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The Southwestern Pond Turtle (*Actinemys pallida*) in Baja California, Mexico: New Localities and Persistent Threats

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Abstract.—The Southwestern Pond Turtle (*Actinemys pallida*), the only native freshwater turtle in Baja California, is experiencing alarming population declines, echoing global patterns observed in freshwater turtles. We conducted comprehensive field surveys across the major drainages of northwestern Baja California to delineate the species' current distribution, identify critical threats to its persistence, and provide guidance for conservation actions. We documented the continued presence of *A. pallida* at 27 sites across 10 watersheds, ranging from sea level to 1,525 m in elevation. These include nine historically known sites and 18 newly recorded localities. The most pervasive threats we identified were habitat degradation, the proliferation of invasive aquatic species, and unsustainable water extraction. Despite these pressures, our findings confirm that *A. pallida* still occupies much of its historical range. However, urgent ecological research is needed to inform evidence-based strategies that ensure the long-term viability of this imperiled species.

The Southwestern Pond Turtle (*Actinemys pallida*), formerly recognized as *Emys marmorata pallida* (Spinks et al. 2014), is one of many freshwater turtle species undergoing significant population declines globally (Bury et al. 2012; Böhm et al. 2013; Macip-Ríos et al. 2015). It is the only native freshwater turtle species in the state of Baja California, Mexico (Legler and Vogt 2013), and its distribution is limited to the central coast of California, south of the San Francisco Bay, excluding the San Joaquin Valley, extending into northwestern Baja California (Stebbins 1954; Bury and Germano 2008; Spinks et al. 2014). *Actinemys pallida* is a small to medium-sized turtle, typically reaching a carapace length of 150-160 mm (Seeliger 1945; Bury and Germano 2008), with some individuals in California attaining up to 240 mm, this larger CL is reported for the congener, *A. marmorata* (Lubcke and Wilson 2007). Alarmingly, dramatic population declines have been documented across southern California, from Ventura County to the U.S.-Mexico border (Bury and Germano 2008; Thomson et al. 2016). In this region, known localities decreased from 87 in 1960 to just 20 by 1987 (Brattstrom

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1988). Recently Gregory et al. (2024a) conducted a population viability analysis for this species and modelled that by the end of the century there is a mean range-wide probability of extinction of 57.8%.

Multiple factors have contributed to this ongoing decline. Overexploitation in the 19th century likely initiated the collapse (Bettelheim 2005), which has been exacerbated by widespread habitat loss, degradation, and fragmentation due to urban expansion, agricultural development, and the spread of invasive species (Thomson et al. 2016; Nicholson et al. 2020; Manzo et al. 2021; Peralta-García et al. 2023). Due to these persistent threats, *A. pallida* is currently listed as a Species of Special Concern in California (Thomson et al. 2016) and is under evaluation by the United States Fish and Wildlife Service for potential protection under the Endangered Species Act (USFWS 2023).

In México, *A. pallida* is restricted to northwestern Baja California, where it inhabits riparian habitats along Pacific drainages of the Sierra Juárez and Sierra San Pedro Mártir, reaching as far south as Arroyo Grande, east of El Rosario (Grismer 2002). An additional isolated disjunct population occurs in the central desert region of Baja California (Valdez-Villavicencio et al. 2016). Similarly, a few isolated desert populations are found in the Mojave Desert of California (Lovich and Meyer 2002; Lovich et al. 2021; Muth et al. 2024). Notably, Grismer (2002) did not address any conservation concerns for Baja California populations, whereas Stebbins (2003) suggested that the species may be extirpated from the northern portion of its historical range in Mexico. Bury and Germano (2008) later refined the species' distribution, indicating its presence is limited to the Pacific slopes of the Sierra San Pedro Mártir.

The latest taxonomic study by Spinks et al. (2014) demonstrated that *Actinemys marmorata* comprises a species complex of two, and possibly three, distinct taxa. Populations occurring south of San Francisco, west of the Central Valley, and throughout southern California and Baja California are now recognized as *Actinemys pallida* (Spinks et al. 2014; Hansen and Shedd 2025). These findings underscore the urgency for targeted conservation efforts, especially since many populations south of Los Angeles have already been extirpated (Brattstrom 1988; Thomson et al. 2016). Furthermore, Spinks et al. (2014) suggested the possible existence of a unique evolutionary lineage in Baja California that warrants further investigation (see also Seeliger 1945). Several studies have reported that *A. pallida* individuals in southern California tend to be significantly smaller than *A. marmorata* found elsewhere in the state, with few individuals exceeding 150 mm in carapace length and almost none surpassing 170 mm (Germano and Rathbun 2008; Nicholson et al. 2020). In this study, we document the current distribution and status of *Actinemys pallida* (= *A. marmorata pallida*) across its range in Baja California, identify key threats, and provide essential baseline data to inform species management and protection efforts in México.

