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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 2017–March 2018. 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 2017–March 2018

Data Summary



Draft Final: Western Pond Turtle Response to Translocation and Nonnative Aquatic Species Removal, March 2017–March 2018

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U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Data Summary

Prepared for:

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

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Cover photographs: Pump Pond at Rancho Jamul ER (top left) and western pond turtle (bottom right) at Sycuan Peak 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 (Thomson et al. 2016). Having been extirpated from much of coastal southern California, this species is in decline throughout its range (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, 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). 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 was petitioned for listing by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act in 1992 and again in 2012 (Center for Biological Diversity 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 localized threats, such as from nonnative taxa. Specifically, our research seeks to understand the causes of decline of the pond turtle on conserved 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 head-starting (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 and 2016, 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 and removal of nonnative aquatic species (from 15 March 2017 to 15 March 2018). 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 has been a collaborative effort between USGS and our 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 six sites across four watersheds within MSPA management units (MU's) 3, 4, and 5 (Figures 1–2, Table 1). One site was located in the upper portions of the San Dieguito River within MU5, three sites were in the San Diego River watershed within MU4, one site was in the Sweetwater River watershed in MU3, and one site was in the Otay River watershed in MU3. Together, these watersheds combined total over 300,000 hectares of central San Diego County and include the coastal drainages for the northwestern Laguna, Cuyamaca, and San Ysidro mountain ranges (Figure 1, Table 1).

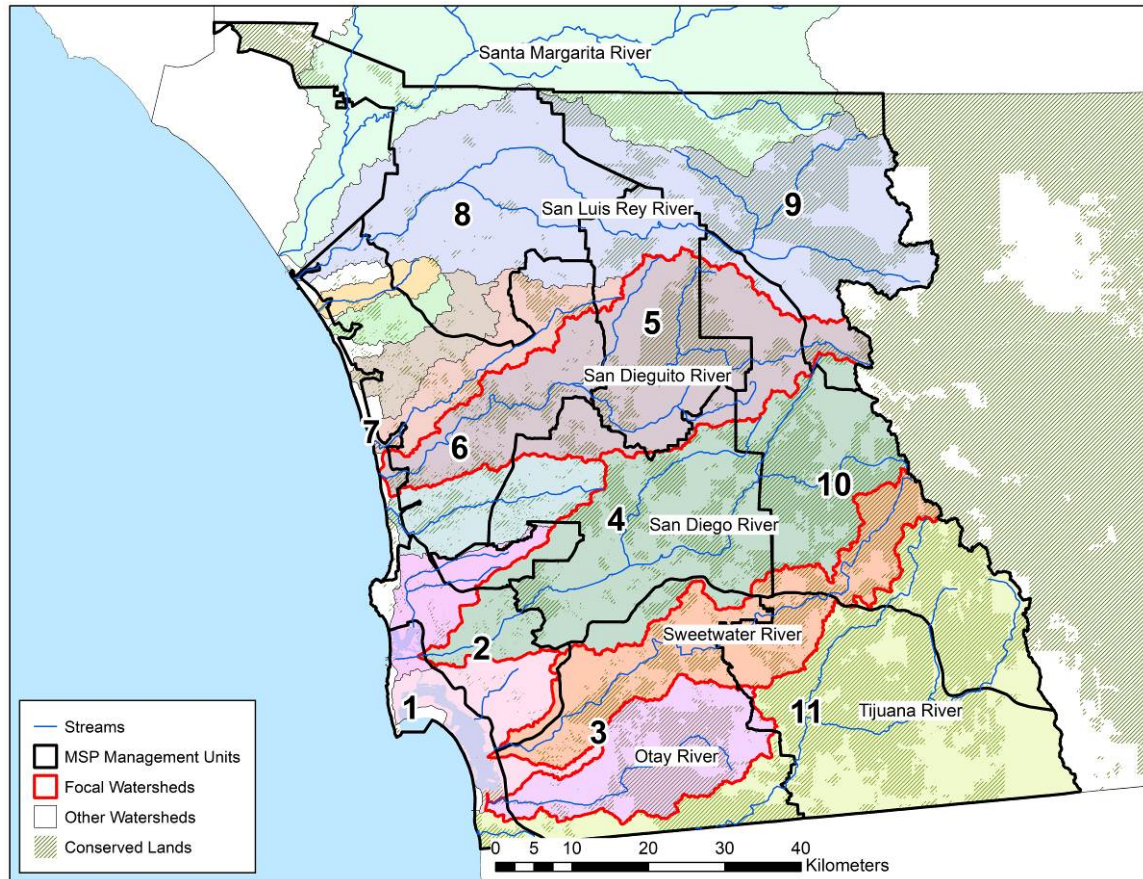


Figure 1. Study Area. The San Dieguito, San Diego, Sweetwater, and Otay River watersheds in reference to other major coastal watersheds in San Diego county and the MSPA management units. The numbers on the map are in reference to the MSPA management units.

