STAFF SUMMARY FOR APRIL 17, 2019

8. SAN BERNARDINO KANGAROO RAT (CONSENT)

Today's Item **Information** ☒ **Action** ☐

Receive petition from the Endangered Habitats League (EHL) to list San Bernardino kangaroo rat (*Dipodomys merriami parvus*) as endangered under the California Endangered Species Act (CESA).

Summary of Previous/Future Actions

- Received petition — Mar 15, 2019
- FGC transmitted petition to DFW — Mar 22, 2019
- Published notice of receipt of petition — Apr 12, 2019
- **Today's public receipt of petition** — **Apr 17, 2019; Santa Monica**
- Receive DFW 90-day evaluation — Aug 7-8, 2019; Sacramento
- Determine if listing may be warranted — Oct 9-10, 2019; San Diego

Background

A petition to list San Bernardino kangaroo rat as endangered under CESA was submitted by EHL on Mar 15, 2019 (Exhibit 1). On Mar 22, 2019, FGC staff transmitted the petition to DFW for review. A notice of receipt of petition was published in the California Regulatory Notice Register on Apr 12, 2019.

Fish and Game Code Section 2073.5 requires DFW to evaluate the petition and provide FGC a recommendation as to whether the petition contains sufficient information that the petitioned action may be warranted. Until FGC receives the DFW evaluation, FGC cannot consider the petition.

Significant Public Comments (N/A)

Recommendation

Receive the petition and accept any public comment under a motion to adopt the consent calendar.

Exhibits

1. Petition to list San Bernardino kangaroo rat as endangered, dated Mar 14, 2019

Motion/Direction

Moved by _____ and seconded by _____ that the Commission adopts the staff recommendations for items 4-11 on the consent calendar.

FGC - 670.1 (3/94)

A PETITION TO THE STATE OF CALIFORNIA
FISH AND GAME COMMISSION

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) and Sections 2072 and 2073 of the Fish and Game Code relating to listing and delisting endangered and threatened species of plants and animals.

I. SPECIES BEING PETITIONED:

Common Name: San Bernardino Kangaroo Rat

Scientific Name: (*Dipodomys merriami parvus*)

II. RECOMMENDED ACTION:

(Check appropriate categories)

a. List X b. Change Status ☐

As Endangered X from _____

As Threatened ☐ to _____

Or Delist ☐

III. AUTHORS OF PETITION:

Name: Michael White, PhD; Gerald Braden; Dan Silver, MD

Address: c/o Endangered Habitats League, Attn: Dan Silver

8424 Santa Monica Blvd, Suite A 592, Los Angeles, CA 90069-4267

Phone Number: (213) 804-2750

I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.

Signatures: _____

Date: March 14, 2019

PETITION TO THE STATE OF CALIFORNIA FISH AND GAME COMMISSION SUPPORTING INFORMATION FOR

San Bernardino Kangaroo Rat	***(Dipodomys merriami parvus*)**
Common Name	**Scientific Name**

EXECUTIVE SUMMARY

Based on a scientific review of its distribution and status, this petition requests that the San Bernardino kangaroo rat (*Dipodomys merriami parvus* [SBKR]) be listed as Endangered by the California Fish and Wildlife Commission. SBKR is a heteromyid rodent that historically occurred in alluvial fan scrub habitats associated with active floodplains across over 325,000 acres of the San Bernardino and San Jacinto/Perris valleys. Habitat quality and SBKR densities (varying from 1-30 individuals/acre) are higher in floodplains with active fluvial processes and sandy or gravelly soils and substrates, generally supporting open-structured alluvial fan scrub vegetation, that are connected to nearby upland and/or less frequently inundated terraces that serve as flood refugia. Due to extensive urban, commercial, and agricultural development of these areas, SBKR is currently restricted to about 5% of this historical range, and much of this remaining habitat is highly fragmented and degraded by indirect effects. Critically, extensive channelization and water management activities have irreversibly degraded the natural fluvial processes that historically maintained SBKR habitat. Climate change is expected to exacerbate adverse impacts to SBKR.

In response to the dramatic loss of habitat experienced by SBKR, it was listed as Endangered by the U.S. Fish and Wildlife Service (Service) in 1998. Since its listing, however, its status has continued to decline. The Service considers seven populations extant in 1998 to be extirpated, and SBKR is now confined to three discontinuous blocks of habitat: Lytle Creek/Cajon Wash, Santa Ana River, and San Jacinto River. Although the Service designated 33,295 acres of Critical Habitat in 2002, it considers only 16,300 acres of that to be currently functioning for SBKR (but not necessarily occupied by SBKR). Since 1998 we estimate that over 11,000 acres of potential SBKR habitat (regardless of its quality or occupation) has been lost even when regulated under the Endangered Species Act. Since the 1998 federal listing, federal permitting allowed the fundamental hydrologic basis for persistence of the largest SBKR population to be lost, and mitigation measures performed under federal consultations have been ineffective.

SBKR historical habitat occurs in naturally functioning alluvial fan systems, which are highly dynamic, constantly shifting networks of braided channels. Habitat quality is frequently reworked through scouring and alluvium deposition during fluvial events, and subsequent vegetation establishment and succession on floodplain terraces. SBKR population persistence relies on the availability of higher elevation floodplain terraces to escape lethal flooding events. Individuals from these higher elevation areas can repopulate reworked habitats once suitable.

Much of the remaining SBKR habitat has been adversely modified by channelization, flood control, and water management activities such that the natural hydrologic regimes of the alluvial fan systems, that historically maintained SBKR habitat, are now gone and/or much of the higher elevation refugia available to the species are physically disconnected from remaining SBKR

populations. For example, the prospect for long-term persistence of SBKR and its habitat in the Santa Ana River area is poor because of the construction of Seven Oaks Dam (SOD), and nonnative plant invasion and vegetation type conversion limit habitat quality and persistence in the Plunge Creek area. Likewise, probability of persistence is poor in the upper reaches of City Creek and in Mill Creek habitats as a result of flood control operations and suburban development. Habitat along Lytle Creek now largely exists within levee-modified or channelized floodplains which are subject to high stream velocity and scouring events relative to historical conditions, exposing SBKR populations to potentially catastrophic flood events with little available refugia. The cumulative impacts of habitat loss and land-use changes jeopardize the continued existence of the species under existing conditions, yet new development proposals further threaten important blocks of SBKR habitat that still have functioning fluvial processes.

The primary threat to SBKR is the direct impact of past and present modification and destruction of its habitat. A new range-wide genetic assessment of SBKR confirms these negative trends in habitat and population loses for conservation and recovery of the species. SBKR in the Lytle/Cajon creeks, Santa Ana River, and San Jacinto River/Bautista Creek blocks of habitat have low effective population sizes. The genetic structure of the three populations is unique, reflecting their relatively recent isolation from each other due to loss of connectivity. The conservation genetics research by the San Diego Zoo Institute for Conservation Research confirm the isolation, low genetic diversity, and small effective population sizes and recommend "preventing further impacts to SBKR populations and increasing numbers."

Since the federal listing, mitigation efforts for past impacts to SBKR have not successfully compensated for the loss of suitable, as well as occupied, SBKR habitat. Yet, at this time, major additional loss of SBKR habitat is proposed and is being reviewed by the Service. For example, the City of Rialto approved the Lytle Creek Ranch development in 2010 and the project is undergoing an Endangered Species Act section 7 consultation. According to the Service, ~1,920 acres of the proposed Lytle Creek Ranch project falls within SBKR Critical Habitat and ~1,191 acres of that (62%) would be adversely impacted by the project. Mitigation measures proposed by the project applicant include the same unproven measures that have not adequately mitigated the loss of SBKR habitat in the past. Furthermore, the project would eliminate the vital terrace refugia habitat that remains along Lytle Creek. Given the negative consequences to SBKR from the loss of hydrologic functions on the Santa Ana River due to the operation of the SOD, the loss of additional functional, SBKR-occupied habitat on Lytle Creek would likely be catastrophic to the long-term persistence of SBKR.

An objective look at SBKR status, trends, and conservation needs based on these negative trends is essential. Innovative and creative conservation actions are needed, based upon an assessment of what has not worked in the past and what has promise in the future. While the federal listing is not providing these functions, the State of California is well suited to do so. Furthermore, the tools currently available to the State—Streambed Alteration Agreements and the CEQA comment process—are either inherently limited in scope (the former) or have proven ineffective (the latter). For example, recommendations offered by the California Department of Fish and Wildlife during the Lytle Creek Ranch CEQA process were ignored by the lead agency.

State listing will also remedy a serious limitation in the federal system that has contributed to SBKR decline. Due to proximity of SBKR habitat to river systems, federal permitting for SBKR impacts typically occurs via section 7 consultations (with resulting Biological Opinions) requested by the Army Corps of Engineers in association with impacts to Waters of the United States, rather than through Habitat Conservation Plans under section 10 of the ESA.

Unlike a Habitat Conservation Plan, there is no general requirement in a section 7 consultation to minimize and mitigate the impacts of the take of an endangered species to the maximum extent practicable. Indeed, unless the extreme case of jeopardy to the very existence of a federally endangered species is reached, *no mitigation whatsoever is required* (per the Endangered Species Consultation Handbook, "It is not appropriate to require mitigation for the impacts of incidental take."). Rather, section 7 seeks to minimize take as long as such measures are "reasonable and prudent" and "minor" in extent. Under these circumstances, it is not surprising that mitigation for impacts to SBKR under the federal listing has failed to compensate for the substantial loss of habitat that has occurred.

To the contrary, under the California Endangered Species Act (CESA), project applicants would not be able to circumvent providing effective mitigation. Under CESA, take must be minimized and "fully mitigated." Elevating the regulatory status of SBKR in California to Endangered will provide the Department of Fish and Wildlife a heightened level of review and regulatory authority to arrest the decline of SBKR. Only with sufficient mitigation on all projects can the negative trends in SBKR population begin to be reversed. U.S. Army Corps regulations are no substitute, as its focus is on wetlands and Waters of the U.S. rather on the surrounding uplands that are vital to SBKR.

Finally, there is strong and ample evidence of the politicization of federal regulatory agencies under the current Executive Administration and the ascent of an anti-science and anti-regulatory agenda. Scientific panels have been disbanded and there is open hostility to objective science, such as in the realm of climate change. State listing is a necessary backstop to the disregard of law and science by federal environmental agencies under the current Administration.

For these reasons, described more fully below, listing by the Commission is imperative given the failures of the federal listing as an alternative regulatory mechanism and the gravity of impending threats.

1. POPULATION TRENDS

The San Bernardino kangaroo rat (*Dipodomys merriami parvus*), or SBKR, is a heteromyid rodent that historically occurred in alluvial fan scrub associated with active floodplains of the San Bernardino and San Jacinto/Perris valleys (McKernan 1997). Because of extensive urban, commercial, and agricultural development, <5% of SBKR's historical habitat was occupied by 2008 (USFWS 2009). Much of this remaining habitat is highly fragmented and degraded, and more than half is considered non-functional with low long-term habitat value (USFWS 2018).

The density of SBKR, generally 1-30 individuals/acre (McKernan 1997), is controlled by local habitat conditions, which change and shift spatially and temporally in response to flooding and fluvial processes. Areas with natural fluvial processes support higher SBKR abundances than areas where these processes have been modified or eliminated (McKernan 1997, USFWS 2009). Channel-floodplain connectivity and fluvial processes have been significantly modified in the region, and SBKR populations are now present at lower densities where habitat quality has declined. As the understanding of trends in abundance is poor, the dramatic loss and fragmentation of the species' habitat, rather than a population abundance trend per se, is the best descriptor of SBKR's status and need for California Endangered Species Act (CESA) protection.

2. RANGE AND DISTRIBUTION

Historical range/abundance

The San Bernardino kangaroo rat historically occurred in alluvial fan habitats in two broad geographic areas: (1) floodplain terraces at the bases of the San Gabriel and San Bernardino mountains in the northern portion of the San Bernardino Valley, and (2) floodplain terraces in the San Jacinto, Perris, and Menifee valleys at the base of the San Jacinto Mountains (Figure 1, McKernan 1997). McKernan (1997) estimated a historical range of more than 325,000 acres of alluvial floodplains, but by the 1930s only about 28,000 acres of its habitat remained. In the northern portion of its range, habitat extended from the base of the Cajon Pass (Cajon and Lytle creeks), west to San Antonio and Cucamonga creeks, south along the Santa Ana River floodplain to the Jurupa Mountains and Reche Canyon, and east to terraces along Mill Creek and the upper Santa Ana River. In the southern portion of its range, habitat extended from the upper San Jacinto River and Bautista Creek, north along the San Jacinto River to the northern Moreno Valley, and southwest to the Menifee and Paloma valleys. By the time serious investigations of SBKR status were initiated, over 90% of its habitat had already been eliminated.

Range at time of Federal ESA listing (1998) and Critical Habitat designation (2002)

McKernan (1997) prompted the U.S. Fish and Wildlife Service (Service) to emergency-list the SBKR as Endangered. In the final rule for the listing, the Service estimated that SBKR was restricted to a mosaic of 13,193 acres of its historical potential habitat but occupied only 9,797 acres (USFWS 1998) primarily in three locations: Santa Ana River (3,861 acres), Lytle Creek and Cajon Wash (5,161 acres), and San Jacinto River (775 acres) (Table 1). In the emergency listing, the Service (1998) also estimated smaller amounts of habitat at City Creek (20 acres), Reche Canyon (5 acres), Etiwanda alluvial fan (5 acres), and South Bloomington (2 acres).

Figure 1. Historical range of San Bernardino kangaroo rat, all known trap locations, and trap locations from 2008-2018 (from USFWS 2018).

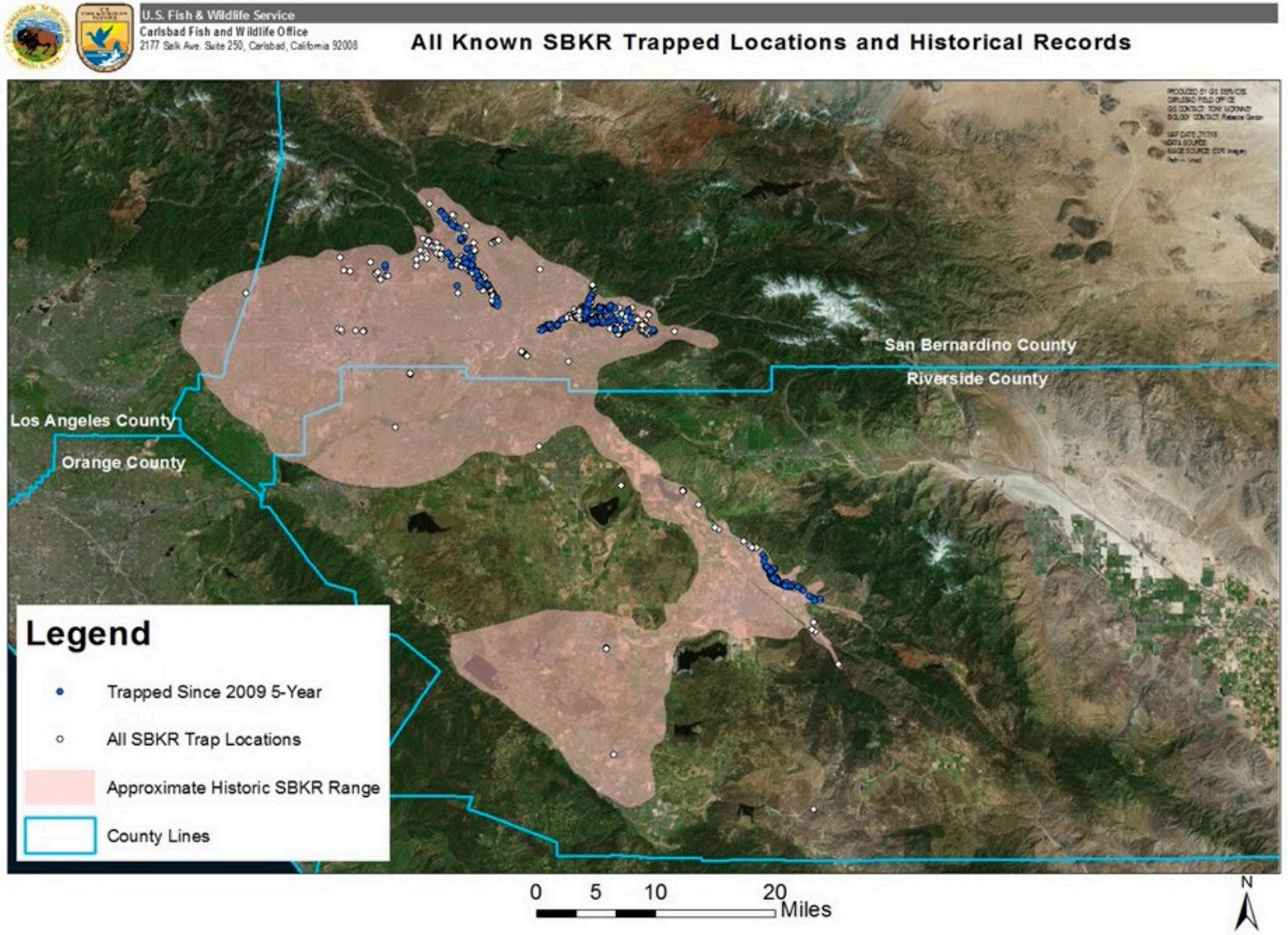


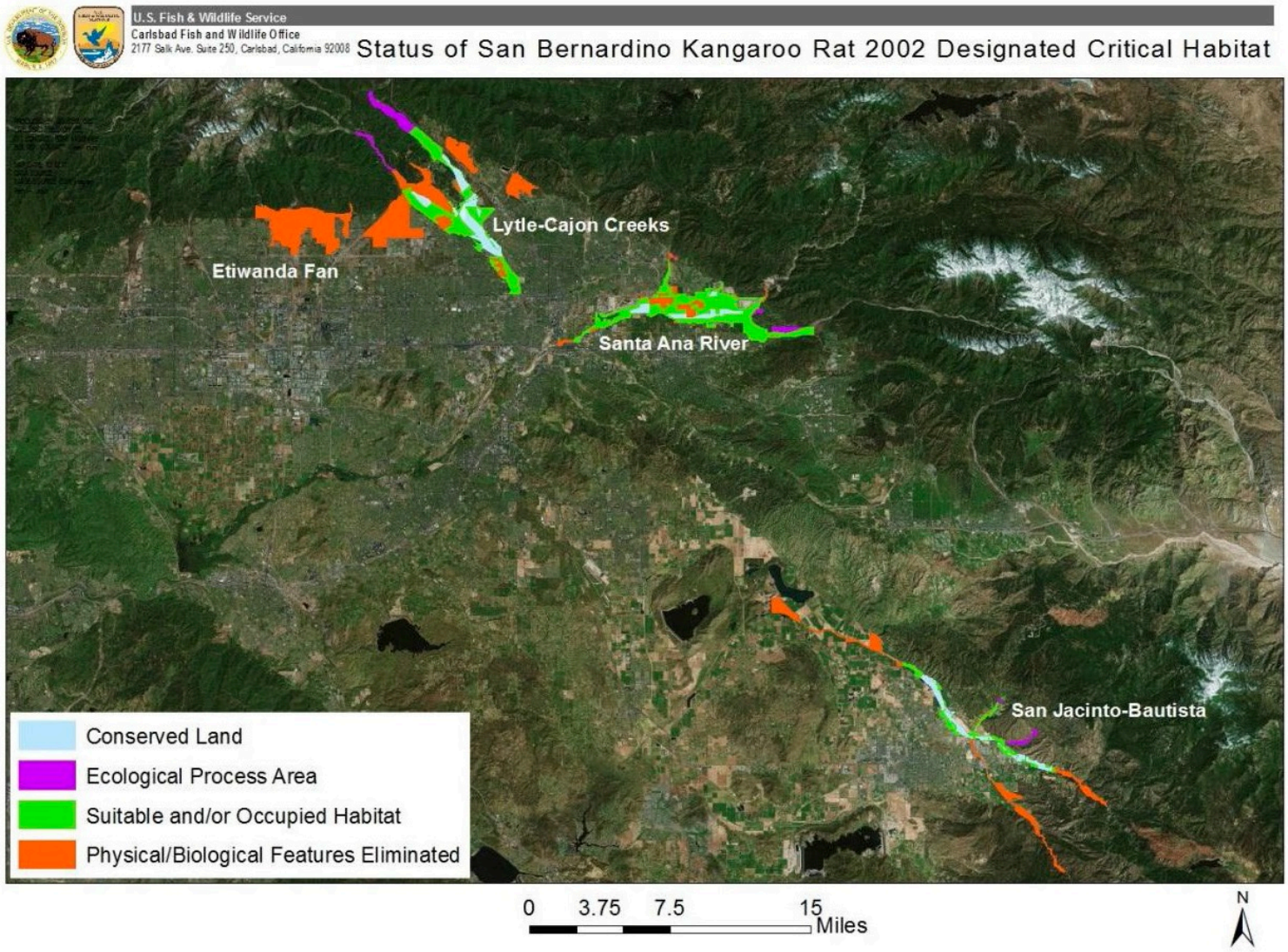
Table 1. U.S. Fish and Wildlife Service's estimates of area of SBKR habitat (acres) at time of federal listing (1998), area of Designated Critical Habitat (2002), and functioning habitat remaining in 2018.

Unit	Potential Habitat Estimated at Listing (1998[1])	Designated Critical Habitat (2002[2])	Estimated Functioning Habitat (2018[3])
Etiwanda Alluvial Fan	Extant	4,820	Extirpated[3]
Lytle Creek/Cajon Wash	6,967	13,970	6,471
Santa Ana River	5,224	8,935	7,426
San Jacinto River	1,002	5,565	2,403
Bautista Creek	Part of San Jacinto R.	Part of San Jacinto R.	Extirpated[3]
Cable Creek	Part of Lytle/Cajon	Part of Lytle/Cajon	Extirpated[3]
Devil's Canyon	Part of Lytle/Cajon	Part of Lytle/Cajon	Extirpated[3]
City Creek	Extant	Part of Santa Ana R.	Extirpated[3†]
Reche Canyon	Extant	Not designated	Extirpated[4]
South Bloomington	Extant	Not designated	Extirpated[4]
Estimated Totals	**13,193[5]**	**33,295 (10,969[6])**	**16,300[7]**

[1] USFWS 1998
[2] USFWS 2002a
[3] USFWS 2018
[4] Extirpated by 2008 (USFWS 2009)
[5] A total of 3,396 acres of the 13,193 acres of the potential habitat was considered to "have too much cover or is otherwise degraded" to support SBKR.
[6] A total of 33,295 acres have been designated as Critical Habitat for SBKR (USFWS 2002a), but the Service (USFWS 2009) considered 10,969 acres of this to be "much of the remaining occupied habitat" at the time.
[7] Habitat considered "currently functioning" may not necessarily be occupied by SBKR.
[†] Refers to City Creek reach upstream of Highland Ave.

Prior to designation of Critical Habitat (USFWS 2002a), development, agriculture, stream channelization, management of flow and associated edge effects destroyed or degraded large portions of historical habitat in western San Bernardino Valley and Moreno, Perris, and Menifee valleys. In the final Critical Habitat rule (USFWS 2002a), the Service estimated the species' range (not all occupied) was at least 32,480 acres within the 33,295 acres of Critical Habitat, but some areas supported low abundance populations with a low likelihood of long-term sustainability in 2002 (e.g., Etiwanda fan; Cable Canyon; Devil Creek; northeast Fontana). Remaining habitat occurred in four larger disjunct blocks (Figure 2, Table 1): Etiwanda Fan (including Deer/Day/Etiwanda creeks), Lytle Creek/Cajon Wash, Santa Ana River/City Creek/Plunge Creek/Mill Creek, and San Jacinto River/Bautista Creek; and two small disjunct tracts: Cable Creek and Devil Creek (tributaries of Cajon Wash). This represents <5% of historical habitat that once occurred in large tracts of naturally functioning, interconnected patches. Over 90% of this remaining habitat occurred in two disjunct blocks: Lytle Creek/Cajon Wash and Santa Ana River, which were fragmented internally by development, mining, highways, and water management infrastructure.

Figure 2. Critical Habitat for San Bernardino kangaroo rate (USFWS 2002a, 2018) and the status of SBKR habitat within those units.



Range/abundance at 5-year review (USFWS 2009)

As part of the 5-year assessment of the SBKR (USFWS 2009), the Service considered that two of the remaining known locations likely were extirpated since the ESA listing in 1998 (i.e., South Bloomington and Reche Canyon). Within the Etiwanda alluvial fan, SBKR was confined to the San Bernardino County Flood Control District's Etiwanda Debris Basin Lower Spreading Grounds and associated facilities.

The 5-year assessment described the distribution of SBKR as of 2008 (USFWS 2009) in the three remaining significant habitat blocks, but did not report acreages of suitable or occupied habitat. The acreage estimates of suitable habitat and SBKR distribution have evolved over the 10 years following the emergency listing; we now know that by 2008 SBKR occupied a greatly reduced and significantly fragmented portion of its former range, occurred in very low numbers in some portions of its designated Critical Habitat (e.g., Etiwanda Alluvial Fan, Cable Creek), and it has been extirpated from areas it once occupied, following its listing as an Endangered Species and designation of Critical Habitat by the Service.

Santa Ana River

In 2008, SBKR occurred along the upper reach of the Santa Ana River from its confluence with Mill Creek to just below Tippecanoe Avenue. This habitat was a mosaic of (1) developed and disturbed areas that do not support SBKR, (2) undeveloped but disturbed habitats that support SBKR in limited numbers, and (3) higher quality habitats that support SBKR in higher numbers. However, vegetation succession from lack of flooding has degraded many of these once higher quality habitats. SBKR also still occurred in alluvial fan habitats in the lower portions of Mill, Plunge, and City creeks where they flow into the Santa Ana River, although habitat on Plunge Creek was fragmented and largely isolated from other high-quality habitats occupied by SBKR.

Lytle Creek, Cajon Wash, and Cable Creek

In 2008, SBKR still occurred in discrete, fragmented locations along approximately 3 miles of Lytle Creek from upstream of the Interstate 15 crossing of the creek to the confluence of Cajon Wash. Lytle Creek was deeply incised, and channelization and levees had modified the habitat significantly. The largest block of habitat along Lytle Creek occurred just upstream of the aggregate mining operations, where the creek meandered within its deeply incised channel, creating alluvial terraces with high quality habitat. However, these alluvial terraces were subject to high velocity floods, little high elevation refugia habitat in the channel was available, and adjacent upland areas occupied by SBKR have been isolated from the creek by development.

In 2008 SBKR occupied an approximately 8-mile reach of Cajon Wash from approximately 4.5 miles upstream of the Interstate 15 crossing of the creek to its confluence with Lytle Creek. Cajon Wash experienced normal fluvial process necessary to maintain suitable SBKR habitat.

In 2008 SBKR occupied habitat along Cable Creek, which was historically part of the Cajon Wash floodplain. However, SBKR habitat along Cable Creek was isolated from Cajon Wash by

development and Interstate 215. Habitat quality along Cable Creek was variable and adversely affected by disturbances such as off-highway vehicles and trash dumping.

San Jacinto River and Bautista Creek

In 2008 SBKR occurred in the approximately upper 13 miles of the San Jacinto River, but all habitat downstream of this had been eliminated (USFWS 2009). Lower Indian and Poppet creeks, while not considered historical habitat by McKernan (1997) or discussed in the 2009 5-year Assessment (USFWS 2009), were included in Critical Habitat. Bautista Creek, a tributary of the San Jacinto River, was historically part of a large habitat block contiguous with the San Jacinto (McKernan 1997). However, the Bautista Creek habitat is now isolated from the San Jacinto River by an over 4-mile developed and channelized creek reach that did not support habitat in 2008. While not well-surveyed, the Service considered the upper 4 miles of Bautista Creek to be a self-sustaining population distinct from the San Jacinto River population (USFWS 2009).

