United States Department of the Interior
U.S. GEOLOGICAL SURVEY
Western Ecological Research Center
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5/15/2020

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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: Follow-up to Rancho Jamul and Sycuan Peak Western Pond Turtle Translocation June 2015-March 2017. 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: Follow-up to Rancho Jamul and Sycuan Peak Western Pond Turtle Translocation June 2015–March 2017

Data Summary

Draft Final: Follow-up to Rancho Jamul and Sycuan Peak Western Pond Turtle Translocation June 2015–March 2017

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U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Data Summary

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Cover photographs: Western pond turtle (*Emys marmorata*) at Ramona Grasslands Preserve and western pond turtle being measured 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. This species 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 (Holland 1994; 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 bass (*Micropterus salmoides*) (Brattstrom and Messer 1988; Stephenson and Calcarone 1999). Because of recent declines, the pond turtle was listed 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 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 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 since 2009 (Brown et al. 2015). 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; Brown et al. 2012). 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 (Brown et al. 2015).

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. 2015). Here we report on the continued monitoring of translocated pond turtles and removal of nonnative aquatic species is aggressively pursued. Specifically, USGS conducts bullfrog eradication surveys and monitors pond turtles at two pond turtle translocation sites (SPER and RJER) to study the response of the pond turtle and other native aquatic species to the recovery effort. The two main areas that were the focus of this study were the RJER in the Otay River watershed and SPER along the Sweetwater River. This study focused on monitoring headstarted turtles in SPER, translocated pond turtles in SPER, and the success of nonnative aquatic species removal at both sites. 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), and U.S. Forest Service (USFS). This report covers the USGS work for this pond turtle project from 01 June 2015 to 15 March 2017 and is part of a larger study to examine effectiveness of methods used for pond turtle recovery and conservation in the south coast ecoregion.

Study Area

The study area included two CDFW reserves in separate watersheds in the MSPA Management Unit 3 (Figures 1 and 2; Table 1). SPER is located in the Sweetwater River watershed and RJER is located in the Otay River watershed. Together, these watersheds combine to total approximately 100,000 hectares of southern San Diego County and provide the coastal drainages for the southern Cuyamaca and San Ysidro mountain ranges (Figure 1; Table 1).

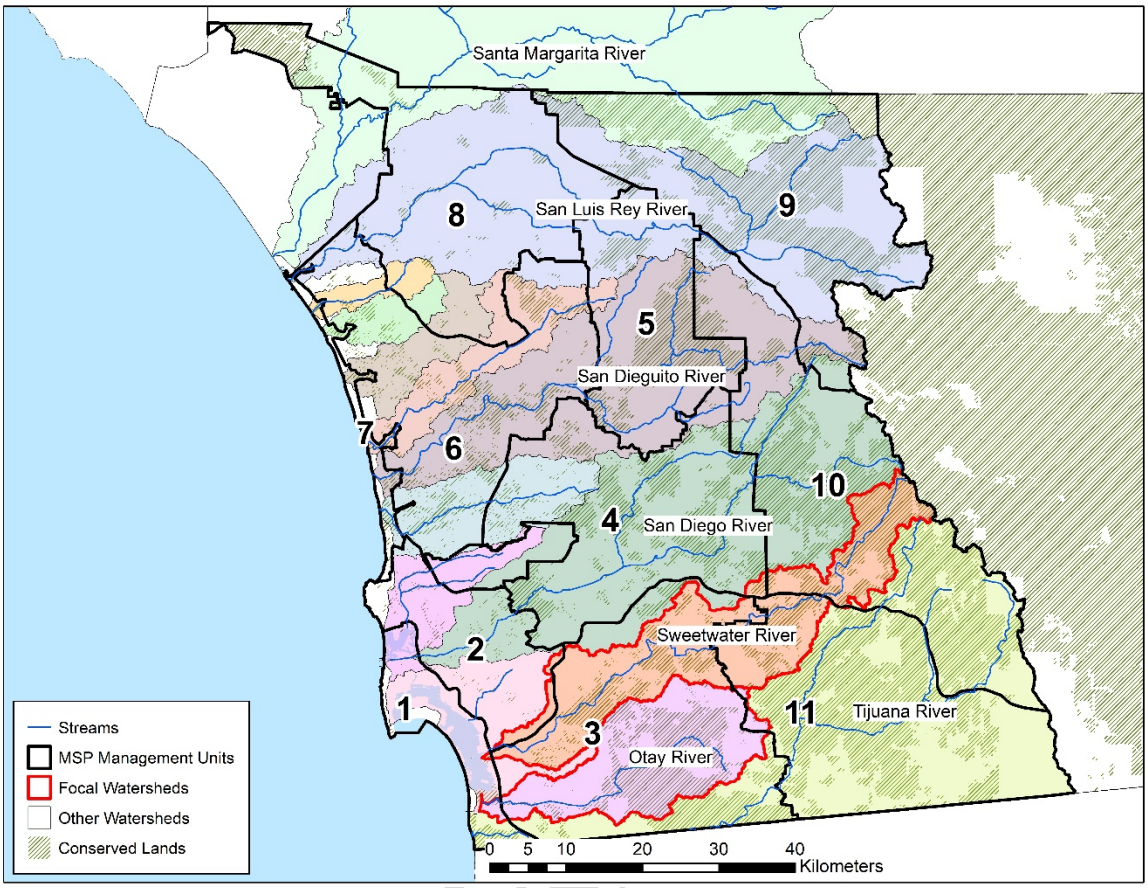

Figure 1. Study Area. The Sweetwater River and Otay River watersheds in reference to other coastal watersheds in the county and the MSPA management units. The numbers on the map are in reference to the MSPA management units.

