

# WESTERN POND TURTLES (*CLEMMYS MARMORATA*) IN THE CENTRAL VALLEY OF CALIFORNIA: STATUS AND POPULATION STRUCTURE

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**ABSTRACT:** The Central Valley of California once may have been the area of greatest turtle density within the range of the western pond turtle (*Clemmys marmorata*). Extensive draining of wetlands and habitat alteration in the past century has left few aquatic areas that are suitable for this species. A recent petition to the U. S. Fish and Wildlife Service argued that the western pond turtle needed protection from the Endangered Species Act because its populations were declining seriously, especially in the Central Valley where remaining populations were comprised of non-reproducing old adults. In 1999, we visually surveyed 55 aquatic habitats on the valley floor of the Central Valley and, of these, trapped 17 (and some hand capture) to determine the current status of the western pond turtle. We saw or caught turtles at 15 sites. Also, we suspect that turtles occur, at least in low numbers, at numerous other sites. Turtles were abundant at 5 sites in the Central Valley. At each of these sites, populations consisted of many young, but large, turtles. Turtles grew rapidly at all sites. Despite suffering large population declines in this century, western pond turtles in the Central Valley still persist at a number of sites and these populations appear to have sufficient recruitment to maintain numbers.

**Key words:** Western pond turtle, *Clemmys marmorata*, California, Central Valley, survey

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The western pond turtle (*Clemmys marmorata*) occurs along the Pacific coast of North America from Washington State into Baja California in Mexico (Figure 1). The species inhabits a variety of aquatic systems, mainly west of the Cascade-Sierra Nevada-Peninsula Mountains. Like other species throughout the world, the pond turtle has experienced population declines as human numbers have increased (Jennings and Hayes 1994), and the U.S. Fish and Wildlife Service was petitioned to list the species under the Endangered Species Act in 1992 (U. S. Fish and Wildlife 1992). The Central Valley of California (consisting of the Sacramento Valley north of the Sacramento Delta and the San Joaquin Valley south of the delta) once may have been the area of greatest abundance of the western pond turtle (Holland and Bury, in press), but extensive conversion of native wetlands for urban and agricultural uses has eliminated most habitat of the species (Williams et al. 1998). Extirpation of western pond turtle populations may be most extensive in southern California and the San Joaquin Valley (U. S. Fish and Wildlife 1992). Additionally, in much of the San Joaquin Valley, no recruitment appears to be taking place in the few remaining populations (Jennings and Hayes 1994). However, there has been a lack of extensive fieldwork in this area and the status of the turtle is poorly known throughout the Central Valley.

In part, lack of recruitment throughout the range, but especially in the San Joaquin Valley, has been deduced from age/size structures biased towards adults (U. S. Fish

and Wildlife Service 1992, Jennings and Hayes 1994). Two issues need to be considered when evaluating population status of the few remaining populations. First, much of the initial work on the species in the valley was done in the mid-to-late 1980s (Holland, unpublished report) when conditions were extremely dry in California (Jennings and Hayes 1994). This may have decreased recruitment of young into populations by increased mortality in nests or lower productivity of remaining aquatic habitats (e.g., shallows were lost). However, because turtles are long-lived, populations may survive periods of low recruitment by greater juvenile survivorship during favorable environmental conditions. Second, growth rates of individual turtles are affected by the habitat in which they occur (Germano and Bury, unpublished data). Thus, a relatively large turtle could be misidentified as an adult or subadult. When conducting visual surveys, rapid growth by juveniles could lead to concluding that a population contains only adults and that little or no recruitment has occurred.

As part of a larger study of growth and population structure of western pond turtles in California and Oregon (Bury and Germano, unpublished data), we gathered data on populations of turtles in the Central Valley. A general survey of the Central Valley has not been done in at least a decade (and no results were published), and trapping has not been used to verify visual survey data. Because of the high levels of impacts and the apparent lack of recruitment, we limited our work to the valley floor

and did not attempt to evaluate any populations in streams or ponds in the foothills and mountains surrounding the valley floor, where numerous populations still exist (map in Jennings and Hayes 1994). We used visual surveys to assess initially populations at a number of sites in the valley and also to compare turtle observations with trap results. Although there are problems associated with visual surveys of turtles, they have been used with some success in Oregon to census populations of western pond turtles (Bury, personal observation). At a selected number of sites, we returned and trapped for one or more days in July, August, and September 1999. Here we report on the results of visual surveys and trapping conducted in the Central Valley and assess the reproductive capability of turtle populations in the San Joaquin Valley.

## METHODS

### Visual Surveys

We surveyed 55 sites in the Central Valley (Figure 2) during May-July 1999. The majority of locations that we visited were from a list of known sites in Holland (unpublished report), and we supplemented these sites with locations showing water on maps. Many existing wetlands

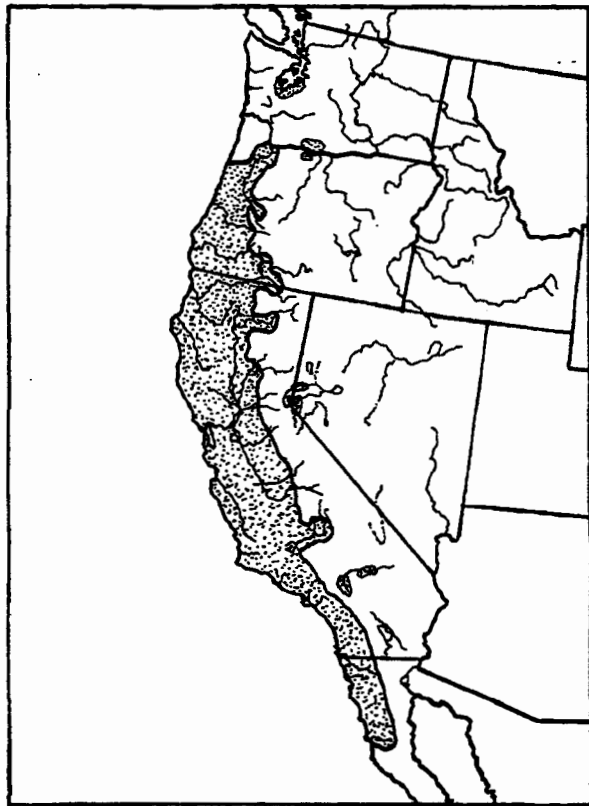


Figure 1. Distribution of the western pond turtle (*Clemmys marmorata*) in western North America. Populations in Nevada may have been introduced. Modified from Bury (1970) and Holland (1994).

on the valley floor are man-made (e.g., settling ponds at sewage treatment plants) or highly modified.

