



## United States Department of the Interior

U.S. GEOLOGICAL SURVEY  
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December 2, 2021

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Dear Dr. Gregory,

This letter transmits the U.S. Geological Survey (USGS) Western Ecological Research Center's draft data summary entitled Southwestern Pond Turtle Trapping and Invasive Species Removal at Shady Canyon, Draft Final, 2021. This information is provided to fulfill USGS obligations under the Collaborative Agreement 22ZCCOLLIRCWPT1. We expect to publish these data in early 2023 and a final publication will be distributed when available.

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.

We appreciate the opportunity to work with the Irvine Ranch Conservancy to provide scientific information relevant to resource management in southern California. Please direct any questions to Dr. Robert Fisher at (619) 206-5686.

Sincerely,

Principal Investigator



# Southwestern Pond Turtle Trapping and Invasive Species Removal at Shady Canyon, Draft Final, 2021



Credit: Jared Heath, USGS

# Southwestern Pond Turtle Trapping and Invasive Species Removal at Shady Canyon, Draft Final, 2021

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U.S. GEOLOGICAL SURVEY  
WESTERN ECOLOGICAL RESEARCH CENTER

Data Summary

Prepared for:

**Irvine Ranch Conservancy**

Research authorized by:

**California Department of Fish and Wildlife**  
Scientific Collecting Permit (Entity) and MOU: SCP838

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## Introduction

The southwestern pond turtle (*Actinemys pallida*; pond turtle) is the only native freshwater turtle in coastal California. Dramatic declines have occurred in southern California due to habitat loss, altered hydrology, and the introduction of non-native species (Thomson et al. 2016). Currently the pond turtle is a state species of special concern (CNDDDB 2020) and is under review for listing under the Endangered Species Act (U.S. Endangered Species Act [ESA 1973, as amended]) based on a 90-day finding issued in April 2015 (USFWS 2015).

In 2001, Harmsworth Associates, an environmental consulting group, translocated 27 pond turtles from Bommer Creek and an adjacent tributary to a pond in Shady Canyon to mitigate for the loss of turtle habitat from the development of the Shady Canyon Golf Course and residences near Bommer Creek. The pond at Shady Canyon was a former cattle pond that was reconstructed in 2002 to better retain water and provide habitat for pond turtles (Harmsworth Associates & Goodman 2002). The location of the pond in upper Shady Canyon is within the Nature Reserve of Orange County (Figure 1). The pond was chosen because it had some protections being within a nature reserve, it had suitable upland habitat, and it was relatively isolated from public access (Harmsworth Associates & Goodman 2003). Since the translocation, pond turtles have established a successful breeding population (Harmsworth Associates 2007, 2013). However, in 2005, the African clawed frog (*Xenopus laevis*), a non-native species, invaded the site and established a successful breeding population. The American bullfrog (*Lithobates catesbeianus*) has also been documented at Shady Canyon as recently as 2021, but in much lower numbers. Both clawed frogs and bullfrogs directly compete with pond turtles for food. In addition, bullfrog adults are known predators of juvenile pond turtles (Moyle 1973, Holland 1991).

In 2007, Harmsworth Associates and the Irvine Ranch Conservancy implemented a long-term management plan for the Shady Canyon pond. The plan outlined the need for continued maintenance and the control of non-native species for continued and improved pond turtle persistence (Harmsworth Associates 2007). Two trapping sessions were conducted to inventory pond turtles and remove non-native species, one in May/June and one in August/September; these months were chosen based on past pond turtle, clawed frog captures and cost efficacy (Harmsworth Associates 2007). With U.S. Geological Survey (USGS) in an advisory role, Harmsworth Associates conducted the non-native species removal and pond turtle population monitoring for much of the history of Shady Canyon pond (Harmsworth and Associates 2013). In 2018, at the request of Irvine Ranch Conservancy, the USGS began a population demographic study of the pond turtle while continuing non-native species control efforts at Shady Canyon pond (USGS unpublished data).