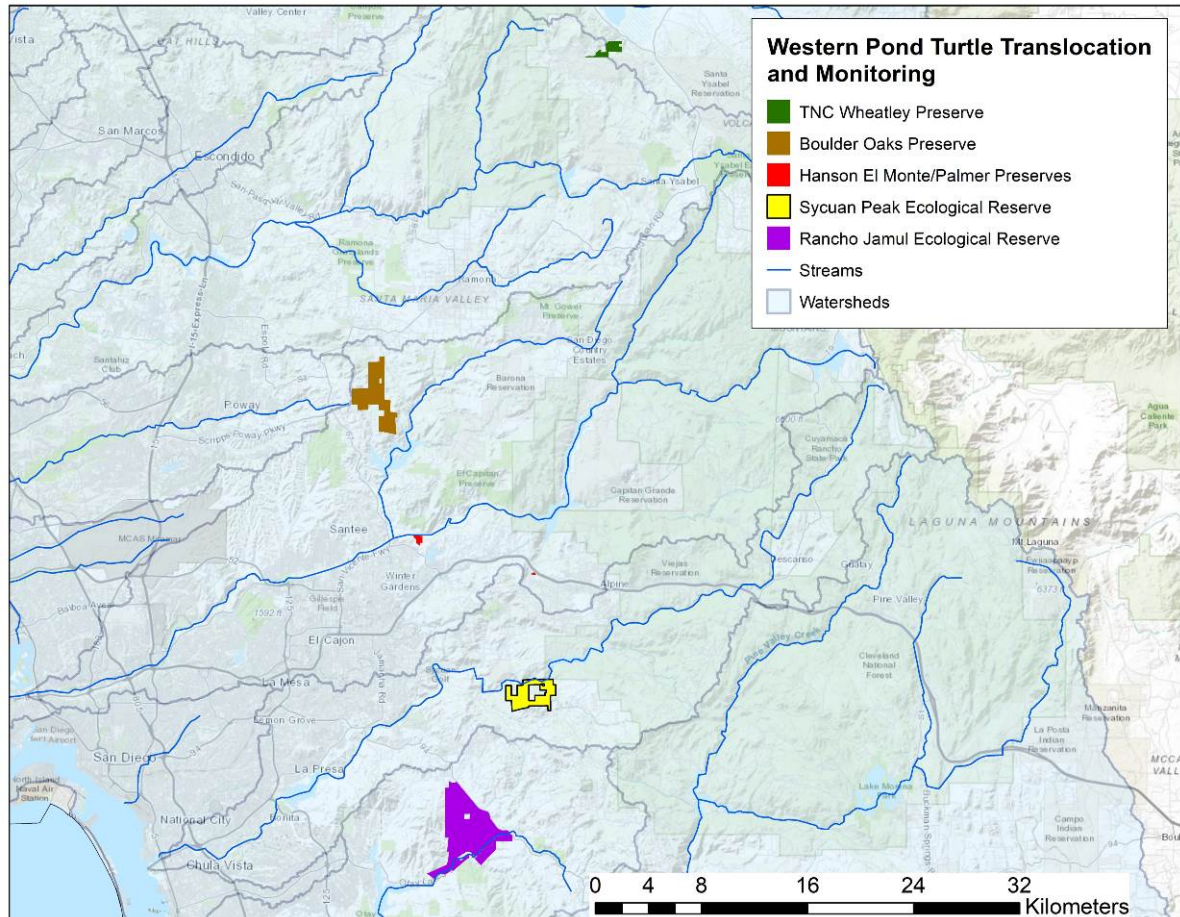


Figure 2. Preserve Locations. Map of the preserve locations where pond turtle management and restoration was conducted from north to south: TNC Wheatley Preserve, Boulder Oaks Preserve, Hanson El Monte Preserve, Sycuan Peak Ecological Reserve, and Rancho Jamul Ecological Reserve.

Table 1. Pond Turtle Restoration Research Study Sites. Sites surveyed from 15 March 2017 to 15 March 2018 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, MSPA MU, pond turtle presence during previous studies and experimental management and monitoring activities for March 2017–March 2018.

		Preserve (area ha)	Land Manager	Stream/Creek	MU	Pond Turtles Previously	Management/ Monitoring
Watershed	San Dieguito (90,000 ha)	TNC Wheatley Preserve (162 ha)	The Nature Conservancy	Scholder Creek	5	None	Bullfrog removal
	San Diego (112,000 ha)	Boulder Oaks Preserve (513 ha)	County of San Diego	San Vicente Creek	4	None	Bullfrog removal
		Hanson El Monte Preserve (64 ha)	Endangered Habitats Conservancy	San Diego River	4	None	Bullfrog removal
		Palmer Preserve (4.5 ha)	Endangered Habitats Conservancy	Alpine Creek	4	None	Crayfish Removal
	Sweetwater (60,000 ha)	Sycuan Peak Ecological Reserve (931 ha)	California Department of Fish and Wildlife	Sweetwater River	3	Adults and juveniles(Som e translocated in headstart program in 2013 and 2014)	Pond turtle monitoring Nonnative aquatic species removal
	Otay (40,000 ha)	Rancho Jamul Ecological Reserve (2,266 ha)	California Department of Fish and Wildlife	Jamul Creek	3	Adults (Translocated from Oak Valley in 2014 and 2015)	Pond turtle monitoring Nonnative aquatic species removal

TNC Wheatley Preserve

The TNC Wheatley Preserve (which contains the Scholder Creek Pond) is a 162 hectare preserve managed for conservation by TNC and the USFWS Partners Program. Scholder Creek Pond near the headwaters of Scholder Creek is a clay lined, permanent pond within the upper portion of the San Dieguito River watershed (Figures 3–4). Having permanent water with no nonnative fish or crayfish (*Procambarus* sp.; though bullfrogs were present), it was chosen for management and recovery for pond turtles based on suitability for restoration, priorities from previous studies, and the overlay of conserved lands (Brown et al. 2019a). In 2017, USGS became involved with the USFWS Partners Program to study removal of nonnative bullfrogs from the preserve to support native aquatic species and future translocation of pond turtles.