Materials and Methods

We surveyed most of the drainages in northwestern Baja California, from the United States–Mexico border southward to Misión San Fernando Velicatá, and from the Pacific coastline eastward to the western foothills of the Sierra Juárez and Sierra San Pedro Mártir. Nearly the entire area lies within the Mediterranean Region, which is characterized by chaparral, coastal sage scrub, and coastal succulent scrub; one additional site that was surveyed was located in the central desert (González-Abraham et al. 2010). We searched for historical records of *A. pallida* in museum databases (www.vertnet.org), the herpetological collection of the Universidad Autónoma de Baja California (UABC) in Ensenada, Baja California, and from published sources (Linsdale 1932; Roberts 1982; Buskirk 1984; Welsh 1988; Grismer 2002; Lovich et al. 2005, 2007; Barela and Olson 2014). We georeferenced localities lacking precise coordinates using the point-radius method (Wieczorek et al. 2004), depending on the quality of the original locality descriptions.

As part of a broader study on amphibians in the region (Peralta-García et al. 2016, 2018), we began recording turtle observations in streams, pools, and ponds with permanent water within riparian zones from March to July 2013 and February to June 2014. In 2015, we initiated dedicated turtle surveys using hoop traps baited with sardines, which remained deployed for 16 to 18 hr, including one overnight period. We conducted trapping efforts from August to November 2015, March to April 2016, and March to October 2022. We visited 38 sites, including 16 of the 19 historically documented sites (recorded between 1894 and 1999), along with four additional published localities, and 18 new sites. At each location, we recorded GPS coordinates and habitat characteristics. For each captured turtle, we measured sex, carapace length and width, plastron length, and body weight.

Adult turtles were considered at CL of 105 mm as our measure of presumed sexual maturity for our analysis according to the following. Holland (1994) stated that most animals showed secondary characteristics at 110 mm at his project site in Oregon, he noted that males showed signs of reproductive behavior at 90 mm. Ernst and Lovich (2009) and Ashton et al. (1997) state that size and age at maturity decreases as the range extends southward. Nearly all of our turtles showed clear signs of secondary sexual characteristics (as reported by Holland [1994]) at 105 mm.

At each site, we used minnow traps and dip nets to detect the presence of exotic aquatic species, supplemented by records from Peralta-García et al. (2023). We also documented other potential threats to the turtles, including various types of habitat disturbance such as the presence of livestock (i.e., direct sightings or tracks of cattle, goats, and horses), recreational human activities (e.g., ponds used for swimming or areas with off-road vehicle trails), and infrastructure related to water extraction (e.g., wells and pumps).

Results

Through a comprehensive review of the literature and other sources, we identified the oldest record of turtles in Baja California dating back to 1894 near Tecate, and the most recent from 2016 at Rancho El Chicharo (Table 1). Our final database comprised 41 locality records across 15 watersheds (Table 1, Fig. 1), with confirmed pond turtle presence at 27 of 38 sites (71%) within 10 watersheds in northwestern Baja California. These sites ranged in elevation from sea level to 1,525 m. The 27 confirmed sites include six historical localities, three from previously published records, and 18 newly documented during our surveys (Table 1, Fig. 1). At two historical sites, current presence of turtles could not be confirmed due to lack of access.

We collected morphological data from 707 captured turtles (275 females, 292 males, and 140 individuals of undetermined sex) across 23 sites (Table 2). Adult females showed a larger carapace length than males, averaging 122.8 mm (n = 208) and 120.6 mm (n = 253), respectively (t-test = 2.063, $p < 0.05$). Also, females were significantly heavier than males, with mean weights of 248.6 g and 215.1 g, respectively ($t = 5.571$, $p < 0.001$). The largest turtles measured were recorded at Rancho San Faustino (Site 5), where some individuals reached up to 160 mm of carapace length (Table 2).

