern Willow Flycatcher*. Federal Register 60:10694-10715.

USFWS (U.S. Fish and Wildlife Service). 1995. *Internal Biological Opinion on the Proposed Issuance of Recovery Permits to Take the Endangered Southwestern Willow Flycatcher*. 17 pp.

USFWS (U.S. Fish and Wildlife Service). 1996. *Draft Recovery Plan for the Tidewater Goby (Eucyclogobius newberryi).* United States Fish and Wildlife Service, Region 1, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 1998. *Draft Recovery Plan for the Least Bell's Vireo (Vireo bellii pusillus)*. United States Fish and Wildlife Service, Region 1, Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 1999. *Arroyo Southwestern Toad (Bufo Microscaphus Californicus) Recovery Plan*. United States Fish and Wildlife Service, Portland, Oregon. vi + 119 pp.

USFWS (U.S. Fish and Wildlife Service). 1999. *Endangered and Threatened Wildlife and Plants; Final Determination of Critical Habitat for the Southwestern Willow Flycatcher*. Federal Register 62:39129-39147.

USFWS (U.S. Fish and Wildlife Service). 2000. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Tidewater Goby. Final Rule*. Federal Register 65:69693-69717.

USFWS (U.S. Fish and Wildlife Service). 2001. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Arroyo Toad. Final Rule*. Federal Register 66:9413-9474.

Wang, J. 1982. *Early Life History And Protection Of The Tidewater Goby Eucyclogobius Newberryi (Girard) In The Rodeo Lagoon Of The Golden Gate National Recreation Area*. Cooperative National Park Resources Studies Unit and University of California at Davis. Tech. Rep. No. 7. 24 pp.

Wells, W. G., II. 1982. *Hydrology of Mediterranean-type Ecosystems: A Summary and Synthesis*. In Conrad, C. E., and Oechel, W. C., coordinators, Dynamics and Management of Mediterranean-type Ecosystems: Proceedings of the symposium: San Diego, California, June 22-26, 1981. General Technical Report. PSW-58, Berkeley, California: USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. Pp. 426-430.

Whitfield, M. J. 1990. *Willow Flycatcher Reproductive Response To Brown-Headed Cowbird Parasitism*. Masters theses, Calif. State Univ., Chico. 25 pp.

Whitfield, M. J. 1990. *Summary of Southwestern Willow Flycatchers on the South Fork Kern River, California*. Kern River Research Center.

Withler, I. L. 1966. *Variability in Life History Characteristics of Steelhead Trout (Salmo Gairdneri) Along the Pacific Coast of North America*. J. Fish. Research Board Canada 23:365-392.

Yong, W., and D. M. Finch. 1997. *Migration Of The Willow Flycatcher Along The Middle Rio Grande*. Wilson Bulletin 109:252-268.

Zedler, J. B. [ed]. 2001. *Handbook For Restoring Tidal Wetlands*. CRC Marine Science Series.

Zeiner, D. C., W., F. Laudenslayer, Jr., K. E. Mayer, M. White. Editors. 1990. *California's Wildlife. Volume 2. Birds*. State of California, Department of Fish and Game. Sacramento, California. 731 pp.