County-wide translocations are consistent with the goals of the Coastal-Central HCP/NCCP (R.J. Meade Consulting, Inc. 1996) and could increase the resiliency of the population in Orange County against drought and other impacts. Shady Canyon could be a source population for translocations. The population size and demographic data on pond turtles, in addition to the data collected on invasive species at this site, will help determine appropriate numbers of pond turtles to be used in the county-wide translocation program. Having a baseline understanding of these metrics will allow the program to move forward once re-establishment sites are identified and approved by the County and other partners. Our data collection on monitoring and demographics were continued in 2021.

## Methods

In 2021, USGS conducted two trapping sessions (June and August/September) for pond turtles and non-native species (Table 1). We followed USGS protocol for trapping and visual encounter surveys (USGS 2006a, b). We deployed eight traps of varying types for each session: (30" diameter hoop single fingered-mouth funnel traps, 20" diameter hoop single fingered-mouth funnel traps, 30" oval traps and mesh minnow traps). Traps were baited with mackerel. Minnow traps were set to target the smaller non-native species and all other trap types had larger openings to target pond turtles. We used an additional ski net technique to target non-native species. The ski net was developed to sample for tiger salamanders with minimal disturbance to the pond bottom or vegetation. It is also ideal for ponds like Shady Canyon with deep mud that make wading and seining difficult (Sam Sweet, personal communication). We ran the ski net across the pond 12 times during the June trapping session.

The USGS also conducted a one-night survey of the pond on August 31<sup>st</sup> to remove any bullfrogs. Local law enforcement and landowners were contacted beforehand to authorize the use of firearms. We first conducted an aural survey, for calling bullfrogs. We then circumnavigated the pond, using bright flashlights to look for bullfrog eyeshine (Corben and Fellers 2001). If a bullfrog was detected, a USGS employee certified in firearm safety used a Ruger long rifle 0.22 with a mounted scope to target and euthanize the animal.

All captured pond turtles were weighed (in grams; g), measured (in millimeters; mm), sexed, and individually marked with Passive Integrated transponder (PIT) tags or marginal scute notches for mark/recapture analysis. Not all neonates were PIT tagged but all were given marginal scute notches. The PIT tags and marginal scute notches allowed for identification of unique individuals and are expected to last the life of an animal. Measurements included maximum carapace length from the first marginal scute to the last (twelfth in most cases), minimum carapace length from the front notch to the back notch, maximum plastron length from the highest point on the right to the longest point on the right, minimum plastron length from the front notch to the back notch scute, maximum carapace width, bridge carapace width (taken at narrowest point where the carapace and plastron meet on the side of the turtle), maximum height taken parallel to the animal's body, and minimum height taken perpendicular to the animal's body. Other markings and injuries, including the marginal scute notches of the adults made by Harmsworth Associates, were also recorded. We used these marginal scute notches and the capture data reported by Harmsworth Associates and Goodman (2002, 2003, 2005, 2006) and Harmsworth Associates (2013), including the size and age class at the original capture date, to estimate the current age of the pond turtles.

Population estimates for pond turtles were conducted using the application Program MARK after the August/September trapping session. The closed capture population model in Program MARK takes into account variation in time, behavior and heterogeneity among individuals that the Lincoln-Peterson estimator cannot (Pollock 1981). A closed capture Full Likelihood Heterogeneity pi, p and c model was used so that individual covariates could be considered when estimating population size.

## Results

A total of 58 unique live pond turtles were captured (49 adults, 8 juveniles and one neonate) during the 2021 trapping efforts (Tables 2 and 3). During the June trapping session, we captured 42 unique adults, one neonate and six unique juveniles pond turtles (four juveniles were first-time captures). The adult and juvenile turtles were caught in all four types of turtle traps; one adult was captured in the ski net and the neonate was captured in the minnow trap. Four of the female pond turtles were gravid, based on manual palpation. The August/September trapping session yielded 44 unique adults and five unique juvenile pond turtles (one juvenile was a first-time capture). All four types of turtle traps successfully caught turtles. See Table 3 and Figure 2 for turtle captures broken down by sex and approximate age.