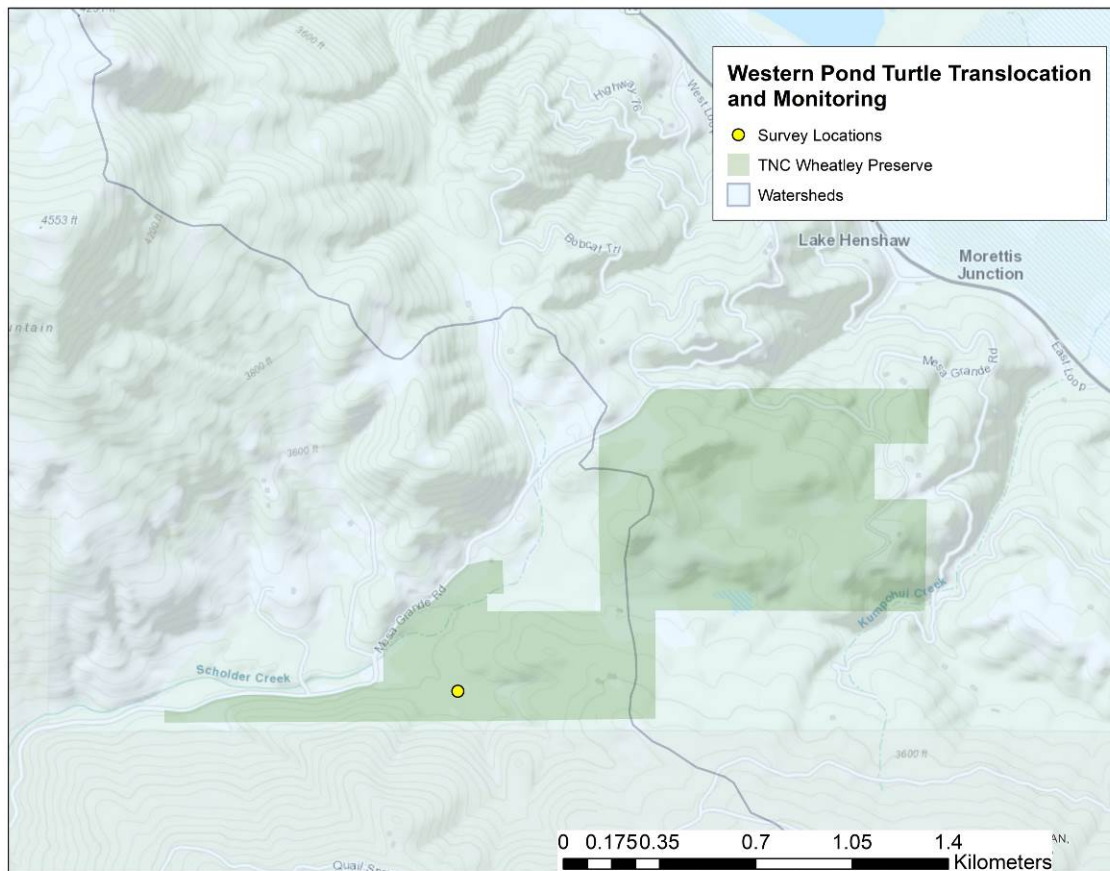


Figure 3. TNC Wheatley Preserve Survey Locations. The colored dot represents the location of the pond where surveys for nonnative aquatic species were conducted and removal of bullfrogs was implemented.

Scholder Creek Pond consist of a small natural ponding area at the confluence of the two tributaries to Scholder Creek which has been enhanced by the addition of an earthen dam and a clay liner (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 included the development of a limited grazing strategy to maintain native grasslands and fencing to keep cattle out of the riparian and restoration areas.



Figure 4. Scholder Creek Pond. Photos taken 22 May 2017 showing abundant habitat for pond turtle foraging and basking.

Boulder Oaks Preserve

Boulder Oaks Preserve is a 513 hectare preserve along West Branch San Vicente Creek in the San Diego River watershed and is currently owned and managed for conservation by the County of San Diego Department of Parks and Recreation (Figures 5–6; Brown et al. 2019a). This site was identified by USGS as a potential site for translocation after surveys were negative for pond turtles in 2007 and 2008 (Brown and Fisher 2008). The isolation from the main stem of San Vicente Creek and the controlled access made this location highly suitable for pond turtles (Brown et al. 2019a). In 2017 USGS continued to survey the ponds at Boulder Oaks Preserve for nonnative aquatic species to further assess the suitability of the site for future pond turtle translocation.

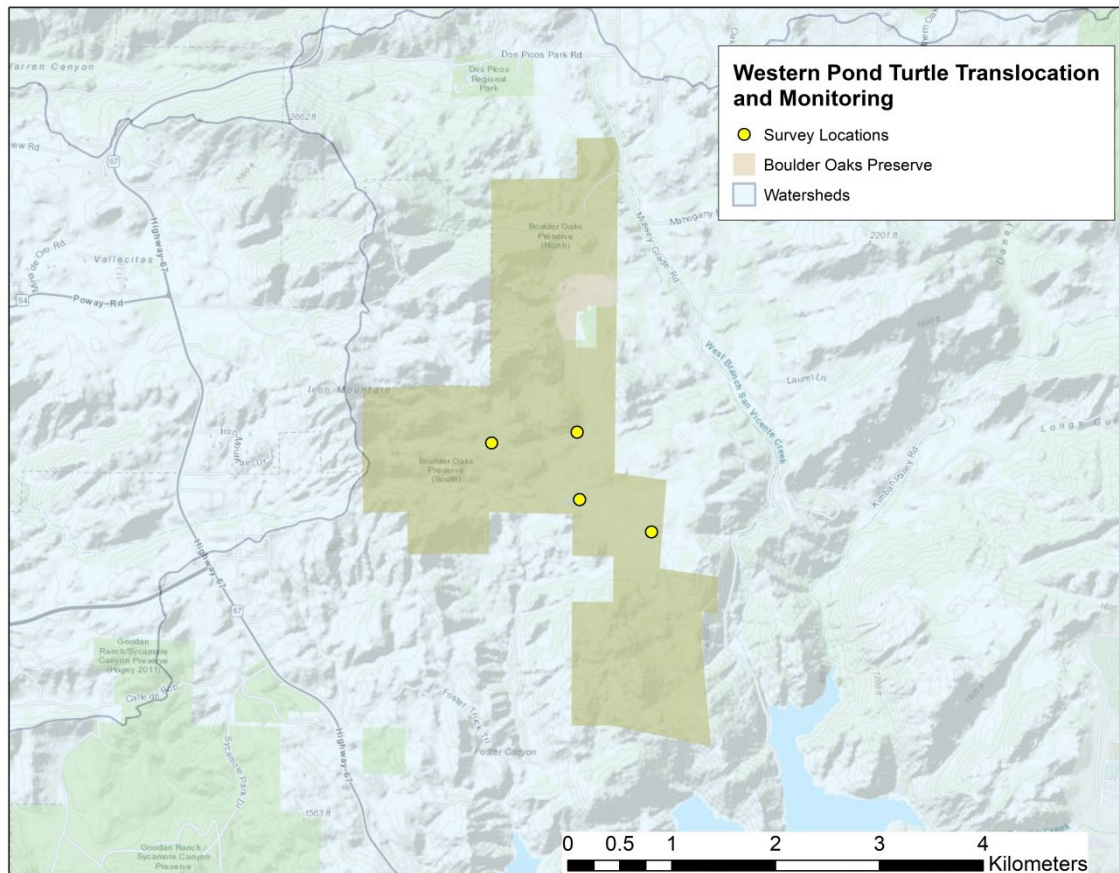


Figure 5. Boulder Oaks Preserve potential pond turtle receiver site. The colored dots represent the midpoint of the two large ponding areas at Boulder Oaks Preserve.

Boulder Oaks Preserve contains two large manmade semi-permanent ponds, one which could be filled from an on-site well (Figure 6). The Office Pond and West Branch San Vicente Creek Pond feature approximately 2.25 hectares of surface water (0.75 hectares and 1.5 hectares respectively). Uplands include mixed chaparral and sage scrub with open areas of native and nonnative grasses. The site had been fenced and gated at the roadway with no public access. This site was surveyed by USGS in 2007 and 2008 and found not to contain pond turtles but to have potential habitat with management for removal of nonnative bullfrogs (Brown and Fisher 2008).