Table 1. Historical and present sites for *A. pallida* in Baja California watersheds. Sites are grouped by watershed and arranged from north to south. Threats: Exotic species (E), Livestock (L), Water extraction (W), and Recreation (R).

Locality	Status	Year collected/observed	Elevation	Source	Threats
Tijuana Watershed					
1. Tecate River	Absent	1894	420	USNM 22052	E, W
2. Cañón El Alamo, Tecate	Present	2013, 2022	488	This study	E, R
3. Rancho El Compadre, Sierra Juárez	Present	2023	1,082	This study	E, L, R
4. Rancho El Chaco, Arroyo El Chícharo (~6 km S of El Testerazo)	Absent	1983, 2016		Buskirk (1984), this study	E, L
5. Rancho San Faustino, Sierra Juárez	Present	2013, 2022	1,270	This study	E, L, W
El Descanso Watershed					
6. Cañón El Descanso	Present	2020, 2022	84	This study	E, R
Guadalupe Watershed					
7. Cañón Agua Caliente, Arroyo Guadalupe	Present	2013, 2022	390	This study	E, W, R
8. La Misión	Absent	1963	1	SDNHM 52843	E, W, R
San Antonio Watershed					
9. Cañada Miracielo, Arroyo San Antonio	Present	2013, 2014	358	This study	E, L, W
10. Rancho Jesús María, 11.2 km NE Ensenada, on Hwy. 3	Absent	1983	287	Buskirk (1984)	E, W
Ensenada Watershed					
11. Emilio López Zamora dam, Ensenada	Absent	1999	32	UABC 136	E, R
Maneadero Watershed					
12. Arroyo San Carlos, 13 km below Ensenada	Absent	ND	82	Roberts (1982)	E, W, R
Santo Tomas Watershed					
13. Agua Caliente, Arroyo Santo Tomás	Present	2013, 2022	495	This study	E, L
14. Lagoon at mouth of Santo Tomás Canyon (=Bocana Santo Tomás)	Absent	ND; 1952	4	LACM 105322; UAZ 22057	E, R
15. Arroyo Santo Tomás (4.4 km ENE of Rancho Las Aguilas)	Present	2004, 2022	400	UABC 1514-15, Lovich et al. 2005; this study	E, L
16. Las Tinajitas, Ejido Nativos del Valle	Present	2016, 2022	325	This study	L
San Vicente Watershed					
17. Rancho Las Cruces spring (N of Ejido Erendira)	Absent	1957	302	SDNHM 19222	L, W
18. Rancho Agua Caliente, Arroyo San Vicente	Present	2013, 2014, 2022	226	This study	E, L, W
19. Arroyo San Vicente, 15.3 km E Rancho Guadalupe	Present	1958, 2022	185	SDNHM 43635; this study	E, L, W
El Salado Watershed					
20. Valle de La Trinidad	Present	1926, 2022	764	MVZ 10494 (Linsdale 1932); this study	E, L, W

Table 1. Continued.