We trapped and euthanized one adult bullfrog during the June session. No bullfrogs were detected during the September night survey. No other non-native species were detected during the trapping or night surveys. Western toads (*Anaxyrus boreas*) were also present during the night survey.

Using a Full Likelihood Heterogeneity  $\pi$ ,  $p$ , and  $c$  closed capture model in Program MARK on both trapping sessions, our estimate of the pond turtle population size at Shady Canyon was 61.98 individuals with a 95% CI of 54.28 to 69.68 (SE = 3.60).

## Discussion

Our 2021 data suggest that the demographic structure of the pond turtle population at Shady Canyon pond was skewed towards adults (Table 3). The one neonate turtle found in 2021 is evidence of second recruitment since turtles were placed back in the pond following a draining and sediment removal project in 2016 (USGS unpublished data). All adult pond turtles captured in 2021 were at least 9 years old, and ~81% (47 of the 58) of the turtles detected in 2021 were 10 years old or older (Figure 2). An analysis of pond turtle size in 2019 showed that the Shady Canyon pond turtles were significantly smaller (in both carapace length and mass) than those of similar age at other southern California populations (USGS unpublished data). This could be a sign of overcrowding at Shady Canyon pond, which may lead to food scarcity and thus smaller size. The smaller size of the turtles could also be contributing to the low recruitment observed, since carapace length is correlated with clutch size (Scott et al. 2008).

Given the age structure at Shady Canyon pond, the turtle population here could be in decline. Furthermore, USGS caught 62 unique animals in 2016 and 68 unique animals 2018, yet fewer turtles were captured in 2019, 2020, and 2021: 49 unique captures, 47 adult unique captures and 49 adult unique captures, respectively (Figure 3). This could be an anomaly in the data, or an indication of a downward trend. Pinpointing the cause of a potential population decline at Shady Canyon could be difficult. Water levels could also contribute to the numbers of individuals captured and counted. The lower water levels of the pool in September/October 2020 and August/September 2021 (Appendix 1) might account for the greater capture success than the previous year. For example, we recorded twenty-two unique captures in September 2019 versus 45 in September/October 2020 and 49 in August/September 2021.

There is a correlation between the timing of the start of the possible population decline and the start of the longest drought in California which lasted from 2011 to 2019, with the most intense

period lasting from 2014 to 2017 (NIDIS 2019). Drought can have several effects on turtles, including drying out nests (Tucker and Pukstis 2000, Bury et al. 2012) and causing the mass exodus from a pond (Gibbons et al. 1983). The drying of nests is a likely consequence of the drought at Shady Canyon, leading to a lack of recruitment and thus to a decline in the population. The heavy rains of the winter of 2020 may have created better conditions for recruitment as evidenced by the four neonates captured (Appendix 2), the first sign of recruitment in this population in four years. In the absence of American bullfrogs, neonates have fewer predation pressures which may contribute to their survival. Thus, we may find an upward tick in future recruitment, which could be very important for the persistence of this aging population.

Food scarcity may also be affecting the Shady Canyon population. Aquatic invertebrates make up the majority of the pond turtle's natural diet (Bury 1986). The high density of pond turtles could negatively affect the number of freshwater invertebrates. During the ski netting, we did not capture any Odonate larvae or aquatic beetles, and very few other aquatic invertebrates were detected. In addition, we did not trap any amphibian larvae that could serve as an alternative food source during ski netting or in the minnow trapping. The lack of aquatic invertebrates at Shady Canyon further suggests that the pond may have reached the carrying capacity of pond turtles, which could cause a decline in pond turtle captures. If Shady Canyon pond is expected to support a source population of pond turtles for repatriation across Orange County in future years, it could be helpful to conduct an aquatic invertebrate study comparing invertebrate diversity and density at Shady Canyon pond to other similar ponds nearby.

