



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Western Ecological Research Center
San Diego Field Station
4165 Spruance Road, Suite 200
San Diego, California 92101

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Kim Smith
Senior Environmental Planner
San Diego Association of Governments
401 B Street, Suite 800
San Diego, CA 92101

Kris Preston
San Diego Management and Monitoring Program
4165 Spruance Road, Suite 200
San Diego, California 92101

Dear Ms. Smith and Dr. Preston,

This letter transmits the U.S. Geological Survey (USGS) Western Ecological Research Center's Draft Final: Western Pond Turtle Response to Translocation and Nonnative Aquatic Species Removal, March 2018-March 2019. This work was completed under agreement number 5004597. We expect to publish these data in a synthesis paper in 2021 as part of the U.S. Fish and Wildlife Service prelisting synthesis of the western pond turtle.

Please note that this information is preliminary or provisional and is subject to revision. It is being provided to meet the need for timely best science. The information has not received final approval by the USGS and is provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the unauthorized use of this draft data for interpretation or resource decision-making.

Please direct any questions to me at (619) 206-5686.

Sincerely,

Robert Fisher

Principal Investigator

Draft Final: Western Pond Turtle Response to Translocation and Nonnative Aquatic Species Removal, March 2018–March 2019

Data Summary



Draft Final: Western Pond Turtle Response to Translocation and Nonnative Aquatic Species Removal, March 2018–March 2019

By: Chris W. Brown, Denise R. Clark, Cynthia J. Hitchcock, and Robert N. Fisher

U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Data Summary

Prepared for:

**San Diego Association of Governments,
San Diego Management and Monitoring Program,
U.S. Fish and Wildlife Service Conservation Partnerships Program,**

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¹San Diego Field Station
USGS Western Ecological Research Center
4165 Spruance Road, Suite 200
San Diego, CA 92101

²San Diego Field Station – Santa Ana Sub-station
USGS Western Ecological Research Center
1801 East Chestnut Ave
Santa Ana, CA 92701

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Cover photographs: Juvenile western pond turtle (*Emys marmorata*; top left) and arroyo toad (*Anaxyrus californicus*; bottom left) from Sycuan Peak ER, Pacific treefrog (*Pseudacris regilla*; top right) from TNC Wheatley Preserve, and basking western pond turtle (bottom right) at Rancho Jamul ER by Chris Brown.

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Introduction

The western pond turtle (*Emys marmorata*, hereafter referred to as the pond turtle) is California's only extant native freshwater turtle and is in decline throughout its range, having been extirpated from much of coastal southern California (Bury and Germano 2008, Thomson et al. 2016). Historically, the pond turtle inhabited coastal draining streams, ponds, and lakes feeding primarily on small aquatic invertebrates and vegetation while having no native aquatic predators (Bury and Germano 2008). However, threats to the pond turtle now include altered hydrology (dams and diversions), habitat fragmentation and direct mortality from roads and development, and predation by nonnative aquatic species including bullfrogs (*Lithobates catesbeianus*) and largemouth bass (*Micropterus salmoides*) (Brattstrom and Messer 1988, Stephenson and Calcarone 1999; Brehme et al. 2018). Because of recent declines, the pond turtle was identified as a Species of Special Concern by California Department of Fish and Wildlife (CDFW) in 1994 (Jennings and Hayes 1994, Thomson et al. 2016) and has been petitioned for listing by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act in 1992 and again in 2012 (CBD 2012). In 1997, the pond turtle was included as one of the 75 species that the San Diego Multiple Species Conservation Program (MSCP) aims to conserve within coastal San Diego County (City of San Diego 1998). The San Diego Management and Monitoring Program (SDMMP) supports the MSCP and has developed the Management Strategic Plan to define the management area (the western portion of San Diego County; MSPA) with distinct management units (11 management units grouping preserves and preserve complexes; MU) within the MSPA to assist with prioritizing management actions to conserve the 75 species covered by the MSCP, including the pond turtle (SDMMP 2013; Figure 1).

USGS conducts research on the natural history of and threats and impacts to reptiles and amphibians in coastal southern California to understand the demography of rare and listed taxa in the region which includes the MSPA. This research includes studying the responses of the pond turtle to large scale threats, such as drought and wildfire, as well as smaller scale threats, such as from nonnative taxa. Specifically, our research seeks to understand the causes of decline of the pond turtle on conserved lands, which includes lands within the MSPA, and how the populations respond to management actions including pond turtle translocation and nonnative aquatic species removal.

Translocations of pond turtles and nonnative species removal have been the primary methods used for restoration of the pond turtle within the MSPA of San Diego County, CA (Brown et al. 2015) since 2009. In 2009, USGS partnered with San Diego Zoo and CDFW to study the effects of removing nonnative aquatic species and headstarting (raising hatchlings in a controlled environment before releasing them to the wild) pond turtles at CDFW's Sycuan Peak Ecological Reserve (SPER). In 2014, USGS began to study translocations as a conservation tool for pond turtles and 18 pond turtles were translocated from private ponds in the Pine Valley Creek watershed to ponds at CDFW's Rancho Jamul Ecological Reserve (RJER) to restore the pond turtle to the Otay River watershed. In 2015 through 2017, USGS continued to monitor these translocations and conducted surveys on other conserved lands to find additional translocation study sites.

This study builds on the previous work by USGS and its partners in support of pond turtle restoration and management in the MSPA (Brown et al. 2019a and 2019b). Here we report on the continued monitoring of translocated individuals continues and removal of nonnative aquatic species (from 15 March 2018 to 15 March 2019). Specific activities reported here are summarized in Table 1. This work is part of the larger study to examine effectiveness of methods used for pond turtle recovery and conservation in the south coast ecoregion. Pond turtle restoration and translocation experiments have been a collaborative effort between USGS and its partners: San Diego Zoo, CDFW, SDMMP) San Diego Association of Governments (SANDAG), City of San Diego (City), County of San Diego (County), U.S. Forest Service (USFS), USFWS, Endangered Habitats Conservancy (EHC), and The Nature Conservancy (TNC).

Study Area

The study area included nine sites across five watersheds within MSPA MU's 3, 4, 5, 6, and 10 (Figures 1–2, Table 1). Two sites were located in the upper portions of the San Dieguito River watershed within MU 5, one site was in the Los Penasquitos watershed within MU 6, two sites were in the San Diego River watershed within MU 4, two sites were in the Sweetwater River watershed in MU 3 and two sites were in the Otay River watershed in MU 3. Together, these watersheds combine to total over 325,000 hectares of central San Diego County and provide the coastal drainages for the northwestern Laguna, Cuyamaca, and San Ysidro mountain ranges (Figure 1, Table 1).

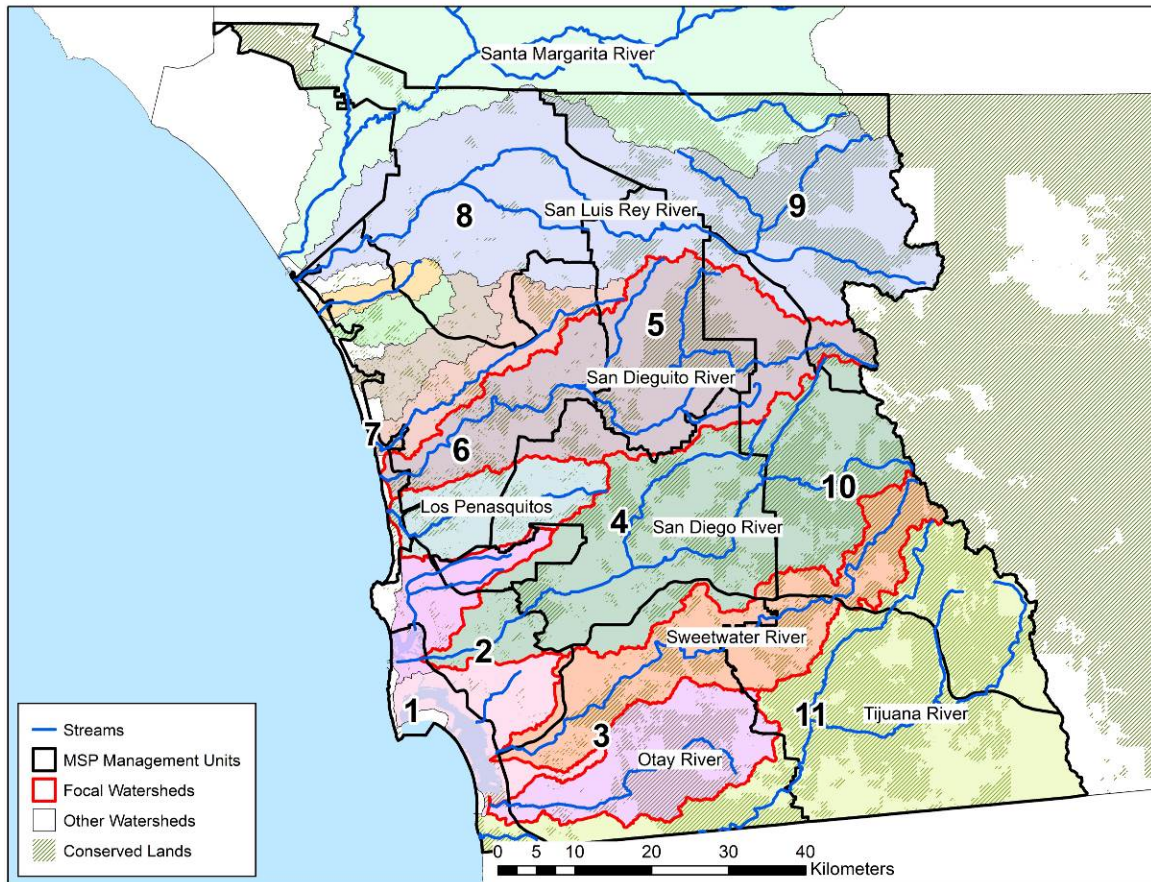


Figure 1. Study Area. The San Dieguito, Los Penasquitos, San Diego, Sweetwater, and Otay Rivers watersheds in reference to other major coastal watersheds in the county and the MSPA management units. The numbers on the map are in reference to the MSPA management units.

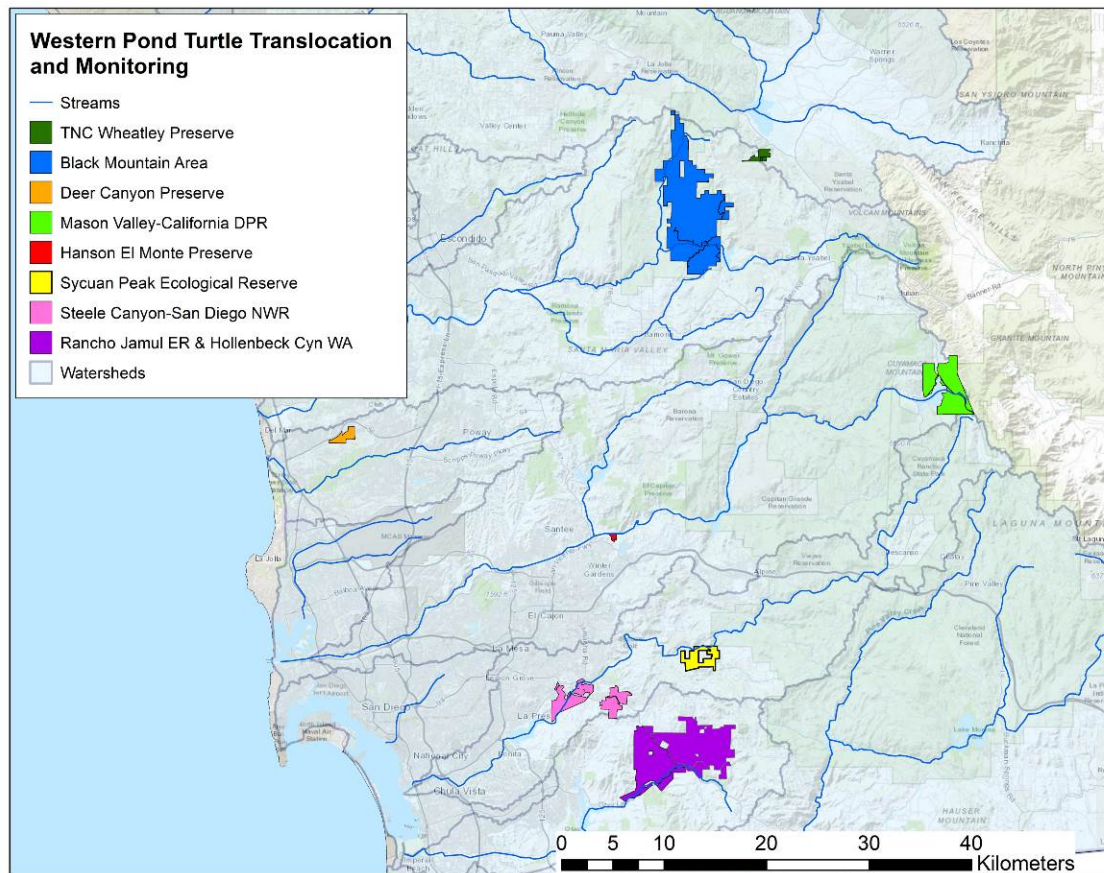


Figure 2. Preserve Locations. Map of the preserve locations where pond turtle management and restoration was being conducted from north to south: TNC Wheatley Preserve, Black Mountain Area, Deer Canyon Preserve, Mason Valley, Hanson El Monte Preserve, Sycuan Peak Ecological Reserve, Steele Canyon, Hollenbeck Wildlife Area, and Rancho Jamul Ecological Reserve.

