A REVIEW OF THE HISTORICAL MARKET: EFFECT OF THE WEST COAST COMMERCIAL FISHERY ON WESTERN POND TURTLES (Actinemys marmorata and A. pallida)

MATTHEW P. BETTELHEIM¹ AND CHI-WAH WONG

AECOM, 300 Lakeside Drive, Suite 400, Oakland, California 94612 ¹Corresponding author, e-mail: matthew.bettelheim@aecom.com

Abstract.—In the mid to late 1800s and early 1900s, Western Pond Turtles (*Actinemys marmorata* and *A. pallida*) were sought after in California as an ingredient in turtle soups and stews. At the height of the commercial terrapin fishery in California in 1895, about 63,000 Western Pond Turtles were reported in the markets, but agency records are sporadic and a full accounting of the market data remains incomplete. The U.S. Fish and Wildlife Service (USFWS) initiated a review of the status of Western Pond Turtles in 2015 to determine if there is sufficient evidence to warrant their listing as an Endangered or Threatened species. To better understand the magnitude of the commercial terrapin fishery, we reexamined commercial fish landing reports of the USFWS and California Department of Fish and Wildlife (CDFW) and other relevant texts available in digital repositories to determine the Reported (known) market data (262,600 turtles). Then we estimated the Model-fitted (unknown) market data (261,500 turtles) to calculate the overall Estimated market total (524,100 turtles). Because the source material suggests that the market data reported in agency reports underrepresented the overall terrapin fishery, we calculated scaled estimates that suggest as many as a million turtles were captured for human consumption. These numbers demonstrate the magnitude of the historical terrapin fishery and could provide a baseline to inform future listing decisions.

Key Words.—California; commercial exploitation; commercial fishery; data analysis; endangered or threatened species; historical record; population decline; reptiles.

INTRODUCTION

The Western Pond Turtle (Fig. 1) complex (Actinemys marmorata and A. pallida) and the Western Painted Turtle (Chrysemys picta) are the only freshwater turtles native along the North American Pacific Coast west of the Sierra-Cascade divide between Canada and Baja California (Iverson et al. 2017; Turtle Taxonomy Working Group 2017). Excluding the Sonora Mud Turtle (Kinosternon sonoriense) that is now extirpated from locations where its range along the Colorado River once extended into California (Turtle Taxonomy Working Group 2017; Stebbins 2003), Actinemys are the only freshwater turtles native to California. Western Pond Turtles (listed as terrapin in the historical record) were once sought after in California as an ingredient in turtle soups and stews served in hotels and restaurants of San Francisco in the mid to late 1800s and early 1900s (Wallace W. Elliot and Co. 1883a, 1883b). At the height of the commercial terrapin fishery in California in 1895, about 63,000 Western Pond Turtles were reported in the meat markets that year alone (Wilcox 1902).

Although the history of the commercial market for Western Pond Turtles was documented previously (Bettelheim 2005), a full accounting of the market data was incomplete. Between 1888 and 1931, intermittently published fishery records of agencies documented the commercial harvest of turtles that were collected throughout the state for sale in the San Francisco market (Bettelheim 2005); however, there are data gaps of as many as 17 y (e.g., 1863–1879) in the historical record between 1863 and 1931. In 1992, the U.S. Fish and Wildlife Service (USFWS) initiated a review of the status of the Western Pond Turtle (considered at that time to be a single species) to determine if there was sufficient evidence to warrant listing as an Endangered or Threatened species under the Endangered Species Act (USFWS 1992). At that time it was determined that the species did not warrant such listing based on the best scientific and commercial information available (USFWS 1993). In 2015, the USFWS initiated a new review of its status (USFWS 2015), and this review is still in progress. A better understanding of the magnitude of the commercial terrapin fishery could provide insight into previous distribution and population sizes and



FIGURE 1. Northwestern Pond Turtle (*Actinemys marmorata*) from the upper Klamath River in southern Oregon, USA. (Photographed by Matthew Bettelheim).

establish a baseline to inform future listing decisions. This paper reexamines the historical terrapin fishery of the west coast of North America to better quantify its magnitude and extent.