Visual surveys were made by driving to known and suspected sites for western pond turtles and scanning habitat using 10 X 50 binoculars. Each site was characterized for important vegetation attributes, size and quality of the water, and the presence and nature of basking sites. Any turtles seen basking were classified to size category (large, medium, or small). Size category also was estimated for turtle heads observed at the surface of water.

### Trapping Surveys

We trapped for turtles at 17 sites (Figure 2). We used both homemade wire mesh traps and commercially made 0.95 m-(3 foot)-diameter hoop traps with nylon mesh. In most instances, we set 8 traps 1 day, and checked and pulled traps the next day. In some cases we set fewer traps but left them for 2 or 3 days, or set more traps and left them for 1-3 days. All traps were baited with cans of sardines (in soybean oil), and were rebaited each day if left for more than 1 day. Trapping occurred in July, August, and September 1999.

We took several whole body measurements with tree calipers, weighed the animal, and determined its sex if it was  $\geq 120$  mm carapace length (CL). Age was determined by counting growth rings on the carapace and plastron (Bury and Germano 1998) for any turtles young enough to be laying down epidermal layers (Germano and Bury 1998).

## RESULTS

Turtles were found at 6 of 13 sites we classified as ponds or lakes (including man-made bodies); at 1 of 9 sites classified as canals, sloughs, or streams; at 1 of 3 river sites; and at 2 of 3 marsh sites in the San Joaquin Valley (Figure 2). In total, we found turtles at 10 of 28 (35.7%) sites in the San Joaquin Valley. At 5 sites listed by Holland (unpublished report), we did not find habitat that could support turtles (Appendix). In the Sacramento Valley, we found turtles at 4 of 14 pond/lake sites, at 1 of 5 canal/slough/stream sites, and none at the 1 marsh habitat site we surveyed. We did not attempt any surveys of river habitat in the Sacramento Valley. Total occurrence of turtles in the Sacramento Valley was 5 of 20 sites (25%). Overall, we found turtles at 37.0 % of pond and lake sites, 14.3 % of the canal/slough/stream habitats, 33.3 % of the river sites, and 50.0 % of the marsh habitats in the Central Valley. Many of the other sites visited likely contain turtles, but short-duration surveys did not detect individuals. No surveys were attempted in most of the Sacramento Delta because of the extensive area of large water and high human use combined with our limited time to survey.

### Trapping Surveys

Turtles were captured at 11 of the 17 sites that were trapped or hand collected (Table 1). At the 6 sites where no turtles were captured in traps, no turtles were sighted during earlier visual surveys (Appendix). One or more turtles were seen during earlier surveys at most of the sites where we captured turtles. Many turtles were captured at the Fresno Wastewater Treatment Plant, Dry Creek, and Five-Mile Slough in Fresno County, and in moderate numbers at Goose Lake and the Hanford Wastewater Treatment Plant (Table 1).

### Population Structure

Based on measurements and age estimates, turtles grew at fast rates at all pond and slough sites throughout the valley and only moderately at the 1 creek where turtles were caught in abundance. We captured turtles at 3 of the 6 southern San Joaquin Valley locations (Table 1). The 1 western pond turtle caught at the Coles Levee Ecosystem Preserve was a moderate-sized male (155 mm CL), and based on scute annuli was only 4 years old. We also caught one red-eared slider (*Trachemys scripta elegans*), an exotic species, which we retained. A half a dozen or