Table 1. Pond Turtle Restoration and Management Sites. Sites surveyed from 15 March 2018 to 15 March 2019 listed by watershed from north to south. This table includes approximate watershed size in hectares, preserve name with reserve size in hectares, land manager/owner, stream name, MU, pond turtle presence during previous studies and experimental management and monitoring activities for March 2018–March 2019.

		Preserve	Land Manager	Stream / Creek	MU	Pond Turtles Previously	Management / Monitoring
Watershed	San Diegoito (90,000 ha)	TNC Wheatley Preserve (162 ha)	The Nature Conservancy	Scholder Creek	5	None	Bullfrog removal
		Black Mountain Area (5,437 ha)	USDA Forest Service	Black Canyon, Carney Canyon, Temescal Creek	5	Historic records; CDFW surveys in 2010	Potential Source for Translocation
	Los Penasquitos (24,346 ha)	Deer Canyon Preserve (12.6 ha)	California Department of Transportation	Deer Canyon Pond	6	Unknown	New site investigation
	San Diego (112,000 ha)	Mason Valley (1,516 ha)	California Department of Parks and Recreation	Mason Valley Creek	10	Unknown	New site investigation
		Hanson El Monte Preserve (64 ha)	Endangered Habitats Conservancy	San Diego River	4	None	Bullfrog removal
	Sweetwater (60,000 ha)	Sycuan Peak Ecological Reserve (931 ha)	California Department of Fish and Wildlife	Sweetwater River	3	Adults (some translocated in headstart program in 2013-14) and juveniles	Pond turtle monitoring Nonnative aquatic species removal
		San Diego NWR (4,978 ha)	U.S. Fish and Wildlife Service	Steele Canyon	3	Visual observation by FWS in 2010	Population verification
	Otay (40,000 ha)	Hollenbeck Canyon WA (2,725 ha)	California Department of Fish and Wildlife	Hollenbeck Canyon, Jamul Creek	3	None	New site investigation
		Rancho Jamul Ecological Reserve (2,266 ha)	California Department of Fish and Wildlife	Jamul Creek	3	Adults (Translocated from Oak Valley in 2014-15)	Pond turtle monitoring Nonnative aquatic species removal

TNC Wheatley Preserve

The TNC Wheatley Preserve is a 162 hectare preserve managed for conservation by TNC and the USFWS Partners Program. It contains a series of enhanced ponds in both the San Luis Rey and San Dieguito watersheds. Scholder Creek Pond at the headwaters of Scholder Creek is a 0.75 hectare, clay lined, permanent pond within the upper portion of the San Dieguito River watershed and drains into Scholder Creek (Figures 3–4). The upper and lower stock ponds are earthen dam ponds along Kumpohui Creek in the upper San Luis Rey watershed on the preserve and near the San Dieguito watershed. The house pond is a small artificial water feature at the onsite residence and is disconnected from the other two creeks. Having permanent water with no nonnative fish or crayfish (*Procambarus* sp.; though bullfrogs were present), Scholder Creek Pond was chosen for management and recovery for pond turtles based on suitability for restoration, information from previous studies, and the overlay of conserved lands (Brown et al. 2019c). In 2017, USGS became involved with the USFWS Partners Program to study removal of nonnative bullfrog from the preserve to support native aquatic species and future translocation of pond turtles.

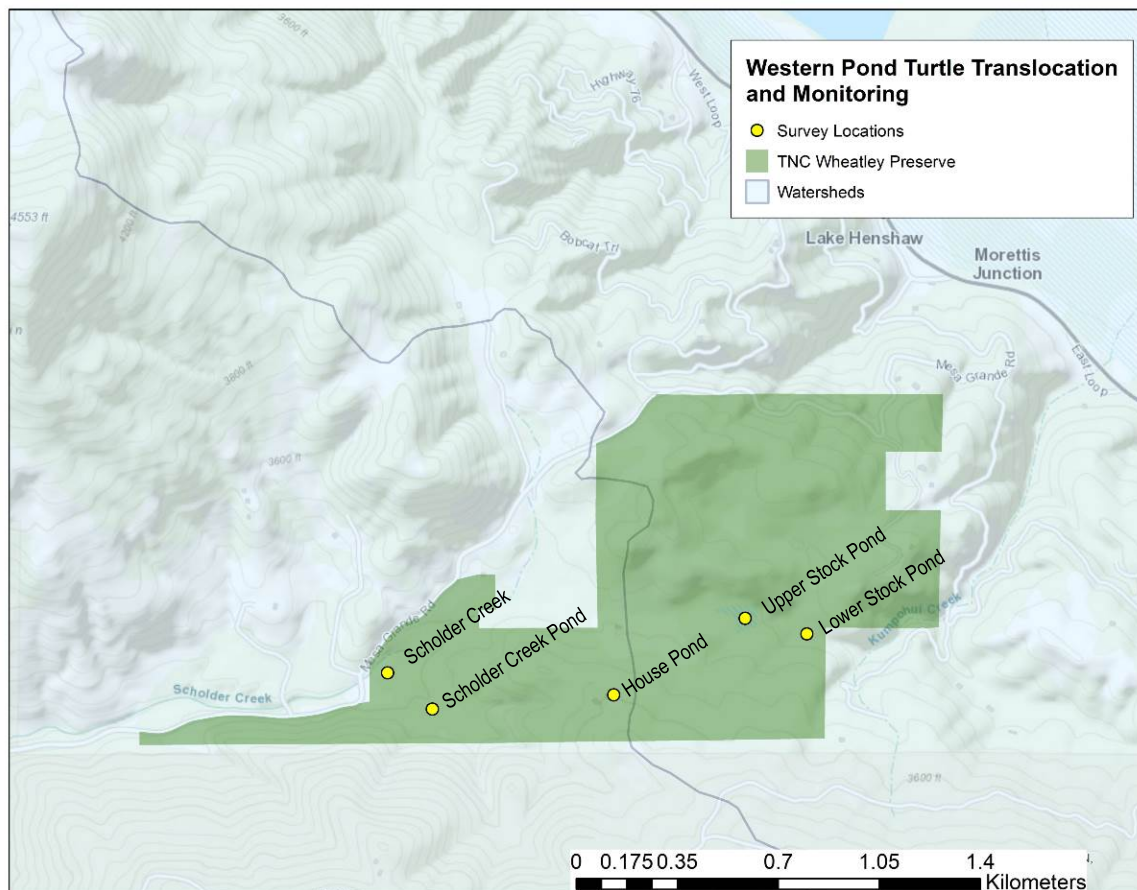


Figure 3. TNC Wheatley Preserve survey locations. The colored dot represents the locations of the ponds and creek where surveys for native and nonnative aquatic species were conducted and removal of bullfrogs was implemented.

Scholder Creek Pond consists of a natural ponding area at the confluence of the two tributaries to Scholder Creek which was enhanced by the addition of an earthen dam and a clay liner to create a 0.75 hectare permanent pond (Figure 4). The site features approximately 1.5 kilometers of oak woodland riparian up and downstream of the pond. Uplands include mixed chaparral, sage scrub, and oak woodland with open areas of native and nonnative grasses. The surrounding area was historically grazed but is currently undergoing riparian and upland restoration by USFWS Partners Program and San Diego State University's Soil Ecology Restoration Group (SERG). Additional actions by site managers include the development of a limited grazing strategy to maintain native grasslands and fencing to keep cattle out of the riparian and restoration areas.

The upper and lower stock ponds are two approximately 0.25 hectare ephemeral earthen dam ponds along Kumpohui Creek (Figure 4 lower). These ponds are disconnected from Scholder Creek but are close enough to Scholder Creek Pond (approximately 1.2 kilometer) that they could potentially be a source of adult bullfrogs.



Figure 4. TNC Wheatley Preserve survey photos. Photo of Scholder Creek Pond taken 08 May 2018 looking south from the marsh at the northern point of the pond (top). Photos of the lower (lower left) and upper (lower right) stock ponds along Kumpohui Creek from 20 June 2018.

Black Mountain Area

The Black Mountain Area consists of approximately 5,437 hectares of the Cleveland National Forest managed by the USFS as part of the Orasco/Black Mountain Unit. This area includes the reaches of Black Canyon, Carney Canyon, and Temescal Creek (Figures 5–6).

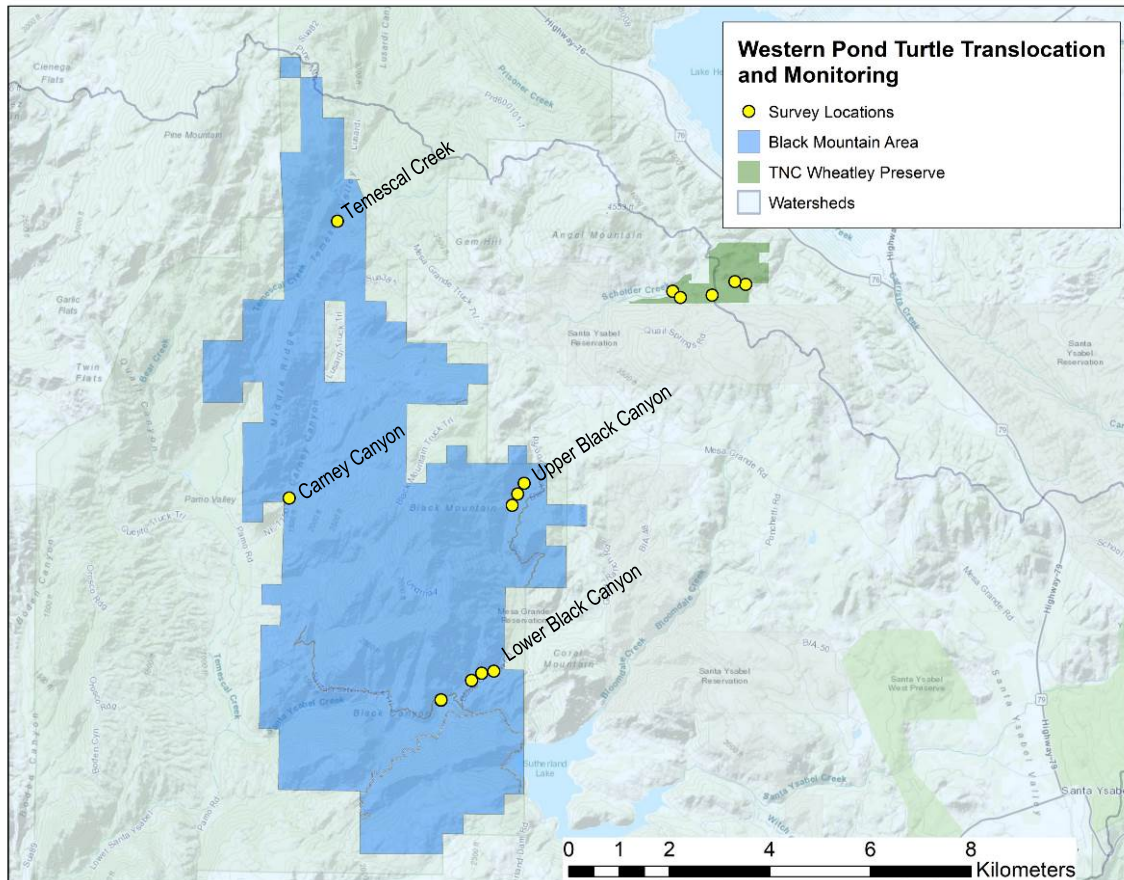


Figure 5. Black Mountain Area survey locations. Survey locations within US Forest Service’s Black Mountain Area. The TNC Wheatley Preserve is also shown for reference. Yellow dots represent centers of pooling areas or 250-meter stream reaches.