If we are in fact observing the effects of overpopulation at Shady Canyon pond, using the Shady Canyon population as a source population for other restored ponds in Orange County could be considered. This could give the remaining pond turtles a better chance of success by decreasing intraspecific competition for resources such as food, nesting sites, basking sites, and refugia. Having fewer turtles could also potentially create conditions for a sustainable aquatic insect population to be restored.

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**Table 1.** Summary of captures during southwestern pond turtle (*Actinemys pallida*) and invasive trapping surveys at Shady Canyon, 2021.

Trapping Date		Native	Non-native	
		Southwestern Pond Turtle ( <i>Actinemys pallida</i> )	African Clawed Frog ( <i>Xenopus laevis</i> )	American Bullfrog ( <i>Lithobates catesbeianus</i> )
Session 1	June 8, 2021	34	0	1
	June 9, 2021	26	0	0
	June 10, 2021	15	0	0
	June 11, 2021	17	0	0
Session 2	August 31, 2021	29	0	0
	September 1, 2021	22	0	0
	September 2, 2021	24	0	0
	September 3, 2021	33	0	0

**Table 2.** Summary of unique southwestern pond turtles (*Actinemys pallida*) captured in June and August/September at Shady Canyon, 2021.

Trapping Session		Unique Individuals			Total
		Females	Males	Unknown	
Session 1	June 8–11, 2021	17	25	7	49
Session 2	August 31–September 3, 2021	17	27	5	49
<b>Total # Unique Animals</b>		<b>20</b>	<b>29</b>	<b>9</b>	<b>58</b>

Note: the total number of unique animals is the number of individual turtles captured in 2021.

**Table 3.** Southwestern pond turtle (*Actinemys pallida*) demographics at Shady Canyon, 2021. (continued on next page).

Unique ID	Scute Number <sup>1</sup>	Age	Sex	Maximum Carapace Length (mm)	Maximum Weight (g)	Estimated Age <sup>2</sup>
836537773	0031	Adult	Female	129	272	18
836576799	0045	Adult	Female	123	241	19
836517079	0049	Adult	Female	131	307	18
836367269	0052	Adult	Female	128	266	20
836533321	0065	Adult	Male	121	205	18
836543818	0066	Adult	Male	122	217	19
845532600	0068	Adult	Male	112	170	19
845529607	0400	Juvenile	Unknown	59.85	32	1
845296045	0401	Juvenile	Unknown	72.9	56	1
	0402	Juvenile	Unknown	76.4	58	1
845531101	0403	Juvenile	Unknown	65.7	40	1
	0404	Juvenile	Unknown	37.15	9	<1
	0404A	Juvenile	Unknown	72.5	53	1
845533366	0405	Juvenile	Unknown	70.77	49	1
845534294	0406	Juvenile	Unknown	71.4	47	1
845527539	0407	Juvenile	Unknown	66.1	38	1
836529846	0800	Adult	Male	114.5	177	16
836544583	0802	Adult	Male	109	147	13
836533296	0806	Adult	Male	99.5	120	12
836527302	0808	Adult	Female	122.5	231	14
836532792	0825	Adult	Male	124	244	16
836515568	0827	Adult	Female	124.1	246	13
836521098	0828	Adult	Male	117	171	17
836541082	0829	Adult	Male	110	162	17
836543318	0832	Adult	Male	97.1		9
836532113	0837	Adult	Male	118	197	14
836516836	0839	Adult	Male	123	226	18
836537303	0841	Adult	Female	124.25	269	14
836535089	0842	Adult	Female	119.5	210	10
836536063	0843	Adult	Male	111	161	12
836541006	0847	Adult	Male	121.5	213	18
836538073	0849	Adult	Female	120	233	19
836516054	0851	Adult	Male	110	185	12
836568573	0853	Adult	Female	119	216	13
836532523	0856	Adult	Female	124.4	233	18

<sup>1</sup>Scute numbers are notches on outside scutes for individual identification of turtles by Harmsworth Associates.