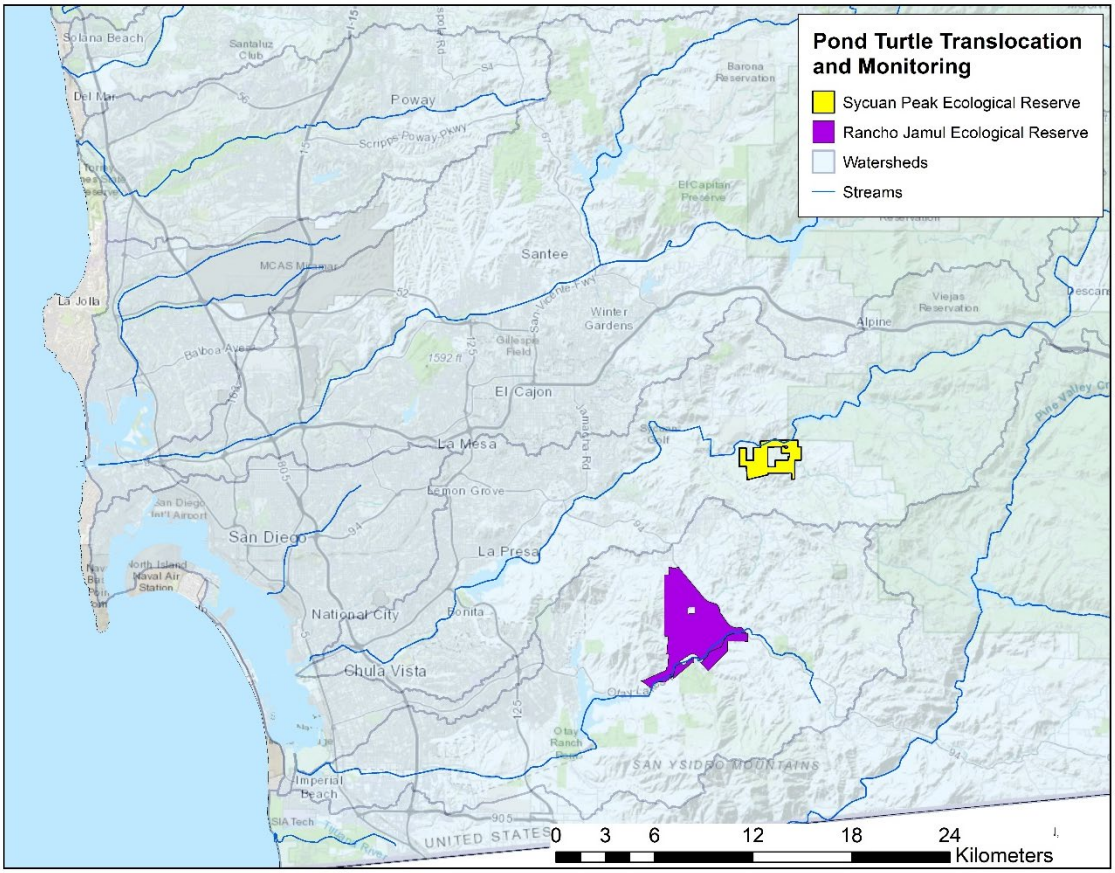

Figure 2. Preserve Locations. Map of the preserve locations where pond turtle translocation and monitoring research is being conducted: Sycuan Peak Ecological Reserve and Rancho Jamul Ecological Reserve.

Table 1. Pond Turtle Restoration Research Study Sites. Sites surveyed from 15 March 2015 to 15 March 2017 by watershed. This 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 management and monitoring activities for 2017.

		Preserve (area ha)	Land Manager	Stream / Creek	MU	Pond Turtle Presence	Management and Monitoring Activity
Watershed	**Sweetwater (60,000 ha)**	Sycuan Peak Ecological Reserve (931 ha)	California Department of Fish and Wildlife	Sweetwater River	3	Adults and juveniles after 2010	Monitoring natural and headstarted turtles and nonnative aquatic species removal
	Otay (40,000 ha)	Rancho Jamul Ecological Reserve (2,266 ha)	California Department of Fish and Wildlife	Jamul Creek	3	Translocated adults only	Monitoring translocated turtles and nonnative aquatic species removal

Sycuan Peak Ecological Reserve

Sycuan Peak Ecological Reserve is a 931 hectare CDFW preserve located along the Sweetwater River approximately one kilometer below Loveland Dam and approximately four kilometers southeast of Dehesa, San Diego, CA (Figure 2). Specific trapping locations for this area were in Sweetwater River, downstream of Loveland Reservoir (Figure 3). The upland habitat consisted of mixed sage scrub with some chaparral, and the riparian was 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*). The canopy along the stream channel was open where there were larger bedrock or sandy pools (Figure 4).