Current range/abundance (2018)

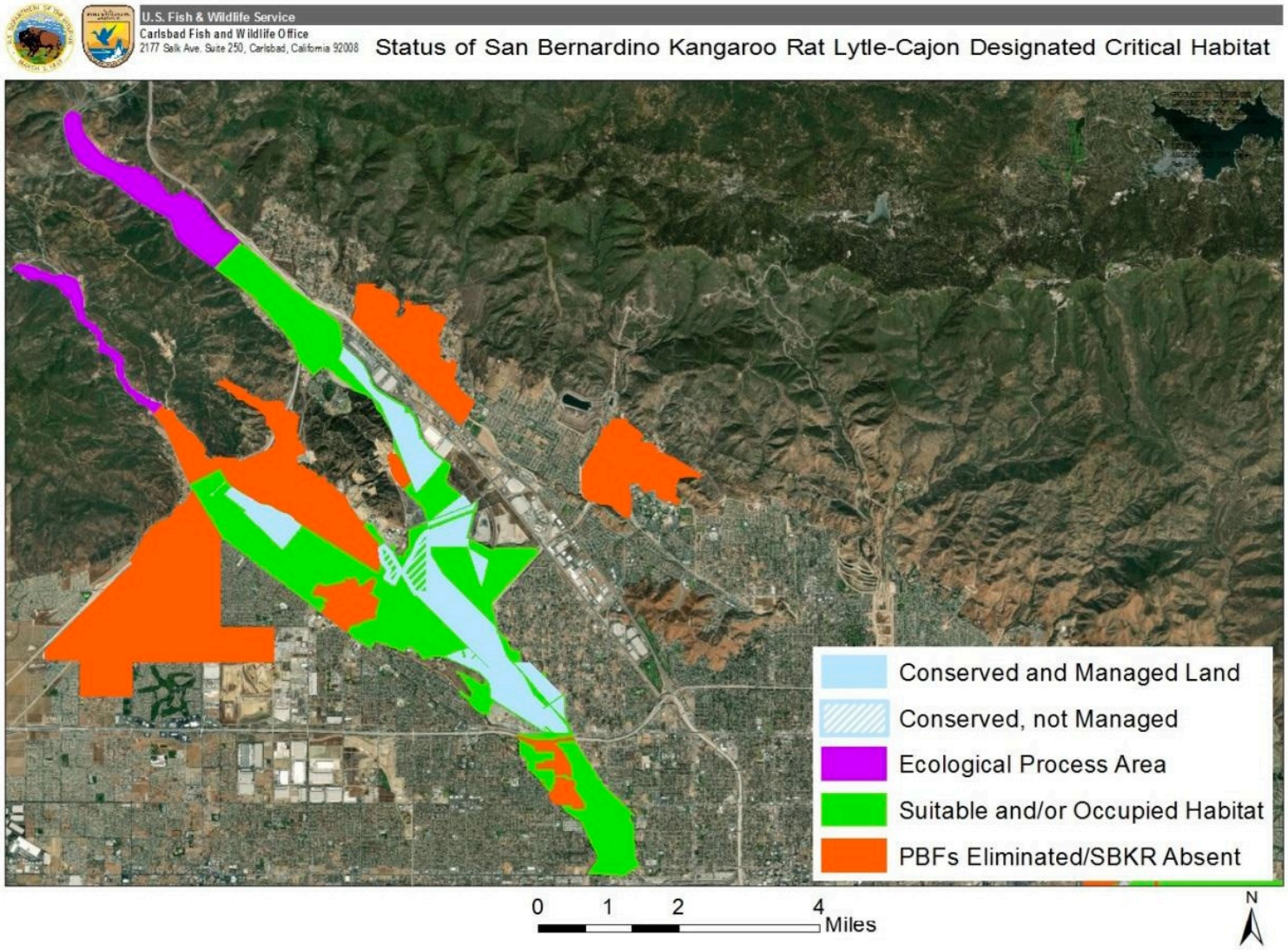
This section uses the best scientific information available to describe current distribution, including museum records, recent unpublished survey and research reports (e.g., Shier et al. 2018), other publicly available location data, and recent Service unpublished information on its distribution and status (USFWS 2018). Over 85% of remaining functional SBKR habitat is associated with Lytle Creek and Cajon Wash and the Santa Ana River, with the only other significant populations along the San Jacinto River (Figure 2, Table 1). It is likely that the SBKR has been extirpated (or occur in such small numbers as to be effectively extirpated) from the Etiwanda Fan and Bautista Creek since 2008 (Shier et al. 2018, USFWS 2018).

Lytle Creek/Cajon Wash

The habitat block along Lytle Creek/Cajon Wash is one of the two largest remaining (Santa Ana River being the other). In Cajon Wash, SBKR occur from 1.5 miles above Interstate 15 downstream to the Lytle Creek confluence. In Lytle Creek SBKR occur from 0.6 mile above the Interstate 15 crossing downstream to Route 66. Recent, extensive trapping in suitable habitat within this block found many sites had low or no SBKR (Shier et al. 2018). The most SBKR were trapped within the Lytle Creek Conservation Bank and Cajon Wash Conservation Bank, and few or no animals were trapped at five other sites (Institution, Glen Helen, Highway 210, Muscovy, and Cemex). Land use changes in this area have fragmented the remaining habitat (Figure 3). Connectivity between upstream and downstream patches along Lytle Creek has been virtually eliminated by the CEMEX mining operation and Lytle Creek North development.

The small SBKR population in Cable Creek, discovered in the late 2000s, has been isolated by development from the historic Cajon/Lytle drainages and is unlikely to persist without intensive management to maintain appropriate habitat conditions (attempts at active SBKR habitat management are discussed further below). The Service considers that the physical and biological features necessary to support SBKR at Cable Creek have been eliminated (Figure 3, USFWS 2018).

Figure 3. SBKR status habitat within the Lytle Creek/Cajon Wash Critical Habitat unit (from USFWS 2018).



In 2018 the Service identified 6,471 acres of suitable, occupied, and/or conserved SBKR habitat, and approximately 6,530 acres where physical and biological features necessary for SBKR have been eliminated from within this Critical Habitat unit (Figure 3, USFWS 2018). The Service currently estimates only 46% of Critical Habitat in this the largest (13,970 acres) of the Critical Habitat units is suitable, occupied or conserved for SBKR, and this remaining habitat is threatened by additional development (discussed further below).

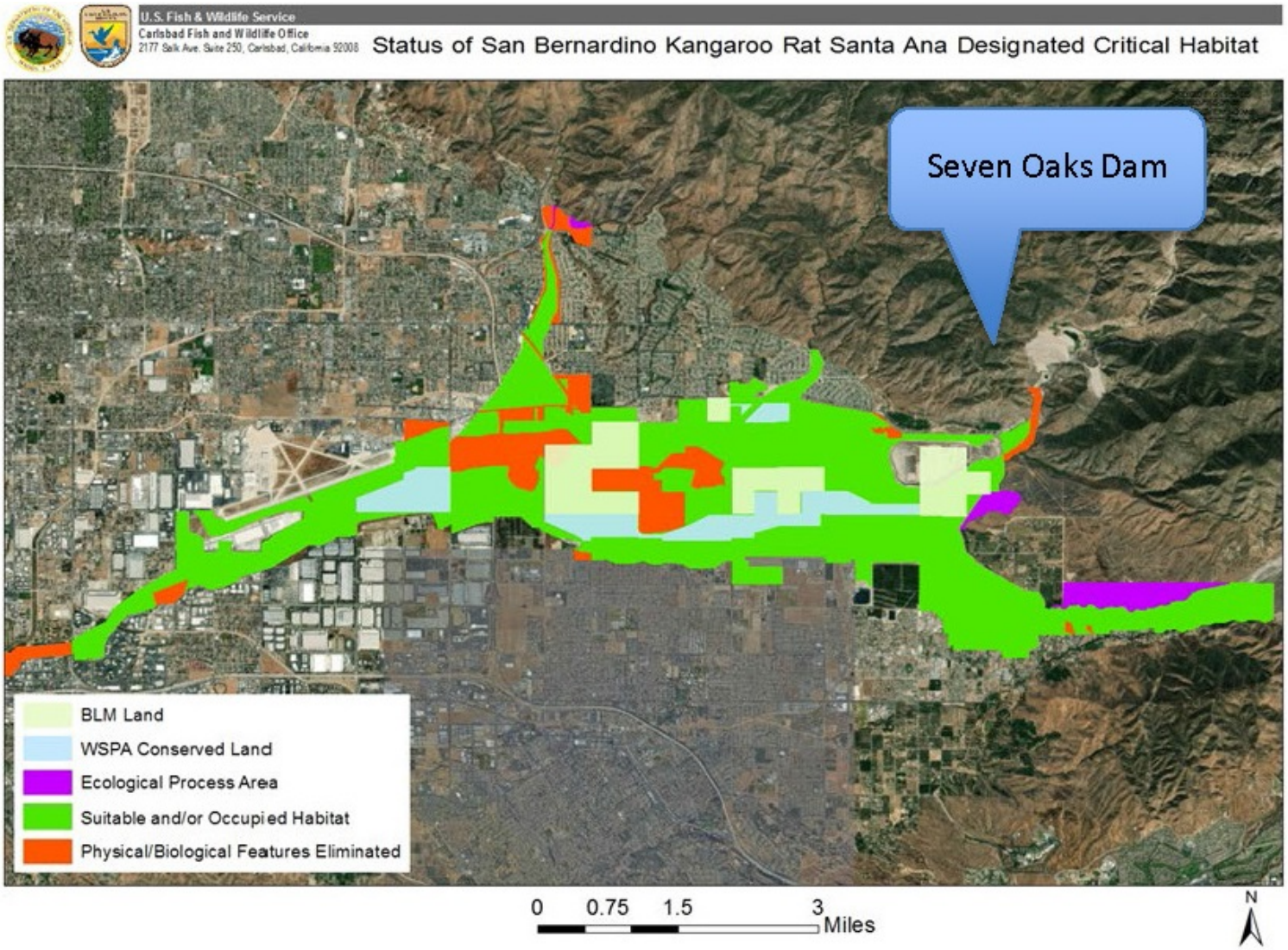
Santa Ana River

SBKR distribution within this second largest Critical Habitat unit includes the lower portions of Mill Creek, Plunge Creek, and City Creek near their confluences with the Santa Ana River, and the mainstem Santa Ana River from the mouth of the canyon down to Tippecanoe Avenue. The mainstem Santa Ana River habitat has been fragmented by road, mining, and development. The Mill Creek population above Greenspot Road is also small, isolated, and adversely affected by creek channelization, water conservation basins, and flood control. City Creek upstream of Highland Avenue no longer supports necessary physical and biological features for SBKR (Figure 4, USFWS 2018).

Construction of the SOD and flood control operations of the reservoir have dramatically altered the hydrology of the Santa Ana River and eliminated the hydrological and ecological processes that have historically maintained habitat for SBKR. While the Biological Opinion for Seven Oaks anticipated periodic water releases to mimic historic flood flows and rejuvenate habitat (USFWS 2002b), such releases have not occurred and have not yet been planned by dam operators. In addition, the design of the dam physically limits the amount of water that can be released to a small fraction of the river's larger historical peak flows (ICF 2019). As a result of dam construction, large proportions of existing and proposed conservation areas along the Santa Ana River are no longer hydrologically active and will require long-term active management actions (as yet unproven) to maintain suitable habitat for SBKR (USFWS 2018). Recent hydrological studies of the Santa Ana River system (ICF 2018) conclude that the current tributary flow regimes, even if augmented by theoretically maximum dam releases, will not, given the deeply incised channel and reduced discharge relative to historical conditions, reconnect the channel with the historical floodplain. The lack of flooding in the disconnected floodplain will lead to succession by mature floodplain vegetation and invasion by nonnative plants inhospitable to SBKR.

In 2018 the Service identified 7,426 acres of suitable, occupied, and/or conserved SBKR habitat, and approximately 1,240 acres where physical and biological features necessary for SBKR have been eliminated from within the 8,935-acre Critical Habitat Unit (Figure 4, USFWS 2018). This includes ~773 acres in the WSPA (Figure 4). Therefore, the USFWS currently estimates 83% of Critical Habitat in this Critical Habitat unit is suitable, occupied or conserved for SBKR, but some of the conserved habitat is not occupied (USFWS 2018).

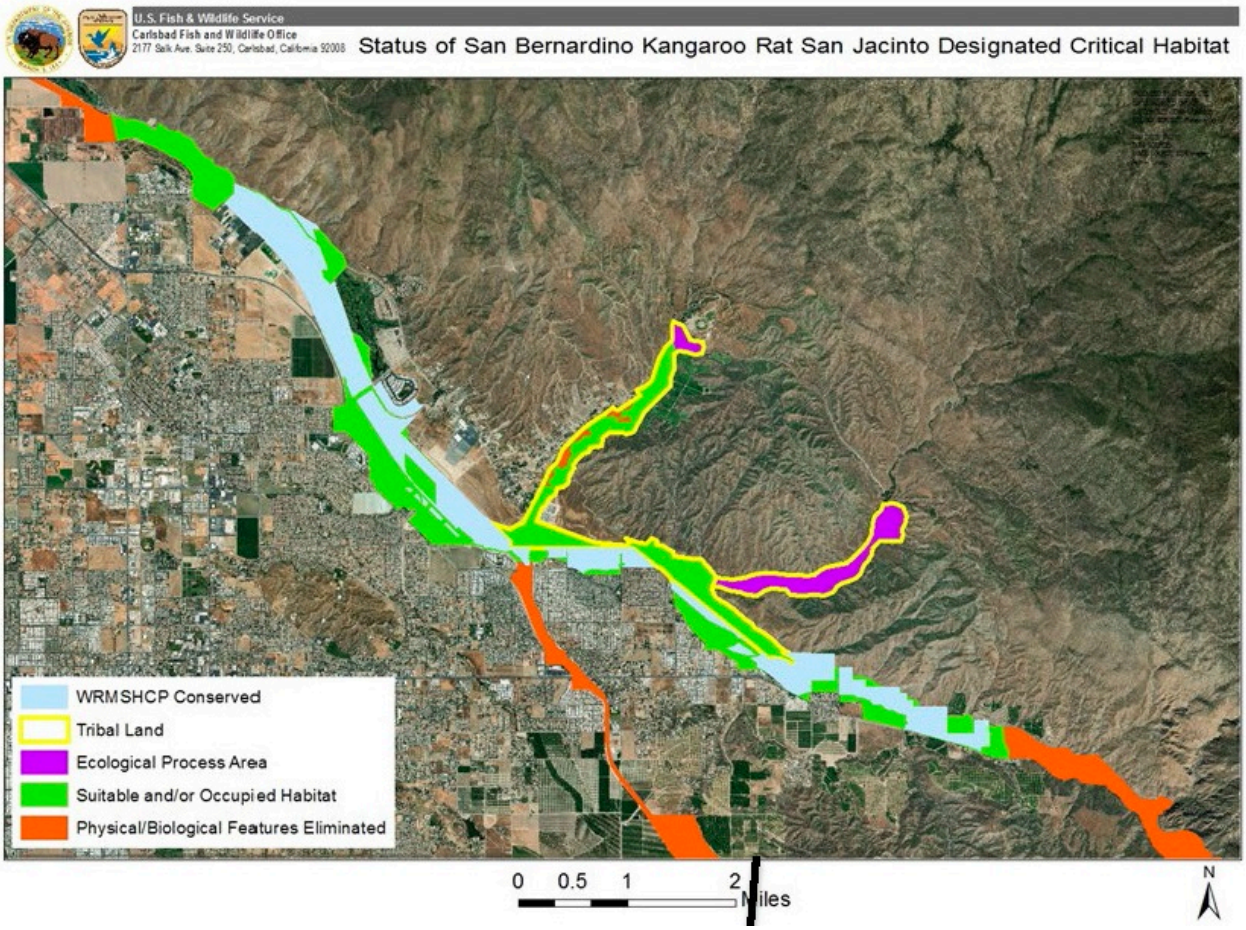
Figure 4. SBKR status habitat within the Santa Ana River Critical Habitat unit (from USFWS 2018).



San Jacinto River and Bautista Creek

The Service currently considers only the upper 6 miles of the San Jacinto River to be occupied based on trapping surveys conducted since 2009, and only 43% (2,403 acres) of the 5,565 acres of Critical Habitat in this unit to be functioning (USFWS 2018), while the necessary physical and biological features for SBKR have been eliminated on 2,913 acres of the unit (Figure 5). This remaining habitat is fragmented by roads and stream channelization. The Service considers the Bautista Creek population, which has been physically isolated from the confluence of the San Jacinto River by a 4-mile long concrete channel, to be extirpated (Figure 5). Monitoring for SBKR in 2015 found only 451 acres of occupied habitat in the MSHCP preserve, 32% of the "suitable" habitat that was sampled by the Biological Monitoring Program, and far short of the MSHCP conservation objective for this species (Biological Monitoring Program 2016). Shier and colleagues (2018) trapped no SBKR at one of their Valle Vista sites, and SBKR were absent from the occupied Hemet site when it was re-trapped in 2017.

Figure 5. SBKR habitat status within portions of the San Jacinto River/Bautista Creek Critical Habitat unit (from USFWS 2018). The status of the upper portions of the unit not shown in the map is Physical/Biological Features Eliminated.



Etiwanda Alluvial Fan

Only a few SBKR remained extant within the Etiwanda Alluvial Fan Critical Habitat unit when it was designated (USFWS 2002a). Shier and colleagues (2018) trapped but did not capture SBKR at Wilson and Edison. Service records indicate that the remaining SBKR on the Etiwanda Fan occur on the periphery of San Bernardino County Flood Control basins which inadvertently provide a narrow margin of suitable, marginally occupied habitat. The few remaining animals and limited habitat have little viability, as the population is small, isolated, and subject to flood control activities; the Service now considers that physical and biological features necessary for SBKR in the Etiwanda Fan Critical Habitat unit have been eliminated (Figure 2, USFWS 2018).

Land cover change 1998-2018

We estimated the loss of potentially suitable SBKR habitat in the decade between the emergency listing habitat of SBKR in 1998 and 2018. We used aerial photographs from NASA and Google Earth, focusing on lands inside and outside designated Critical Habitat for the species. The objective of this analysis is to identify the relative geographic distribution of remaining SBKR habitat and estimate the amount of land cover change experienced by the remaining populations since the time of the federal listing. To assess the nature, magnitude, and rate of SBKR habitat loss, we used aerial photographs, SBKR survey reports submitted to the Service, Biological Opinions issued by the Service, project Environmental Impact Reports, and decades of field work and SBKR trapping by the author (GB) and Biological Consultant (PB) to map the remaining "potential" SBKR habitat at the time of its listing as Endangered by the Service in (1998) and then again in 2018 (Table 2).

Because the condition, quality and actual occupancy of SBKR across its current range changes over time and is not comprehensively known at any given point in time, for years 1998 and 2018 we mapped all "potential" SBKR habitat, including alluvial fan scrub vegetation and adjoining ruderal and disturbed habitats that in our experience have the potential to support SBKR. The mapping within SBKR Critical Habitat was carried out regardless of documented occupancy. Outside of Critical Habitat, potential habitat was mapped in adjoining areas where historical records of SBKR were found. This exercise yielded a likely maximum estimate of potential SBKR habitat, and it is certain that not all of it is suitable, functional, or occupied. Most importantly, this mapping exercise identified areas that are not considered potential habitat for SBKR because of human-induced land cover changes (for example, conversion to residential development). Therefore, this exercise documents the magnitude and rate of the *irreversible* loss of potential SBKR habitat since listing by the Service in 1998.

By late 1998 SBKR occupied habitat was in seven populations largely restricted to four geographic areas (USFWS 1998): Etiwanda Alluvial Fan (Figure 6), Lytle Creek/Cajon Wash (including Cable and Devils creeks, Figure 7), Santa Ana River (Figure 8), and San Jacinto River/Bautista Creek (Figure 9a, b). These four areas ultimately served as the basis of the Service's designation of Critical Habitat for SBKR (USFWS 2002a). In 1998, we estimate approximately 36,464 acres of potential habitat existed, with a little more than 3,200 acres of unsuitable areas within the boundaries of designated Critical Habitat (Table 2).

By 2018, under federal Endangered Species Act regulation, each of the four areas had lost significant acreages of habitat (Table 2). Nearly 11,000 acres of potential habitat was converted to areas unsuitable for SBKR during this 20-year period, an increase of 337%. This represents a rate of 539 acres of habitat lost per year since federal listing of the species. In addition, there was a particularly large loss of potential habitat in Lytle Creek and Cajon Wash (5,613 acres), which, with the Santa Ana River, is one of the two remaining significant populations. While the acreages in Table 2 significantly overestimate the actual area occupied by SBKR (e.g., San Jacinto River is estimated to support only a total of 451 acres [Biological Monitoring Program 2016] and the Service considers the Etiwanda Alluvial Fan population extirpated [USFWS 2018]), these estimates provide an objective picture of the rates of land cover change in the only remaining areas that still supported SBKR in 1998. Given that significant portions of remaining potential habitat have lost the physical and biological features necessary to support SBKR (USFWS 2018), the current status and trajectory of SBKR is truly dire. Further, as demonstrated by these steep and ongoing rates of loss of suitable habitat, this negative trajectory is *not* being effectively addressed through the federal listing.

Table 2. Acreages of potential, suitable and unsuitable SBKR habitat in 1998 and 2018. Units are shown in Figures 6-9.

Unit	1998 Unsuitable	1998 Suitable	2018 Unsuitable	2018 Suitable	% Loss Suitable 1998-2018	% Increase Unsuitable 1998-2018
Inside Critical Habitat						
Etiwanda Alluvial Fan	248	5,645	2,402	3,491	24%	435%
Lytle Creek/Cajon Wash	1,285	15,891	6,898	10,278	19%	187%
Santa Ana River	1,004	8,829	2,661	7,172	10%	75%
San Jacinto River/Bautista Creek	664	6,099	2,036	4,727	4%	221%
Outside Critical Habitat						
Etiwanda Alluvial Fan	0	1,075	1,075	0	100%	-
Lytle Creek/Cajon Wash	0	3,205	3,205	0	100%	-
Santa Ana River	0	897	897	0	100%	-
San Jacinto River/Bautista Creek	0	1,198	1,198	0	100%	-
Estimated Totals	**3,201**	**36,464**	**13,997**	**25,668**	**30%**	**337%**

Figure 6. A comparison of the distribution of remaining "potentially suitable" San Bernardino kangaroo rat habitat within and adjacent to the Etiwanda Fan Critical Habitat unit (designated in 2002) and areas considered unsuitable for SBKR in 1998 (top) and 2018 (bottom).

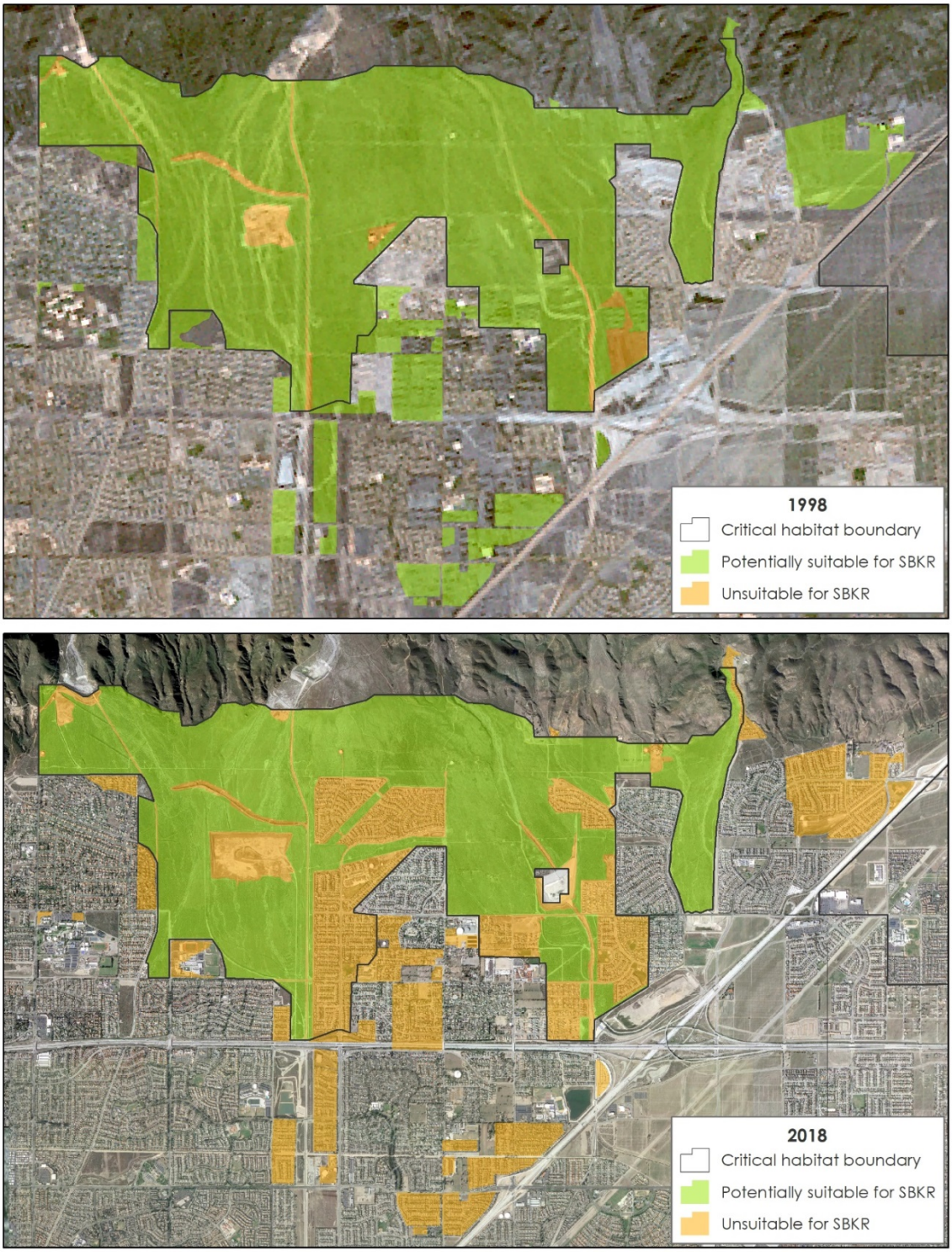


Figure 7. A comparison of the distribution of remaining “potentially suitable” San Bernardino kangaroo rat habitat within and adjacent to the Lytle Creek/Cajon Wash Critical Habitat unit (designated in 2002) and areas considered unsuitable for SBKR in 1998 (left) and 2018 (right).