The streams in this management area has a mixture of historical uses and impacts. Black Canyon has a large recreation area featuring swimming and fishing with historic and ongoing impacts from nonnative aquatic species. Carney Canyon has limited and seasonal public access with low impact primitive camping and day use. Temescal Creek features the same limited, seasonal public access, but the majority of the stream is accessible only by hiking. Uplands include mixed chaparral, sage scrub, and oak woodland with open areas of native and nonnative grasses. In addition, Carney Canyon and Temescal Creeks also contain long reaches of fern lined stream with scattered patches of stream orchids (*Epipactis gigantea*). Their uplands also feature large expanses of Cleveland sage (*Salvia clevelandii*).

These creeks have historically supported large populations of pond turtles but portions of

these creeks have also been impacted by nonnative aquatic species and recreation (USDA 2005). These stream reaches were identified by USFS and the USFWS Partners Program as potential source populations for translocation to the TNC Wheatley Preserve. USGS surveyed these streams with USFWS in 2018 to assess the pond turtle population within the management area.

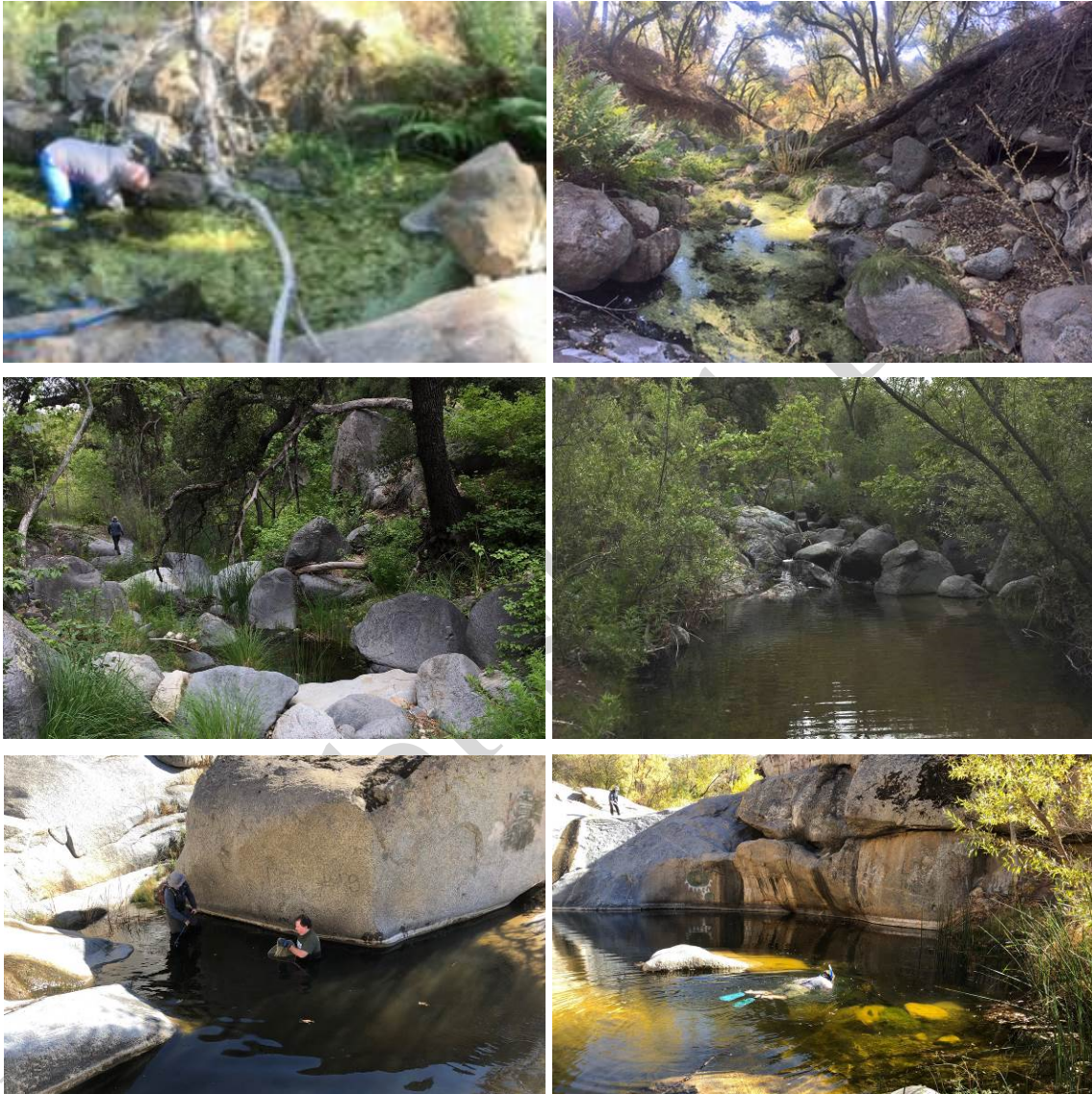


Figure 6. Black Mountain Area survey photos. Photos taken during surveys on 28 November 2018 at Temescal Creek (top), Carney Canyon (middle), and Black Canyon Recreation Area (bottom).

Deer Canyon

Deer Canyon consists of a 12.6 hectare preserve within the Los Penasquitos watershed and is currently owned and managed by California Department of Transportation (Caltrans; Figures 7–8). Deer Canyon Pond is a 1.75 hectare earthen dam pond along Deer Canyon which drains into Carmel Valley and into Los Penasquitos creek. This preserve was recently acquired and conserved, and no previous surveys for turtles had been conducted at this site.

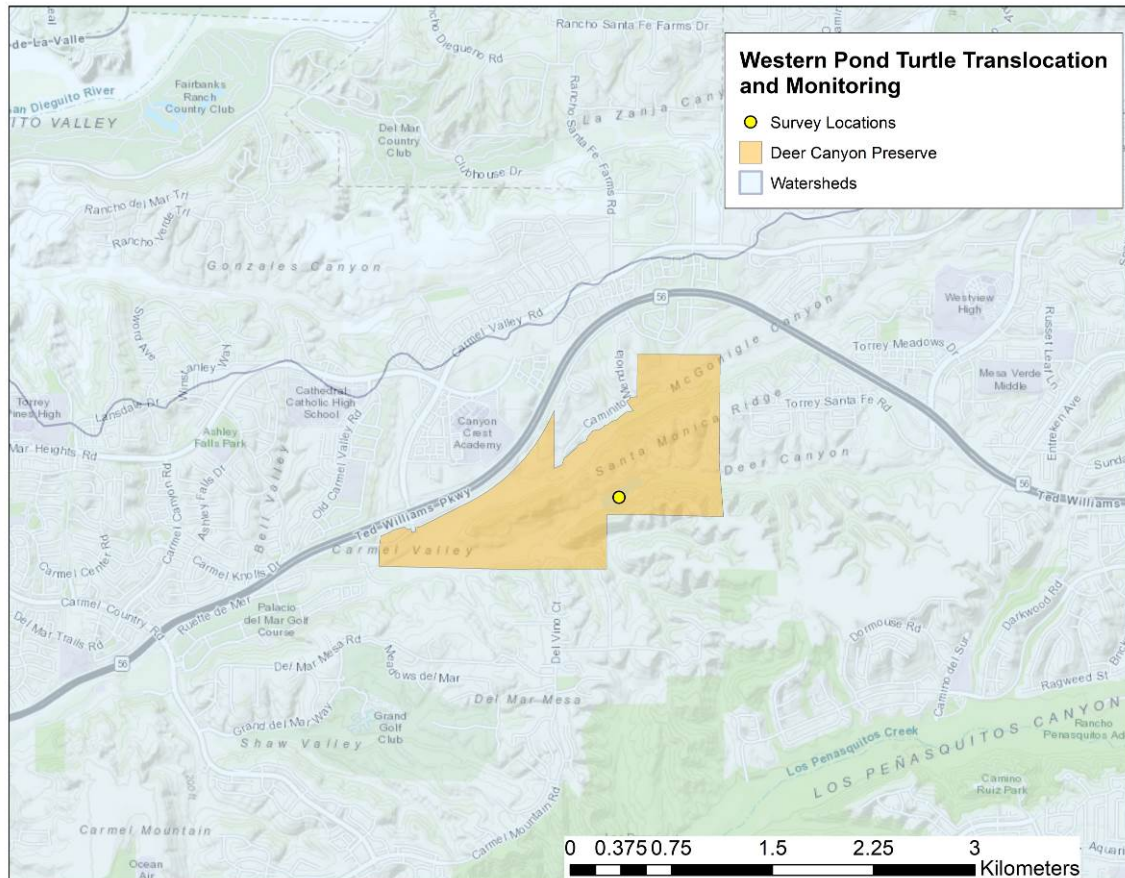


Figure 7. Deer Canyon Preserve survey location. The yellow dot represents the center of Deer Canyon Pond within the preserve.

Deer Canyon Pond is a large artificial pond (approximately 1.75 hectares) with sycamore willow riparian at the west end and shallow cattail marsh at the east end. The pond was used historically for recreational fishing, but at the time of our surveys, access was restricted with no swimming or fishing allowed. No surveys had been previously conducted to determine presence of native or nonnative aquatic taxa.



Figure 8. Deer Canyon Pond survey photos. Photos of the aquatic habitat at Deer Canyon Pond trapped on 16–20 October 2018.

Mason Valley

Mason Valley consists of a 1,516 hectare portion of State Park that used to be part of Tulloch/Cuyamaca Ranch and is currently owned and managed by California Department of Parks and Recreation. Mason Valley Pond is along Mason Valley Creek in the upper portions of the San Diego watershed (Figures 9–10). The site contains one large manmade semi-permanent pond with an adjacent large meadow/seasonal wetland.