Locality	Status	Year collected/observed	Elevation	Source	Threats
San Rafael Watershed					
21. Rancho El Carrizo (tributary of Arroyo San Rafael)	Present	1966, 2022	932	SDNHM 46798; this study	E, L
22. Arroyo San Rafael (23 km E of Colonet)	Present	2014, 2015, 2022	220	This study	E, L, W
23. Arroyo San Rafael medio (32 km E of Colonet)	Present	2014, 2022	340	This study	L, W
24. 9.7 km E of Mike's Sky Ranch (Arroyo El Wicko)	Unknown	ND	1,525	Welsh (1988)	Unknown
25. Arroyo San Rafael, Sierra San Pedro Mártir (near Rancho Mike's Sky)	Present	2008, 2022	1,270	UABC 1772, M. Jones pers. comm. 2016; this study	L, R
26. Arroyo San Rafael, 17.1 km ENE of Colonet	Absent	2005	157	Lovich et al. (2007)	L, W
27. 32.2 km S San Matias Pass (=Rancho Garet, Arroyo San Rafael)	Unknown	1960	1,350	LACM 105323	Unknown
San Telmo Watershed					
28. San Telmo Creek, 3.2 km below San Telmo	Absent	1925	80	MVZ 9818-19 (Linsdale 1932)	L, W
Santo Domingo Watershed					
29. Arroyo El Potrero arriba	Present	2013	1,465	This study	W
30. Rancho El Potrero, Sierra San Pedro Mártir	Present	2013, 2014, 2022	895	This study	L
31. Rancho Valladares, Arroyo Valladares	Present	2013, 2015	730	This study	L
32. Valladares Creek, San Pedro Martir Mts.	Present	1923, 2014, 2015	718	CAS 56884-85; this study	L
33. Arroyo Valladares (4.7 km SW of Rancho Valladares)	Present	2014, 2015, 2022	645	This study	None
34. Arroyo San Antonio, 1.6 km E junction Arroyo La Zanja, Sierra San Pedro Mártir	Present	1973; 2014, 2022	590	MVZ 207759-63 (Welsh 1988); this study	None
35. Arroyo San Antonio Murillos, Sierra San Pedro Mártir	Present	1936; 2004, 2013, 2014, 2016, 2022	555	CAS 7759; UABC 858-59; this study	L
36. Arroyo El Caballo (near junction with Arroyo San Antonio)	Present	2014	505	This study	None
37. Arroyo Santo Domingo, near Rancho La Canastilla	Present	2013	160	This study	E, W
38. Rancho San Isidoro, Arroyo El Horno, Sierra San Pedro Mártir	Present	2014, 2022	905	This study	None
El Rosario Watershed					
39. Rancho San Juan de Dios (48.3 km E of El Rosario)	Absent	1974	565	CAS 138885	L, W
San Fernando Watershed					
40. Misión San Fernando	Absent	ND	460	Roberts (1982)	L, W, R
San José Watershed					
41. Rancho San José, Ejido San José de las Palomas, Central Desert	Present	2009, 2014, 2022	107	UABC 1993, Valdez-Villavicencio et al. 2016	None