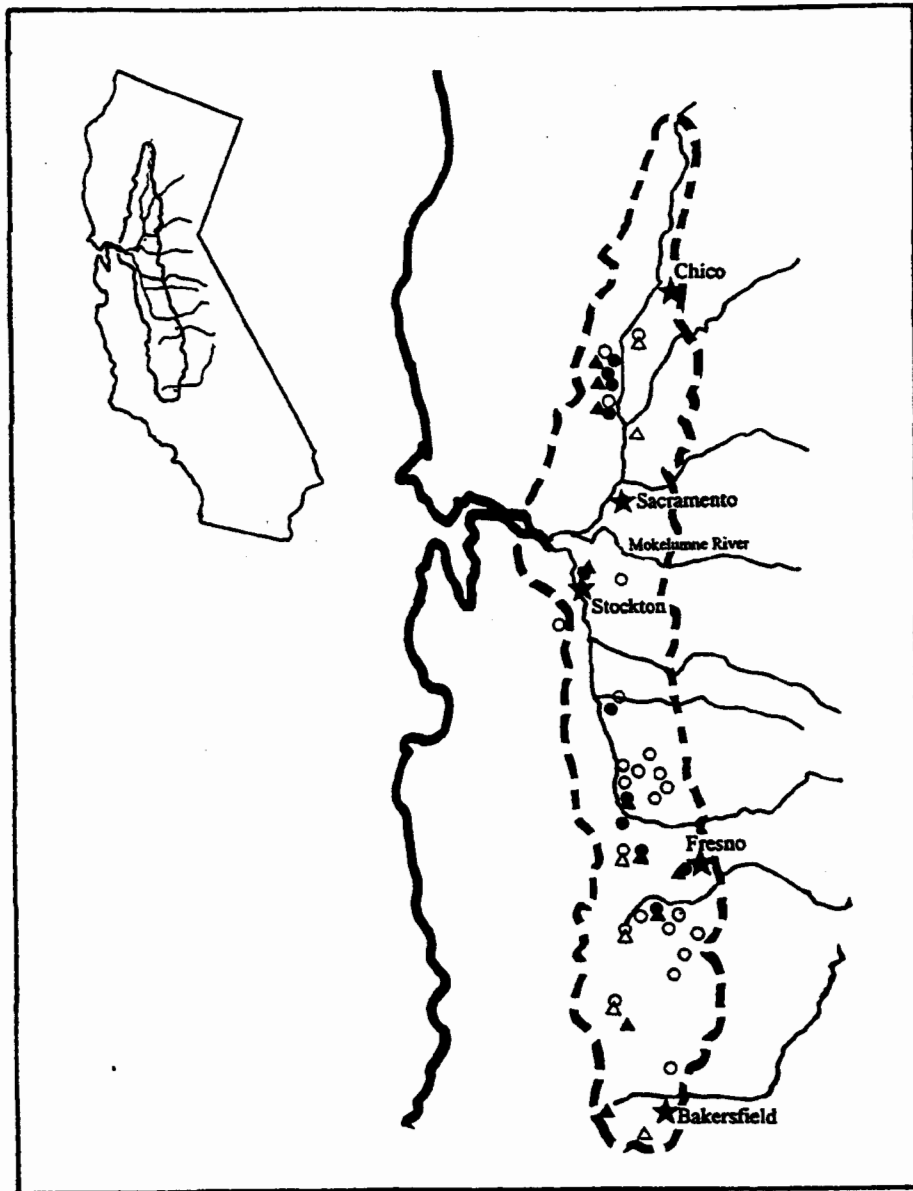


Figure 2. Locations at which visual surveys (circles) and trappings (triangles) were done for western pond turtles in the Central Valley of California in 1999. Closed symbols are where turtles were found. The dotted line represents the general outline of the floor of the Central Valley.

Table 1. Results of trapping for western pond turtles (*Clemmys marmorata*) in the Central Valley during July, August, and September 1999. Areas are listed from south to north.

Location	Date	Number of		
		Trap Days	Turtles Captured M : F : Juv.	Turtles / Trap Day
<b>Southern San Joaquin Valley</b>				
<b>Kern Co.</b>				
1. Former Nature Conservancy Preserve (near Mettler)	29-31 Aug.	18	0:0:0	0
2. Coles Levee Ecosystem Preserve Pond	7-9 July	15	1:0:0	0.07
3. Goose Lake	8-9 July	18	0:2:7	0.50
4. Main Drain, W. side near Hwy. 46 & I-5	18 Aug.	7	0:0:0	0
<b>Kings Co.</b>				
5. Kings River, at Hwy. 41 & N. 2 mi.	18 Aug.	7	0:0:0	0
6. Hanford Wastewater Treatment Plant	19 Aug.	8	3:5:0	1.00
<b>Northern San Joaquin Valley</b>				
<b>Fresno Co.</b>				
7. Fresno Wastewater Treatment Plant	19 Aug.	8	16:14:1	3.88
	9 Sept.	30	18:29:3	1.70
8. Dry Creek	9 Sept.	1.5 hours (hand capture)	7:12:21	26.7 (per hour)
9. Mendota Wildlife Management Area (Fresno Slough)	20 Aug.	8	0:0:0	0
10. Five-Mile Slough	20 Aug.	8	14:9:13	4.50
	10 Sept.	20	31:24:32	4.35
<b>Madera Co.</b>				
11. Firebaugh Marsh/Grassland	21 Aug.	8	0:2:0	0.25
<b>Stanislaus Co.</b>				
12. White Slough Wildlife Area	11 Sept.	12	1:0:0	0.08
<b>Sacramento Valley</b>				
<b>Sutter Co.</b>				
13. Sutter National Wildlife Refuge	16 Aug.	8	0:0:0	0
<b>Colusa Co.</b>				
14. Colusa National Wildlife Refuge	15-17 Aug.	59	1:9:1	0.19
15. Delevan National Wildlife Refuge	15-16 Aug.	32	2:2:2	0.19
<b>Glenn Co.</b>				
16. Sacramento River Nat. Wildl. Refuge	17-18 Aug.	32	2:2:0	0.13
<b>Butte Co.</b>				
17. Llano Seco Unit, Sacramento NWR	18 Aug.	8	0:0:0	0

more turtles have been seen basking at this site, including a few very small turtles (Wes Rhodehamel, personal communication). Seven of the turtles caught at Goose lake were < 120 mm carapace length, and 6 of these turtles were only 2 years old. At the Hanford Wastewater Treatment Plant, all 8 turtles captured were large-sized; however, 1 was only 3 years old and 2 were 4 years old. Plant personnel said that they often see many turtles basking along the sides of the ponds (9 ponds of various sizes), including many small turtles.

We captured turtles at 5 of 6 northern San Joaquin Valley sites (Table 1). Of 77 turtles we captured at the Fresno Wastewater Treatment Plant, only 3 were small and most were quite large (Figure 3). Yet, 47 turtles (61%) were young enough to estimate age using scute rings

and ranged from 1-11 years old. Running through the treatment plant is Dry Creek, which essentially functions as an artificial canal in this area. In August 1999, we set 3 traps in Dry Creek and caught 4 turtles in traps and 1 more on a road next to the creek. Based on visual surveys, we suspected that more turtles were present and attempted capture by hand when snorkeling and muddling (feeling along edge habitat and capturing by hand). In only about 1.5 hours (3 person hours), we had captured 40 turtles, many of which were small sized (Figure 3). Turtles also were abundant at Five-Mile Slough. In contrast to the Fresno and Hanford sites, many of the turtles were 1-3 years old (Figure 4). We also saw dozens of small turtles basking on logs and on the muddy banks of the slough during trapping efforts.