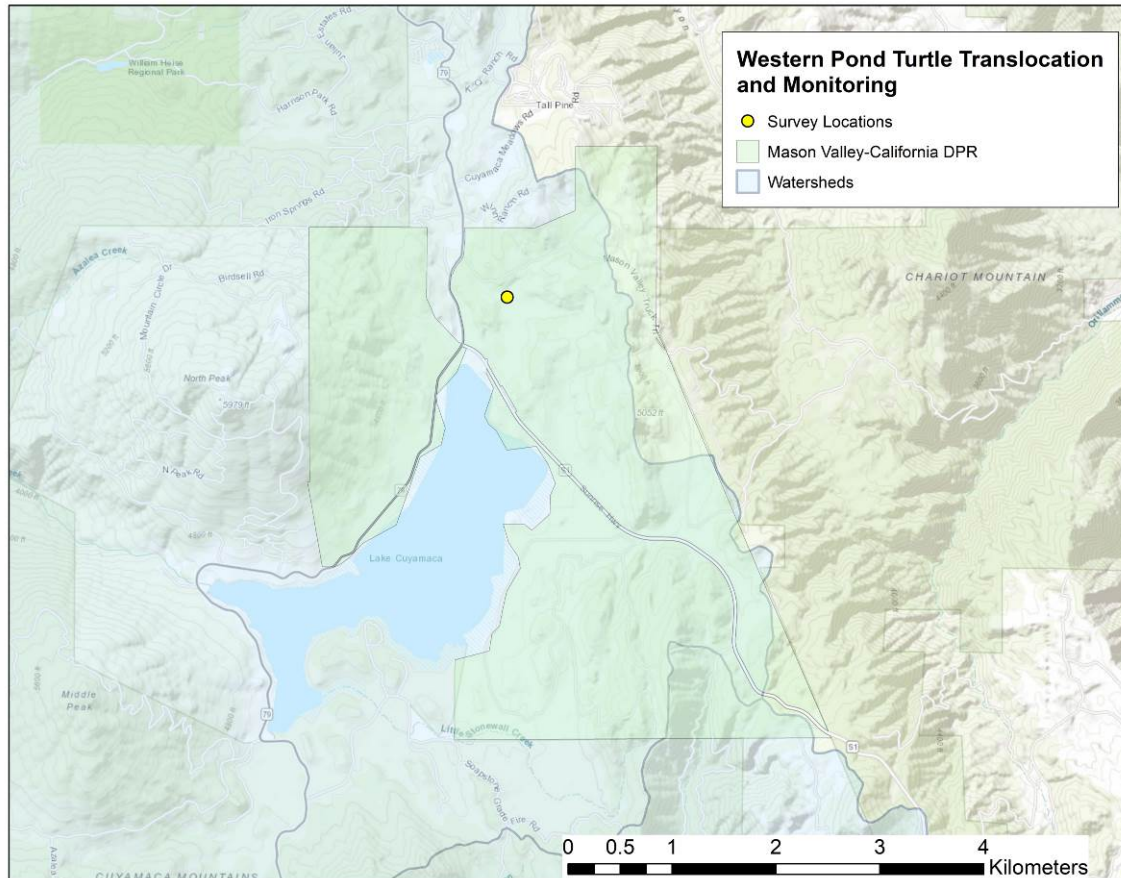


Figure 9. Mason Valley Pond survey locations. The colored dot represents the midpoint of the large ponding area at Mason Valley.

The Mason Valley pond is a large pond with an earthen dam at retaining the water on a permanent or near-permanent basis. The pond is lined with cattails with some open banks where there are boulders or where large mammals accessing the pond cleared the vegetation (Figure 10). Adjacent to the pond is a large meadow that was damp even in fall of 2018. At the time of this work, the pond was approximately 0.6 hectares and the adjacent meadow was approximately 4.72 hectares.



Figure 10. Mason Valley Pond survey photos. Photos of the Mason Valley Pond and adjacent meadow habitat form 12 October 2018.

Hanson El Monte Preserve

The Hanson El Monte Preserve consists of 64 hectares and at the time of the survey was owned and managed for conservation of native riparian and aquatic species by the EHC. It is located in the San Diego watershed approximately 30 kilometers northeast of San Diego (Figures 11–12). The Hanson El Monte Pond was a former quarry, which was purchased for conservation in 2015. In 2016, USGS began to collaborate with the preserve staff on strategies for nonnative aquatic species removal with the goal of removing bullfrogs and other aquatic predators for future translocations of pond turtles (Brown et al. 2019c). In 2018, USGS continued to survey Hanson El Monte Preserve for nonnative aquatic species with staff from EHC.

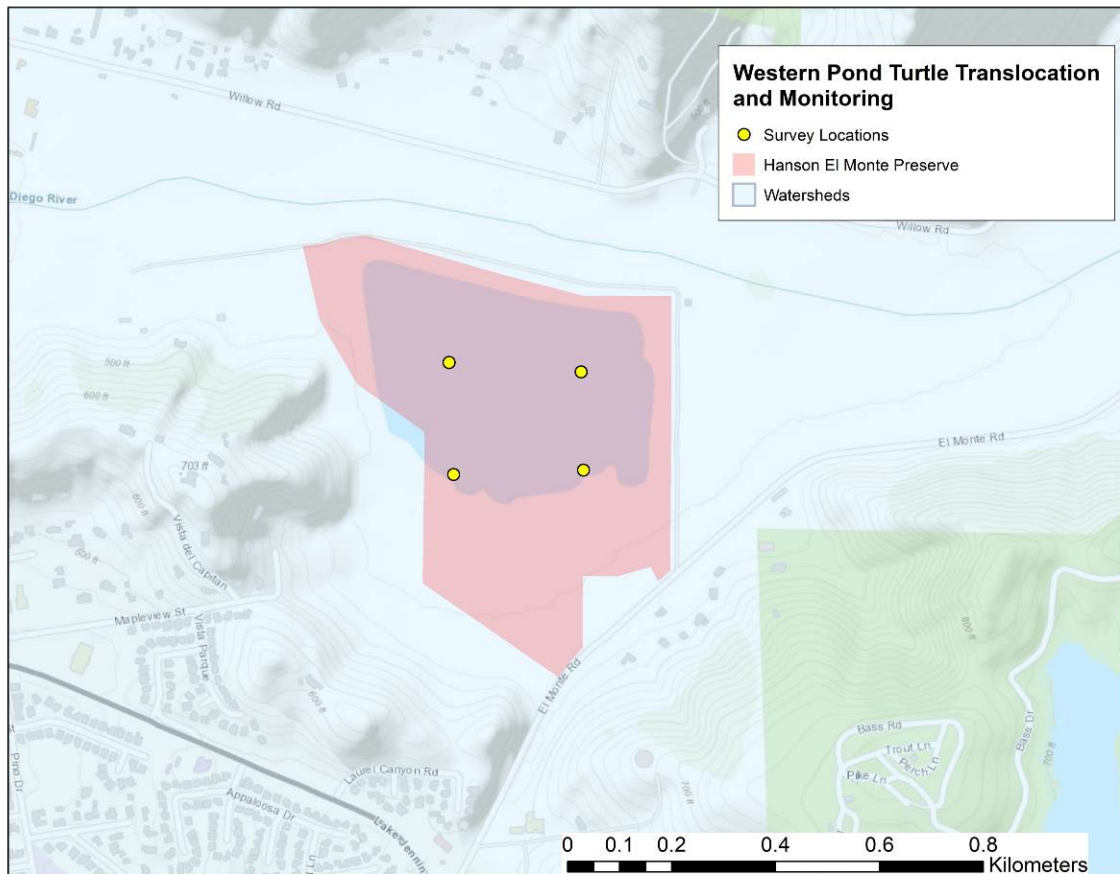


Figure 11. Hanson El Monte Preserve survey locations. The colored dots mark the corners of the large ponding area at Hanson El Monte Pond. The pond was divided into quadrants to quantify nonnative species removal surveys.

At the time of the survey reported here, the Hanson El Monte Pond contained approximately 50 hectares of pond and marsh habitat with permanent water and was undergoing habitat restoration through recontouring and revegetation (Figure 12). This site had been surveyed by USGS in 2015 and found not to contain pond turtles but to have potential habitat with management for removal of nonnative aquatic species (Brown et al. 2019c).

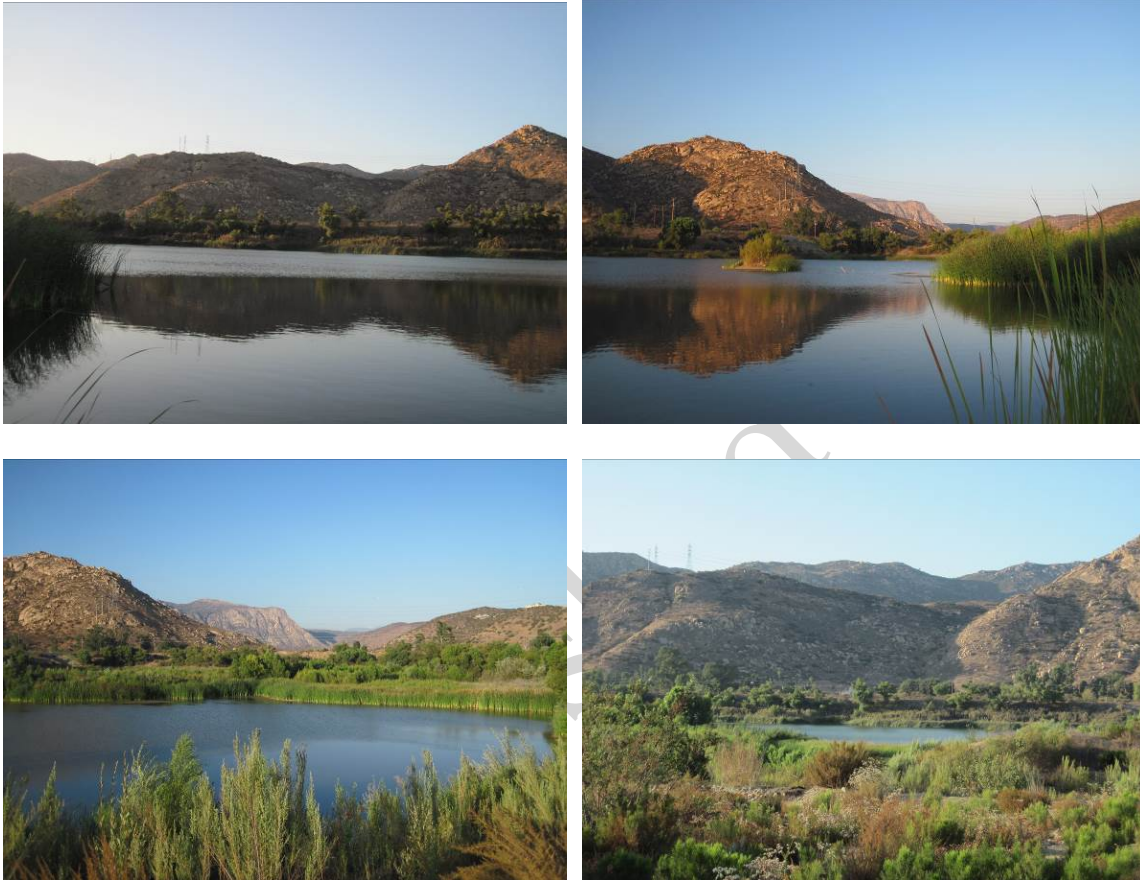


Figure 12. Hanson El Monte Preserve survey photos. Photos of the Hanson El Monte Pond on 14 August 2018 showing the adjacent riparian habitat restoration and abundant aquatic habitat and structure for foraging and basking.

Sycuan Peak Ecological Reserve

Sycuan Peak Ecological Reserve (SPER) is a 931 hectare preserve owned and managed for conservation by CDFW along the Sweetwater River approximately one kilometer below Loveland Reservoir and approximately four kilometers southeast of Dehesa, San Diego, CA (Figures 13–14). This site has been actively managed for pond turtles since 2009 when USGS began studying the response of the pond turtle to the removal of nonnative aquatic species (Brown et al. 2015). This site contains permanent ponds (Lower and Middle Ponds; Figure 14) that continue to contain abundant surface water during the late summer and fall when adjacent stream reaches are dry.