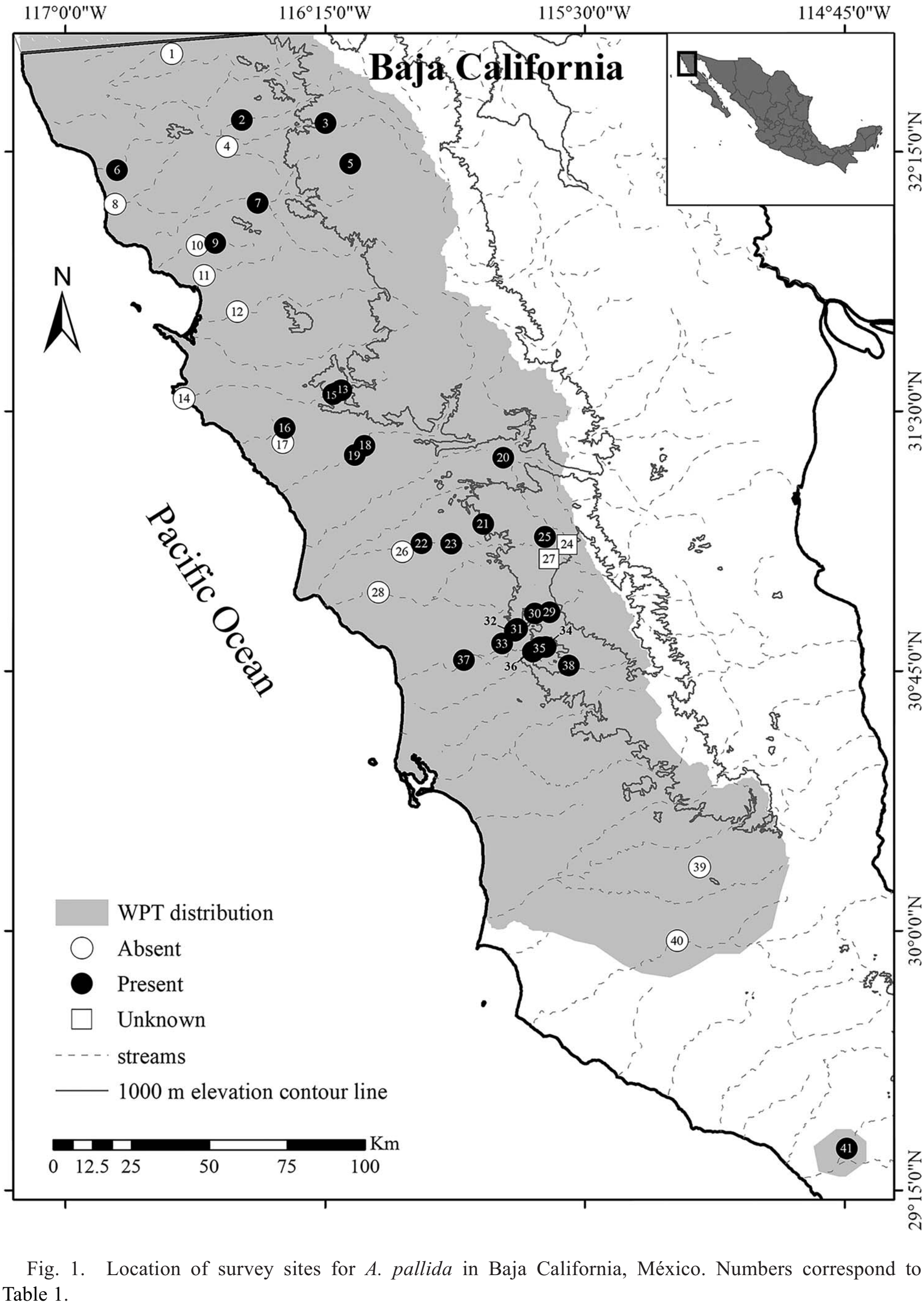

Fig. 1. Location of survey sites for *A. pallida* in Baja California, México. Numbers correspond to Table 1.

At least one conservation threat was detected at most of the surveyed sites. Freshwater exotic species were present at 51% of the sites ($n = 21$), with some locations harboring up to eight non-native species (e.g., Site 11, Emilio López Zamora Dam). The most frequently encountered exotic species included Mosquitofish (*Gambusia affinis*) (Sites: 1, 2, 7, 8, 9, 10,

Table 2. Number of captures, mean carapace length (CL), plastron length (PL) and mass of adult Southwestern pond turtles (*A. pallida*) in Baja California, México. Abbreviations are F = females, M = males.

	Captures		CL (mm)		PL (mm)		Mass (g)	
Locality	F	M	F	M	F	M	F	M
Pine Valley Creek*	14	17	118.9	113.6	105.5	98.8	232.2	198.5
Jamul*	4	8	136.0	141.3	117.7	120.1	-	297.7
Cañón El Alamo	8	11	107.7	120.2	95.3	108.2	180.7	211.8
Rancho San Faustino, Sierra Juárez	19	24	134.1	141.7	116.0	115.8	322.0	308.4
Cañón Agua Caliente, Valle de Guadalupe	2	9	106.1	108.2	92.0	94.1	169.0	164.6
Cañada Miracielo, Arroyo San Antonio	8	8	120.6	117.1	107.7	101.9	208.0	188.3
Agua Caliente, Arroyo Santo Tomás	30	19	109.9	112.9	95.0	95.7	176.3	167.5
4.4 km ENE of Rancho Las Aguilas	7	5	112.2	116.4	101.2	97.4	178.6	156.6
Ejido Nativos del Valle	5	7	129.7	131.7	109.0	108.8	310.0	255.5
Rancho Agua Caliente, Arroyo San Vicente	13	10	123.9	107.1	106.6	90.8	260.0	156.4
15.3 km E of Rancho Guadalupe, Arroyo San Vicente	3	5	131.1	97.5	113.7	83.9	290.0	142.0
Arroyo San Rafael	40	47	116.1	116.7	101.3	99.3	215.6	193.2
Arroyo San Rafael medio	12	13	107.1	115.3	93.7	96.8	180.6	194.3
Rancho El Potrero	6	11	118.2	105.6	105.6	93.6	233.9	161.1
Arroyo Valladares	15	15	105.3	104.6	92.3	89.2	181.8	159.2
Arroyo San Antonio Murillos	78	71	109.5	111.4	95.8	94.7	186.5	185.5
1.6 km E of junction with Arroyo La Zanja	27	18	108.7	110.6	94.5	93.4	183.6	174.0
Rancho San Isidoro, Arroyo El Horno	10	8	108.8	109.5	94.5	93.8	170.6	184.3
Oasis San José, Ejido San José de las Palomas	5	31	118.5	120.1	100.0	99.8	228.7	217.7