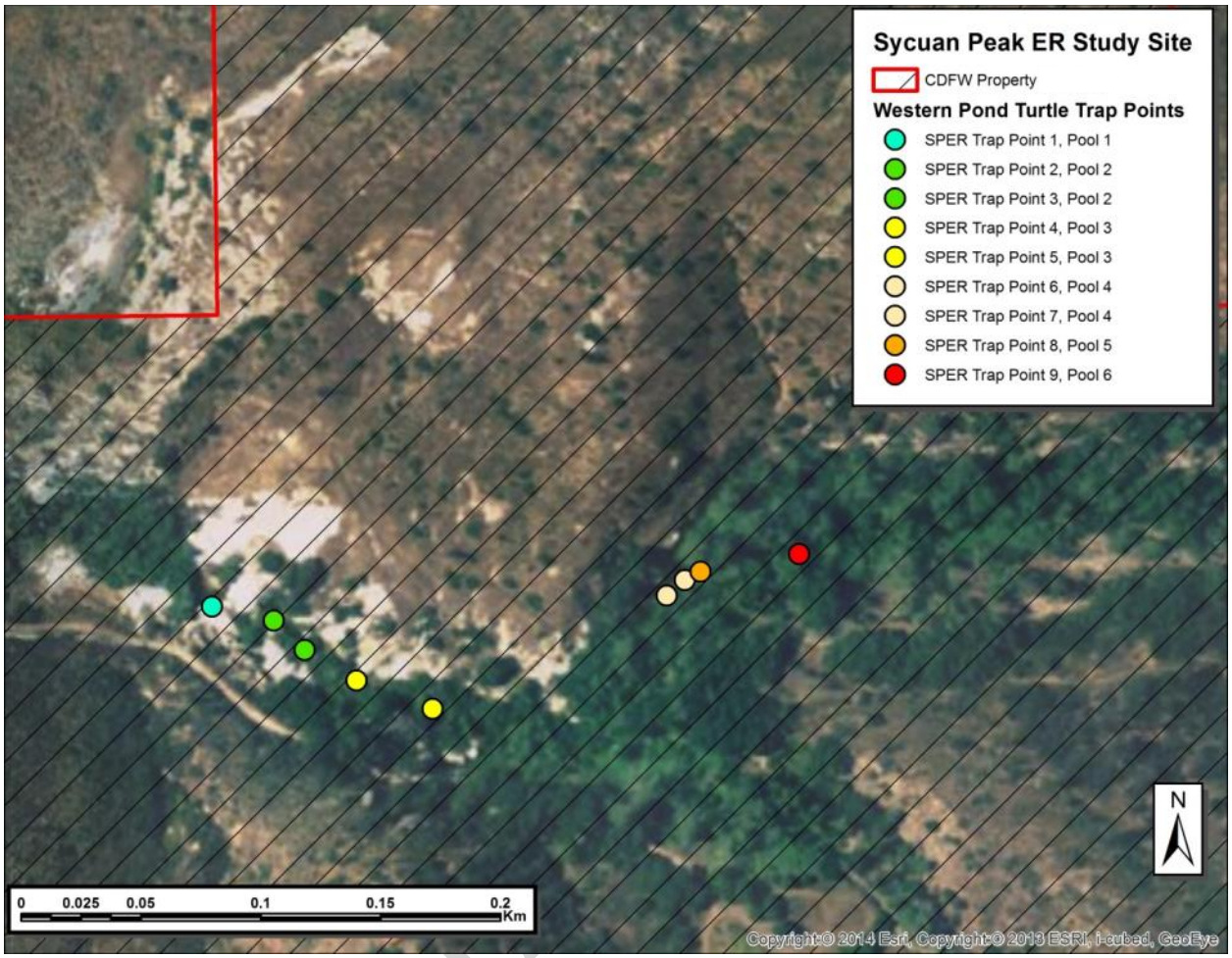

Figure 3. Pond turtle habitat and trapping locations at SPER, San Diego, CA. SPER is located downstream of Loveland Reservoir along the Sweetwater River. The most suitable pond turtle habitat occurred in six large pool complexes (Pools 1–6) within the reserve. The mapped trap locations were numbered 1–9, going from west to east and were color coded by pool. These locations were used for both monitoring and source for the headstarted turtles.

Figure 4. Photographs of trapping points from suitable pond turtle habitat at SPER. Two to five traps were set up in each of these pools to monitor previously headstarted turtles and record new recruits. Pools 1–5 photos correspond to named locations labeled in Figure 3.