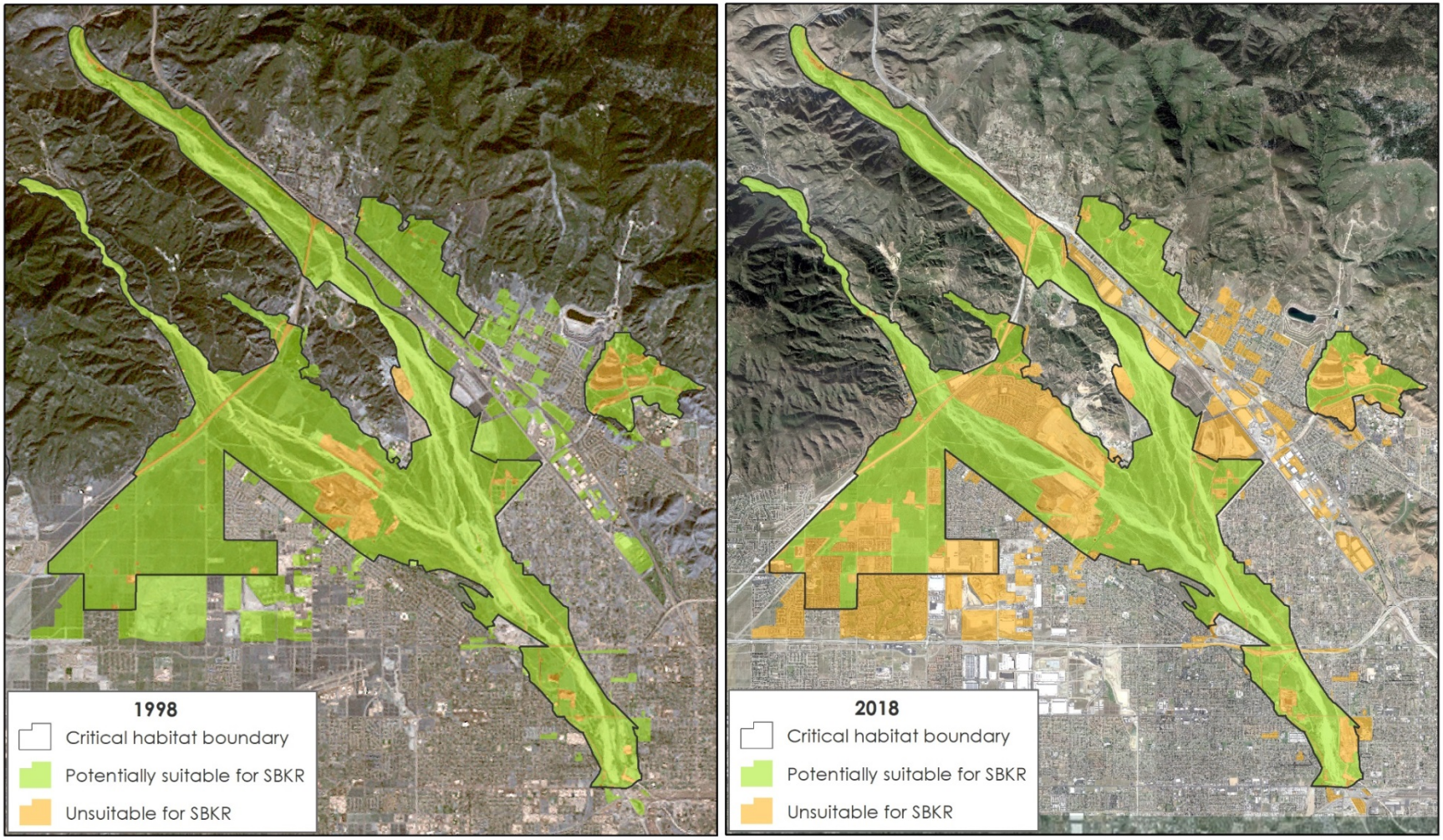


Figure 8. A comparison of the distribution of remaining “potentially suitable” San Bernardino kangaroo rat habitat within and adjacent to the Santa Ana River Critical Habitat unit (designated in 2002) and areas considered unsuitable for SBKR in 1998 (top) and 2018 (bottom).

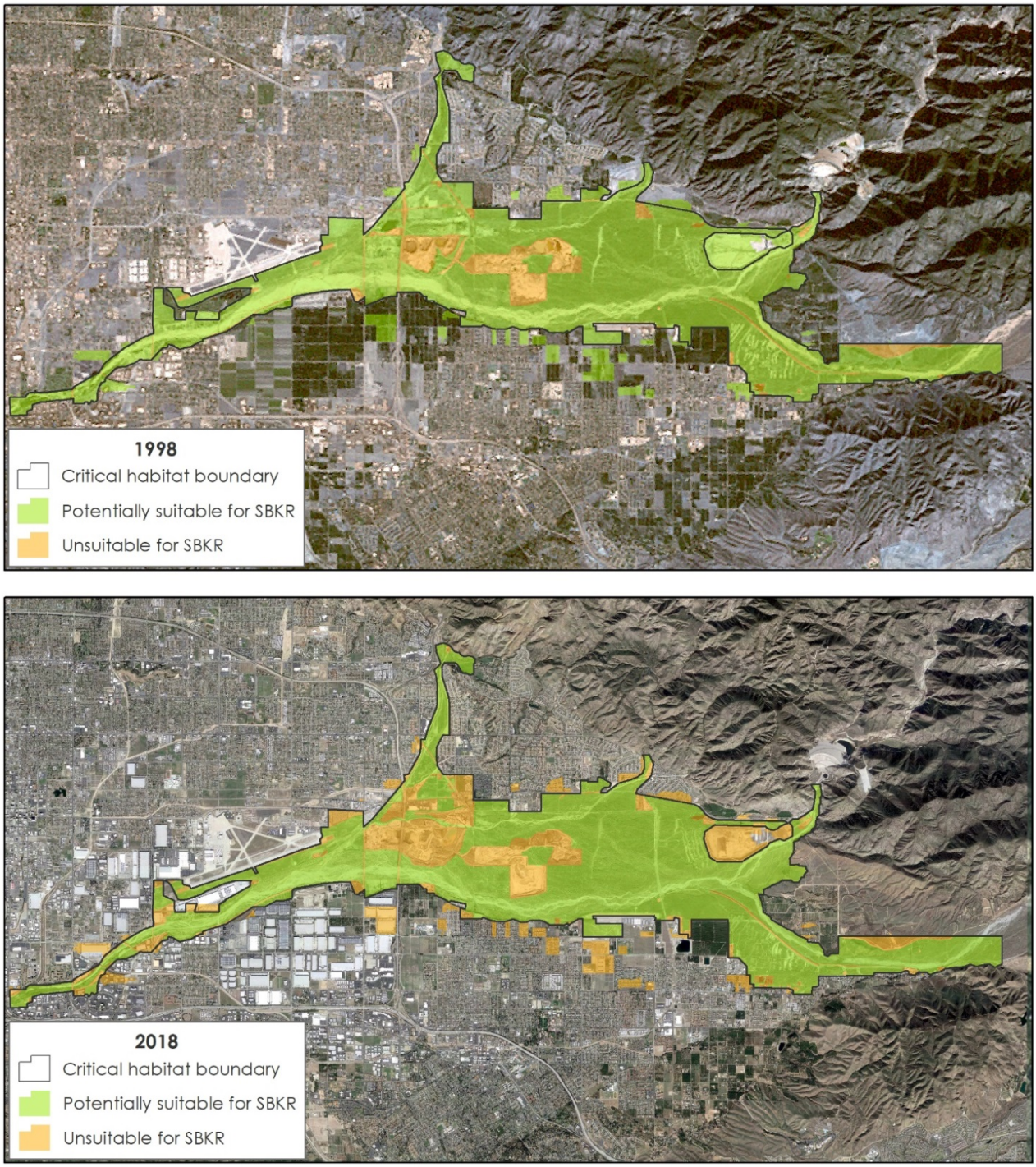


Figure 9a. Comparison of the distribution of remaining “potentially suitable” SBKR habitat within and adjacent to the northern portion of the San Jacinto River/Bautista Creek Critical Habitat unit (designated in 2002) and areas considered unsuitable for SBKR in 1998 (top) and 2018 (bottom).

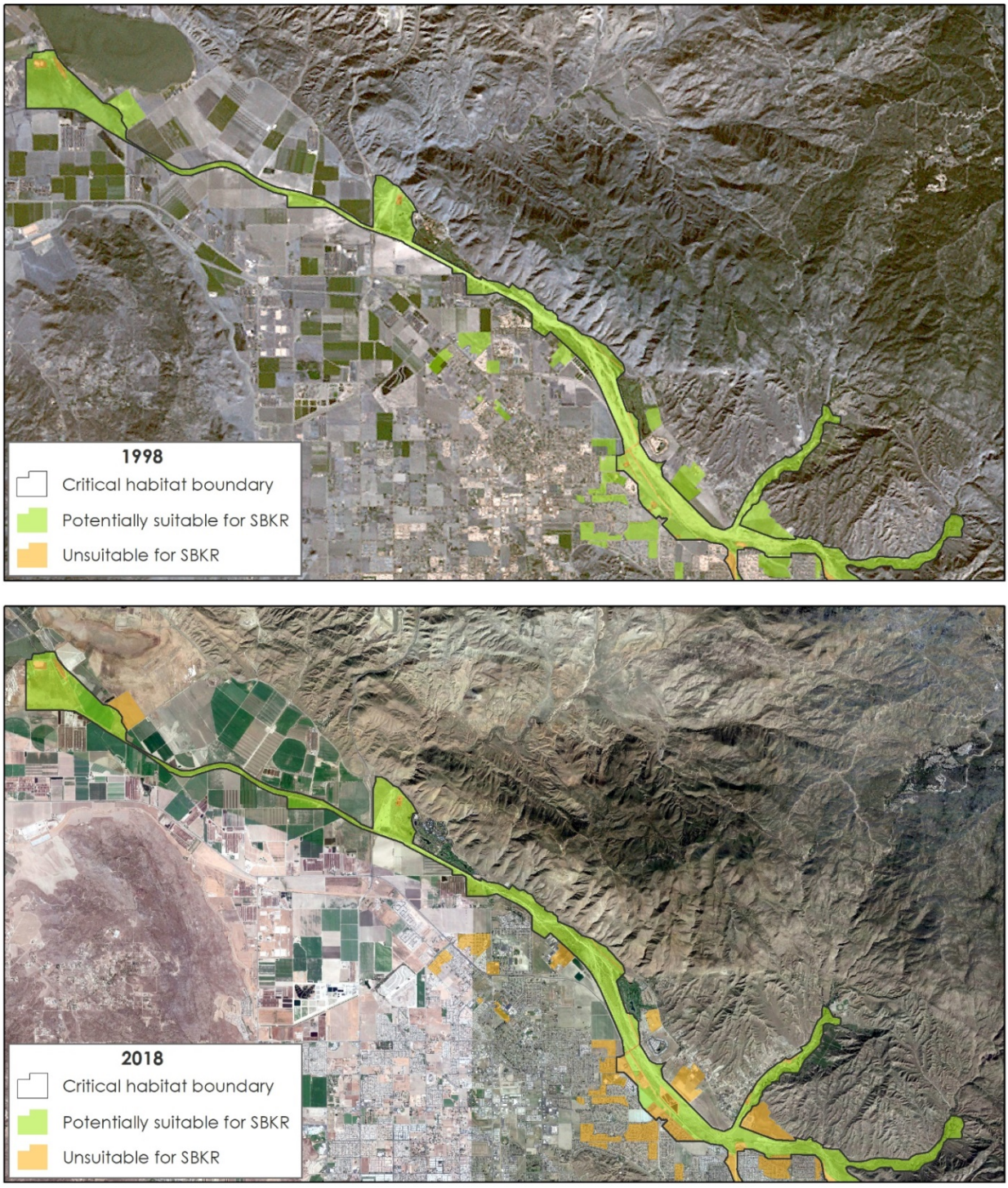
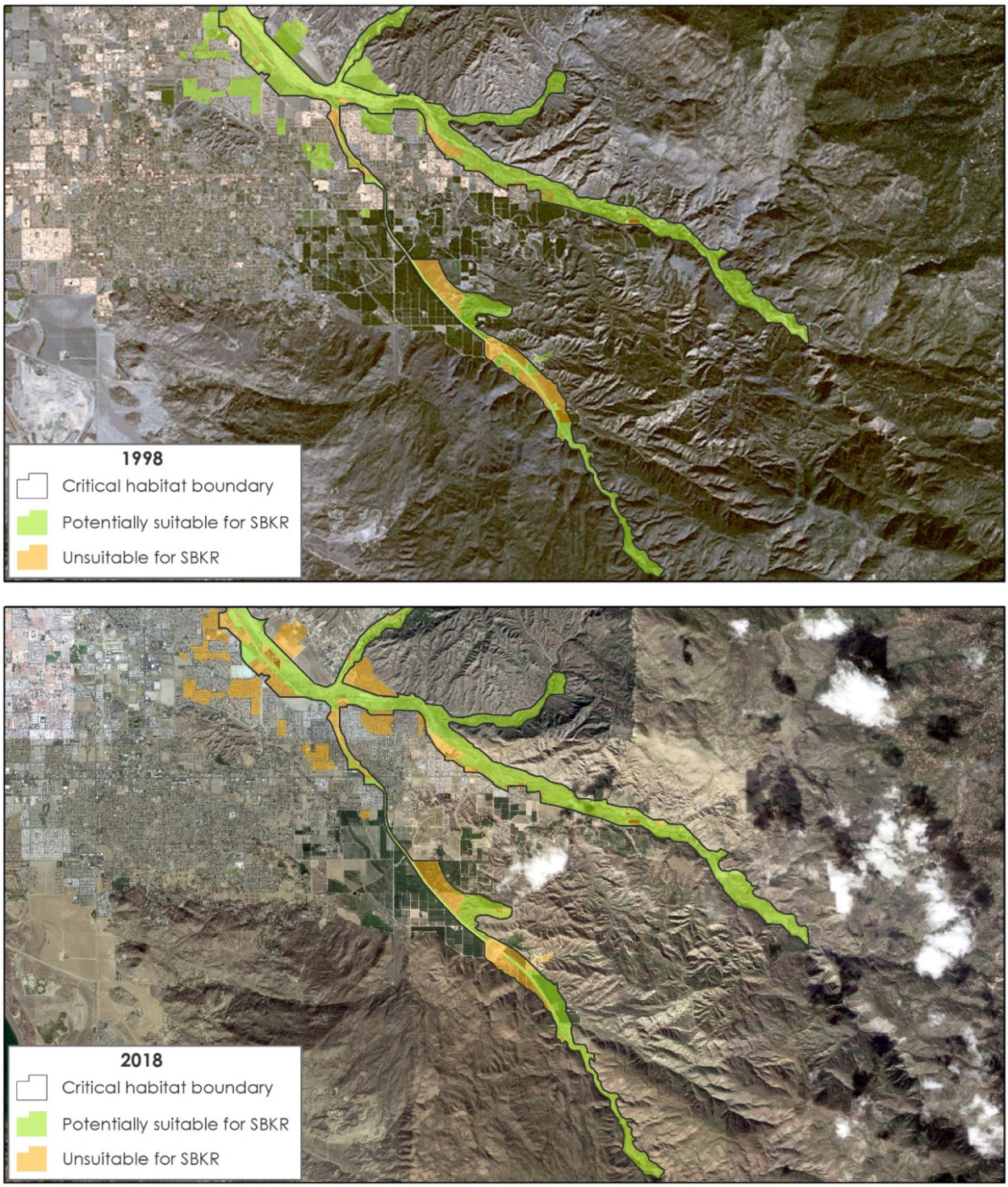


Figure 9b. Comparison of the distribution of remaining “potentially suitable” SBKR habitat within and adjacent to the southern portion of the San Jacinto River/Bautista Creek Critical Habitat unit (designated in 2002) and areas considered unsuitable for SBKR in 1998 (top) and 2018 (bottom).



3. ABUNDANCE

SBKR historically occurred in alluvial fan scrub habitats associated with the active floodplains of the San Bernardino and San Jacinto/Perris valleys (McKernan 1997). As discussed above, due to the urban, commercial, and agricultural development of these areas, less than 5% of SBKR's historic range was still occupied by 2008 (USFWS 2009). However, much of this remaining habitat has low value because it is highly fragmented, degraded, and lacks necessary ecological functions to support SBKR. As discussed further in Section 5, local habitat conditions control population abundance, which generally ranges from 1 to 30 individuals/acre (McKernan 1997, Root 2008, Root 2010). Habitats in areas with natural fluvial processes support greater abundance than areas where these processes have been modified or eliminated (McKernan 1997, USFWS 2009, USFWS 2018). Population abundance trends are poorly understood across SBKR's range. Therefore, the dramatic loss and fragmentation of the species' habitat, rather than a population abundance trend per se, is the best descriptor of SBKR's status and need for additional CESA protection.

4. LIFE HISTORY (SPECIES DESCRIPTION, BIOLOGY, AND ECOLOGY)

Description

SBKR (*Dipodomys merriami parvus*) is one of three recognized subspecies of Merriam's kangaroo rat within California (Lidicker 1960) that occur in alluvial fan scrub habitats in northern San Bernardino and Riverside counties. The San Bernardino kangaroo rat is morphologically distinct from the other two *D. merriami* subspecies in California (*D. m. merriami* and *D. m. collinus*). It has yellowish-brown colored pelage with dark brown tail stripes, foot pads, and tail hairs. It has an average body length of 95 millimeters (3.7 inches) and a total length (tail included) of 230-235 millimeters (9-9.3 inches). Its hind feet are <36 millimeters (1.4 inches) in length. On average, the San Bernardino kangaroo rat is smaller and darker than the other two California *D. merriami* subspecies.

Taxonomy and current population genetics

Kangaroo rats belong to the genus *Dipodomys* within the Heteromyidae family of rodents. Merriam's kangaroo rat (*D. merriami*) occurs throughout arid regions of the western United States and northwestern Mexico, with 19 described subspecies across this range (Hall 1981, Williams *et al.* 1993). Only three of the 19 subspecies occur in California: *Dipodomys merriami merriami*, *D. m. collinus*, and *D. m. parvus*. SBKR was initially described as a full species (*D. parvus*) but is currently considered a subspecies of *D. merriami* (Hall 1981, Williams *et al.* 1993).

SBKR is geographically isolated from the other two *D. merriami* subspecies. At the northern end of its range, near Cajon Pass, the SBKR is separated from *D. merriami merriami* (in the Mojave Desert) by 5-8 miles of currently unsuitable habitat. At the southern end of its range, it is geographically separated from *D. m. collinus*, which it may have intergraded with in the distant

past (Lidicker 1960). Morphological divergence suggests potential genetic differentiation as well, and it has been suggested that the SBKR may be a separate species (Lidicker 1960).

Dispersal and home range

While no data exist on home ranges for SBKR specifically, home range size for Merriam's kangaroo rat averages 0.33 hectare (0.82 acre) for males and 0.31 hectare (0.77 acre) for females (Behrends *et al.* 1986). Edges of the home ranges of neighboring kangaroo rats sometimes overlap. However, adults often defend core areas near their burrows. Overlap between male-male and male-female kangaroo rat home ranges is often extensive, while female-female overlap is generally much less (Jones 1993). Zeng and Brown (1987) found that 75% of adult male and 59% of adult female *D. merriami* dispersed between 197 feet (60 meters) and 787 feet (240 meters) from their initial capture sites (in the Chihuahua Desert).

Reproduction and growth

SBKR reproductive timing is variable and likely depends on annual precipitation and associated plant growth. Pregnant and lactating females have been found between January and November, and reproductively active males have been observed from January through August (McKernan 1997). Green vegetation following rainfall is consumed prior to reproductive activity. Merriam's kangaroo rat may forgo breeding during years of poor plant growth in response to drought conditions (Tremor et al. 2017). Females can have more than one litter per year, with an average litter size of two to three young (Eisenberg 1993).

Foraging ecology and diet

Merriam's kangaroo rats are nocturnal and primarily granivorous. They store seeds temporarily in external fur-lined cheek pouches before stashing the seeds in either shallow pit caches or a larder within their burrows, which they utilize during periods of food scarcity (Jenkins et al. 1995, Reichman and Price 1993). Individuals within the same population may exhibit different food-hoarding preferences (Murray et al. 2006). Although seeds are a central component of their diets, they also forage for green vegetation and insects. These additional food supplies provide essential sources of water for kangaroo rats, which can live indefinitely without direct consumption of water (Reichman and Price 1993). Foraging rates are lower during full moon compared to new moon conditions (Kotler 1984, Wang and Shier 2017).

Natural mortality and population regulation

Merriam's kangaroo rats (*D. merriami*) live for 3.7- 5 months on average, but single individuals can live for >3 years (French *et al.* 1967). Kangaroo rat populations fluctuate dramatically in response to food availability (Goldingay et al. 1997). *Dipodomys* species, unlike other Heteromyids, do not have the ability to enter a state of torpor, or inactivity, which would help prevent dramatic populations declines during times of drought or low resource abundance (Brown and Harney 1993). Major flood events also negatively affect local population abundance, and kangaroo rat mortality is often high following these episodic events (USFWS 2002a). Predation by coyotes (*Canis latrans*), grey foxes (*Urocyon cinereoargenteus*), badgers (*Taxidea*

taxus), long-tailed weasels (*Mustela frenata*), bobcats (*Lynx rufus*), snakes (*Crotalus* spp. and *Pituophis* spp.), and raptors (e.g., great horned owls [*Bubo virginianus*]) also acts as a natural population regulator (French et al. 1967, Daly et al. 1990, Shier unpublished).

5. HABITAT NECESSARY FOR SURVIVAL

Necessary habitat characteristics for the SBKR include: sandy or gravelly soils and substrates, generally supporting open-structured alluvial fan scrub vegetation, in floodplains with active fluvial processes and nearby upland and/or less frequently inundated terraces (USFWS 2002a). These habitat characteristics are described further below.

The SBKR's habitat occurs within naturally functioning alluvial fan systems, which are highly dynamic, constantly shifting networks of braided channels. The active channels can range from a few decimeters to several meters deep. Alluvium and soils in the floodplain typically have sand, sandy loam, or gravel textures (McKernan 1997). Habitat quality is frequently reworked in these systems through scouring, sediment relocation, and alluvium deposition during fluvial events. There are three successional phases of alluvial fan scrub habitat, the distribution of which is determined by three characteristics: elevation, distance from main channel, and time since previous flooding. The three successional phases are pioneer, intermediate, and mature (Hanes et al. 1989). The pioneer phase has been subject to recent flooding and often occurs close to the main channel. The intermediate phase is generally between the active channels and terraces and experiences periodic flooding over longer temporal intervals. The climax, or mature, phase is rarely affected by flooding and has dense vegetation cover (Smith 1980). The SBKR prefers more open vegetation structures (between 7 and 22% shrub cover), which is typically in the early and intermediate seral stages (McKernan 1997). The intermediate terraces have been observed to host the highest densities of kangaroo rats (Smith 1980).

A geomorphic analysis of the upper Santa Ana River alluvial fan carried out in 1999 (Mussetter Engineering 1999, MEC Analytical 2000) examined SBKR habitat in relation to flood history. Data on soil characteristics (weathering on the surface of boulders, gravel, cobble, boulder, and sand grain size; surface texture; presence and size of lichens, cryptogramic crusts on soil surfaces, sediment depths, and successional phases of the vegetation) were used to map the locations of channels, overbank, and interfluvial areas associated with major floods, notably the 1862/1869, 1938, and post-1938 floods.

The main classes of flood influence were areas influenced by the 1938 flood and more recent floods; areas overtopped by the 1938 flood; and areas that last experienced substantial flooding during the 1862/1869 floods. The 1862/1869 floods, with estimated peak glows of 120,000 cubic feet/sec (cfs) (the largest on record, representing a 200-year pre-SOD flood event) flooded most or all of the fan of the Santa Ana River and hydraulically re-worked most of the fan. The 1938 flood, with an estimated peak flow of about 45,000 cfs (representing a 50-year storm pre-SOD) flooded large areas of the fan with the exception of the area between the percolation basins and Plunge Creek. This area was last flooded or over-topped by the 1862/1869 floods but not affected by the 1938 flood and now supports senescent alluvial fan sage scrub habitat. Data indicate that geomorphically significant events that re-set alluvial fan sage scrub plant succession

have occurred twice in the last 140 years in the pre-SOD history (1862/1869 and 1938), suggesting a recurrence interval of 60-70 years.

The absence of fluvial processes for 60-70 years leads to senescent alluvial fan sage scrub via plant community succession, and senescent alluvial fan sage scrub habitat is not used by SBKR. Senescent alluvial fan sage scrub dominates the Etiwanda fan Critical Habitat unit, is the dominant native plant community in the western part of the Lytle Creek-Cajon Wash unit and occurs in the Santa Ana River between the percolation basins and Plunge Creek. SBKR are most abundant in the early pioneer phase alluvial fan sage scrub habitat, which occupies a small part of the Santa Ana River Critical Habitat unit. Most of the alluvial fan sage scrub in the Santa Ana River Critical Habitat unit is intermediate phased AFSS dominated by juniper trees/shrubs. SBKR historical occurrences are distributed widely in this habitat type, but in lower numbers than in early successional stage alluvial fan sage scrub. Moreover, in the absence of fluvial processes, juniper-dominated intermediate phased alluvial fan sage scrub probably developed 20 years after the latest major flood event, and successional changes after 60 or 70 years can be expected to lead to the senescent phase alluvial fan sage scrub.

Flood events can destroy burrows and force the movement of individuals occupying flooded habitats or they drown. Local population survival is therefore dependent on connectivity to nearby refugia, often on intermediate to higher elevation floodplain terraces, where individuals can escape floods and later colonize early successional habitats (USFWS 2002a).

There is a body of evidence demonstrating the adverse effects of habitat fragmentation and edge effects (e.g., night lighting) on small mammals such as SBKR (e.g., Wilcox and Murphy 1985, Beier 2006). Rodents change their foraging behavior during full moons presumably to reduce their risk to visual predators (Daly et al. 1992, Wang and Shier 2017), and artificial lights can elicit the same responses (Kotler 1984, Wang and Shier 2017). SBKR are significantly less likely to deplete a foraging patch under continuous lighting than under motion detection lights or natural moon conditions. The effect of artificial lighting on SBKR foraging decisions was significant up to 82 feet (25 meters) from the light source (Wang and Shier 2017). Thus, edge effects affect SBKR foraging decisions, and so large unfragmented blocks of suitable habitat not subject to edge effects likely provide the highest habitat quality for SBKR.

6. FACTORS AFFECTING ABILITY TO SURVIVE AND REPRODUCE

The primary threat to SBKR is the direct impact of past and present modification and destruction of its habitat. McKernan (1997) first documented the extensive loss and fragmentation of this species' historical habitat. This work by McKernan and others in the late 1990s led the Service to emergency-list SBKR as Endangered in 1998. By that time, SBKR habitat had been reduced from two large contiguous blocks of habitat in the San Bernardino and San Jacinto/Perris valleys, respectively, into four small, internally fragmented blocks of habitat (Etiwanda Fan, Lytle Creek/Cajon Wash, Santa Ana River, and San Jacinto River/Bautista Creek), with >90% of the remaining habitat found in only two of these blocks (Santa Ana River, Lytle Creek/Cajon Wash). These four remaining blocks of habitat were the focus of the Service when designating Critical Habitat (USFWS 2002).

However, habitat in these areas has continued to be lost, fragmented, and degraded by land use changes. We estimate that on average over 500 acres of SBKR habitat have been lost each year, with over 11,000 total acres of habitat having been lost since federal listing in 1998. Just as important as the direct loss of habitat, however, significant ecological and hydrological processes that historically maintained SBKR habitat have also been lost due to channelization, flood control operations and water management, and loss of upland refugia. The result is an increasing reliance on experimental, unproven, and as yet unsuccessful, management measures to recover these declining populations.

Habitat loss is the primary driver of species extinction (e.g., Fahrig 2003, Wilcove et al. 2008), and over 95% of the SBKR's historical habitat has been eliminated, including the complete loss of significant portions of its original range (McKernan 1998). This in and of itself potentially jeopardizes the continued existence of the SBKR. Structural impacts to SBKR habitat as a result of habitat conversion to developed uses (e.g., residential, commercial, and flood control), and other land use changes, have led to the loss and degradation of connectivity between remaining habitat patches, which has also been eliminated or greatly reduced. Habitat fragmentation can have negative effects on animal populations (Fahrig 2003, Prugh et al. 2008), particularly when remaining habitat patches have low habitat quality, which can increase extinction rates in individual patches and reduce the long-term viability of a species (Lindenmayer and Luck 2005, Prugh et al. 2008, Rhoades et al. 2008). Because much of the remaining suitable habitat is now located in highly active and flood-prone channels and near stream locations with limited connectivity to suitable habitat on higher, less frequently flooded terraces, elevated local extinction rates of SBKR are expected. In addition, Prugh and colleagues (2008) emphasize the importance of the intervening "matrix" lands (land between suitable habitat patches) to population persistence; i.e., when matrix lands have low or no habitat suitability, the adverse effects of habitat loss and fragmentation on population viability increase. Most of the undeveloped matrix lands around higher quality patches of SBKR habitat lack appropriate fluvial processes and vegetation succession, support nonnative grass, and have elevated night lighting and other edge effects. Without immediate intervention to reverse the extensive losses and modifications to its habitat, the long-term viability and persistence of SBKR is questionable.