<sup>2</sup>Estimated age is based on Harmsworth Associates capture data from 2000-2013.

Note: the length and weight are the maximum measurements from both trapping sessions.

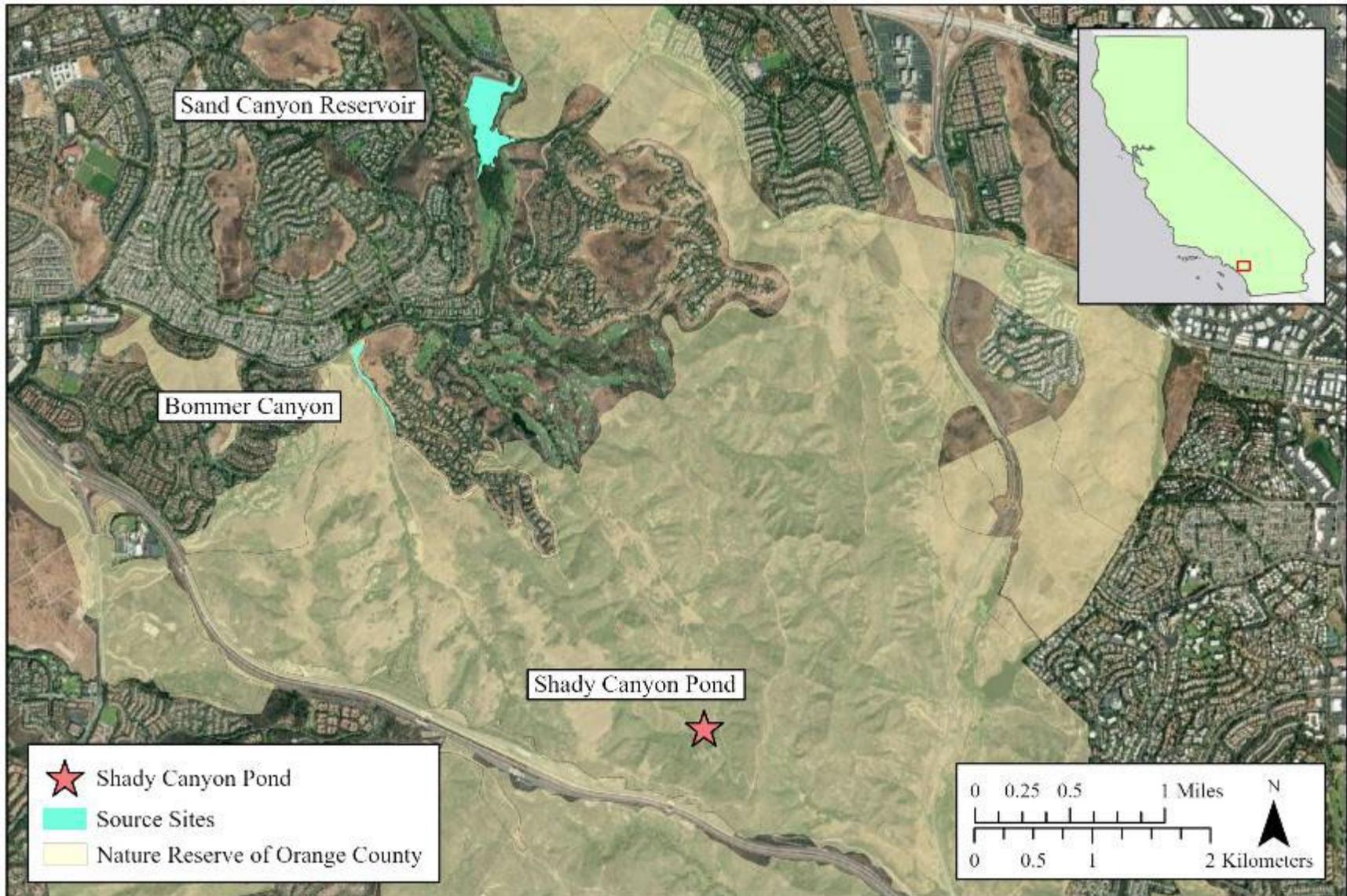
**Table 3.** Southwestern pond turtle (*Actinemys pallida*) demographics at Shady Canyon, 2021. (continued from previous page).