Figure 6. Boulder Oaks Preserve potential pond turtle habitat. Conditions of the Office Pond (top) and the West Branch San Vicente Creek Pond (bottom) on 02 October 2017.

Hanson El Monte/Palmer Preserves

The Hanson El Monte Preserve consists of 64 hectares and the Palmer preserve consists of 4.5 hectares. Both preserves are currently owned and managed for conservation by the EHC and are in the San Diego watershed (Figures 7–8). Both were recently purchased for conservation and are being managed for native riparian and aquatic species (Brown et al. 2019a). 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. 2019b). From March 2017–March 2018, USGS continued to survey Hanson El Monte pond for bullfrog removal and Palmer Preserve for crayfish removal with staff from EHC.

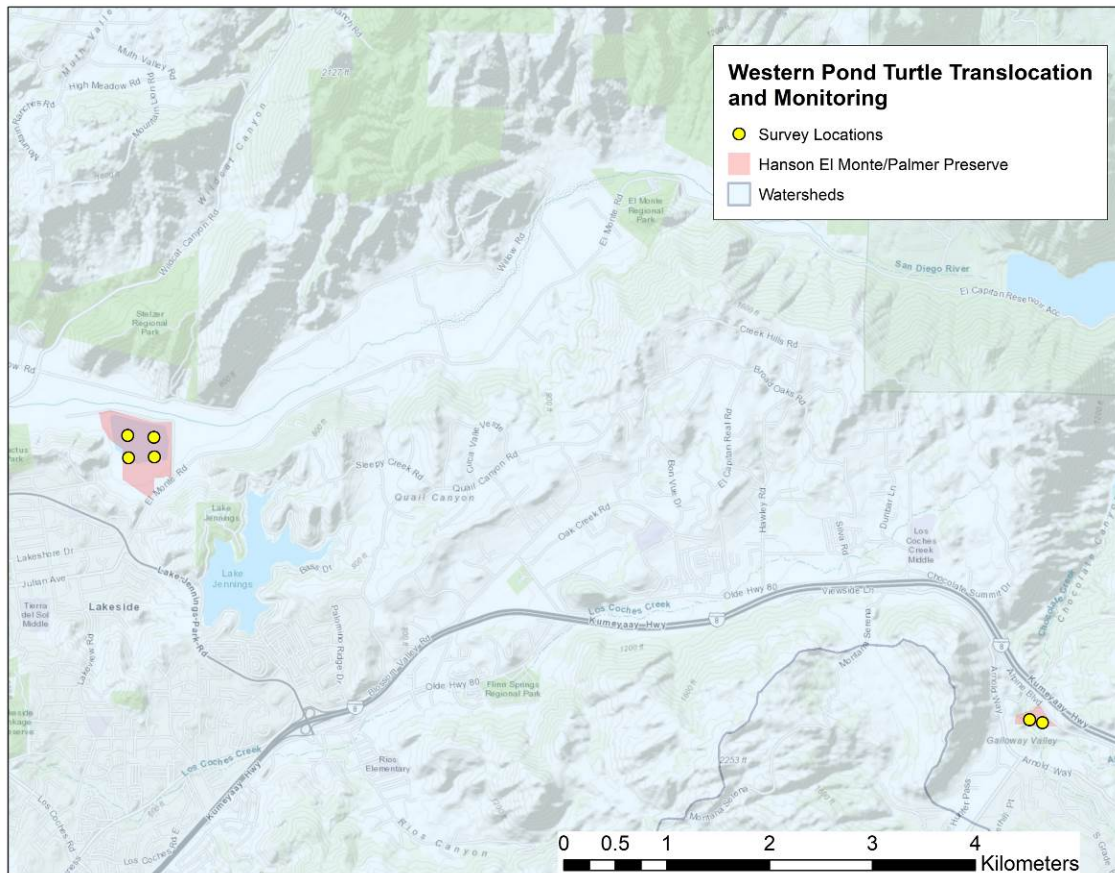


Figure 7. Hanson El Monte Preserve Survey Locations. The colored dots mark the corners of the large ponding area at Hanson El Monte Pond.

The Hanson El Monte Pond adjacent to the San Diego River in El Monte Valley was a former quarry. The site consists of approximately 50 hectares of conserved habitat with permanent water (Figure 8). This site was surveyed by USGS in 2015 and found not to contain pond turtles but to have potential habitat if managed for removal of nonnative aquatic species (Brown and Fisher 2019a). The Palmer Preserve was a former residence along Alpine Creek with an off-channel pool. The preserve contains approximately 250 meters of Alpine Creek, a 0.1 hectare pool, and coastal sage upland (Figure 8).



Figure 8. Hanson El Monte and Palmer Preserves potential pond turtle habitat. Photos of the Hanson El Monte Pond on 27 April 2017 (top) and Palmer Preserve on 28 April 2017 showing abundant aquatic habitat and structure for foraging and basking.

Sycuan Peak Ecological Reserve

Sycuan Peak Ecological Reserve (SPER) is a 931 hectare preserve along the Sweetwater River approximately one kilometer below Loveland Reservoir and approximately four kilometers southeast of Dehesa, San Diego, CA (Figures 9–10). This site, which is owned and managed for conservation by CDFW, was 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 9) that continue to contain abundant surface water during the late summer and fall when adjacent stream reaches are dry.