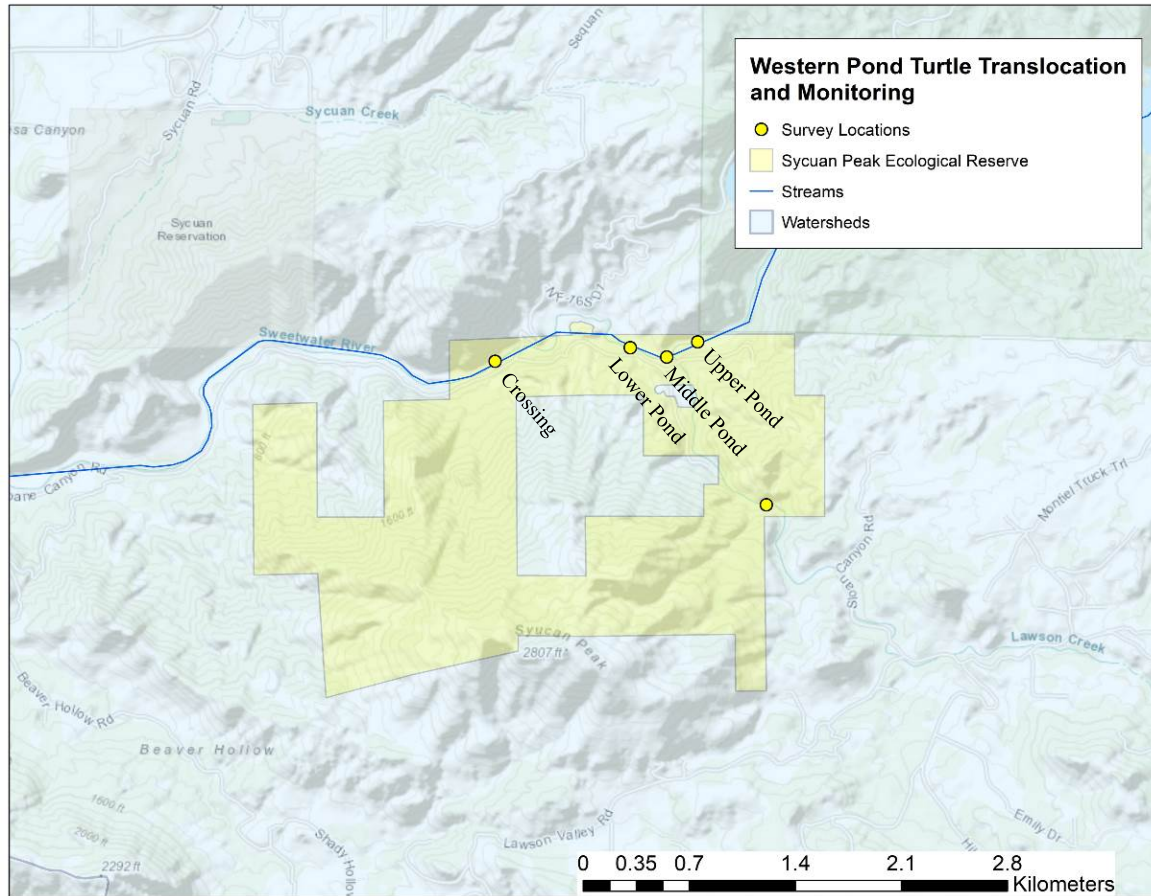


Figure 13. Sycuan Peak ER survey locations. Ponding areas along Sweetwater River below Loveland Reservoir surveyed for pond turtle monitoring and nonnative aquatic species removal.

The upland habitat consists of mixed sage scrub with some chaparral and the riparian is dominated by California sycamore (*Platanus racemosa*), willow (*Salix* spp.), and live oak (*Quercus agrifolia*) with a thick understory of false indigo (*Amorpha fruticosa*) and wild grape (*Vitis girdiana*). At the time of this work, the canopy along the stream channel was open where there were larger bedrock or sandy pools. Only middle pond and lower pond contained surface water through 2018 (figure 14). During 2009 to 2014, USGS collaborated on a pond turtle headstarting program with the San Diego Zoo in combination with nonnative species removal to study methods for enhancing the pond turtle population at SPER (Brown et al. 2012, Brown et al. 2015). During the initial study

in 2009 and 2010, African clawed frogs (*Xenopus laevis*), bullfrogs, crayfish, green sunfish (*Lepomis cyanellus*), and largemouth bass were removed from the study site (Brown et al. 2012). Sunfish and largemouth bass were shown to reinvade subsequent to overtopping of Loveland Dam which created a more sustained flow from Loveland Reservoir (Brown et al. 2012). Bullfrogs, crayfish, and African clawed frogs were also observed reinvading from outside of the site and were subsequently removed during monitoring efforts (Brown et al. 2012; Brown et al. 2015; Brown et al. 2019b).



Figure 14. Sycuan Peak ER survey photos. Photo of pond turtle habitat and basking area at middle pond 14 September 2018 (top). Photos of lower pond on 27 April 2018 (middle) and on 17 August 2018 (bottom) showing annual fluctuations of the water level at the lower pond.

San Diego NWR-Steele Canyon

The Steele Canyon area of the 4,978 hectare San Diego National Wildlife Refuge currently encompasses approximately 1,133 hectares of riparian and upland habitat approximately 20 kilometers east of San Diego. Steele Canyon Creek is in the lower portions of the Sweetwater watershed (Figures 15–16).

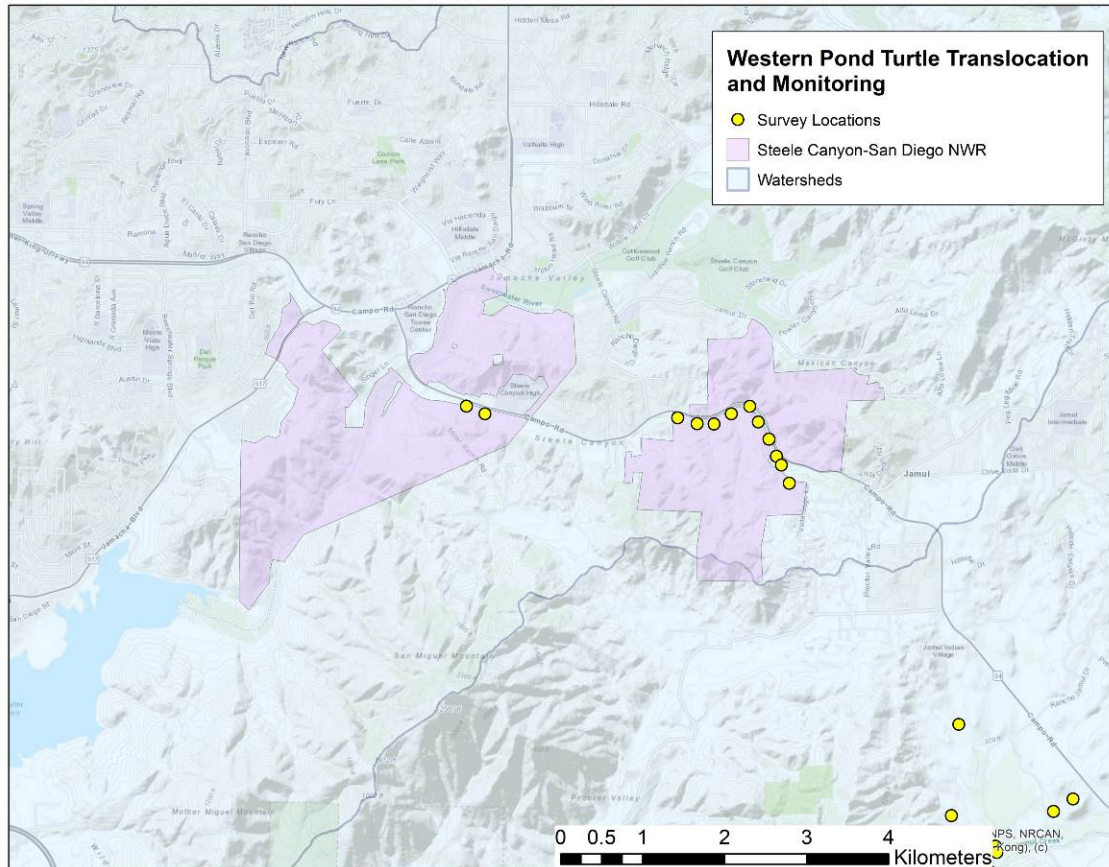


Figure 15. Steele Canyon survey locations. The yellow dots represent the midpoint of the stream reaches at Steele Canyon.

Steele Canyon Creek is a predominately ephemeral creek along Highway 94 from Jamul to its confluence with the Sweetwater River near Rancho San Diego. However, several small reaches have the potential to retain surface water throughout the year, and some deeper, permanent pools are scattered along the stream. Habitat includes sycamore, willow riparian with some nonnative vegetation and uplands of primarily coastal sage scrub or urban.



Figure 16. Steele Canyon survey photos. Photos from Steele Canyon surveys on 08 November 2018.

Hollenbeck Canyon Wildlife Area

Hollenbeck Canyon Wildlife Area (WA) is a 2,725 hectare preserve owned and managed by CDFW for conservation with limited access by foot for recreation (Figures 17–18). It is located approximately 15 miles south of El Cajon and contains the upper portions of Jamul, Hollenbeck, and Honey Springs creeks.

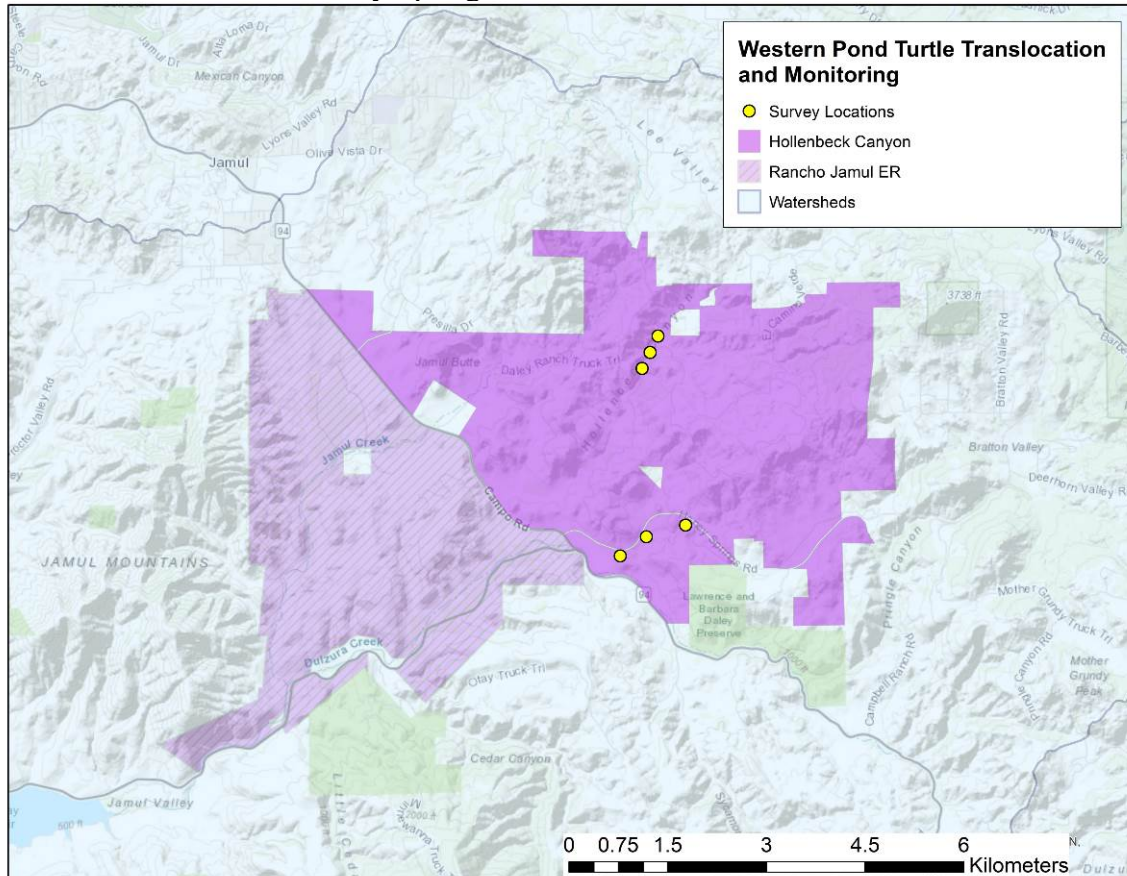


Figure 17. Hollenbeck Canyon WA survey locations. The colored dots represent the midpoint of the stream reaches at Hollenbeck and Honey Springs Creeks. RJER is shown for reference.