A range-wide genetic assessment of SBKR confirms these negative trends in habitat and population loses for conservation and recovery of the species. SBKR in the Lytle Creek/Cajon Wash, Santa Ana River, and San Jacinto River/Bautista Creek blocks of habitat have low effective population sizes (N_e, Shier et al. 2018). Effective population sizes in Lytle Creek/Cajon Wash (85.8), Santa Ana River (30.4), and San Jacinto River (14.7) are an order of magnitude below the target for maintaining genetic diversity in the species (N_e>500), and the Santa Ana River and San Jacinto River fall below targets to prevent inbreeding depression (N_e>50). Shier and colleagues (2018) documented significant levels of inbreeding of SBKR within these three blocks of habitat and no natural interbreeding among them (their work did detect the translocation of SBKR between the Santa Ana River and Cajon Wash populations). The genetic structure of the three populations is unique, reflecting their relatively recent isolation from each other due to loss of connectivity. Genetic diversity in the San Jacinto block was particularly low and suggestive of a population bottleneck in the past.

SBKR populations use fluvially dynamic alluvial floodplains that support a shifting but interconnected mosaic of flood terraces, varying in elevation with different aged and structured stands of alluvial fan scrub habitat. However, flood control and water management, rail lines, roads and culverts, commercial and urban development, agricultural conversion, and nonnative plant species have modified or eliminated floodplain connectivity and these processes. The prospect for long-term persistence of SBKR and its habitat in the Santa Ana River area is poor because of the operation of the SOD, and nonnative plant invasion and type conversion. Likewise, SBKR appear to have been extirpated in the upper reaches of City Creek (upstream of Highland Avenue). Habitat along Lytle Creek now exists within levee-modified or channelized floodplains which are subject to high stream velocity and scouring events relative to historical conditions, exposing SBKR populations to potentially catastrophic flooding events with little available refugia that remains available for SBKR to move to elevations above the flood zone. Habitat that is currently occupied will become unsuitable for SBKR over time. The cumulative impacts of habitat loss and land use changes jeopardize the continued existence of the species under existing conditions. New development proposals along Lytle Creek and the loss of natural hydrological processes on the Santa Ana River further threaten the last remaining irreplaceable blocks of SBKR habitat with functioning fluvial processes and will further degrade connectivity to important refugia habitats.

Much of the remaining population is subject to indirect impacts from “edge effects” (Harris 1988) associated with human land uses, such as increased nighttime illumination, weed invasions, disturbances from off-highway vehicles, dumping, etc. (USFWS 1998). The effects of lights on nocturnally active animals such as SBKR are of particular concern. Rodents change their foraging behavior during full moons presumably to reduce their risk of predation (Daly et al. 1992, Wang and Shier 2017) and artificial lights can elicit the same responses (Kotler 1984, Wang and Shier 2017). Illumination associated with human land uses, particularly roads, is an order of magnitude above those that cause behavioral responses or increase risk of predation (Beier 2006). Wang and Shier (2017) found that artificial lighting significantly influenced the probability that SBKR would deplete a resource patch. Although their acute hearing may mitigate some increased predation risk under high levels of natural illumination such as full moons (Kotler 1984, Brown et al. 1988), artificial light levels generated by roads and developments in the vicinity of occupied habitat are high enough to cause significant adverse effects. Numerous roadways, including interstate freeways, and commercial and residential development generate artificial lights that adversely affect adjacent SBKR habitat. When habitat coincides with or is nearby to flood control channels, rodenticide bait targeting ground squirrels can pose a danger to SBKR.

Climate change will likely exacerbate the adverse effects to SBKR of human landscape modifications in the future. Hall and colleagues (2012) projected >4ºF warming in the region by mid-century. Projections of rainfall changes are less certain, but climate model results (Cal Adapt 2018) for example, show 2040-2060 average annual rainfall in the Lytle Creek watershed varying ±2-4 inches from its 1961-1990 average of 29.5 inches, depending on the leanings of the specific climate model (e.g., warmer/drier or cooler/wetter). Furthermore, modeling provides evidence of a greater amount of fall and summer rainfall, instead of the historical winter/spring rainfall pattern (Cayan et al. 2008), changing stream hydrology (e.g., seasonal timing of flows, flood magnitude and return intervals). Climate changes can affect the distribution of plants and

animals (e.g., Crimmins et al. 2011, Kuepper et al. 2005). For example, Hayhoe and colleagues (2004) found that shrub cover in California declines under all climate model scenarios. Vegetation communities could shift their position in the landscape to more suitable climates (e.g., Crimmins et al. 2011), but many opportunities for habitats to shift have been precluded in this landscape by permanent loss of SBKR habitat. Much of the highest quality SBKR habitat is now located between levees within flood control channels and is disconnected from higher elevation refugia. Increased rainfall and additional storm runoff from impervious surface cover associated with human land uses (e.g., pavement and buildings) will cause elevated discharges and peak flows that are likely to destroy SBKR habitat and extirpate SBKR populations unless connectivity to refugia can be provided. This is particularly true for larger catastrophic events that occur infrequently, but now have much more significant consequences to the continued existence of SBKR than they did historically.

7. DEGREE AND IMMEDIACY OF THREAT

As documented above, human land use modifications have greatly reduced the extent, quality, and functionality of SBKR historical habitat. By the 1930s, the historical range of SBKR had been reduced by >90%, and by the time it was listed by the Service as Endangered in 1998, the species was eliminated from >95% of its range (McKernan 1998). Listing SBKR as federally Endangered in 1998 and designating Critical Habitat in 2002 has done little to stop the loss, fragmentation, and degradation of habitat and associated populations. Since the listing, populations in Reche Canyon, South Bloomington, Devil's Canyon, Cable Creek, Bautista Creek, and Etiwanda Fan have been effectively extirpated (USFWS 2018), and the remaining three population centers of Lytle Creek/Cajon Wash, Santa Ana River, and San Jacinto River in total have lost significant potential habitat (5,613 acres; 1,657 acres; and 1,372acres respectively), including critical refugia in upland and higher elevation flood terraces. Shier and colleagues (2018) confirm the isolation, low genetic diversity, and small effective population sizes and recommend "preventing further impacts to SBKR populations and increasing numbers." Dam operations or other hydrologic modifications have largely eliminated the ecological processes necessary for the long-term persistence of SBKR at the largest (Santa Ana River) population and along the San Jacinto River. Active management has yet to be effective in maintaining, let alone increasing, these populations. Thus, the existing status of SBKR is precarious, and there is no clear conservation strategy for the species.

Moreover, additional planned or proposed projects will directly or indirectly impact remaining occupied habitat, including some of the best remaining habitat for the species, ensuring further adverse consequences to SBKR populations. These additional threats to the species are discussed further below.

Lytle Creek/Cajon Wash

Two important projects have significantly affected SBKR in the Lytle Creek/Cajon Wash Critical Habitat unit. A Biological Opinion was issued for the Lytle Creek North Master Planning Community in 2003. The project included 5,120 feet of revetment along the northeast bank of Lytle Creek and construction of 2,466 residential units and infrastructure. The Service estimated that 296 acres of suitable habitat would be lost. As mitigation, 160 acres of floodplain

and wash, including a 56.8-acre “island” of habitat (a proposed refugium), and 5.7 acres of upland terrace were conserved with the objective of protecting as much of the population as would be lost to the project (that is, a net loss of 50%). The 56.8-acre refugium was projected to be high enough to remain above the flood elevation of a 100-year storm event, while the remaining 150.2 acres would be subject to inundation during a 100-year flood. The project analysis anticipated that a significant number of SBKR in the lower elevation floodway and adjacent wash habitat of the conservation area would be lost during high-flow events but would be recolonized from adjacent habitats above flood elevations.

However, a 2005 flood event, estimated at an 8.5-year flood return interval (USFWS 2017), washed part of the island away, and subsequent studies of this reach (Chang 2016, cbec 2018) predicted continued erosion of the island and failure of its southern bank from high flow velocities. Proposals by the project applicant to further armor the island if additional erosion occurs are of unknown efficacy and may have unintended negative consequences to occupied SBKR habitat. Furthermore, using the best available flood data and state-of-the-art sediment transport modeling, the cbec (2018) study shows that the great majority of the island would actually be inundated during a 100-year event, negating its purported value as refugium.

Mitigation also included vegetation thinning and herbicide application on 40 acres on the island, with performance standards for SBKR population numbers established by the Biological Opinion (Lytle Creek supporting documents, various dates). However, this mitigation has failed, and in the 15 years of its existence, the conservation area has not demonstrated it can support a sustainable population. Central to the mitigation performance standards was achieving a population of 72 individuals on the island for 3 consecutive years. Despite the many years of management at the site, this criterion has not been met. All surveys performed using a standard Service protocol found a declining population after 2010.

In conclusion, after the Biological Opinion issued by the Service, and after many years of active conservation management, there was a net loss of SBKR habitat as a result of the Lytle Creek North project. The in-channel refugium in exchange for lost habitat outside the floodplain has failed to date.

The City of Rialto approved the Lytle Creek Ranch development in 2010, which is undergoing an Endangered Species Act section 7 consultation with the Service. The project proposes ~8,407 homes on a 2,447-acre site, which includes high quality SBKR habitat supporting a relatively large population and upland terrace habitats that currently function as refugia during floods.

According to the Service (May 24, 2013), ~1,920 acres of the proposed Lytle Creek Ranch project falls within SBKR Critical Habitat and about 1,191 acres of that (62%) would be adversely modified by the project. According to the applicant, 489 of 700 acres of occupied habitat would be conserved, with additional habitat restored to total 529 acres. Thus, even under the applicant’s mitigation proposal, 171 acres of occupied habitat in one of the last two remaining population centers would be lost, and the proposed conservation measures would rely on unproven restoration practices. Moreover, the Service considers the applicant’s survey methods faulty and assumes that more occupied acres would be impacted than reported by the applicant. Importantly, the habitat proposed for conservation is located largely between the

proposed project revetment and existing levees bounding the north side of the creek. The remaining upland terraces that provide important habitat and a refugium would be developed. As a result, with the exception of the mitigation island described above, all SBKR would remain in the lower elevation and more frequently scoured active channel where they would be vulnerable to medium and large flow flood events. The applicant is proposing to create 40 acres of SBKR habitat off-site and to restore 35 acres onsite, thereby exchanging areas with functioning hydrogeomorphic processes for areas that would need to be artificially maintained and managed.

The proposed mitigation expands conservation activities to the downstream portion of the mitigation island described above for the Lytle Creek North project. Yet the inundation of the island by large flood events leaves the entire Lytle Creek population without refugia and subject to loss. Thus, even in light of the lack of success of previous mitigation attempts on the island, and its inundation during large flood events, the island is still being proposed to compensate for the loss of functioning habitat and refugia on the terraces adjacent to the active channel.

Within this last hydrologically intact reach of remaining SBKR habitat on Lytle Creek, the project proposes to build ~7 miles of revetments, which will constrict the channel and create higher velocity flows with increased scour and erosion. The upland terraces outside the floodplain would be developed, and remaining individuals on the project site would be forced into the highly active flood channel. The increased scour from the project would create bare ground unsuitable for SBKR for long periods of time. Studies by cbec (2018) also showed loss over time of the fine, sandy sediments essential to SBKR from the modified hydrology. This effect extended to the downstream conservation banks. If the Lytle Creek Ranch project is built, there will be no functional flood refugia on this reach of Lytle Creek, which brings into question the long-term viability of this area for SBKR. This would be a highly significant loss of habitat in one of the two remaining population centers for the species.

The Service and Endangered Habitats League have independently offered modified project designs to more effectively mitigate the effects of the proposed development and retain viable refugia. (USFWS 2018, FORMA 2015). Despite an economic analysis showing viability for a modified project (Developers Research 2016), no such redesign has been undertaken by the project proponent. The outcome of federal permitting by the U.S. Army Corps of Engineers (Army Corps) and Service is unknown at the time of petition submittal. According to Service correspondence though, the project applicant has “elevated” its concerns to Service headquarters in Washington DC, potentially politicizing this agency decision-making. (USFWS 2018)

The CEMEX mining company is also processing a take permit for SBKR via an Army Corps section 7 consultation to reestablish aggregate mining in the Lytle Creek channel. (USACE 2015). In 2005, high flows caused a levee breach. Subsequent to the breach, a large mining pit within the channel has been filling. A more natural flow regime has also resulted, with less scour in the channel and vegetation regrowth. The current consultation calls for levee reconstruction.

The outcome of the consultation, the configuration of new levees, and ultimate creek hydrology are unknown at present. However, levee repair will of necessity reverse to some degree the beneficial effects of the 2005 breach on channel hydrology. If, as is likely, the pit or portions thereof continue to fill, however, the current detention basin function of the pit will diminish,

increasing inundation of the island during high flow events (cbec 2018). This fact further heightens the dire consequence of losing terrace refugia as proposed by the Lytle Creek Ranch development.

Santa Ana River

A Biological Opinion was issued for the construction and operation of the SOD on the upper Santa Ana River (USFWS 2002b). The CEQA and NEPA documents for construction and operation of SOD had anticipated that operation of SOD would eliminate natural fluvial processes and associated flooding of habitats on the fan of the Santa Ana River where SBKR occur. The Biological Opinion anticipated that water releases from SOD would be designed and implemented to mimic natural flooding of fan habitats rejuvenating scrub habitats on the fan that support SBKR. Flooding of these habitats would re-set affected parts of the fan to early successional changes preferred by SBKR. However, these releases have not been implemented by the U.S. Army Corps of Engineers (ACOE) and the sponsoring Flood Control Districts, nor are they being planned. The project proponents were also required to fund a large endowment (~$6,000,000) for long-term management and enhancement of the Woollystar Preserve Area to improve habitat quality for SBKR and other species (USFWS 2002b). Long-term management has generally consisted of weed removal to improve habitat quality, which has not been successful (Montgomery 2011). There is currently litigation pending against the ACOE to reinitiate a section 7 consultation with the Service and to compel releases and implement other mitigation measures in the original Biological Opinion for the project.

Not only were project impacts to SBKR not adequately mitigated through the Biological Opinion, USFWS permitting allowed the fundamental hydrological processes maintaining SBKR habitat along the Santa Ana River to be lost, and the largest of the remaining functioning SBKR habitat blocks to be permanently altered. This situation is especially dire in light of the negative trajectory of SBKR in the other large habitat block at Lytle Creek/Cajon Wash, and makes protection of SBKR habitat in Lytle Creek/Cajon Wash imperative.

To investigate the potential efficacy of water releases from SOD, San Bernardino Valley Municipal Water District and San Bernardino Valley Water Conservation District have studied flood scenarios, with discouraging results (ICF 2018). Even with theoretically maximal releases from the dam, coupled with 100-year floods on Mill Creek and other tributaries, there are no significant overbank flows out of the incised channel, meaning that there would be no rejuvenation of the floodplain to reset vegetation succession. There are also major operational and institutional obstacles to obtaining water releases for habitat of *any* magnitude from the dam.

Other Habitat Conservation Plans (e.g., the Wash Plan and Upper Santa Ana River HCP) would affect development authorizations and conservation of SBKR. For example, the Public Review Draft Wash Plan Habitat Conservation Plan (HCP, ICF 2018) would allow 680 acres of impact in exchange for ultimately conserving 1,622.5 acres of habitat for the species. About half of the conserved acreage is currently considered medium or high suitability habitat.

San Jacinto River/Bautista Creek

The status and trajectory of SBKR in the San Jacinto River and Bautista Creek block of habitat are also negative. The Service now considers SBKR extirpated from Bautista Creek, and trapping studies suggest relatively low rates of occupancy of suitable habitat elsewhere (Biological Monitoring Program 2016). SBKR is covered by the Western Riverside MSHCP, but conservation efforts are well below goals for the species (4,400 acres of conserved habitat, 75% of which is to be occupied). Given the Service's assessment of the remaining suitable habitat in this block (2,403 acres, USFWS 2018), it appears the MSHCP conservation goal for SBKR is not feasible without a massive habitat creation effort. SBKR habitat creation has not yet been successfully implemented. In addition, recent efforts to translocate SBKR, required by a Biological Opinion to mitigate loss of habitat resulting from a recharge basin in the San Jacinto riverbed, have failed. Additional projects (e.g., San Jacinto River Levee Project Stage 4 project, KPC Promenade (City of San Jacinto), Eastern Municipal Water District San Jacinto River floodplain recharge basins) are being planned or are under consideration that would adversely affect additional SBKR habitat.

8. IMPACT OF EXISTING MANAGEMENT EFFORTS

SBKR conservation to date has been under the purview of the Service under sections 7 and 10 of the Federal Endangered Species Act (ESA). Based on an extensive review of the majority of Biological Opinions issued under section 7 of the ESA (40) and five HCPs issued under section 10 of the ESA since SBKR was listed, conservation of SBKR can be reduced to three basic strategies: (1) relocation, (2) habitat restoration, and (3) purchase of mitigation credits from mitigation banks (almost exclusively the Lytle Creek and Cajon Wash banks). There are significant problems with all three strategies.

Relocation of SBKR has taken two forms: movement of SBKR from a project area to adjacent habitat, and large-scale relocation of SBKR from one geographic area to another. In only one instance was either form of relocation at least partially successful, and that was a translocation of individuals to a site already occupied by SBKR. The former strategy involved the movement of SBKR caught within a fenced project area to areas outside a fenced project area. The strategy has rarely considered the impact of the relocation to existing SBKR populations outside the fencing, nor has it necessarily required the habitat outside the fenced area be suitable for SBKR. There has been no substantive effort to determine the fate of the relocated SBKR in any of these projects. This mitigation strategy has been the most common requirement in the Biological Opinions and has accomplished nothing substantive or quantifiable with regard to ensuring SBKR survival and persistence.

Habitat restoration has been a common element in the Biological Opinions and HCPs. Habitat restoration has not yet resulted in persistently occupied SBKR habitat. Moreover, there is no requirement in any of the Biological Opinions or HCPs that SBKR occupation be confirmed before occupied SBKR habitat is taken. This mitigation strategy of habitat restoration has not been effective in compensating for loss of habitat.

Purchase of lands in available mitigation banks, mostly in the Lytle-Cajon confluence and Cajon Creek, but also in a small bank near Mill Creek, is also a common requirement in Biological Opinions. However, like all mitigation banks, the purchase of credits in the Lyle and Cajon mitigation banks still results in a *net* loss of SBKR habitat, and permanent impacts to SBKR populations in project impact locations. When using a bank to mitigate project impacts to SBKR habitat, the project applicant is exchanging the protection of existing habitat within the bank for the loss of habitat outside of the bank. For example, mitigation at a 1:1 ratio would result in a 50% net loss of habitat (purchase of 1-acre of credits in the bank for each acre of habitat lost). Additionally, the Judson/Brown Preserve is small, hydrologically disconnected, and management for SBKR habitat poses a conflict with California gnatcatcher management objectives.

Despite the above inherent limitations, the Lytle and Cajon banks – and their financial success – are rare encouraging notes for species conservation. In the majority of the Cajon Creek bank, rejuvenating fluvial processes increase habitat suitability and likelihood of SBKR persistence over the long-term. SBKR trapping started there in 2017 and shows presence/absence of SBKR rather than population size. For the Lytle bank, about half is outside the active floodplain, meaning that those lands will need long-term intensive management. Surveys for SBKR in the Lytle bank within the last 10 years are limited. Both banks have management plans in place, but implementation of management actions is in early stages, with uncertain prospects for long-term efficacy. It must be stressed that the Lytle Creek (182-acre) and Cajon Wash (1,300-acre) banks in isolation are far too small in size and population, and too vulnerable to stochastic events, to sustain the species genetically.

When the HCPs are specifically evaluated, none includes a population viability analysis or a minimum population viability analysis for SBKR. Instead, they call for habitat restoration, which as described above, has not been successful, with no clear or credible monitoring strategy or abundance/occupation targets.

Ultimately, the Service's current approach to conserving SBKR has been inconsistent and has relied on unproven mitigation tactics. Of the three prevalent management strategies by USFWS in its permitting decisions, two (relocation and restoration) have not been effective to date, and the third (mitigation banking) has both inherent limitations and significant on-the-ground uncertainties regarding long term benefits to the species. The overall result has been a substantial and ongoing loss of SBKR and SBKR habitat since the species' listing. The existing federal listing, while theoretically an alternative regulatory mechanism to state listing, has in reality proven ineffective.

In the sections below, we describe some of the mitigation and management activities that have occurred in the three remaining SBKR population centers.

Santa Ana River

As described above, a Biological Opinion was issued for the Santa Ana River Mainstem Project and SOD (USFWS 2002b). Operation of the SOD eliminated natural fluvial processes and removed major flood flows in the mainstem portion of the Santa Ana River block of SBKR habitat. The anticipated water releases identified in the Biological Opinion to mimic natural

scouring and vegetation succession patterns have not been implemented. Management of the Woollystar Preserve Area (WSPA) has generally consisted of weed removal, which has not been successful (Montgomery 2011). In addition to this unsuccessful management, subsequent studies of potential water releases from the dam (as described above) have disclosed that fixed engineering constraints render the Biological Opinion's water release strategy largely moot.

The majority, but not all, of the remaining potential SBKR habitat on the Santa Ana River falls either within the WSPA or the Santa Ana River Wash Plan Habitat Conservation Plan (Wash Plan HCP) being developed by the San Bernardino Valley Water Conservation District (ICF 2018) or is land owned by the San Bernardino Flood Control District (SBCFCD). The SBCFCD lands are managed to maintain flood capacity rather than for SBKR persistence or benefit. Channel maintenance has, at times, occurred under an emergency process without consideration of SBKR or mitigation of impacts to the species. Flood district lands are not secure. The SBCFCD has sold upland SBKR refugia along City Creek in the Highlands area, as well as upland habitat in Etiwanda Fan near Rancho Cucamonga, for development purposes.

The Wash Plan HCP, which also incorporates some BLM properties, is expected to be completed in late 2019. As proposed by the draft Wash Plan HCP, 570.9 acres of permanent impacts and 109.1 acres of temporary impacts to SBKR would be offset by conservation of 1,622.5 acres of conserved and managed lands. However, over half (54%) of the total Wash Plan HCP Preserve SBKR conservation lands are considered low or very low suitability for SBKR, and only 18% of the conservation lands are considered high suitability for SBKR (ICF 2018). While the plan impacts relatively little highly suitable habitat, and seeks to balance interests, it nevertheless would permit the continued loss of SBKR habitat and relies on unproven management measures.

Further downstream, the Upper Santa Ana River HCP is being undertaken primarily to address the endangered Santa Ana suckerfish, but will propose some SBKR impacts in retention basin facilities. Both the Wash Plan HCP and the Upper Santa Ana River HCP are properly coordinating with state and federal regulatory agencies to address specific impacts to SBKR and are being designed to meet both state and federal permitting standards. However, the effect of the loss of natural hydrology on the Santa Ana River population due to SOD remains an overwhelming obstacle to the viability of this population over the long term. To date, efforts to enhance habitat quality downstream of the dam have been unsuccessful in establishing persistently occupied habitat.

San Jacinto River

SBKR habitat in this area falls under the Western Riverside County Multiple Species Habitat Conservation Plan (WRC MSHCP), implemented by the Western Riverside County Regional Conservation Authority (RCA 2003). Conservation objectives for SBKR include 4,440 acres of conserved habitat, of which 75% (3,300 acres) is to be occupied, and at least 20% of the occupied habitat is to support medium to high population densities. Monitoring for SBKR in 2015 demonstrated that there were only 451 acres of occupied habitat in the MSHCP preserve, far short of the MSHCP conservation objective for this species (Biological Monitoring Program 2016). In light of future proposed projects along the San Jacinto River (e.g., San Jacinto River

Levee Project Stage 4 Project, etc.), there is low probability of the WRC MSHCP achieving its conservation objectives for this species.

Furthermore, as part of a reconsultation under ESA section 7 with the Service, SBKR were translocated as mitigation for an Eastern Municipal Water District water recharge project that impacted occupied habitat. The RCA implemented a Vegetation Control Plan in this area to improve habitat suitability for the translocated individuals. However, no SBKR were detected in the translocation area (Biological Monitoring Program 2016), suggesting that this mitigation effort failed. Thus, additional occupied habitat in the San Jacinto River was lost as a result of the water recharge project and not adequately mitigated, and additional water recharge projects are being contemplated on EMWD lands in the San Jacinto River.

Lytle Creek/Cajon Wash

Vulcan Materials Corporation owns and operates the Cajon Wash Habitat Conservation Area on Cajon Wash and Lytle Creek, totaling about 1,300 acres. It is both a state and federally permitted mitigation bank. Wildlands, Inc. established the 182-acre Lytle Creek Conservation Bank in 2014 to provide Service-approved mitigation credits for SBKR. CDFW is considering using the Bank for mitigating State of California-permitted impacts to SBKR. Funding for management derives from endowments, and management plans have been developed for both banks, with implementation of those plans in early stages.

9. SUGGESTIONS FOR FUTURE MANAGEMENT

The most critical actions to protect existing SBKR populations are: (1) preventing additional significant loss of suitable habitat and particularly occupied habitats and those with a functional hydrologic system, and (2) expanding areas occupied by SBKR. Clearly, preventing the additional loss of habitat requires preventing the direct loss of habitat via land use conversion, which has still occurred via Federal Endangered Species Act consultations with the Service. The proposed loss of occupied habitat by the Lytle Creek Ranch project would continue this trend. Developments should be permitted only if impacts avoid occupied habitat with long term biological viability. Stronger hazard zoning for floodplains is warranted in jurisdictions with SBKR habitat so that there is no further channelization of creeks.

In addition to habitat loss, SBKR has been affected negatively by changes in ecological processes, habitat fragmentation, edge effects, and invasion by nonnative species. Developing management actions to prevent loss of currently suitable habitat adversely affected by factors such as altered hydrologic processes and nonnative plant invasions will also be required to secure the long-term persistence of SBKR in areas it currently occupies.

Additional conservation banking should be encouraged, such as on the Lytle Creek Ranch development site, where a smaller project could be coupled with highly marketable credits.

To date, as shown by the results of numerous Section 7 consultations, techniques for enhancing SBKR habitat have not proven successful. Nevertheless, such efforts should continue, noting, for example, that soil restoration on the Cajon bank has shown initial promise in a limited location.

The management activities discussed below should be explored for their efficacy in enhancing SBKR populations, but these activities should not be considered “mitigation measures” for loss of additional occupied habitat until they are proven successful in other contexts (such as those described below) and the status of SBKR is stable. They are presented here merely to be complete.

Enhancing Sediment Transport – SBKR habitat requires active fluvial processes that in many areas have been modified, leaving unsuitable conditions. For example, reaches of Lytle Creek have a boulder-cobble substrate unsuitable for SBKR. Increased sand deposition could hypothetically improve the substrate for SBKR. Installing culverts under Glen Helen Parkway to allow sand to move downstream, would be beneficial. Glen Helen Parkway was widened in 2006 to accommodate the Lytle Creek North development without a section 7 consultation for impacts to SBKR. It was designed with three small culverts and one large culvert to allow water through, but the culverts essentially prevent most sediment from passing under the road. San Bernardino County Flood Control District has been mechanically straightening the channel upstream to ensure that the water flows through the main culvert (creating further impacts to SBKR habitat). The creek downstream of Glen Helen will continue to be deprived of sand that is captured behind Glen Helen Parkway. Modifying the structures that provide for water flow under Glen Helen Parkway or bridging the creek to allow transport of sand during small and moderate events would decrease the time required to reestablish SBKR use areas in the scour zones. It could promote connectivity across scour areas and maximize the area available for use by SBKR.

Nonnative Plant Management – Invasion of nonnative annual grasses into SBKR habitat reduces its quality. Management activities that reduce cover of nonnative annual grasses and promote native annuals, would benefit SBKR. Active vegetation management may be one of the most cost-effective management measures for SBKR, but its ultimate efficacy and benefit are unproven. The upper Santa Ana River, which is now deprived of fluvial processes, is a logical place for testing such measures.

Translocation of SBKR – Moving SBKR into suitable but unoccupied habitats may be necessary to recover the species. This assumes that individual SBKR and suitable receiver sites would be available for such translocations. However, translocations have had very limited success. In 2012, 60 SBKR were relocated within the San Jacinto River floodplain to a receiver site just upstream. In the following year, only one SBKR was captured at the receiver site, and zero to one was trapped in the 5 years following. In 2015 and 2016, 366 SBKR were relocated from a site within the Santa Ana River floodplain to the Cajon Conservation Area. Only 59 SBKR were captured at the receiver site in 2018, a low success rate of the translocation.