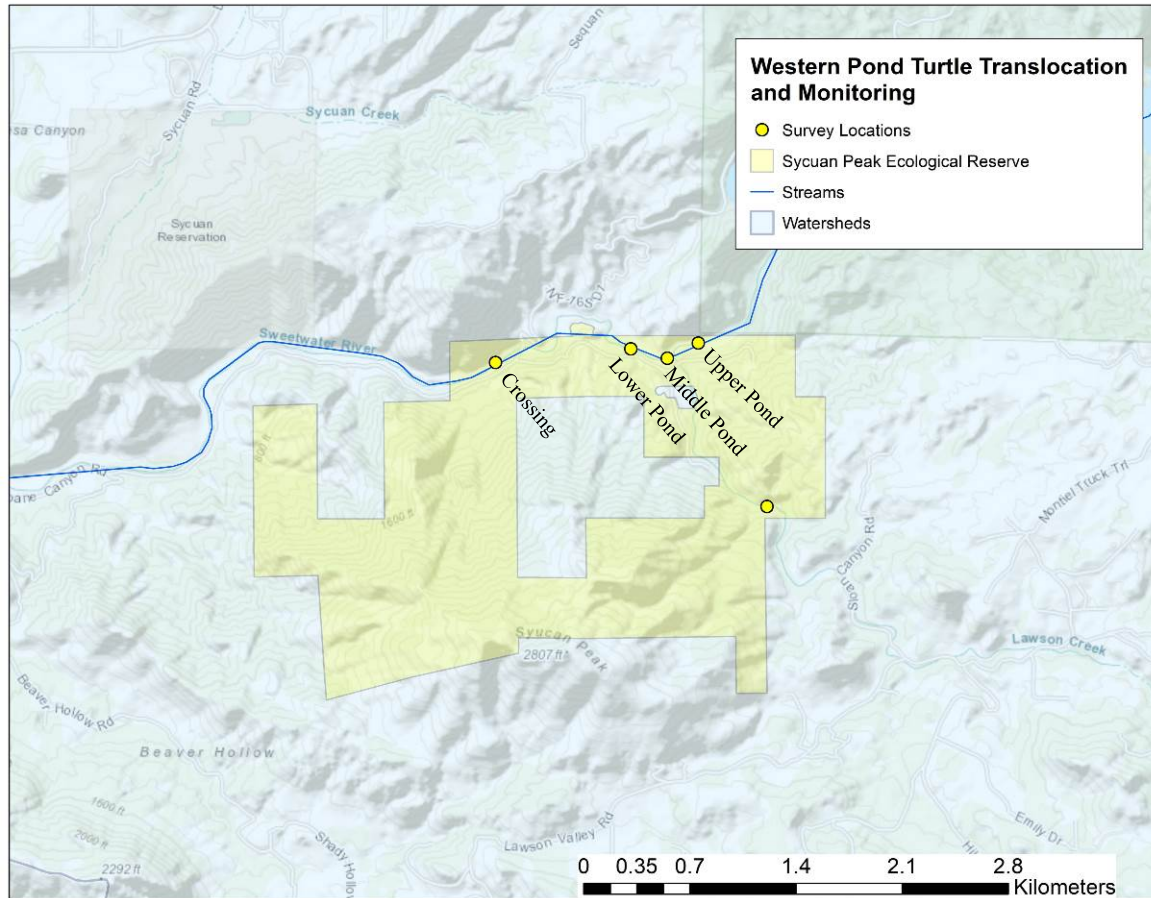


Figure 9. Sycuan Peak ER Survey Locations. Ponding areas along Sweetwater River below Loveland Reservoir surveyed for pond turtle monitoring and nonnative aquatic species removal.

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*). During this study, the canopy along the stream channel was open where there are larger bedrock or sandy pools. Only middle pond and lower pond contained surface water through 2017 (Figure 10). This site has been managed for pond turtles by CDFW since 2000 to present (2020). From 2009 to 2014, USGS collaborated on a pond turtle head-starting 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).



Figure 10. Photographs of Survey Points within Sycuan Peak ER. Photos of pond turtle habitat at middle pond 06 April 2017 (top), lower pond on 17 March 2017 (middle), and lower pond on 06 April 2017 (bottom).

Rancho Jamul Ecological Reserve

Rancho Jamul Ecological Reserve (RJER) is a 2,266 hectare preserve along Jamul and Dulzura creeks in the Otay watershed (Figures 10–11). The preserve contains a diverse range of habitats from grassland to coastal sage to willow-sycamore dominated riparian. 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 11).

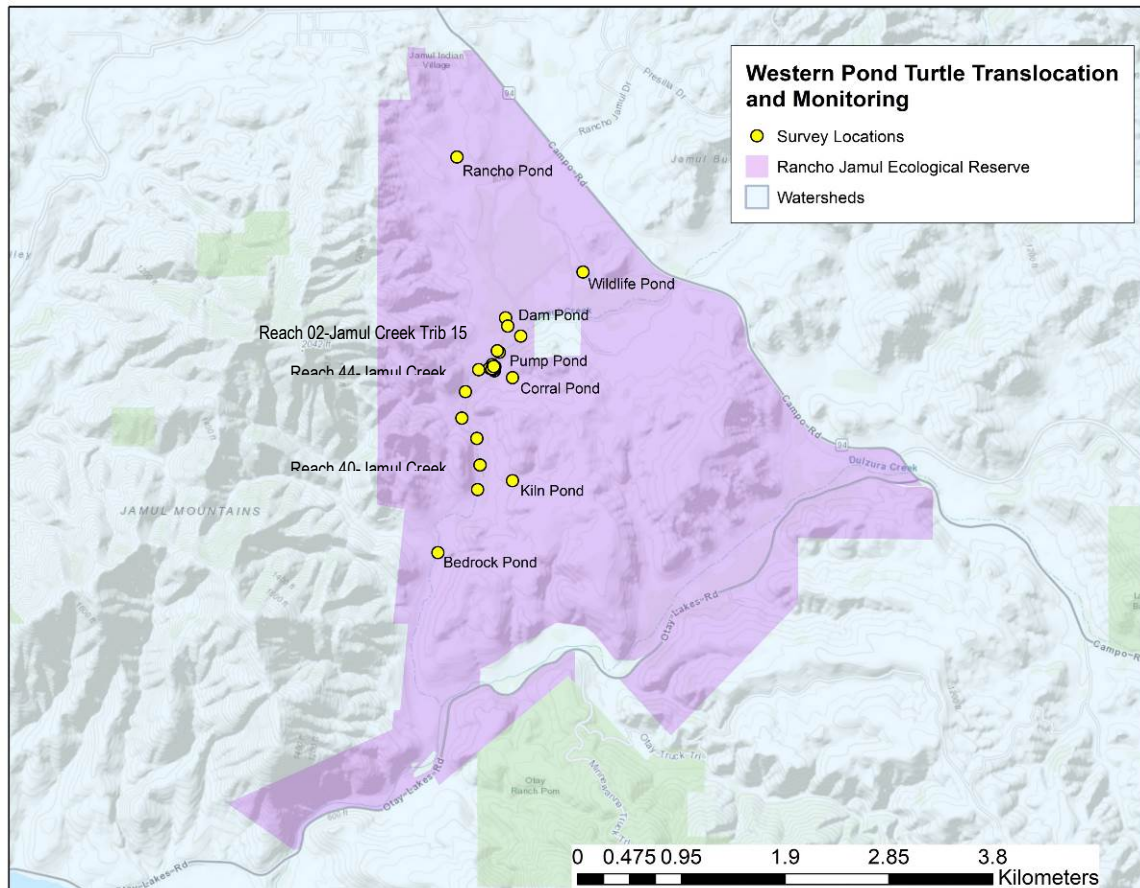


Figure 11. Rancho Jamul ER Survey Locations. Ponding areas along Jamul Creek and within RJER that were surveyed for suitability for pond turtles and removal of nonnative aquatic species.