Methods

Nomenclature.--The Western Pond Turtle complex includes both the Northwestern Pond Turtle (A. marmorata) and Southwestern Pond Turtle (A. pallida; Iverson et al. 2017). Because we examined primarily historical source materials that did not recognize two species, we used the name Western Pond Turtles collectively to represent both species throughout their ranges. Based on repeated context clues throughout the literature, the term terrapin was traditionally used in the late 1800s and early 1900s in the commercial fish landing reports of the west coast of North America to refer to any edible, non-marine turtle, while the word turtle was used to refer only to sea turtles. For example, terrapin were sold by the dozen, which was not an observed standard unit of sale for sea turtles. The reported origins of terrapin that were captured included both coastal and inland California counties rather than strictly coastal counties and the reported origins of turtles was strictly limited to Mexico. This usage is consistent with common parlance around this time, which in Webster's New International Dictionary of the English Language in 1939 recognized a terrapin as "any of various edible North American turtles of the family Testudinidae living in fresh or brackish water, esp. any of those constituting the genus Malaclemys," and recognized a turtle as "any marine reptile of the order Chelonia." A similar commercial market existed for Diamond-backed Terrapin (Malaclemys terrapin), which dates back to the 1500s, and was still active on the east coast of North America during the late 1800s and early 1900s (Brennessel 2006).

Although we found little distinction made between Western Pond Turtles and the Diamond-backed Terrapin in the commercial fisheries, it is unlikely that Diamondbacked Terrapin were regularly imported from the East

Coast to the West Coast to supply the San Francisco market. There is no mention in the literature of an attempt to import Diamond-backed Terrapin to support a commercial market on the west coast. Attempts to introduce Diamond-backed Terrapin to the marshlands in the San Francisco Bay Area were made in 1894 (Newspaper 1; Newspaper 2), in 1896 (State Board of Fish Commissioners 1900; Taft 1944; Brown 1971), and in 1943 (Taft 1944; Hildebrand and Prytherch 1947; Brown 1971). There is no evidence that these experimental introductions were successful (Jennings 1983). Therefore, we inferred all references to terrapin in the literature on the West Coast fisheries (e.g., terrapin market, terrapin fishery, terrapin trade), when not explicitly corroborated by name, to be Western Pond Turtles. We considered only commercial fishery data specific to terrapin, rather than turtle, during literature searches.

We collected data for the commercial terrapin market from two primary agencies: the California Department of Fish and Wildlife (CDFW) and the USFWS. Although both agencies underwent several organizational name changes between their inception and the present, and published agency reports accordingly under those various names, for simplicity we refer to each agency in the text by their contemporary name. Similarly, we refer to the California Fish and Game Commission, which is the regulatory body of CDFW.

Source material.—We revisited the commercial terrapin market data from Bettelheim (2005) plus additional resources to fill in missing data that may have been digitized since 2005. This included a review of all available annual/biennial commercial fish landing reports of CDFW, including its biennial reports, the journal California Fish and Game (now, California Fish and Wildlife Journal), select issues of the Fish Bulletin of CDFW that revisit historical commercial fishery data, and assorted USFWS fisheries reports (Table 1). We searched for the key word terrapin using Optical Character Recognition in digital repositories (Table 1)

TABLE 1. Source materials searched for data on the commercial terrapin market	in California. Abbreviations are USFWS = U.S. Fish
and Wildlife Service and CDFW = California Department of Fish and Wildlife.	Online searches were made with the term terrapin.

Source	Reference
USFWS fisheries reports	Collins (1892), Smith (1895), Wilcox (1895), Wilcox (1898), Townsend (1900), Wilcox (1902), Wilcox (1907), Sette (1928), Fiedler (1932), Fiedler (1933)
CDFW biennial reports	State Board of Fish Commissioners 1886, 1900 California Fish and Game Commission 1910, 1913, 1914, 1916, 1918, 1921, 1923, 1924, 1927, 1929, 1931, 1933
California Fish and Game/ California Fish and Game Journal	Board of Fish and Game Commissioners 1918a,b,c,d, 1919a,b,c,d, 1920a,b,c,d, 1921a,b,c,d, 1922a,b,c,d, 1923a,b,c,d, 1924a,b,c,d, 1925a,b,c,d, 1926a,b,c,d, 1927a,b Division of Fish and Game 1927a, b, 1928a,b,c,d, 1929a,b,c,d, 1930a,b,c,d, 1931a,b,c,d, 1932a,b,c,d
Fish Bulletin	Staff of the Bureau of Commercial Fisheries 1929, 1930, 1935, 1936, 1949
Online	www.escholarship.org, www.hathitrust.org, www.archive.org, www.californiawarden.com, www.biodiver- sitylibrary.org, www.library.noaa.gov, cdnc.ucr.edu, and chroniclingamerica.loc.gov

and constrained searches to 1848 through 1940, using the California Gold Rush (when there was a sudden influx of prospectors and settlers to California) as a starting point, and as an end point a span of roughly 10 y beyond 1931 when Western Pond Turtles were last reported in the market (Bettelheim 2005).