*San Diego County, California

11, 12, 14, 18, 19, and 20), Red Swamp Crayfish (*Procambarus clarkii*) (Sites 1, 3, 5, 7, 8, 12, 14, 15, 21, and 22), Green Sunfish (*Lepomis cyanellus*) (Sites 4, 7, 8, 9, 11,12, 13, 15, 20, and 37), and American Bullfrog (*Lithobates catesbeianus*) (Sites 8, 9, 10, 11, and 12). Livestock were also observed at 51% (n = 21) of the sites. Additionally, 46% of the surveyed localities (n = 19), all located near the coast, had dry drainages with no flowing water or permanent ponds, which we attribute to water overextraction. In the San Rafael, San Telmo, and Santo Domingo watersheds, we documented extensive water withdrawal infrastructure, including a large number of wells and pumps immediately adjacent to the river bed, which were used primarily for agriculture on the San Quintín coastal plain. For instance, in the lower Arroyo San Rafael, over 60 pumps were recorded along a 24 km stream segment in Ejido Benito Juárez, mostly for agricultural purposes (R. González, pers. comm. 2020). We also noted that some streams were repurposed for recreational use, particularly swimming. Recreational activity was recorded at 24% of the sites (n = 10), mostly in areas with known hot springs, which attract visitors.

Discussion

The distribution of *A. pallida* in Baja California appears to be broader than in adjacent southern California, United States. Despite being recorded in only 32% of historical localities, new records suggest that the species persists across most of its historic range in Baja California (Grismer 2002; McGinnis and Stebbins 2018). Turtles were found from Sierra Juárez to the Sierra San Pedro Mártir mountain ranges. South of this region, current evidence indicates only three records: Rancho San Juan de Dios (or Rancho El Metate, Site 39), from which a specimen was collected in 1974 but was presumed introduced from a northern population (Welsh 1988) where *A. pallida* is apparently extirpated; Misión San Fernando (Site 40), where a population disappeared in 1978 after heavy rains caused pond siltation (Roberts 1982; Grismer 2002) and pond turtles have not been seen for 44 years despite several searches, including this study; and further south, in Rancho San José (Site 41), is the only current oasis population in Baja California (Valdez-Villavicencio et al. 2016). It is unclear whether this population is natural or introduced. Further genetic analysis of these turtles may help clarify the origin of this population.

Holland (1994) reported that *A. pallida* extended as far south as the Sierra San Pedro Mártir, and other populations south of this area likely resulted from translocation. Welsh (1988) surveyed the region south of the Sierra San Pedro Mártir extensively but did not find any *A. pallida*, supporting the notion that the species does not naturally range beyond this area. Despite our efforts, we recommend more intensive surveys to better define the current distribution of *A. pallida* in the southern part of Baja California. The presumed absence of pond turtles at 12 historical localities require revisitation to confirm their extirpation. Furthermore, it is crucial to estimate the abundance and population trends of each population, particularly at sites where few individuals were observed or captured. We found large numbers of turtles (>25) at five sites, and initial conservation efforts should focus on the management and protection of these sites. The Santo Domingo watershed, which has the highest number of records (n = 10 localities, Sites 29–38, Table 1), is the largest and most important watershed in the region supporting pond turtles. This watershed only has a single exotic species, the Green Sunfish, which was found at the lower elevation site (Site 37), closer to more densely populated coastal agricultural areas. Deeper into the foothills (i.e., eastward), inaccessibility has allowed *A. pallida* to thrive in large numbers, and populations of other species of conservation concern remain secure (e.g., *Rana draytonii*, *Oncorhynchus mykiss nelsoni*, *Microtus californicus*; Jones et al. 2024). However, water overuse and diversions threaten the future survival of even these remote populations as technology and industry extends its reach into the back country.

In our study, turtles in Baja California were smaller than previously reported by Grismer (2002), as our largest individual measured only 160 mm in carapace length, with a mean of 116.2 mm (Table 2; Fig. 2). Mean carapace lengths of 163.6 mm have been reported for Central California (Germano 2010), and 151.5 mm for a population in northern Los Angeles County (Germano and Riddle 2015), both of which represent *A. marmorata*. Germano and Rathbun (2008) reported mean carapace lengths under 145 mm for *A. pallida* in coastal Santa Barbara County, and for the population closest to México in San Diego County, mean carapace lengths ranged from 116.3 mm at Pine Valley, CA to 138.7 mm at Jamul, CA (Nicholson et al. 2020). An exception is the population at San Faustino, where turtles were larger and resembled the sizes observed at Jamul, CA. Both populations are located in ponds, but it is unclear whether ponds are related to the large size, although the site from Germano (2010) with large turtles was a pond site also. Length variation in the western pond turtle occurs across its range and can be influenced by factors such as food availability, predation, activity periods, hydrodynamics (e.g., permanent vs. ephemeral sites), population density, and anthropogenic impacts (Lubcke and Wilson 2007; Germano and Bury 2009; Bury et al. 2010; Nicholson et al. 2020). Future studies may help clarify the causes of the body size differences among populations. Some studies have indicated that southern populations in California reach sexual maturity earlier than northern populations, leading to smaller adult sizes (Holland 1994; Germano and Rathbun 2008), and this could also be the case for populations in San