Rancho Jamul Ecological Reserve

Rancho Jamul Ecological Reserve is a 2,266 hectare CDFW preserve along Jamul and Dulzura creeks with a diverse range of habitats from grassland to coastal sage to willow-sycamore dominated riparian (Figures 2, 5, and 6; CDFW 2008). RJER is a former land grant from 1829 used historically for agriculture and grazing. It has an aqueduct system and several artificial ponds, most of which are no longer maintained (CDFW 2008). The property was designated an ecological reserve by the State of California in 2001, and at that time USGS began to study the removal of nonnative aquatic species to benefit the native riparian obligate reptiles and amphibians in this area (Hathaway et al. 2002). USGS also previously surveyed the reserve specifically for pond turtles in 2002 and 2003 and none were detected (Madden-Smith et al. 2005). These data were beneficial in this study to aid in restoration of pond turtles to the area. During the early USGS surveys, several of the natural and augmented areas held enough water to pond up, including some reaches with permanent ponded water in Jamul Creek. Many of these pools and ponds were considered to be suitable for pond turtle translocations following habitat restoration and/or nonnative species removal (Brattstrom and Messer 1988; Madden-Smith et al. 2005). In 2014, pond turtle habitat suitability surveys were conducted along the entire length of Jamul Creek west of Highway 94 to assess water availability for pond turtle reintroductions through translocation (Brown et al. 2015, Figures 5 and 6). Pond turtles were subsequently translocated to RJER from nearby Oak Valley Creek which drains into Pine Valley Creek in the Tijuana River Watershed in 2014 and 2015.

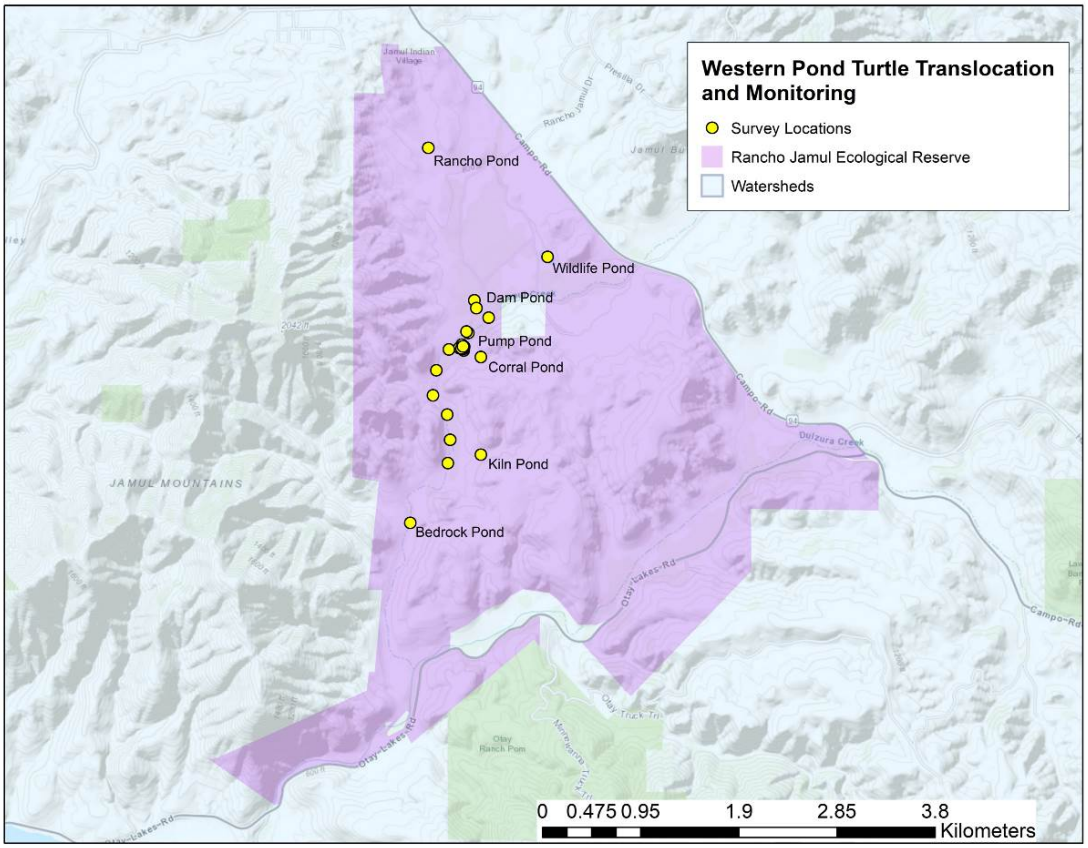

Figure 5. Ponding areas along Jamul Creek and neighboring sites within RJER that were examined for suitability for pond turtles.

A.

B.

C.

Figure 6. Pond turtle habitat at RJER: A. Two areas of pooling in Jamul Creek (June 2014), B. Bedrock Pond (June 2014 (left) and after dry down in September 2014 (right)), and C. aerial (Google Earth image October 2012) and ground views of pump pond (September 2014).

Methods

This study involved monitoring of natural (SPER), headstarted (SPER), and translocated (RJER) pond turtles, native and nonnative species monitoring, and nonnative aquatic species removal at SPER and RJER. Specifically, the activities undertaken at SPER were trapping surveys, time lapse and motion triggered camera photography, and visual

encounter surveys for native species monitoring and nonnative species removal. The activities at RJER were trapping surveys and radio telemetry for monitoring of translocated pond turtles, and visual encounter surveys for native species monitoring and nonnative species removal.