Units of measurement and abundance.---We reported all units of measure in the metric system, but included the equivalent conversion in the imperial system when describing turtle weight as they were originally reported in the source material for comparative purposes. We reported all commercial terrapin market data by total number (e.g., 3,600 turtles). In select years between 1918 and 1924, CDFW reported the products or yield of the fisheries for the commercial terrapin fishery market data in both pounds and dozens (California Fish and Game Commission 1921, 1923, 1924, 1929; Staff of the Bureau of Commercial Fisheries 1930, 1936), offering an average weight per turtle of 907 g (2 lbs), a number confirmed in later Bureau of Commercial Fisheries records (Staff of the Bureau of Commercial Fisheries 1930). We therefore divided data originally reported in pounds by a factor of two (assuming an average weight per turtle of 907 g = 2 lbs), and multiplied data originally reported in dozens by a factor of 12, to convert pounds/ dozens measurements into a total number of turtles.

Data analysis.—To determine the magnitude of the terrapin fishery, we made certain assumptions based on the Reported (known) market data to estimate the Model-fitted (unknown) market data (i.e., data in-between reported years), and then calculate the overall Estimated market totals. Assuming an average weight per turtle of 907 g, we converted all market data into total number of individual turtles and plotted them in Microsoft Excel on a time-series chart (Fig. 2). Next, for years where market

data were unavailable between 1862 and 1931, we estimated the total number of turtles for each unreported year based on an ascending exponential fit of Reported data between 1862 and 1895, as follows:

$$y = 2.4068 e^{0.3133x}$$

where y = number of turtles per year and x = number of years since 1862 (i.e., x = 0 at 1862, x = 1 at 1863, etc.). For unreported years between 1899 and 1931, we estimated numbers based on a descending exponential fit of Reported data between 1899 and 1931 as follows:

$$v = 96433096 e^{-0.2082x}$$

where y = number of turtles per year and x = number of years since 1862 (i.e., x = 37 at 1899, x = 38 at 1900, etc.). We then combined and plotted the Reported data and the Model-fitted curve together on a single timeseries chart (Fig. 2) to examine the overall results. Next, for the single unreported year of 1896 (data were reported for 1895 and 1897) not covered by the two other exponential fits, a linear interpolation based on the 1895 and 1897 values was used to represent an estimate for the year of 1896. Lastly, we used the sum of the Reported data and Model-fitted data (where Reported data were not available) to calculate the Estimated market totals between 1863 and 1931.

RESULTS

History of the San Francisco terrapin fishery.— We include a brief history of the San Francisco terrapin fishery here. A more exhaustive review is available elsewhere (Bettelheim 2005). In 1863, the terrapin fishery of the west coast of North America was first documented through a brief mention describing terrapin



FIGURE 2. Time-series chart depicting the Reported (known) and Model-fitted (unknown) market data for Western Pond Turtles (*Actinemys marmorata* and *A. pallida*) from California for the years 1863 through 1931, based on U.S. Fish and Wildlife Service and California Department of Fish and Wildlife annual/biennial commercial fish landing reports and other relevant texts.

Bettelheim and Wong • Historical terrapin fishery effect on Western Pond Turtles.



FIGURE 3. Historical map of California showing the primary water bodies in the Central Valley where the historical terrapin fishery took place. As depicted here, during flood events, Tulare Lake would engulf neighboring water bodies in the southern San Joaquin Valley floor. The outer limits of the lake (blue overlay) represent the reported extent of the shoreline in 1854 (base map adapted from the Map of Public Surveys in California to Accompany Report of the Surveyor General, 1854; http://www.geographicus.com/mm5/ cartographers/landoffice.txt).

caught for meat markets (Cooper 1863). A few years later, Cronise (1868) reported that Western Pond Turtles were almost constantly for sale in the markets of San Francisco (Fig. 3).