Hollenbeck Canyon WA encompasses the upper portions of Jamul, Hollenbeck, and Honey Springs creeks and consists primarily of coastal sage scrub with riparian woodland corridors containing sycamore, oak, and willow. The streams in the preserve are in large part ephemeral; however, some permanent surface water was present in some reaches of Hollenbeck Canyon and Honey Springs Creek during our surveys. The sites surveyed in this study had permanent surface water and little access, having only one hiking trail intersecting upper Hollenbeck Canyon WA and no trails along Honey Springs Creek.



Figure 18. Hollenbeck Canyon WA survey photos. Riparian habitat in upper Hollenbeck Canyon (top and middle) and Honey Springs Creek (bottom) on 26 October 2018.

Rancho Jamul Ecological Reserve

Rancho Jamul Ecological Reserve (RJER) is a 2,266 hectare preserve owned and managed by CDFW for conservation. It is located approximately 15 miles south of El Cajon along Jamul and Dulzura creeks in the Otay watershed (Figures 19–20). The preserve contains a diverse range of habitats from grassland to coastal sage to willow-sycamore dominated riparian (CDFW 2008). During this study, RJER had several natural and augmented ponds that held enough water to be considered semi-permanent, with some reaches of Jamul Creek retaining ponded surface water when the remainder of the creek was dry (Reach 44 Jamul Creek and Reach 02 of Jamul Creek Trib 15; Figure 20).

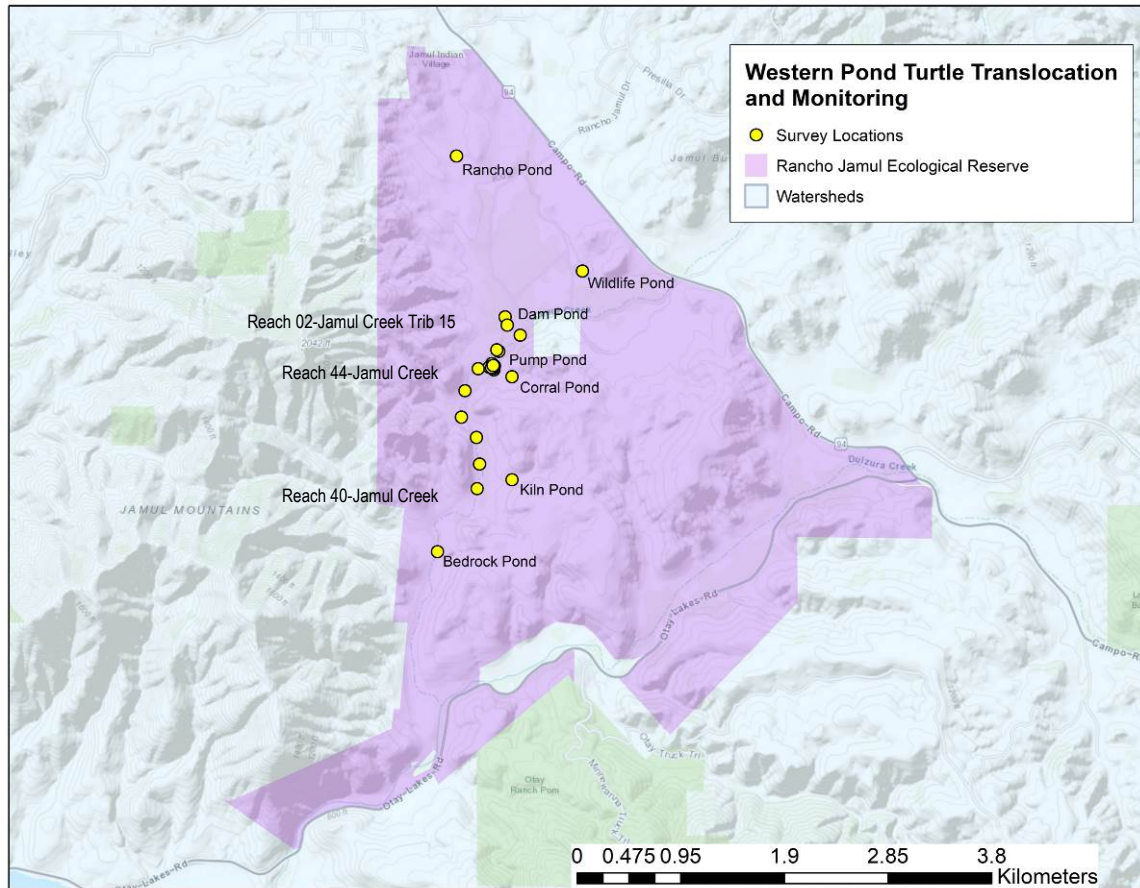


Figure 19. Rancho Jamul ER survey locations. Ponding areas along Jamul Creek and within RJER that were surveyed for suitability for pond turtles and removal of nonnative aquatic species.

RJER contains six ponds that frequently have surface water all year with adjacent habitat and upland including willow-sycamore riparian, coastal sage scrub and mixed native/nonnative grasslands (Figure 12). USGS has been investigating removal of nonnative aquatic species in this area since 2001, to benefit the native riparian obligate reptiles and amphibians (Brown et al. 2015, Hathaway et al. 2002).



Figure 20. Rancho Jamul survey photos. Ponding areas along Jamul Creek and within RJER that were surveyed for suitability for pond turtles and removal of nonnative aquatic species: Pump Pond on 27 April 2018 (top) Pump Pond nonnative grass removal site between Pump Pond and Jamul Creek on 14 September 2018 (second row), Corral Pond on 08 March 2019 (third row, left), Rancho Pond on 08 March 2019 (third row right), Jamul Creek (bedrock pool) on 09 November 2018 (bottom left) and on 28 September 2018 (bottom right).

Methods

Surveys for native and nonnative aquatic species were conducted following USGS protocols for aquatic species in the south coast ecoregion (USGS 2006a–d). Semi-aquatic species are included in these methods and results as aquatic species since they are most commonly detected in aquatic environments during these surveys. Survey methods included daytime visual encounter surveys, nighttime visual encounter surveys for bullfrog removal, radio telemetry, and trapping (Table 1). While this report covers March 2018 through March 2019, all surveys were done in 2018. Telemetry was done in 2018 and 2019. Daytime visual encounter surveys were used to determine species presence and activity as well as to remove bullfrogs if they were observed. Nighttime visual encounter surveys focused on detecting and removing bullfrogs at TNC Wheatley Preserve, RJER, and Hanson El Monte Preserve. Radio telemetry surveys were used to determine movement and site preference of translocated pond turtles at RJER from Oak Valley in 2014 and 2015. Trapping was used to assess native and nonnative aquatic species presence and to capture turtles to assess health and change transmitters. Time lapse and motion triggered cameras were also deployed at SPER and RJER to detect juvenile pond turtles, nonnative aquatic species, and disturbance.

Table 2. Surveys conducted by type at each site, 15 March 2018–15 March 2019. Surveys listed by type, count, and location.

Watershed	Site	Day Visual	Night Visual	Radio Telemetry	Trapping
San Dieguito	TNC Wheatley Preserve	3	14		
	Black Mountain Area	3			
Los Penasquitos	Deer Canyon Preserve	1			1
San Diego	Mason Valley	1			
	Hanson El Monte Preserve	1	3		
Sweetwater	Sycuan Peak ER	14			2
	San Diego NWR-Steele Cyn	1			
Otay	Hollenbeck Canyon WA	1			
	Rancho Jamul ER	17	13	21	3
Total:		40	30	21	6

Daytime Visual Encounter Surveys

Daytime visual encounter surveys were conducted to assess riparian and aquatic habitat and determine presence of active aquatic species. Daytime visual encounter surveys were conducted at RJER prior to radio tracking (telemetry) to determine activity or presence of any pond turtles without transmitters. Daytime visual encounter surveys were also conducted at Deer Canyon Preserve, SPER, and RJER prior to and during trapping surveys to determine presence of species not captured in the traps. Surveys were conducted by walking the creek and pond perimeter, and recording any native or nonnative amphibians or reptiles encountered in accordance with the USGS stream survey protocol (USGS 2006a). Dip-nets and seine nets were used to detect species underneath aquatic vegetation, floating material, and overhanging banks and tree roots. In addition to hand capture, polespears, nets, and .22 rimfire firearms were often utilized during visual encounter surveys to collect and remove nonnative species. Visual encounter surveys at SPER and RJER were conducted on the same days and timing of surveys alternated between the two sites to maximize the detection of crepuscular species (e.g., treefrogs and toads).

Nighttime Visual Encounter Surveys

Nighttime nonnative aquatic species management focused on removal of bullfrogs from the creek channels and ponds at the sites (Table 2). These surveys were conducted 15 March 2018 to 15 March 2019 and followed the USGS protocols for aquatic species (USGS 2006d). Methods included using hand capture, polespears (slings), and .22 caliber rimfire rifles using lead free frangible ammunition to collect adult bullfrogs. Dip nets and seine nets were also used to collect larval and metamorphosing bullfrogs. Captured bullfrogs were taken to USGS where stomachs were removed to examine contents. Bodies were sent to the Aquatic Parasite Observatory at the University of Colorado for examination and results are pending.

Radio telemetry

Telemetry was used at RJER to determine site fidelity of the pond turtles translocated during the previous study. Data on specific pond or stream reaches and habitat use (whether turtles were in the water, on the shore, under the cattail mat, or in the upland) were recorded when possible. Presence data were recorded for other aquatic or riparian species observed. Pond turtles were tracked semi-monthly (twice a month) during the year with the exception of coldest months, where previous data indicate less activity, for a total of 21 daytime radio tracking surveys.

In addition to manually locating the pond turtles, a Telonics TR5 radio receiver was mounted to a California walnut (*Juglans californica*) tree at the south end of the Pump Pond and attached to a 12 volt RV/Marine deep cycle battery. This device recorded transmitter pulse period and signal strength every 20 minutes. The relative strength of the signal combined with the pulse period was used to determine whether the individual turtles were in the pond, on the surface of the pond, or potentially in the creek adjacent to the pond.

Trapping Surveys for Aquatic Species

Trapping surveys were used to capture pond turtles and other native and nonnative aquatic species. Trapping pond turtles was used for monitoring at SPER and RJER as well as to replace transmitters at RJER. Deer Canyon was trapped to confirm presence of native pond turtles and/or other species present as a baseline effort. Trapping surveys were useful for removing nonnative aquatic species including crayfish, sunfish, and bullfrog larvae.

Methods followed Madden-Smith et al. (2005) and the “USGS western pond turtle (*Emys marmorata*) trapping survey protocol for the south coast ecoregion” (USGS 2006b). Trapping surveys at both sites used 1.5 foot diameter flat mouthed hoop traps baited with freshly frozen commercial mackerel, canned sardines, or commercial dog food. Traps were deployed with floats to provide an area for trapped animals to surface and breathe. Traps were checked daily.

When transmitters were replaced, the old transmitter (if still present) was gently removed using soft plastic spatula or plastic putty knife. The rear of the carapace of each pond turtle was gently cleaned with water and cotton cloth to determine the most suitable scute for transmitter placement. Scute selection was made based on cleanliness, size, and shape such that when the transmitter was placed, the antenna would lay naturally along the rear of the carapace with no large gaps.

We used 10 gram RI-2BT temperature sensing transmitters from Holohil with frequencies approved for use on this project by USFWS. Transmitters were configured for glue attachment to the turtles. Each transmitter was first attached with kitchen and aquarium approved silicone adhesive and allowed to dry. Then a bead of clear five-minute epoxy was placed around the transmitter to adhere it to the scute. Care was taken to not cover any sutures with epoxy. If the scute was too small to avoid covering sutures, a bead of silicone was placed over the suture in order to not impact the carapace growth.