Surveys for native and nonnative aquatic species were conducted following USGS protocols for aquatic species in the south coast ecoregion (USGS 2006a–c). These protocols focus on data collection for mark/recapture studies of target species (pond turtle), occupancy of native aquatic reptiles and amphibians (e.g., treefrogs, gartersnakes, western toads), and collection of nonnative aquatic species (e.g., bullfrogs, crayfish, African clawed frogs). Survey methods included visual encounter, radio telemetry, and trapping (Table 2). Visual encounter surveys were used to determine species presence and activity. Radio telemetry was used to determine movement and activity of translocated pond turtles. Trapping was used to capture turtles for monitoring, to assess health and growth and to change transmitters. Health was assessed by examining each marked pond turtle for increased weight and length from last capture, clear eyes and nares, deformities, injuries, signs of infections, and growths. Day and nighttime visual encounter surveys for nonnative aquatic species control were used to remove bullfrogs and other nonnative species at RJER and SPER (Table 2).

Table 2. Survey types and visits at SPER and RJER, 01 June 2015 to 15 March 2017. Number of surveys listed by watershed, site, and survey type.

Watershed	Site	Day Visual	Night Visual	Radio Telemetry	Trapping*
Sweetwater	Sycuan Peak ER	44			1
Otay	Rancho Jamul ER	15	17	40	7
	Total:	59	17	40	8

*Trapping surveys consist of five continuous days (four continuous nights).

Daytime Visual Encounter Surveys

Visual encounter surveys were conducted between 01 June 2015 and 15 March 2017, at both RJER and SPER. Fifteen daytime visual encounter surveys were conducted at RJER and 44 visual encounter surveys were conducted at SPER during camera battery and SD card changes. Surveys were conducted by walking the creek and pond perimeter, and recording all amphibians, reptiles, fish, and crayfish encountered and removing nonnative bullfrogs and crayfish when able to be captured. Visual searches were enhanced by using seine and dipnets to detect species hiding under aquatic refugia like fallen logs or emergent vegetation. Nonnative aquatic species detected were captured by dipnet, seine, or hand for removal.

Nighttime Visual Encounter Surveys

Nighttime nonnative aquatic species management focused on removal of bullfrogs from the creek channels and ponds at the sites. Nonnative aquatic species removed at RJER included bullfrogs, crayfish, and African clawed frogs, but removal was focused

primarily, in terms of timing and effort, on bullfrogs from the pump pond and adjacent reaches of Jamul Creek. These removals were conducted 01 June 2015 to 15 March 2017 and included 17 nighttime visual encounter surveys. Methods included using hand capture, slings, airgun, and .22 rimfire rifle. Captured bullfrogs were taken to USGS where stomachs were removed to examine content, and bodies were sent to the Aquatic Parasite Observatory at the University of Colorado for examination.

Telemetry Surveys

The pond turtles previously translocated to pump pond were tracked to specific points using radio telemetry. 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. Similar data were recorded for other aquatic species observed. Pond turtles were tracked weekly during the spring and and summer and every two to three weeks during fall and winter from 01 June 2015 to 15 March 2017 for a total of 40 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

Trapping surveys were used at RJER and SPER for monitoring, to assess health and growth and to attach new transmitters (Table 2). 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 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. At both sites, snorkeling surveys were conducted with the trapping to increase capture rate.

Traps were set at the main pooling areas at SPER (Figure 3) from 01 August 2016 to 05 August 2016 to monitor natural and headstarted turtles and to detect new juvenile pond turtles. At RJER, traps were placed in pump pond and the adjacent Jamul Creek on three occasions. Trapping surveys were conducted in May and September of 2015 and August of 2016. Transmitters older than six months were removed from turtles and new transmitters fitted. Turtles were weighed, measured and assessed for health.

Transmitters on the translocated pond turtles at RJER were changed during trapping surveys. To remove the old transmitters, a soft plastic utility (putty) knife was used to gently pick at the old epoxy around the perimeter of the transmitter. After the epoxy was removed, the transmitter was wiggled to loosen the remaining silicone. Once the silicone was loosened, the transmitter was lifted off of the scute. The rear of the carapace of each pond turtle was then 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 previously observed (pools 1 and 2, Figures 3 and 4). 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. Over 23,000 photos were taken.

Results

Sycuan Peak Ecological Reserve

SPER Visual Encounter Surveys for Nonnative Species Removal

We used visual encounter surveys to detect nonnative aquatic species, including focused nighttime visual encounter surveys to remove nonnative bullfrogs subsequent to bullfrog detections during camera surveys. Several bullfrogs were removed using these methods in previous years (Brown et al. 2015). No bullfrogs were detected at SPER during the camera surveys covered by this report or by the daytime visual encounter surveys, so no nighttime surveys were conducted. Additional herpetofauna observed in SPER during our daytime visual surveys included African clawed frog, orange-throated whiptail (*Aspidoscelis hyperythra*), and speckled rattlesnake (*Crotalus pyrrhus*).