One trapper in Tulare Lake in the San Joaquin Valley employed a common fishing seine 30 m in length dragged between two men and on a good day, this method would yield as many as 80 or 90 turtles on each set (Wallace W. Elliot and Co. 1883b; Brown and Richard 1940). Another trapper seined Tulare Lake between 1884 and 1894 with a net 400 m long dragged by horses, which yielded an average of several dozen turtles a catch that were packed two dozen to a barley sack and shipped to San Francisco on a Railroad Express car (Newspaper 3; Gist 1976). Two brothers employed a sailing vessel to fish for turtles and in one season they caught as many as 3,600 turtles (Newspaper 3; Wallace W. Elliot and Co. 1883a, 1883b; Mitchel 1970; Haslam 1993).

At the same time, farmers diverted the waters and feeder streams of the San Joaquin Valley for irrigation, and the lakes in the Tulare and Buena Vista basins (Tulare, Buena Vista, and Kern lakes), which during wet years could merge into a giant lagoon, instead dried up, destroying the local fisheries, depriving regional wildlife (waterfowl, beavers, otters, grizzlies, elk) of a key water source, and eliminating the local terrapin fishery (Haslam 1993). By the early 1900s, the once 80,937 ha Tulare Lake was all farmland, with the waters diverted to irrigate cotton and safflowers (Haslam 1993). By 1892, one turtle meat operation was underground beneath the California Street Market of San Francisco (Newspaper 4). There, turtles gathered up from the sluices and creeks along the Sacramento and San Joaquin rivers were "piled up like so many thousands of brick[s]" to be sold for \$0.50 apiece (Newspaper 4; Fig. 4). In

1897, another wholesaler reported shipping 7,200 turtles to San Francisco markets (Newspaper 5). Their stock came from the big canyons and high mountain streams of the upper Sacramento River, and was collected at times by Native Americans (Newspaper 5). They also had an additional stock of 9,000 turtles on hand in northern California, with the intent of increasing their stock to 20,000 turtles by hunting on the Klamath Indian Reservation in Oregon the following year (Newspaper 5). Tracy Irwin Storer, Professor at University of California Davis, documented the later years of the terrapin fishery. In 1923, he questioned one trapper who would ship his largest turtles to market in barley sacks with as many as 54 turtles apiece (T.I. Storer, archived field notes, California Academy of Sciences; J.S. Dixon, archived field notes, Museum of Vertebrate Zoology). In 1925, Storer met with a San Francisco turtle dealer who had been in business for 22 y supplying frogs and turtles to colleges and restaurants. His turtles came from the Central Valley (Sacramento and San Joaquin valleys) and were purchased from various trappers at \$3.00 to \$5.00 per dozen. At the time of the visit by Storer, the dealer had > 50 turtles on hand (T.I. Storer, archived field notes, op. cit.). As the terrapin fishery drew to a close, in 1931 Storer interviewed a northern California market hunter who was keeping 1,400 Western Pond Turtles for the market to be sold for \$2.50 per dozen in Chinatown of San Francisco (T.I. Storer, archived field notes, op. cit.).

Market numbers.—By 1880, a minimum of 3,600 turtles, representing the haul of one trapper in Tulare Lake, was sent to San Francisco in one season (Wallace W. Elliot and Co. 1883a, 1883b; Figs. 2 and 3). Between 1888 and 1894, USFWS records on fisheries of the Pacific Coast reported between 12,000 and 24,000 turtles



FIGURE 4. The 22 April 1892 issue of The Morning Call, a San Francisco newspaper, included a description of a terrapin ranch in operation underground beneath California Street Market of San Francisco (Newspaper 4).

per year passing through the San Francisco market alone (Collins 1892; Smith 1895; Wilcox 1895). The 1890s marked the apex of the terrapin fishery. At the apparent height of the terrapin fishery in 1895, 42,864.5 kg (94,500 lbs) of turtles (explained in a footnote to represent 63,000 turtles) were sold in San Francisco originating from the Central Valley and Bay Area (Wilcox 1898). In the years that followed, 7,200 turtles (from northern California), 6,063 turtles (no origin reported), and 53,935 turtles (from the Bay Area and Central Valley) were marketed in 1897, 1898, and 1899, respectively (Newspaper 5; Townsend 1900; Wilcox 1902).

After the turn of the century, records were scarce. Then, starting in 1916, the California Fish and Game Commission began tracking commercial catch (based on what were called landing receipts or fish-tickets) submitted by markets and packing facilities (Table 1). Market numbers between 1916 and 1931 rarely exceeded 500 turtles, with the exception of higher numbers reported in 1916 (1,608 turtles), 1917 (4,728), and 1919 (3,247).