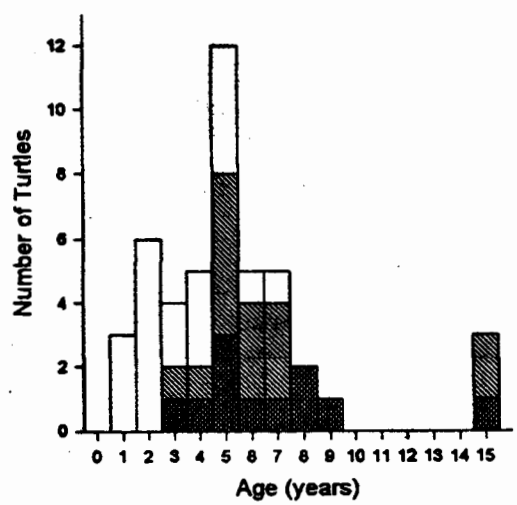
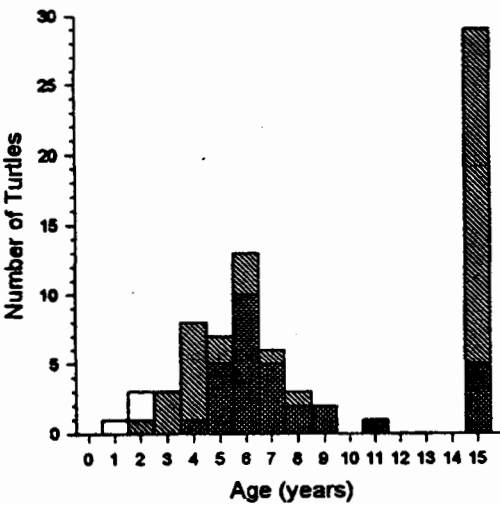
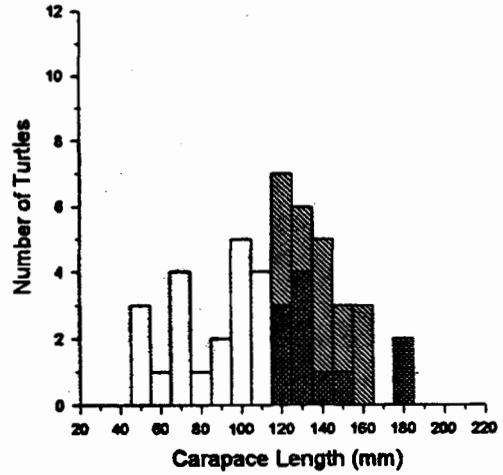
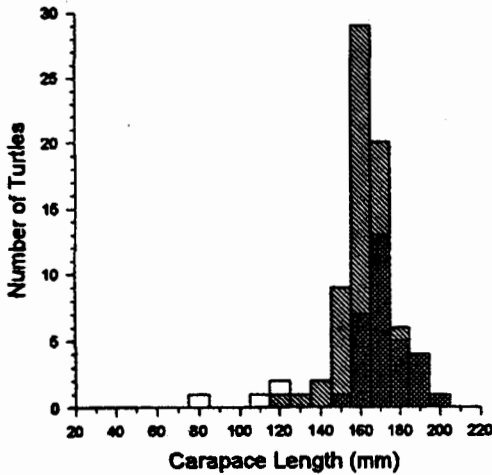


Figure 3. Carapace lengths and ages of western pond turtles caught in August and September 1999 at the Fresno Wastewater Treatment Plant (left) and at Dry Creek, Fresno Co., California. Males crosshatched, females slanted lines, juveniles clear bars. Turtles listed as age 15 are turtles considered >15 yr but for which an exact age is undetermined.

Although both the Firebaugh grassland/marsh area and the White Slough Wildlife Area appeared to be favorable habitat, and a number of turtles were seen during visual surveys (Appendix), we captured few turtles (Table 1). We only captured 2 adult females at the Firebaugh site. One female was > 15 years old and the other 7 years old. At White Slough, we caught only 1 adult male, which was 7 years old.

At 3 refuges in the Sacramento Valley, 21 turtles were caught during an extensive trapping effort (Table 1). Much of the marshy ground at the refuges was drained by the time we trapped and turtles may have moved to

the large creeks and canals on the refuges. Collectively, turtles from the refuges were generally large (only 1 turtle < 100 mm CL), but 10 of the 21 were 10 years old or younger, and 5 turtles were ≤ 5 years old (Figure 4).

*Visual Censuses and Trapping Correlation*

The number of turtles seen during visual surveys was significantly correlated with the number of turtles captured in traps (Pearson's Correlation,  $r = 0.689$ ,  $P = 0.0045$ ), but the relationship was not particularly strong (Figure 5). No turtles were captured at the 4 sites that lacked turtles sightings. Conversely, we did not see any turtles

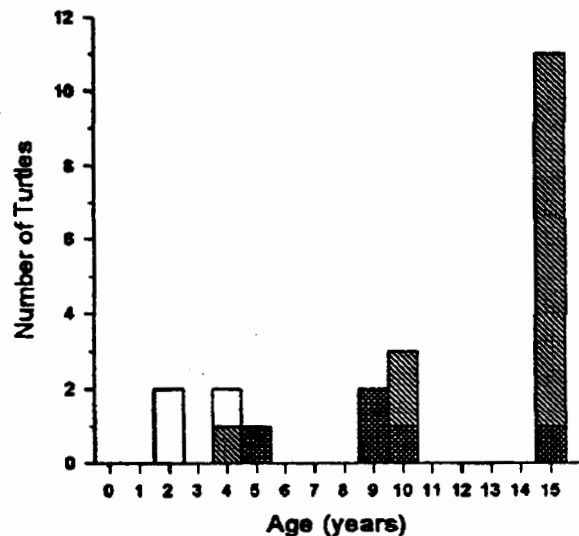
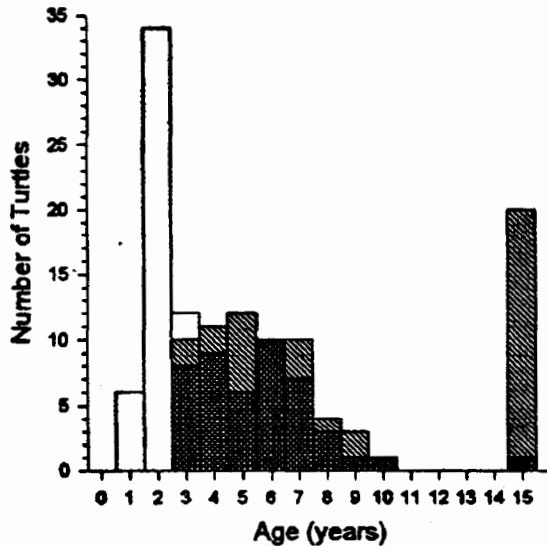
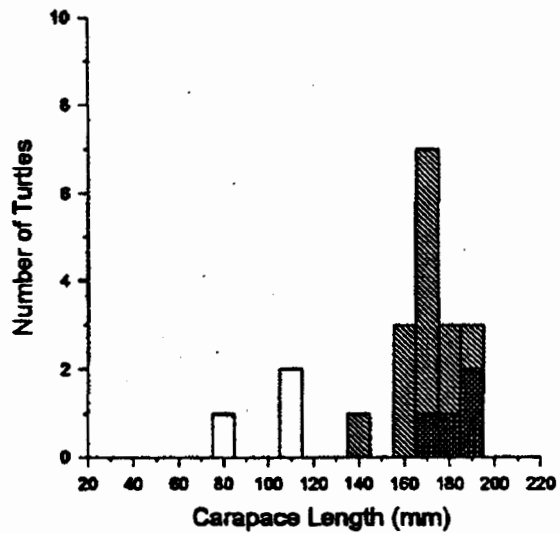
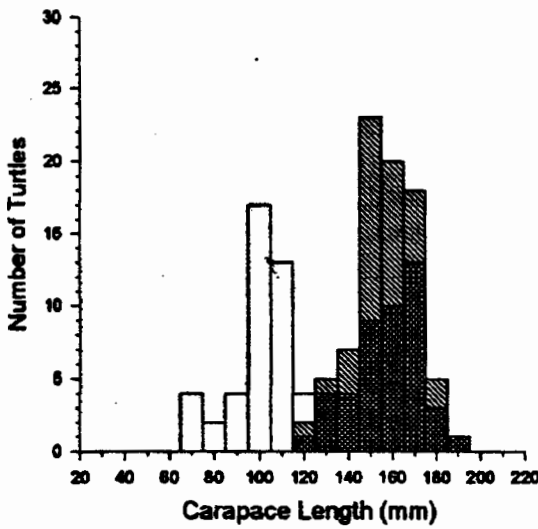