RJER contained 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; CDFW 2008). USGS has been investigating removal of nonnative aquatic species in this area since 2001, to benefit the native riparian obligate reptiles and amphibians (Hathaway et al. 2002; Brown et al. 2015).



Figure 12. Photos of ponding sites at RJER. 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 28 September 2017 (top left) Wildlife Pond on 25 April 2017 (top right), Kiln Pond on 03 May 2017 (middle), Jamul Creek on 03 May 2017 (bottom left), and Corral Pond on 21 March 2017 (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 surveys for bullfrog removal, radio telemetry, and trapping (Table 2). Daytime visual encounter surveys were used to determine species presence and activity as well as to remove bullfrogs if they were observed. Nighttime surveys were focused on detecting and removing bullfrogs (timed to optimal bullfrog activity and quietly searching at a distance for eyeshine). Though timing and procedures were optimized for detecting bullfrogs, other nonnative aquatic species, including crayfish and nonnative fishes, were removed when captured. Radio telemetry was used to determine movement and activity of translocated pond turtles. Trapping was used to capture turtles to monitor pond turtles and to assess health and change transmitters on pond turtles which had previously been translocated in 2014 and 2015 as well as to capture nonnative species for removal. In addition, time lapse and motion sensor cameras were used at SPER to identify potential threats or disturbances and to document pond turtle presence supplemental to trapping surveys.

Table 2. Surveys conducted by type at each site, 15 March 2017–15 March 2018. Surveys listed by type, count, and location.

Site	Day Visual	Night Visual	Radio Telemetry	Trapping
TNC Wheatley Preserve	3	15		1
Boulder Oaks Preserve	2			
Hanson El Monte Preserve		3		
Palmer Preserve	1			
Sycuan Peak Ecological Reserve	10	6		1
Rancho Jamul Ecological Reserve	23	17	10	3

Daytime Visual Encounter Surveys

Daytime visual encounter surveys were conducted to assess riparian and aquatic habitat and determine presence of active aquatic species. These surveys were conducted independently at TNC Wheatley Preserve, Boulder Oaks Preserve, Palmer Preserve, SPER, and RJER to assess trapping or nighttime survey needs or to record changes in habitat from prior surveys. Daytime surveys were also conducted at RJER prior to radio tracking to determine activity or presence of any pond turtles without transmitters and during trapping surveys to determine presence of species not captured in the traps. Daytime surveys follow the USGS protocols for aquatic species (USGS 2006a) and were conducted by walking the creek and pond perimeter, and recording any native or nonnative amphibians or reptiles encountered. 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.

Nighttime Visual Encounter Surveys (for Bullfrog Removal)

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 2017 to 15 March 2018 and followed the USGS protocols for nighttime aquatic species searches (USGS 2006d). Two biologists walked the perimeter of the ponds and streams with headlamps and binoculars to detect eyeshine from bullfrogs (light reflected from the back of the eyes). Methods of adult bullfrog removal included hand capture, nets, polespears (slings), and .22 caliber rimfire rifles using lead free frangibleammunition. Dip nets and seine nets were also used to collect larval and metamorphosing bullfrogs. Captured bullfrogs were taken to USGS where their stomachs were removed to examine content; bodies were sent to the Aquatic Parasite Observatory at the University of Colorado for examination. While these methods were optimized for the take of bullfrogs, other nonnative aquatic species that could be captured were also collected (crayfish, African clawed frogs, nonnative fishes).

Radio Telemetry

Telemetry was used at RJER to determine site preferences, habitat preferences, and site fidelity of the pond turtles translocated during 2014 and 2015. Data on habitat use (whether they were in the water, on the shore, under the cattail mat, or in the upland) were recorded when possible. Pond turtles were tracked monthly during Spring, Summer, and Fall for a total of 10 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 Monitoring and Transmitter Attachment

Trapping surveys were used to capture pond turtles and nonnative aquatic species. Trapping pond turtles was used for mark recapture monitoring and assessing health of individuals at SPER and RJER as well as to replace transmitters at RJER. Trapping surveys were used at Scholder Creek Wheatley Preserve to determine presence or absence of pond turtles. Trapping surveys were also useful at 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 southcoast 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.

During this project, SPER was surveyed for pond turtles using baited traps for five days (four trap nights) starting on 30 May 2017. During this time, the amount of available habitat to be trapped was reduced due to prolonged drought conditions and low groundwater levels. Only two locations contained enough water to place traps, 26 traps being placed in the middle and lower ponds (Figures 9–10).

Time Lapse and Motion Triggered Cameras

We utilized time lapse and motion sensor cameras at SPER to identify potential threats or disturbances 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

The surveys conducted between 15 March 2017 and 15 March 2018 resulted in 1,144 observations of six native species and 24,434 captures of nine nonnative species (Table 3). The most numerous species were both nonnative: mosquitofish (*Gambusia affinis*, 15,275) and bullfrogs (7,709). Six native aquatic species were observed during the surveys, the most abundant being the Baja California treefrog (*Pseudacris hypochondriaca*) which were detected at all sites.