Time Lapse and Motion Triggered Cameras

We utilized time lapse and motion sensor cameras to identify potential threats or disturbances at SPER and to document pond turtle presence supplemental to trapping surveys. Camera stations were established at the two largest pools where the most pond turtle activity had been observed (pools one and two, Figure 6). RECONYX PC800 Hyperfire Professional IR motion cameras were set facing the ponding water and attached to trees with Master Lock Python cable locks. The cameras were set to take five photos per trigger at approximately two frames per second and to take a time lapse photo every 10 minutes from 15 June 2015 to present. Photos were downloaded bi-weekly and cataloged by site with download date in the shared file management system at USGS San Diego Field Station. Photo metadata included date/time, temperature, time lapse or motion trigger, and photo identification number (if motion triggered). Photos were viewed by USGS staff and volunteers familiar with SPER to look for presence of animals or disturbance.

Results

A total of 5,717 aquatic species were captured during the surveys conducted between 15 March 2018 and 15 March 2019; we recorded 1,423 observations of nine native species and 4,288 captures of 10 nonnative species (Table 3). The most numerous species observed was the nonnative red swamp crayfish (*Procambarus clarkii*) with 2,799 captures followed by the native western toad (*Anaxyrus boreas*) with 1,081 total observations, both mostly at RJER. While numbers of bullfrogs and African clawed frogs were both high (825 and 233 respectively), they were much less numerous than in the previous year (7,707 and 889 respectively in 2017; Brown et al. 2019b).

Table 3. Species observations by preserve. A total of 5,717 aquatic species were captured during the surveys conducted between 15 March 2018 and 15 March 2019. Crayfish were detected at two sites but were not captured and are indicated by a “D”.

	Aquatic Species Observations																				Total
	Native										Nonnative										
	Western Pond Turtle Adults	Western Pond Turtle Juveniles	Two-striped Gartersnake	Arroyo Toad	Western Toad	Western Spadefoot	California Treefrog	Pacific Treefrog	Monterey Ensatina	Garden Slender Salamander	Red-eared Slider	Bullfrog	African Clawed Frog	Green Sunfish	Bluegill Sunfish	Largemouth Bass	Bullhead Catfish	Mosquitofish	Common Carp	Crayfish	
TNC Wheatley Preserve			11		34			34	2	3	2	227									
Carney Canyon								7													
Temescal Creek																					
Black Canyon							4					1			2						
Deer Canyon								1			2			7	2					32	
Mason Valley																					
Hanson El Monte Preserve												40		1		1		1	1	D	
Sycuan Peak ER	22	6		1			1	3					98	270						207	
Steele Canyon								3										2		D	
Hollenbeck Canyon WA								1													
Rancho Jamul ER	152		5		1,047	6		80				556	135				1	140		2,560	
Total:	174	6	16	1	1,081	6	5	129	2	3	4	824	233	271	9	3	1	143	1	2,799	
	Total Native: 1,423										Total Nonnative: 4,288										

TNC Wheatley Preserve

TNC Wheatley Preserve Visual Encounter Surveys

A total of three daytime and 14 nighttime visual encounter surveys were conducted at the TNC Wheatley Preserve. During these surveys, 227 bullfrogs and two red-eared sliders were removed from the Scholder Creek Pond and adjacent creek. Three native aquatic species were also detected during these surveys, including the two-striped gartersnake (*Thamnophis hammondi*), western toad, and Pacific treefrog (*Pseudacris regilla*; Table 3). No fish or crayfish were detected during these surveys.

Black Mountain Area

Black Canyon Visual Encounter Surveys

A total of two daytime visual encounter surveys were conducted at Black Canyon on 27 and 28 November 2018. Two deep pools (> 2 meters) were present requiring the use of snorkel and mask to be effective. During these surveys, California treefrogs (*Pseudacris cadaverina*), bullfrogs, and bluegill sunfish (*Lepomis macrochirus*) were detected (Table 3).

Temescal Creek and Carney Canyon Visual Encounter Surveys

One daytime visual encounter survey was conducted at the Carney Canyon on 28 November 2018 (Table 3). Water levels were low, but the site did contain several pools between 1 and 2 meters in depth. Pacific treefrogs were detected at Carney Canyon, but no aquatic species were observed at Temescal Creek. No fish were detected during either of these surveys.

Deer Canyon Preserve

Deer Canyon Pond Trapping Surveys

Trapping surveys for this location were used to assess presence of native or nonnative turtles and were conducted 16 to 20 October 2019. During the surveys, two red-eared sliders were captured and removed. The only amphibian detected was the Pacific treefrog. Fish detected at this site included bluegill sunfish and largemouth bass. Thirty-two crayfish were collected in the turtle traps.

Mason Valley

Mason Valley Pond Visual Encounter Surveys

One daytime visual encounter survey was conducted at Mason Valley Pond and the adjacent meadow on 12 October 2018. The surveys were intended to find permanent surface water resources without impacts from nonnative aquatic species. Ample surface water was present at the pond, but no aquatic species were observed (Table 3).

Hanson El Monte Preserve

Hanson El Monte Visual Encounter Surveys

Three nighttime visual encounter surveys were conducted at Hanson El Monte Pond and one daytime visual encounter survey was conducted at the Palmer Preserve. During these surveys, 25 bullfrogs, two largemouth bass, one common carp (*Cyprinus carpio*), one green sunfish and two mosquitofish (*Gambusia affinis*) were collected from the Hanson El Monte Pond. Crayfish were detected at the Palmer Preserve. The Pacific treefrog was detected at both sites and was the only native aquatic species found during these surveys (Table 3).

Sycuan Peak Ecological Reserve

A total of 608 observations of four native and three nonnative aquatic species were made during 14 visual encounter surveys and 10 days of trapping surveys conducted

between 15 March 2018 and 15 March 2019 at SPER (Table 4). Trapping surveys were more effective at detecting and capturing pond turtles and nonnative aquatic species. The arroyo toad (*Anaxyrus californicus*) and two treefrog species were only observed during visual encounter surveys.

Table 4. Species detected by survey method at SPER

	Days	Arroyo Toad	Western Pond Turtle		California Treefrog	Pacific Treefrog	Green Sunfish		Crayfish		African Clawed Frogs	
		Juvenile	Adult	Juvenile	Adult	Adult	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Visual Encounter:	14	1	4		1	3	2	7			1	
Trapping:	10		18	6			16	245	141	66	89	8
Total:	24	1	22	6	1	3	18	252	141	66	89	9

SPER Visual Encounter Surveys

Fourteen visual encounter surveys were conducted to detect native and nonnative aquatic species. Nonnative species detected during these surveys included the African clawed frog and green sunfish. Native species detected visually included the pond turtle, California and pacific treefrogs, and the arroyo toad (*Anaxyrus californicus*). This is the first verified observation of an arroyo toad within SPER since 1996 (USFWS 2015).

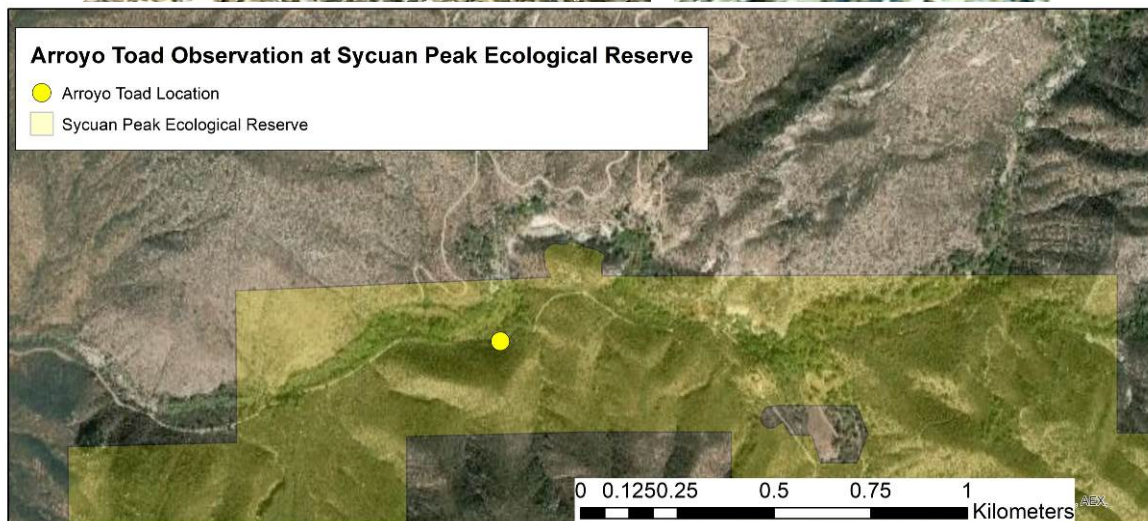


Figure 21. Arroyo toad at SPER. An arroyo toad was observed at the end of a visual encounter survey at SPER along the road while exiting the site on 01 February 2019. The location at the preserve is indicated by the yellow dot in the bottom figure.

SPER Trapping Surveys

Trapping surveys for this location were used for monitoring pond turtles in-situ that had been previously translocated from the headstart program in 2014/2015 or that were naturally recruiting post nonnative species removal. They were also used for continued removal of nonnative aquatic species (Brown et al. 2019b). During this project, SPER was surveyed using baited traps for five days (four trap nights) starting on 10 April 2018 and again starting on 9 October 2018. The three main ponds at SPER (upper, middle, and lower) contained enough water to place traps in 2018, 32 traps being placed between the three ponding sites in April, and 57 traps being placed in October. This resulted in 28 pond turtle captures of seven recaptured adults and two new juveniles which were not previously marked before.

SPER Time Lapse and Motion Triggered Cameras

The motion and time lapse cameras recorded over 500 observations of pond turtle activity, including swimming, basking, and interaction of multiple turtles (Figure 22). We used the photos to improve detectability during trapping surveys by setting traps during peak activity. Previously, we successfully used the time lapse cameras to detect bullfrogs (Brown et al. 2019b). No bullfrogs were detected by cameras during this sampling period, nor were they observed during any visual or trapping surveys.



Figure 22. Camera station photos of aquatic species at SPER. Time lapse photography was used to identify preferred basking locations and timing (middle pond, 16 August 2018; top) and to identify new juvenile turtles at the site (middle pond, 01 September 2018; bottom left). White dots of nail polish were added to the carapace of the turtles in unique patterns to assist with identification in the time lapse photos beginning in October 2018 (11 October 2018; bottom right).

San Diego NWR-Steele Canyon

Steele Canyon Visual Encounter Survey

One daytime visual encounter survey was conducted at Steele Canyon within the San Diego National Wildlife Refuge on 08 November 2018. Crayfish, mosquitofish, and

Pacific treefrogs were detected during this survey (Table 3). No predatory fish or bullfrogs were detected during this survey.

Hollenbeck Canyon Wildlife Area

Hollenbeck and Honey Springs Creeks Visual Encounter Surveys

One daytime visual encounter survey was conducted at Hollenbeck Creek and Honey Springs Creek within Hollenbeck Canyon WA on 26 October 2018. The surveys were intended to find permanent surface water resources without impacts from nonnative aquatic species. Honey Springs Creek had less than 200 meters of surface water, none of which was greater than 10 centimeters in depth. No aquatic species were observed at Honey Springs Creek.

Hollenbeck Creek was previously surveyed by USGS in March and May of 2002 when water was much more prevalent and bullfrogs, green sunfish, mosquitofish, and crayfish were all detected (Hathaway et al. 2002, Madden-Smith et al. 2004). In October of 2018, Hollenbeck Creek contained only approximately 400 meters of surface water and only approximately 50 meters was greater than 10 centimeters in depth. During this survey, Baja California treefrogs were observed at Hollenbeck Creek (Table 3), but no fish or crayfish were detected.