Figure 4. Carapace lengths and ages of western pond turtles caught in August and September 1999 at Five-Mile Slough, Fresno Co. (left) and in the Sacramento Valley in July 1999 at Colusa and Delevan National Wildlife Refuges, Colusa Co., and Sacramento River NWR, Glenn Co. (right), California. Symbols are the same as for Figure 3.

at the Coles Levee Ecosystem Preserve site or at 1 of the ponds at the Colusa National Wildlife Refuge, but we caught 2 and 10 turtles, respectively. Six turtles were seen at the Firebaugh grassland/marshland site and 10 turtles were seen at White Slough State Wildlife Area, yet only 2 and 1 turtles, respectively, were trapped. Also affecting the correlation was the low number of turtles trapped (6) at Dry Creek compared to the relatively high numbers (17) seen during surveying. Forty turtles were hand captured at this site later in the summer.

## DISCUSSION

Western pond turtles still occur throughout the Central Valley of California, and are abundant at a few sites (Table 2). The abundance of turtles in the Central Valley, especially in the San Joaquin Valley subunit, is believed to be a small fraction of historical levels (Jennings and Hayes 1994). Based on the extensive loss of wetland habitat due to heavy agricultural use of the Central Valley, this conclusion seems reasonable. However, our data do not support that populations are adult-biased and that recruitment is not occurring (Jennings and Hayes, 1994; Holland and Bury, in press). Although many of the remaining wetlands are highly altered or human-created, turtle populations at several sites are abundant and composed of many young, albeit large-sized, turtles. Because we estimated ages of turtles, we found that the age structure of populations invariably showed a much higher number of young turtles than would be expected by sizes

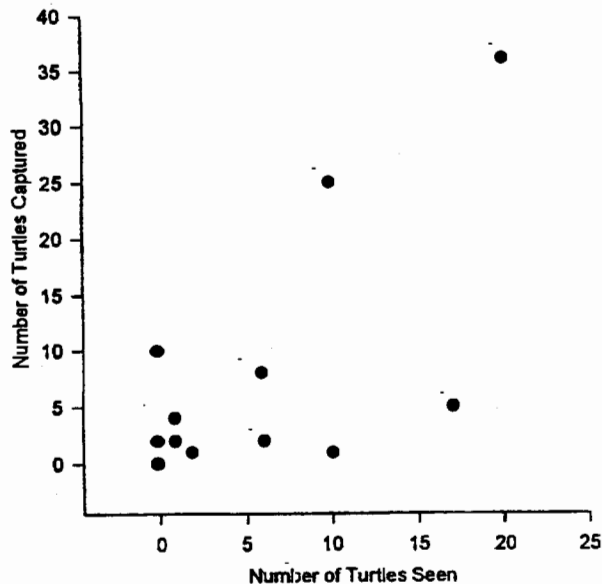


Figure 5. Correlation between the number of western pond turtles seen during a 30-60 minute survey and the number of turtles caught in traps at sites in the Central Valley of California in 1999.

alone. Western pond turtles in the Central Valley are not thriving and loss of more habitat would only worsen the problem. If key remaining populations can be protected, though, western pond turtles may not face imminent demise. Turtles can still be found in large-water habitats, such as rivers and shallow lakes, in man-made structures such as canals and sewage ponds, and in marsh habitats (Table 2).

Several sites in the San Joaquin Valley clearly have large populations of western pond turtles. Although we only caught 8 turtles at the Hanford Wastewater Treatment Plant, based on the number of other turtles we saw while at the plant and interviews with plant personnel, we suspect that several hundred turtles probably occur there. The Fresno Wastewater Treatment Plant may have an extremely large population of western pond turtles. There are 100 2-3 ha ponds at this site (Silvester Perez, personal communication), and each pond could support 25-50 turtles. Also, Dry Creek runs through the treatment plant and we suspect only limited exchange of turtles between treatment ponds and the creek. We base this on the very different rates of growth decipherable on the shells of turtles from these two habitats. Hundreds of turtles likely occur in the creek. Between the ponds and the creek, several thousand turtles may exist at this site.

Another site with an abundance of turtles is Five-Mile Slough, about 50 km west of Fresno. This is not a man-made site, although the slough is only about 500 m long and roughly 20 m wide and is surrounded by irrigated agriculture. The water in the slough is from agricultural runoff. Despite the unappealing look of the site and the scarcity of emergent vegetation, the site supports a thriving turtle population.

Special mention should be made of the Goose Lake site, where one of us (DJG) has been studying western pond turtles since 1995. Long-term trapping at Goose Lake has yielded > 550 turtles to date and clearly western pond turtles are abundant at this site (Germano, unpublished data), including many young that survive to remain in the population. Goose Lake seems to be a favorable site for western pond turtles despite being part of an active agricultural irrigation operation. The habitat used by turtles is fairly natural but only contains water during the winter into early summer. When this habitat dries, turtles apparently are able to enter adjacent canals, which contain water all year.