SPER Trapping Surveys

Trapping surveys for this location were used solely for the purpose of monitoring pond turtles in-situ that had been previously been released from the headstart program of 2009 thorough 2012. The results of the turtle monitoring trapping surveys at SPER are presented in Table 3. During August of 2016, the amount of available habitat to be

trapped was greatly reduced due to prolonged drought conditions. Only pool 1 held sufficient water for traps to be placed deep enough to be effective, and only five traps could be placed in the ponding area (Figures 3 and 4). This resulted in 12 captures of seven adults and five juveniles; two juveniles were new captures and had not been marked previously (Table 3; Figure 7). The two new, unmarked juvenile pond turtles were most likely a result of on-site naturally occurring recruitment.

Table 3. SPER turtle trapping survey. Turtle captures at SPER for the trapping period from 01 August 2016 to 05 August 2016.

Time Period	Number of Traps	Number of Captures	Average Captures/ Trap Night	Number Adults	Number Juveniles	Number New Juveniles
1 Aug 2016 – 5 Aug 2016	5	12	0.6	7	5	2

Figure 7. New juvenile pond turtles from SPER. Photos of one of the new juvenile pond turtles captured during trapping surveys (2 August 2016), most likely from on-site naturally occurring recruitment.

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 8). We used the photos as an indication of activity at the site to improve detectability during trapping surveys by setting traps during peak activity.

Figure 8. Camera station pond turtle photos. Representative photos of pond turtle observations from the camera stations at different angles in the lower pond.

The motion and time lapse cameras also recorded observations of other native and nonnative species utilizing the riparian habitat (Table 4 and Figure 9). In addition, they were useful in detecting disturbance from recreational hikers and dogs visiting the ponds. Species of interest that were detected included raccoons (*Procyon lotor*), two dogs multiple times, one African clawed frog (*Xenopus laevis*), and one ringtail (*Bassariscus astutus).* Camera detections of recreational activity also provided information managers could use to decide whether and where informative signage could be placed to protect native species. Recreation has not been observed at the pond turtle sites since April 2016.

Table 4. SPER significant species observations. Observations of species relevant to pond turtle activity, including nonnative aquatic species, domestic animals, people, and native scavengers.

Date	Observation	Notes
14 November 2016	1 ringtail	Foraging along shoreline
18 March 2017 29 February 2016 21 July 2016	3 raccoons	Foraging along shoreline Climbing on boulder
24 January 2016 to 19 April 2016	2 dogs	9 observations along bank and in pond
4 February 2016 18 February 2016	2 people	Hiking on rocks near pond
9 November 2015	1 African clawed frog	In the water in lower pool

Figure 9. Camera station photos from SPER. At night, the cameras detected raccoons (*P. lotor*, left), a ringtail (*B. astutus*, middle), and an African clawed frog (*X. laevis*; right).

Table 5. SPER nonnative aquatic species captures. Nonnative aquatic species captures captures at SPER from 01 June 2015 to 15 March 2017 include largemouth bass (*Micropterus salmoides*), African clawed frogs (*Xenopus laevis*), and crayfish (*Procambarus clarkii*).

Date	Capture Method	Species	Number of Captures
05 June 2015	Net	Largemouth bass	7
		Crayfish	1
04/06/16	Hand	Crayfish	1
05/12/16	Hand	Crayfish	3
05/14/16	Hand	Crayfish	1
05/24/16	Net	Crayfish	1
05/25/16	Net	African clawed frog	733
05/30/16	Net	African clawed frog	440
08/02/16	Net	Largemouth bass	3
08/18/16	Hand	Crayfish	1

Rancho Jamul Ecological Reserve

RJER Daytime Visual Encounter Surveys

Visual encounter surveys were used to verify telemetry surveys and establish native and nonnative aquatic species presence. During visual encounter surveys pond turtles were often seen basking on banks or woody debris (Table 6; Figure 10). We also recorded six species of snakes and three anuran species using visual surveys (Table 6).

Figure 10. Pond turtles basking at pump pond. Pond turtles were frequently observed basking on branches along the shoreline at pump pond (Photo taken by Elizabeth Grolle, 18 May 2016).

Table 6. RJER visual encounter species observations. Reptiles and amphibians observed visually 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. Pond turtle observations were turtles visually observed basking or swimming prior to telemetry surveys.

Species	Number of Days Observed	Number of Observations
Pond turtle (*Emys marmorata*)	19	66
California kingsnake (*Lampropeltis californiae*)	1	1
Southern Pacific rattlesnake (*Crotalus helleri*)	1	1
Striped racer (*Coluber lateralis*)	1	1
Long nosed snake (*Rhinocheilus lecontei*)	1	1
Black-headed snake (*Tantilla planiceps*)	1	1
Two-stripped gartersnake (*Thamnophis hammondii*)	2	2
Baja California treefrog (*Pseudacris hypochondriaca*)	1	1
Western toad (*Anaxyrus boreas*)	1	1
Bullfrog (*Lithobates catesbeianus*)	18	161

RJER Nighttime Visual Encounter Surveys

Our nonnative removal efforts were focused on removing bullfrogs from the pump pond and the remaining wetted locations along Jamul creek where bullfrogs are still being detected (Jamul Creek 1, and Jamul Creek 3 in Figure 11). During five survey events, a total of 303 bullfrogs were removed from the site. During surveys on 20 August 2015 and 6 September 2015, 77 recently metamorphosed juvenile bullfrogs were hand captured while emerging from pump pond. Adult bullfrogs were taken by the use of airguns and .22 rimfire rifles, 10 adults were removed during three airgun surveys and 19 adults were removed during one .22 rimfire rifle survey (Table 7).