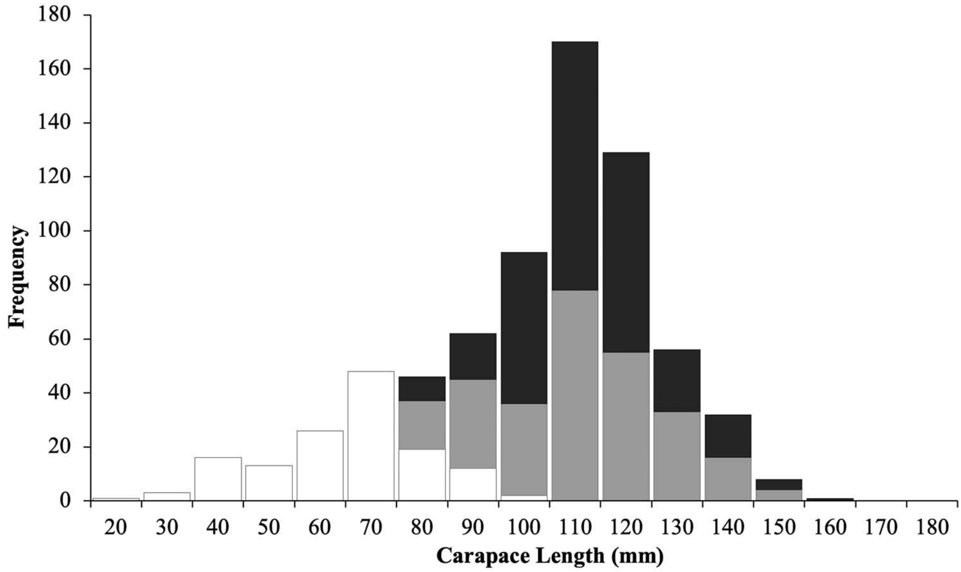

Fig. 2. Frequency distribution of carapace lengths of *A. pallida* from Baja California, Mexico. Black bars represent males; gray bars, females; and open bars, turtles for which gender could not be determined.

Diego and Baja California. However, age was not assessed in this study. Future research should include age analysis to determine whether Baja California turtles reach sexual maturity at a smaller size and in fewer years than those from northern populations.

The main range-wide threats to this pond turtle include introduced predators or potential competitors (Nicholson et al. 2020; Manzo et al. 2021), climate (Gregory et al. 2024a), livestock presence, habitat loss, alteration, and fragmentation (Bury and Germano 2008), and anthropogenic habitat modifications due to recreational activities. We observed exotic species in 21 sites co-occurring with *A. pallida*, including bullfrogs and several fish species known to prey on hatchlings and juveniles of *A. pallida* (Moyle 1973; Bury and Whelan 1984; Nicholson et al. 2020). Although other exotic species may not directly prey on turtles, they may compete for food, modify or remove emergent vegetation that serves as microhabitat for hatchlings, alter aquatic community dynamics, or spread diseases (Bury et al. 2012). In Baja California, no studies have yet confirmed the effects of introduced species on local *A. pallida* populations; however, local ranchers in Cañada Miracielo report that turtles were formerly common, but since the arrival of bullfrogs (*L. catesbeianus*) several years ago, they have seen fewer turtles. At three locations (Sites 8, 11, and 12) with high bullfrog abundance, *A. pallida* was not observed.

Livestock was present in 21 locations. The presence of cattle in or near streams or ponds can cause turtle mortality by trampling (JHVV and APG pers. observ. 2015), lead to the loss of aquatic vegetation that is both consumed by livestock and used as habitat by hatchlings, or crush turtle nests on streambanks (Hays et al. 1999). Additionally, livestock activity can degrade habitat quality through soil compaction, increased evaporation, streambank destabilization, increased sediment load, and reduction in depth of and composition of native vegetation (Kaufman and Kreuger 1984; Orodho et al. 1990; Fleischner 1994; Peralta-García et al. 2016; O'Callaghan et al. 2019). Habitat was lost in four sites due to apparent overuse of water, and the potential reasons for the absence of turtles in eight other sites remain unclear.