Although we did not see or catch any turtles at Mendota Wildlife Management Area or the grassland/marsh site 16 km SE of Los Banos (site #22 in Appendix), we suspect turtles are present in similar abundance to Goose Lake. Both sites have a habitat structure similar to that of Goose Lake, where marsh habitat occurs in the spring, but dries up in the summer. Turtles may go to deep water (creeks, sloughs, and canals) when the marshes

Table 2. Estimated and actual occurrence of western pond turtles (*Clemmys marmorata*) in the Central Valley of California. Occurrence based on recent surveys, trapping, recent sightings from biologists in the area, and assessment of habitat. Other small habitats in this area could support turtles.

Location	Confirmed Presence	Suspected Presence	Habitat Quality	Estimated Population Size
<b>San Joaquin Valley</b>				
<b>Kern County</b>				
- Goose Lake	X <sup>1</sup>		Good	Large
- Kern River (base of canyon west to Manor Drive)	X <sup>2</sup>		Moderate	Medium
- Main Drain (vicinity of I-5)		X	Moderate	Small-Medium
- Coles Levee Ecosystem Preserve Pond	X <sup>3</sup>		Good	Small
- California Aqueduct	X <sup>4</sup>		Poor	Large?
- Tule Elk Preserve	X <sup>5</sup>		Moderate	Small
<b>Kings County</b>				
- Kings River	X <sup>6</sup>		Good	Medium-Large
- Hanford Wastewater Treatment Plant	X <sup>3</sup>		Moderate	Large
<b>Tulare County</b>				
- Tule River		X	Moderate	Medium
- Kaweah River		X	Moderate	Medium
- Camp Vandalla - Porterville		X	Good	Small
<b>Fresno County</b>				
- Fresno Wastewater Treatment Plant	X <sup>3</sup>		Moderate	Very Large
- Dry Creek	X <sup>3</sup>		Moderate	Large
- Five Mile Slough	X <sup>3</sup>		Poor	Large
- Fresno Slough - Mendota SWA		X	Good	Large?
- San Joaquin River	X <sup>3</sup>		Moderate	Medium?
<b>Madera County</b>				
- Grassland/Marshland N of Firebaugh	X <sup>3</sup>		Good	Medium-Large
- Cottonwood Creek		X	Moderate	Small
- Berenda Slough/Reservoir		X	Moderate	Small-Medium
<b>Merced County</b>				
- Marsh/Grassland/Canals near Agatha	X <sup>7</sup>		Good	Medium
- Complex of State and Federal Wildlife Areas N of Los Banos	X <sup>7</sup>		Good	Very Large?
- Merced River		X	Moderate	Medium

Table 2. cont.

Location	Confirmed Presence	Suspected Presence	Habitat Quality	Estimated Population Size
<b>Stanislaus County</b>				
- Wastewater Treatment Plant SW of Modesto	X <sup>3</sup>		Moderate	Large?
- Toulumne River	X <sup>8</sup>		Good	Large?
- Stanislaus River	X <sup>9</sup>		Moderate	Medium?
<b>San Joaquin County</b>				
- White Slough Wildlife Area	X <sup>3</sup>		Good	Medium-Large
- Mokelumne River		X	Moderate	Medium?
<b>Sacramento County</b>				
- Cosumnes River		X	Moderate	Medium?
<b>Sacramento Delta</b>				
- Complex of Rivers, Sloughs and Marshes	X <sup>10</sup>		Good	Very Large
<b>Sacramento Valley</b>				
<b>Sutter County</b>				
- Sutter NWR		X	Moderate	Medium?
<b>Colusa County</b>				
- Colusa NWR	X <sup>3</sup>		Good	Large?
- Delevan NWR	X <sup>3</sup>		Good	Large?
<b>Butte County</b>				
- Gray Lodge Waterfowl Management Area		X	Moderate	Medium?
- Angel Slough	X <sup>11</sup>		Moderate	Small?
<b>Glenn County</b>				
- Sacramento River NWR	X <sup>3</sup>		Good	Medium-Large
<b>Sacramento River</b>				
- Entire Length of Sacramento Valley		X	Moderate	Large?

<sup>1</sup> Germano, unpublished data<sup>2</sup> Germano, personal observation, 2000<sup>3</sup> This Study<sup>4</sup> Wes Rhodehamel, personal communication, 1999<sup>5</sup> Germano, unpublished observation, 1991<sup>6</sup> Theo Glenn, personal communication, 1999; Patrick Kelly, personal communication, 2000<sup>7</sup> Melanie Paquin, personal communication, 1999<sup>8</sup> Farmer, personal communication, 1999<sup>9</sup> Laurissa Hamilton, personal communication, 1999<sup>10</sup> Stephen Tabor, personal communication, 1998; Germano, personal observation, 1997<sup>11</sup> Mary Ann Griggs, personal communication, 2000

dry. When we returned to trap in mid-July at the Mendota Wildlife Management Area, the marshy habitat that we saw in early June was essentially dry. We had to set traps in the Kings (Fresno) Slough, which is about 80-100 m wide and had much recreational and boat activity (e.g., 1 trap was stolen there). We did not catch any turtles. The drying of marshes and possible movement of turtles to deeper, permanent water is similar to changes we suspect occur at Goose Lake in the summer.

Given the large number of trap days we expended at the wildlife refuges in the Sacramento Valley, few turtles were caught. We believe that this also is a function of the time of year when we trapped and not a true reflection of turtle abundance. Most of the aquatic habitats in July 1999 at the refuges were creeks and large canals, although several large shallow ponds did persist. Marsh habitat was drained, or was being drained. Turtles likely had either moved to permanent creeks and rivers or may have found terrestrial sites in which to aestivate until water returned to the seasonal marshes.

We saw a relatively large number of turtles at both the White Slough Wildlife Area and the privately owned grassland/marsh habitat east of Firebaugh, but we caught only 1 and 2 turtles, respectively. Both seem to have suitable habitat for turtles. We suspect that both sites could support several hundred turtles.