Table 7. RJER bullfrog removal. Numbers of bullfrogs removed by method during 2015 and 2016. A total of 291 bullfrogs were removed during 17 survey events.

Method of Capture	Number of Surveys	Number of Adults	Number of Juveniles	Total Number Removed
Hand capture	3	0	77*	77
Airgun	3	10	23**	33
Rimfire rifle	11	109	84	193

*60 recently metamorphosed bullfrogs were hand captured during one survey event
**Includes 17 recently metamorphosed bullfrogs

RJER Trapping Surveys

The trapping surveys at RJER produced 51 captures of the 18 pond turtles at pump pond. All captured pond turtles appeared healthy with no new lesions, injuries, or sign of

infection (e.g., inflamed tympanum, blocked nares, difficulty breathing). During this time period, most pond turtles retained their body weight. Two pond turtles lost weight in the fall of 2015; body weight decreased 0.9 percent in one pond turtle (585 to 580 grams) and 3.0 percent in a second pond turtle decreased (320 to 310 grams). Growth was detected in all captured pond turtles including the two pond turtles that lost weight. Increases in length were between one and three millimeters.

RJER Telemetry and Monitoring

For the 18 pond turtles released into the RJER ponds in 2014 and 2015 during the previous study (Brown et al 2015; Figure 11), we recorded the majority of the pond turtle observations in pump pond (labeled "pond" in Figure 11, Tables 8 and 9). The first group of pond turtles translocated in 2015 to pump pond remained at the pond through the winter and into the spring and summer of 2015. During the fall of 2015, however, three pond turtles began to move from the pond into adjacent locations within Jamul Creek (labeled JC 1–7 in Figure 11, Tables 8 and 9). One of the turtles moved downstream nearly 500 meters and overwintered under a coast live oak.

RJER Time Lapse and Motion Triggered Cameras

Camera trapping was not used at RJER. This method was only used in SPER as a way to streamline surveys for pond turtle activity.

Table 8. Radio telemetry results for the 18 translocated pond turtles by location at RJER June 2015 to March 2017 (Figure 11).

	Number of Observations per Radio Tracked Pond Turtle																	
Site	RJ01	RJ02	RJ03	RJ04	RJ05	RJ06	RJ07	RJ08	RJ09	RJ10	RJ11	RJ12	RJ13	RJ14	RJ15	RJ16	RJ17	RJ18	Total
Pond	13	30	26	11	20	13	24	24	12	25	44	39	23	22	26	24	23	15	414
JC 1			1		6					16			1	1	4	1	8	1	39
JC 2										1		5							6
JC 3												1						1	2
JC 4					5									1					6
JC 5														6					6
JC 6					1														1
JC 7										1						1			2
Total Obs:	13	30	27	11	32	13	24	24	12	43	44	45	24	30	30	26	31	17	