Unique ID	Scute Number <sup>1</sup>	Age	Sex	Maximum Carapace Length (mm)	Maximum Weight (g)	Estimated Age <sup>2</sup>
836523801	0857	Adult	Male	113.5	182	18
836537787	0859	Adult	Male	119.5	192	18
836382060	0863	Adult	Female	120.5	229	12
836528013	0865	Adult	Male	102	123	16
836542116	0866	Adult	Male	119.5	207	17
836515851	0868	Adult	Male	119	206	18
836529615	0876	Adult	Male	114.5	176	15
836541267	0877	Adult	Female	119	262	16
836544040	0878	Adult	Female	119	222	16
845526812	0879	Adult	Male	96	112	15
836525825	0882	Adult	Male	99.5	140	10
836516295	0885	Adult	Female	124.5	239	13
836532585	0888	Adult	Female	109	171	12
836520895	0889	Adult	Male	124.5	215	12
836541113	1601	Adult	Male	99.5	129	11
836831093	1602	Adult	Female	95.2	123	9
836532291	1605	Adult	Male	103.5	140	10
836544301	1611	Adult	Male	108.5	160	12
836515862	1613	Adult	Male	109	144	12
836523854	1614	Adult	Female	106	154	10
836541867	1630	Adult	Female	109.5	155	10
836516887	3230	Adult	Male	123	238	18
836539317	3258	Adult	Female	134.5	335	24

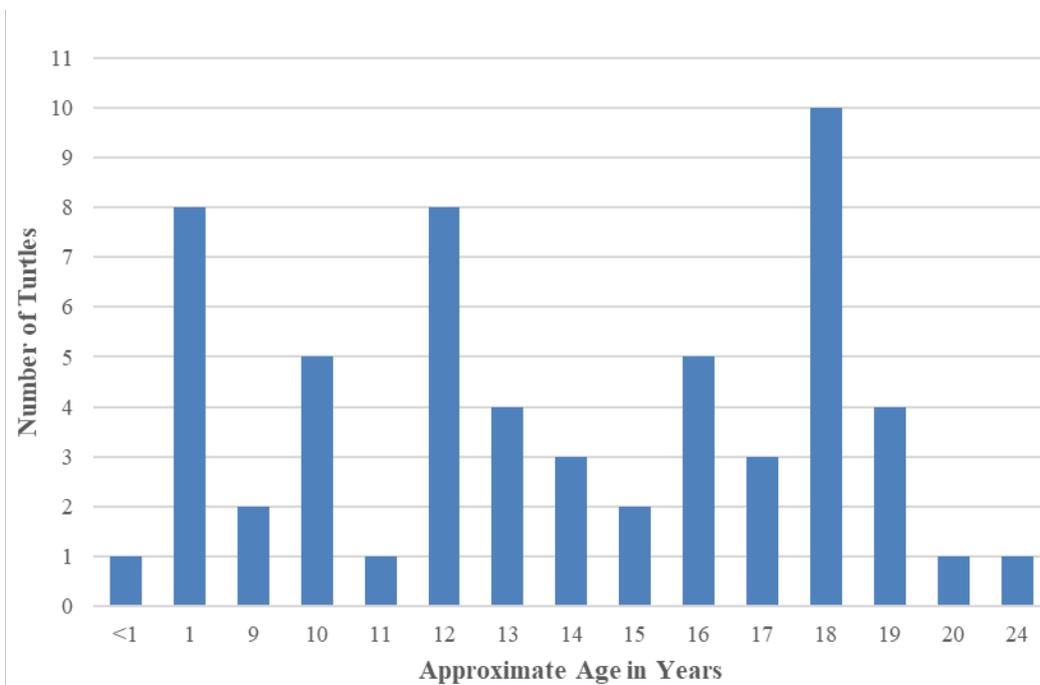
<sup>1</sup>Scute numbers are notches on outside scutes for individual identification of turtles by Harmsworth Associates.