Several areas in the Central Valley that we did not attempt to survey also may have turtles. We did not survey most rivers, which now comprise a major portion of remaining aquatic habitat in the valley. Turtles are known to occur in rivers and backwaters throughout their range (Holland 1994, Reese and Welch 1998, Bury and Germano personal observation), and records occur for several rivers in the valley (e.g., Kern, San Joaquin, Merced, Tuolumne; Jennings and Hayes 1994, Holland unpublished report). We have also been told of recent sight records for other rivers, such as the Stanislaus River (L. Hamilton, personal communication) and the Kings River (T. Glenn, P. Kelly, personal communication). The rivers in the valley that have permanent water flow also likely contain populations of western pond turtles. Ephemeral rivers, like the western part of the lower Kern River, no longer support turtles on a regular basis. We do not know how many turtles may be supported by river habitat.

We also did not attempt to survey the myriad aquatic habitats of the Sacramento Delta. We know that turtles occur in this large area of sloughs and rivers (S. Tabor personal communication, Germano personal observation), but the size of the population there is unknown. Similarly, we did not attempt to survey the considerable amount of marsh and pond habitat contained in the Los Banos State Wildlife Area, San Luis National Wildlife Refuge, Kesterson National Wildlife Refuge, and Volta

State Wildlife Area. This area is known to have turtles (M. Paquin personal communication) and may contain thousands of turtles, based on habitat features. These large waters merit surveys, which might be better searched from a small boat or canoe by drifting along with the current in rivers. However, we have shown only a weak relationship between the number of turtles observed and the number actually trapped in valley habitats, so only visually surveying rivers probably will underestimate turtle populations. We recommend comparing visual searches of rivers to trapping (e.g., set traps with floats along a set route and recheck from a boat).

In the southern San Joaquin Valley, the only large population of western pond turtles may be at Goose Lake. We surveyed for turtles at a number of other sites at which we saw or caught few or no turtles. Populations at these sites are probably quite small, or may not exist. More extensive trapping or hand capturing turtles will be necessary to determine conclusively if small populations occur at most of these sites. This may be the case with the west-side drain near Goose Lake and at the lower end of the Kings River. Both appear to provide suitable habitat, but we did not see or catch any turtles during our limited surveying. Similarly, only 1 turtle was caught at the small pond of the Coles Levee Ecosystem Preserve, although several individuals have been seen basking in the past. Interestingly, turtles have been seen in the California Aqueduct near here, which could be an important route of dispersal for western pond turtles in the southern San Joaquin Valley. No turtles were caught at the former Nature Conservancy preserve near Mettler in the very southern end of the San Joaquin Valley. The pond is small but is isolated from human activity because of the dense plant growth surrounding the pond. The habitat seems to be suitable for *Clemmys*, and turtles have been found here in the past (Holland unpublished data), but we could not catch any in traps. It is possible that turtles were eliminated from this isolated site during the late 1980s and early 1990s when a severe drought occurred in California. If this pond totally dried for over a year, turtles may not have been able to survive.

#### *Problems in Assessing Status*

There are a number of problems associated with attempting to survey western pond turtles over a large area, such as the Central Valley. We, and the previous effort in the 1980s, only devoted a limited amount of time to any one site (with the exception of Goose Lake). Only very abundant populations of turtles in limited habitat are likely to be detected in short periods of surveying. Also, it may require returning to a site at more favorable times to find turtles active, even if turtles are active at other sites.

We also found that visual searches were not a good predictor of turtle presence or population size in Central

Valley habitats. As an example, few turtles are observed at Goose Lake and those that are visible when basking are invariably large turtles. At most, we have observed only up to 20 turtles basking at one time at Goose Lake. The inability of visual searches to detect many turtles basking, even at areas where we trapped numerous turtles, may be explained by the time of year when searches were conducted (summer). It is likely that western pond turtles bask less when water temperatures increase. In the Central Valley, the combination of hot air temperatures in the summer and shallow water habitats means that water temperatures are elevated. Turtles may be able to reach suitable body temperatures by floating in the upper water column or sitting in algal mats, being only partially exposed from above. We saw this at Dry Creek in September when we captured many turtles in algal mats on the banks of the creek where the water temperature was quite high (about 35° C). Visual searches in the valley would probably be better done in the spring when air and water temperatures are much lower, forcing turtles to aerially bask to increase body temperature.

However, the timing of visual searches will not alleviate the inability of surveyors to distinguish young, large-sized turtles from adult turtles. This emphasizes the inadequacies of basing population status only on visual surveys because it is impossible to account for differential growth rates of turtles among sites. Some of the large turtles seen basking may only be 4 or 5 years old. Even some 3-year-old turtles in the San Joaquin Valley are "adult" size because turtles grow fast at most valley sites, especially sites that are eutrophic wetlands. These shortcomings render questionable population status assessments based solely on visual surveys.

Capturing turtles and determining their rate of growth is essential to assessing the status of most populations of western pond turtles. Trapping seems to be an effective way to determine the status of most populations in the Central Valley. Although aquatic habitats of fast moving water or with small, deep pools may be searched effectively by hand-capturing turtles, many of the aquatic habitats on the valley are open bodies of water or marshes not conducive to hand-capture. In large bodies of water, trapping has the added advantage of capturing many small turtles, which can be missed when hand-capturing (Galen Rathbun, personal communication). This is essential to determining accurately the population structure of western pond turtles.

## CONCLUSIONS

From our surveys and work done previously, it is apparent that populations of western pond turtles are much reduced from historic levels in the Central Valley of California. However, we have found a number of populations

that appear to be doing well. Additional work will be necessary to understand the long-term dynamics of these populations and to assess adequately other areas that may support turtles. This study was limited in scope because of the short duration of the study (one season). However, much more is known about turtles in the valley that now can be used to begin to understand how populations survive in this highly altered landscape, and how we might better manage for the species.

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Appendix. Results of visual surveys for western pond turtles (*Clemmys marmorata*) in the Central Valley of California during May, June, and July 1999. Locations taken from Holland (unpublished report), except those marked with an asterisk, and locations were limited to those from the valley floor. Turtles judged to be > 130 mm carapace length (CL) were classified as large, turtles judged to be 80 - 130 mm were classified as medium, and turtles < 80 mm were classified as small.