Captive Propagation – If SBKR could be successfully translocated, captive propagation may be a means of providing individuals. However, the limiting factor for this species is not reproductive capacity but rather a lack of suitable habitat across its range. Thus, methods for captive propagation should not be explored until there is a conservation rationale. The primary threat to SBKR is habitat loss, the conservation and recovery strategy must be to conserve as much remaining habitat as possible.

Restoration of Hydrological Processes – Outside of Lytle Creek-Cajon Wash, all SBKR habitat is downstream of flood control structures that have eliminated historical flooding regimes. The result has been markedly diminished flood flows and associated sediment dynamics and has reduced sediment contributions from tributary streams, leaving systems that are unable to rejuvenate late-successional habitats that eventually become unsuitable for SBKR. Indeed, recent studies have shown that, due to construction constraints, even maximal releases from SOD would be too small to hydrologically connect the historical floodplain to the currently deeply incised channels along the Santa Ana River. However, it might be possible to install berms, modify streambed elevation with transported sediment, or construct channels to create overbank flows from Mill Creek or other tributaries. Further investigation is warranted, with close attention to unintended consequences and potential adverse effects downstream of the berms on high density populations of SBKR and other species of concern, such as the Santa Ana sucker. New – and heretofore unprecedented – collaborations between the ACOE, local flood control districts, local water districts, and state and federal wildlife agencies would be essential. Maintaining natural hydrology and floodplain integrity and connectivity along Lytle Creek and Cajon Wash remains a top priority.

In addition, the current population status of SBKR in existing conserved lands is unclear, and a range-wide monitoring program is necessary to make informed decisions on management and any permitted conversion of habitat. Population viability and minimum viable population analyses would be useful tools for developing recovery objectives and targets for population management and would help planners and managers better understand the implications of development decisions.

California Endangered Species Act Protections

An endemic taxon of California, SBKR is part of the unique biological heritage of the state. It has been recognized as worthy of protection and conservation by the Service. However, federal Endangered Species Act processes have not halted its precipitous decline. A new and objective look at SBKR status, trends, and conservation needs is essential. Innovative and creative conservation actions are needed to be based upon an assessment of what has not worked in the past and what has promise in the future. While the federal Endangered Species Act process is not providing these functions, the State of California is well suited to do so. CESA requires that "all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation, will be protected or preserved."

The tools currently available to the State to conserve and manage SBKR – Streambed Alteration Agreements and the CEQA comment process – are either inherently limited in scope (the former) or have proven ineffective (the latter). For example, recommendations offered by the California Department of Fish and Wildlife during the Lytle Creek Ranch CEQA process were ignored by the lead agency.

State listing will also remedy a serious limitation in the federal system that has contributed to SBKR decline. Due to proximity of SBKR habitat to river systems, federal permitting for SBKR impacts typically occurs via section 7 consultations (with resulting Biological Opinions)

requested by the Army Corps of Engineers in association with impacts to Waters of the United States, rather than through Habitat Conservation Plans under section 10 of the ESA. Indeed, a review of all Habitat Conservation Plans and Biological Opinions issued by the Service from 1997 to the present shows 61 (94%) Biological Opinions and 5 (6%) Habitat Conservation Plans.

Unlike a Habitat Conservation Plan and section 10 consultation under the ESA, there is no general requirement in a section 7 consultation to minimize and mitigate the impacts of the take of an endangered species to the maximum extent practicable. Indeed, unless the extreme case of jeopardy to the very existence of a federally endangered species is reached, *no mitigation whatsoever is required* (per the Endangered Species Consultation Handbook, "It is not appropriate to require mitigation for the impacts of incidental take." USFWS and NMFS 1998). Rather, section 7 seeks to minimize take as long as such measures are "reasonable and prudent" and "minor" in extent. Under these circumstances, and with more than 9 of every 10 take permits issued through section 7 rather than section 10, it is not surprising that mitigation for impacts to SBKR under the federal listing has failed to compensate for the substantial loss of habitat that has occurred.

To the contrary, under the California Endangered Species Act (CESA), project applicants would not be able to circumvent providing effective mitigation. Under CESA, take must be minimized and "fully mitigated." Elevating the regulatory status of SBKR in California to Endangered will provide the Department of Fish and Wildlife a heightened level of review and regulatory authority to arrest the decline of SBKR. Only with sufficient mitigation on all projects can the negative trends in SBKR population begin to be reversed. U.S. Army Corps regulations are no substitute, as its focus is on wetlands and Waters of the U.S. rather on the surrounding uplands that are vital to SBKR.

Finally, there is strong and ample evidence of the politicization of federal regulatory agencies under the current Executive Administration and the ascent of an anti-science and anti-regulatory agenda. Scientific panels have been disbanded and there is open hostility to objective science, such as in the realm of climate change. State listing is a necessary backstop to the disregard of law and science by federal environmental agencies under the current Administration.

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Additional relevant literature and reports are provided digitally

Biological consultant (CV enclosed)

Phil Brylski, PhD

Credits

GIS analyses and maps prepared by Streamscape Environmental

Salvador Contreras

Jennifer Mongolo

Individuals supporting the petition

Dr. Wayne Spencer, Conservation Biology Institute, wdspencer@consbio.org

Scott Tremor, San Diego Natural History Museum, stremor@sdnhm.org

Organizations supporting the petition

Defenders of Wildlife

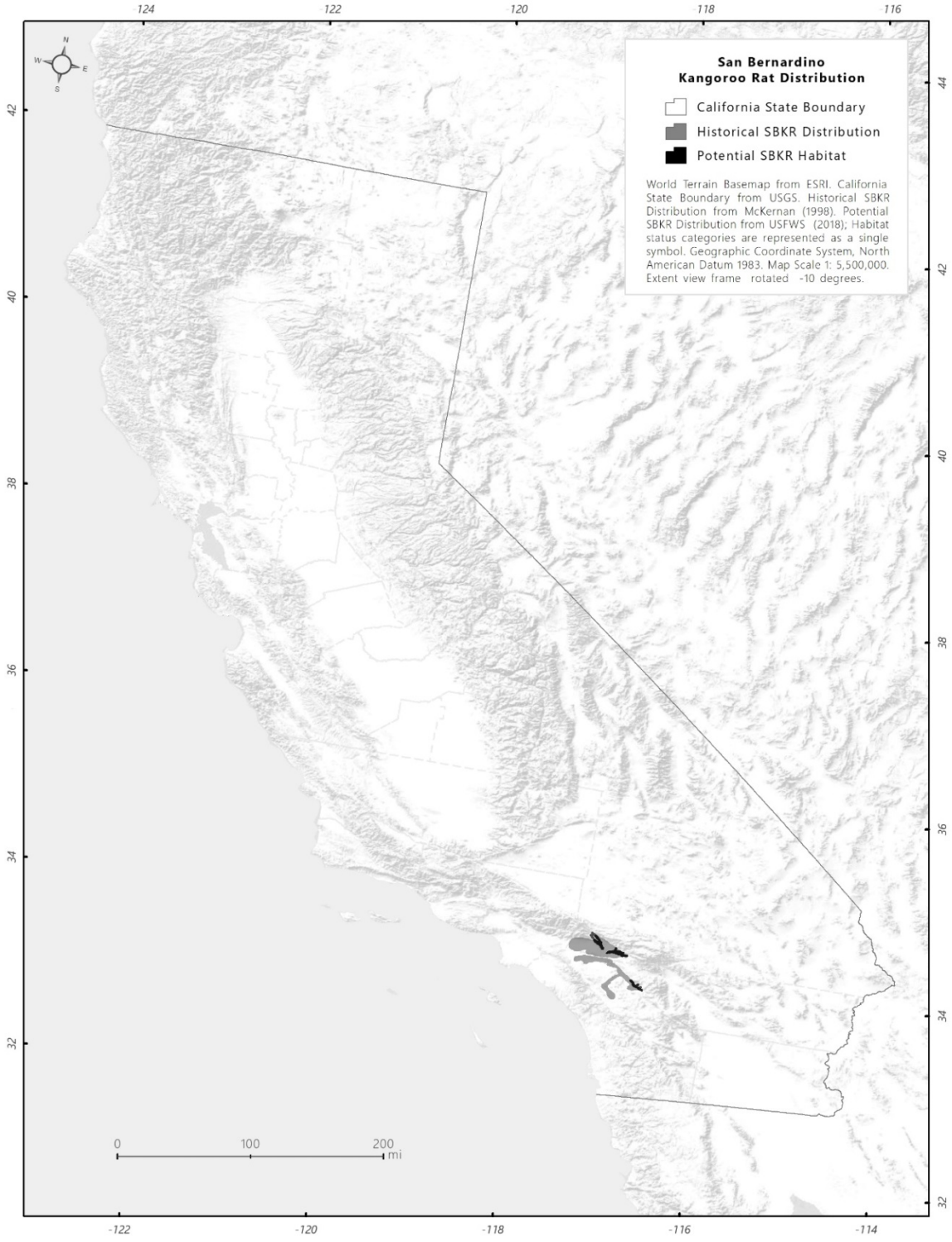
Natural Resources Defense Council

Audubon California

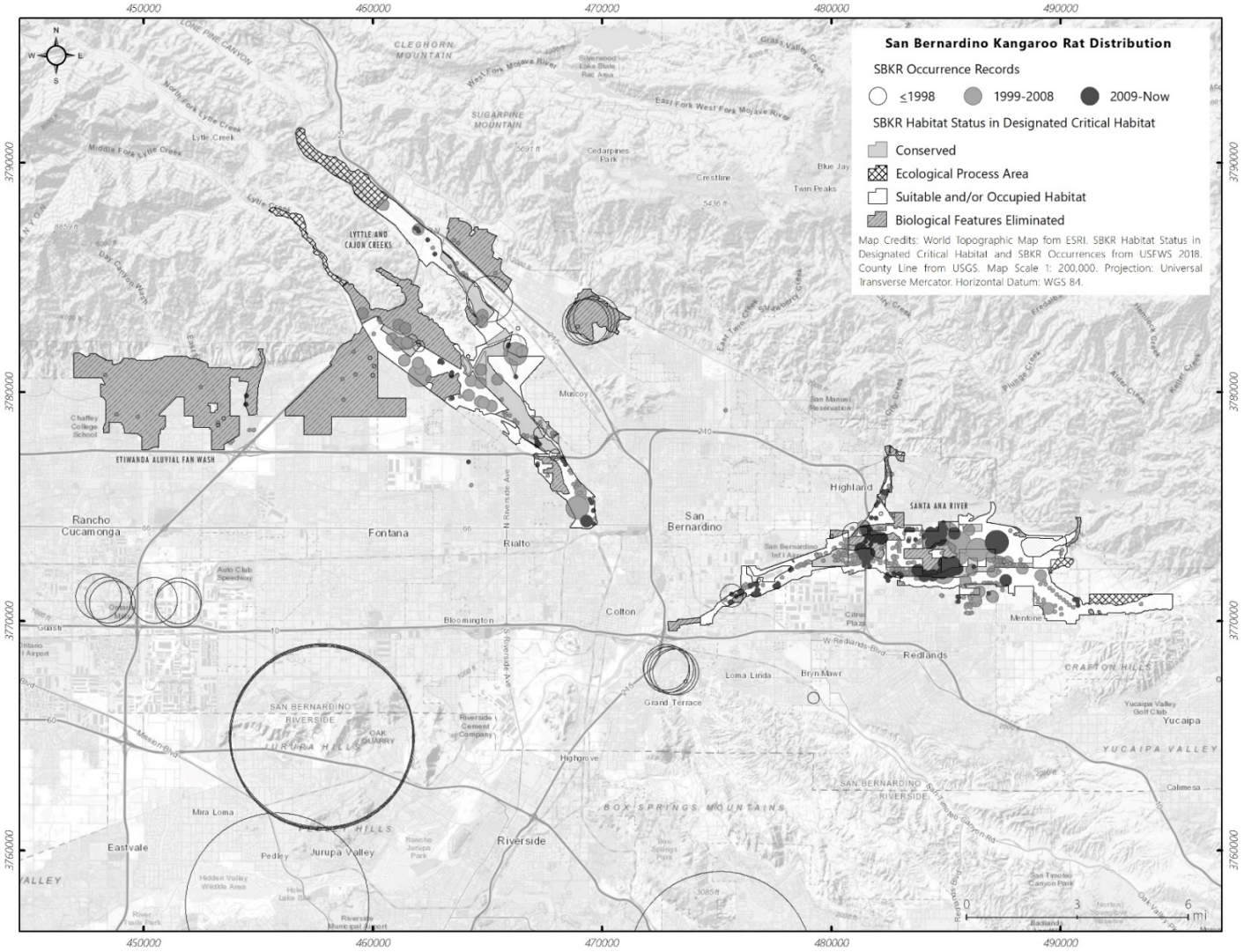
Save Lytle Creek Wash

11. DETAILED DISTRIBUTION MAP

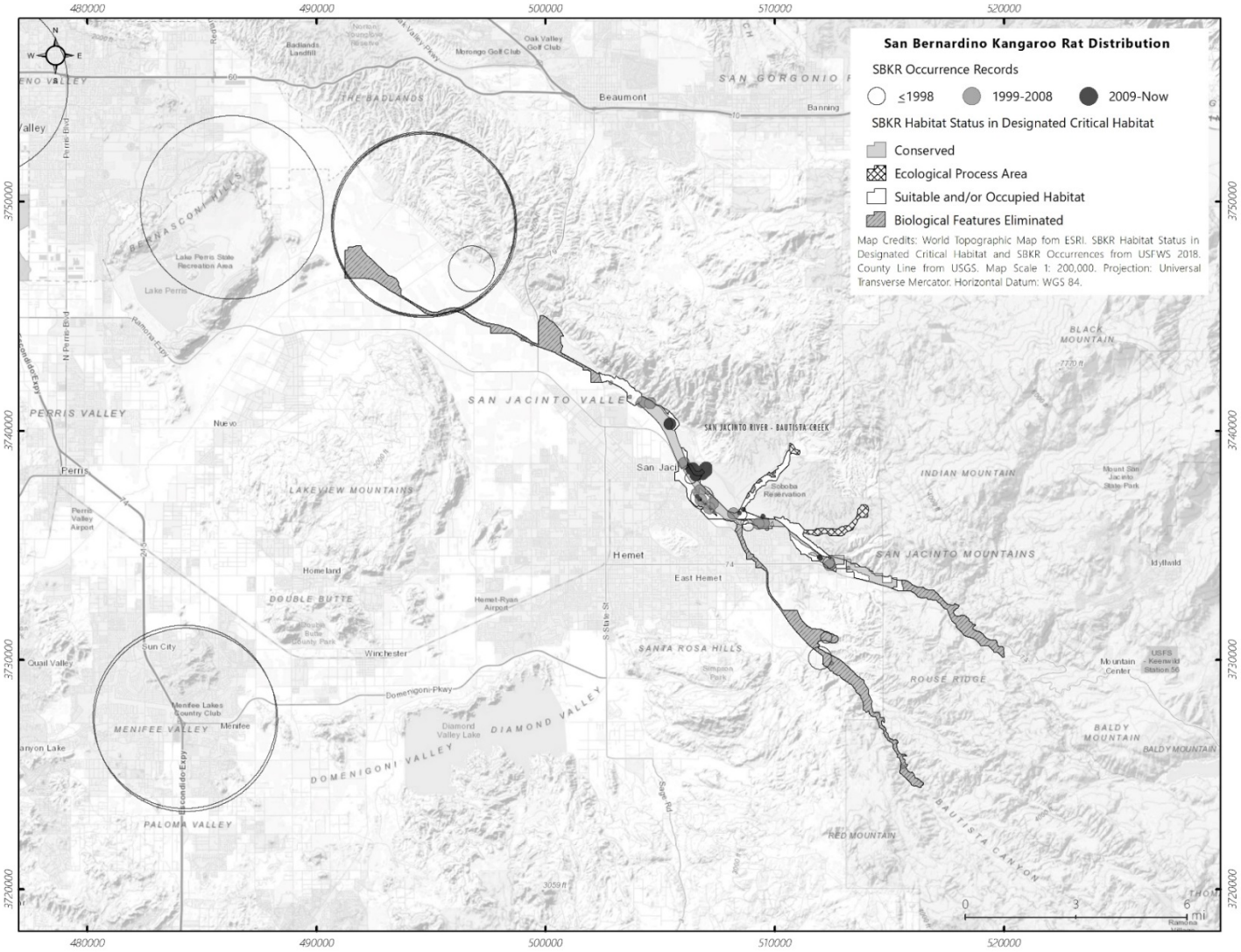
Map 1: Distribution of historical and current, potentially suitable habitat for the San Bernardino kangaroo rat.



Map 2a: San Bernardino kangaroo rat habitat status and occurrence records in the northern portion of its current range. The size of the circle around the occurrence record indicates the level of uncertainty of its location.



Map 2b: San Bernardino kangaroo rat habitat status and occurrence records in the southern portion of its current range. The size of the circle around the occurrence record indicates the level of uncertainty of its location.



White, Braden, Silver and Brylski CVs

Michael D. White, Ph.D.

Michael White Consulting

Dr. White is an ecologist with 30 years of professional experience with conservation planning, environmental regulations, and ecosystem assessment, management, and restoration. Has work has required extensive coordination with local government agencies, state and federal wildlife and land management agencies, local academic and research institutions, non-governmental organizations, private and foundation funders, landowners, and the general public.

Dr. White has served as the lead biologist on many high-visibility and multi-stakeholder projects in California. These included developing management and restoration strategies for the Lower Colorado River Multiple Species Conservation Program, developing a reserve design and adaptive management plan for the Tejon Ranch, producing a conservation framework for Las Californias Binational Conservation Initiative, resource management planning for the Sonoran Desert in California, and identifying conservation priorities and forest management strategies for the Sierra Checkerboard Initiative. In these efforts, he has used an objective science-based approach to develop practical land use and conservation outcomes that are trusted by diverse stakeholders.

From 2004-2008, Dr. White was science advisor to the environmental groups that negotiated the Tejon Ranch Conservation and Land Use Agreement, which conserved 90% of the 270,000-acre Tejon Ranch, the largest private property in California. The Agreement created the Tejon Ranch Conservancy to steward its diverse and unique conservation resources. Dr. White served as the Conservancy's first Conservation Science Director from 2009-2017, where he hired and directed staff to develop and implement Science, Stewardship, and Public Access programs; developed partnerships with universities, governmental agencies, and other nonprofits; helped to develop and implement organizational policies and procedures necessary to obtain the Conservancy's accreditation from the Land Trust Alliance; and worked closely with the Executive Director and Board to acquire funding to purchase over 60,000 acres of conservation easements and support the Conservancy's programs. He led public education tours and taught the California Naturalist course for 3 years as part of developing the Conservancy's volunteer program. Working collaboratively with the landowner, Dr. White prepared the first adaptive management plan for Tejon Ranch, and worked with the landowner and its ranching lessees to raise funding to implement elements of the plan.

Dr. White presently a Visiting Scholar at University of California Berkeley Department of Environmental Sciences, Policy and Management, an Adjunct Associate Professor at San Diego State University Department of Biology, and Principal of Michael White Consulting, which advises nonprofit organizations on conservation and management issues.

March 2019

EDUCATION

Ph.D. Ecology, San Diego State University and University of California, Davis, 1991. Dissertation: *Horizontal distribution of pelagic zooplankton in relation to predation gradients.*

B.A. Ecology, Behavior and Evolution, University of California, San Diego, 1982.

PERSONAL

Born July 20, 1960, Los Angeles, California (citizen of U.S.A.).
Married.

PROFESSIONAL ORGANIZATIONS AND AFFILIATIONS

Visiting Scholar, Department of Environmental Sciences, Policy and Management, University of California Berkeley 2017-present

Adjunct Associate Professor, San Diego State University 1991-present

Society for Conservation Biology

Southwest Association of Naturalists

Society for Range Management

Natural Areas Association

California Native Plant Society

EMPLOYMENT HISTORY

August 2017 – present. Principal, Michael White Consulting. Providing environmental consulting services to nonprofit organizations in the areas of environmental analyses, habitat and species conservation, land management and monitoring, and fundraising.

July 2017 – present. Visiting Scholar, University of California Berkeley, Department of Environmental Science, Policy and Management. As a Visiting Scholar, Dr. White is continuing his work with Dr. Bartolome and his lab members developing models for conservation management of rangeland resources in California. Building on years of collaborative field ecology studies of grasslands and riparian systems at Tejon Ranch, Dr. White is working with the lab to synthesize these findings into a deeper understanding of system structure and function and implications for conservation management of rangeland resources in an under-studied part of California.

August 2009 – June 2017. Conservation Science Director of the Tejon Ranch Conservancy. Responsible for developing and implementing research, management, and public access programs for 240,000 acres of Tejon Ranch. Responsibilities included research and monitoring, development and implementation of a Ranch-wide Management Plan for conserved lands, science staff supervision, coordination of research projects, fundraising, and annual planning and budgeting.

July 1999 – July 2009. Senior Ecologist and San Diego Director of the Conservation Biology

Institute, Encinitas, California. Providing administrative and fiscal oversight of a four-person operation with a budget of approximately $500K/yr. Responsibilities include annual budgeting, fundraising and proposal preparation, oversight of office contracts, staff timekeeping and project tracking, accounts payable, accounts receivable, project management, and technical studies.

July 1998 – July 1999. Senior Technical Specialist. Ogden Environmental and Energy Services Co., Inc., San Diego, California. Responsibilities included providing technical oversight of the Lower Colorado River Multiple Species Conservation Program project and senior technical support of project staff.

January 1997 – June 1998. Manager, Aquatic Sciences Group. Ogden Environmental and Energy Services Co., Inc., San Diego, California. Managed a group of nine professional aquatic scientists with revenues of approximately $2M/year. Responsibilities included administration, marketing and proposal preparation, strategic planning, annual budgeting and performance tracking, timekeeping oversight, personnel supervision (including direct supervision of four professional biologists), project management, and project technical support.

January 1994 – December 1996. Deputy Manager, Biological Resources Group, Ogden Environmental and Energy Services Co., Inc., San Diego, California. Deputy Manager for a group of 23 professional biologists. Responsibilities included marketing and proposal preparation, strategic planning, annual budgeting, group health and safety program oversight, personnel supervision (including direct supervision of five professional biologists), project management, and project technical support.

September 1989 – July 1994. Senior Ecologist, Ogden Environmental and Energy Services Co., Inc., San Diego, California. Responsibilities included marketing and proposal preparation, project management, project technical support, and direct supervision of three professional biologists.

September 1983 – December 1990. Graduate Assistant, San Diego State University, San Diego, California.

July 1984 – June 1985. Graduate Assistant, UC Davis Tahoe Research Group, Lake Tahoe City and Davis, California.

SELECTED PROJECT EXPERIENCE

Conservation Science Director – Tejon Ranch Conservancy. As the first Conservation Science Director of the new Conservancy, Dr. White was responsible for creating the Conservancy's science and stewardship programs from scratch. This entailed synthesizing existing information, prioritizing research and monitoring efforts, planning and budgeting, developing funding proposals, coordinating researchers and contractors, interfacing with the landowner, overseeing conservation easement stewardship, and hiring and managing staff. He regularly presents to public, as well as academic and professional audiences on the work of the Conservancy.

One of Dr. White's primary responsibilities at the Conservancy was preparing the first adaptive management plan for the conserved lands at Tejon Ranch (called the Ranch-wide Management

Plan [RWMP]). The Tejon Ranch Conservation and Land Use Agreement provides for the continued use of lands under easement by the landowner, the Tejon Ranch Company, for commercial ranching, hunting and other compatible uses. Thus, the focus of the RWMP was to maintain, enhance and restore conservation values within a private, working lands context. Working with contractors, academic partners, and citizen scientists, the Conservancy's Science Program has been inventorying the natural resources on Tejon Ranch, elucidating drivers of ecosystem structure and function, and hypothesizing management actions to enhance resource conditions to inform resource management planning. The RWMP defined the Conservancy's rationale and vision for adaptive management at Tejon, and established Best Management Practices (BMPs) for the landowner's land uses to protect and, where feasible, enhance conservation values.

Following adoption of the RWMP in 2013, Dr. White's focus has prioritized and implemented stewardship actions laid out in the plan. These have primarily involved cattle grazing management to achieve conservation objectives in grasslands and riparian and wetland ecosystems across tens of thousands of acres of Tejon Ranch. Grasslands enhancement projects seek to use cattle to reduce the biomass of nonnative Mediterranean grasses to favor native forb species and improve habitat structure for native animals. Riparian and wetland enhancement projects intend to reduce livestock grazing pressure during summer and fall months to enhance diversity, cover and structure of vegetation communities to improve habitat condition and function. These grazing management projects have required installation and reconfiguration of ranching infrastructure (e.g., fences and water systems) to enable the desired conservation grazing management, which has required extensive coordination with the landowner, ranching operators, funding and permitting agencies, and contractors.

Dr. White facilitated an extensive amount of external research at Tejon Ranch, with over 40 research projects started on the property during his tenure. These projects ranged in scope from species inventories, habitat modeling, population dynamics, climate change responses and adaptation, and various geological investigations. Dr. White served on several graduate committees for Tejon-related projects and has overseen several group projects with universities. He developed and coordinated the first Citizen Science projects at Tejon Ranch, co-taught the Conservancy's California Naturalist (Master Naturalist) coarse to members of the public, and frequently led public tours.

REGIONAL HABITAT CONSERVATION PLANNING, MONITORING, RESTORATION, AND MANAGEMENT

State Wildlife Action Plan Forest and Rangelands Companion Plan Development Team – California Department of Fish and Wildlife. While with Tejon Ranch Conservancy, served as part of a technical advisory group to the Department and their consultant team during the development of the Forest and Rangelands Companion Plan to California's State Wildlife Action Plan revision in 2016. The role of the advisory group was to help identify conservation issues and strategies pertinent to forest and rangeland ecosystems.

California Landscape Conservation Collaboration Technical Advisory Team. While with Tejon Ranch Conservancy, served on the Technical Advisory Team for the development of a Strategic Plan and Scientific Management Framework for the California LCC. The role of the advisory group was to provide technical input to LCC staff on conservation and adaptive management issues in the planning area.

Yuba Foothills Conservation Assessment – The Trust for Public Land. Dr. White prepared a conservation assessment of a 600,000-acre study area in the northern Sierra Nevada foothills. The purpose of the assessment was to identify meaningful conservation objectives and opportunities and provide a case statement for the study area to guide TPL's land conservation work. As part of the assessment, Dr. White conducted a landscape integrity analysis for the entire northern Sierra Nevada foothills subregion as a way of providing a regional context for the conservation values of the study area.

Effective Conservation and Management of the Sonoran Desert of California – The Nature Conservancy. Working with TNC, CBI evaluated ways of increasing the effectiveness of conservation and management over the 6 million-acre portion of the Sonoran Desert ecological region within California. CBI and TNC made use of the Marxan reserve selection algorithm to identify portions of the study area that support specific conservation values, and then identified how existing land ownership and management patterns protect these conservation values from an array of potential threats, including land conversion, inappropriate recreational activities, mining, alternative energy production, and exotic plant species. The results of this project will be used to guide TNC's conservation activities in the region.

Northstar Habitat Management Plan – Booth Creek. Dr. White provided technical review of the Habitat Management Plan (HMP) developed for the 8,000-acre Northstar at Tahoe ski resort in the Martis Valley, California. Development of the HMP was an obligation of the settlement agreement between Northstar and local environmental organizations for which Dr. White served as a technical expert. The Northstar ski resort supports areas of relatively intact late seral conifer forest supporting species such as California spotted owl, pine martin, and northern goshawk, as well as high quality riparian and aquatic habitats, meadows, and deer fawning habitat. The HMP will be used to guide expansion of the ski resort authorized by the settlement agreement, and forest management measures to enhance late seral forests and other habitats on the property.