These numbers may underestimate the intensity of the terrapin fishery underway. In 1931, the last year for which commercial terrapin market data was reported, at least one market hunter was storing turtles (T.I. Storer, archived field notes op. cit.). That same year, however, official records for the San Francisco terrapin fishery reported only 330 turtles sold (California Fish and Game Commission 1933; Staff of the Bureau of Commercial Fisheries 1935; Staff of the Bureau of Commercial Fisheries 1936; Division of Fish and Game 1932b). Depending on whether the 330 turtles sold that year originated from the 1,400 turtles harvested by the market hunter Storer interviewed (1,400 turtles total harvested in 1931) or were harvested by a second party (1,400 + 330)turtles total harvested in 1931), as many as 1,730 turtles may have been harvested that year. This discrepancy in numbers suggests that the 330 turtles officially reported for sale in the San Francisco market that year may have underrepresented the actual terrapin fishery by an order of five times or greater (Table 2).

TABLE 2. Estimated underrepresentation (last column) of the actual number of Western Pond Turtles (Actinemys marmorata and A.
pallida) harvested compared to commercial terrapin fishery data based on the reported number sold in 1897, 1904, and 1931. Headings
are Sold = reported number of turtles sold, Unsold = reported number of turtles unsold, Harvested = number of turtles sold and unsold,
Percentage = number of turtles sold / harvested, and Underrepresentation = number of turtles harvested / sold.

Year	Sold	Unsold	Harvested	Percentage	Underrepresentation
1897	7,200	9,000	16,200	44.44%	2.25 ×
1904	15,770	9,730	25,500	61.84%	1.61 ×
1931	330	1,400	1,730	19.08%	5.24 ×

The potential for underrepresenting the terrapin fishery is further reinforced by two more instances. In 1904, Wilcox (1907) reported 11,567 kg (25,500 lbs) total for the state of California, followed by two entries for the products of Sacramento County (907 kg = 2,000lbs) and San Joaquin County (10,659 kg = 23,500 lbs). The two county totals equal the sum of the state total, and there is a third entry of just 7,153 kg (15,770 lbs) for what is termed the wholesale fishery trade of San Francisco. Of the 11,567 kg marketed from the Central Valley that year, only a portion of the product, 7,153 kg (roughly 61.8%), reached the San Francisco market to be recorded. Lastly, in 1897 one northern California wholesaler reported shipping 7,200 turtles to San Francisco, with an additional stock of 9,000 turtles on hand (Newspaper 5; Table 2).

Based on commercial terrapin market data, the reported terrapin fishery from 1863 and 1931 was about 262,600 turtles. When plotted on a time-series chart, the Reported data is a curved ascending line and a curved descending line. Based on Model-fitted data for which Reported data were not available for a given year, an additional 261,500 turtles may have been harvested. Therefore, we estimated that a total of 524,100 Western Pond Turtles were harvested between 1863 and 1931 (Table 2).

DISCUSSION

We estimate that more Western Pond Turtles were being harvested by trappers in the wild or captivity than were being reported in market receipts, fish-tickets, or fish landing reports. Thus, the number of Western Pond Turtles sold to retailers and consumers in the market each year likely represents a fraction of the number of Western Pond Turtles actually harvested in the wild. This suggests that the actual magnitude of the terrapin fishery may have been much greater than the overall estimated total. The likelihood that the Reported and Model-fitted market data underrepresent the actual magnitude of the overall terrapin fishery is substantiated by two agency reports that state that their numbers reflect only a small part of the turtle catch because most of the turtles caught were handled by dealers not in the regular fish business (Staff of the Bureau of Commercial Fisheries 1936) and most of the catch was not listed on the commercial fish receipts because turtle dealers were not required to submit

statistical records (Staff of the Bureau of Commercial Fisheries 1949).

Our analysis assumes that turtles continued to be harvested and sold in years for which no commercial terrapin market data were reported. The historical record includes several instances where trappers were supplying the market with turtles, while holding stocks of turtles on reserve. Further, if we treat the inventory of these three unique dealers in business in 1897, 1904, and 1931 not as isolated occurrences but as a reasonable representation of standard market practice between 1863 and 1931, and assume these and other dealers were operating simultaneously, then the overall magnitude of the terrapin fishery could be over a million turtles (assuming the estimated total of 524,100 Western Pond Turtles was underrepresented by an order of at least two times).