Location	Date	Habitat Type	Number of Turtles Seen
<b>Kern County</b>			
1. Main Drain on west side near Hwy. 46 and I-5	28 May	Large, shallow earthen canal	0
2. Poso Creek, east of Granite Road	1 June	Shallow ephemeral creek	0
<b>Kings County</b>			
3. Kings River - at Hwy. 41 crossing, north 2 miles	28 May	Slow moving river	0
4. Java Road	28 May	Shallow evaporation ponds	0
5. Avenue 10 and Kansas Ave.	28 May	No habitat at this location	—
6. Sewage treatment plant - Hanford	28 May	Series of large settling ponds	5 large (heads), 1 small
<b>Tulare County</b>			
7. Visalia	28 May	No specific location, no habitat seen	—
8. Sewage treatment plant - Tulare*	28 May	4-5 settling ponds	0
9. Deer Creek at Hwy. 65	1 June	Very shallow, ephemeral creek	0
10. Camp Vandalla - Porterville*	1 June	ca. 5 acre pond, surrounded by cattails	0
11. Yokohl Creek/Valley'	1 June	Shallow stream; valley into oak woodland	0
<b>Fresno County</b>			
12. Fresno Wastewater Treatment Plant*	1 June	Settling ponds	1 large (head)
13. Dry Creek just S of Fresno Wastewater Treatment Plant*	1 June	Fast-moving, narrow creek/canal	9 large, 5 medium, 3 small
14. Five-mile Slough, 4.7 miles E of Mendota S.W.A.	2 June	Large drainage ditch; farmland on both sides	20 large (heads)
15. Fresno Slough / Mendota State Wildlife Area	2 June	Long, wide slough marshy/pond areas; cattails	0
16. San Joaquin River, 1.5 miles N of Mendota	2 June	Large pond-like area of still water; cattails	1
<b>Madera County</b>			
17. Marshland/grassland, ca. 3 miles N of Firebaugh*	2 June	Marshes, small ponds	6 large
18. Madera Wastewater Treatment Plant*	2 June	2 small settling ponds	0
19. Cottonwood Creek at Ave. 14, ca. 7 mi. E of Madera*	2 June	Narrow creek; rushes and riparian growth	0
20. Berenda Reservoir/ Berenda Slough*	2 June	ca. 20 acre reservoir; no aquatic vegetation	0
<b>Merced County</b>			
21. Marsh area along 25th St., SW of El Nido	2 June	No habitat found at this location	—
22. Near Agatha, ca. 10 miles SE of Los Banos!	2 June	Marshes (dry), multiple canals	0
23. First ditch crossing N of Los Banos Creek	2 June	Couldn't find area listed (site may be gone)	—

Appendix cont.

Location	Date	Habitat Type	Number of Turtles Seen
<b>Merced County continued</b>			
24. Mud Slough, N of Kesterson National Wildlife Refuge	2 June	Large slough	0
25. Sandy Mush Road, 4.5 mi. W of Highway 99	2 June	Several small farm ponds; no aquatic vegetation	0
<b>Stanislaus County</b>			
26. Sewage treatment plant ca. 10 mi SW Modesto*	3 June	6 large settling ponds, 3 huge reservoirs	1 large (head)
27. Tolumne River, SW of Modesto2	3 June	Large river	0
<b>San Joaquin County</b>			
28. Coldani Marsh3	3 June	Couldn't find area listed (no habitat apparent)	
29. White Slough Wildlife Area (Coldani Marsh)	3 June	ca. 30 ha marsh with open water; slough	10 large
30. Liberty Road, 6.3 mi. E jct. with Kennefick Road	3 June	Small (10x10 m) cattle pond	0
31. Del Puerte Canyon, 11 mi. W of I-5	3 June	Narrow, shallow creek with plunge pools	0
<b>Colusa County</b>			
<b>Delevan National Wildlife Refuge</b>			
32. Pond S end, just N of Maxwell Road	14 July	ca. 5 ha pond with cattails	0
33. Pond/Marsh T26, just E Four Mile Road	14 July	ca. 2 ha pond/cattail marsh	0
34. Canal N edge of refuge	15 July	Narrow canal, cattails	0
35. Pond S end, just N of Maxwell Road	15 July	ca. 5 ha pond with cattails	1 large
36. Canal/Pond NW edge of refuge	15 July	Enlarged canal/pond; much algae	0
37. Pond, just N of Maxwell Road, S end of refuge	15 July	ca. 5 ha pond	0
38. Pond, just N of Maxwell Road, S end of refuge	15 July	ca. 5 ha pond/ cattails	0
<b>Colusa National Wildlife Refuge</b>			
39. Irrigation canal, just N of Abel Road	15 July	Large, earthen canal; reeds on banks	0
40. Pond T14	15 July	ca. 10 ha pond with reeds/cattails	0
41. Pond 10A.2	15 July	ca. 2 ha pond; shallow	2 large
42. Pond N end of refuge	15 July	ca. 1 ha pond; long/narrow; reeds/cattails	0
43. Pond T14	16 July	ca. 10 ha pond with reeds/cattails	0
<b>Glenn County</b>			
<b>Sacramento River National Wildlife Refuge</b>			
44. Pond/Marsh T14.3 (from E end)	16 July	ca. 6 ha shallow pond with cattails, pond lilies	0
45. Pond P2 (from W end)	16 July	ca. 20 ha pond; much open water; cattails	0
46. Logan Creek	16 July	Muddy creek; ca. 8 m wide; cattails on edges	0

## Appendix cont.

Location	Date	Habitat Type	Number of Turtles Seen
<b>Glenn County continued</b>			
47. Pond/Marsh T14.3 (from W end)	16 July	ca. 6 ha shallow pond cattails, pond lilies	0
48. Pond P2 (from E end)	16 July	ca. 20 ha pond; much open water; cattails	0
49. Logan Creek	16 July	Muddy creek; ca. 8 m wide; cattails on edges	1 small (head)
50. Logan Creek	17 July	Muddy creek; ca. 8 m wide; cattails on edges	0
<b>Butte County</b>			
<b>Sacramento NWR, Llano Seco Unit</b>			
51. Two ephemeral ponds	17 July	Shallow, small ponds with arrowweed and algae	0

<sup>1</sup> includes 3 locations in Holland, unpublished report

<sup>2</sup> includes 2 locations in Holland, *ibid*

<sup>3</sup> includes 4 locations on/near Thornton Road listed in Holland, *ibid*.

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