Table 3. Species observations by preserve. A total of 25,580 aquatic species observations were made during the surveys conducted between 15 March 2017 and 15 March 2018. Numbers of nonnative species observations represent individuals collected except where the species was detected during a survey, but not collected, indicated by a “D”

	Aquatic Species Observations															
	Native							Nonnative								
	Western Pond Turtle Adults	Western Pond Turtle Juveniles	Two-striped Gartersnake	Western Toad	Western Spadefoot	California Treefrog	Baja California Treefrog	Red-eared Slider	Bullfrog	African Clawed Frog	Green Sunfish	Largemouth Bass	Bullhead Catfish	Mosquitofish	Common Carp	Crayfish
TNC Wheatley Preserve			4	13			732	1	2,834							
Boulder Oaks Preserve			1				2		60							D
Hanson El Monte Preserve							2		25		1	2		2	1	
Palmer Preserve							2									D
Sycuan Peak Ecological Reserve	8	2				4	7		1	1	87					4
Rancho Jamul Ecological Reserve	13		9	173	9		163	1	4,787	888	303		57	15,273		104
Total:	21	2	14	186	9	4	908	2	7,707	889	391	2	57	15,275	1	110

TNC Wheatley Preserve

TNC Wheatley Preserve Visual Encounter Surveys

A total of three daytime and 15 nighttime visual encounter surveys were conducted at the TNC Wheatley Preserve. During these surveys, 2,834 bullfrogs were collected 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 (*Anaxyrus boreas*), and Pacific treefrog (Table 3). No fish or crayfish were detected during these surveys.

TNC Wheatley Preserve Trapping Surveys

One five-day trapping survey was conducted at this site to assess presence of native or nonnative turtles. During the survey, no pond turtles were detected and one red eared slider was captured and removed.

Boulder Oaks Preserve

Boulder Oaks Preserve Visual Encounter Surveys

A total of two daytime visual encounter surveys were conducted at the Boulder Oaks Preserve. During these surveys, 60 bullfrogs and one crayfish were collected from the West Branch San Vicente Creek Pond and the adjacent wetland. Two native aquatic

species were also detected during these surveys including the two-striped gartersnake and Pacific treefrog (Table 3). No fish were detected during these surveys.

Hanson El Monte/Palmer Preserves

Hanson El Monte and Palmer Preserves Visual Encounter Surveys

Three nighttime visual encounter surveys using only polespears and nets were conducted at Hanson El Monte Pond. During these surveys, 25 bullfrogs, two largemouth bass, one common carp (*Cyprinus carpio*), one green sunfish and two mosquitofish were collected from the Hanson El Monte Pond.

One daytime visual encounter survey was conducted at the Palmer Preserve to assess habitat and the potential need for future trapping for removal of nonnative aquatic species. Crayfish were detected at the Palmer Preserve. The Pacific treefrog was detected at both the Palmer Preserve and Hanson El Monte Pond and was the only native aquatic species found during these surveys (Table 3).

Sycuan Park Ecological Reserve

SPER Day and Night Visual Encounter Surveys for Nonnative Species Removal

Six nighttime and 10 daytime visual encounter surveys were conducted to detect and remove nonnative aquatic species. During these surveys, one African clawed frog, four crayfish and 87 green sunfish were removed. In addition to scheduled visual encounter surveys, we conducted one visual encounter survey on 30 May 2017 at middle pond to remove a bullfrog detected by the camera surveys.

SPER Trapping Surveys

Trapping surveys for this location were used solely for the purpose of monitoring pond turtles in-situ that had been previously translocated from the headstart program in 2014/2015 or were were naturally recruiting post invasive species removal (Brown et al. 2019b). Because this location had no pond turtles prior to translocation, all pond turtles captured are the result of the translocation effort. Nine separate pond turtles were captured; seven were adults previously captured and marked, including three headstarted turtles, and two were new juveniles which were not previously captured and marked. One adult pond turtle was captured twice resulting in eight adult captures and two juvenile captures. One of the juvenile pond turtles was a recapture from the previous year and the other had not previously been trapped or marked (Table 6).

SPER Time Lapse and Motion Triggered Cameras

The motion and time lapse cameras recorded observations of pond turtle activity including swimming, basking, and interaction of multiple turtles (Figure 13). We used the photos as an indication of activity at the site to improve detectability during trapping surveys by setting traps during peak activity. We also used the time lapse cameras to detect bullfrogs (Figure 14). One bullfrog was first recorded by the cameras on 17 May 2017 and was detected by viewing the time lapse photos collected on 19 May 2017. A follow-up nighttime visual encounter survey was conducted on 30 May 2017, and the bullfrog was removed.



Figure 13. Camera station photos of pond turtle at SPER. Time lapse photography was used to identify preferred or new pond turtle basking locations (middle pond, 17 September 2017)



Figure 14. Camera station photos of immigrating bullfrog at SPER. Time lapse photography was used to identify nonnative aquatic predators, including bullfrogs, moving into the study site (lower pond, 17 May 2017, top; middle pond, 18 May 2017, bottom).

Rancho Jamul Ecological Reserve

RJER Daytime Visual Encounter Surveys

Visual encounter surveys were conducted prior to or after telemetry and nonnative aquatic species removal surveys during the same site visits to detect juvenile pond turtles and other native species associated with the pond turtle habitat. No new juvenile pond

turtles were detected during these surveys, but 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 seven species of snakes and three lizard species using visual surveys (Table 4).

Table 4. RJER visual encounter other species observations. These are the numbers of other reptiles and amphibians observed at RJER's pump pond during telemetry surveys. The numbers are 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>)	1	1
Southern Pacific rattlesnake (<i>Crotalus helleri</i>)	2	2
Coachwhip (<i>Coluber flagellum</i>)	1	1
Gophersnake (<i>Pituophis catenifer</i>)	1	1
Black-headed snake (<i>Tantilla planiceps</i>)	2	1
Two-striped gartersnake (<i>Thamnophis hammondi</i>)	5	6
Night snake (<i>Hypsiglena ochrorhyncha</i>)	1	1
Western Toad (<i>Anaxyrus boreas</i>)	1	1
Western whiptail (<i>Aspidoscelis tigris</i>)	1	1
Alligator lizard (<i>Elgaria multicarinata</i>)	1	1
Horned lizard (<i>Phrynosoma blainvillii</i>)	1	1

RJER Nighttime Visual Encounter Surveys

Our nonnative removal efforts were focused on removing bullfrogs from the Pump, Corral, Kiln, and Bedrock ponds and the adjacent Jamul Creek (Table 5, Figure 11). During 17 nighttime survey events, a total of 4,787 bullfrogs were removed from the site. Adult and juvenile bullfrogs were taken by the use of .22 caliber rimfire rifles and polespears with dip nets and seines being used for bullfrog larvae and metamorphs. Native amphibians, including Baja California treefrogs and western spadefoots, were also detected frequently during the nighttime surveys (Table 5).