Tejon Ranch Reserve Design. CBI, working with the South Coast Wildlands Project, developed a science-based reserve design for the 270,000-acre Tejon Ranch. The reserve design used a series of conservation planning principles and the results of previous CBI studies conducted for the Ranch to design and justify a reserve that captures regional conservation objectives, such as habitat representation goals, protection of intact watersheds, rare and endangered species protection and recovery, and maintenance of intact core reserve areas. The reserve design underwent peer review by a group of academics, resource agency staff, and local experts. The final reserve design was provided to stakeholders with an interest in significant conservation on Tejon Ranch for use in negotiations with the landowner.

Environmental Monitoring and Habitat Management Planning Program for the Ramona Grasslands – The County of San Diego Department of Parks and Recreation and The Nature Conservancy. Dr. White was the lead scientist for the development of a habitat management plan for the Ramona Grasslands in central San Diego County. The Ramona Grasslands are a regionally important conservation area, supporting a variety of target resources, including vernal pools and rare vernal pool species, Stephens' kangaroo rat, wintering and breeding raptors, riparian habitats and arroyo southwestern toads, and native grasslands. Development of the management plan was preceded by a 2-year baseline field monitoring program that was coordinated by Dr. White. The Ramona Grasslands are grazed by cattle, which maintain habitat suitability for some species but can adversely affect other natural resources. The adaptive management plan proposed a managed grazing strategy to balance these resource needs and optimize habitat quality across the preserve. Monitoring activities proposed by the management plan include surveys of grassland, vernal pool, and riparian plants; characterization of stream channel geomorphology and water quality; and avian, small mammal, amphibian, and fairy shrimp surveys. The management plan built on the science foundation CBI articulated for the Ramona Grasslands in the Framework Management Plan previously developed for The Nature Conservancy.

Hydrologic and Hydraulic Assessment of Santa Maria Creek – The Nature Conservancy. Dr. White was the lead scientist for a project conducted in collaboration with researchers from San Diego State University's Department of Geography. The purpose of the project was to analyze historic, current, and future hydrologic and hydraulic regimes, and associated changes in channel geomorphology and riparian vegetation of Santa Maria Creek, Ramona, San Diego County. The analysis focused on how changes in land uses in the watershed affect runoff quantity, stream discharge and stage, and channel geomorphology and riparian vegetation distribution. Historic land uses were quantified from California Department of Water Resources land use maps and historic channel geomorphology and riparian vegetation distribution from historic aerial photography. Future land use was projected from County of San Diego General Plan information. This information is being incorporated into management planning for the Ramona Grasslands Open Space Preserve, which is traversed by Santa Maria Creek.

Shirttail Creek Forest Property Conservation Assessment – Endangered Habitats Conservancy and California Wildlife Foundation. Dr. White prepared a conservation assessment to support the acquisition of the 1,000-acre Shirttail Creek Forest Property outside of Foresthill, California in the northern Sierra Nevada. The assessment characterized the resource values of the property, which included pristine reaches of Shirttail Creek, oak woodlands, and old-growth conifer forests, special status species supported by the property, and the role of the property

in regional connectivity.

El Monte Valley Restoration Project – Endangered Habitats Conservancy. Dr. White is directing restoration planning for approximately 450 acres of the San Diego River and its floodplain in the El Monte Valley, Lakeside, California. The riverine functions and values of the site are currently compromised by a lack of surface-water hydrology due to the El Capitan dam upstream of the site, lowered groundwater elevations from groundwater withdrawals, and significant invasion of the river channel by exotic species. The project entails coordinating the design of the restoration project with a groundwater recharge project proposed for the Valley by the Helix Water District. Dr. White coordinated field studies within the project area including vegetation mapping, avian point counts, and establishment of a bird banding (MAPS) station.

Conservation Assessment of Ranch Guejito. CBI prepared a conservation assessment for the 20,000-acre Rancho Guejito in northern San Diego County, one of the most important conservation targets in the region. The assessment documents the conservation significance of Rancho Guejito from both a natural and cultural resources perspective. The assessment evaluated the resources of Rancho Guejito within a Southern California regional context, and assessed its potential contribution to conservation of landscape-scale processes, protecting intact watershed basins, under-protected vegetation associations, and key sensitive species, as well as prehistoric and historic cultural resources. The assessment is being used by conservation organizations to justify and develop strategies for conservation of the property.

Las Californias Binational Conservation Initiative – San Diego Foundation and Resources Legacy Fund Foundation. In partnership with the Mexican non-governmental organization, *Pronatura*, and The Nature Conservancy, CBI designed a conservation reserve for a 2.5 million-acre area of Southern California and northern Baja California. The study area extends from the Sweetwater River watershed in California to the Rio Guadalupe watershed in Baja California. The project used the reserve selection algorithm, *SPOT*, to select a reserve portfolio. The project has required extensive manipulation and merging of various U.S. and Mexican digital datasets (e.g., land cover, roads, digital elevation models, etc.) and cross-walking of different vegetation classification systems. Conservation achievements within the Las Californias Binational Conservation Initiative study area total over 3,500 acres to date, and are currently a priority of local, state, and federal governmental agencies and non-governmental conservation organizations.

Sierra Nevada Checkerboard Initiative – The Trust for Public Land. Ownership in the Central Sierra Nevada is characterized by a "checkerboard" pattern of public and private land, which potentially complicates management of the landscape for conservation, recreational, and timber harvest values. The Trust for Public Land's Sierra Checkerboard Initiative attempts to affect changes in ownership and management patterns in the northern Sierra to ameliorate the conflicts caused by the checkerboard ownership. Dr. White, working with TPL and its conservation partners, Sierra Nevada Forest Protection Campaign and California Wilderness Coalition, first conducted a science assessment of the 1.5-million acre Sierra Checkerboard Initiative study area to identify high resource value areas, threats to these resources, and spatially explicit management strategies that could be implemented by TPL and its partners to improve resource values. As part of the assessment, Dr. White assembled and worked with a Scientific Advisory Panel of academics and resource agency staff with relevant experience in the Sierra Nevada to advise and review our

work on the project. Working with TPL's forestry consultant, Dr. White then prepared a conservation strategy that identified priority areas for conservation actions and available private lands conservation approaches. TPL is currently implementing the conservation vision developed for the Initiative.

Tejon Ranch Conservation Assessments – Environment Now and Resources Legacy Fund Foundation. Dr. White was the lead scientist for two assessments characterizing the conservation value of the 270,000-acre Tejon Ranch, California. The Conservation Significance Project was conducted in partnership with the South Coast Wildlands Project and California Wilderness Coalition. The Conservation Significance Project made use of available data, museum records, and expert opinion and assessed the biogeographic importance of the Tejon Ranch, its core habitat and natural community representation values, roadlessness, terrestrial and watershed integrity, importance as a habitat linkage, and habitat for rare and endangered species. CBI also conducted an additional Conservation Assessment Project that identified the distribution of a set of conservation values across Tejon Ranch. Conservation values included threatened, endangered and endemic species distributions, roadless areas analysis, watershed integrity analysis, habitat diversity, and regionally under-protected vegetation communities. As part of the Conservation Assessment Project, CBI conducted a remote sensing analysis to update information on roads, land cover, and vegetation community distributions.

South Coast Missing Linkages Project – South Coast Wildlands Project. Dr. White participated in partnership with the South Coast Wildlands Project, The Nature Conservancy, and Pronatura to conduct planning studies on five important habitat linkages in the U.S.-Mexico border region. The CBI is took the lead on two of the five linkages. One was linking National Forest land in the Laguna Mountains with important habitats in Baja California through the Campo Valley area of San Diego County. The other was linking habitats in the Jacumba Mountains with those in the Sierra Juarez in Baja California.

Habitat Management Planning for the Lake Hodges/San Pasqual Valley MSCP Preserve Area – City of San Diego. Dr. White developed a habitat management plan for the over 9,000-acres Lake Hodges/San Pasqual Valley MSCP Preserve Area. He coordinated a team of specialists comprised of local biologists, the U.S. Geological Survey, and San Diego State University to conduct baseline field surveys and map the distributions of key resources, including vegetation communities, rare plants, Hermes Copper butterfly, herpetofauna (including the endangered arroyo southwestern toad), and breeding riparian birds (including the endangered least Bell's vireo and southwestern willow flycatcher). The management plan addressed issues such as control of adjacent land use impacts, fire management, recreational access, fencing, exotic species control, monitoring, and research.

Monitoring Program for the Santa Margarita River – The Nature Conservancy. Dr. White developed a program to monitor future potential changes in the Santa Margarita River associated with modification of base flows resulting from a water rights settlement on the river. Base flow augmentation resulting from the settlement has been designed to mimic natural discharge patterns historically observed in the river. The objective of the monitoring program was to quantify conditions prior to the modification of base flows and to track changes following base flow augmentation. The monitoring plan was structured around distinct reaches of the river that are

anticipated to respond similarly to river hydrology. Elements considered in the monitoring plan include biological resources (riparian and coastal stream communities), water quality, discharge, and channel geomorphology.

Regional Conservation Planning and Constraints Analyses for Eastern San Diego Mountains – The Nature Conservancy. CBI worked with The Nature Conservancy and a team of regional scientific experts to prioritize conservation opportunities for a 400,000-acre area in San Diego County that includes the headwaters of five major watersheds. The study involved development and review of a spatial and non-spatial database for the area, identification of regionally important resources and landscape connections, and a gap analysis to identify regionally important resources that were in private ownership and zoned for development or agriculture. CBI identified and evaluated the potential effects of land uses and other stressors, including those that may affect downstream portions of the watersheds. CBI and a team of scientists conducted biological surveys of selected properties. As a result of the studies, CBI prepared a conservation strategy report that identifies conservation priorities, research needs, land use constraints, potentially compatible land uses and appropriate locations, restoration opportunities, and habitat management goals.

MSCP Monitoring Program Coordination – California Department of Fish and Game (CDFG), U.S. Fish and Wildlife Service (USFWS) and City of San Diego. CBI worked with the City of San Diego and other San Diego County jurisdictions, USFWS, and CDFG to implement the Subregional Biological Monitoring Program for the San Diego MSCP. As part of this effort, CBI compiled an inventory of existing monitoring efforts in western San Diego County, developed a strategic framework of the roles and responsibilities of the monitoring partners, refined biological monitoring protocols, developed structures and protocols for managing large biological databases, formulated a strategy for developing a centralized database repository, and developed a web site to disseminate MSCP-related information to the public.

Regional Biological Monitoring Plan for the Multiple Habitats Conservation Program – San Diego Association of Governments. In coordination with the California Department of Fish and Game and the U.S. Fish and Wildlife Service, and the seven North San Diego County cities participating in the Multiple Habitats Conservation Program (MHCP), CBI developed a regional biological monitoring plan for the MHCP planning area. The MHCP biological monitoring program is intended to provide a systematic data collection effort to gauge the progress and success of the habitat preserve system. The plan addresses regional monitoring objectives and describes specific monitoring approaches for riparian communities, uplands, vernal pools, coastal lagoons, and wildlife movement corridors within the preserve system.

Habitat Management Planning for the Marron Valley Preserve Area – City of San Diego. Dr. White developed a habitat management plan for the 2,600-acre Marron Valley MSCP Preserve Area. He coordinated a team of biologists associated with CBI, the U.S. Geological Survey, and the San Diego Natural History Museum to conduct baseline field surveys and map the distributions of key resources, including vegetation communities, rare plants, endangered Quino checkerspot butterflies, herpetofauna (including the endangered arroyo southwestern toad), and breeding riparian birds (including the endangered least Bell's vireo and southwestern willow flycatcher). Dr. White conducted surveys for the endangered San Diego fairy shrimp in vernal pools on the property. The management plan addressed issues such as cattle grazing, fire management, access,

fencing, exotic species control, monitoring, and research.

Wildlife Corridor Monitoring Study – City of Poway and City of San Diego. This study evaluated the use of designated wildlife corridors by target mammal species, including mountain lions, bobcats, coyotes, mule deer. Field monitoring was conducted in the Los Peñasquitos, Carmel Valley, Carmel Mountain/Del Mar Mesa, and eastern Poway areas by a graduate student and by a local volunteer organization using different methodologies over several seasons. Dr. White analyzed the data generated to assess the functionality of the wildlife corridors and to compare the methods. CBI's report made recommendations on wildlife corridor monitoring methodologies for the MSCP.

Lower Colorado River Multi-Species Conservation Program – National Fish and Wildlife Foundation. Dr. White served as the Technical Coordinator of the plan development team for the Lower Colorado River Multiple Species Conservation Program (LCR MSCP). The LCR MSCP plan was prepared for a consortium of federal and state agencies (California, Nevada, and Arizona), water and hydropower interests, and Native American Tribal governments. The LCR MSCP was initiated to optimize opportunities for current and future water and power development in the lower Colorado River basin, while working towards conservation of listed and selected unlisted species and their habitats in compliance with both the federal and California Endangered Species Acts. The result of the plan will be the issuance of incidental take authorizations under Sections 7 and 10(a)(1)(B) of the Endangered Species Act, and Section 2835 of the California Natural Communities Conservation Program Act for those species deemed to be adequately addressed by the plan, through a combination of conservation, management, restoration, and operational measures.

Dr. White's responsibilities included providing overall technical oversight for the project team, including development of a conservation strategy for the program and alternatives for evaluation under the California Environmental Quality Act and National Environmental Policy Act. The conservation strategy involved a strong riparian habitat restoration component, which involves integrating the requirements of riparian species with the hydrologic and hydraulic conditions on the river in light of future water management scenarios (e.g., intrastate water transfers to achieve compliance with California's 4.4 Plan, offstream storage and interstate transfer rules). The conservation strategy had to consider large-scale water management activities and water accounting practices dictated by the large body of legislation and court decrees collectively known as the Law of the River.

Multiple Species Conservation Program – City of San Diego Clean Water Program. Dr. White participated in development of a conservation and management plan for federally listed species and key candidate species and their habitats in a 900-square-mile area in San Diego County. He coordinated the development of a GIS-based habitat evaluation model, prepared hydrologic management guidelines for the preserve system, and assisted with development of the species and habitat monitoring program for the preserve system.

TECHNICAL STUDIES

Fairy Shrimp Survey Protocol Analysis – Western Riverside County Regional Conservation Authority. Dr. White performed an analysis of Endangered Species Act section 10(a)(1)(A) fairy shrimp survey data to assess the adequacy of a single survey, as opposed to multiple surveys, in detecting fairy shrimp in vernal pools. The analysis used the survey data to determine the conditional probability of detecting shrimp in the second survey period if shrimp either were or were not collected in the first survey period.

The Influence of Watershed Urbanization on the Hydrology and Biology of Los Peñasquitos Creek – The San Diego Foundation Blasker Rose-Miah Fund. Dr. White was awarded a research grant to study the effects of urbanization in the Los Peñasquitos Creek watershed. The Los Peñasquitos Creek watershed is a small coastal watershed in San Diego, California that contains significant areas of conserved natural habitats, but has experienced rapid urban growth. The study examined how patterns of land use change in the Los Peñasquitos Creek watershed have affected downstream hydrology of the creek, channel geomorphology, and associated riparian vegetation communities. The research showed that urbanization of the watershed has resulted in significant increases in discharge, annual runoff, flood peaks, and dry-season flows. These hydrologic changes have driven changes in the distribution and composition of riparian habitats associated with Los Peñasquitos Creek.

Source Water Protection Guidelines – The City of San Diego Water Department. Dr. White provided technical assistance to City of San Diego Water Department staff in preparing development guidelines intended to ensure protect of the quality of San Diego source water supply reservoirs. The project was conducted by a consulting firm, Brown and Caldwell, and Dr. White served as a technical advisor directly to the City.

Guajome Lake Water Quality Assessment Project – County of San Diego. Dr. White served as project manager for a water quality study at Guajome Lake in northern San Diego County funded under the U.S. Environmental Protection Agency's (USEPA) Clean Lakes Program. The focus of the project was to characterize water quality in the lake through field sampling and chemical analysis of soil, sediment, stream flow, and lake water to identify pollution problems in the lake and its watershed. The project included preparation of a Quality Assurance Project Plan (QAPP), assessing historic uses of agricultural chemicals in the watershed, estimating sediment and chemical constituent loadings to the lake with watershed modeling techniques, developing and assessing pollution control measures, and developing pollution control and water quality monitoring programs for the lake.

San Diego River Live Stream Discharge Studies – City of San Diego. Dr. White was biology task manager for analysis of potential effects of live stream discharge of reclaimed water to the San Diego River. The objectives of the study were to determine the feasibility of a live stream discharge program in light of the potential effects to wetlands (including habitat for the endangered least Bell's vireo), aquatic fauna, water quality, and public health. Responsibilities included an assessment of the effects of varying quantities of live stream discharge on fisheries habitat, riparian and salt marsh wetlands, wetland-associated terrestrial species, and disease vectors. Completion of this task required interpretation of the QUAL2E water quality model output and hydraulic

modeling output.

Salton Sea Water Quality Management Project – Salton Sea Authority. As project manager for a program funded under a USEPA Clean Lakes Grant, Dr. White summarized and presented environmental and economic analyses of salinity and surface elevation management alternatives at the Salton Sea. The project entailed interaction with the USEPA, U.S. Army Corps of Engineers, Bureau of Reclamation, U.S. Fish and Wildlife Service, California Department of Fish and Game, Regional Water Quality Control Board, California Environmental Protection Agency, and local citizens groups to identify and summarize their concerns.

Olivenhain Reservoir Limnological Assessment – Olivenhain Water District. Dr. White served as project manager and technical lead for the assessment of anticipated limnological conditions of a reservoir planned for San Diego County (Olivenhain Reservoir). The assessment projected anticipated thermal stratification and dynamics of nutrients, dissolved oxygen, and other water quality constituents. He recommended design features to better manage water quality in the reservoir, including a multi-port outlet tower to allow selective withdrawals, artificial circulation/hypolimnetic aeration, and a separate inlet structure for aqueduct inflows.

Fairy Shrimp Survey and Assessments – Twentynine Palms Marine Corps Air Ground Combat Center. Dr. White directed field surveys of anostracans (primarily fairly shrimp) in desert playas and impact assessments of base operations on these resources. Field surveys involved collecting samples of sediments containing anostracan eggs that were reared in controlled conditions in the laboratory. The impact assessment primarily evaluated the effects of vehicle traffic (e.g., tanks and armored personnel carriers) on desert playa habitats.

Fisheries Survey – Newhall Land and Farming. Dr. White conducted a field survey of native fishes in the Santa Clara River, Los Angeles County, California, as part of an emergency road crossing project. The purpose of the survey was to document the species present in the study area and to relocate fish potentially impacted by construction operations to areas outside of the impact zone as conditioned in the California Department of Fish and Game Streambed Alteration Agreement for the project. Species of particular interest were three-spined stickleback (*Gasterosteus aculeatus*), arroyo chub (*Gila orcutti*), and Santa Ana sucker (*Catostomus santaanae*).

Impacts of Threadfin Shad on Largemouth Bass – San Diego State University. Dr. White participated in a project to examine the impacts of threadfin shad introductions on aquatic biota in Southern California reservoirs. He sampled fish and plankton, conducted physical and chemical analyses, and conducted echo-sounding in six lakes in San Diego County. Dr. White identified zooplankton and provided statistical review.

Impacts of Opossum Shrimp on Zooplankton – Tahoe Research Group. Dr. White participated in a project assessing the impacts of opossum shrimp (*Mysis relicta*) introductions on Lake Tahoe zooplankton. He installed experimental enclosures with scuba, sampled and counted zooplankton, and performed a variety of routine limnological analyses, as well as conducted short-term opossum shrimp feeding experiments.

ANALYSIS OF ENVIRONMENTAL IMPACT AND REGULATORY COMPLIANCE

Martis Valley Community Plan – Sierra Watch and Mountain Area Protection Foundation. Dr. White conducted a review and provided comments on the Environmental Impact Report prepared of for the update to the Martis Valley Community Plan on behalf of Sierra Watch and Mountain Area Protection Foundation. The Community Plan Update proposed alternatives that would change development patterns in the Martis Valley Community Planning Area, Placer County, California. These impacts would have potentially significant impacts to high value terrestrial and aquatic resources, including forests, shrub communities, meadows, and stream systems. To assist with critiquing the biological resources analyses in the EIR, CBI developed a natural resources conservation vision for the Martis Valley and identified how the proposed developments authorized under the proposed Community Plan would adversely affect these resources. Dr. White participated in landowner negotiations over development designs and provided litigation support.

Evaluation of the Cabo San Quintín Development Project and Environmental Impact Study – *pro esteros* and Endangered Habitats League. CBI conducted an evaluation of the proposed Cabo San Quintín development plan and associated Mexican environmental impact study (Manifestación de Impacto Ambiental) for the Punto Mazo peninsula, San Quintín, Baja California, Mexico. The evaluation discussed inadequacies and inconsistencies of the environmental analysis, and presented an independent analysis of key project features and their potential impacts. Key points discussed in the evaluation included the inadequate consideration of Mexican endangered species laws, state land use regulations, potable and irrigation water supply issues, waste water treatment and potential nutrient loading, potential effects of marina dredging on the Bahía San Quintín, potential impacts to endemic species and sensitive habitats, and potential socioeconomic impacts associated with the increased regional infrastructure and services needs that would result from implementing the project.

Wetlands Permitting, Mission Valley West Light Rail Transit – Metropolitan Transit Development Board. Dr. White was the project manager responsible for coordinating wetlands and endangered species permitting for the Mission Valley West Light Rail Transit project. He conducted a Section 404(b)(1) alternatives analysis, selected potential riparian mitigation sites, acted as permitting agency liaison, coordinated development of a wetlands mitigation plan, conducted U.S. Army Corps of Engineers 404 and California Department of Fish and Game Streambed Alteration Agreement permitting, and coordinated Section 7 consultation for the endangered least Bell's vireo.

Wetlands Permitting and Mitigation Plan, East Mission Gorge Sewer Interceptor Force Main and Pump Station – City of San Diego Water Utilities Department. Dr. White coordinated the development of a detailed wetlands mitigation plan for impacts associated with the construction of a sewage pump station and force main. The wetlands mitigation plan was developed in consultation with the U.S. Fish and Wildlife Service, California Department of Fish and Game, and City of San Diego. The mitigation plan was required for the U.S. Army Corps of Engineers' Section 404 and California Department of Fish and Game 1601 permitting process. Dr. White also conducted the biological resources impact analysis for the California Environmental

Quality Act (CEQA) compliance.

CONSERVATION OUTREACH, TRAINING, AND EDUCATION

San Dieguito River Watershed Information System – San Dieguito River Valley Conservancy. Dr. White directed the development of a Geographic Information System (GIS) based information system that will assist the Conservancy and the San Dieguito River Valley Joint Powers Authority (JPA) with planning, land acquisition and conservation, and community outreach. The project was funded by the San Diego Foundation. The GIS tool combines available regional data layers such as land use, land ownership, biological resources information, topography, water resources information, and political boundaries, into a user-friendly mapping and analysis tool. The tool allows staff at the Conservancy and JPA to combine various data layers for environmental analyses, to track resource and land status in the watershed, and to create maps and displays for outreach purposes.

Conservation Resource Center Feasibility Study – San Dieguito River Valley Conservancy. CBI prepared a study evaluating the feasibility and desirability of establishing a resource support service for conservation groups in San Diego County. The first phase of the study included an exploratory workshop and discussions with individuals from the San Diego conservation community about alternative strategies for sharing resources. CBI conducted research on other organizational models across the country and evaluated the local availability of technical services. We prepared a report summarizing the results of our study and that provided recommendations on a structure and strategy for developing a resource center.

Aquatic Ecology Training Program – Campo Environmental Protection Agency. Dr. White conducted training of tribal members working for the Campo Band of Mission Indians Environmental Protection Agency (Campo EPA) in aquatic and riparian resource ecology, inventory, and restoration. The program was funded under Section 106 of the Clean Water Act. The ultimate goal of the program was to provide tribal members sufficient training to allow for an efficient and effective transition of delegation of authority over water resources matters to the Campo Band. He conducted training in riparian ecology, aquatic invertebrate ecology, Rapid Bioassessment Protocols, and stream and riparian restoration techniques.

ECOLOGICAL RISK ASSESSMENTS

Ecological Risk Assessment, U.S. Naval Activities (NAVACTS), Guam – U.S. Navy. Dr. White coordinated investigations in support of ecological risk assessments for terrestrial and freshwater habitats at four sites at NAVACTS Guam. Field studies included mapping and characterization of vegetation and wildlife habitat, floral and faunal inventories, collection of soils and sediments for toxicity tests and chemical analyses, and analysis of resident biota for contaminant bioaccumulation. This information was compared to data from offsite reference areas. These data were used to develop preliminary ecological risk assessments evaluating the potential risk that the chemicals onsite posed to aquatic and terrestrial communities. Of special concern was the potential for adverse impacts to the endangered Mariana common moorhen, which utilizes freshwater marshes in the area. Chemicals of concern for these sites included metals, pesticides, polychlorinated biphenyls (PCBs), dioxins, petroleum hydrocarbons, and polynuclear

aromatic hydrocarbons (PAHs).

Ecological Risk Assessment, Old WESTPAC Site, NAVACTS, Guam – U.S. Navy. Dr. White coordinated field studies at NAVACTS, Guam to sample soils and freshwater sediments for chemical analyses and toxicity tests. Collected aquatic and terrestrial organisms for tissue analyses to determine bioaccumulation of chemicals found onsite. These data were used to develop a preliminary ecological risk assessment evaluating the potential risk that the chemicals onsite posed to aquatic and terrestrial communities. Of particular concern were wetlands supporting the endangered Mariana common moorhen. Chemicals of concern included metals, pesticides, PCBs, petroleum hydrocarbons, and PAHs.

Ecological Risk Assessment RCRA Facilities Investigation – Rocketdyne Division, Boeing North American. Dr. White oversaw the development of ecological risk assessments at 36 sites at the 2,500-acre Santa Susana Field Laboratory (SSFL) for the Rocketdyne Division of Boeing North American. He supervised biologists conducting extensive field surveys of the SSFL that involved vegetation community mapping, rare plant surveys, and wildlife species inventories. He coordinated with the California Department of Toxic Substances Control (DTSC) on development of a series of "white papers" describing the approach and methodologies that will ultimately be employed to conduct the risk assessments for the SSFL. The white papers dealt with issues such as determining background concentrations, selecting contaminants of concern, proposed conceptual site models, calculation of exposure point concentrations, development of exposure model parameters, and risk-based decision criteria.

PUBLICATIONS AND PRESENTATIONS

PUBLICATIONS AND REPORTS

Tabak, M.A., M.S. Norouzzadeh, D.W. Wolfson, S.J. Sweeney, K.C. Vercauteren, N.P. Snow, J.M. Halseth, P.A. Di Salvo, J.S. Lewis, M.D. White, B.Teton, J.C. Beasley, P.E. Schlichting, R.K. Boughton, B. Wight, E.S. Newkirk, J.S. Ivan, E.A. Odell, R.K. Brook, P.M. Lukacs, J. Clune, R.S. Miller.2018. Machine learning to classify animal species in camera trap images: applications in ecology. *Methods in Ecology and Evolution* 2018;00:1-6. https://doi.org/10.1111/2041-210X.13120

Ratcliff, F.P., J.W. Bartolome, L. Macauly, S. Spiegal, and M.D. White. 2018. Applying ecological site concepts and state-and-transition models to a grazed riparian rangeland. *Ecology and Evolution* 8:4907-4918. https://doi.org/10.1002/ece3.4057.

White, M.D., K. Kauffman, J. Lewis, and R. Miller. 2018. Wild pig use of fenced farm fields in California's San Joaquin Valley. *California Agriculture* 72(2):120-126.

Robeson, M.S., K. Khanipov, G. Golovko, S.M. Wisely, M.D. White, M. Bodenchuck, T.J. Smyser, Y. Fofanov, N. Fierer, and A.J. Piaggio. 2017. Assessing the utility of metabarcoding for diet analyses of the omnivorous wild pig (*Sus scrofa*). *Ecology and Evolution* 00:1-12. https://doi.org/10.1002/ece3.3638.

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White, M.D. and K. Kunkel. 2016. Evaluating feral pig management strategies at Tejon Ranch, California. Proceedings of the 27th Vertebrate Pest Conference (R.M. Timm and R.A Baldwin Eds). Pgs. 124-127. University of California, Davis, CA.