<sup>2</sup>Estimated age is based on Harmsworth Associates capture data from 2000-2013.

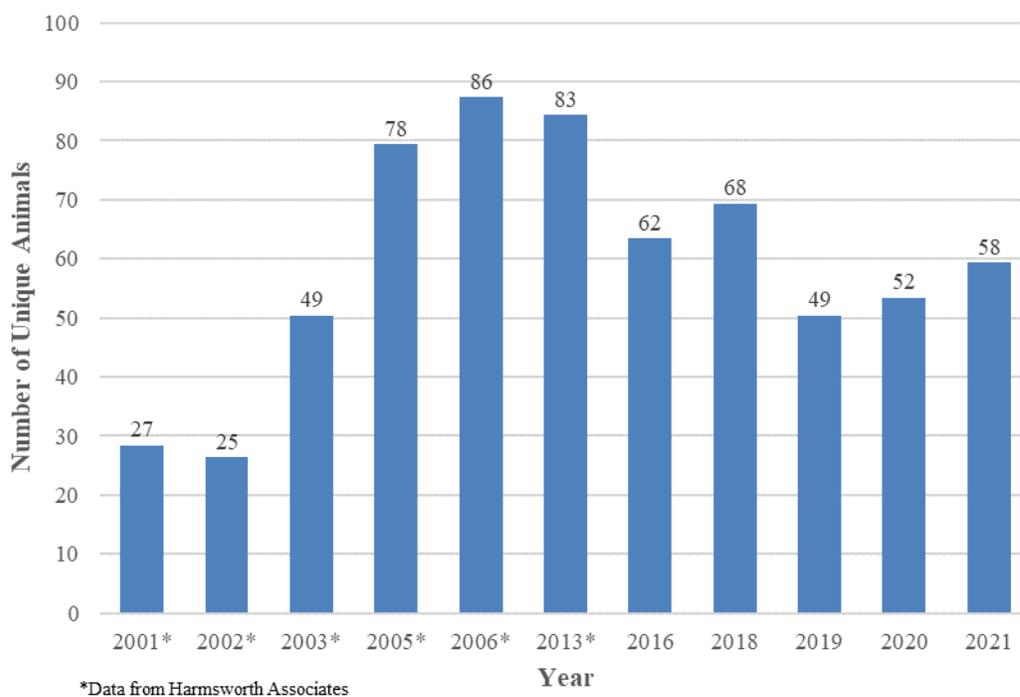
Note: the length and weight are the maximum measurements from both trapping sessions.



**Figure 1.** Location of Shady Canyon pond within the Nature Reserve of Orange County.



**Figure 2.** Approximate age distribution of the southwestern pond turtle (*Actinemys pallida*) population at Shady Canyon, 2021.



**Figure 3.** Number of unique southwestern pond turtles (*Actinemys pallida*) captured at Shady Canyon by year. Note: there are no data for 2004, 2007–2011, 2014, 2015, or 2017.

**Appendix 1.** Water levels at Shady Canyon during the 2021 trapping sessions. Top photo: high water level from first trapping session (7 June 2021); Bottom photo: lower water level from second trapping session (30 August 2021).



Credit: Katherine Baumberger, USGS



Credit: Tiffany May, USGS

**Appendix 2.** Southwestern pond turtle (*Actinemys pallida*) captures at Shady Canyon, 2021. Two age classes are represented; bottom left: neonate (hatchling) and to the right are yearlings.



Credit: Katherine Baumberger, USGS