An explosive bullfrog breeding event was observed during April and May of 2017 at two ponds (Kiln and Corral). These ponds were pumped dry in 2002 to 2003 to remove nonnative aquatic species. They filled periodically, but then dried during the prolonged drought of 2014 to 2016. These ponds then filled with the early winter rains, beginning to hold surface water in late December 2016 and early January 2017. Adult treefrogs were detected in January of 2017 with adult bullfrogs following in March of 2017 (Table 4). Efforts were made to remove as many bullfrogs as possible during the breeding event; however, eggs were laid that went undetected. Large numbers of larvae in these ephemeral ponds metamorphosed in July and August and were collected during our surveys. This timing was much different than what we previously observed at permanent sites (pump pond and Jamul Creek) where small numbers of bullfrog larvae metamorphosed from March through October with a peak of 27 metamorphs in October. Captures at Kiln and Corral ponds accounted for 75% of all bullfrogs at RJER and over

98% of the recently metamorphosed and juvenile bullfrogs captured during July and August of 2017.

Table 5. Bullfrog activity at RJER. Bullfrog captures and activity relative to other local anurans (Pacific treefrog and western spadefoot (*Spea hammondi*)) activity by month.

	Baja California Treefrog			Western Spadefoot			Bullfrog			
	Adult	Larvae	Juvenile	Adult	Larvae	Juvenile	Adult	Larvae	Metamorph	Juvenile
January	4									
March	6			2			22		40	80
April	2	3	7		2	2	20	20	7	37
May		59	7		1	1	49	10	2	67
June	1		34			1	57	101	18	121
July	1						19		200	50
August			17				12	70	1602	1434
September	2		1				6			4
October	1		3				5		118	595
November	1									
December	1									

RJER Telemetry and Monitoring

Pond turtles were tracked on 31 occasions (Table 6). Based on telemetry, Pump Pond, Corral Pond, and Reaches 43 and 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, 160 telemetry observations were made at off channel ponds (Pump and Corral) and 55 observations along Jamul Creek and its tributary (Figure 7 and Table 6). One of the turtles moved downstream nearly 500 meters and overwintered under a coast live oak.

RJER Trapping Surveys

Three trapping surveys were conducted at RJER to detect pond turtle recruitment, to replace radio transmitters, and to assess health. Traps were set for five days (four nights) beginning on 11 May 2017, 05 June 2017, and 25 September 2017. During these surveys, 11 translocated turtles were recaptured and transmitters were replaced. All turtles appeared to be in good health showing no new injuries, lesions, or symptoms of disease. No new or juvenile turtles were detected.

Table 6. 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.

	Pump Pond-RJER	Reach 43-Jamul Creek	Corral Pond-RJER	Reach 44-Jamul Creek	Reach 01-Jamul Creek Trib15	Reach 42-Jamul Creek	Reach 40-Jamul Creek	Reach 02-Jamul Creek Trib15	Dam Pond	Off-channel Ponds Total	Jamul Creek and Tributary Total
03/17/17	8			1						8	1
03/24/17	3	2		1	2		1			3	6
04/06/17	4	2			1		1			4	4
04/11/17	1	3	1				2			2	5
04/21/17	4	1	1	2						5	3
04/26/17	5	1	1	1						6	2
05/05/17	6	1						1		6	2
05/11/17	9	1								9	1
05/12/17	1									1	
05/19/17	5	1	1							6	1
05/26/17	5	1	1							6	1
06/06/17	3									3	
06/07/17	1									1	
06/08/17	1									1	
06/09/17	1									1	
06/16/17	5	1	1							6	1
06/22/17	5	1	1							6	1
06/29/17	5	1	1							6	1
07/06/17	5	1	1							6	1
08/04/17	7	1	1							8	1
08/18/17	7	1						1		7	2
09/15/17	3	1		3						3	4
09/29/17	1					1				1	1
10/13/17	7					2			2	7	4
10/27/17	5					2				5	2
12/11/17	7	1		1	3					7	5
12/22/17	7	1		1	1					7	3
01/05/18	9									9	
01/19/18	4									4	
02/02/18	8				1	2				8	3
03/02/18	8									8	
Total:	150	22	10	10	8	7	4	2	2	160	55

Discussion

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

TNC Wheatley Preserve

The TNC Wheatley Preserve has no existing fish or crayfish populations. Management using traps, visual encounter surveys, and camera stations has the potential to eradicate red eared sliders and bullfrogs from the upper portion of Scholder Creek.

Boulder Oaks Preserve and Hanson El Monte/Palmer Preserves

Because access here is less controlled, there is potential for nonnative species reinvasions. The bullfrogs could be managed at these sites, but control may require more follow-up surveys and monitoring than sites with fully restricted access higher in the watersheds. Nonnative fishes provide recreational opportunities for some visitors, and continued management at these sites could address this.

Sycuan Peak Ecological Reserve

With gated and restricted access and removal of nonnative aquatic predators, Sycuan Peak Ecological Reserve is an example of how pond turtle recovery can proceed. Pond turtle recruitment continues while bullfrog and bass populations continue to be excluded.

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 again detected these three nonnative aquatic species in very low numbers which could be managed for with periodic surveys. Populations are still greatly reduced and could be kept low with careful timing of aquatic species surveys and water release events, as nonnative numbers have been lowest immediately after water releases.

Rancho Jamul Ecological Reserve

The translocated pond turtles at RJER appear to be active and persisting in the riparian habitat. Basking is frequently observed on many features in the pond, including fallen logs, cattail mats, and the shoreline. The pond turtles appear 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 appear healthy and show no signs of disease.

The greatest immediate concern is the bullfrog population and its potential to limit turtle recruitment. Bullfrogs have continued to move into the Pump Pond from nearby areas. Successful pond turtle recruitment within this population may depend upon removal of bullfrogs and upon reducing or stopping bullfrog recruitment.

Surveys at all ponds on the property in early spring could identify bullfrogs and lead to their removal before they can reproduce. In 2017, Bullfrogs were able to colonize and

breed in the previously dry Kiln Pond in March. This breeding event produced over 3,000 metamorphosing bullfrogs by August of 2017.

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 even though the translocated adults have site fidelity and are making use of available habitat at and around the permanent water sources. Bullfrog and crayfish populations are still very large and potentially have an impact on pond turtle recruitment. As bullfrog and crayfish populations are reduced, pond turtle monitoring utilizing cameras and periodic trapping could help 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 are 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

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Unpublished Data

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