Due to the limitations of intermittent agency fishery records and the uncertainties associated with secondary source material, the analysis we performed required model-fitting that may over- or underestimate the magnitude of the terrapin fishery. Further, the primary basis for the terrapin fishery is limited to commercial terrapin market data reported for a portion of California destined for the San Francisco market. There were reported plans to collect turtles in Oregon, but it is unknown whether similar markets existed for Western Pond Turtles elsewhere in the range of the species. Similarly, there is no mention, nor any evidence to support or dispel, the potential for collecting the Western Painted Turtle, whose native range extends into portions of Oregon and Washington (Turtle Taxonomy Working Group 2017). This potentiality, however, is highly unlikely given the ready availability of Western Pond Turtles closer to California and the San Francisco markets. While care should be taken relying on the accuracy of these numbers, this analysis indicates a significant scale of the historical terrapin fishery and puts the decline of Western Pond Turtles in perspective, especially in the context of risks facing these species today.

After 1931, Western Pond Turtles disappeared from the commercial terrapin fishery records. Much like the Diamond-backed Terrapin on the east coast of North America, the demand for Western Pond Turtles had waned over the years, most likely in response to the same economic, legal, and social factors: the involvement of the U.S. in World War I (1914–1918); the Prohibition Era (1920–1933); the Wall Street Crash (1929); and The Great

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-(MRS. T. SECOND ST.)-Three or four are plenty for eight or ten persons. Have ready a pot of boiling water, into which you have put a teaspoonful of salt for each terrapin. Wash the live terrapin in two or three waters, till they are perfectly clean. Throw in the boiling water and cook till so tender that you can easily pull off a leg. Take them out; pull off the top shell, remove the sand bag and gall (very carefully). Cut up all the rest into small pieces, keeping all to cook except the skinny portions and the intestines. Put in a stew pan, with cooking sherry(a small tumbler full to each terrapin). To every terrapin, allow two ounces of butter cut in pieces, and rolled in flour. Season with salt, cayenne pepper, and black pepper. Let this all come to a boil, then just before serving, beat up the yolks of as many eggs as you have terrapin, and stir in.

FIGURE 5. An example of a typical recipe for terrapin that includes the requisite alcohol, in this case sherry, as featured in the 1872 edition of the Recipe Book of the Ladies of California (Ladies of California 1872).

Depression (1929–1933; Coker 1920; Hildebrand 1929). If turtle consumption was only considered palatable if cooked in alcohol such as sherry, dry sherry, white wine, Madeira, or brandy (Ladies of California 1872; Coker 1920; Fig. 5), then the prohibition of the manufacture and sale of alcoholic beverages from 1920–1933 may have ended the general consumption of Western Pond Turtles.

These effects would have been further compounded by local changes in the California landscape, especially the conversion of the Tulare Lake basin to farmland by 1900. Prior to 1895, the peak in number of turtles could be attributed to the drawdown of Tulare Lake. If these turtles originated from Tulare Lake (their point of origin is unreported), they may have been easier to collect as the waters receded and turtles became concentrated in the shallow waters of the lake. Then, in the five years leading up to the complete drawdown of Tulare Lake, the number of turtles drops precipitously from 63,000 turtles in 1895 to roughly 7,200 in 1897 and 6,063 in 1898. The direct cause-and-affect implied here is uncertain, however. Between 1895 and 1898, the turtles reported in the market originated not from Tulare Lake, but from the rest of the San Joaquin Valley and Bay Area, plus the upper Sacramento River. 1895 also marks the first year in which agencies recorded the point of origin of turtles by county. While the practice of reporting the county of origin might simply reflect the implementation of better data collection practices, it might also represent a move of the terrapin fishery away from Tulare, Buena Vista, and Kern lakes and the Sacramento and San Joaquin rivers into the waters of the surrounding counties farther north. By 1900, Tulare Lake would have dried up, depleting the terrapin fishery of this invaluable source of turtles, and despite a second peak of 53,935 turtles in 1899 (again, also from the Bay Area and Central Valley), market data post-1899 shows a steady decline thereafter.