Teton, B., M.D. White, and K. Kunkel. 2016. Grappling with pigs in California High Country: Wild pig population

and disturbance research at Tejon Ranch. Proceedings of the 27th Vertebrate Pest Conference (R.M. Timm and R.A Baldwin Eds.). Pgs. 128-132. University of California, Davis, CA.

Spiegal, S., J.W. Bartolome, and M.D. White. 2016. Applying ecological site concepts to adaptive conservation management on an iconic Californian landscape. *Rangelands* 38(6):365-370.

White, M.D. 2015. Status, conservation, and management of oaks at Tejon Ranch, California. Pgs 495-503 in: Standiford, Richard B.; Purcell, Kathryn L., tech. cords. 2015. Proceedings of the seventh California oak symposium: managing oak woodlands in a dynamic world. Gen. Tech. Rep. PSW-GTR-251. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 579 p.

Ratcliff, F.P., J.W. Bartolome, M. Hammond, S. Spiegal, and M. White. 2015. Developing Ecological Site and State-and Transition Models for Grazed Riparian Pastures at Tejon Ranch, California. Pgs 209-218 in: Standiford, Richard B.; Purcell, Kathryn L., tech. cords. 2015. Proceedings of the seventh California oak symposium: managing oak woodlands in a dynamic world. Gen. Tech. Rep. PSW-GTR-251. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 579 p.

Principe, Z. and M.D. White. 2015. Hidden treasures of the Tehachapi Region. *Fremontia* 43(2):2-9.

Bartolome, J.W., B. H. Allen-Diaz, S. Barry, L. D. Ford, M. Hammond, P. Hopkinson, F. Ratcliff, S. Spiegal, and M. D. White. 2014. Grazing for biodiversity in Californian Mediterranean grasslands. *Rangelands* 36:36–43.

White, M.D. and J.R. Strittholt. 2014. Forest conservation planning. *In* Reynolds, K.M., P.F. Hessburg, and P.S. Bourgeron (eds). 2014. *Making Transparent Environmental Management Decisions: Applications of the Ecosystem Management Decision Support System*. Berlin: Springer.

White, M.D. and K. Penrod. 2012. The Tehachapi Connection: a case study of linkage, design, conservation, and restoration. *Ecological Restoration* 30(4):279-282.

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White, M.D., J.A. Stallcup, K. Comer, M.A. Vargas, J.M. Beltran-Abaunza, F. Ochoa, and S. Morrison. 2006. Designing and establishing conservation areas in the Baja California-Southern California border region. *In* Hoffman, K. (ed.), *The U.S. – Mexican Border Environment: Transboundary Ecosystem Management*. Southwest Consortium for Environmental Research and Policy Monograph Series, no. 15. San Diego State University Press.

White, M.D., and K.A. Greer. 2006. The effects of watershed urbanization on stream hydrologic characteristics and riparian vegetation of Los Peñasquitos Creek, California. *Landscape and Urban Planning* 74(2):125-138.

Strittholt, J.R., N.L. Staus, and M.D. White. 2000. Importance of Bureau of Land Management Roadless Areas in the Western U.S.A. Prepared for the National Bureau of Land Management Wilderness Campaign by the Conservation Biology Institute. March.

White, M.D. 1998. Horizontal distribution of pelagic zooplankton in relation to predation gradients. *Ecography* 21:44-62.

Hurlbert, S.H., and M.D. White. 1994. Experiments with invertebrate zooplanktivores: Quality of statistical analysis. *Bulletin of Marine Science* 53(2):128-153.

PRESENTATIONS

White, M.D., S. Spiegal, and J.W. Bartolome. 2019. Using ecological site descriptions and State and Transition Models to inform native plant restoration strategies. Society for Range Management 2019 Annual Meeting. Minneapolis, MN. February.

Bartolome, J.W., P.J. Hopkinson, and M.D. White. 2018. Drivers of California Mediterranean grassland biodiversity. Presented at the Society for Range Management 2018 Annual Meeting. February.

White, M.D. 2016. Private Lands Conservation and Management in the Face of Changing Climates: a Case Study from Tejon Ranch. Natural Areas Association Conference. October.

White M.D. and K. Kunkel. 2016. Evaluating Feral Pig Management Strategies at Tejon Ranch, California. 27th Vertebrate Pest Conference, Newport Beach, CA. March.

Jesse S. Lewis, Matthew L. Farnsworth, Ryan S. Miller, Daniel Grear, Steven J. Sweeney, Raoul Boughton, Michael White, Dennis Orthmeyer, and Kurt C. VerCauteren. 2016. Development of a comprehensive feral swine field study: population dynamics, response to culling, space use patterns, and behavioral interactions. 2016 International Wild Pig Conference, April.

Maloney, T., Z. Principe, and M.D. White. 2015. The Tehachapi Linkage: large landscape conservation success. Part of a workshop at the Land Trust Alliance Rally. October.

White, M.D. 2015. Using an ecological sites framework to prioritize conservation management of grasslands at Tejon Ranch, California. Presented at the California Native Plant Society 2015 Conservation Congress. January.

White, M.D. 2014. Status, conservation, and management of oaks at Tejon Ranch, California. Presented at the 7th California Oak Symposium. November.

White, M.D. 2014. Conservation management of San Joaquin Valley grasslands at Tejon Ranch. Presented at the San Joaquin Valley Natural Communities Conference, The San Joaquin Valley chapter of The Wildlife Society. March.

White, M.D. 2013. Ecological restoration from a conservation practitioner's perspective. Presented at the Pritzlaff Conservation Symposium, Santa Barbara Botanic Garden. October.

White, M.D. 2012. Developing conceptual models to inform conservation management of working landscapes at Tejon Ranch, California. Presented at the North American Congress of the Society for Conservation Biology. July.

White, M.D. 2011. Conservation management planning at Tejon Ranch, CA, USA. Presented at the MEDECOS XII conference. September.

White M.D., E.R Pandolfino, and A. Jones. 2010. A Purple Martin survey expedition on Tejon Ranch, California. Presented at the Western Field Ornithologists Annual Conference. October.

White, M.D. 2009. Conservation in the Tehachapi Connection. Presented at the California Native Plant Society Conservation Conference. January.

White, M.D. 2007. Designing landscape reserves in light of climate change. Presented at the Public Lands and Climate Change Symposium, Berkeley, CA. November.

White, M.D. 2007. Las Californias Binational Conservation Plan: Importance of the Sierra Juárez. Presented at the National Ecology Week Symposium, Universidad Autonomia Baja California, Ensenada, Baja California. November.

White, M.D. 2006. Applying landscape ecology to wetland and watershed management in Southern California. Presented at the Southern California Wetlands Recovery Project Symposium 2006, Santa Barbara, CA. March.

White, M.D., J.A. Stallcup, K. Comer, M.A. Vargas, J.M. Beltran-Abaunza, F. Ochoa, and S. Morrison. 2004. Designing and establishing conservation areas in the Baja California-Southern California border region. Presented at Border Institute VI, Transboundary Ecosystem Management, organized by the Southwest Center for Environmental Research and Policy. April.

White, M.D., and K.A. Greer. 2003. The effects and conservation implications of watershed urbanization in a Southern California stream system. Presented at the Society for Conservation Biology Annual Meeting, Duluth, MN. July.

White, M.D. 2003. The influence of human land use modifications on Southern California stream hydrology. Presented at the Western Division of the American Fisheries Society Annual Meeting, San Diego, CA. April.

Stallcup, J.A., and M.D. White. 2002. Wildlife corridor monitoring for the Multiple Species Conservation Program. Presented at the MSCP Annual Workshop. San Diego, CA. October.

White, M.D. 2002. A review of the ecological effects of roads with examples from Southern California. Presented to the National Research Council Committee on the Ecological Impacts of Road Density. Newport Beach, CA.

June.

White, M.D., and J.A. Stallcup. 2000. The Lower Colorado River – Conservation planning in a degraded riverine ecosystem. Presented at the Society for Conservation Biology Annual Meeting, Missoula, MO. June.

White, M.D. 1998. Moderator for a panel discussion on salinity and surface elevation management options for the Salton Sea. Salton Sea Symposium II. La Quinta, CA. January.

White, M.D. 1995. Managing salinity and surface elevation at the Salton Sea, California. Presented at the American Society of Civil Engineers Annual Convention 95, San Diego, CA. October.

White, M.D. 1993. Morphological characteristics of threespined sticklebacks (*Gasterosteus aculeatus*) from the Sweetwater River, San Diego County, California. Presented at the American Fisheries Society Western Division Annual Conference, Sacramento, CA. July.

White, M.D. 1991. Horizontal distribution of zooplankton in relation to predation gradients. Presented at the Zooplankton Ecology Symposium, Lawrence University, Appleton, WI. August.

Hurlbert, S.H., and M.D. White. 1991. Quality of statistical analyses in studies on the effects of invertebrate zooplanktivores. Presented at the Zooplankton Ecology Symposium, Lawrence University, Appleton, WI. August.

White, M.D., T. Morrison, G. Orlob, H. Chang ,and C. Nordby. 1991. An environmental assessment of the potential effects of live stream discharge of reclaimed water to the San Diego River. Presented at the Symposium on Water Supply and Water Reuse: 1991 and beyond. American Water Resources Association, San Diego, CA. June.

White, M.D. 1989. The role of vertebrate and invertebrate predation gradients in producing horizontal heterogeneity of zooplankton populations. Symposium on Intrazooplankton Predation, University of Sao Paulo, Sao Carlos, Brasil. June.

Hurlbert, S.H., and M.D. White. 1989. A review of the experimental intrazooplankton predation literature with emphasis on experimental design and analysis. Symposium on Intrazooplankton Predation, University of Sao Paulo, Sao Carlos, Brasil. June.

White, M.D. 1989. Evidence for diel horizontal migrations of an invertebrate predator, *Mesocyclops edax*. Southern California Academy of Sciences Annual Meeting, Thousand Oaks, California. May.

White, M.D. 1988. Predation-induced horizontal zooplankton gradients. Ecology Supplement 69(2) pg. 340. Ecological Society of America Annual Meeting, Davis, California. August.

CURRICULUM VITAE

Gerald T. Braden

Education

Bachelors of Arts - Environmental Studies. California State University San Bernardino, California. Graduated with Honors - 10 December, 1981
Bachelors of Arts - Physical Geography. California State University San Bernardino, California. Graduated with Honors - 10 December, 1981
Masters of Science - Biological Sciences. California State Polytechnic University, Pomona, California (CSPUP). Graduated with High Honors - 15 March 1991

Relevant Professional Work Experience

Position: Self employed: Independent Biological Consultant
From: January 2010 **To:** Present

Activities: Surveys of land, shore and water birds, reptiles, amphibians and small mammal communities. Also Desert Tortoise, California Gnatcatcher, Peninsular Bighorn Sheep, San Bernardino Kangaroo Rat, Vireo (Least and Arizona), Clapper Rail (Yuma, Light-footed, Black), Southwestern Willow Flycatcher and Yellow-billed Cuckoo surveys, monitoring, and habitat assessments. Bat surveys and habitat assessments. Fox trapping/relocation. Consultation and document review on threatened/endangered and sensitive species. Project and construction monitoring.

Research Biologist/ Interim Curator; San Bernardino County Museum Biological Sciences Division
From: October 1994 **To:** January 2010

Responsibilities: My primary responsibilities as a research biologist and interim curator were characterized by a high level of independence to design, perform, interpret, publish, and review original, professional, and scientific research using statistical, problem solving, personnel management, budget management, inter-agency coordination, and supervisory skills on a daily basis.

As Research Biologist (1994-2010) I was responsible for the development, implementation and supervision of Contract Field Studies program. The Contract Field Studies Program involved the conception, design, development, implementation, analysis, and reporting on original long-term field studies. Studies pertained to varied aspects of the distribution, life history, biology, and/or ecology of vertebrate taxa of the Southwestern United States and Northern Mexico. The studies involved the application of standard biological survey and sampling methodologies (for all plants and animals), development of new methodologies when warranted, and a strong capacity for independent problem solving and original thought. The studies required a working knowledge of contemporary scientific biological theories and

paradigms.

Many of the contract field studies involve federal and state threatened or endangered species, therefore the studies required a working knowledge, understanding, and application of state and federal environmental laws such as the Endangered Species Act, Clean Water Act, National Environmental Policy Act, Federal Coordination Act, and California Environmental Quality Act.

Contract field studies I was responsible for hiring, training, supervising and evaluating four permanent staff and up to forty-seven seasonal staff in standard scientific survey and data collection techniques, and a variety of population sampling, estimation, area use and persistence models. Duties required the application and interpretation of a broad array of univariate, multivariate, probabilistic and ecological statistics, and the ability to effectively use statistical packages and scientific plotting software, such as SASS, BMDP, SigmaStat, and SigmPlot, in addition to the commonly used spreadsheet and database software.

As interim curator (2003-2010) I was accountable for matters pertaining to the Biological Sciences Division. Responsibilities entail overseeing, augmenting, and maintaining regionally significant research collections of the herpetofauna, small mammals, avifauna, botanical, and invertebrate taxa of the Southwestern United States and northern Mexico. Duties included the collection, preparation, and preservation of specimens and tissues to modern museum standards and practices. Duties also entail developing and maintaining research collaboration and strong working relationships with local universities and museum scientists. Duties also included responding to requests and dissemination of collections information to professional and amateur biologists, resource managers, educators, and the general public.

Duties also included generating and managing a $500,000 annual budget (variable by year). Budget revenue was generated by contract solicitations and grant sources. Duties included hiring and supervising staff, assigning work details, scheduling, and performance evaluations. How many people?

Duties also included interfacing with museum visitors via tours, lectures, exhibit and web module conception, design, and creation. Consultation with other county departments, regulatory agencies, other museums, and academia pertaining to expertise, advice, environmental compliance, and general networking were likewise part of daily activities.

Wildlife Biologist; U. S. Fish and Wildlife Service/Ecological Services
From: May 1991 **To:** October 1994

Responsibilities: The federal wildlife biologist position was characterized by a high level of independence to provide guidance to federal, state, local, and private jurisdictions to facilitate compliance with the Endangered Species Act (ESA), Federal Coordination Act, National Environmental Policy Act, and Clean Water Act. The position was also characterized by a high level of independence to design and implement studies on threatened and endangered species to provide a scientific basis for endangered and threatened species survey protocols as well as management and recovery plans.

Foremost among these studies of threatened and endangered species were long-term life history, habitat/fitness, nest placement, parasitism, detection, and dispersal studies of the

threatened California Gnatcatcher. The results of these studies included three primary literature publications, multiple gray literature reports and the development of the present day U. S. Fish and Wildlife California Gnatcatcher Survey Protocol. Other field studies involved protocol surveys for other listed species including Stephens' Kangaroo Rat, Light-footed Clapper Rail, Southwestern Willow Flycatcher, and Least Bell's Vireo.

In addition to the skills necessary to conceive, implement, and successfully complete scientific research, responsibilities involved developing and maintaining partnerships among the FWS, University of California Riverside, San Bernardino County Museum, Riverside County Parks Department, Metropolitan Water District, and the private sector.

Other duties involving ESA guidance entailed working with jurisdictions to assure project compliance with the ESA and related environmental laws. Most often this involved providing guidance toward obtaining Threatened and Endangers Species take permits (Sections 10(a)1a, 10(a)1b, and 7) and advice on possible non-compliance (Section 9, illegal take) or other potential ESA and Clean Water Act violations. Not infrequently, these duties were performed in a highly charged emotional, often combative arena, which required substantial amounts of tact, diplomacy, creativity, and patience to arrive at constructive resolutions.

Graduate Student; Biological Sciences Department, California State Polytechnic University Pomona.
From: Oct. 1987 **To:** Oct. 1991

Responsibilities: My thesis worked consisted of four years of study on the territory size, habitat use, den characteristics, and seasonal ranges of Black Bears (*Ursus americanus*) in the San Gabriel Mountains of Southern California. The work involved trapping bears by culvert traps and leg snares, administering tranquilizers, attaching radio collars, determining locations and den sites through telemetry, converting telemetry locations to territory and seasonal use-areas using multiple home range algorithms, data analysis, report writing, and professional presentations to scientific organizations and the general public. The work involved long hours alone in remote locations of the San Gabriel Mountains in all types of weather conditions. Because the bear project was on going, duties also included training subsequent graduate students in proper use of traps, snares, and telemetry, sedating wild bears, and home range analyses.

I also trained and assisted graduate students studying habitat use and territory utilization of coyote, raccoon, and opossums along urban-rural interfaces. Duties included the live capture of coyote, raccoons, and opossums and home range/territory delineation for the same taxa using standard home-range algorithms. Independent of my graduate career I also studied age and growth patterns of California Walnut (*Juglans californica*) by analysis of tree ring growth data.

Hydrologist; U.S. Geological Survey
From: ca. March 1981 **To:** October 1987

Responsibilities: The hydrologist position involved the collection, analysis, and reporting of surface flow and ground water data. Duties involved constructing, maintaining, and monitoring surface water gage stations and measuring surface water discharges at remote locations in the deserts, mountains, and coastal valleys of Southern California. These duties required a practical knowledge of standard construction techniques and equipment, surface water flow

characteristics, hydrologic dynamics of current and historic flood events, the effects of varied geologic formations, soil types, and substrates on surface and subsurface flows, and the ability to work effectively under remote, hazardous, and unsupervised conditions under all extremes of weather. Analysis of surface and ground water data required a working knowledge of basic hydrological mathematics and principals. The position was a permanent federal government position with full benefits.

Miscellaneous Work Experience

In no particular order - fire fighter, bookstore clerk, drywall hanger, motorcycle/auto mechanic, water safety instructor, life guard, Iranian house parent, janitor, nightclub (rock and roll) worker, wood cutter, fish hatchery worker, construction worker, finish carpenter, college tutor (science, math, english, philosophy), graduate/teaching assistant, part-time college instructor.

Endangered/threatened species experience

- California Gnatcatcher (*Polioptila californica californica*): Principal investigator on an eight-year study of the life history, habitat affinities, fitness, detection, nest monitoring and dispersal of CAGN in western Riverside. Developed the current FWS CAGN survey protocol. Two years of protocol surveys for the San Bernardino Valley Multi-species Plan. Multiple gray literature reports and three peer reviewed publications in primary ornithological journals. Invited review of FWS population modeling, protocols and policies pertaining to the sub-species.

- Least Bell's Vireo (*Vireo bellii pusillus*): Five years of protocol surveys on the Santa Ana and Mojave Rivers and associated tributaries.

- Arizona Bell's Vireo (*Vireo bellii arizonae*): Five-years of surveys in the Lower Grand Canyon. Three years of surveys, nest monitoring, and habitat study on the Virgin River in Southern Nevada.

- Southwestern Willow Flycatcher (*Empidonax traillii extimus*): Nine years of study of the life history, distribution, habitat affinities, fitness, nest success, detection and dispersal of SWWF along the lower Colorado River and its tributaries. Six years of protocol surveys for the U. S. Forest Service. Multiple gray literature reports. Invited reviewer of FWS regulations, protocols and policies pertaining to the species.

- Yuma Clapper Rail (*Rallus longirostris yumanensis*): Nine years of Yuma Clapper Rail surveys along the Virgin River and its tributaries in Southern Nevada. Multiple gray literature reports. FWS invited reviewer of current YCRA/BLRA survey protocol.

- Light-footed Clapper Rail (*Rallus longirostris levipes*): Two years of presence/absence protocol surveys at the Southern California estuaries.

- Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*): Nine years of Yellow-billed Cuckoo surveys along the Virgin River and associated tributaries in Southern Nevada. Incidental observations on the lower Colorado River (Virgin River south to the Mexican

border, two years). Multiple gray literature reports.

- Stephens' Kangaroo (*Dipodomys stephensi*): Two years of protocol surveys in western Riverside County and Camp Pendleton.

- San Bernardino Kangaroo Rat (*Dipodomys merriami parvus*): Five years of protocol trapping for SBKR for the San Bernardino Valley Multi-species Plan and the U.S. Forest Service. Multiple gray literature reports. FWS invited reviewer of current SBKR survey protocol. FWS invited reviewer of Seven Oaks Dam BA as it pertains to SBKR impacts and mitigation.

- Desert Tortoise *(Gopherus agassizii*): Relocation and radio telemetry study of Desert Tortoise in the west Mojave Desert in the late 1980's. A combined four years of Desert Tortoise surveys in the upper Coachella Valley and the eastern Mojave Desert.

- **FWS Permit # TE-43668A-0**: Authorization for-
  CAGN, SWWF, LBV, LFCL, YCLR; Includes surveys, nest searching, nest monitoring, cowbird egg removal, mist netting, and banding throughout each species' distribution.

  SKR, SBKR; Includes surveys, assessments, live trap and release throughout each species' distribution.

- **FWS Permit # TE-802450-6**: Desert Tortoise: Authorized to handle, move, and attach and remove transmitters throughout the species' distribution.

Professional Memberships

American Association for the Advancement of Science
American Society of Mammalogists
American Society of Ichthyologists and Herpetologists
American Ornithologists' Union
Association of Field Ornithologists
Cooper Ornithological Society
Raptor Research Foundation
Wilson Ornithological Society
Copeia

Activities

S Scientific Reviewer: Reviewer of original scientific studies submitted for publication to primary scientific societies, including The Wilson Bulletin, Journal of Field Ornithology, AUK, Condor, Journal of Wildlife Management, and The Journal of Canadian Zoology.

S Presentation of original ornithological research at American Ornithologist and Cooper Ornithological Societies meetings.

S Invited participant on the Science Consistency Review Panel for the USDA EIS Revised

Land Management Plan for Southern California National Forests: October, 2004.

- **S** Solicited for review, opinion, advice and consultation on the San Bernardino Kangaroo Rat, California Gnatcatcher, Southwestern Willow Flycatcher, and other federally listed or sensitive species and ecosystems of the Southwestern United States. Solicitors included U. S. Fish and Wildlife Service, U. S. Bureau of Reclamation, U. S. Bureau of land Management, U. S. Forest Service, U. S. Park Service, California Department of Fish Game, Nevada Department of Game and Fish, County of San Bernardino, Metropolitan Water District, Endangered Habitats League, Center for Biodiversity, Natural Heritage Institute.

- **S** Invited speaker on original research at specialized symposia such as: CalGnat 1994 at University of California Riverside, Coastal Sage Scrub Symposium 1995 at the San Diego Zoo; Puente Hills Wildlife Corridors and Vanishing Habitats Symposium 1995 at California State University Fullerton 1995; 1999 Annual Convention of Environmental Journalist speaking on "Science and Multispecies Habitat Conservation in Coastal Southern California"; Occasional guest lecturers at the Wildlife Ecology Graduate Student Seminar, California State Polytechnic University Pomona.

- **S** Expert Witness on California Gnatcatcher for the U. S. Department of Justice. DJ File Number 90-8-6-04239, United States of America v Granite Homes, INC.

Current Interests

- **S** Pre-post fire comparisons of small vertebrate communities in Alluvial Fan Sage Scrub.
- **S** Affects of water availability on Desert Riparian Communities.
- **S** Tamarisk and mixed native riparian affects on avian diversity in desert riparian systems.
- **S** Habitat/fitness relationships, dispersal, and community associations of organisms, particularly with regards to endangered/threatened species.
- **S** Any studies pertaining to community and/or species responses to habitat fragmentation and patch size in terrestrial ecosystems.
- **S** Alternative Energy Development affects on biological systems.
- **S** International and domestic travel with an emphasis on ecological systems or indigenous and current cultures.

Book Review

Braden, G. T. 1997. Journal of Wildlife Management 83(3):130-131. Monitoring Bird Populations by Point Counts. C. J. Ralph, J. R. Sauer, and S. Droege. (Eds.) General Technical Report PSW-GTR-149. U. S. Department of Agriculture, iv + 181 pages.

Primary Literature Publications

Braden, G. T. 1999. Does nest placement affect the fate or productivity of California Gnatcatcher nests? Auk 116:984-993.

Braden, G. T., R. L. McKernan, and S. M. Powell. 1997. Effects of nest parasitism by the

brown-headed cowbird on nesting success of the California Gnatcatcher. Condor 99(4): 858-865.

Braden, G. T., R. L. McKernan, and S. M. Powell. 1997. Association of within-territory vegetation characteristics and fitness components of California Gnatcatchers. Auk 114(4): 601-609.

Stubblefield, C. and **G. T. Braden**. 1994. Denning Characteristics of black bears in the San Gabriel Mountains of southern California. Cal. Academy of Sciences 93(1)30-37.

Alexander Sokoloff, R. F. Ferrone, J. D. Chaney, **J. Braden**, and R. J. Munoz. 1987. Linkage studies in *Tribolium castaneum* (Herbst). XII. A revision of linkage group II. Genome 29:26-33.

Selected Gray Literature Reports

Braden, G. T., L. Crew, and A. Miller. 2009. Avian diversity, vegetation composition and vegetation structure of the Las Vegas Wash: 2005 to 2009. San Bernardino County Museum, Biological Sciences Division, 2024 Orange Tree Lane Redlands, CA 92374. Prepared for the Las Vegas Wash Coordination Committee. November 2009. 75 pp.

Braden, G. T., M. Rathbun, T. Hoggan, A. Davenport, and K. Carter. 2009. The Status of Yuma Clapper Rail and Yellow-billed Cuckoo along portions of the Virgin River and Muddy River in Southern Nevada, with incidental observations of Southwestern Willow Flycatcher. 2008. Final. Report prepared for the Southern Nevada Water Authority by the Biological Sciences Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands, California 92374. February 2009. 58 pp.

Braden, G. T., K. Carter, M. Rathbun, and T Hoggan. 2009. Occurrence, distribution, and abundance of vertebrate species on the Old Woman Mountains Preserve: 2004-2008. Revised Final. Biological Sciences Division, San Bernardino County Museum, 2024 Orange Tree Lane, Redlands CA 92374. Report to the Native American Lands Conservancy and the 29 Palms Band of Mission Indians. January 2009. 158 pp.

Braden, G. T. and R. L. McKernan. 2006. Status, distribution, life-history, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 7 – 2002 Final Report-Revised. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. January 2006.

Braden, G. T., L. Crew, and A. Miller. 2005. Changes in avian breeding season diversity, microclimate, and habitat coincident with changes in surface water in a tamarisk dominated riparian habitat along the Virgin River in southern Nevada. Report submitted to Zane L. Marshall, Southern Nevada Water Authority, Las Vegas Nevada by the Biological Sciences Division, San Bernardino County Museum, Redlands, California.

Braden, G. T. and R. L. McKernan. 2000. A data based survey protocol and quantitative

description of suitable habitat for the endangered San Bernardino Kangaroo Rat (*Dipodomys merriami parvus*). Biology Section, San Bernardino County Museum, Redlands, CA. June, 35 pp.

Braden, G. T. and R. L. McKernan. 1999. Possible effect of low level nest parasitism by the Brown-headed Cowbird (*Molothrus ater*) on the nest success of the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) at sites monitored by the San Bernardino County Museum: A data review, progress report, and power's analysis. Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. December, 21 pp.

Braden, G. T., and R. L. McKernan. 1998. Nest stages, vocalizations, and survey protocols for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Final Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. October, 36 pp.

Braden, G. T., and R. L. McKernan. 1998. Observations on nest cycles, vocalization rates, the probability of detection, and survey protocols for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Report submitted to the U. S. Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada, by the San Bernardino County Museum Biological Sciences Section, Redlands, California. March, 38 pp.

Braden, G. T. and Stacey L. Love. 1994. Dispersal and non-breeding season habitat use by the Coastal California Gnatcatcher (*Polioptila californica californica*) in western Riverside County. USFWS report to the Metropolitan Water District. 25 pp.

Carter. K. J., **G. T. Braden**, M. Rathbun, and T. Hoggan. 2006. Southwestern Willow Flycatcher, habitat suitability, and amphibian survey results for the San Bernardino National Forest: 2004. Final Report. Submitted to the San Bernardino National Forest by the Biological Sciences Division, San Bernardino County Museum, Redlands, California. January 2006.