At Site 4, we found only two adult turtles in a small pond in 2016, and when we revisited the site in 2022, the habitat was completely dry. Other sites lacking turtles, La Misión, the Emilio López Zamora Reservoir, and Arroyo San Carlos (Sites 8, 11, and 12), harbored the greatest number of exotic freshwater species.

At Bocana Santo Tomás (Site 14), a large lagoon at the mouth of the Santo Tomás basin, locals indicated that agricultural waste is discharged into the water. During our 2017 survey, salinity measured 7.6 ppt, whereas in 1996 it ranged from 0.8 to 2.4 ppt (Rivera-Campos 2006), indicating an increase in salinity over a 10 yr period. *Actinemys pallida* can inhabit brackish marshes (Nicholson et al. 2020 for site references; Agha et al. 2019 for *A. marmorata*); however, it is unknown whether salinity levels at Bocana Santo Tomás fluctuate enough to support turtle survival. Our own observations and surveys lead us to believe that turtles have been extirpated from San Juan de Dios and Misión San Fernando, whereas the decline at Rancho Las Cruces (Site 17) remains unclear.

Excessive water use for irrigation in agricultural areas throughout the southern range of *A. pallida* is lowering stream water levels and leading to ponds loss (Peralta-García et al. 2016). In most watersheds, we did not find flowing water near the coast, and in some cases 20 river km from the coast was completely dry, presumably due to the presence of numerous groundwater pumps and a surface pipeline network that delivers water throughout the region (Sites 8, 15, 19, 26, 28, and 37). Four historical sites (4,10, 26 and 28; Fig. 1) no longer have surface water and are therefore no longer suitable habitat. In addition to these factors, reduced rainfall and thus prolonged droughts could strongly affect turtle survival in the future (Gregory et al. 2024b).

Recreational activities involving swimming in ponds or streams were observed at 10 sites and may disrupt normal turtle behavior (Bury and Germano 2008). At the historical site Arroyo San Carlos (Site 12), just south of Ensenada, no turtles were found. This site is heavily impacted by several artificial ponds built within the stream channel, altering the natural habitat for several km and contributing to high stream pollution (CONAGUA 2021). In Cañón El Alamo (Site 2), off-road vehicles use the streambed as a trail, degrading the habitat and potentially causing mortality in *A. pallida* (Bury et al. 2012).

Our results indicate that *A. pallida* is still present throughout its historical range in Baja California, contradicting earlier reports of extirpation (Stebbins 2003; McGinnis and Stebbins 2018). However, population trends remain unknown. A better understanding of the demographic structure, conservation status, and ecological needs of these populations is essential for informing management strategies, particularly as suitable habitat continues to decline, especially in coastal areas. We found that most of the conservation threats reported for the species in the United States are also present in Mexico (Nicholson et al. 2020; Manzo et al. 2021), though possibly to a lesser degree, such as shell disease (Woodburn et al. 2019; Lambert et al. 2021). Urgent action is needed to mitigate these pressures, as the long-term survival of *A. pallida* in Baja California will depend on the implementation of effective conservation strategies that address both current and emerging threats. Only through sustained effort and continuous monitoring can we ensure that this unique species persists in the region.

Conclusions

Given the continued presence of *A. pallida* in Baja California, it is crucial to adopt a proactive and multifaceted approach to its conservation. While the species is not yet extirpated, it faces numerous threats that may hinder its long-term survival, including habitat loss, invasive species, and anthropogenic disturbances. Immediate actions should focus on habitat protection and restoration, particularly in coastal areas where degradation is most pronounced. Furthermore, it is essential to implement more comprehensive monitoring programs to track population dynamics, demographic structures, and identify emerging threats, such as disease outbreaks. Effective management strategies must prioritize controlling introduced species, protecting vital aquatic habitats, and mitigating human-induced pressures from agriculture, livestock, and recreational activities. Additionally, further research into the ecological requirements of *A. pallida*, including its response to climate change, is necessary to guide adaptive conservation measures. A concerted effort from government agencies, local communities, and conservation organizations is crucial to ensure the persistence of this vulnerable species in the future.

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