Trappers undoubtedly sought out large adult turtles that would yield more meat for sale at market. The harvest of adult turtles reduces reproductive capacity in the population (Close and Seigel 1997). In general, turtles are long-lived, have low reproductive rates, and high juvenile mortality, which makes them vulnerable to collecting (Pough and Janis 2019). Western Pond Turtles attain reproductive maturity at approximately 130 to 135 mm carapace length (CL), which may require 5-10 y to reach this size in more northern portions of their range (Bury et al. 2012), but they can reach maturity as young as 4-5 y in Central Coast of California (Germano and Rathbun 2008) and in the San Joaquin Valley (Germano 2016, 2021). Collecting for the commercial harvest likely had an impact on turtles by removing a greater number of reproductively viable adults and, consequently, acted as an intense population suppressant. Given that turtles throughout Central California exhibit fast growth rates and early maturity (Germano and Rathbun 2008; Germano 2016, 2021) compared to more northern areas of their range, the commercial harvest at Tulare Lake and throughout the valley floor may have permitted the collection of younger adult-sized turtles, functionally increasing the number of turtles acceptable for sale in the commercial market. Demographic studies of other turtle species indicate that population stability is sensitive to changes in adult or juvenile survival (see Congdon et al. 1993, 1994). Across multiple turtle species exhibiting a range of mean annual fecundity, annual survival, and age at maturity, Heppell (1998) demonstrated that adult survival had the greatest influence on the annual population multiplication rate of turtle species. Levell (2000) reports similar patterns in Clemmys and Emydoidea pond turtles where adult survivorship is central to the long-term persistence of functional wild turtle populations. Accordingly, Bury et al. (2012) reinforced that the recovery of a long-lived and slowgrowing turtle species like Western Pond Turtles could be difficult after a population is depleted.

Although the demand for Western Pond Turtles all but disappeared during the post-1929 depression, new risks continue to threaten their populations today, including urbanization and development, water projects, and habitat fragmentation. Other potential (but not yet shown) problems are introduced non-native turtles like Red-eared Sliders (*Trachemys scripta*) and potential nonnative predators such as American Bullfrogs (*Lithobates catesbeianus*; Bury et al. 2012), and most recently, the emerging fungal pathogen Shell Disease (*Emydomyces testavorans*; Haman et al. 2019; Woodburn et al. 2019; Adamovicz et al. 2020; Woodburn et al. 2021). The vulnerability of Western Pond Turtles to these threats may have been exacerbated by the commercial terrapin fishery that began more than 150 y ago, and the ability for the populations to recover after more than half of a century of harvest would only be complicated by these emerging risks.

Without an estimate of the overall population sizes of Western Pond Turtles today, it is difficult to quantify the effects the terrapin fishery exacted on population numbers overall. Still, the market numbers from earlier show the magnitude of this terrapin fishery. Now, we need estimates of remaining populations. By establishing a baseline for the magnitude of the terrapin fishery, this information could help inform future listing decisions, and future researchers and resource managers can make more informed management decisions on behalf of the species.

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MATTHEW BETTELHEIM is a Herpetologist, Certified Wildlife Biologist, and Natural Historian in the San Francisco Bay Area, California, USA. Matthew has been exploring the effects of the historical commercial terrapin fishery on Western Pond Turtles for over 20 y and is involved in the Western Pond Turtle Conservation Project of the Association of Zoos & Aquariums SAFE (Saving Animals From Extinction), organized and presented at the 2005 and 2015 Western Pond Turtle Workshop: Ecology & Conservation sponsored by the Western Section of The Wildlife Society. He was involved in a 15–y radio–telemetry study of Western Pond Turtle nesting behavior in coordination with the Oakland and San Francisco zoos. Matthew received his B.S. from University of California, San Diego, California, USA. His 2005 paper, Marmorata: The Famed Mud Turtle of the San Francisco Market in *California History* provides a more exhaustive review of the historical commercial terrapin fishery for the Western Pond Turtle. (Photographed by Sarah Anne Bettelheim).

CHI-WAH WONG is a Senior Scientist and Environmental Statistician in the San Francisco Bay Area, California, USA. Chi-Wah has been the leading statistician and data analyst for a global environmental and engineering consultant firm for over 20 y. He has been involved in many projects entailing quantitative and statistical modeling. His expertise includes efficient data discovery and practical interpretation of available historical data using statistical or probabilistic models customized to the needs of each individual project. His works include subjects such as biological monitoring of various floras and faunas, population dynamics, and other mathematical modeling in the life sciences, and provide indispensable support for technical determination and policy decision-making. (Photograph not provided).