Rancho Jamul Ecological Reserve

RJER Daytime Visual Encounter Surveys

Daytime visual encounter surveys were conducted to detect juvenile pond turtles and other native species associated with the pond turtle habitat immediately prior to telemetry surveys at Pump Pond and the adjacent creek and immediately after telemetry surveys at Kiln and Corral ponds. No new juvenile pond turtles were detected during these surveys, but the translocated adult pond turtles were often seen basking on banks or woody debris at Pump Pond and Reach 44 of Jamul Creek (Figure 11). We also recorded three species of snakes using visual surveys (Table 5).

RJER Nighttime Visual Encounter Surveys

Our nonnative visual encounter surveys were focused on removing bullfrogs from the pump, Corral, Kiln, and bedrock ponds and the adjacent Jamul Creek (Table 6, Figure 20). During 13 nighttime survey events, a total of 476 bullfrogs were removed from the site. A total of 132 adult and 344 juvenile bullfrogs were removed by the use of .22 caliber rimfire rifles and polespears for adults and dip nets and seines for approximately 80 bullfrog larvae and metamorphs.

In spring 2018, we did not observe an explosive bullfrog breeding event as occurred during April and May of 2017 at two ponds (Kiln and Corral; Brown et al. 2019b). However, we did observe Pacific treefrog and western spadefoot (*Spea hammondi*) activity later than in 2017. We also detected increased western toad activity compared with 2017 (Table 5; Brown et al. 2019b).



Figure 23. Pond turtle activity at RJER. Pond turtles basking at pump pond on 23 May 2018 (left) and 31 August 2018 (right).

Table 5. RJER visual encounter other species observations. Other reptiles and amphibians observed at RJER's pump pond during telemetry surveys. These are numbers of observations and not captures or recaptures and are not representative of the total numbers of individuals at the site.

<u>Species</u>	<u>Number of Days Observed</u>	<u>Number of Individuals Observed</u>
California kingsnake (<i>Lampropeltis californiae</i>)	2	2
Southern Pacific rattlesnake (<i>Crotalus helleri</i>)	1	1
Two-striped gartersnake (<i>Thamnophis hammondi</i>)	4	5

Table 6. Bullfrog activity at RJER. Bullfrog captures and activity relative to Pacific treefrog and western spadefoot activity by month.

	Baja California Treefrog		Western Spadefoot		Western Toad			Bullfrog			
	Adult	Larvae	Adult	Juvenile	Adult	Juvenile	Larvae	Adult	Juvenile	Metamorph	Larvae
January											
February	2										
March	14	40			22		1000	21	71	4	
April	11		1	1	14	6		28	109	7	6
May	3		1		3	1		28	65	1	1
June								4	3		1
July								1	3		
August	3							31	67	18	
September	2				1			19	26	42	
October	1										
November											
December	4		3								

RJER Telemetry and Monitoring

Pond turtles were radio tracked on 21 occasions and trapped on two occasions for a total of 23 location observations (Table 7). Based on telemetry and trapping, Pump Pond and Reaches 44 of Jamul Creek were the most frequently inhabited parts of the reserve, with the turtles spending most of their time at Pump Pond. In total, 120 telemetry/trapping observations were made at Pump Pond and 28 observations along Jamul Creek (Figure 7 and Table 7). One of the turtles moved downstream nearly 500 meters to Reach 42 of Jamul Creek then returned to Reach 44 of Jamul Creek.

RJER Trapping Surveys

Three trapping surveys were conducted at RJER to detect pond turtle recruitment and to replace radio transmitters. Trapping surveys consisted of traps being set for five days (four nights) beginning on 21 May 2018 and 25 September 2018. During these surveys, 11 of the translocated turtles were recaptured and transmitters were replaced. All turtles appeared to be in good health showing no loss of weight, new injuries, lesions, or symptoms of disease. No new or juvenile turtles were detected.

Table 5. Pond turtle activity at RJER. Dates and locations of turtle observations based on telemetry, including a total number for off-channel ponds (Pump and Corral) and for Jamul Creek and its tributary.

Date	Pump Pond-RJER	Reach 042-Jamul Creek	Reach 044-Jamul Creek	Reach 045-Jamul Creek	Jamul Creek Combined
03/16/18				1	1
03/30/18	9	1	2		3
04/27/18	10		4		4
05/11/18	11				0
05/22/18	4				0
05/23/18	1				0
05/24/18	3		2		2
05/25/18	1				0
06/08/18	6		2		2
06/22/18	8		3		3
07/06/18	7		2		2
07/20/18			3		3
08/03/18	12		1		1
08/17/18	9		3		3
08/20/18	1				0
08/31/18	1		1		1
09/14/18	8		2		2
10/12/18			1		1
10/26/18	8				0
11/09/18	11				0
12/07/18	2				0
12/21/18	7				0
03/08/19	1				0
Total:	120	1	26	1	28

Discussion

Site specific discussions are included below for the current reporting period.

TNC Wheatley Preserve

We detected no fish or crayfish at the TNC Wheatley Preserve in 2018. However, red-eared sliders and bullfrogs were detected in 2018. Using traps and visual encounter surveys has reduced the numbers of nonnative species and may potentially eradicate these species from the upper portion of Scholder Creek. While large numbers of juvenile bullfrogs were detected in 2018, numbers were significantly reduced compared with the previous year (227 in 2018 versus 2,834 in 2017). Based on the low numbers of metamorphosing juveniles in 2018, it appears that bullfrog breeding was inhibited in 2018. Nighttime visual encounter surveys and camera surveys could continue until bullfrogs are no longer detected at the site.

Black Mountain Area

This large area of USFS forest lands historically supported pond turtles with large numbers of pond turtles being observed at the Black Canyon Recreation Area as recently as 2008 to 2010 (Fisher et al. 2014); however, detectability was reduced substantially during the drought years (Brown et al. 2019c). During the 2018 surveys, the portions of Black Canyon that contained water were impacted by nonnative aquatic species. Translocating turtles from this area to the conserved pond at the TNC Wheatley Preserve could create a secure population that would potentially provide offspring to repopulate portions of Black Canyon after nonnative aquatic predators are removed.

Deer Canyon Preserve

With the current gated and restricted access, Deer Canyon Pond has potential as a site for translocation of pond turtles and conservation of native aquatic species if nonnative species are removed. The pond is large, deep, and permanent with abundant structure for basking and foraging. The large size of the pond and the extent and depth of the aquatic habitat may require different methods, including nets and traps that could be more effective across larger water bodies and in deeper water.

Mason Valley

Mason Valley Pond was surveyed in the fall of 2018 to assess presence of permanent water resources and nonnative aquatic species. While there was relatively abundant surface water for the area and time of year, there were no nonnative aquatic species detected. A follow up survey could be conducted in the spring or early summer to assess the presence of native aquatic species. This site could potentially be suitable as a translocation receiver site for pond turtles if they are not detected in subsequent surveys.

Hanson El Monte Preserve

Hanson El Monte pond is a large, permanent water source in a relatively dry landscape. The large number of nonnative aquatic predators and the large size of the pond and the extent and depth of the aquatic habitat could require different methods, including nets,

gillnets and traps that could be more effective across larger water bodies and in deeper water.

Sycuan Peak Ecological Reserve

Pond turtle recruitment at SPER appears to be continual, and bullfrog and bass were not detected in our surveys. The arroyo toad was detected at this site for the first time in over 20 years. While known from much lower in the watershed where surface water is much more ephemeral, it had been absent from the preserve where there were permanent pools with nonnative aquatic predators, even though adjacent sandy stream reaches continued to exist. The management actions for the pond turtle may have also benefited the arroyo toad and allowed it to repopulate SPER.

Crayfish, African clawed frogs, and green sunfish were removed from the site in 2009 and 2010 and reinvaded in 2011 when sustained flow returned to the stream, connecting the pools in the site to the rest of the stream (Brown et al. 2013). These species were again removed during subsequent monitoring efforts (Brown et al. 2015). In 2017 we detected these three nonnative aquatic species in very low numbers which could be managed with periodic surveys and removal. Populations are currently still greatly reduced and could be kept low with careful timing of aquatic species surveys and water release events, as nonnatives have been lowest in numbers immediately after water releases (Brown et al. 2013).

San Diego NWR-Steele Canyon

Steele Canyon Creek has thick riparian habitat with some scattered, deep, permanent pools that could support pond turtles. A pond turtle was observed at the site by USFWS staff on multiple occasions for one week in April to May 2010, but it has not been observed since. After the observation by USFWS, the site was trapped by USGS and no pond turtles were captured. However, the creek appeared to be populated by invasive plants and nonnative aquatic predators, including crayfish. The site also has potential for increased runoff and sedimentation from the adjacent highway; this could be monitored using STICs (Stream Temperature, Intermittency, and Conductivity data loggers) and/or time lapse camera stations.

Hollenbeck Canyon Wildlife Area

Upper Hollenbeck Canyon contained the best conditions for potential pond turtle translocation to the WA. During the driest months of the year, it still contained some surface water, and only native aquatic species were observed. During surveys prior to the prolonged drought, bullfrogs, crayfish, green sunfish, and mosquitofish were detected; however, during the current surveys they were not. The prolonged drought of 2015–2016 may have greatly reduced or eliminated the nonnative aquatic species that were present in the system in 2002. Surveys could be conducted in the spring to determine if these species are detected anywhere in the creek or if crayfish or bullfrogs were able to persist through the drought conditions in the lower reaches.

Access at Hollenbeck Canyon WA is limited to foot traffic along the lower portion of the Hollenbeck Creek with a single, more remote, spur trail crossing the upper portion of

Hollenbeck Creek. There is a dam/drop structure where this spur trail crosses the upper creek and water pools on the bedrock at this location. A further assessment of translocation feasibility could include investigating the potential to enhance the habitat by increasing the water depth either above or below the dam.

Rancho Jamul Ecological Reserve

The translocated pond turtles at RJER appeared to be active and persisting in the riparian habitat. Basking was frequently observed on many features of the pond, including fallen logs, cattail mats, and the shoreline. They appeared to move freely between the stream and the pump pond but spend the majority of the time in the pump pond, moving up and down stream to the deepest pools within the stream channel. When captured in traps, they appeared healthy and showed no signs of disease.

Bullfrogs were reduced throughout the site but continue to be large and to be a concern and potential risk to this population. Continued nighttime survey and removal of bullfrogs, especially in the late winter and early spring, could further reduce the population. The crayfish at the site remained very abundant, however. Efforts to trap crayfish did not appear to be as effective as incremental top to bottom crayfish removal efforts conducted by the Mountain Restoration Trust (MRT) in the Santa Monica Mountain streams (Milligan et al. 2017). An incremental, but consistent, crayfish removal effort from top of the watershed down with collaboration between the wildlife agencies could be modeled after MRT program.

Long-term monitoring and management of this population could follow the same guidelines suggested for the pond turtles at SPER (Brown et al. 2015). We expected to observe juvenile pond turtles by 2017 to 2018, but no juvenile pond turtles were detected during this project. Bullfrog and crayfish populations were still numerous at the time of these surveys and could potentially have an impact on pond turtle recruitment. Pond turtle monitoring utilizing cameras and periodic trapping could continue as bullfrog and crayfish populations are reduced in order to determine the long-term success of the translocation.

Successful recruitment is an indicator of population viability and is necessary for the long-term survival of this population. Once again, pond turtles were moving throughout natural riparian areas in the Otay River watershed, and this population is within conserved lands with active management for restoration. With continued management for bullfrog and crayfish removal and riparian restoration, this population could continue to thrive.

General Guidelines for Future Pond Turtle Monitoring and Management

General guidelines for pond turtle monitoring and management could include minimizing disturbance and take, mitigating the effects of roads, removal of nonnative aquatic species, monitoring the effects of drought, increased outreach and education, and continued monitoring for recruitment. These topics are not discussed here but have been included in Madden-Smith et al. 2005 and Brown et al. 2015.

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Site Access

The California Department of Fish and Wildlife, Fallbrook Public Utilities District, County of San Diego, U.S. Forest Service, and the cities of San Diego, Carlsbad, Oceanside, and San Marcos have provided and coordinated access to the reserves.

Historic Records and Location Information

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