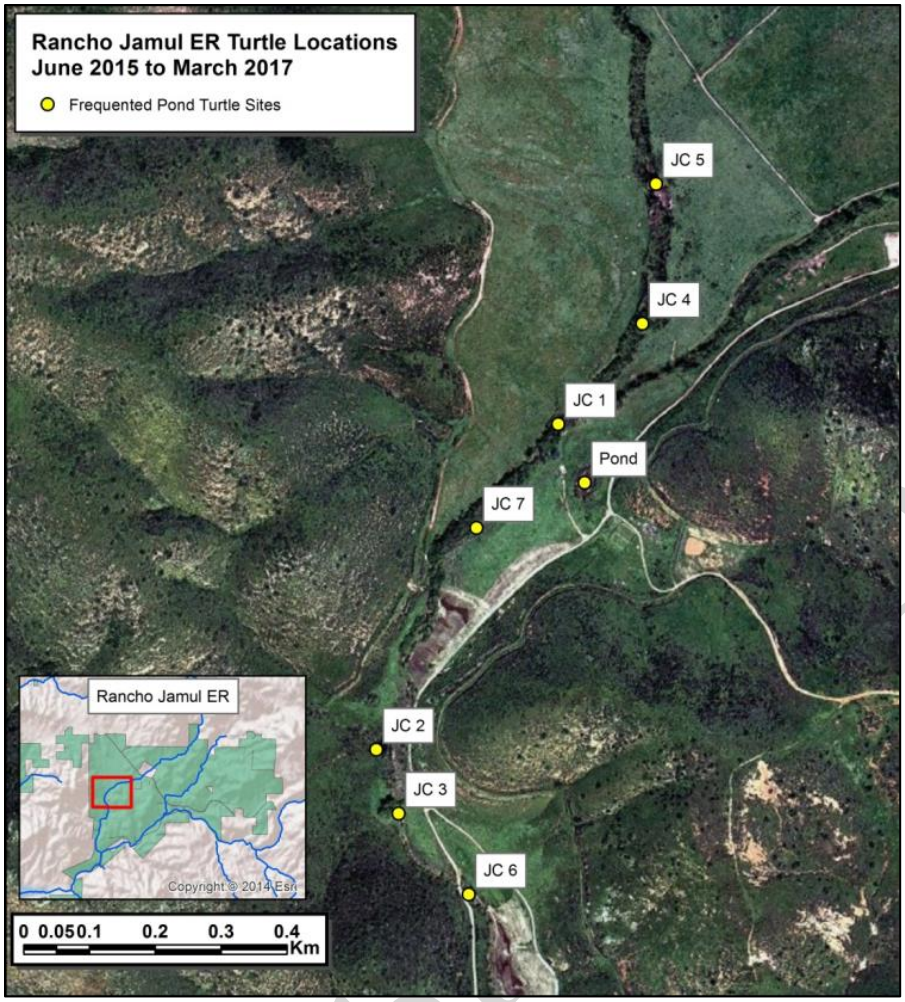

Figure 11. Pond turtle radio telemetry data collection at pump pond. The translocated pond turtles were located in a quadrant and data on habitat use (whether they were in the water, on the shore, under the cattail mat, or in the upland) were recorded. Similar data were recorded for other aquatic species observed.

Table 9. Radio telemetry results for pond turtles RJ05, RJ10, RJ12, and RJ14 by date and location at RJER June 2015 to March 2017 (Figure 11). Surveys where the individual was not located to a specific location were left blank.

	RJ05				RJ10			RJ12			RJ14			
Date	Pond	JC 1	JC 4	JC 6	Pond	JC 1	JC 7	Pond	JC 2	JC 3	Pond	JC 1	JC 4	JC 5
06/05/15	1				1			1						
06/23/15	1				1			1						
06/29/15								1						
07/09/15	1				1			1						
07/16/15					1			1						
07/24/15	1				1			1						
07/31/15	1				1			2						
08/14/15	1				1			1						
09/10/15	1				1			1						
09/24/15	1				1			1						
09/28/15	1							2						
10/08/15											1			
10/13/15											1			
10/20/15											1			
10/27/15						2								
11/05/15	1					1					1			
11/08/15	1				1			1						
11/13/15	1					1			1		1			
11/20/15	1				1			1						
11/25/15					1			1			1			
12/03/15									1		1			
12/16/15	1					1		1			1			
12/18/15	1				1									
01/14/16	1					1			1		1			
01/28/16	1					1			1		1			
04/13/16	1				1				1		2			
04/20/16	1				1					1		1		
05/04/16	1					1		1			1			
05/12/16		1				1		1			1			
05/18/16		1				1		1			1			
05/26/16			1		1			1			1			
06/01/16			1		1			1			1			
06/14/16		1			1			1			1			
06/24/16					1			1						
08/01/16								2						
09/09/16						1		1			1			
09/16/16						1		1			1			
09/22/16			1			1		1						
09/29/16						1		1						
10/07/16			1			1		1			1			
10/21/16						1		1						1
10/28/16		1												
11/10/16		1			1			1						1
11/17/16			1		1			1					1	
11/23/16		1			1			1						1
01/04/17					1			1						1
01/11/17					1			1						1
02/01/17				1			1							1
03/10/17				1	1			1			1			

Discussion

Sycuan Peak Ecological Reserve

Our data suggest that the pond turtle recovery program at SPER has had some great successes in light of the prolonged drought. Even with available wetted habitat being reduced to two small, isolated pools in 2016, new on-site recruitment was documented during the pond turtle monitoring trapping survey with the capture of two new, unmarked, juvenile pond turtles.

We also developed and tested the effectiveness of new tools in the management of nonnative aquatic species. The placement of time lapse and motion triggered IR cameras facing the water at the boundaries of the site have proven effective at documenting the immigration of African clawed frogs. This has allowed managers to keep numbers of these nonnatives low which improves the effectiveness of the turtle translocations. This also reduced the time necessary to conduct the nonnative aquatic species removal study, reduced disturbance to the native species, and reduced expenditures. Testing cost effective monitoring and recovery methods at SPER could help maintain pond turtles in the Sweetwater River watershed and potentially provide a source population for future restorations elsewhere in San Diego County.

Rancho Jamul Ecological Reserve

The pond turtles which were translocated to RJER during the previous study (Brown et al 2015) 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 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.

The greatest immediate concern was the bullfrog population and its potential to limit recruitment. Bullfrogs have continued to move into pump pond from nearby areas and may need continued management for successful pond turtle recruitment to occur within this population. Surveys could be conducted to determine the source of new bullfrogs coming into pump pond. It also appears that their development was very fast at this site, reaching metamorphosis within six months of egg laying. Pressure on the adult bullfrogs could be maintained to stop recruitment of bullfrogs at the site.

Long-term monitoring and management of this population could follow the same guidelines suggested for the pond turtles at SPER (Brown et al. 2015). Pond turtle monitoring could continue in order to determine the long-term success of the translocation. No juvenile pond turtles were detected during this study, but they were not expected to appear until spring 2017 or 2018.

Successful recruitment is generally an indicator of population viability and is necessary for the long-term survival of any population. Once again, pond turtles were moving throughout natural riparian areas in the Otay River watershed, and this population was

within conserved lands with active management for restoration. With managers continuing bullfrog removal and riparian restoration, we anticipate that this population could continue to thrive.

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