Rathbun M., **G. T. Braden**, and K. J. Carter. 2004. Results of Southwestern Willow Flycatcher, Mountain Yellow-legged Frog, California Red-legged Frog, and Arroyo Toad surveys in the San Bernardino National Forest: 2003 Final Report. Report submitted to the San Bernardino National Forest by the Biological Sciences Division, San Bernardino County Museum, Redlands, California.

McKernan, R. L. **G. T. Braden**. 2002. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 6 - 2001. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. May 2002.

McKernan, R. L. and **G. T. Braden**. 2001. Status, distribution, and habitat affinities of the Southwestern Willow Flycatcher along the lower Colorado River, Year 5 - 2000. Report submitted to the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service and U. S. Bureau of Land Management. May 2002.

References

Susan Wynn Susan_Wynn@r1.fws.gov
Carlsbad Fish and Wildlife Office
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Carlsbad, CA 92011
(760) 431-9440

Arthur Davenport mailto:davenportbio@gmail.com
Davenport Biological Services
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Barstow, CA 92312
(619)-729-4242

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California State University
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San Bernardino National Forest, Mountaintop Ranger District
Big Bear Ranger Station
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(909) 382-2832

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Consulting Biologist
P.O. Box 628
Running Springs, CA 92382-0628

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Endangered Habitats League
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Los Angeles, CA 90069-4267
(213) 804-2750

Résumé

Dan Silver, MD

Education

B.A., History & Western Society, Univ. of California, Berkeley, 1974 (Phi Beta Kappa)
M.D., Columbia University, College of Physicians and Surgeons, 1978
Medical Internship and Residency, Cedars Sinai Medical Center, Los Angeles, 1978-1981
Board Certification, Internal Medicine, 1981

Employment

Practice of internal medicine, Los Angeles, 1981–1991

Hawthorne Community Medical Group
Prairie Medical Group
Kuhn, Crystal and Silver, M.D.s

President, Preserve Our Plateau, 1989 – 1991

Executive Director, Endangered Habitats League, 1991 – present

Accomplishments

- Founding the only regional conservation organization in Southern California and using collaboration and conflict resolution as the primary means of achieving its mission
- Forming effective partnerships with business interests and local governments, and earning the respect of all sectors
- Leading environmentalists toward "smart growth" as a way to comprehensively address conservation, land use, and transportation needs
- Reconciling environmental protection with economic development through comprehensive regional habitat plans in four counties
- Permanently protecting vital natural resources within an interconnected preserve network and working with property owners on project designs and land acquisitions toward this end
- Building consensus with business, environmental, and landowning interests on sustainable transportation and land use principles and incorporating these principles into historic general plan updates in two counties
- Negotiating land use agreements on two of the largest and most iconic properties in California, the Tejon Ranch and the Rancho Mission Viejo

- Working with the Counties of San Diego and Los Angeles on new Wind Energy Ordinances that address biological impacts and streamlines the approval process

- Helping develop and adopt Regional Advanced Mitigation Programs for transportation infrastructure in three counties

Awards

- Metropolitan Water District of Southern California, *Certificate of Appreciation*, 1991
- The Nature Conservancy, *Recognition for Santa Rosa Plateau*, 1991
- Sea and Sage Audubon Society, *Conservation Award,* 1993
- World Wildlife Fund, *Innovation Grant*, 1993
- City of Los Angeles, *Good Earthkeeping Award*, 1994
- Planning and Conservation League, *David Gaines Award,* 1995
- United States Department of the Interior, U.S. Fish and Wildlife Service, *Certificate of Appreciation*, 1998
- County of Riverside, *Recognition of Outstanding Public Service*, 2003
- American Planning Association, California Chapter*, Outstanding Distinguished Leadership: Layperson Award,* 2004
- California Legislature Assembly, *Certificate of Recognition*, 2004
- City of Glendale, *Mayor's Commendation*, 2004
- U.S. Fish and Wildlife Service, *Recovery Champion, 2016*,

Conservation, land use, and transportation planning experience

Current Co-Chair

- County of San Bernardino Vision Process Environment Element

Past Chair

- Finance Subcommittee, San Diego Multiple Species Conservation Program Working Group
- Finance Subcommittee, Riverside County Habitat Conservation Agency Advisory Committee
- San Diego Supervisorial Task Force on Transfer of Development Credits
- Resource Protection and Orderly Development Work Group, State of California

Current Member

- Measure M Environmental Oversight Committee, Orange County Transportation Authority
- Southern California Association of Governments Open Space Conservation Working Group
- California Habitat Conservation Planning Coalition
- Steering Committee, San Diego North County Multiple Species Conservation Program

Past Member

- Steering Committee, California Natural Communities Conservation Planning Program
- Working Group, San Diego Multiple Species Conservation Program
- Advisory Committee, San Diego Assoc. of Governments Multiple Habitat Conservation Program
- County of San Diego Resource Protection Ordinance and Open Space Committee
- Advisory Committee, San Diego Assoc. of Governments Open Space Element
- Working Group, Orange County Central/Coastal Natural Community Conservation Plan
- Working Group, Orange County Southern Natural Community Conservation Plan
- Advisory Committee, Riverside County Habitat Conservation Agency
- Steering Committee, San Bernardino Valley-Wide Multiple Species Program
- Advisory Committee, Santa Margarita River Watershed Management Program
- Advisory Committee, Riverside County Community and Environmental Transportation Acceptability Process
- Advisory Committee, Riverside County Multiple Species Habitat Conservation Plan
- Advisory Committee, Riverside County General Plan Update
- Steering Committee, Riverside County Integrated Project
- Technical Advisory Committee, State Route 94 Major Investment Study
- Interest Group, San Diego County General Plan "2020" Update
- Citizens Advisory Committee, Southern California Assoc. of Governments Compass Growth Vision Project
- CEQA Improvement Advisory Group, State of California
- Advisory Committee, Southern California Assoc. of Governments Open Space Element
- Steering Committee, San Diego County Multiple Species Conservation Program-East
- Advisory Committee, San Diego County Multiple Species Conservation Program-North
- State of California Fish and Game Strategic Vision Stakeholder Advisory Group
- Stakeholders Advisory Committee, Western Riverside County Regional Conservation Authority

Participant

- Southern Calif. Assoc. of Governments "Four Corners" (Orange, Los Angeles, San Bernardino, Riverside Counties) Transportation Study
- San Diego Assoc. of Governments Regional Growth Management Technical Committee
- Southern California Assoc. of Governments Regional Transportation Plan Technical Advisory Committee
- Riverside County General Plan Update
- Los Angeles County 2035 General Plan Update

Member, Board of Directors

- California Futures Network (past)
- Riverside Land Conservancy
- Tejon Ranch Conservancy

- Endangered Habitats Conservancy
- Endangered Habitats League
- Terra Peninsular

Available upon request

References
Speaking engagements and invited testimony

Phillip Brylski

Ph.D. Zoology, 1986, Museum of Vertebrate Zoology, University of California, Berkeley
Master of Forest Science, 1980, Yale University
Bachelor of Science, Forestry, 1977, Berkeley

Ecologist / Conservation biology scientist. Carries out conservation studies over last 30 years on California fauna, including focused surveys for sensitive species, CEQA/NEPA biological impact analyses, status reviews, and genetic studies.

Permits: San Bernardino kangaroo rat (SBKR), Stephens kangaroo rat (SKR), Giant kangaroo rat (GKR), Tipton kangaroo rat (TKR), Fresno kangaroo rat, Pacific pocket mouse (PPM), Mohave ground squirrel (MGS), Amargosa vole, salt marsh harvest mouse, riparian woodrat (FWS TE-148555-2). MOU for most California Mammal Species of Special Concern (small mammals only)

Small Mammals Experience

- Heteromyids and gophers: live-trapping surveys and research on nearly every species of California heteromyid (all kangaroo rats, both species of kangaroo mice, all pocket mice species), and selected gophers.

- Squirrels: live trapping and visual surveys on Mohave ground squirrel, Antelope ground squirrel, Palm Springs ground squirrel, live-trapping for chipmunk species (Sierra Nevada only).

- New World rats and mice: live trapping experience with most species of California cricetids (*Microtus*, *Neotoma, Peromyscus, Reithrodontomys, Onychomys*, and *Sigmodon*).

San Bernardino kangaroo rat (*Dipodomys merriami parvus*, SBKR) experience

SBKR live-trapping survey, Renaissance Specific Plan site in Rialto, San Bernardino County, California. 2017

SBKR survey at the proposed Cucamonga Basin Maintenance Project site in Upland, San Bernardino County, California. 2016

SBKR surveys for the Rancho Cucamonga North Eastern Sphere Annexation Area, San Bernardino County. 2015, 2016

SBKR survey for SoCalGas North-South gas line project, Reche Canyon. 2015

SBKR survey for Devils Canyon area, San Bernardino County Flood Control District. 2014

SBKR survey for Caltrans Interstate 15 Expansion Project, San Bernardino County. 2013, 2014

SBKR survey and relocation effort, State Department of Water Resources EBX II project site, Redlands. 2013

SBKR survey at a proposed SoCalGas gas repair site and access corridor in the North Fontana/Devore area of San Bernardino County. 2013

SBKR survey on the approximately 9.1 Acre Otto Property, Redlands. 2012

SBKR survey for approximately 1 mile Right of Way along Rialto Municipal airport (SCE). 2012

Survey for SBKR and LAPM on APNs 433-150-057 and 433-150-053 in the City of San Jacinto (San Jacinto Flood Control District). 2012

SBKR and LAPM survey for the San Jacinto River Stage 4 levee project area (San Jacinto Flood Control District). 2012

SBKR survey for the Pepper Avenue Road extension project, Rialto. 2012

SBKR survey for the California Department of Water Resources EBX II construction landing site, Redlands. 2012

SBKR survey for the proposed expansion of Highway 210 at City Creek, Plunge Creek, and Santa Ana River, San Bernardino County (CalTrans). 2012

SBKR survey for three Geotechnical Study Sites near Vulcan Materials Company's Muscoy Groin #2 Storm Drain Project Site, San Bernardino County (Vulcan Mining). 2012

SBKR survey along an approximately 0.75-mile proposed AT&T telephone line repair site and access corridor in the Beacon/Devore area of San Bernardino County (ATT). 2012

SBKR survey at site of a proposed transmission tower replacement project along Lytle Creek, San Bernardino County (SCE). 2012

SBKR survey on the Robertson's Ready Mix / Cemex mine expansion and mitigation sites, San Bernardino County. 2011

SBKR percent area occupied (PAO) survey of the Santa Ana River Woolly Star Preserve Area, San Bernardino County. 2007-2011

SBKR survey at the La Rivera Surface Drainage Improvement Project Site, Riverside, Riverside County, California. 2011

SBKR and LAPM survey on the Soboba Horseshoe Grande Fee to Trust project area, Riverside County. 2011

SBKR survey of the Opal Avenue Mitigation Property, San Bernardino County. 2011

SBKR survey of the Mill Creek/Garnet Street and Cone Camp Road Sites, San Bernardino County. 2011

SBKR survey on an approximately 5 Acre Site on the Wooly Star Preserve Area in the City of Redlands. 2010

SBKR live-trapping survey, Arrowhead project (SCE), San Bernardino County. 2009

SBKR survey of the SCE Alder-Declez project site, San Bernardino. 2009

SBKR Survey, Soboba Indian Reservation, Riverside County. 2009

SBKR survey at reference locations in the Woolly Star Preserve area, San Bernardino County 2007-2012

Selected Publications

Brylski, P., W.M. Miller, S. Dodd, and S. Montgomery. 2009. Addendum to the Pilot Monitoring Project for the Pacific Pocket Mouse, Orange County, California. Prepared for the Center for Natural Lands Management.

------. 2008. Pilot Monitoring Project for the Pacific Pocket Mouse CNLM Dana Point Preserve, Orange County, California. Prepared for the Center for Natural Lands Management.

Hedtke, S.M., K.R. Zamudio, C.A. Phillips, J. Losos, and P. Brylski. 2007. Conservation genetics of the endangered Coachella Valley fringe-toed lizard (*Uma inornata*). Herpetologica 63(4): 411-420.

Swei, A. P.V. Brylski, W.D. Spencer, S.C. Dodd, and J.L. Patton. 2003. Hierarchical genetic structure in fragmented populations of the Little Pocket Mouse (*Perognathus longimembris*) in Southern California. Conservation Genetics 4(4):501—514.

Brylski, P., R. Erickson, and D. Laabs. 1994. Pacific pocket mouse In Life on the edge: a guide to California's endangered natural resources: wildlife, C. G. Thelander and M. Crabtree, eds. Biosystems Books, Santa Cruz, California.

Brylski, P., L. Barkley, B. McKernan, S.J. Montgomery, R. Minnich, and M. Price. 1993. Proceedings of the Biology and Management of Rodents in Southern California Symposium. San Bernardino County Museum, Redlands, California, June 26, 1993. Presented by the Southern California Chapter of the Wildlife Society.

State/federal reports

U.S. Fish and Wildlife Service. 1998,. Pacific Pocket Mouse (*Perognathus longimembris pacificus*) Recovery Plan. Portland Oregon, 112 pp. (prepared by P. Brylski, L. Hayes and J. Avery)

Brylski, P. V., P. W. Collins, E. D. Pierson, W. E. Rainey, and T. E. Kucera. 1997. Mammal Species of Special Concern in California. Draft Final Report Prepared for the California Department of Fish and Game, Wildlife Management Division, Bird and Mammal Conservation Program, Sacramento, CA. Contract FG3146WM. 251 pp.

California Department of Fish and Game. 1990. California wildlife habitat relationships system. Volume III: Mammals. Zeiner, D. C., W. F. Laudenslayer, Jr., K. E. Mayer, and M. White, eds. California Interagency Wildlife Task Group, Sacramento, California. (prepared species accounts, range maps, and habitat relations data for selected small mammals)

Phillip Brylski, Ph.D.
Projects

Permits: San Bernardino kangaroo rat, Stephens kangaroo rat, Giant kangaroo rat, Tipton kangaroo rat, Fresno kangaroo rat, Pacific pocket mouse, Mohave ground squirrel, Amargosa vole, Mohave ground squirrel, salt marsh harvest mouse, and riparian woodrat. MOU for most California Mammal Species of Special Concern (small mammals only).

Small Mammals Experience

- Heteromyids and gophers: live-trapping surveys and research on nearly every species of California heteromyid (all kangaroo rats, both species of kangaroo mice, all pocket mice species), and selected gophers.

- Squirrels: live trapping and visual surveys on Mohave ground squirrel, Antelope ground squirrel, Palm Springs ground squirrel, live-trapping for chipmunk species (Sierra Nevada only).

- New World rats and mice: live trapping experience with most species of California cricetids (*Microtus*, *Neotoma, Peromyscus, Reithrodontomys, Onychomys*, and *Sigmodon*).

San Bernardino kangaroo rat surveys (SBKR, *Dipodomys merriami parvus*)

SBKR live-trapping survey, Renaissance Specific Plan site in Rialto, San Bernardino County, California. 2017

SBKR survey at the proposed Cucamonga Basin Maintenance Project site in Upland, San Bernardino County, California. 2016

SBKR surveys for the Rancho Cucamonga North Eastern Sphere Annexation Area, San Bernardino County. 2015, 2016

SBKR survey for SoCalGas North-South gas line project, Reche Canyon. 2015

SBKR survey for Devils Canyon area, San Bernardino County Flood Control District. 2014

SBKR survey for Caltrans Interstate 15 Expansion Project, San Bernardino County. 2013, 2014

SBKR survey and relocation effort, State Department of Water Resources EBX II project site, Redlands. 2013

SBKR survey at a proposed SoCalGas gas repair site and access corridor in the North Fontana/Devore area of San Bernardino County. 2013

SBKR survey on the approximately 9.1 Acre Otto Property, Redlands. 2012

SBKR survey for approximately 1 mile Right of Way along Rialto Municipal airport (SCE). 2012

Survey for SBKR and LAPM on APNs 433-150-057 and 433-150-053 in the City of San Jacinto (San Jacinto Flood Control District). 2012

SBKR and LAPM survey for the San Jacinto River Stage 4 levee project area (San Jacinto Flood Control District). 2012

SBKR survey for the Pepper Avenue Road extension project, Rialto. 2012

SBKR survey for the California Department of Water Resources EBX II construction landing site, Redlands. 2012

SBKR survey for the proposed expansion of Highway 210 at City Creek, Plunge Creek, and Santa Ana River, San Bernardino County (CalTrans). 2012

SBKR survey for three Geotechnical Study Sites near Vulcan Materials Company's Muscoy Groin #2 Storm Drain Project Site, San Bernardino County (Vulcan Mining). 2012

SBKR survey along an approximately 0.75-mile proposed AT&T telephone line repair site and access corridor in the Beacon/Devore area of San Bernardino County (ATT). 2012

SBKR survey at site of a proposed transmission tower replacement project along Lytle Creek, San Bernardino County (SCE). 2012

SBKR survey on the Robertson's Ready Mix / Cemex mine expansion and mitigation sites, San Bernardino County. 2011

SBKR percent area occupied (PAO) survey of the Santa Ana River Woolly Star Preserve Area, San Bernardino County. 2007-2011

SBKR survey at the La Rivera Surface Drainage Improvement Project Site, Riverside, Riverside County, California. 2011

SBKR and LAPM survey on the Soboba Horseshoe Grande Fee to Trust project area, Riverside County. 2011

SBKR survey of the Opal Avenue Mitigation Property, San Bernardino County. 2011

SBKR survey of the Mill Creek/Garnet Street and Cone Camp Road Sites, San Bernardino County. 2011

SBKR survey on an approximately 5 Acre Site on the Wooly Star Preserve Area in the City of Redlands. 2010

SBKR live-trapping survey, Arrowhead project (SCE), San Bernardino County. 2009

SBKR survey of the SCE Alder-Declez project site, San Bernardino. 2009

SBKR Survey, Soboba Indian Reservation, Riverside County. 2009

SBKR survey at reference locations in the Woolly Star Preserve area, San Bernardino County 2007-2012

Stephens' kangaroo rat (SKR, *Dipodomys stephensi*)

SKR survey for the Meridian Trunk Sewer, March Air Base, Riverside County. 2018

SKR survey for the Freeway Business Center Project, Moreno Valley, Riverside County. 2018

SKR surveys for the SDG&E TL 686 wood to steel pole replacement project, Warner Springs, San Diego County. 2017, 2018

SKR surveys for the SDG&E Cleveland National Forest Power Line Replacement Projects. 2017

SKR survey at SoCalGas project at the Moreno Compressor Station, Moreno, Riverside County. 2014

SKR survey, Fallbrook Naval Weapons Center, San Diego County. 2013

SKR and LAPM survey, Lake Perris Dam Remediation project, Riverside County. 2009, 2012

SKR and LAPM survey, Alberhill System Project (SCE), Riverside County. 2011

SKR survey for the County Parks Oak Country II Trails Project, San Diego County. 2011

SKR survey for the proposed southern route of the SDGE Sunrise Powerlink project in San Diego County. 2010

SKR survey at the Center for Natural Land Management March SKR Preserve, March Air Force Base Annex, Riverside County. 2009

SKR survey, Portero and LaBorde Canyons, Riverside County. 2008

Pacific pocket mouse (PPM, *Perognathus longimembris pacificus*)

Results of a trapping survey for the federally endangered Pacific pocket mouse (PPM, *Perognathus longimembris pacificus*) at the proposed Caltrans SR-133 Safety Improvement Project at El Toro Road in Laguna Beach, Orange County. 2016

Pacific Pocket Mouse Focused Trapping Results for the Relocation of the 41 Area Landing Zone and MILCON P-1331 Project Actions, Marine Corps Base Camp Pendleton, San Diego County. 2015

PPM survey for 2013 Marine Corps Forces Special Operations Command Expansion Project, Camp Pendleton, San Diego County. 2013.

Monitoring for PPM on the CNLM Dana Point Preserve, Orange County, California. 2012

Addendum to the Pilot Monitoring Project for the PPM, 2009 CNLM Dana Point Preserve, Orange County. 2012

Focused Surveys for the PPM and SKR for the Marine Corps Base Camp Pendleton Basewide Water Infrastructure and Stuart Mesa Bridge Replacement (BWI & SMBR) project, San Diego County, California. 2011.

PPM survey, Exchange Hospital, MCB Camp Pendleton. 2009.

PPM survey for San Mateo North Population, California State Parks. 2010

PPM survey, Combat Marksmanship Range (CMR), Marine Corps Base Camp Pendleton, California. 2010.

PPM survey, 31 Area, Marine Corps Base Camp Pendleton, California. 2010.

PPM survey, Range 501, Marine Corps Base Camp Pendleton, California. 2011.

Los Angeles pocket mouse (LAPM, *Perognathus longimembris brevinasus*)

LAPM survey, Mt. San Jacinto Community College District, San Gorgonio Pass Campus, Banning, Riverside County. 2012

LAPM Survey, Murrieta, SCE Transmission Line Right-of-Way. 2008.

LAPM survey on the Banning Truck Weigh Station, a 5-Acre Property in Banning, Riverside County. 2010.

LAPM survey on APN 459-020-067 (southern part), Riverside County. 2012.

Survey for SKR and LAPM for the Lake Perris Dam Remediation Project, Riverside County.

Giant kangaroo rat (*Dipodomys ingens*)

Live-trapping survey for the giant kangaroo rat (GKR, *Dipodomys ingens*) at the proposed Exxon-Mobil Midway meter site, Kern County, California. 2016

Mojave ground squirrel (*Xerospermophilus mohavensis*, MGS**)**

Mohave ground squirrel surveys, BigBeau solar project, Kern County. 2018

Surveys for Mojave ground squirrel and desert tortoise, Mojave-Rosamond Recycling and Sanitary Landfill, Kern County. 2018.

Mohave Ground Squirrel Habitat Assessment, Sanborn Solar Project, Kern County. 2018

Mohave Ground Squirrel Habitat Assessment and Live-Trapping Survey, Edwards Air Force Base Solar Project. 2018

Mohave Ground Squirrel Survey for the Victor Elementary School No. 20, APN 0394-031-37, Victorville, San Bernardino County. 2017

Mohave Ground Squirrel Survey for the Pathways to College Charter School, APN 0394-031-37 Hesperia, San Bernardino County. 2017

Mohave Ground Squirrel Survey for the North First Avenue - Mojave River Bridge Replacement Project, Barstow, San Bernardino County. 2017

Live-trapping survey for the California-threatened Mohave ground squirrel for the Leadership Academy School, Hesperia, San Bernardino County. 2016

Results of a trapping survey for the California-threatened Mohave ground squirrel on APN 0465-6311-3-0000 in Helendale, San Bernardino County. 2015

MGS live-trapping survey for SoCalGas North-South gas line project in Adelanto. 2015

MGS live-trapping survey for the Adelanto Solar Project. 2013

MGS habitat assessment and live-trapping survey, North First Avenue Grade Separation and Bridge Replacement Project, Barstow. 2013.

MGS habitat assessment for the California Threatened Mohave Ground Squirrel (MGS) on the Fremont Valley System New Well 1-02 Project, APN 470-251-20-8, Kern County. 2012.

MGS live-trapping survey, Amethyst Basin, Victorville, San Bernardino County (San Bernardino County Flood Control District). 2012.

MGS live-trapping survey, CalTrans High Desert Corridor project, San Bernardino County. 2011.

MGS surveys, Edwards Air Force Base, Kern County. 1994, 2009-2011, 2013.

MGS live-trapping Survey, Mohave Element Energy, Assessor's Parcel Number 427-020-45, Mojave, Kern County. 2012

MGS habitat assessment of the SCE Oasis Substation, Palmdale, Los Angeles County. 2010.

MGS live-trapping survey, Snowline Joint Unified School District Support Services Complex, APNs 3098-311-11, Phelan, San Bernardino County. 2008.

MGS live-trapping survey, Snowline Joint Unified School District, High School #2, APNs 3097-391-02 through 3097-391-10, San Bernardino County. 2008.

MGS live-trapping survey, Capital Pacific Homes 80-acre Parcel, Rosamond, Kern County. 2007.

Studies of MGS and other small mammals for baseline assessment of geothermal power development impacts. China Lake Naval Weapons Center and adjoining areas of Owens Valley. (client: China Lake Naval Weapons Center; main biological contractor: Philip Leitner). 1979.

Other Small Mammal Surveys

Small mammal surveys, Imperial Irrigation District. Carried survey for cotton rats (*Sigmodon* spp.) in support of the Imperial Irrigation District's Habitat Conservation Plan.

Surveys for Palm Springs ground squirrel and Palm Springs pocket mouse, Desert Hot Springs, Riverside County. 2009.

Burrrowing owl

Burrowing owl survey for the Falcon Ridge Substation Project, Rancho Cucamonga, Fontana, and Rialto, San Bernardino County. 2014. (protocol survey)

Burrowing owl survey, Mt. San Jacinto Community College District, San Gorgonio Pass Campus, Banning, Riverside County. 2012 (protocol survey)

Burrowing owl survey, Hesperia Crosswalk school site, San Bernardino County. 2012 (protocol survey)

Burrowing owl survey, APN 388-110-008, Menifee Wireless Facility, 29801 Scott Road, Menifee, Riverside County. 2012 (protocol survey)

Burrowing owl survey, SiteMaster Site, APN 532-180-044, Banning, Riverside County. 2013 (protocol survey)

Beaumont High School Overpass, Burrowing Owl Survey, Beaumont, San Bernardino County 2012 (protocol survey)

Habitat Assessment for Sensitive Plants; Burrowing Owl Survey, Perris Middle School and Central Kitchen, Perris (protocol survey)

Habitat Assessment for Sensitive Plants; ; Burrowing Owl Survey; MSHCP Consistency Analysis for APN 436-280-010, San Jacinto, Riverside County (protocol survey)

Desert Tortoise and burrowing owl survey (non-protocol survey) and rare plant assessment, SCE Oasis Substation Project Site, Los Angeles County (2009)

Burrowing owl surveys (non-protocol sweeps), Southern California Edison TRTP project, Los Angeles County, 2010 – 2012.

Regional burrowing survey, San Diego Association of Governments, San Diego County. 2010. (non-protocol survey)

Biological Assessments

Antelope Valley Area Plan Update EIR (program level biological assessment). 2014

Anaheim Canyon Specific Plan EIR (program level biological assessment). 2013

Perris Middle School and Central Kitchen, Habitat Assessment for MSHCP Consistency Analysis, Perris, Riverside County. 2013

MSHCP consistency analysis and habitat assessment for sensitive plants and burrowing owl, APN 436-280-010, San Jacinto, Riverside County. 2013

San Clemente General Plan EIR, Orange County (program level biological assessment). 2013

Two Bunch Palms Elementary School Solar Array, Desert Hot Springs, Riverside County. 2013

Hesperia Crosswalk Charter School, San Bernardino County. 2012

Mt. San Jacinto College San Gorgonio Pass Campus, Banning, Riverside County. 2012

Jurisdictional wetlands permitting, Palm Desert High School. 2011

Beaumont High School Expansion, Riverside County. 2010

Carlsbad High School #2, San Diego County. 2010

Irvine Business Complex EIR, Irvine, Orange County (program level biological assessment). 2009

Palm Springs Unified District Service Center. 2009

Bristol Street Widening At 17th Street NES, Santa Ana. 2009

University High School Stadium Project, Irvine, Orange County. 2008

Tonner Canyon Vegetation Management Area, Los Angeles and San Bernardino counties. 2008

Snowline Joint Unified School District, High School #2, Victorville, San Bernardino County. 2008

Vista Del Mar Elementary School, San Diego. 2008

Rowe School Site Biological Constraints Analysis, San Diego County. 2007

Snowline School District Support Services Complex Development Plan, Phelan, San Bernardino County. 2007

Construction Monitoring

Beacon Solar project, California City (MGS, desert tortoise). 2013-2016 (on-going)

SCE, TRTP construction monitor. 2010-2015

CalTrans construction monitor, Interstate-15 improvement project (SBKR). 2013

Camp Pendleton construction monitor (PPM). 2012

SanBag, Palm Avenue Grade Separation project (SBKR). 2013, 2014

San Diego Gas & Electric Sunrise Power Link Project, construction monitor for bighorn sheep. 2012, 2013